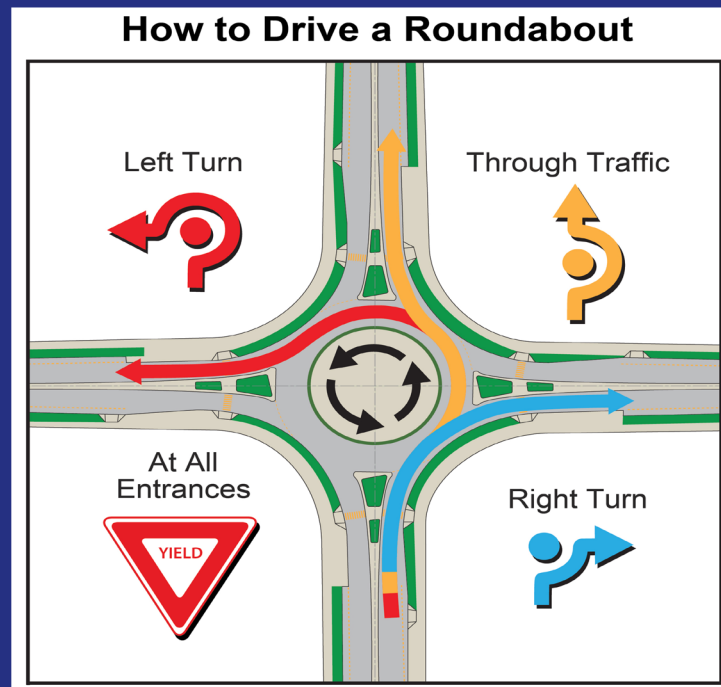


# JOINT TRANSPORTATION RESEARCH PROGRAM

INDIANA DEPARTMENT OF TRANSPORTATION  
AND PURDUE UNIVERSITY



## Public Acceptance of INDOT's Traffic Engineering Treatments and Services



**Sarah E. Adsit, Theodora Konstantinou,  
Konstantina Gkritza, Jon D. Fricker**

## RECOMMENDED CITATION

Adsit, S. E., Konstantinou, T., Gkritza, K., & Fricker, J. D. (2021). *Public acceptance of INDOT's traffic engineering treatments and services* (Joint Transportation Research Program Publication No. FHWA/IN/JTRP-2021/01). West Lafayette, IN: Purdue University. <https://doi.org/10.5703/1288284317280>

## AUTHORS

### **Sarah E. Adsit**

Graduate Research Assistant  
Lyles School of Civil Engineering  
(814) 350-9263  
[sadsit@alumni.purdue.edu](mailto:sadsit@alumni.purdue.edu)  
*Corresponding Author*

### **Theodora Konstantinou**

Graduate Research Assistant  
Lyles School of Civil Engineering  
Purdue University

### **Konstantina Gkritza, PhD**

Professor of Civil Engineering  
Lyles School of Civil Engineering  
Department of Agricultural & Biological Engineering  
Purdue University  
*Principle Investigator*

### **Jon D. Fricker, PhD**

Professor of Civil Engineering  
Lyles School of Civil Engineering  
Purdue University  
*Principle Investigator*

## JOINT TRANSPORTATION RESEARCH PROGRAM

The Joint Transportation Research Program serves as a vehicle for INDOT collaboration with higher education institutions and industry in Indiana to facilitate innovation that results in continuous improvement in the planning, design, construction, operation, management and economic efficiency of the Indiana transportation infrastructure. [https://engineering.purdue.edu/JTRP/index\\_html](https://engineering.purdue.edu/JTRP/index_html)

Published reports of the Joint Transportation Research Program are available at <http://docs.lib.purdue.edu/jtrp/>.

## NOTICE

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views and policies of the Indiana Department of Transportation or the Federal Highway Administration. The report does not constitute a standard, specification or regulation.

## COVER IMAGE

INDOT. (n.d.). *Roundabout features* [Illustration]. Indiana Department of Transportation. <https://www.in.gov/indot/3249.htm>

# TECHNICAL REPORT DOCUMENTATION PAGE

<b>1. Report No.</b> FHWA/IN/JTRP-2021/01		<b>2. Government Accession No.</b>		<b>3. Recipient's Catalog No.</b>	
<b>4. Title and Subtitle</b> Public Acceptance of INDOT's Traffic Engineering Treatments and Services				<b>5. Report Date</b> December 2020	
				<b>6. Performing Organization Code</b>	
<b>7. Author(s)</b> Sarah E. Adsit, Theodora Konstantinou, Konstantina Gkritza, and Jon D. Fricker				<b>8. Performing Organization Report No.</b> FHWA/IN/JTRP-2020/01	
<b>9. Performing Organization Name and Address</b> Joint Transportation Research Program Hall for Discovery and Learning Research (DLR), Suite 204 207 S. Martin Jischke Drive West Lafayette, IN 47907				<b>10. Work Unit No.</b>	
				<b>11. Contract or Grant No.</b> SPR-4441	
<b>12. Sponsoring Agency Name and Address</b> Indiana Department of Transportation (SPR) State Office Building 100 North Senate Avenue Indianapolis, IN 46204				<b>13. Type of Report and Period Covered</b> Final Report	
				<b>14. Sponsoring Agency Code</b>	
<b>15. Supplementary Notes</b> Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.					
<b>16. Abstract</b> <p>As a public agency, interacting with and understanding the public's perspective regarding agency activities is an important endeavor for the Indiana Department of Transportation (INDOT). Although INDOT conducts a biennial customer satisfaction survey, it is occasionally necessary to capture public perception regarding more specific aspects of INDOT's activities. In particular, INDOT needs an effective way to measure and track public opinions and awareness or understanding of a select set of its traffic engineering practices. To evaluate public acceptance of specific INDOT traffic engineering activities, a survey consisting of 1,000 adults residing within the State of Indiana was conducted. The survey population was representative in terms of age and gender of the state as of the 2010 U.S. Census. The survey was administered during the months of July and August 2020. Public awareness regarding emerging treatments not currently implemented in Indiana is low and opposition to the same new technologies is prominent. Older or female drivers are less likely to be aware of emerging treatments, and older drivers are more likely to oppose potential implementation of these treatments. Although roundabouts are commonplace in Indiana, multi-lane roundabouts remain controversial among the public. Regarding maintenance and protection of traffic during work zones and considering full or partial roadway closure, public preference is for partial closure; this preference is stronger in rural areas. The public equally agrees and disagrees that INDOT minimizes construction related traffic delays. Approximately 76% of Indiana drivers believe themselves to be above average drivers, while an additional 23% believe themselves to be average. Driver perceptions of average highway speeds are not aligned with posted speed limit as the perceived average speed on Indiana's urban freeways and rural and urban state highways is considerably higher than the actual speed limit.</p>					
<b>17. Key Words</b> public opinion, traffic engineering, interchange designs, acceptance, survey			<b>18. Distribution Statement</b> No restrictions. This document is available through the National Technical Information Service, Springfield, VA 22161.		
<b>19. Security Classif. (of this report)</b> Unclassified		<b>20. Security Classif. (of this page)</b> Unclassified		<b>21. No. of Pages</b> 57 including appendices	<b>22. Price</b>

## EXECUTIVE SUMMARY

### Introduction

As a public agency, interacting with and understanding the public's perspective regarding agency activities is an important endeavor for the Indiana Department of Transportation (INDOT). Although INDOT conducts a biennial customer satisfaction survey, it is occasionally necessary to capture public perception regarding more specific aspects of INDOT's activities. In particular, INDOT needs an effective way to measure and track public opinions and awareness or understanding of a select set of its traffic engineering practices. A statewide public opinion survey focusing specifically on traffic engineering activities was undertaken in order to better understand public perception.

This research project and survey instrument focused on public perception of the following emerging traffic engineering infrastructure treatments and current traffic engineering practices.

- Ramp Metering
- Alternative Intersection/Interchange Designs
  - Roundabout
  - Restricted Crossing U-Turn (RCUT)
  - Displaced Left Turn (DLT)
  - Diverging Diamond Interchange (DDI)
- INDOT Communications
- Work Zone and Construction Traffic Management Operations
- Roadway Lighting and Visibility
- Driver Speed Behavior

### Methodology

To evaluate public acceptance of specific INDOT traffic engineering activities, a survey was conducted of 1,000 adult residents within the state of Indiana. The survey population was representative in terms of age and gender of the state as of the 2010 U.S. Census. The survey was administered during the months of July and August 2020.

### Findings

Public awareness regarding emerging treatments not currently implemented in Indiana is low and opposition to these new technologies is prominent. Older or female drivers are less likely to be aware of emerging treatments, and older drivers are more likely to oppose potential implementation of these treatments. Although roundabouts are commonplace in Indiana, multi-lane roundabouts remain controversial among the public.

Regarding maintenance and protection of traffic during work zones and full or partial roadway closure, public preference is for partial closure; this preference is stronger in rural areas. The public equally agrees and disagrees that INDOT minimizes construction-related traffic delays.

Approximately 76% of Indiana drivers believe themselves to be above average drivers, while an additional 23% believe themselves to be average. Driver perceptions of average highway speeds are not aligned with posted speed limit, since the perceived average speed on Indiana's urban freeways and rural and urban state highways were considerably higher than the actual speed limit.



## CONTENTS

1. INTRODUCTION . . . . .	1
1.1 Overview . . . . .	1
1.2 Study Objectives. . . . .	1
1.3 Organization of the Report . . . . .	3
2. DESIGN OF SURVEY INSTRUMENT . . . . .	3
2.1 Literature Review. . . . .	3
2.2 Description of Survey . . . . .	3
2.3 Visual Media . . . . .	4
2.4 IRB Approval . . . . .	5
3. DATA COLLECTION . . . . .	6
3.1 Survey Administration . . . . .	6
3.2 Sample Description. . . . .	6
4. DATA ANALYSIS. . . . .	10
4.1 Data Cleaning Procedures. . . . .	10
4.2 Descriptive Statistics. . . . .	10
5. CONCLUSIONS . . . . .	18
5.1 Summary of Key Findings . . . . .	18
5.2 Recommendations . . . . .	19
5.3 Limitations and Future Work . . . . .	20
REFERENCES . . . . .	20
APPENDICES	
Appendix A. Survey Instrument . . . . .	22
Appendix B. Media Used in the Survey. . . . .	22

## LIST OF TABLES

Table	Page
<b>Table 3.1</b> Age and Gender Composition of Survey Sample	7
<b>Table 3.2</b> Income Distribution of Survey Sample	7
<b>Table 3.3</b> Educational Attainment of Survey Sample	8
<b>Table 3.4</b> Vehicle Ownership Characteristics of Survey Sample	8
<b>Table 3.5</b> Annual Vehicle Mileage of Survey Sample	8
<b>Table 3.6</b> Driver History Length of Participants	9
<b>Table 4.1</b> Participants' Cross-Treatment Understanding	12
<b>Table 4.2</b> Participants' Understanding Statement Results for Roundabouts and RCUTs	13
<b>Table 4.3</b> Participants' DDI Understanding Statement Results	13
<b>Table 4.4</b> Full and Partial Closure Scenario Results	15
<b>Table 4.5</b> Traffic Control Device Visibility	16
<b>Table 4.6</b> Participants' Curve Warning Sign Responses	18
<b>Table 4.7</b> Participants' Work Zone Speed Scenario Results	18

## LIST OF FIGURES

Figure	Page
<b>Figure 2.1</b> RCUT arrow diagram	5
<b>Figure 2.2</b> RCUT flyer	5
<b>Figure 2.3</b> RCUT video screen capture	6
<b>Figure 2.4</b> RCUT simulation screen capture	6
<b>Figure 3.1</b> Survey sample distribution by county of residence	7
<b>Figure 3.2</b> Trip length frequency distribution	9
<b>Figure 3.3</b> Roadway type frequency distribution	9
<b>Figure 3.4</b> Self-perceived driving ability of participants	10
<b>Figure 4.1</b> Awareness of emerging technology	11
<b>Figure 4.2</b> Acceptance of emerging technology	11
<b>Figure 4.3</b> Driver confidence in emerging technology	12
<b>Figure 4.4</b> Desired sources of information for INDOT projects and activities	13
<b>Figure 4.5</b> Current sources for real-time information	14
<b>Figure 4.6</b> Respondent agreement of work zone statements	15
<b>Figure 4.7</b> Respondents' agreement of lighting statements	15
<b>Figure 4.8</b> Results of accessibility choice scenario	16
<b>Figure 4.9</b> Commuter frustration over constant vs. varied commutes	17
<b>Figure 4.10</b> Perceived average of Indiana highway speeds	17

## 1. INTRODUCTION

### 1.1 Overview

The Indiana Department of Transportation (INDOT) is a public state-level agency responsible for transportation across the state. As a public agency, interacting with and understanding the public's perspective regarding agency activities is an important endeavor. To that end, INDOT conducts a biennial customer satisfaction survey to better understand public opinions and priorities regarding INDOT and its activities. The biennial survey focuses primarily on the fundamental elements of INDOT's activities, including bridge maintenance, snow and ice removal, and general construction-related experience. While this information is valuable, it is not able to capture public perception regarding more specific aspects of INDOT's activities.

In particular, INDOT needs an effective way to measure and track public opinions and awareness or understanding of a select set of its traffic engineering infrastructure treatments, use of common traffic control devices, and practices in traffic operations and transportation system management. A statewide public opinion survey focusing specifically on traffic engineering activities of interest provides a way to measure current public perceptions.

The rest of this report is devoted to description and analysis of this survey instrument.

### 1.2 Study Objectives

The present study is intended to capture the public's awareness, understanding, and acceptance of several emerging traffic engineering infrastructure treatments and to capture public perception of several specific current INDOT traffic engineering practices. Thus, a public opinion survey was designed and conducted to complement INDOT's customer satisfaction survey. The current and emerging treatments and practices considered are described in more detail below.

#### *1.2.1 Emerging Traffic Engineering Infrastructure Treatments*

In recent years, several non-traditional traffic engineering infrastructure treatments have emerged into practice. INDOT has implemented or is considering implementing a variety of these treatments in situations that warrant them. However, according to a recent report from the National Cooperative Highway Research Program (NCHRP, 2020) that surveyed every state department of transportation (DOT) in the United States (U.S.), 86% of DOTs (including INDOT) somewhat or strongly agreed that public opposition has hindered agency efforts to implement alternative intersection designs. This public opposition has not to date been quantified in Indiana, but rather perceived as prevalent through public outreach efforts for alternative intersection projects.

Improved understanding and quantification of public perceptions regarding emerging treatments will guide the public outreach process during their implementation across the state. The emerging treatments of particular interest for this project are freeway ramp meters and a collection of alternative options to traditional four-way stop and signalized intersections. These are described in more detail below.

**1.2.1.1 Ramp Meter.** Freeway ramp meters are typically used on ramps leading to high-volume freeways in order to control traffic entering the freeway. They are intended to prevent large volumes of entering traffic from causing congestion on the freeway's mainline. They consist of a two-lens signal unit that allow one or two vehicles through to the mainline per green. Ramp meters are typically only operational during peak periods for the roadway. They are being considered for implementation by INDOT and are currently in use in Illinois and Ohio, as well as in several other states.

**1.2.1.2 Roundabout.** The roundabout is a circular intersection in which traffic circulates about a center island in a counterclockwise direction. Traffic enters the intersection after yielding to vehicles already in the circular roadway before proceeding to the desired leg and exiting. They can be used to replace both four-way stop-controlled intersections and signalized intersections and typically provide operational and safety improvements due to the reduced speeds, geometry, and yield control; benefits which have been confirmed through studies in Indiana (Day et al., 2013; Tarko et al., 2008; Tarko et al., 2015) and other states (Gbologah et al., 2019). Although roundabouts are now relatively commonplace around Indiana, public opposition to their implementation remains an issue and misconceptions regarding operations and the ability of large vehicles to use them persist among the public regarding both single-lane and multi-lane roundabouts. Retting et al. (2007) and Savolainen et al. (2012) both found that for single-lane roundabouts, driver experience with the intersection was the single most important factor in increasing public acceptance of the roundabout. Hu et al. (2014) found that for a double-lane roundabout, some confusion regarding the intersection persisted a year after construction and that some older drivers were actively avoiding the intersection.

**1.2.1.3 Restricted Crossing U-Turn.** The restricted crossing U-turn (RCUT), also referred to as a reduced conflict intersection, is an intersection design that redirects all minor-street movements and major-street left turns into a U-turn downstream of the main intersection. They are more commonly seen at locations where the major street volume is significantly higher than the minor street, frequently at rural intersections along highways. RCUTs use traffic signals to control movements at minor streets, but a common variant

known as the J-turn utilizes stop signs instead. Studies have confirmed their safety and operational benefits in Indiana (Tarko et al., 2008) and other states (Edara et al., 2015; Inman & Haas, 2012). INDOT has begun implementing intersections of this form around Indiana, primarily at sites with safety problems along four-lane high-speed rural highways. Public opposition to this treatment remains an obstacle despite proven success and misconceptions related to the ability of larger vehicles to utilize them persist among the public. Few studies have evaluated public acceptance of RCUTs, but a North Carolina based-project (Ott et al., 2015) evaluated public acceptance separately for residents, commuters, and businesses that utilized the intersection. All three groups recognized the safety and operational benefit the RCUT provided, but residents perceived an increase in travel time, commuters felt the intersection was more difficult to navigate, and businesses felt the intersection had negatively impacted their business due to access and confusion issues attached to the RCUT design. Schneider et al. (2019) studied the economic effect of RCUTs in Louisiana and found no evidence of a decline in sales for businesses located near the intersections.

**1.2.1.4 Displaced Left Turn.** The displaced left turn (DLT), also known as a continuous flow intersection (CFI), is an intersection design that crosses left turning traffic over oncoming traffic at a small signal upstream of the main intersection. As a result, all three movements (right turns, through movements, and left turns) can proceed at the same time for both directions since left turns have already crossed over. They are utilized at large signalized intersections on major arterials and can provide operational and safety benefits when a large volume of left-turning vehicles is present (Qi et al., 2018; Tarko et al., 2008). They are not currently utilized in Indiana and are rare around the U.S. The closest one is located just south of Dayton, Ohio.

**1.2.1.5 Diverging Diamond Interchange.** The diverging diamond interchange (DDI) (also referred to as a double crossover diamond, DCD) eliminates the need for separate left-turn lanes and phases at a traditional diamond interchange by transferring all traffic to the left-hand side of the roadway for the over/underpass portion of the interchange. This transfer allows for a free-flow entry to all ramps, compared to a free-flow right turn and a cross-traffic (often signalized) left turn at a traditional diamond ramp terminal. Several studies have confirmed safety and operational improvements in Indiana (Day et al., 2015; Tarko et al., 2017a, 2017b) and other states (Hummer et al., 2016). A small number of DDI's have been constructed in Indiana, but public opposition to them remains high despite their proven effectiveness; several misconceptions regarding their safety and the ability of pedestrians and cyclists to use them remain prominent. Few formal studies have evaluated public acceptance of DDI. Jackson et al.

(2014) evaluated acceptance at five DDIs using focus groups and surveys after construction and found that participants had a positive opinion on operations, safety, and driver understanding although some driver confusion had been observed. The Missouri Department of Transportation's evaluation of the first DDI in the U.S. included a public acceptance survey component that found a majority felt the traffic flow had improved, safety had improved, and that driver understanding at the site was good (Chilukuri et al., 2011).

### *1.2.2 Current Traffic Engineering Practices of Interest*

The present study investigated public perception of INDOT practices in four general areas, listed and described in further detail below.

**1.2.2.1 Work Zone and Construction Traffic Operations.** Effective maintenance and protection of traffic during construction operations ensures motorist and worker safety and attempts to minimize delay caused by construction. Roadway maintenance and repairs are an ongoing and permanent part of INDOT's operations, so understanding public perception regarding these activities is vital. The specific topics of interest in this area include INDOT's communications regarding upcoming work, ease of following detours and understanding of signing at work zones.

Of additional interest is the public's perceptions regarding full and partial roadway closure for more serious repair and maintenance activities. A full closure renders a roadway completely impassable but allows for a shorter construction period, while a partial closure leaves the roadway open (often with delays) and results in a longer construction period. The public's preferences regarding these tradeoffs are currently unknown but would provide valuable insight for INDOT decision makers.

**1.2.2.2 Roadway Lighting and Traffic Control Device Visibility.** Of key importance to highway safety is the ability of drivers to clearly see the roadway environment, other vehicles, and traffic control devices. Visibility is primarily a concern at night and during inclement weather. Of interest are public perceptions regarding roadway lighting and drivers' ability to see traffic control devices (including pavement markings, signing, and temporary traffic control devices) in less optimal conditions.

**1.2.2.3 Accessibility and Mobility.** Accessibility and mobility are two related but distinct characteristics of an effective transportation system. One key area of interest is the public's understanding and preferences regarding the tradeoff between accessibility and mobility, because increased mobility typically results in loss of accessibility, and vice versa. Additionally, understanding public preferences regarding travel time reliability is another area of interest in the mobility sphere.

**1.2.2.4 Driver Speed Behavior.** Speeding remains a fundamental safety concern on highways across the United States, and Indiana is no different. Understanding the way Indiana drivers perceive speed-related traffic control devices and speed in general on Indiana's highways is a key step in attempting to educate drivers to alter their behavior and reduce speed related injuries and fatalities on Indiana's roads.

### 1.3 Organization of the Report

Following this introduction, the focus of the report will first turn to the design of the survey instrument (Chapter 2), the sampling and data collection processes (Chapter 3), survey data analysis (Chapter 4), and finally discussion and conclusion (Chapter 5).

## 2. DESIGN OF SURVEY INSTRUMENT

### 2.1 Literature Review

Several transportation agencies and their university partners have conducted public opinion surveys around a variety of transportation topics which are discussed below. These prior projects informed the research team during the design of the public opinion survey instrument.

#### 2.1.1 INDOT Biennial Survey

INDOT conducts a biennial survey customer satisfaction survey among Hoosier taxpayers in order to get a basic understanding of public perception regarding fundamental INDOT activities. This survey allows INDOT to track its performance over time, and has been conducted since 2011, most recently in 2019. The biennial survey includes topics such as public priorities and funding allocation, construction management, satisfaction with a variety of INDOT services, preferences regarding INDOT communication practices, and opinions regarding Indiana's transportation system performance. Several topics included on the biennial survey are explored in greater detail in the present project.

The 2019 biennial survey (Bawa, 2020) results indicate that overall satisfaction with INDOT and confidence in INDOT to continue to meet Indiana's transportation needs are high. In general, the public agrees with INDOT's funding priorities and are satisfied with performance on the most important activities. However, the public reports low satisfaction with construction management, including keeping projects on time and minimizing disruption to communities and drivers during projects.

#### 2.1.2 Other DOT Survey Projects

Several general customer satisfaction surveys were reviewed for guidance in developing the survey instrument. Many of these surveys were similar in content to INDOT's biennial customer satisfaction survey, with

a few notable differences. Wisconsin's 2012 statewide customer satisfaction survey (Tatham, 2013) included a question regarding visibility of pavement markings during daytime, nighttime, and inclement weather conditions that was expanded in this survey to assess visibility of traffic control devices. A project conducted by the University of Minnesota on behalf of MnDOT (Schneider et al., 2013) provided a list of additional topics related to travel time including satisfaction with commute travel time, which was included in this project.

Additionally, survey projects addressing more specific areas of transportation pertinent to this project were consulted. Veneziano et al. (2013) evaluated public response to a collection of proposed roundabout projects across the state of Montana and found several common concerns across the projects including driver confusion, large vehicle issues, and loss of safety or efficiency, all of which became questions posed during the present survey. Additionally, the project noted a common "exceptionalism" viewpoint in which respondents believed that while roundabouts might work in other communities, they would not be successful in Montana. A similar question was added to the present project. Savolainen et al. (2012) and Hu et al. (2014) conducted projects regarding public perception of single lane roundabouts in Michigan and double-lane roundabouts in Washington, respectively. Both projects included questions regarding motorist avoidance of roundabouts, which became a question on this survey. A 2018 study from the University of Minnesota (Douma & Alarcon, 2018) regarding public perceptions of speed and speed behaviors inspired the inclusion of speed and driver behavior questions on this survey, particularly perceived average speed and self-perceived driving skill.

### 2.2 Description of Survey

#### 2.2.1 Survey Sections

The survey instrument consisted of four sections, listed below and subsequently discussed in more detail.

1. Awareness of Current and Emerging INDOT Treatments and Strategies
2. Attitudes and Preferences Towards INDOT Services
3. Respondents' Travel Characteristics and Patterns
4. Socio-Demographic Questions

The entire survey instrument is appended to this report as Appendix A.

Questions were developed for the survey using several different guiding principles. Multiple choice and three or five-point Likert scales were commonly used because these question types are easier for respondents to answer and simpler to analyze. Questions were intended to be easy to understand, unambiguous in wording, and were written with the intention of addressing a specific concern. Travel behavior and socio-demographic questions were phrased in such a way as to

align with existing data sources, such as the National Household Travel Survey (NHTS) and the U.S. Census.

**2.2.1.1 Awareness of Current and Emerging INDOT Treatments and Strategies.** The primary focus of this section was to assess participant awareness and acceptance of emerging traffic-management treatment and strategies that INDOT has or is considering implementing. The treatments are listed below.

- Ramp Meter
- Roundabout
- Restricted Crossing U-Turn (RCUT)/J-Turns
- Displaced Left Turn (DLT)
- Diverging Diamond Interchange (DDI)

For each treatment, the participant was shown a visual representation of the treatment and asked a series of questions. These visual representations included an arrow diagram, a static PDF flyer, a brief informational video, and a short simulation. The questions evaluated the participant's awareness of the treatment on a three-point scale, and their understanding and opinions regarding the operations of the treatment and the operational and safety goals of implementation, their acceptance of the treatment in their community using a five-point Likert scale, and their confidence navigating the treatment as a driver on a scale of one to five.

In addition to these questions, a series of questions assessing the effectiveness of different visual representations was asked. Also included in this section were questions discussing the media preferences of participants. Specifically, participants were asked to list their current information sources for INDOT projects and activities, their desired information sources for INDOT projects and activities, and their current information sources for real-time (driver) information.

**2.2.1.2 Attitudes and Preferences Towards INDOT Services.** This section included questions regarding a variety of topics, discussed individually below.

*Work Zones and Construction.* Several different aspects of work zones were discussed. Participants were asked to provide agreement or disagreement on a five-point Likert scale as to statements from INDOT's communications regarding road work, minimization of traffic delay, and understanding of work zone and detour signing. Participants were asked to assess the visibility of work zone traffic control devices, equipment, and workers at night, in the rain, and in the snow on a three-point scale of "Generally Poor," "Generally Fair," and "Generally Good." Two questions asked for participants to choose between full and partial closure for construction, pertaining to a state highway bridge and major interchange rehabilitation project separately. Additionally, several questions required respondents to indicate driver behavior regarding speed in response to different combinations of worksite speed limit signing were included.

*Lighting and Visibility.* Participants were asked to provide their levels of agreement or disagreement on a five-point Likert scale with statements regarding lighting or interchanges and roadways in both urban and rural areas. Additionally, participants were asked to rate visibility of signs, raised pavement markers, and pavement markings at night, in the rain, and in the snow on a three-point scale of "Generally Poor," "Generally Fair," and "Generally Good."

*Mobility.* Two questions addressed mobility-related topics. Participants were asked to choose between two similar trips—a trip that was longer by distance taken on predominately freeways with smaller arterials required connect to the freeways, and a trip that was shorter by distance taken on predominately major highways with some traffic signals and slightly slower speeds than the freeways.

A different question required participants to first provide their typical (pre-COVID-19) commute time, and then asked how frustrated they were with two commute-related scenarios. The first scenario was a constant commute equivalent to their provided time, and the second scenario was a variable commute taking  $\pm 25\%$  of their provided time, with an even distribution (half the time longer, half the time shorter).

*Driver Behavior.* A group of questions discussed driver behaviors pertaining to speed. Participants were asked what they perceived to be the average speed to be on interstates, urban roads, and rural roads. They were also asked for opinions and actions regarding a standard speed limit sign, a variable speed limit sign, and a curve warning sign with speed advisory plaque.

**2.2.1.3 Respondents' Travel Characteristics and Patterns.** This short section consisted of four questions evaluating respondents' travel behaviors, including vehicle ownership and mileage, typical trip distances, and typical roadways used. Participants were asked to report behavior prior to any changes in travel behavior caused by the COVID-19 pandemic.

**2.2.1.4 Socio-Demographic Information.** This section asked for socio-demographic information, including participant age, gender, educational attainment, income, and employment status. Additionally, information on driver history and the length of Indiana residency was included. Participants were identified geographically by providing their home ZIP code.

## 2.3 Visual Media

The visual representations used in the first section of the survey (see Awareness of Current and Emerging INDOT Treatments and Strategies in section 1 of Appendix A) were included to improve participant understanding of the different and potentially new treatments included in that section. With the exception of the ramp meter, each treatment was presented through one of four representations: a diagram with arrows



showing traffic movements (Figure 2.1), a two-page flyer including a diagram and information regarding the treatment (Figure 2.2), an informational video

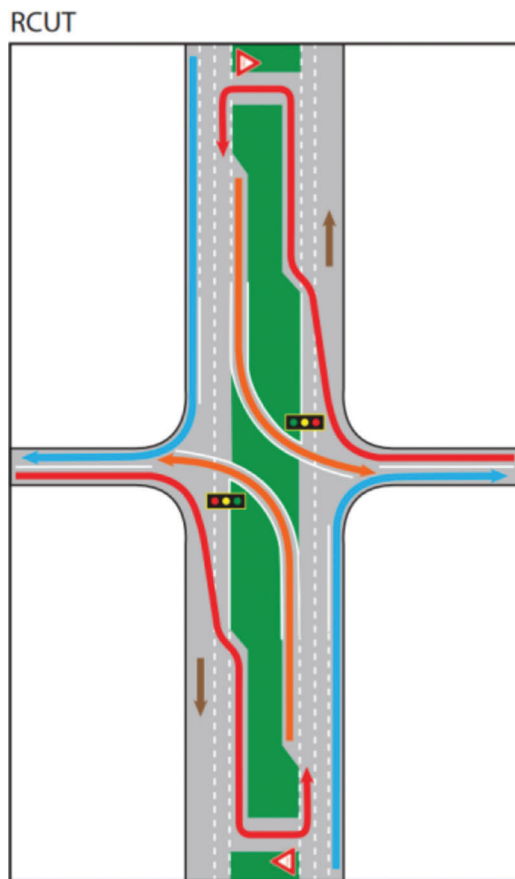


Figure 2.1 RCUT arrow diagram (INDOT, n.d.b).

lasting approximately 3 minutes showing operations and providing information regarding the treatment (Figure 2.3), and a short simulation showing operations of the treatment (Figure 2.4). All of the flyers and videos were provided by the Virginia Department of Transportation (VDOT) from their Innovative Intersections and Interchanges series (VDOT, 2020). The diagrams and simulations were sourced from a variety of other public sources. The ramp meter was represented using a picture of a ramp meter in its environment. The sequence of these visual representations was varied in order to reduce bias in participant response. As an example, the media options for the RCUT are shown here. Media choices for all treatments are included in Appendix B and the video-based options are available on YouTube.

## 2.4 IRB Approval

Because this project involves human subject research, approval by the Purdue University Institutional Review Board was required. As a survey project being conducted on an adult population, this project was granted an exemption from an in-depth review and was approved to proceed on April 21, 2020. The IRB# is IRB-2020-337.

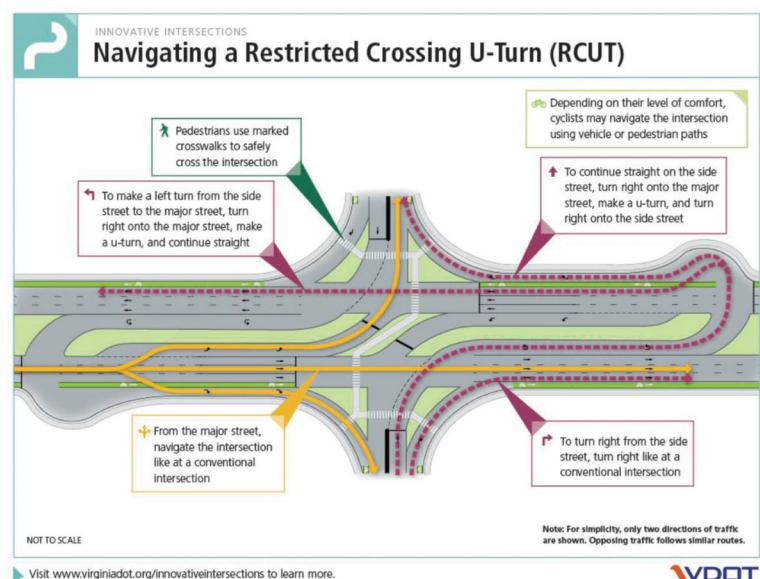
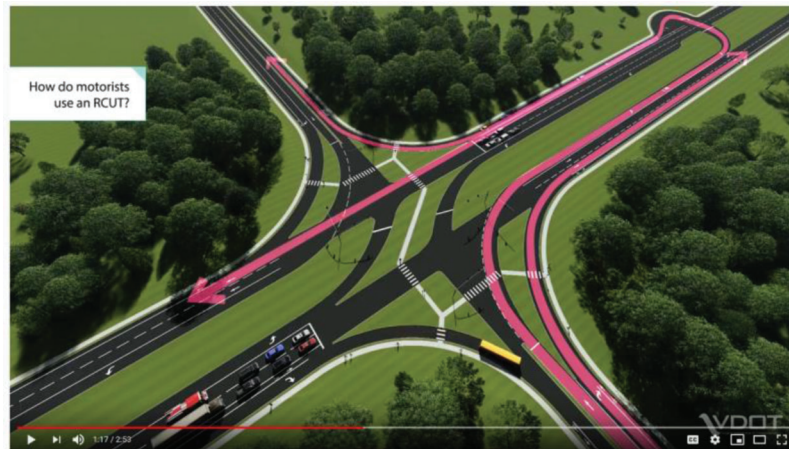
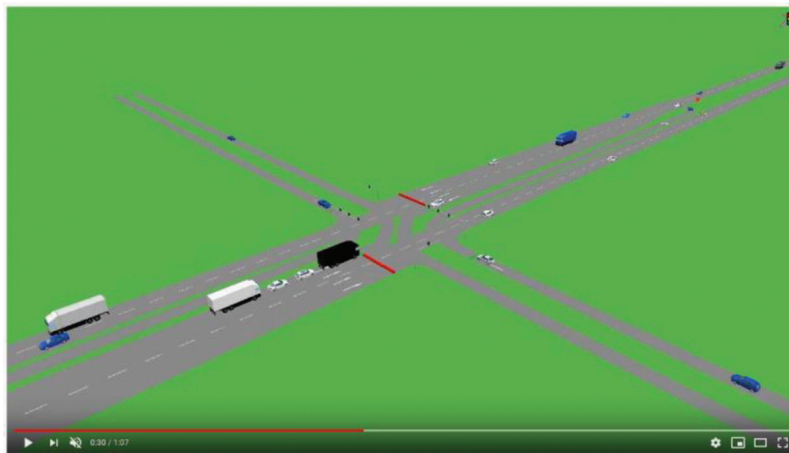


Figure 2.2 RCUT flyer (VDOT, 2020).





**Figure 2.3** RCUT video screen capture (VDOT, 2018).



**Figure 2.4** RCUT simulation screen capture (INDOT, n.d.a).

### 3. DATA COLLECTION

#### 3.1 Survey Administration

##### 3.1.1 Administration Company

The survey was administered through a contract with Kantar, a market research company. Participants were sourced from their pool of adult participants in Indiana and compensated by Kantar for their time. The survey was administered using Qualtrics.

##### 3.1.2 Pilot Testing

A pilot test consisting of 10% of the total sample (approximately 100 responses) was conducted during the week of July 12, 2020. Following pilot testing and data cleaning, a quality check was also implemented through the use of attention check questions. The quality check was located among the questions asking participants to assess visibility and required them to select a specific choice.

##### 3.1.3 Full Launch

Full data collection ran from July 20, 2020 through August 24, 2020.

#### 3.2 Sample Description

The sample consisted of 1,000 adults residing in the state of Indiana. This sample size is required to achieve a margin of error of 3% and a confidence level of 95%. Hard quotas concerning the gender and age of respondents were implemented as a remedy to selection bias (under-coverage), based on U.S. Census data for Indiana (as described in section 3.2.1).

##### 3.2.1 Socio-Demographic Information

The sample was representative of the state in terms of age and gender according to data collected in the 2010 decennial census. Exact composition by age and gender is shown in Table 3.1.

Additionally, current/former employees of INDOT, any other transportation governmental agency (local or federal), or any transportation consultant were screened out on the grounds that these individuals may introduce bias in the sample as they have a higher level of awareness of the current and emerging INDOT treatments and strategies compared to the average Hoosier.

For the purposes of geographic location, respondents provided their home ZIP code. Because no further

geographic locators were collected, respondents are considered to reside at the geographic centroid of their ZIP code area. The sample ended up being sufficiently geographically representative across Indiana, with responses coming from 83 of Indiana's 92 counties. The counties not included in the sample were Blackford, Daviess, Gibson, LaGrange, Martin, Newton, Rush, Pulaski, and Warren counties. Figure 3.1 shows the distribution of the survey sample across all Indiana Counties.

Additionally, respondents were classified utilizing the U.S. Census Bureau definitions into Urbanized Areas (population greater than 50,000), Urban Clusters (populations between 2,500 and 50,000), and Rural Areas (populations less than 2,500) (United States Census Bureau, 2020). 708 (70.8%) respondents reported residing in Urbanized Areas, 192 (19.2%) respondents reported residing in Urban Clusters, and 93 (9.3%) respondents reported residing in Rural Areas. Six respondents provided ZIP codes which could not be located.

The survey sample is reasonably representative of the state in terms of income, as shown in Table 3.2. Sample incomes were compared with the 5-year 2018 estimates from the American Community Survey (ACS). Incomes between \$50,000 and \$100,000 are slightly overrepresented, and incomes over \$100,000 are underrepresented, likely due to the fact that these individuals would be less motivated by financial incentive to be part of the survey pool. Additionally, 76 individuals opted not to disclose their incomes to the research team.

The survey sample is more educated on average than Indiana as a whole considering individuals aged 25 and older compared with the 5-year 2018 ACS as shown in Table 3.3. Those with higher educational attainment (some college (no degree), college degree, and graduate or professional degrees) are overrepresented, while those with lower educational attainment (high school graduates and lower) are underrepresented. Both associate's and bachelor's degrees are considered under "college graduate."

### 3.2.2 Travel Behavior and Driver History

As the survey was administered during the COVID-19 pandemic during the summer of 2020, participants were asked to consider their travel behavior prior to

TABLE 3.1  
Age and Gender Composition of Survey Sample

	Males	Females
18–24	86 (8.6%)	90 (9.0%)
25–34	81 (8.1%)	85 (8.5%)
35–44	81 (8.1%)	85 (8.5%)
45–54	89 (8.9%)	92 (9.2%)
55–64	73 (7.3%)	76 (7.6%)
65+	79 (7.9%)	83 (8.3%)
Total	489 (48.9%)	511 (51.1%)

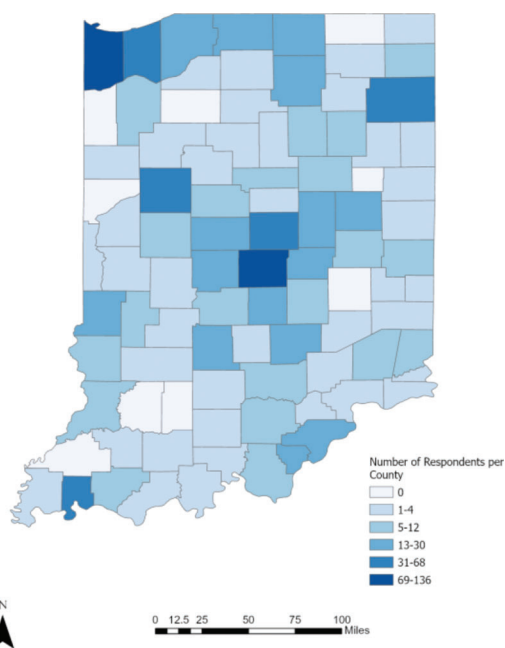


Figure 3.1 Survey sample distribution by county of residence.

TABLE 3.2  
Income Distribution of Survey Sample

Income	Sample Distribution (%)	2018 5-Year ACS Estimate (%)
Under \$25,000	21.2	21.2
\$25,000–\$49,999	24.9	24.8
\$50,000–\$74,999	20.6	19.3
\$75,000–\$99,999	16.7	13.1
\$100,000–\$149,999	11.7	13.3
\$150,000 or more	4.9	8.2

TABLE 3.3  
Educational Attainment of Survey Sample

Educational Attainment	Sample Distribution (%)	2018 5-Year ACS Estimate (%)
Less than 9th grade	0.6	3.7
Some high school	1.7	7.7
High school graduate and technical training beyond high school	24.9	33.5
Some college (no degree)	21.9	20.4
College graduate	34.1	25.2
Graduate or professional school	16.8	9.4

TABLE 3.4  
Vehicle Ownership Characteristics of Survey Sample

Number of Vehicles	Sample Distribution (%)	2018 5-Year ACS Estimate (%)
0	4.5	2.8
1	33.8	19.2
2	39.7	42.2
>3	22.0	35.9

TABLE 3.5  
Annual Vehicle Mileage of Survey Sample

Mileage	Sample Distribution (%)
I do not own a personal vehicle	5.2
<5,000 miles	20.3
5,000–9,999 miles	23.3
10,000–14,999 miles	23.4
15,000–19,999 miles	11.7
20,000–24,999 miles	5.0
>25,000 miles	5.5
I do not know	5.6

any restrictions or pattern changes caused by the pandemic. As expected, a large portion of the survey sample currently hold a valid Indiana driver's license (92%), while an additional 3% have previously held a license. Only 5% of the sample indicated they have never possessed a driver's license. Household vehicle ownership and annual mileage across the survey sample is shown in Tables 3.4 and 3.5. Figures 3.2 and 3.3 show the trip frequency of the survey sample based on trip length and roadway type utilized.

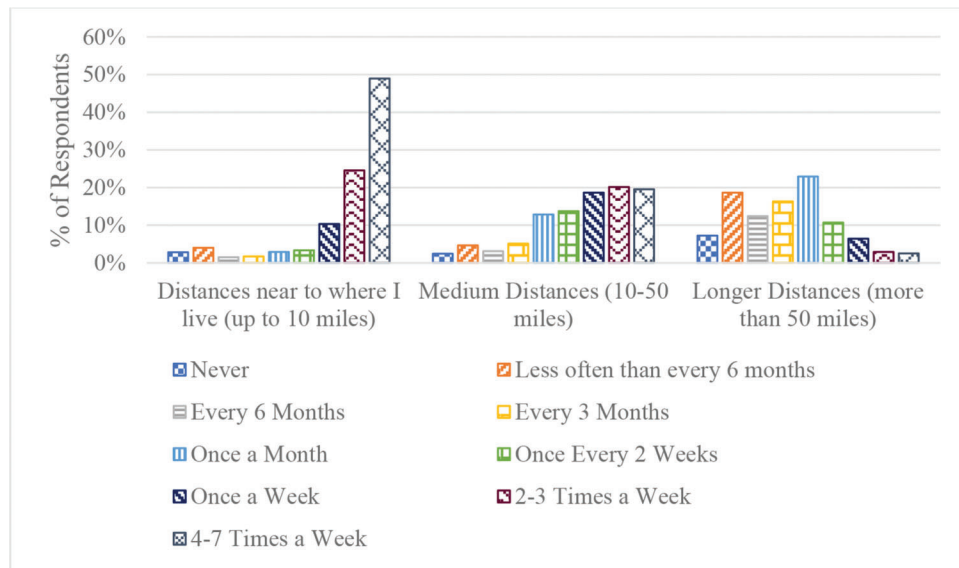
In addition to providing their travel behavior, participants were asked to provide information regarding their driver history, including how long they had been driving, crash history, and their perceived driving ability. The sample distribution of the length of time driving is shown in Table 3.6. The median length was 27

years. The majority of the sample stated a good recent crash history, with 83% having experienced no crashes in the last 3 years, 13% having experienced one crash, and the remaining 4% having experienced two or more crashes in that time.

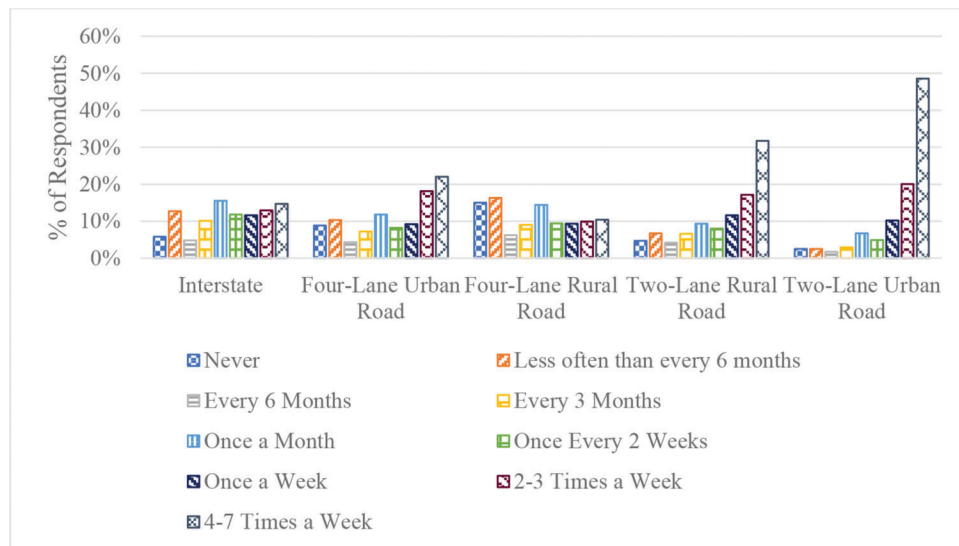
The sample has a high proportion of young drivers—of the 21.3% that have less than 10 years driving experience, 13.6% have less than 5 years of experience.

Lastly, participants were asked to rate their own driving ability on a five-point scale ranging from “Very Poor” to “Excellent.” This distribution is shown in Figure 3.4.

As shown in Figure 3.4, 76% survey respondents believe themselves to be at least above average drivers. This finding is consistent with other studies posing this question (Douma & Alarcon, 2018).



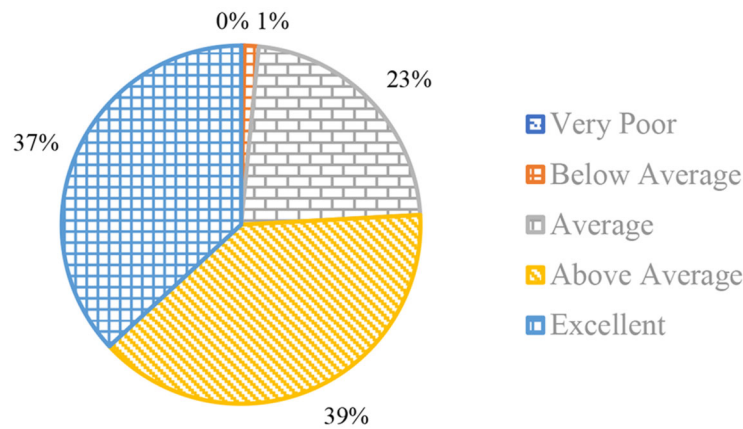
**Figure 3.2** Trip length frequency distribution.



**Figure 3.3** Roadway type frequency distribution.

**TABLE 3.6**  
**Driver History Length of Participants**

Number of Years Driving	Sample Distribution (%)
0–10	21.3
11–20	17.0
21–30	17.2
31–40	17.9
41–50	14.7
50+	11.9



**Figure 3.4** Self-perceived driving ability of participants.

## 4. DATA ANALYSIS

### 4.1 Data Cleaning Procedures

During data collection and afterward, data was cleaned to remove poor quality responses and ensure a complete, high quality sample. Responses were initially screened for three primary criteria. All responses with a duration shorter than 520 seconds (approximately 8.5 minutes) were removed as the research team believed it impossible to complete the survey and read all the questions in that time. All responses that failed the aforementioned quality check were also removed. Additionally, any self-contradictory response was removed with special attention paid to the questions evaluating understanding of the emerging treatments (it is impossible for a treatment to increase and reduce crashes simultaneously). After initial cleaning, data was screened for outliers, which were removed.

### 4.2 Descriptive Statistics

#### 4.2.1 Emerging Treatment Awareness, Acceptance, and Confidence

For each treatment, each participant was asked to provide their awareness of the treatment. Three levels of awareness were used ranging from no awareness, peripheral awareness, and total awareness. Their responses are shown in Figure 4.1.

As expected, awareness is highest for the familiar and ubiquitous roundabout, and lowest for the rare Displaced Left Turn (DLT). There are currently no ramp meters or DLTs installed in Indiana, few RCUTs/J-turns, and only three DDIs, so it follows that more than 40% of the sample is unfamiliar with these technologies.

Additionally, age, gender, and income factor into awareness of emerging technologies, excluding the well-known roundabout. These relationships were stronger for some treatments than others, but generally visible across all of them. Younger populations (18–35 years

old) were the least unaware of new treatments, while older populations were far less likely to be familiar with new technologies. Across all emerging treatments with the exception of roundabouts, women were more unaware of emerging technologies than men (test of proportions,  $p$ -value  $< 0.01$ ).

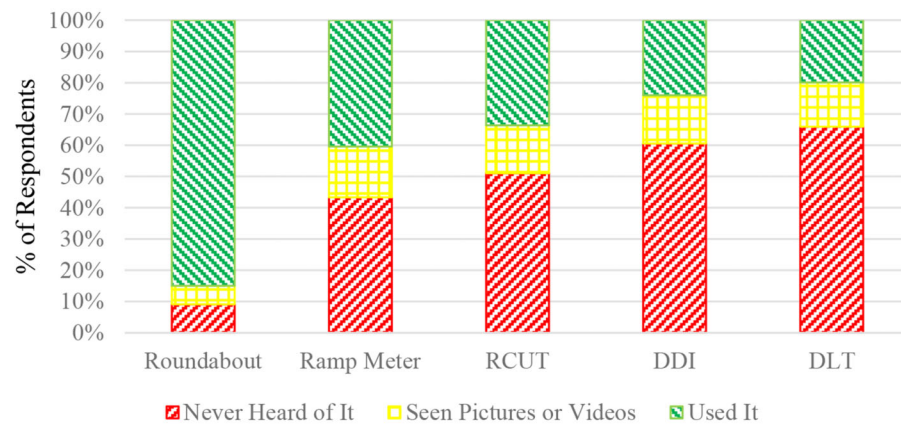
For each treatment, each participant was asked to provide their opinion regarding potential implementation of the treatment in their area on a five-point scale, which was used to indicate acceptance of the treatment. As it is known that the public often have different opinions regarding single and multi-lane roundabouts, they are considered separately. Their responses are shown in Figure 4.2.

A large portion of the sample is neutral regarding emerging technologies, but they are most ambivalent toward the ramp meter and least ambivalent toward the multi-lane roundabout. The most accepted technology was the single-lane roundabout, and the least accepted technology was the DDI (45% oppose), followed closely by the DLT (43% oppose). Multi-lane roundabouts garnered significantly more opposition and less acceptance than their single-lane counterparts.

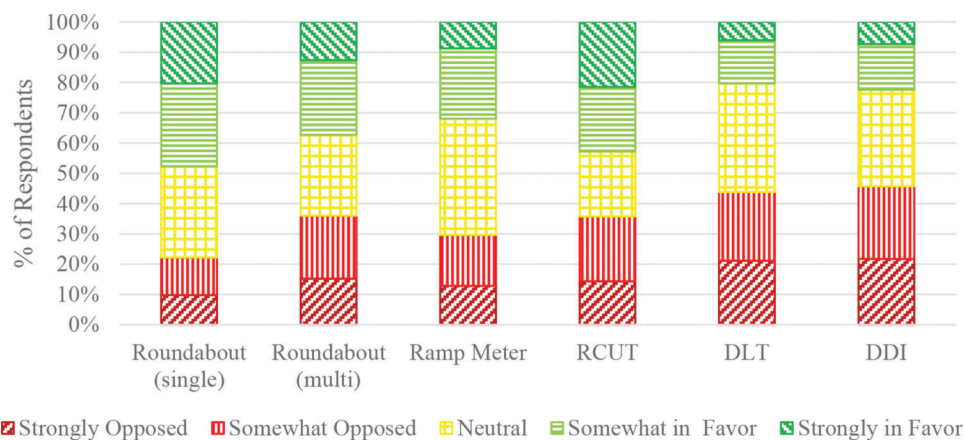
One key trend emerges from this data, especially in comparison to the awareness data shown in Figure 4.1. It is relatively clear from this data that treatments with higher levels of awareness have higher levels of acceptance, and vice versa. This is consistent with other research (Jackson et al., 2014; Savolainen et al., 2012) that has shown that people are frequently more accepting of treatments after they have had experience using them.

The one exception to this trend is the multi-lane roundabout, which has more opposition than the ramp meter and nearly equivalent opposition as the RCUT, even though multi-lane roundabouts are far more common than either of these two technologies. However, the multi-lane roundabout also has more acceptance than any technology aside from the single-lane variety. Additionally, the sample was comparatively least ambivalent about this technology. Taken together, these facts lead to the conclusion that the public is more





**Figure 4.1** Awareness of emerging technology.



**Figure 4.2** Acceptance of emerging technology.

opinionated regarding multi-lane roundabouts than other treatments and that this opinion is split, as roughly equal proportions indicated acceptance and opposition.

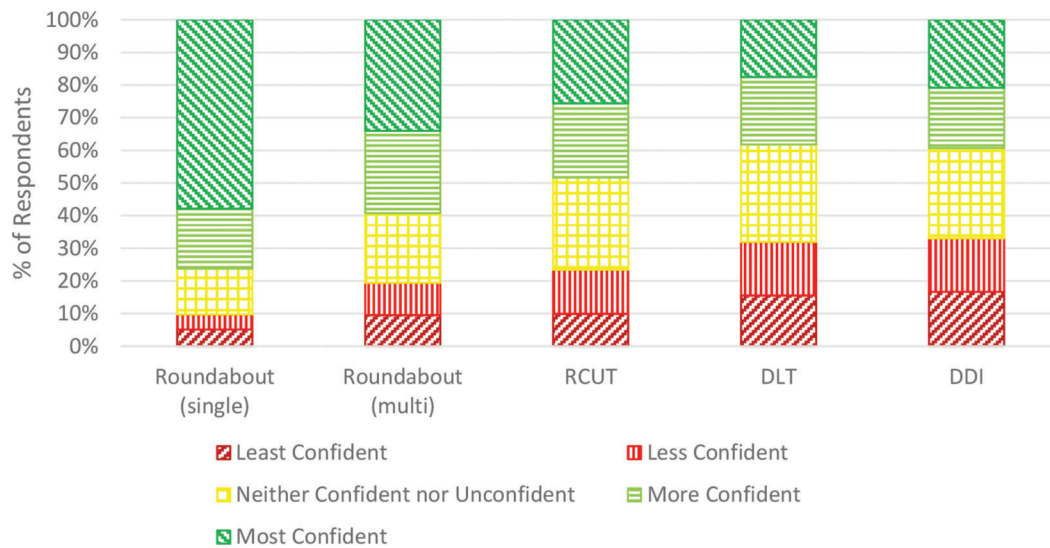
In general, respondent age does impact acceptance of emerging technologies, excluding the ramp meter (to which age groups respond evenly). Younger populations (18–35 years old) are generally least opposed to the implementation of new technologies, and opposition rises with age. In general, the difference between younger and older populations becomes noticeable beginning with those aged 45–54 years old. This conclusion is consistent with previous research in this area (Savolainen et al., 2012).

The form of media used for participants also impacts acceptance of emerging technologies. Across all emerging technologies, the brief informational video (approximately 3 minutes) garnered the highest rate of acceptance. As increasing acceptance of a proposed treatment is one goal of public outreach, effectiveness of a media type was measured using the number of people who stated that they would be somewhat or strongly in favor of a treatment. The effectiveness of the video compared with other media types varied across

the technologies. For multilane roundabouts, the arrow diagram performed significantly worse (test of proportions,  $p$ -value < 0.05) than the video. For the RCUT, the arrow diagram and the flyer performed significantly worse than the video (test of proportions,  $p$ -value < 0.1 for the diagram,  $p$ -value < 0.05 for the flyer). For the DLT, the arrow diagram and flyer performed significantly worse than the video (test of proportions,  $p$ -value < 0.01 for the diagram,  $p$ -value < 0.05 for the flyer). For the DDI, the flyer and simulation performed significantly worse than the video (test of proportions,  $p$ -value < 0.01).

Lastly, participants were asked to rank their confidence regarding navigating each treatment. These results are shown in Figure 4.3. The ramp meter was omitted from this question, as it is assumed that drivers are able to easily stop at a traffic signal.

The same shape as seen in Figures 4.1 and 4.2 appears here—the familiar roundabout has high confidence, and the unfamiliar DLT and DDI have lower confidence. Notable is the fact that although 60%–65% of the sample have never heard of either the DLT or the DDI, only 32%–33% of the sample indicated they



**Figure 4.3** Driver confidence in emerging technology.

**TABLE 4.1**  
**Participants' Cross-Treatment Understanding**

Statement	Roundabout (%)	Ramp Meter (%)	RCUT (%)	DLT (%)	DDI (%)
Is too confusing	10.3/40.6 <sup>a</sup>	–	36.0	49.5	38.6
Drivers will avoid	28.6	20.8	29.0	31.4	28.3
Will cause more crashes	14.8	–	20.3	27.5	21.4
Will cause fewer crashes	32.7	–	26.5	22.9	21.9
Will increase travel time	10.2	16.6	19.8	16.2	11.2
Will reduce travel time	46.8	40.0	22.0	21.7	21.2
Won't work here	11.7	25.1	20.6	25.0	24.7
Will work here	33.1	25.4	24.3	20.8	20.8

<sup>a</sup>Single lane/multi-lane.

would not be confident navigating through the treatment, although an additional ~30% indicated neutral confidence.

Additionally, notable and concerning are the confidence levels for both roundabout types. Despite their prevalence on Indiana's highways, only 76% of respondents indicated that they are confident using single lane roundabouts, a figure that drops to 60% for the multi-lane version. One in four drivers stated that they are not confident in their ability to navigate a single-lane roundabout, and one in three drivers stated that they are not especially confident in their ability to utilize a multi-lane roundabout.

#### 4.2.2 Understanding of Emerging Treatments

For each treatment, participants were asked to choose from a series of statements evaluating their understanding of the treatment's purpose and their opinion of the treatment. Participants were not required to pass judgement on every statement (but had to choose at least one), and as a result, no single statement had more than 50% of the sample select it. The average selection rate across all treatments was approximately 25%. Table 4.1 shows the response rates between

treatments for some statements common across most of the treatments. Not all options were included for both single-lane roundabouts and multi-lane roundabouts but rather were offered for roundabouts in general unless otherwise noted.

From the information in Table 4.1, a couple of important conclusions arise. Firstly, all of the treatments, with the exception of the single-lane roundabout, are thought to be too confusing by more than a third of the survey sample. Additionally, it is thought that drivers will actively avoid intersections where these treatments are installed.

Statements regarding crashes and travel time were phrased in comparison to the relevant traditional intersection/interchange; roundabouts and DLTs were compared with a signalized intersection, the RCUT with a two-way stop, and the DDI with a traditional diamond interchange. Regarding crashes, more people think that roundabouts and RCUTs will reduce crashes and that DLTs will increase crashes; the DDI is approximately a 50/50 split. Across all treatments, more people think that travel time will be reduced by varying margins.

The pair of "Won't/Will Work Here" is attempting to capture a sense of community exceptionalism and refers

TABLE 4.2  
Participants' Understanding Statement Results for Roundabouts and RCUTs

Statement	Roundabout (%)	RCUT (%)
Large vehicles can't use	32.9	25.1
Large vehicles can use	22.7	18.1
Entry to multi-lane roundabout—yield to all traffic in roundabout	40.2	—
Entry to multi-lane roundabout—yield to traffic only in lane I am entering	37.7	—

TABLE 4.3  
Participants' DDI Understanding Statement Results

Statement	DDI (%)
Driving on the left side is unsafe	18.1
People will drive the wrong way	36.1
Peds/bikes can't use	21.3
Peds/bikes can use	14.6

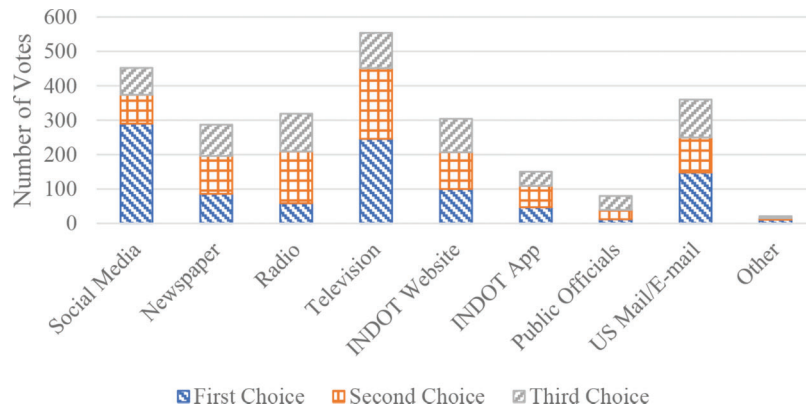


Figure 4.4 Desired sources of information for INDOT projects and activities.

to the potential belief that a treatment might work somewhere else but won't or will work here in the local community. People believe that roundabouts and RCUTs will work in their local communities, but neither the DLT nor the DDI will; the ramp meter is approximately a 50/50 split.

For select treatments, additional statements were included to evaluate the public belief regarding common misconceptions for those individual treatments. Tables 4.2 and 4.3 show the results for those statements.

A pervasive myth regarding both roundabouts and RCUTs is that larger vehicles (specified as trucks, buses, farm equipment, and emergency vehicles) cannot use them. These myths remain prominent among the survey population. Additionally, there is obviously confusion regarding proper yielding behavior at a multi-lane roundabout.

The crossover to the left-hand side of the roadway required by the DDI can raise concerns among the public regarding potential safety issues. More than a

third of the sample believe that at least some drivers will drive the wrong way through a DDI. Traffic control devices located at DDIs strongly reinforce the desired pathway, but these traffic control devices (particularly signs) are not typically shown on DDI-related media. It is also clear that myths surrounding pedestrians and bicyclists at DDIs remain in the minds of respondents.

#### 4.2.3 Media Preferences

For these questions, participants were required to choose their most utilized source and to optionally list a second and third source. This section evaluated both current and desired sources for information regarding INDOT projects and services, and current sources for real-time driver information. The response profile for desired information sources regarding projects and services almost exactly matched the current sources profile, meaning that people are currently receiving information from their preferred sources. For brevity, only the desired profile is shown in Figure 4.4.

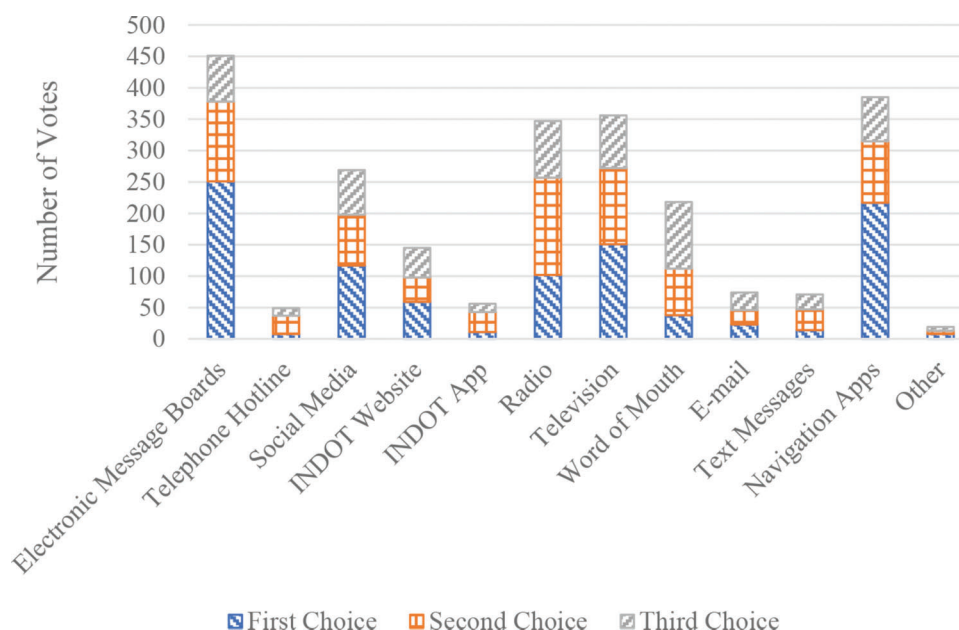


For current and desired sources information regarding INDOT projects and services, social media was the most common response for the first choice source, while television received the most votes overall. Radio, newspaper, and word of mouth were also heavily utilized sources. Although the profile for current and desired information sources is almost identical, there is one key area where they differ—U.S. mail/e-mail. A significantly larger portion of respondents (360) indicated they would like to receive information from U.S. mail/e-mail than those who indicated they are receiving information through that channel presently (59).

Desirable sources of information across all age groups was not uniform and largely conforms to already known trends. Social media is most popular among the youngest age groups, noticeably dropping off for those over 35 years old. Television is most popular among the older three age groups beginning with those over 45 years old. Radio was not a popular first choice but was a common second or third choice across all age groups. Newspapers were by far most popular among those 65 and older, but still pulled a fairly large number of individuals 55–64 years old. Interest in e-mail or U.S. mail communications was also highest among those 65 and older, but significant interest was also shown by those aged 35–64.

The response profile for real-time driver information is shown in Figure 4.5.

Electronic message boards along highways are the most common response for most utilized source, followed by navigation apps such as Google Maps and Waze. Radio, television, social media, and word-of-mouth were all also relatively commonly listed sources for real-time information. Somewhat fewer respondents reported using the INDOT website or app for this purpose.



**Figure 4.5** Current sources for real-time information.

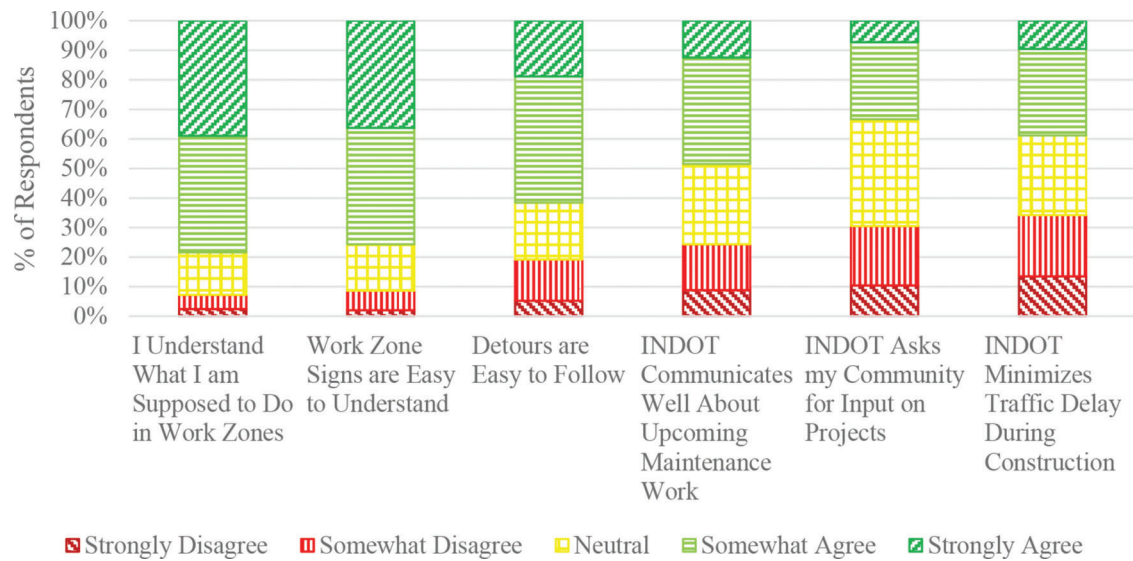
#### 4.2.4 Work Zones and Construction Traffic Management Operations

Respondents were asked to provide their level of agreement or disagreement regarding a series of statements pertaining to work zone communication and traffic control operations. The results are shown in Figure 4.6.

The general perception of the survey sample is that INDOT's communication and outreach regarding work zones is lacking as only 50% of the sample agrees that INDOT communicates well regarding upcoming work, while only 35% agree that INDOT takes community input on projects. Regarding work-zone related signing, respondents generally agree that construction detours are easy to follow, and that work zone traffic control devices do a good job of conveying the desired driver behavior at the zone. The sample is mixed regarding minimization of traffic delays, with approximately 35% disagreeing that delays are minimized, and approximately 40% agreeing that they are minimized.

The survey included two questions evaluating public perception and opinions regarding full and partial closure of roadways for construction, the results of which are shown in Table 4.4.

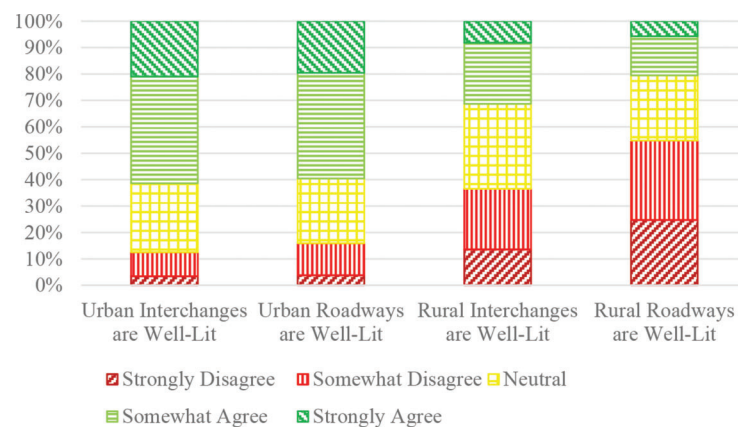
For both options, full closure was the more popular choice. The wider margin attached to the state highway bridge scenario may be partially due to the relatively small gap in time between the full and partial scenarios. There was a significant difference ( $p$ -value  $< 0.05$ ) in response pattern for these choices depending on whether the respondent's ZIP was located in an urbanized area (50,000+ population), urban cluster (2,500–50,000 population), or a rural area ( $< 2,500$  population) as defined by the U.S. Census Bureau (United States Census Bureau, 2020). More rural populations were more likely to prefer a partial closure than their urban counterparts,



**Figure 4.6** Respondent agreement of work zone statements.

**TABLE 4.4**  
**Full and Partial Closure Scenario Results**

	Full Closure (%)	Partial Closure (%)
State highway bridge scenario (detour required and 4 months full closure, passable and 6 months partial)	63	37
Major interchange scenario (main freeway closed and 1.5 years full closure, passable and 2.5 years partial)	58	42



**Figure 4.7** Respondents' agreement of lighting statements.

perhaps due to the potentially lengthier detour caused by a full closure in a rural area.

#### 4.2.5 Lighting and Visibility

Participants were asked to agree or disagree with four statements regarding urban and rural roadway and interchange lighting. Their responses are shown in Figure 4.7.

As shown in Figure 4.7, a majority of respondents agreed or strongly agreed that urban interchanges and urban roadways are well-lit. However, they looked less favorably on rural lighting; approximately 55% disagreed or strongly disagreed that rural roadways are well-lit. Rural interchanges received mixed reviews as nearly equal proportions agreed or strongly agreed (31%) and disagreed or strongly disagreed (36%) that rural interchanges are well-lit.

Respondents were also asked to rate visibility of a series of temporary and permanent traffic control devices on a three-point scale ranging from “Generally Poor” to “Generally Good”; the results of this question are shown in Table 4.5.

Far and away the least visible item was pavement markings in the rain, with around 37% giving “Generally Poor” and about 45% giving “Generally Fair.” As expected, visibility for the same category of items was worst in the snow, followed by rain, followed by clear night. Across all three conditions, temporary traffic control devices were more visible than workers and work equipment. Raised pavement markers were more visible than pavement markings at night and in the rain. A majority of respondents (58.2%) rated visibility of large overhead signs at night to be “Generally Good.”

TABLE 4.5  
Traffic Control Device Visibility

	Generally Poor (%)	Generally Fair (%)	Generally Good (%)
Pavement markings at night	16.6	52.8	30.6
Pavement markings in rain	36.8	45.4	17.7
RPMS at night	11.6	47.4	40.9
RPMS in rain	16.6	49.3	34.0
Signs at night	14.2	46.0	39.7
Signs in rain	20.3	51.4	28.3
Signs in snow	25.9	52.0	22.1
Work zone control devices at night	11.1	44.2	44.6
Work zone control devices in rain	11.8	50.6	37.6
Work zone control devices in snow	17.8	49.6	32.5
Road workers + equipment at night	16.9	46.2	36.8
Road workers + equipment in rain	18.7	53.9	27.4
Road workers + equipment in snow	17.8	55.6	26.6
Large overhead signs at night	6.4	35.4	58.2

#### 4.2.6 Accessibility & Mobility

In order to evaluate the tradeoff between accessibility and mobility, participants were asked to choose between two scenarios describing trips that took the same amount of time, but one trip utilized high-speed freeways and local roads while the other utilized lower-speed highways. The entire question and its results are shown in Figure 4.8. A small majority of 56% of respondents chose the freeway option, while the remaining 44% chose the highway option.

Travel time reliability was addressed by providing two scenarios—a constant commute time, and a variable commute time, and asking participants for their frustration with each. In order to ensure the scenarios were responsive to participant behavior, participants were first asked to provide their pre-COVID commute time in

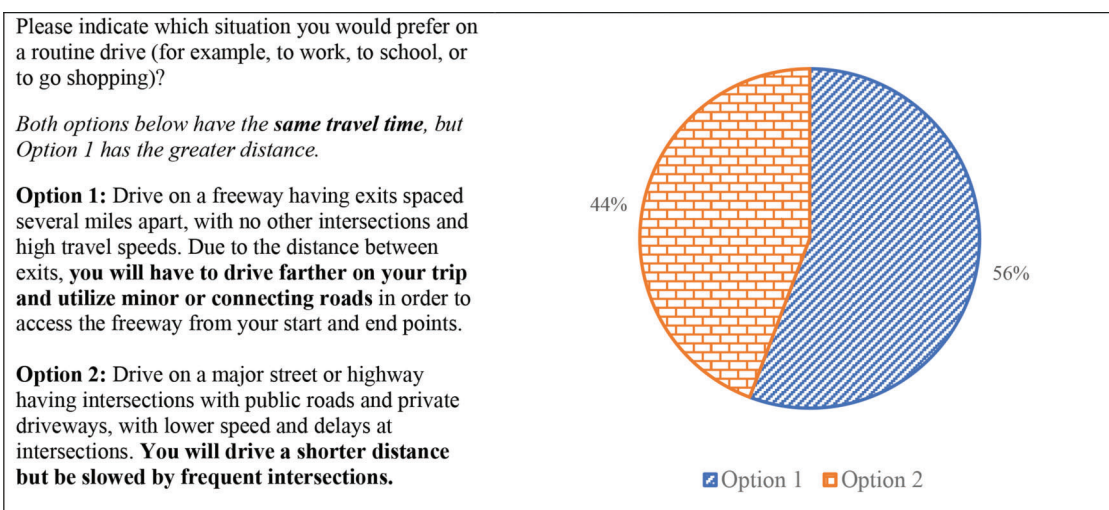


Figure 4.8 Results of accessibility choice scenario.

minutes. They were then asked to provide their frustration with both a constant commute of the length they provided, and a variable commute that was 25% longer than they provided for half of their trips, and 25% shorter than they provided for the other half of their trips. The mean commute time provided was 23 minutes, and the frustration levels for both scenarios are shown in Figure 4.9.

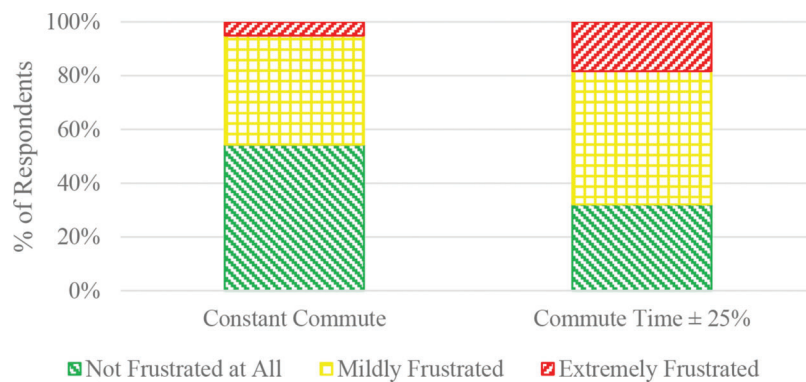
As shown in Figure 4.9, travel time reliability is important to respondents. Having a variable commute time, even if that variability is in their favor half of the time was considered mildly or extremely frustrating by nearly 70% of the time. It is also worth noting that approximately 45% of respondents are frustrated by their commute even when it is constant.

#### 4.2.7 Driver Speed Behavior

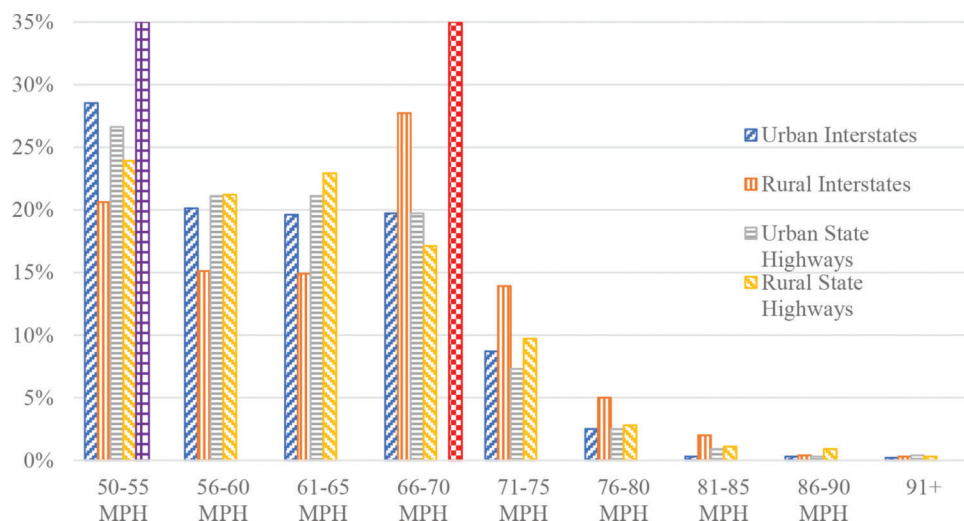
Speeding remains a major problem on Indiana's highways. Perceptions of average speed on Indiana's highways are shown in Figure 4.10, with regulatory speed limits for roadways noted as red (rural interstate) and purple lines (all other roadways).

From the data shown in Figure 4.10, that for urban interstates, urban state highways, and rural state highways, most of the public believe average speeds to be higher than the posted speed limit (55 mph). For these roadway types, only 20%–30% of respondents chose an average speed at or below the speed limit, while 60% chose speeds between 1 and 15 mph above the posted limit (56 mph–70 mph), with the remainder choosing speeds above 70 mph. The picture is different for rural interstates, as 78% of respondents chose speeds at or below the posted speed limit for this roadway (typically 70 mph). Perhaps the most striking observation from this data is that it would appear that a large portion of the sample appear to treat these roadways somewhat similarly, despite their differing characteristics and posted limits. In fact, approximately 60% of the responses for all four roadways lie between 56 mph and 70 mph, even though this is speeding on three of the four.

Participants were generally positive regarding two speed-related intelligent transportation technologies. Nearly 70% of participants agreed (somewhat or strongly) that speed radar signs displaying current



**Figure 4.9** Commuter frustration over constant vs. varied commutes.



**Figure 4.10** Perceived average of Indiana highway speeds.



TABLE 4.6  
Participants' Curve Warning Sign Responses

Response	% of Respondents Selecting
Choose not to slow down	1.0
Choose to slow down to 50 mph	1.6
Choose to slow down to 45 mph	5.6
Choose to slow down to 35 mph	64.0
Required by law to slow to 35 mph	27.8

TABLE 4.7  
Participants' Work Zone Speed Scenario Results

Response	Work Zone Speed Limit (%)	Work Zone Speed Limit & Workers (%)	Work Zone Speed Limit & Radar (%)
Don't slow down	0.4	0.4	0.3
Slow down slightly (65 mph)	1.3	0.6	0.7
Slow down moderately (60 mph)	2.9	2.4	2.3
Slow down significantly (55 mph)	8.9	7.6	9.5
Slow down to work zone SL (50 mph)	86.5	89.0	87.2

speed in school and work zones help to reduce speeding. Additionally, 66% of respondents indicated they would be likely or very likely to obey a Variable Speed Limit (VSL) as opposed to a fixed posted speed limit.

Participants were asked to provide their expected speed-related behavior in response to a number of signs. The first scenario described a curve warning sign with an advisory speed plaque of 35 mph attached (signs W1-2 and W13-1P in the *Indiana Manual on Uniform Traffic Control Devices*), and asked participants what they would do. Responses to this question are shown in Table 4.6.

Although it seems that there is some confusion regarding the regulatory power of an advisory speed plaque, the vast majority of respondents chose to slow down to the advisory speed.

The next series of scenarios described the approach to a work zone on a rural highway, with the vehicle traveling at 70 mph and advance signing indicated an upcoming lane closure. Participants were shown three sign combinations; a work zone speed limit sign (at 50 mph) in isolation (R2-1 and XG20-5P), a work zone speed limit sign accompanied by a workers sign (W21-1) and a note that there appears to be work zone activity, and finally a work zone speed limit sign alongside a radar sign indicating the 70 mph travel speed. The results for these three scenarios are shown in Table 4.7.

For all three sign combinations, the vast majority of respondents indicated that they would slow down to the posted work zone speed limit. The addition of the workers sign and the note that the work zone is active was most effective by a small margin, while the work zone speed limit sign in isolation was least effective—the presence of the radar sign seems to improve speed behavior slightly.

Tables 4.6 and 4.7 also serve to highlight the primary limitation of the stated preference survey; people often behave differently in reality than they indicate they will on a stated preference survey, especially when being asked about dangerous or illegal behavior. However, what the response patterns shown in these tables does prove is that drivers know the appropriate and desirable behavior in work zones.

## 5. CONCLUSIONS

### 5.1 Summary of Key Findings

This project uncovered several important aspects of the public's awareness, understanding, and acceptance of several emerging traffic engineering infrastructure treatments and public perception of several specific current INDOT traffic engineering practices.

Awareness and acceptance of emerging alternative intersections and interchanges is generally poor among the public, particularly pertaining to the restricted crossing U-turn/J-turn, displaced left turn (DLT), and the diverging diamond interchange (DDI). Awareness is influenced in general by both age and gender, while acceptance is influenced by age. Younger (under age 35) and male populations are more likely to be aware and accepting of new technologies, while older populations (over age 45) are more likely to be opposed to the implementation of alternative intersection and interchange designs. Additionally, acceptance of emerging technologies was highest for participants who viewed the informational video for those technologies. Although single lane roundabouts are familiar and accepted, multilane roundabouts remain controversial and confusing to the public. Myths regarding the ability of large vehicles, pedestrians, and bicyclists to utilize roundabouts, RCUTs, and DDIs remain prevalent.

Drivers are generally confident or neutral regarding their ability to navigate these new intersections, with confidence decreasing as awareness and acceptance decrease. All of the alternative intersection and interchange designs except the single lane roundabout are considered to be too confusing by at least a third of respondents.

Comparing full and partial roadway closure for construction activities, the public prefers partial closure and retaining use of the roadway during construction activities, even if that means they last for a longer duration. Additionally, the public feel they understand the intent of work zone signing and that detours are generally easy to follow. Visibility of work zone temporary traffic control devices, workers, and work equipment is generally acceptable at night and in inclement weather conditions.

Public perception and understanding regarding roadway speed and speed behavior was surprising. The perceived average speeds are remarkably similar for four different types of roadways; urban and rural interstates, and urban and rural state highways, despite the fact that these four roadways do not have identical speed limits or roadway environments. Additionally, drivers understand what desirable speed behavior is in work zones and respond positively to the inclusion of the workers sign and the speed radar sign.

When it comes to project-related communications, INDOT is generally providing information through the channels the public prefers to receive these types of information, although more people would prefer to receive information by e-mail or U.S. mail. Age distribution across the different channels follows known trends—younger individuals preferring social media, older individuals relying on television and newspapers, while everybody receives information secondarily through radio. Most people are receiving their real-time information via electronic changeable message signs along highways or navigational apps such as Google Maps or Waze, but are also using social media, radio, and television to receive this information. INDOT is perceived as doing a middling job regarding communications regarding road work (pertaining to content and frequency, rather than channel as discussed above), taking community input regarding prospective work, and in minimizing roadway delays during construction.

## 5.2 Recommendations

As INDOT continues to implement RCUTs/J-turns and DDIIs in different locations around the state, public outreach will remain fundamentally important to reducing opposition to these technologies. In general, real-world experience with alternative intersections and interchanges is the best way to reduce opposition, but as these designs remain relatively rare, it will remain unlikely that the public has such experience. The next best thing will continue to be information regarding the treatment and showing how it operates. The information regarding understanding and misconceptions

related to the treatments previously discussed within this report can inform outreach efforts.

Outreach efforts in this area to increase awareness should also take into consideration the reality that in general, women and older populations are less likely to be aware of these emerging technologies than younger or male populations are. As older populations are also more likely to be getting their information from more traditional sources such as television and newspaper, a focus could be placed on disseminating information regarding alternative treatments through those channels. All participants desire to receive more information than they are presently through the U.S. mail/e-mail and these channels could be utilized for information regarding emerging treatments alongside other project and service-related information.

A roundabout outreach project interviewing several state DOTs (Veneziano et al., 2013) noted that for many DOTs, ensuring that a roundabout project was successful (in the right location, works well and as intended) helped the DOT with public outreach for future projects, since the success story could be highlighted in outreach efforts. Although intended for roundabouts, this recommendation easily extends to other alternative intersections. Highlighting Indiana's successful implementations of these technologies would be a useful part of any outreach campaign.

Public outreach efforts should also be shaped by the conclusions that the informational video was generally most effective in gaining acceptance and that the dynamic mediums of video and simulation performed in general better than the static diagram and flyers. The 3-minute informational videos (which were produced by the Virginia Department of Transportation (VDOT)) all featured a realistic animation of vehicles utilizing the treatment. A narrator describes briefly how the treatment works, what some of its benefits are in terms of safety and operations, and openly states that the treatment is accommodating for all users. The most unique element of the video compared with the other treatments is the use of multiple perspectives—the camera shows both overhead intersection-wide operations and a practically first person view of an individual vehicle utilizing the treatment. As INDOT continues to develop its own alternative intersection outreach tools, these aspects of the VDOT video can provide guidance.

As INDOT continues to add multi-lane roundabouts to its roadway network, more driver education would be beneficial. A large portion of the survey respondents indicated opposition to multi-lane roundabouts, confusion related to their operation, and a lack of confidence using them. As they are far more common than the other technologies on the list, the opposition and confusion cannot be as easily attributed to lack of awareness. It is highly likely that the opposition is related to poor experiences with multilane roundabouts, likely stemming from driver confusion on the part of both the respondent and other drivers on the roadway related to yield and lane change behavior.

Although responses regarding lighting and visibility were generally positive, there is clearly room for improvement in these areas. Rural interchanges and roadways could potentially benefit from additional lighting. Visibility of traffic control devices at night, in the rain, and in the snow was considered as generally fair or poor by a majority of respondents; these devices could potentially benefit from increased reflectivity or more frequent replacement.

Traffic management practices or roadway improvements that increase travel time reliability and reduce variability, such as ramp meters and other TSM&O strategies, should be considered as relevant and significant improvements to the transportation system. Poor travel time reliability caused by varying traffic conditions negatively impacts users and frustrates them, even if the variability is in their favor half the time.

Regarding speed behavior, it is recommended that INDOT approach driver education in this area operating on the assumption that drivers know what they are supposed to be doing (i.e., what is legal) and are likely ignoring those rules. Speeding, particularly on roadways with a speed limit of 55 mph or lower, is clearly perceived as typical behavior. This may increase the probability that an individual will speed as they may believe that because the behavior is common, that it is safe and legal consequences unlikely to be enforced. This assumption should extend to driver education regarding speed in work zones. Although nearly all respondents chose that they would slow to the work zone speed limit when approaching a work zone, data does not support that this behavior is as predominant in reality as the survey suggests.

### 5.3 Limitations and Future Work

This survey project covered a wide range of topics, each distilled down to what was determined to be of utmost importance. Not all data that could have been used to further understanding of the areas of interest for this survey could be collected, and nearly all of the topics could be studied more thoroughly with additional survey instruments or alternative research methods. Additionally, like all stated preference surveys, this survey is subject to the reality that provided behavior on stated preference surveys often does not match the behaviors observed in reality.

Two additional limitations arise in the demographics of the survey population. Although the sample was forced to be representative in terms of age and gender, it was not so forced in terms of geography, income, and education. Although the sample is fairly representative in terms of geography, the sample is slightly overeducated and of slightly lower-income than the Indiana average. Additionally, collecting only ZIP limits what analysis can be done in the urban vs. rural sphere as respondents appear to reside at the centroid of their ZIP code area—which may be in a town even if the actual respondent lives several miles outside of town.

Future work in this area could include continued study regarding emerging technology awareness and acceptance as emerging technologies become more common to understand the way the public acceptance improves (or does not). More in depth studies regarding speeding behavior or driver behavior in general could help further define public awareness of these topics. Additionally, studies evaluating effectiveness of communication and driver education efforts could help better direct INDOT's outreach efforts.

## REFERENCES

- Bawa, S. (2020, February 24). *2019 INDOT customer satisfaction survey results* [Powerpoint slides]. [https://www.in.gov/indot/files/2019 CS Survey web.pdf](https://www.in.gov/indot/files/2019%20CS%20Survey%20web.pdf)
- Chilukuri, V., Siromaskul, S., Trueblood, M., & Ryan, T. (2011, February). *Diverging diamond interchange performance evaluation* (Report No. OR11-012). HDR Engineering. <https://spexternal.modot.mo.gov/sites/cm/CORDT/or11012.pdf>
- Day, C. M., Hainen, A. M., & Bullock, D. M. (2013). *Best practices for roundabouts on state highways* (Joint Transportation Research Program Report No. FHWA/IN/JTRP-2013/14). West Lafayette, IN: Purdue University. <https://doi.org/10.5703/1288284315216>
- Day, C. M., Stevens, A., Sturdevant, J. R., & Bullock, D. M. (2015). *Evaluation of alternative intersections and interchanges: Volume II—Diverging diamond interchange signal timing* (Joint Transportation Research Program Report No. FHWA/IN/JTRP-2015-27). West Lafayette, IN: Purdue University. <https://doi.org/10.5703/1288284316012>
- Douma, F., & Alarcon, F. (2018, February 1). *Toward greater understanding of the relationship between public perceptions of speed, speed laws, and safety* (Report No. CTS 18-02). Humphrey School of Public Affairs. <https://rosap.nhtl.bts.gov/view/dot/34915>
- Edara, P., Breslow S., Sun, C., & Claros, B. R. (2015). Empirical evaluation of J-turn intersection performance: Analysis of conflict measures and crashes. *Transportation Research Record*, 2486(1), 11–18. <https://doi.org/10.3141/2486-02>
- Gbologah, F. E., Guin, A., & Rodgers, M. O. (2019). Safety evaluation of roundabouts in Georgia. *Transportation Research Record*, 2673(7), 641–651. <https://doi.org/10.1177/0361198119843265>
- Hu, W., McCartt, A. T., Jermakian, J. S., & Mandavilli, S. (2014). Public opinion, traffic performance, the environment, and safety after construction of double-lane roundabouts. *Transportation Research Record*, 2402(1), 47–55. <https://doi.org/10.3141/2402-06>
- Hummer, J. E., Cunningham, C. M., Srinivasan, R., Warchol, S., Claros, B., Edara, P., & Sun, C. (2016). Safety evaluation of seven of the earliest diverging diamond interchanges installed in the United States. *Transportation Research Record*, 2583(1), 25–33. <https://doi.org/10.3141/2583-04>
- INDOT. (n.d.a). *Median U-turns* [Illustration]. Retrieved April 12, 2021, from <https://www.in.gov/indot/3392.htm>
- INDOT. (n.d.b). *RCUT image* [Illustration]. Retrieved October 29, 2020, from <https://www.in.gov/indot/3392.htm>
- Inman, V. W., & Haas, R. P. (2012, June). *Field evaluation of a restricted crossing U-turn intersection* (Publication No. FHWA-HRT-11-067). Science Applications International Corporation. <https://www.fhwa.dot.gov/publications/research/safety/hsis/11067/11067.pdf>

- Jackson, K., Cunningham, C. M., Yeom, C., Hummer, J. E., & Kirk, A. (2014). Public perception of double crossover diamond interchanges. *Journal of Transportation*, 6(1), 33–54. <https://trid.trb.org/view.aspx?id=1323921>
- NCHRP. (2020). *Alternative intersection design and selection* (Report No. NCHRP Synthesis 550). National Cooperative Highway Research Program. <https://doi.org/10.17226/25812>
- Ott, S. E., Fiedler, R. L., Hummer, J. E., Foyle, R. S., & Cunningham, C. M. (2015). Resident, commuter, and business perceptions of new superstreets. *Journal of Transportation Engineering*, 141(7), 04015003. [https://doi.org/10.1061/\(ASCE\)TE.1943-5436.0000754](https://doi.org/10.1061/(ASCE)TE.1943-5436.0000754)
- Qi, Y., Zhao, Q., Asimi, M., Sun, Q., & Shah, S. (2018, September). *Use of innovative intersection designs for improving mobility and reducing roadway traffic congestion* (Project 08). Center for Advanced Multimodal Mobility Solutions and Education. <https://cammse.uncc.edu/sites/cammse.uncc.edu/files/media/CAMMSE-UNCC-2017-UTC-Project-Report-08-Qi-Final.pdf>
- Retting, R. A., Kyrychenko, S. Y., & McCartt, A. T. (2007). Long-term trends in public opinion following construction of roundabouts. *Transportation Research Record*, 2019(1), 219–224. <https://doi.org/10.3141/2019-26>
- Savolainen, P. T., Kawa, J. M., & Gates, T. J. (2012). Examining statewide public perceptions of roundabouts through a web-based survey. *Transportation Research Record*, 2312(1), 25–33. <https://doi.org/10.3141/2312-03>
- Schneider, H., Barnes, S., Pfetzer, E., & Hutchinson, C. (2019, November). *Economic effect of restricted crossing U-turn intersections in Louisiana* (Report No. FHWA/LA.17/617). Louisiana Transportation Research Center. [https://www.ltrc.lsu.edu/pdf/2019/FR\\_617.pdf](https://www.ltrc.lsu.edu/pdf/2019/FR_617.pdf)
- Schneider, I. E., Guo, T., & Schroeder, S. (2013, January). *Quality of life: Assessment for transportation performance indicators* (Report No. MN/RC 2013-05). University of Minnesota Tourism Center & Department of Forest Resources. <http://www.dot.state.mn.us/research/TS/2013/201305.pdf>
- Tarko, A. P., Inerowicz, M., & Lang, B. (2008). *Safety and operational impacts of alternative intersections* (Joint Transportation Research Program Report No. FHWA/IN/JTRP-2008/23). West Lafayette, IN: Purdue University. <https://doi.org/10.5703/1288284314313>
- Tarko, A. P., Romero, M., Hall, T., Matin, S. A., & Lizarazo, C. (2015) *Evaluation of alternative intersections and interchanges: Volume I—Roundabout capacity and rollover analysis for heavy vehicles* (Joint Transportation Research Program Report No. FHWA/IN/JTRP-2015/26). West Lafayette, IN: Purdue University. <https://doi.org/10.5703/1288284316011>
- Tarko, A. P., Romero, M. A., & Sultana, A. (2017a). *Performance of alternative diamond interchange forms: Volume I—Research report* (Joint Transportation Research Program Report No. FHWA/IN/JTRP-2016/01). West Lafayette, IN: Purdue University. <https://doi.org/10.5703/1288284316385>
- Tarko, A. P., Romero, M. A., & Sultana, A. (2017b). *Performance of alternative diamond interchange forms: Volume II—Guidelines for selecting alternative diamond interchanges* (Joint Transportation Research Program Report No. FHWA/IN/JTRP-2017/02). West Lafayette, IN: Purdue University. <https://doi.org/10.5703/1288284316386>
- Tatham, C. (2013, February). *WisDOT 2012 statewide customer satisfaction survey* (Report No. WisDOT 0092-12-10). ETC Institute. [https://rosap.ntl.bts.gov/view/dot/25896/dot\\_25896\\_DS1.pdf?](https://rosap.ntl.bts.gov/view/dot/25896/dot_25896_DS1.pdf?)
- United States Census Bureau. (2020, December 7). *Urban and rural* [Webpage]. Retrieved October 29, 2020, from <https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html>
- VDOT. (2018, April 25). *VDOT's innovative intersections: Restricted crossing u-turn* [Video]. YouTube. <https://www.youtube.com/watch?v=g1SA1mAXmfk&list=PLiCpIfP-UWcAyWyzg75uZ0UI6m44evCeT&index=8&t=1s>
- VDOT. (2020, November 18). *Innovative intersections and interchanges. Virginia Department of Transportation*. [http://www.virginiadot.org/images/innovate/RCUT\\_Final\\_082417.pdf](http://www.virginiadot.org/images/innovate/RCUT_Final_082417.pdf)
- Veneziano, D., Levi, E., & Stephens, J. (2013, September). *Information/education synthesis on roundabouts* (Report No. FHWA/MT-13-007/8117-042). Montana Department of Transportation. [https://www.mdt.mt.gov/other/webdata/external/research/docs/research\\_proj/ROUNABOUT\\_EDUC/FINAL\\_REPORT\\_SEP13.pdf](https://www.mdt.mt.gov/other/webdata/external/research/docs/research_proj/ROUNABOUT_EDUC/FINAL_REPORT_SEP13.pdf)



## APPENDICES

### **Appendix A. Survey Instrument**

### **Appendix B. Media Used in the Survey**

## APPENDIX A. SURVEY INSTRUMENT

Following is the entire survey instrument utilized in this project. All of the media types shown in the survey are the arrow diagram option. All media choices are shown in Appendix B.

### Public Acceptance and Awareness of INDOT's Transportation Services (SPR-4441)

#### Final Survey

#### Section 0: Screening Questions

Are you a legal resident of Indiana (meaning you pay taxes and vote)?

- ☐ Yes
- ☐ No

Are you a current or former employee of the Indiana Department of Transportation or of any other transportation industry (e.g., consultants, local or federal transportation employees etc.)?

- ☐ Yes
- ☐ No

What gender do you identify with?

- ☐ Male
- ☐ Female

What is your age?

- ☐ Under 18 (respondents will be directed out of the survey)
- ☐ 18–24
- ☐ 25–34
- ☐ 35–44
- ☐ 45–54
- ☐ 55–64
- ☐ Over 65

## INFORMED CONSENT INFORMATION

### PUBLIC ACCEPTANCE AND AWARENESS OF INDOT'S TRANSPORTATION SERVICES

IRB Research Project Number: 2020-337

Konstantina Gkritza, Ph.D.

Jon Fricker, Ph.D.

Theodora Konstantinou, M.S.C.E.

Sarah Adsit

Lyles School of Civil Engineering, Purdue University

#### **What is the purpose of this study?**

The purpose of this study is to assess public acceptance and awareness of the services of the Indiana Department of Transportation (INDOT). Specifically, more information about public awareness and attitudes regarding traffic engineering practices, including use of highway signs, pavement markings (striping), construction zones, and select intersection and interchange forms.

#### **What will I do if I choose to be in this study?**

If you choose to participate in this study, you will be asked to answer questions related to your understanding and approval of various traffic engineering practices at the Indiana Department of Transportation (INDOT), your travel behaviors and patterns, and some basic demographic information.

#### **How long will the survey take?**

The survey will take approximately 25 minutes.

#### **What are the possible risks or discomforts?**

The risks of participating are minimal and no greater than those encountered in everyday activities. However, if you have distressing feelings after completing this questionnaire and feel that you may need to talk with someone, you can contact the national crisis hotline at 1-800-273-8255.

#### **Will information about me and my participation be kept confidential?**

The project's research records may be reviewed by departments at Purdue University responsible for regulatory and research oversight. Your responses and participation are completely anonymous and any information you provide will be confidential. Only Professor Konstantina Gkritza, Ph.D., Professor Jon Fricker, Ph.D., Graduate Research Assistant Theodora Konstantinou, M.S.C.E, and Graduate Research Assistant Sarah Adsit will have access to the data, which will be non-identifiable. All data from the surveys will be coded and entered into a computerized data file that will be stored in password-protected computers accessible only to the research study personnel.

#### **What are my rights if I take part in this study?**

Your participation in this study is completely voluntary. You may choose not to participate or, if you agree to participate, you can withdraw your participation at any time without penalty or loss of benefits to which you are otherwise entitled.

#### **Will I receive payment or other incentive?**

You will receive compensation from Kantar, a global market research company who administers the survey. That compensation will be in the form of LifePoints, the quantity of which corresponds directly to your time

investment. You will receive no more than a \$6.00 value for your participation; actual compensation may be less. Any discrepancies or questions related to expected compensation should be directed to Kantar.

**Who can I contact if I have questions about the study?**

If you have questions, comments, or concerns about this project, you can talk to one of the researchers. Please contact Sarah Adsit at [sadsit@purdue.edu](mailto:sadsit@purdue.edu), or Theodora Konstantinou at [tkonstan@purdue.edu](mailto:tkonstan@purdue.edu).

If you have questions about your rights while taking part in the study or have concerns about the treatment of research participants, please call the Human Research Protection Program at (765) 494-5942, email ([irb@purdue.edu](mailto:irb@purdue.edu)) or write to:

Human Research Protection Program – Purdue University

Ernest C. Young Hall, 10th floor – Room 1032

155 S. Grant Street, West Lafayette, IN 47907-2114

*Please Print this Information Sheet for Your Records*

## Section 1: Awareness of Current and Emerging INDOT Treatments and Strategies

### *Ramp Metering*

---



Source: ADOT, 2017

#### 1.1 Do you recognize the roadway environment pictured above, seen on freeway ramps?

- I have never seen something like this before
- I have seen pictures or videos of this environment but never in real life
- I have used freeway ramps with these signals in other states (they do not currently exist in Indiana)

This treatment is known as a **ramp meter**. It consists of a traffic light that shows red to stop cars from entering the freeway, and green to allow a single car to enter the freeway. They are used in areas with high traffic volumes and typically only stop cars during peak periods.

**1.2 Which of the following statements regarding ramp meters do you agree with? Check all that apply.**

- ☐ Ramp meters waste drivers' time
- ☐ People will avoid interchanges with ramp meters
- ☐ Ramp meters **reduce efficiency of the highway**
- ☐ Ramp meters **improve efficiency of the highway**
- ☐ These meters might work somewhere else, but they **won't work** in my local community
- ☐ These meters might work somewhere else, and **I think they would work** in my local community.

**1.3 What is your general opinion on potential implementation of a ramp meter in your area?**

- ☐ I would be strongly opposed to it
- ☐ I would be somewhat opposed to it
- ☐ I would be neutral
- ☐ I would be somewhat in favor of it
- ☐ I would be strongly in favor of it

### ***Roundabouts***

---



**1.4 Do you recognize the roadway environment you just saw?**

- I have never seen something like this before
- I have seen pictures or videos of this environment but never in real life
- I have used intersections like this before in Indiana or elsewhere

**1.5 Which of the following statements regarding this intersection do you agree with? Check all that apply.**

- ☐ Roundabouts with a single lane are too confusing for drivers
- ☐ Roundabouts with multiple lanes are too confusing for drivers
- ☐ People avoid roundabouts
- ☐ On approach to a multilane roundabout, I yield to **traffic in the roundabout lane I wish to enter**
- ☐ On approach to a multilane roundabout, I yield to **all traffic in the roundabout**
- ☐ Larger vehicles (trucks, buses, farm equipment, emergency vehicles) **can't utilize** roundabouts
- ☐ Larger vehicles (trucks, buses, farm equipment, emergency vehicles) **can utilize** roundabouts
- ☐ Roundabouts cause **more crashes** than a traditional signalized intersection
- ☐ Roundabouts cause **fewer crashes** than a traditional signalized intersection
- ☐ Roundabouts **increase travel time** compared with a traditional signalized intersection
- ☐ Roundabouts **reduce travel time** compared with a traditional signalized intersection
- ☐ Roundabouts might work somewhere else, but they **won't work** in my local community
- ☐ Roundabouts might work somewhere else, and **I think they would work** in my local community.

**1.6 What is your general opinion on single-lane roundabouts that have been implemented in your area?**

- I am strongly opposed to them
- I am somewhat opposed to them
- I am neutral
- I am somewhat in favor of them
- I am strongly in favor of them

**1.7 What is your general opinion on multilane roundabouts that have been implemented in your area?**

- I am strongly opposed to them
- I am somewhat opposed to them
- I am neutral
- I am somewhat in favor of them
- I am strongly in favor of them



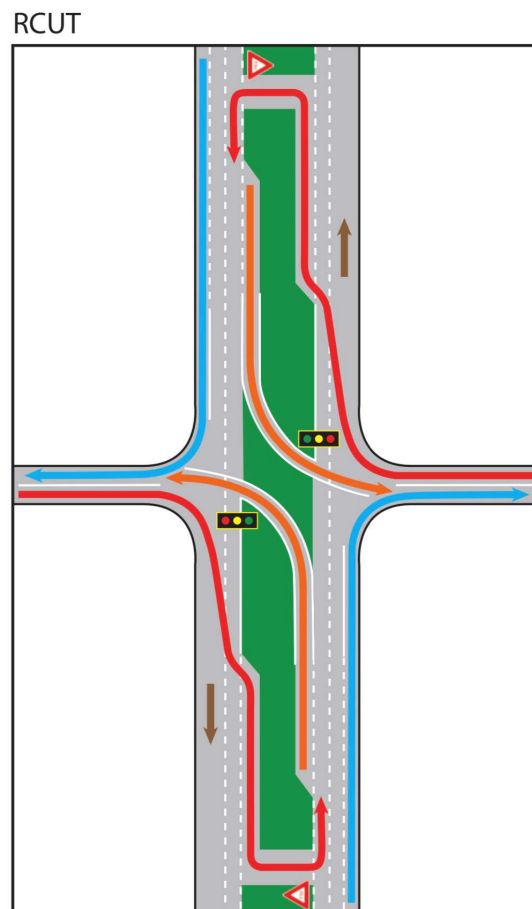
1.8 On a scale of 1–5, where 5 is most confident and 1 is least confident, how confident are you that you can safely navigate *single-lane* roundabouts when you encounter them?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

1.9 On a scale of 1–5, where 5 is most confident and 1 is least confident, how confident are you that you can safely navigate *multilane* roundabouts when you encounter them?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

#### Reduced Conflict Intersection



**1.10 Do you recognize the intersection you just saw?**

- ☐ I have never ever seen something like this before
- ☐ I have seen pictures or videos of this environment but never in real life
- ☐ I have used intersections like this before in Indiana or elsewhere

**1.11 Which of the following statements regarding this intersection do you agree with? Check all that apply.**

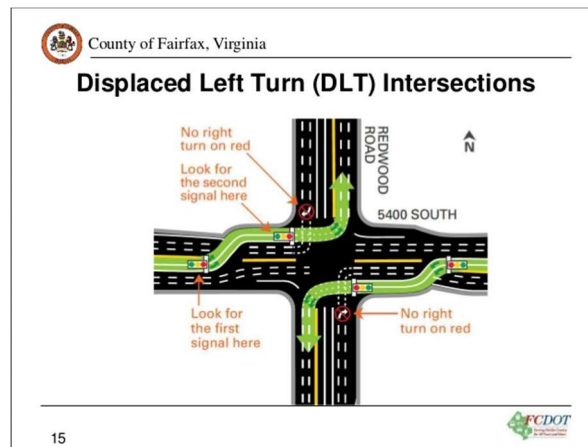
- ☐ Restricted crossing U-turns are too confusing for drivers
- ☐ People will avoid restricted crossing U-turns
- ☐ Larger vehicles (trucks, buses, farm equipment, emergency vehicles) **can't utilize** restricted crossing U-turns
- ☐ Larger vehicles (trucks, buses, farm equipment, emergency vehicles) **can utilize** restricted crossing U-turns
- ☐ Restricted crossing U-turns will cause **more crashes** than a two-way stop-controlled intersection
- ☐ Restricted crossing U-turns will cause **fewer crashes** than a two-way stop-controlled intersection
- ☐ Restricted crossing U-turns **increase travel time** compared with a two-way stop-controlled intersection
- ☐ Restricted crossing U-turns **reduce travel time** compared with a two-way stop-controlled intersection
- ☐ Restricted crossing U-turns might work somewhere else, but they **won't work** in my local community
- ☐ Restricted crossing U-turns might work somewhere else, and **I think it would work** in my local community.

**1.12 What is your general opinion on potential implementation of a Restricted Crossing U-Turn in your area?**

- ☐ I would be strongly opposed to it
- ☐ I would be somewhat opposed to it
- ☐ I would be neutral
- ☐ I would be somewhat in favor of it
- ☐ I would be strongly in favor of it

**1.13 On a scale of 1–5, where 5 would be most confident and 1 would be least confident, how confident are you that if you were to encounter this intersection while driving that you could safely navigate it?**

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5



**1.14 Do you recognize the intersection you just saw?**

- ☐ I have never seen something like this before
- ☐ I have seen pictures or videos of this environment but never in real life
- ☐ I have used intersections like this before in Indiana or elsewhere

**1.15 Which of the following statements regarding this intersection do you agree with? Check all that apply.**

- ☐ Displaced left turns are too confusing for drivers
- ☐ People will avoid displaced left turns.
- ☐ Displaced left turns will cause **more crashes** than a traditional signalized intersection
- ☐ Displaced left turns will cause **fewer crashes** than a traditional signalized intersection
- ☐ Displaced left turns **increase travel time** compared with a traditional signalized intersection
- ☐ Displaced left turns **reduce travel time** compared with a traditional signalized intersection
- ☐ Displaced left turns might work somewhere else, but they **won't work** in my local community
- ☐ Displaced left turns might work somewhere else, and **I think they would work** in my local community.

**1.16 What is your general opinion on potential implementation of a Displaced Left Turn in your area?**

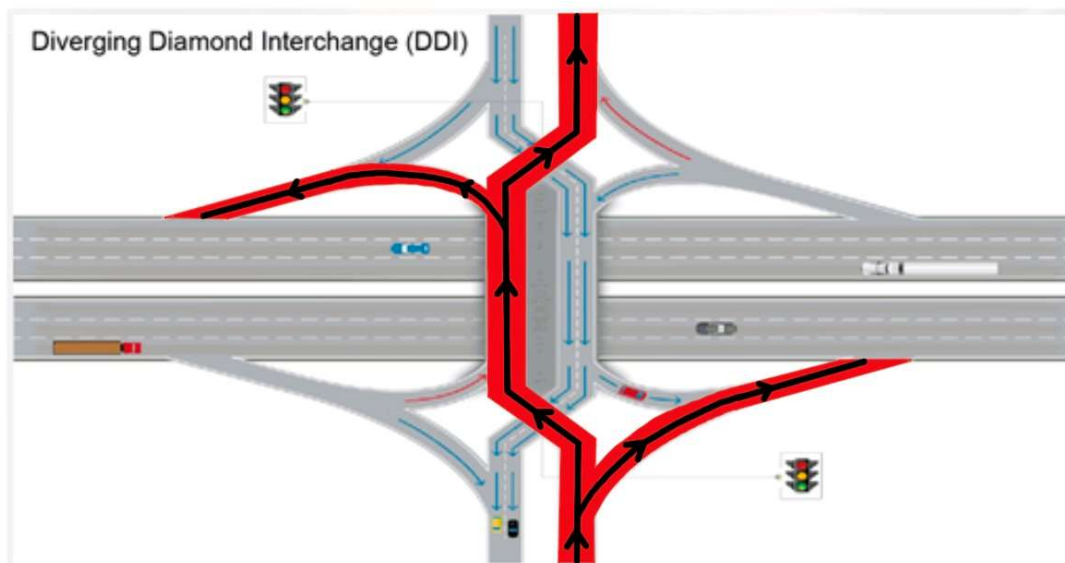
- ☐ I would be strongly opposed to it
- ☐ I would be somewhat opposed to it
- ☐ I would be neutral
- ☐ I would be somewhat in favor of it
- ☐ I would be strongly in favor of it

1.17 On a scale of 1-5, where 5 would be most confident and 1 would be least confident, how confident are you that if you were to encounter this intersection while driving that you could safely navigate it?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

### *Diverging Diamond Interchange*

---



1.18 Do you recognize the roadway environment you just saw?

- ☐ I have never seen something like this before
- ☐ I have seen pictures or videos of this environment but never in real life
- ☐ I have used intersections like this before in Indiana or elsewhere

1.19 Which of the following statements regarding this intersection do you agree with? Check all that apply.

- ☐ Diverging diamonds are too confusing for drivers
- ☐ Driving on the left-hand side of the road in this scenario is unsafe
- ☐ People will drive the wrong way through diverging diamonds
- ☐ People will avoid diverging diamonds
- ☐ Pedestrians and Bicyclists **can't utilize** diverging diamonds safely.
- ☐ Pedestrians and Bicyclists **can utilize** diverging diamonds safely.
- ☐ Diverging diamonds will cause **more crashes** than a traditional diamond interchange
- ☐ Diverging diamonds will cause **fewer crashes** than a traditional diamond interchange

- ☐ Diverging diamonds **increase travel time** compared with a traditional diamond interchange
- ☐ Diverging diamonds **reduce travel time** compared with a traditional diamond interchange
- ☐ Diverging diamonds might work somewhere else, but they **won't work** in my local community
- ☐ Diverging diamonds might work somewhere else, and **I think they would work** in my local community.

**1.20 What is your general opinion on potential implementation of a Diverging Diamond Interchange in your area?**

- ☐ I would be strongly opposed to it
- ☐ I would be somewhat opposed to it
- ☐ I would be neutral
- ☐ I would be somewhat in favor of it
- ☐ I would be strongly in favor of it

**1.21 On a scale of 1–5, where 5 would be most confident and 1 would be least confident, how confident are you that if you were to encounter this intersection while driving that you could safely navigate it?**

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

### ***Media Effectiveness***

---

You have just seen four different new intersection designs that were presented using four different media types: (1) a diagram with arrows, (2) a two-page flyer, (3) a 2–3 minute YouTube video, and (4) a short simulation, not necessarily in that order.

**1.22 Please rate each media type from one to five using the slider (not shown in static version) based on how effective they were in helping you to understand the intersection design they presented. (5 being the most effective and 1 being the least effective)**

- \_\_\_ Arrow Diagram
- \_\_\_ Two-Page Flyer
- \_\_\_ Video
- \_\_\_ Short Simulation

**1.23 For the media type you rated most highly in the previous question, consider why you rated it that way. Please select and rank the most important reasons below in regards to how heavily they factored in your decision. You must choose at least one reason. If you have reasons not listed, you may write in up to three additional reasons.**

- \_\_\_ I prefer dynamic (video) media.
- \_\_\_ I prefer static (print) media.
- \_\_\_ The media provided enough information to satisfy me
- \_\_\_ The media required an appropriate amount of time to view
- \_\_\_ INSERT ANSWER
- \_\_\_ INSERT ANSWER
- \_\_\_ INSERT ANSWER

**1.24 Please provide any additional comments in the box below.**

### ***Information Sources***

---

**1.25 From what source(s) do you regularly receive information regarding INDOT projects and activities? Please rank which of the following sources you utilize most frequently. You may choose up to 5.**

- ☐ Facebook/Twitter/ Other Social Media platforms
- ☐ Newspaper
- ☐ Radio
- ☐ Television
- ☐ Word of Mouth
- ☐ INDOT Website
- ☐ Public Officials/Public Meetings
- ☐ U.S. Mail/Email
- ☐ Other:\_\_\_\_\_

**1.26 In which of the following ways would you most like for INDOT to provide you with information regarding INDOT projects and activities? Please rank the following options.**

- ☐ Facebook/Twitter/ Other Social Media platforms
- ☐ Newspaper
- ☐ Radio
- ☐ Television
- ☐ INDOT Website
- ☐ INDOT App
- ☐ Public Officials/Public Meetings
- ☐ U.S. Mail/Email
- ☐ Other:\_\_\_\_\_



1.27 From what source(s) do you regularly receive information regarding real-time travel conditions? Please rank which of the following sources you utilize most frequently. You may choose up to 5.

- ☐ Electronic message boards along highways
- ☐ Motorist assistance telephone hotline
- ☐ Social networks (Facebook, Twitter, etc.)
- ☐ INDOT Website
- ☐ INDOT App
- ☐ Radio
- ☐ Television
- ☐ E-mail
- ☐ Text messages
- ☐ Other Navigation App (Google Maps, Waze, etc.)
- ☐ Other: \_\_\_\_\_

## Section 2: Attitudes and Preferences towards INDOT Services

NOTE: Please answer the following question in reference to *state-owned* highways, which include state roads (SR), US Highways, and interstates, but not county roads or city-owned streets.

### *Respondent Agreement*

---

2.1 Please indicate the extent of your agreement with the following statements:

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
A. INDOT clearly and frequently communicates regarding expected road work in my community including nature and anticipated duration.					
B. INDOT reaches out to my community regarding what work should be done and relevant aspects of projects.					
C. Official (signed/posted) detours are easy to follow.					
D. INDOT minimizes traffic delay on freeways during construction activities.					

E. I understand what I am supposed to do (merge, shift lanes) in work zones based on signs at the zone.					
F. Signs in work zone are easy to understand.					
G. Signs that display your speed in school and work zones reduce speeding.					
H. Interchanges in rural areas are well-lit.					
I. Interchanges in urban areas are well-lit.					
J. Urban roadways are well-lit.					
K. Rural roadways are well-lit					

### *Visibility*

---

**2.2 Please rate the average visibility of the following roadway elements in the roadway conditions listed.**

	Generally poor	Generally fair	Generally good
A. Roadway striping at night.			
B. Roadway striping in rainy weather.			
C. Raised pavement markers (in-pavement reflectors highlighting roadway striping) showing yellow centerlines or lane lines at night.			
D. Raised pavement markers (in-pavement reflectors highlighting roadway striping) showing yellow centerlines or lane lines in rainy weather.			
E. Road signs at night.			
F. Road signs in rainy weather.			
G. Road signs in snowy weather.			
H. Work zone signs, barrels, and cones at night.			
I. Work zone signs, barrels, and cones in rainy weather.			
J. Work zone signs, barrels, and cones in snowy weather.			
K. Road workers and work equipment at night.			
L. Road workers and work equipment in rainy weather.			
M. Please, select 'Generally Good' for this option.			

N. Road workers and work equipment in snowy weather.			
O. Large overhead signs are clearly visible and legible at night.			

### Choice Scenarios

---

**2.3 Please indicate which situation you would prefer if you had to commute a long distance each day.**

*Both options below have the **same travel time**, but Option A has the greater distance.*

- A. Drive on a roadway that has high speeds, with exits spaced several miles apart, such as a freeway or expressway. Having few exits means that you will have to drive for a longer amount of time on streets with slower speeds and more frequent stops at traffic signals to reach your destination.
- B. Drive on a roadway at speeds that are lower than in Option A because there are intersections with county roads every mile. But having more intersections means that you will drive for a shorter amount of time on streets with slower speeds and frequent stops at traffic signals to reach your destination.

**2.4 A state highway bridge along your commute route is to be rehabilitated. Which construction scenario do you prefer?**

- The road is fully closed for 4 months due to the construction work—other roads must be used.
- The road is partially closed, and an on-site detour is built such that you do not drive out of your way; work takes 6 months, and due to restrictions traveling through the area is slower than usual

**2.5 A major interchange along your usual commute highway is in dire need of maintenance work. Which construction scenario do you prefer?**

- The entire interchange (including the highway itself) is closed for 1.5 years while construction takes place. Other roads must be used.
- The interchange is partially closed—individual lanes and ramps are closed or restricted; work takes 2.5 years, and travel through the area is much slower than usual.

2.6 What is your average commute time (in minutes)?

2.7 Assuming that you are travelling to work, please rate your level of frustration regarding each scenario.

	Not frustrated at all	Mildly Frustrated	Extremely Frustrated
A. My trip to work always takes <b>(user provided)</b> minutes. There is always some congestion in predictable locations.			
B. My trip to work takes <b>(user time–25%)</b> minutes roughly half the time, and <b>(user time +25%)</b> minutes the other half of the time. Sometimes there is congestion, sometimes there is not congestion, and not always in the same spot.			

### *Speeding and Signing*

2.8 What do you think average speed on Indiana's roads is? Please choose a speed range for each of the following locations.

	50–55 mph	56–60 mph	61–65 mph	66–70 mph	71–75 mph	76–80 mph	81–85 mph	86–90 mph	91+ mph
A. Urban Interstates									
B. Rural Interstates									
C. Urban State Highways									
D. Rural State Highways									

2.9 Variable Speed Limits (VSL) display safe speeds for different travel conditions by adjusting posted speed limits based on real-time traffic, roadway, and/or weather conditions, including for work zones. Presently the state does not use VSLs but is considering doing so. How likely would you be to obey a variable speed limit compared to a fixed posted speed limit?

- ☐ Very unlikely
- ☐ Not likely
- ☐ Neutral
- ☐ Likely
- ☐ Very likely

2.10 What does the sign pictured below mean to you?



- ☐ 50 MPH is the legal speed limit
- ☐ 50 MPH is the safe speed
- ☐ 50 MPH is the slowest speed I should drive
- ☐ The safe speed is actually 60 MPH (or more)

2.11 You are currently traveling at 55 MPH and encounter the sign pictured below. What does this sign mean to you?



- ☐ There's a curve ahead but I do not need to slow down
- ☐ There's a curve ahead and I should slow down slightly (to 50 MPH) in order to navigate it safely
- ☐ There's a curve ahead and I should slow down moderately (to 45 MPH) in order to navigate it safely

- There's a curve ahead and I should slow down significantly (to 35 MPH) in order to navigate it safely
- There's a curve ahead and I am required by law to slow down to 35 MPH

2.12 You are approaching a work zone while driving on the interstate at 70 MPH. Signs indicate that the left lane will be closed ahead, and you encounter the sign pictured below. What action will you plan to take?



- I will do nothing, and continue into the work zone traveling the same speed
- I will slow down slightly (to 65 MPH) and continue into the zone
- I will slow down moderately (to 60 MPH) and continue into the zone
- I will slow down significantly (to 55 MPH) and continue into the zone
- I will slow down to the work zone speed limit (50 MPH) and continue into the zone

2.13 You are approaching a work zone while driving on the interstate at 70 MPH. Signs indicate that the left lane will be closed ahead, and you encounter the following pair of signs. Looking ahead, there seems to be activity at the work zone. What action will you plan to take?



- I will do nothing, and continue into the work zone traveling the same speed
- I will slow down slightly (to 65 MPH) and continue into the zone
- I will slow down moderately (to 60 MPH) and continue into the zone



- I will slow down significantly (to 55 MPH) and continue into the zone
- I will slow down to the work zone speed limit (50 MPH) and continue into the zone

2.14 You are approaching a work zone while driving on the interstate at 70 MPH. Signs indicate that the left lane will be closed ahead, and you encounter the pair of signs pictured below. What action will you plan to take?



- I will do nothing, and continue into the work zone traveling the same speed
- I will slow down slightly (to 65 MPH) and continue into the zone
- I will slow down moderately (to 60 MPH) and continue into the zone
- I will slow down significantly (to 55 MPH) and continue into the zone
- I will slow down to the work zone speed limit (50 MPH) and continue into the zone

### Section 3: Respondents' Travel Characteristics and Patterns

*Please answer the following questions considering your typical behavior **prior to any restrictions related to the COVID-19 pandemic.***

3.1 How many personal vehicles does your household own?

0 \_\_\_\_\_ 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ > 4 \_\_\_\_\_

3.2 How many miles approximately did you drive your personal vehicle (owned by your household) last year?

I do not own a personal vehicle \_\_\_\_\_ <5,000 miles \_\_\_\_\_ 5,000-9,999 miles \_\_\_\_\_ 10,000-14,999 miles \_\_\_\_\_ 15,000-19,999 miles \_\_\_\_\_ 20,000-24,999 miles \_\_\_\_\_ >25,000 miles \_\_\_\_\_ I do not know \_\_\_\_\_

### 3.3 Thinking about how far you typically drive, how often on average do you travel...?

	Never	Less often than every 6 months	Every 6 months	Every 3 months	Once a month	Once every two weeks	Once a week	2-3 times a week	4-7 times a week
<b>A.</b> Distances near to where I live (up to 10 miles)									
<b>B.</b> Medium distances (10-50 miles)									
<b>C.</b> Longer distances (more than 50 miles)									

### 3.4 How often on average do you travel on the following types of roadway?

	Never	Every 6 months or less	Every 3 months	Once a month	Once every two weeks	Once a week	2-3 times a week	4-7 times a week
<b>A.</b> Interstate								
<b>B.</b> Four-Lane Urban Road								
<b>C.</b> Four-Lane Rural Road								
<b>D.</b> Two-Lane Rural Road								

## Section 4: Socio-Demographic Questions

### 4.1 What is your employment situation?

Work full time \_\_\_\_\_ Work part time \_\_\_\_\_ Homemaker \_\_\_\_\_ Student \_\_\_\_\_ Retired \_\_\_\_\_  
Other: \_\_\_\_\_

### 4.2 What is your approximate annual household income before taxes?

Under \$25,000 \_\_\_\_\_ \$25,000–\$49,999 \_\_\_\_\_ \$50,000–\$74,999 \_\_\_\_\_  
\$75,000– \$99,999 \_\_\_\_\_ \$100,000–\$149,999 \_\_\_\_\_ \$150,000 or more \_\_\_\_\_  
I do not wish to disclose this information \_\_\_\_\_

### 4.3 What is your highest level of education?

Grade school or less \_\_\_\_\_ Some high school \_\_\_\_\_ High school graduate \_\_\_\_\_  
Technical training beyond high school \_\_\_\_\_ Some college \_\_\_\_\_ College graduate \_\_\_\_\_  
Graduate or professional school \_\_\_\_\_

### 4.4 Do you have a valid Indiana driver's license?

- A. Yes
- B. No, but I have/have previously had a valid license issued in another US state or another country
- C. No, I have never had a driver's license issued in the US or elsewhere

If you chose C, please proceed to question 4.8. Otherwise, please continue with question 4.5

### 4.5 How many years have you been driving? (if less than 1, enter 0) \_\_\_\_\_

### 4.6 Please rate your driving ability on the scale provided below:

- ☐ Very Poor
- ☐ Below Average
- ☐ Average
- ☐ Above Average
- ☐ Excellent

4.7 How many crashes/collisions have you experienced in the past 3 years while *driving* a vehicle? A crash or collision occurs when the vehicle strikes any object, including other vehicles, persons, trees, poles, fences, a ditch, and any other roadside object. Do not include incidents involving animals. \_\_\_\_\_

### 4.8 How many years have you resided in Indiana? (If less than 1, enter 0) \_\_\_\_\_

### 4.9 What is your ZIP Code? \_\_\_\_\_

## APPENDIX B. MEDIA USED IN THE SURVEY

### Ramp Meter



Figure B.1 Ramp meter image (used with permission from the Arizona Department of Transportation (ADOT, 2017)). Site photographed is along Arizona State Route 51 in the Phoenix area.

### Roundabout

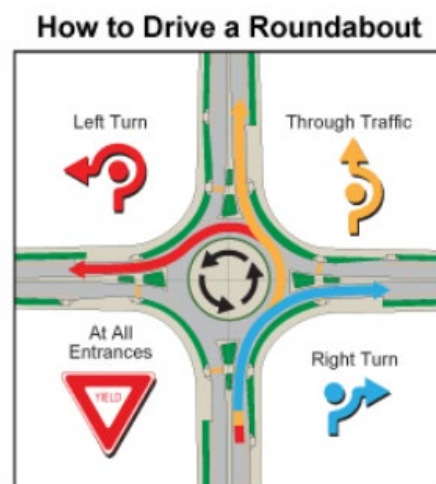


Figure B.2 Roundabout diagram (INDOT, n.d.).

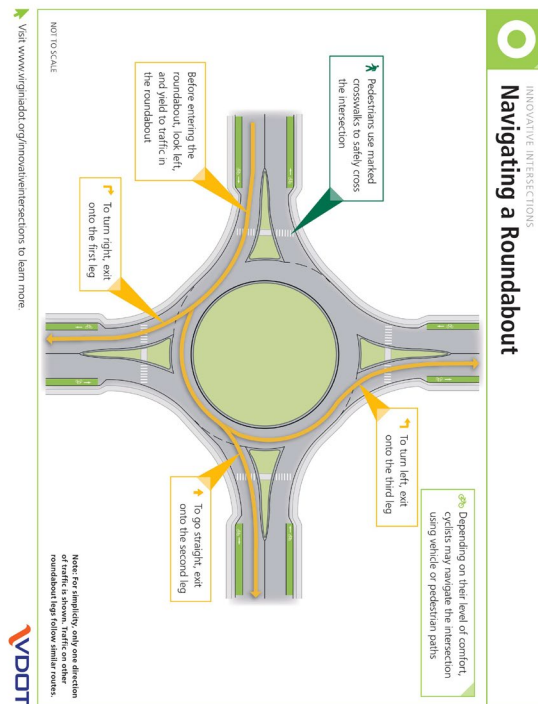


Figure B.3 Roundabout flyer (VDOT, 2020b).



Figure B.4 Roundabout video screen capture (VDOT, 2018c).



## Displaced Left Turn (DLT)

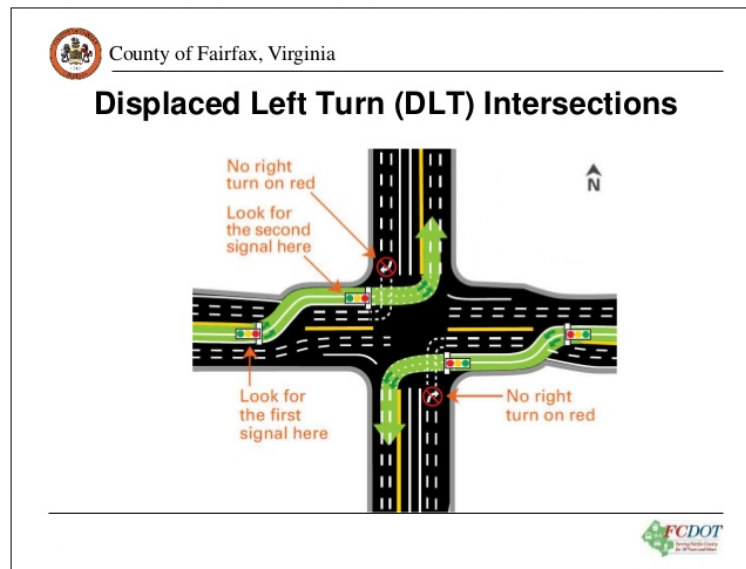


Figure B.5 Displaced left turn diagram (VDOT, 2020).

### INNOVATIVE INTERSECTIONS

## Displaced Left Turn (DLT)

State Route 741 (N Springboro Pike) at Austin Boulevard, Manassasburg, OH

**A DLT IS ALSO KNOWN AS:**

- Continuous Flow Intersection (CFI)
- Crossover Displaced Left (XDL) Intersection

**What is a DLT?**

- Intersection design where left-turn vehicles cross to the other side of the opposing through traffic in advance of the main intersection
- Protected left turns and opposing through movements occur simultaneously at the main intersection
- Intersection can be designed as a partial DLT, with crossovers for left turns only on the major street, or a full DLT, with crossovers for left turns on both the major and side streets
- Main intersection and crossovers are signalized and timed to work together to minimize stops

**When should a DLT be considered?**

- At intersections with moderate to heavy traffic volumes in all directions
- At intersections where opposing legs have similar through traffic volumes
- At intersections with heavy left-turn traffic volumes
- At intersections with a limited number of driveways or access points near the intersection

**What are the benefits of a DLT?**

- **Improved safety:** Reduces and spreads out the number of points where vehicles may cross paths
- **Increased efficiency:** Simultaneous movement of protected left turns and opposing through movements allows for only two traffic signal phases rather than the typical four phases, which reduces delay
- **Better synchronization:** Elimination of left-turn traffic signal phases and synchronization of the main intersection and crossover traffic signals allows through traffic to spend less time stopped, which improves corridor travel times

**What are innovative intersections?**

Intersection designs where traffic movements are modified to improve safety, reduce delay, and increase efficiency.

Visit [www.virginiadot.org/innovativeintersections](http://www.virginiadot.org/innovativeintersections) to learn more.

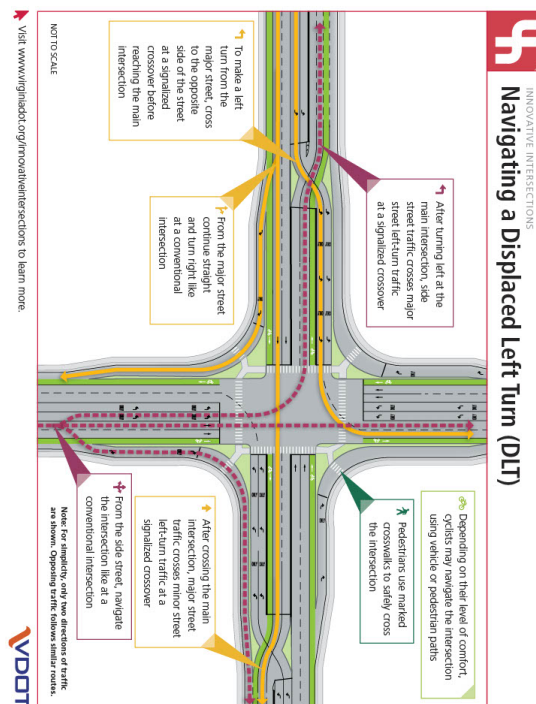


Figure B.6 Displaced left turn flyer (VDOT, 2020a).



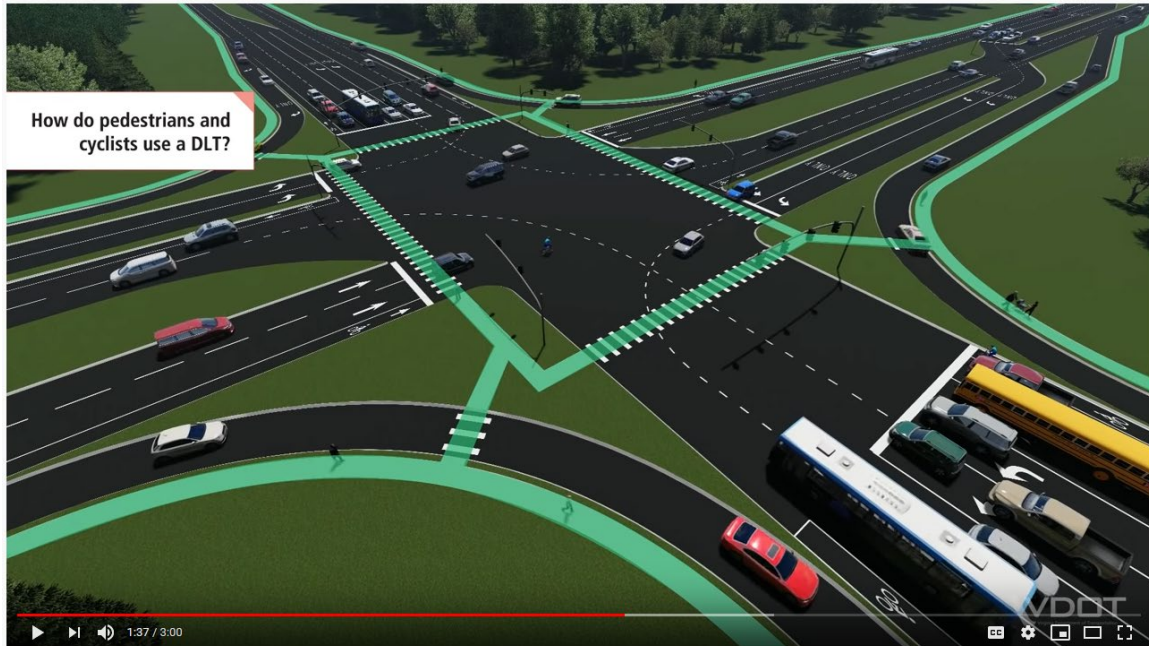


Figure B.7 Displaced left turn video screen capture (VDOT, 2018a).

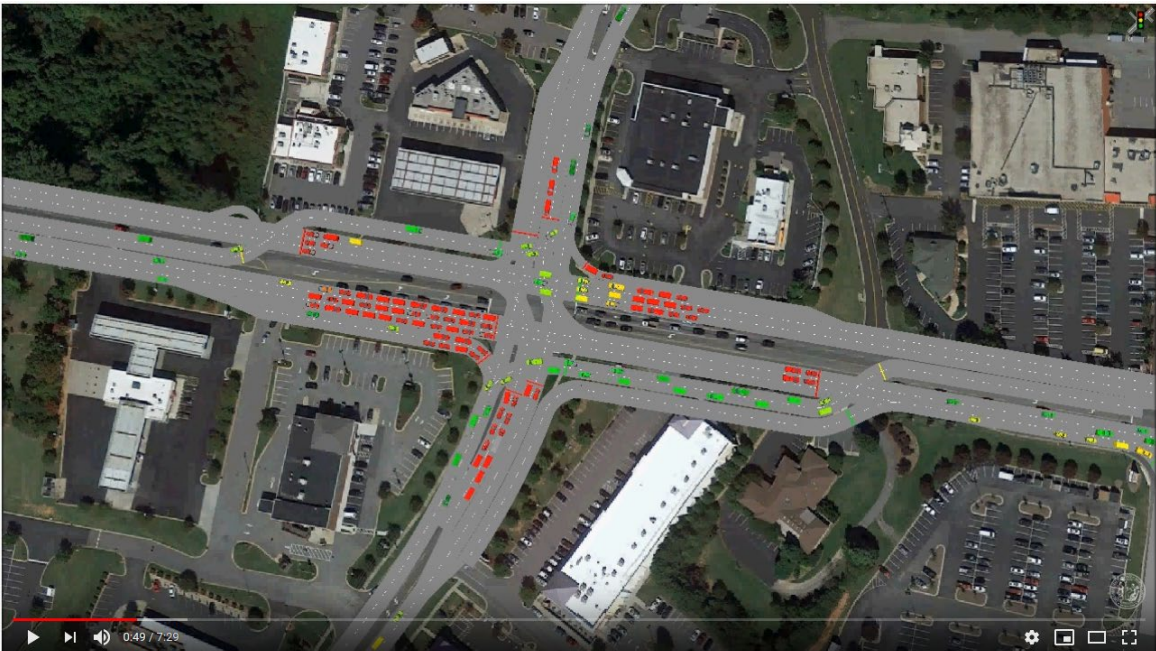


Figure B.8 Displaced left turn simulation screen capture (NCDOT, 2016).

*Note: Although the video is 7:29 long, participants were not required to watch more than the first minute.*

## Diverging Diamond Interchange (DDI)

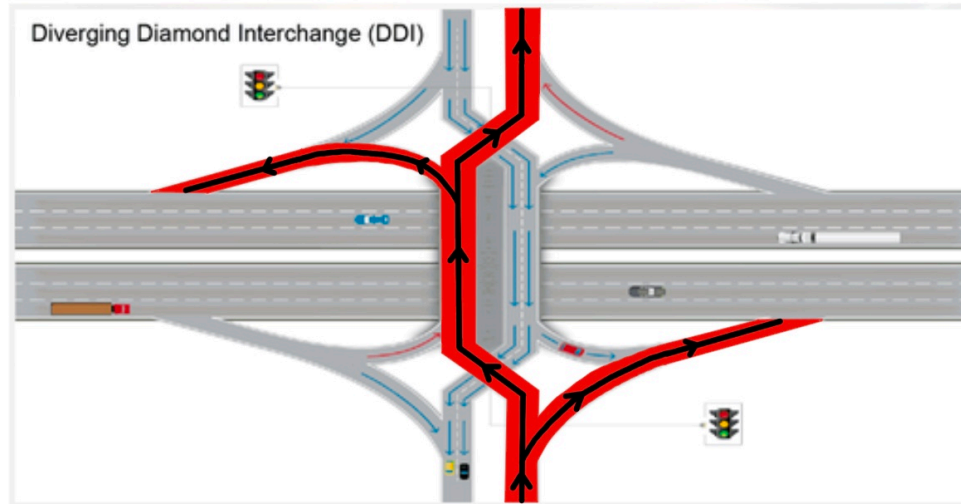


Figure B.9 Diverging diamond interchange diagram (adapted from WisDOT, n.d.).

**INNOVATIVE INTERCHANGES**  
**Diverging Diamond Interchange (DDI)**

**A DDI IS ALSO KNOWN AS:**  
 ■ Double Crossover  
 ■ Diamond Interchange

**What is a DDI?**

- A grade-separated interchange design where arterial traffic crosses to the other side of the roadway between the freeway ramps
- Vehicles can turn left onto and off freeway ramps without stopping or crossing opposing lanes of traffic
- Right turns onto and off the freeway ramps occur either before or after the crossover intersections, when traffic is on the "correct" side of the road
- Both crossover intersections are signalized
- Interchange can be designed as an overpass or underpass

**When should a DDI be considered?**

- At locations with heavy left-turn traffic volumes onto and off the freeway ramps
- At locations without adjacent traffic signals or nearby driveways
- At locations where there is limited roadway width for left-turn lanes between ramp intersections and limited right-of-way to expand

**What are the benefits of a DDI?**

- **Improved safety:** Reduces the number of points where vehicles may cross paths
- **Increased efficiency:** Crossovers can operate with only two traffic signal phases, which allows the interchange to handle a greater volume of traffic and operate with less delay
- **Easier access to freeway:** Design allows traffic to enter and exit the freeway without crossing opposing lanes of traffic
- **Cost effective:** Since there are no left-turn lanes on the arterial, a DDI can have a narrower cross section and may be more cost effective than a retrofit or new interchange construction

**What are innovative interchanges?**  
 Interchange designs where traffic movements are modified to improve safety, reduce delay, and increase efficiency.  
 Visit [www.virginiadot.org/innovativeintersections](http://www.virginiadot.org/innovativeintersections) to learn more.

**VDOT**

I-64 at US 15 (James Madison Hwy), Zion Crossroads, VA

**INNOVATIVE INTERCHANGES**  
**Navigating a Diverging Diamond Interchange (DDI)**

**NOT TO SCALE**

Depending on their level of comfort, cyclists may navigate the intersection using vehicle or pedestrian paths

Pedestrians use marked crosswalks to safely navigate the interchange

To continue straight on the arterial, follow lane markings and traffic signals to cross to the left side of the arterial, and then cross to the right side after passing through the interchange

To turn left from a freeway ramp, follow lane markings and traffic signals to stay on the left side of the arterial, and then cross to the right side after passing through the interchange

To turn right from a freeway ramp, use the right-turn lane like at a conventional diamond interchange

To turn left onto a freeway ramp from the arterial, follow lane markings and traffic signals to stay on the left side of the arterial, and then turn left onto the ramp

Note: For simplicity, only two directions of traffic are shown. Opposing traffic follows similar routes.

**VDOT**

Visit [www.virginiadot.org/innovativeintersections](http://www.virginiadot.org/innovativeintersections) to learn more.

Figure B.10 Diverging diamond interchange flyer (VDOT, 2020).





Figure B.11 Diverging diamond interchange video simulation (VDOT, 2018b).



Figure B.12 Diverging diamond interchange simulation video.

## REFERENCES FOR APPENDICES

- ADOT. (2017, August 7). *Arizona State Route 51 ramp meter*. [Photograph]. Arizona Department of Transportation. <https://azdot.gov/adot-news/next-round-sr-51-ramp-meter-adjustments-begins>
- INDOT. (n.d.). *How to drive a roundabout* [Illustration]. Retrieved October 29, 2020, from <https://www.in.gov/indot/3249.htm>
- NCDOT. (2016). *Continuous flow intersection* [Video]. YouTube. <https://www.youtube.com/watch?v=Xjwpz3qCUm0&t=49s>
- VDOT. (2018a). *VDOT's innovative intersections: Displaced left turn* [Video]. YouTube. <https://www.youtube.com/watch?v=H1ZtO9cwmyY&list=PLiCpIfP-UWcAyWyzg75uZ0UI6m44evCeT&index=7>
- VDOT. (2018b). *VDOT's innovative intersections: Restricted crossing u-turn* [Video]. YouTube. <https://www.youtube.com/watch?v=g1SA1mAXmfk&list=PLiCpIfP-UWcAyWyzg75uZ0UI6m44evCeT&index=8&t=1s>
- VDOT. (2018c). *VDOT's innovative intersections: Roundabouts* [Video]. YouTube. <https://www.youtube.com/watch?v=fPbWjoSYU1Q&list=PLiCpIfP-UWcAyWyzg75uZ0UI6m44evCeT&index=3&t=9s>
- VDOT. (2020a). *Innovative intersections: Displaced left turn (DLT)* [PDF file]. Virginia Department of Transportation. [http://www.virginiadot.org/images/innovate/DLT\\_Final\\_082417.pdf](http://www.virginiadot.org/images/innovate/DLT_Final_082417.pdf)
- VDOT. (2020b). *Innovative intersections: Roundabout* [PDF file]. Virginia Department of Transportation. [http://www.virginiadot.org/images/innovate/Roundabout\\_Final\\_082417.pdf](http://www.virginiadot.org/images/innovate/Roundabout_Final_082417.pdf)
- VDOT. (2020b). *Innovative intersections: Diverging Diamond Interchange (DDI)* [PDF file]. Virginia Department of Transportation. [http://www.virginiadot.org/images/innovate/DDI\\_Final\\_082417\\_rotate.pdf](http://www.virginiadot.org/images/innovate/DDI_Final_082417_rotate.pdf)
- WisDOT. (n.d.). *Diverging diamond interchange (DDI)* [Webpage]. Wisconsin Department of Transportation. Retrieved October 29, 2020, from <https://wisconsindot.gov/Pages/safety/safety-eng/inter-design/ddi.aspx>

## About the Joint Transportation Research Program (JTRP)

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. That collaborative effort was called the Joint Highway Research Project (JHRP). In 1997 the collaborative venture was renamed as the Joint Transportation Research Program (JTRP) to reflect the state and national efforts to integrate the management and operation of various transportation modes.

The first studies of JHRP were concerned with Test Road No. 1 — evaluation of the weathering characteristics of stabilized materials. After World War II, the JHRP program grew substantially and was regularly producing technical reports. Over 1,600 technical reports are now available, published as part of the JHRP and subsequently JTRP collaborative venture between Purdue University and what is now the Indiana Department of Transportation.

Free online access to all reports is provided through a unique collaboration between JTRP and Purdue Libraries. These are available at <http://docs.lib.purdue.edu/jtrp>.

Further information about JTRP and its current research program is available at <http://www.purdue.edu/jtrp>.

## About This Report

An open access version of this publication is available online. See the URL in the citation below.

Adsit, S. E., Konstantinou, T., Gkritza, K., & Fricker, J. D. (2021). *Public acceptance of INDOT's traffic engineering treatments and services* (Joint Transportation Research Program Publication No. FHWA/IN/JTRP-2021/01). West Lafayette, IN: Purdue University. <https://doi.org/10.5703/1288284317280>