# ASSESSING PUBLIC INCONVENIENCE IN HIGHWAY WORK ZONES

**Final Report**

**SPR PROJECT 333**

# ASSESSING PUBLIC INCONVENIENCE IN HIGHWAY WORK ZONES

## Final Report

### STATE PLANNING AND RESEARCH 333

by

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16. Abstract

The traveling public is making increasingly frequent contact with the Oregon Department of Transportation (ODOT) when entering a work zone. Because ODOT remains very sensitive to the needs of the public, it is important to understand their opinions and values. The objective of this research was to conduct a series of focus groups and surveys to investigate highway users' views and their priorities relating to highway work zones. ODOT conducted six focus groups with motorists, school bus drivers, fire and emergency vehicle operators, business owners, and truck drivers. From the focus group results, two surveys were developed and conducted: one with motorists, stratified by geographic area (n=2,002); and a truck driver survey (n=448).

Key study results: Highway users noted the lack of nighttime visibility in work zones and problems seeing signs, lane markings, barriers, and construction personnel at night. Truck drivers also described problematic night work zone lighting, (light plants, rotor beams, headlights, etc.). Drivers voiced willingness to accept 12- to 15-minute construction related delays. Highway users in more populated regions experienced longer actual delays than those in rural areas and reported lower tolerance of acceptable delay. All groups cited the need for greater speed enforcement as an essential change for work zones. Drivers most often used signs, television, radio, and newspapers as sources of work zone information. The authors recommend further review of the prevailing problems and identified trends in order to develop corrective action or mitigation strategies.

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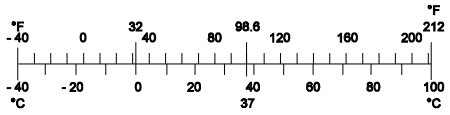
# SI* (MODERN METRIC) CONVERSION FACTORS

## APPROXIMATE CONVERSIONS TO SI UNITS

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| In | Inches | 25.4 | Millimeters | Mm |
| Ft | Feet | 0.305 | Meters | M |
| Yd | Yards | 0.914 | Meters | M |
| Mi | Miles | 1.61 | Kilometers | Km |
| | | **AREA** | | |
| $In^2$ | Square inches | 645.2 | millimeters | $mm^2$ |
| $Ft^2$ | Square feet | 0.093 | meters squared | $M^2$ |
| $Yd^2$ | Square yards | 0.836 | meters squared | $M^2$ |
| Ac | Acres | 0.405 | Hectares | Ha |
| $Mi^2$ | Square miles | 2.59 | kilometers squared | $Km^2$ |
| | | **VOLUME** | | |
| Fl oz | Fluid ounces | 29.57 | Milliliters | ML |
| Gal | Gallons | 3.785 | Liters | L |
| $Ft^3$ | Cubic feet | 0.028 | meters cubed | $m^3$ |
| $Yd^3$ | Cubic yards | 0.765 | meters cubed | $m^3$ |
| NOTE: Volumes greater than 1000 L shall be shown in $m^3$. | | | | |
| | | **MASS** | | |
| Oz | Ounces | 28.35 | Grams | G |
| Lb | Pounds | 0.454 | Kilograms | Kg |
| T | Short tons (2000 lb) | 0.907 | Megagrams | Mg |
| | | **TEMPERATURE (exact)** | | |
| °F | Fahrenheit temperature | 5(F-32)/9 | Celsius temperature | °C |

## APPROXIMATE CONVERSIONS FROM SI UNITS

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| Mm | Millimeters | 0.039 | inches | in |
| M | Meters | 3.28 | feet | ft |
| M | Meters | 1.09 | yards | yd |
| Km | Kilometers | 0.621 | miles | mi |
| | | **AREA** | | |
| $mm^2$ | millimeters squared | 0.0016 | square inches | $in^2$ |
| $m^2$ | meters squared | 10.764 | square feet | $ft^2$ |
| Ha | Hectares | 2.47 | acres | ac |
| $km^2$ | kilometers squared | 0.386 | square miles | $mi^2$ |
| | | **VOLUME** | | |
| ML | Milliliters | 0.034 | fluid ounces | fl oz |
| L | Liters | 0.264 | gallons | gal |
| $m^3$ | meters cubed | 35.315 | cubic feet | $ft^3$ |
| $m^3$ | meters cubed | 1.308 | cubic yards | $yd^3$ |
| | | **MASS** | | |
| G | Grams | 0.035 | ounces | oz |
| kg | Kilograms | 2.205 | pounds | lb |
| Mg | Megagrams | 1.102 | short tons (2000 lb) | T |
| | | **TEMPERATURE (exact)** | | |
| °C | Celsius temperature | 1.8 + 32 | Fahrenheit | °F |




* SI is the symbol for the International System of Measurement

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## DISCLAIMER

# ASSESSING PUBLIC INCONVENIENCE IN HIGHWAY WORK ZONES

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# EXECUTIVE SUMMARY

The traveling public is making increasingly frequent contact with the Oregon Department of Transportation (ODOT) when entering a work zone. Because ODOT remains very sensitive to the needs of the public, it is important to understand their opinions and values. The objective of this research was to conduct a series of focus groups and surveys to investigate highway users' views and their priorities relating to highway work zones. In addition, a literature review was completed which looked at how other state and federal transportation agencies have addressed the issue of reducing inconvenience to highway users in work zones.

Six focus groups were assembled with the intent of determining the public's perceptions and what they value as important when traveling through a highway construction or maintenance work area. The six groups consisted of: (1) two groups of general motorists; (2) one group of school bus drivers; (3) a group of business owners; (4) one group of fire and emergency service personnel; and (5) a group of truck drivers from an interstate trucking company.

For all six focus groups, one of the most frustrating aspects of work zones was not seeing workers present when signs indicated "Workers Ahead." Greater enforcement of speeds was cited by all groups as an essential change needed in work zones. The focus groups also wanted better work zone markings for temporary lanes, lane changes, and merging zones. Nighttime visibility and problems seeing construction personnel at night were also identified as work zone issues by the focus groups.

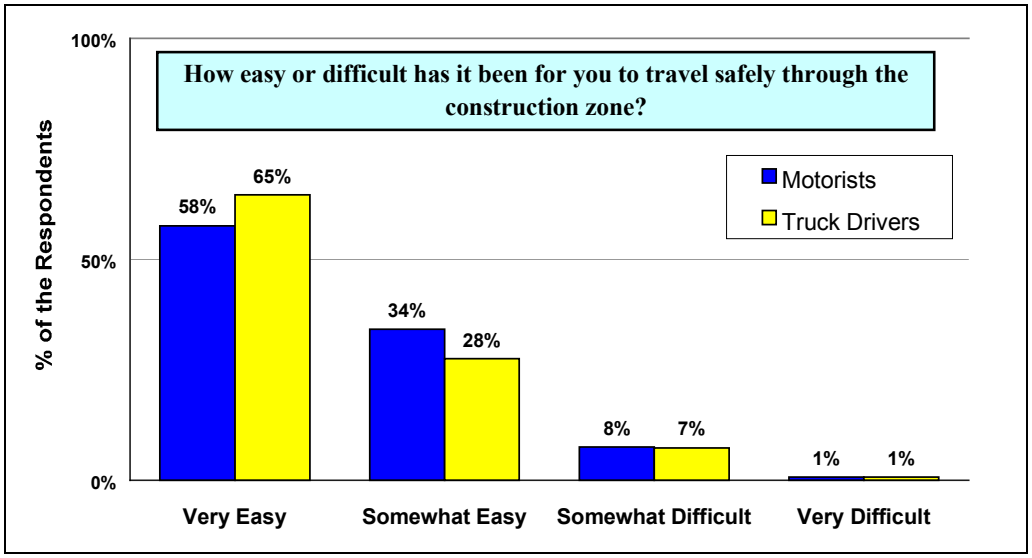
Two surveys were carried out as part of the study. The first one, with motorists (n=2,002), was stratified by ODOT Region (n≈400 in each region). The other was a survey of truck drivers (n=448), which consisted of an on-site survey of truck drivers at two highway rest areas, and a telephone survey. The motorist and truck driver surveys showed an overall positive response to ODOT's management of highway work zones. In Regions 3, 4, and 5, motorists' views of acceptable delays closely matched what they were actually experiencing. In Regions 1 and 2, longer delays were being experienced, partially due to the increased traffic congestion. Motorists ranked speed enforcement in work zones as the most important area to improve in four of the five regions. Region 1 respondents expressed the need to improve nighttime visibility as its number one priority.

The majority of people surveyed did not actively seek advance information about construction work zones prior to traveling. Those that sought advance information primarily used newspapers, electronic media (radio and television), and telephone calls to ODOT. Internet usage as an advance source of information was very low throughout the state.

Truck drivers' opinions on highway work zones were found to be slightly different than those of motorists, but were still consistent overall. Truck drivers provided a variety of suggestions to improve work zones. Their comments included increasing the alertness, visibility and location of

flaggers, as well as making them aware of unique requirements for the stopping and starting of large trucks. Truck drivers regarded glare from construction lighting (light plants, rotor beams, headlights, etc.) as the principal inconvenience within work zones. Unlike motorists, truck drivers rely heavily on CB radios, followed by construction signs, as sources of information about highway work zones. The use of newspapers, television, or the Internet is very low as an information source for truck drivers.

Truck drivers were also asked to respond to a hypothetical scenario involving two possible alternatives for a bridge construction project. Option (A) was to completely close the bridge for two months, and required a 20-mile detour. Option (B) was to leave the bridge open, but drivers would be faced with daily 15-minute delays for a 6-month period. A slight majority chose to close the bridge for two months with a 20-mile detour. The truck drivers' choice reinforces the notion of the public's desire for the highway agency to "get in, get out, and stay out."




Overall, motorists and truck drivers felt they could drive safely through work zones, with more than 90% saying it had been "very" or "somewhat" easy to safely travel through them. Further, highway users were generally satisfied with how ODOT manages construction and maintenance work zones. Over 86% gave ODOT an "excellent" or "good" rating for the management of these areas. Still, this study raised several specific issues that should be addressed to reduce user inconvenience within work zones. These include: (1) greater enforcement of speeds; (2) reducing delay in the work zone; (3) better nighttime visibility and reductions in glare from construction lights; (4) making improvements to signs and striping; (5) improving flagger awareness and visibility; and (6) aligning information sources with the public's methods for obtaining information about construction. Addressing these issues may help provide a more safe and convenient highway work zone for the public and for highway workers. The authors recommend further review of the prevailing concerns and trends identified in this report in order to develop corrective actions or mitigation strategies.

# 1.0 INTRODUCTION

## 1.1 PROBLEM STATEMENT

Highway construction and maintenance operations today are almost always accomplished in the presence of traffic. In order to preserve the Oregon Department of Transportation (ODOT) system of highways and bridges, impacts to the public are inevitable. This is especially problematic on primary highways where high traffic volumes make construction and maintenance activities difficult to undertake without affecting the traveling public and local communities.

The traveling public is making increasingly frequent contact with ODOT when entering a work zone. Maintenance and construction activities frequently impact highway users, including motorists, truckers, pedestrians, cyclists, and transit riders. Additionally, many maintenance and construction projects affect adjacent businesses and neighborhoods. ODOT must consider the views of these highway users and stakeholders when planning and carrying out its maintenance and construction program. They are ODOT's customers, and just as in any business, the Department must fully understand its customer needs, and appreciate the significance of their problems.

The Department's commitment to the public is to provide a safe, reliable and predictable trip through its work zones. ODOT is dedicated to making improvements in its planning, design, construction, and maintenance practices to achieve this objective. Because ODOT remains very sensitive to the needs of its customers, it is essential to find out the public's opinions, and what they value as important. As a tool for making positive change, this research project was undertaken to determine the public's perceptions, their values and relative priority.

## 1.2 OBJECTIVES

The overarching goal of this study was to determine the public values and perceptions about ODOT's highway maintenance and construction program. Thus, the results of the research should provide ODOT planning, design, construction and maintenance personnel with credible information about its customers, to enable them to consider appropriate changes to better serve the public. Specific objectives included:

1. To review previous related research to assess how motorists perceive delay and inconvenience associated with highway construction and maintenance activities.
2. To develop survey research instruments that can be used to identify issues and concerns, and to provide a benchmark of perceptions about ODOT's highway maintenance and construction planning processes and operation.

3. To utilize these instruments to conduct a series of surveys stratified by geographic area and a series of surveys of specific groups, such as commercial trucking companies, neighborhood associations, and businesses.
4. From the data collection and analysis, identify the specific concerns, problems, and priorities that the public regards as important when planning and carrying out construction and maintenance projects.
5. To determine how the results can be incorporated into ongoing policy, planning, and construction and maintenance activities to reduce the adverse impacts to the public.

# 2.0 DATA COLLECTION METHODOLOGY

## 2.1 LITERATURE REVIEW

The first step in the research effort was a review of available literature to determine what other state transportation departments are doing to address, measure, and mitigate public inconvenience. The results of the literature review are presented in Chapter 3.

## 2.2 EXPERIMENT DESIGN

With input from the research Technical Advisory Committee, an experimental design was developed that created a framework for data collection. Data collection methods included focus groups and surveys.

### 2.2.1 Focus Groups

Representatives from the University of Oregon Survey Research Laboratory (OSRL) and the authors conducted focus groups of targeted population groups. Each focus group represented a highway user stakeholder category, e.g., motorists, truckers, emergency vehicle operators, and businesses. The purpose of the focus groups was to obtain in-depth qualitative information to help ODOT understand the problems faced by those impacted by maintenance and construction activities. The results of each session's discussions were used to build the survey instruments. The focus group results are summarized in Chapter 4.

### 2.2.2 The Survey Plan

Based on the information obtained from the focus groups, a survey plan was developed by the Technical Advisory Committee, OSRL and the authors. The survey plan's components included the target population, sampling methods, target number of surveys and the survey instrument.

#### *2.2.2.1 Target Population*

A decision was made to survey two groups of highway users: (1) motorists (who personally own cars, small trucks, and sport utility vehicles); and (2) truck drivers. Later, the term "motorist" was broadened to include people who do not regularly drive, but do ride in cars, small trucks, or sport utility vehicles as a passenger. In this report the term "motorists " includes both surveyed drivers and passengers. Truck drivers were defined as those who drive truck-tractors pulling a single semi-trailer or sets of trailers. Other highway user groups (bus drivers, emergency vehicle operators, etc.) were not targeted because of limited funds, and because their responses in the focus groups were, on whole, very similar to the motorists or truck drivers.

#### *2.2.2.2 Sampling Methods*

Motorists

The motorist survey was a computer-assisted telephone survey. People were selected to be surveyed on a random basis using "random-digit dial" procedures. In random-digit dialing, telephone numbers are generated randomly by the computer and appear automatically on interviewers' computer screens. Telephone calls are placed with a computer keystroke, effectively preventing dialing errors. This sampling system avoids biases encountered from telephone books and similar lists. In addition, new and unlisted telephone numbers have an equal chance of being selected as established numbers (*Gwartney and Wolf 2001*). Thus, every Oregonian with a telephone number had an equal chance of being contacted for the survey.

Truck Drivers

The truck driver survey used two methodologies. The first was an "intercept" survey at Interstate Rest Areas. Two rest areas were chosen; Oak Grove rest area on I-5 north of Eugene; and Memaloose rest area on I-84 east of Hood River. The intercept surveys were conducted by trained interviewers from OSRL on two separate weekdays in July 2001. Interviewers approached truck drivers after they were outside their vehicles and asked them to participate in a survey related to highway work zones. Those who agreed were asked a series of questions about work zones.

Truck driver opinions were also collected using a computer-assisted telephone survey of drivers selected from a database provided to OSRL by ODOT's Motor Carrier Division. Two survey methods were used for truck drivers because there was some uncertainty about how effective either method would be at capturing work zone related information from truck drivers. By employing both methods, it was reasoned that adequate coverage would be achieved.

#### *2.2.2.3 Number of Surveys*

Motorists

The plan established a goal of 2,000 respondents to the motorist survey, stratified by ODOT regions as shown in Figure 3.1. Within each region, either 400 or 401 surveys were completed. Most respondents were licensed drivers; 48 said they were not, but they had regularly ridden in cars or small trucks as a passenger through work zones.

Truck Drivers

The Interstate rest area survey was not random. During the eight-hour survey period every truck driver was approached and asked to participate, with the goal of completing as many surveys as possible. The number of completed interviews at each site was:

| | |
|---|---|
| I-5 north of Eugene | 77 respondents |
| I-84 east of The Dalles | 64 respondents |
| **Total** | 141 respondents |

The goal for the telephone survey of truck drivers was set at 250 interviews. Because of OSRL's efficiency in conducting the survey, 305 interviews were completed.

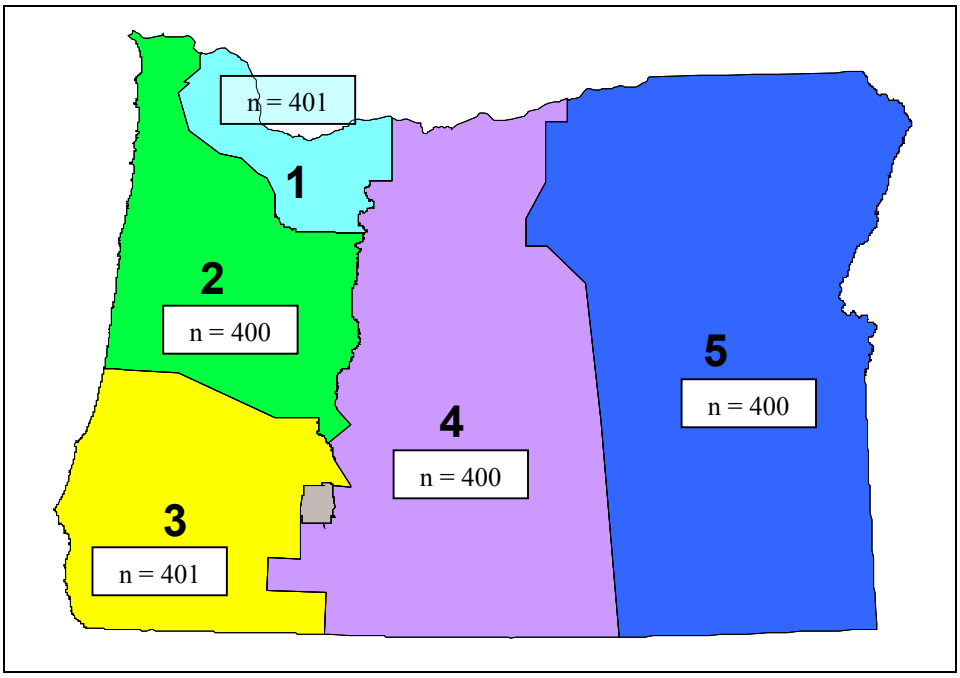



Figure 3.1: ODOT Regions

### *2.2.2.4 Survey Questionnaires*

Motorists

Questionnaires were developed jointly by the research Technical Advisory Committee and OSRL. The final questionnaire for motorists had over 80 questions related to work zones as well as a variety of demographic questions (age, education, number of years driving, etc.). The questionnaire is included in this report as Appendix A.

Truck Drivers

The truck driver questionnaire consisted of over 35 questions. Most of them were similar to the questions asked in the motorist survey. The same questionnaire was employed for the "intercept" rest area survey and the truck driver telephone survey. The questionnaire is included in this report as Appendix B.

The results of the motorists survey and truck driver surveys are presented in Chapters 5 and 6 respectively.

# 3.0 LITERATURE REVIEW

## 3.1 FEDERAL HIGHWAY ADMINISTRATION INITIATIVES

There has been a dedicated effort over the past five years to minimize impacts to the public as they travel through work zones. While national data on the cost of work zone delays is not readily available, daily road-user delay costs on many urban freeway reconstruction projects have been calculated to be over $50,000 per day *(FHWA 1998)*. Because of the significant impacts to the public in terms of delay and user costs, the Federal Highway Administration (FHWA) established the Strategic Work-Zone Analysis Tools (SWAT) program. It addresses work-zone factors and stresses the importance of accounting for work-zone influences when making transportation improvement decisions *(Harding 2000)*. Three tools are being developed as part of the SWAT program:

- An "Expert System" software program;
- "Quick Zone" software program whose features consist of:
    - A traffic impact analysis spreadsheet;
    - A cost/alternative analysis spreadsheet; and
- A detailed simulation model.

### 3.1.1 Expert System

With the Expert System, a user would enter data on the characteristics of the work zone, such as the type of highway improvement or repair work being done and the duration of the work. The program would then provide a list of possible mitigation strategies for reducing work zone delays and costs. The software is still being developed by FHWA and its expected release date is 2004. More information can be found on the FHWA Turner-Fairbank Research Center web site at http://www.tfhrc.gov/////its/swat.htm.

### 3.1.2 Quick Zone

Quick Zone is a spreadsheet based software program (Microsoft Excel 97) that will estimate traveler delay due to work zones. Specifically, the program provides the following functions:

- Quantification of corridor delay resulting from capacity decreases in work zones.
- Identification of delay impacts of alternative project phasing plans.
- Supporting tradeoff analyses between construction costs and delay costs.
- Examination of impacts of construction staging, by:
    - location along mainline;
    - time-of-day (peak vs. off-peak); and
    - season (summer vs. winter).
- Assessment of travel demand measures and other delay mitigation strategies.

- Allowing the establishment of work completion incentives.

The software is available for download at FHWA's Turner-Fairbank Research Center website at: http://www.tfhrc.gov/////its/quickzon.htm.

### 3.1.3 Simulation Model

FHWA's simulation model, planned for release in 2004, is designed to be used in conjunction with Quick Zone to more precisely estimate the impacts of specific work zone strategies and the effectiveness of mitigation techniques. More information about the model can be found at the Turner-Fairbank Research Center website: http://www.tfhrc.gov/////pubrds/nov00/strategic.htm.

### 3.1.4 National Work Zone Safety Information Clearinghouse

FHWA has also been instrumental in establishing the National Work Zone Safety Information Clearinghouse, which serves as a comprehensive information source and referral service regarding work zone operations and safety. The clearinghouse has been operating since February 1998. It currently operates under a cooperative partnership between the American Road & Transportation Builders Association and the Texas Transportation Institute. Examples of work zone related information that can be accessed online at the site include work zone best practices, and descriptions and related technological advances associated with work zone traffic control devices. The clearinghouse's Internet site can be found at: http://wzsafety.tamu.edu/.

## 3.2 METHODS AND PROCEDURES TO REDUCE MOTORIST DELAYS IN EUROPEAN WORK ZONES

In 2000, FHWA and the National Cooperative Highway Research Program (NCHRP) sponsored a scanning tour throughout several European countries to assess their techniques of managing traffic flow through temporary work zones. The members then reported *(Steinke et. al 2000)* back on the observations they made during their visit in *Methods and Procedures to Reduce Motorists Delays in European Work Zones*. This publication is also available at FHWA's International Program's website at: http://www.international.fhwa.dot.gov/Pdfs/workzonebook.pdf.

A summary of the report's key findings includes:

1. In their bidding processes, the European highway agencies encourage proposals that minimize the duration of the work zone.
2. Overhead signs are more prevalent in Europe than in the United States. European drivers are much more attuned to looking upward at overhead signs for guidance and advice on road conditions. When roadside signs are used, they are often placed on the left side of the roadway in the median where they are less likely to be obstructed by other vehicles, mainly large trucks.
3. European highway agencies promote early involvement and coordination by all public sector and private sector organizations involved in the highway construction project.

4. Narrower lanes are used, including shoulders, in order to maintain the number of lanes in the work zone.
5. Yellow pavement markings are used exclusively in work zones. In all other cases, white is used (including centerlines and edgelines).
6. Quality control/quality assurance programs are in place for traffic control and worker safety.

Based on these findings, the scanning team also made several recommendations for U.S. highway agencies, which are included in their report *(Steinke et. al 2000)*.

## 3.3 MOTORISTS' PERCEPTION OF WORK ZONE SAFETY

Kane and others *(1998)* studied motorists' perception about work zone safety in North Carolina. The objective was to examine motorists' perceptions, opinions, expectations and other psychological factors that influence their driving activity within work zones. The research was conducted in two parts:

- An opinion survey of motorists and truck drivers; and
- Seven focus groups (five of motorists and two with truck drivers).

The survey consisted of a two-page, mail-out/mail-in questionnaire for automobile motorists. A similar questionnaire was mailed to commercial truck drivers. A number of the surveys were also distributed to motorists at local Department of Motor Vehicle offices.

Overall, the authors noted that the opinion survey and focus group results were very similar. Work zone signing was a topic of considerable discussion in the focus groups. Several comments were made about the consistency and quality of the signage used within work zones. The posting of work zone signs when in fact no workers were present was frequently mentioned as a problem. Most of the focus group members favored the use of variable message board signing as a means to provide real-time information to motorists. A key finding from both the survey and focus groups was the need for more law enforcement to lower speeds within work zones. The authors concluded that "an increased presence of *authority* [law enforcement] would most likely have the greatest effect on driver behavior in the work zone."

## 3.4 METHODS TO REDUCE CONSTRUCTION-INDUCED TRAFFIC DELAY

ODOT *(2001)* produced a guide which provided a framework for choosing techniques that can be effective in minimizing the impact of work zones on the traveling public. The guide was developed to be incorporated into ODOT's Project Development Guidebook. The guide focuses on three strategies to reduce work zone delays:

- Reduce traffic volumes before design of a highway improvement project;
- Temporarily reduce the amount of time the work zone is in place; and
- Effectively manage work zone traffic during construction.

Examples of the potential techniques include public outreach, constructability reviews, lane rental, innovative contracting (e.g., A + B bidding) and traffic control plan methods.

## 3.5 NATIONAL HIGHWAY USER SURVEY

The National Quality Initiative (NQI) Steering Committee, consisting of Federal, State and highway industry representatives, commissioned a survey in 1995 to determine the general public's satisfaction with the nation's highway system and to identify the public's priorities for highway improvement. The telephone survey resulted in 2,205 completed interviews. Respondents were asked questions about seven characteristics of the highway system:

- Pavement Conditions;
- Bridge Conditions;
- Maintenance Response Time;
- Safety;
- Traffic Amenities;
- Traffic Flow; and
- Visual Appeal.

Of the seven categories, traffic flow was ranked the lowest for overall satisfaction. For further analysis, the dissatisfaction with traffic flow was subdivided into four categories, one of them being *construction delays*. Only 38% of the respondents were satisfied with the time pavement repairs generally took to complete. Only 29% of those surveyed were satisfied (*accepted as reasonable*) with traffic flow caused by construction delays.

The second part of the survey asked participants to rank order the seven highway characteristics by needed improvement. Traffic flow ranked third behind safety and pavement condition. The study's authors concluded, based on the public's opinions, that the top priority for improving the nation's highways is to focus on the quality of the roadway surface *(Coopers & Lybrand L.L.P)*.

## 3.6 ANALYSIS OF TRUCK DRIVERS' OPINIONS ON SAFETY AND TRAFFIC CONTROL ON HIGHWAY WORK ZONES

Benekohal and others *(1995)* surveyed truck drivers on their opinions of safety and traffic control within work zones on Illinois highways. The 43 question survey was administered to 930 truck drivers at truck stops and rest areas in Illinois. The surveys were used to determine:

- Truck drivers' travel characteristics;
- Their concerns about work zone traffic control devices;
- Their assessment of work zone features; and
- The location of accidents and bad driving situations based on their experiences and perceptions.

The survey showed that truck drivers want to know well ahead about work zones; about half of them want to see a sign 3-5 miles ahead. Comments about confusing and/or unclear signs were

directed toward signs for lane closure, speed limit, exit ramps, and work zones without actual work underway. The truckers suggested adding signs about early merging, early notification of work zones, road conditions, construction length, and speed limits. Truck drivers also suggested adding signs to indicate specifically when to merge in order to prevent last minute merging by some automobile drivers. Recommendations based upon the survey results included:

- Improving flagger visibility and clarity of directions;
- Investigating the feasibility and effectiveness of adding signs to work zones; and
- Increasing drivers perception of hazards in the work zone through driver education efforts.

# 4.0 FOCUS GROUPS

In the fall of 2000, ODOT contracted with the University of Oregon Survey Research Laboratory (OSRL) to conduct a series of focus groups with various stakeholders about issues related to highway construction. The intent of the six focus groups was to find out about the public's perceptions, and what they value as important when traveling through a highway construction or maintenance work area.

There were two groups of general motorists, one from Eugene and one from Bend. There was a group of school bus drivers from Beaverton and a group of business representatives from Portland. A group of fire and emergency service personnel from Eugene, and a group of truck drivers from the Portland office of a 13-state trucking company comprised the other two focus groups. Each group met for one and one-half to two hours. The groups varied in size from five to eight people.

## 4.1 GENERAL ISSUES

Each group started by asking participants a general question about their "overall thoughts regarding highway construction, and highway work zones." For the general public, a wide variety of responses were elicited, including:

- Comments about why work zones are sometimes empty of workers;
- The desire for a work zone warning at a distance further upstream from the zone;
- The desire for consistent work hours and periods when no work occurs in the work zone;
- Concerns about safety in work zones; apprehensive thoughts upon entering work zones; and
- A variety of issues around work zone signs (see discussion in Section 4.4 on signs).

For school bus drivers, the general work zone issues were entirely different. School bus drivers were generally concerned about two issues: the effect of construction on maintaining their schedules and routes; and the problems they encounter inside a work zone. Consequently, school bus drivers wanted information about construction projects in close-to-real time and wanted detour information long before they arrived at a work zone. School bus drivers also had concerns about the nature of temporary traffic lanes and the difficulties they sometimes impose on drivers who have an extra-wide vehicle that they can not easily turn. As one driver put it, "the orange barrels are always too close together for my bus."

For business representatives, the general concerns about work zones were primarily related to issues of access and egress from their businesses and problems related to receiving and sending deliveries. Here too, maintaining schedules was an issue, with strong concerns about alternative routes and construction information.

For fire and emergency vehicle operators, their unique work zone issues covered two primary areas. First, how to respond to an emergency call when the work zone was between the fire station and the normal response route. Second, how to adequately respond to emergencies that occur inside the work zone.

Truck drivers commented on issues that were similar to those raised by school bus drivers. They also expressed concerns about:

- The speed of cars in construction zones;
- The frequency with which cars cut in front of them; and
- Inadequate presence of law enforcement presence inside the work zone.

Truck drivers also expressed fear of hitting construction workers within the work zone. Several noted that they had seen workers inadvertently move into the active traffic lane while working.

## 4.2 COMFORT LEVEL AND SAFETY IN WORK ZONES

Most of the motorists acknowledged they feel some discomfort and a heightened anxiety level when traveling through work zones. They also were more concerned about their safety as they traveled through the work zone. Among their concerns were:

- Fears of being tailgated;
- Apprehension about driving close to concrete barriers (especially if there are any curves);
- Not knowing how much distance they had to merge when a lane was closed ahead; and
- A desire for more temporary traffic signals and pilot cars (to make them feel safer).

School bus drivers did not share the same safety concerns as motorists. School bus drivers were not worried about being tailgated; as one respondent said, "we win those." In fact, some expressed an increased sense of safety in work zones because speeds were slower and because they could usually control the lane(s) well enough to prevent cars from cutting in front of them.

For fire and emergency personnel, discomfort increased in work zones, primarily because of the urgent need to respond to an emergency call. However, other work zone issues also bothered these drivers such as:

- The difficulty in seeing traffic delineation devices (tubular and conical markers, barrels, etc.) for lane marking, and signs. This difficulty was especially true for the rear driver in articulated fire equipment.
- The discomfort caused to patients in emergency vehicles because of rough road surfaces; and
- The concerns that they would not be able to easily reach an accident site within the work zone or to get out of such sites after reaching them.

For truck drivers, discomfort and anxiety were greatly increased within work zones. Even though speeds were generally slower inside the work zones, drivers complained that speeds were not slow enough, and motorists could be an increased hazard to them. For example, when two

travel lanes (in the same direction) are being reduced to one, truck drivers noted that many motorists will try to pass a truck no matter what the conditions, in order to avoid being behind the truck in a single lane. A similar problem dealing with a lane closure was the truck driver's frustration with vehicles failing to merge into a single lane until the last moment, causing traffic bottlenecks at the end of the taper.

## 4.3 WHAT DRIVERS DO DIFFERENTLY IN WORK ZONES

Not only did motorists report feeling increased anxiety in work zones, but many of them claimed to change driving behavior when entering and traveling through work zones. Most drivers said that their "state of alertness" increased in work zones as they paid much more attention to the road and other vehicles. Some drivers tried to limit other distractions while in work zones, by doing such things as turning down/off radios or stereos, or by stopping conversations inside their vehicle. Others increased their attention of vehicles around them, and either turned on hazard lights or tapped on their brakes to alert drivers behind them. Almost all drivers reported slowing down, and one driver reported keeping an eye out for places they might be able to get off the road (i.e. the ditch) if an emergency occurred.

School bus drivers had a set of very specific behaviors they altered in work zones. All of the drivers reported turning on hazard lights, as this was a work regulation for the school district (Beaverton). Drivers also reported that they go very slowly in work zones and always drive below the posted speed. They also tried to leave a large distance in front since buses stop slowly and they want to avoid a quick stop, which could throw children out of their seats. In addition, school bus drivers try to control the traffic behind them by using their size to make sure cars do not try to pass them or cut in inappropriately. To accomplish this, they may start driving in the middle of two merging lanes slightly before the merge actually ends, or they may move slightly onto the road shoulder if it is wide enough to allow cars to pass them.

Fire and emergency vehicle drivers also reported altered behavior in a work zone. They also try to control traffic behind them by their use of the lane. Additionally, if they are on an emergency and have lights and sirens engaged, they sometimes turn them off in a work zone to prevent cars from stopping in front of them when there is no shoulder available.

The main changes in behavior reported by truck drivers were an increase in alertness, an increase in the distance between their vehicle and the vehicle ahead, and a watchful eye for workers. Very few reported using "brake tapping" or emergency lights to alert following traffic, feeling that their size and general lighting was sufficient.

## 4.4 SIGNS IN WORK ZONES

Drivers of all types had issues about the signs used in work zones. For motorists, the signs seem to generally work, although there were a few complaints. In particular, respondents would like to know when the work zone is "active." Everyone had experienced driving past signs that indicated an active work zone (i.e., flagger ahead) and never seeing a flagger. In addition, everyone wanted as much advanced warning as possible, especially if there was the possibility of a detour where a decision needed to be made about route choice.

For the professional drivers, advanced warning of construction zones was especially critical. School bus drivers wanted as much time to decide either to detour (if possible), or to slow their speed gradually. Fire and emergency drivers also wanted time to decide about detours. In addition, fire and emergency drivers had concerns about some sign placements and sign heights. In particular, many fire trucks have restricted vision to the ground and, on occasion, found sign placement to be below their sight level.

Truck drivers had relatively few complaints about signs and thought the signage was generally good. However, some drivers thought work zones could have more signs, and that sometimes the distance between the alert signs and actual work was too great. Truck drivers also wanted better illumination or reflectivity of signs when it was dark.

## 4.5 LANE CHANGES IN WORK ZONES

Work zones frequently require drivers to change lanes or to merge. All drivers had issues with how these lane changes take place. A universal concern was with the length of a transition zone and how the merge was indicated (signage). The issue for drivers was not the length of the transition zones, but knowing how much time they had to merge before the end of the taper. Further, there was general frustration expressed by all groups regarding how other drivers misuse the transition zone and cut into the appropriate lane at the last opportunity. As noted earlier, truck drivers were particularly upset over this "cutting in" behavior.

Fire and emergency drivers seemed particularly concerned about the design of traffic control in urban areas for lane closures. They would like traffic control where right and left turns (when possible) are allowed, so they can quickly access possible emergency sites.

Drivers also had concerns with specific types of lane markings. For example, school bus drivers prefer tubular markers or cones to any other type of delineation device, since they can "drive over them" if they need to when making a turn, or in case of an emergency within the work zone. One motorist wanted shorter tubular markers or cones, claiming the "tall" ones intimidate him. Almost all drivers disliked the concrete barriers, although some professional drivers liked them because they prevented motorists from trying to pass in the work zone. Truck drivers were probably the most supportive of concrete barriers, and felt that as long as the lane width was sufficient (at least 10 feet), these provided the best type of lane delineation.

Drivers of all types wanted better marking for the temporary lanes created for changing direction and merging. In most cases, the request was for visible solid white lines marking the lane on both sides. In addition, truck drivers felt that, too often, removed striping in work zones left a "ghost" mark that was hard to distinguish from the temporary striping, especially at night, or under rainy conditions.

## 4.6 DRIVING THROUGH WORK ZONES AT NIGHT

All groups disliked work zones more when it was dark. The lack of visibility in work zones raised issues about the difficulty of seeing signs, lanes, barriers, and construction personnel at night. Drivers generally felt that flaggers were very hard to see at night and their signs were

often impossible to read. One driver mentioned seeing a flagger wearing fluorescent gloves that greatly improved the flagger's visibility. Drivers also complained about the difficulty of seeing the edge of roadway if it did not have a solid white "fog" line.

Depending on the nature of the work zone and the type of illumination used, drivers were split on their feelings about work zones where construction was taking place at night under artificial lighting. Some drivers had experienced work zones where the lighting made the work zone seem as safe to them as during the day. Other drivers had experienced lighting conditions which interfered with their ability to see, were a distraction, or affected their night vision when they left the work zone. Truck drivers, in particular, had this complaint. They noted that the work zone lighting, the construction vehicle lights, and even at times, the lighted variable message signs, caused temporary impairment of their vision.

Drivers also had some difficulties seeing signs, tubular markers, cones or barriers at night. Many felt that construction signs, markers and cones are often in poor condition and not as reflective as they would like. Similar concerns were raised about the reflectivity of barriers. Fire and emergency drivers again addressed the issues they raised earlier about seeing signs from the height they sit to drive. They also noted the condition is worse at night.

Truck drivers mentioned a problem with highway markings at night that is not directly related to construction. According to them, on Oregon freeways at exit ramps, there is a break in the fog stripe at the entrance to the off ramp. The fog striping continues on the freeway at the other side of the exit ramp. This configuration makes it very difficult for them to know exactly where the exit was under conditions of poor visibility. These same drivers claimed that in California, there was no break in striping. Instead, the fog line continues into the entire exit ramp. They believed this configuration made it easier to locate the ramp in the rain and fog when visibility was poor.

## 4.7 DETOURS AND DELAYS

Detours and delays were the most controversial issue raised by each of the groups interviewed. Each driver expressed concerns about either a detour or a delay, but all understood that they are a necessary part of road construction. The main issue raised about detours was adequate signage for any detour. This concern included not only the signs before the work zone announcing the detour, but also the signage along the path of the detour. Drivers wanted as much advance warning about detours as possible. They also wanted to know information about options if any existed. Drivers also mentioned that frequently the path of the detour is not easy to follow, and that signs often are not placed at all critical decision points along the detour. One truck driver noted that he followed a prescribed detour route, but had to stop and find an alternate route because of inadequate clearance at an overcrossing on the detour route.

When drivers were asked how long a delay was acceptable to them, the responses varied widely. Motorists were willing to accept delays in the 5-10 minute range, without expressing concerns that they would be upset or angry. Delays up to 15 minutes or longer were acceptable to many motorists as well, although in these cases, information about the length of the delay played a big role in their willingness to accept this length of time.

School bus drivers were unhappy with delays of any sort because their passengers were harder to control. As one bus driver put it, "you don't want to sit delayed in traffic with a bus full of children."

Fire and emergency drivers were not able to accept a construction delay of any duration. Inside their response zone, the fire and emergency vehicles are distributed and operated in a manner that tries to guarantee a maximum response time of four minutes. Consequently, any delay is unacceptable. These drivers also expressed concern about a delay preventing them from responding to an emergency that might occur inside a work zone.

For business owners and managers, the impact of construction delays depended on the nature of their business. For those owners with retail shops affected by a work zone, delays were just an additional difficulty that they believed might reduce traffic to their business. For owners who had a delivery fleet and a delivery schedule to maintain, delays were a hindrance, but usually were not a devastating impact to their business.

For truck drivers, delays of 10-15 minutes were acceptable. Longer delays bothered them, either because they had schedules to keep, or because they were losing money since they are frequently paid by the mile.

## 4.8 A SCENARIO INVOLVING A CHOICE BETWEEN A DETOUR OR A DELAY

In some cases construction projects face a decision about: (1) closing roads or bridges completely and forcing drivers to detour, or (2) operating the work zone with partial lane closures and delays. In order to get some idea about driver preferences on this issue, participants were asked to listen to a possible scenario about a bridge closure and then choose which alternative they preferred. In addition, they were to imagine that this scenario would affect their daily driving, and not be something that they were exposed to only once, as they might be if driving on vacation. School bus, emergency and fire drivers, were asked to pretend that this was something they encountered during their professional driving workday and not as private motorists. For business owners and managers, the closure would affect their business, rather than their personal driving.

The scenario involved the rehabilitation of a bridge in need of roadbed replacement and strengthening to earthquake standards. There were two options for this construction. The first was the typical approach of partial closures and delays of up to 15 minutes, with construction scheduled to last 6 months. The second option was a complete closure, and a 20-mile detour, with construction shortened to one month.

The almost universal chosen preference for motorists was the detour. They chose this option even with the understanding that by driving the additional 20 miles, their trip would take longer than the average delay time, and the detour would impose additional personal costs through increased fuel and vehicle maintenance. The ideas of "being in control" and "predictability" outweighed cost considerations.

School bus drivers unanimously preferred the detour. Similarly, their reason was the improved predictability of a known detour, versus the unknown time of a delay. The school bus drivers could usually adjust their schedule if they knew what was going to happen. If delays were unavoidable, they preferred to be moving, albeit at slower speeds, as opposed to stopping delays, in part, because of the issue of child control discussed earlier.

For fire and emergency drivers, the issue of delay vs. detour hinge on what options existed for them. For example, if the closure meant that they had to re-deploy equipment to another station or part of town, they might prefer delays and assigning their equipment to "second vehicle" status for emergencies in the area impacted by the work zone. Alternatively, they might prefer the closure option, depending on alternative routes and the feasibility of redeployment. The bottom line for these drivers was, "it depends." And, what it depends on, is the effect of the decision on their ability to respond to an emergency in a timely manner.

For business owners and managers, the decision about delay vs. detour was dependent on the estimated impacts to their business. Some business owners felt that any road closure that isolated their business was unacceptable, while others felt that they would rather sustain a short loss than months of severely reduced sales. Businesses that were primarily delivery-orientated preferred closures to delays, as long as it didn't prevent them from sending out trucks. Here again, the idea of predictability with detours vs. the unpredictability of delays was the dominant factor.

For truck drivers, the detour was, by far, the favored alternative. They felt less anxious moving on the road than waiting inside a work zone. Further, they felt they saved little in gas when stopped because they had to keep their engines running anyway. In addition, the idea of having some control was considered important.

## 4.9 INFORMATION ABOUT HIGHWAY CONSTRUCTION

All the groups were asked about their access to, and use of, information about highway construction. Most groups made very little use of the information sources available. A majority of drivers were aware of the ODOT toll free telephone number for road conditions, although some complained about difficulty getting through to the message. Some drivers used other sources, including AAA, local television, newspapers, ODOT's cable access television station (noted by the Bend focus group), and a limited amount of Internet use, including "Trip Check" on ODOT's web site.

School bus drivers had by far the most comprehensive system of gathering construction information, and distributing it to drivers. On a daily basis, they used ODOT sources (including its web cameras), local government sources, as well as making contact with contractors and ODOT, city, and county project managers. This information was used to plan alternative routes; change travel schedules; and occasionally reorganize daily activities. In addition, the school buses were in communication with their dispatcher and with each other. Using this network, they updated one another on a real time basis about changes in road conditions, including construction.

Fire and emergency drivers were somewhat similar, except their sphere of activity was smaller than the school bus drivers'. Although they did not describe as comprehensive of a system as the school bus drivers, fire and emergency personnel also keep themselves updated on construction and road conditions.

For businesses, the information sources and the communication methods varied from company to company. However, even the best-informed companies were less informed than the school bus, fire and emergency drivers. Some companies had participated in construction planning stakeholder meetings, and had established channels of communication with ODOT or the city on specific projects.

The truck drivers were all hooked to a central office communication system using satellite and phone messaging that included both voice and written material. However, given the huge geographic area covered by the trucking company (13 western states), they did not try to keep up with all construction projects, and rarely used the system to give construction alerts.

All groups were asked for suggestions on how communication about construction might be improved. Only a few ideas were mentioned. Motorists in Bend wanted targeted mailings to people living near state highways planned for construction projects, and more information in the newspaper. Truck drivers also had two suggestions. They wanted local construction site radio information; and increased construction information at truck stops and at state border welcome centers. Truck drivers also noted that the ODOT toll-free telephone number did not work from California. They felt it was important to know about Oregon road conditions in the I-5 corridor while still in California.

## 4.10 QUESTIONS UNIQUE TO BUSINESSES

Business owners and managers were questioned about the effects of construction on their business. As one might guess, impacts varied enormously with the type of business and past experience with work zones. For some businesses, primarily retail, the presence of a work zone had severe financial impacts because of reduced customers and a loss of revenue. For wholesale and service businesses, the impacts were related to scheduling of work hours and deliveries. In their case, work zones generally had little financial impact on the business. For all kinds of businesses, the types of temporary accesses played a large role in how they perceived the impact to their business. Here again, this was particularly true for retail businesses and for a large shopping center. In the same vein, the presence of signs directing traffic to their business at appropriate positions near the entrance to the work zone and inside the work zone was considered very important.

The businesses' greatest concerns about work zones included:

- The hours that construction takes place. In general, they preferred that the work occur outside of their normal business hours.
- Signage issues, such as those mentioned above. They wanted potential customers to be given advanced notice of times when construction would take place in the work zone.

- That flaggers be well informed about the project and business accesses. They wanted flaggers to know where business accesses were located, and to be able to pass that information on to motorists traveling into the work zone.

While businesses would prefer construction outside of their normal business hours, they also understood that this was not something that could always take place. They did however, voice a hope that when construction required actual road closures (especially roads that did not have easy alternative routes, such as bridges and major highways), this work could take place at night.

# 5.0 MOTORIST SURVEY

## 5.1 SURVEY PROCEDURE

As noted in Chapter 2, ODOT contracted with the University of Oregon Survey Research Laboratory (OSRL) to conduct a computer-assisted telephone survey of adult Oregonians to find out about their experiences and opinions when traveling through highway work zones. The goal of the survey was to obtain statistically valid and reliable information concerning a wide variety of issues related to travel through work zones. The survey was conducted by OSRL from July to October 2001. The survey response rate was 72%, resulting in a final sample of 2,002 completed interviews of adults from around the state who had traveled through a work zone in the previous eight weeks. Of the 2,002 completed interviews, 48 were with people who did not drive but had traveled through work zones as a passenger in a vehicle, or cyclist. Because the responses from the 48 non-drivers did not significantly differ from those of drivers, the entire group of 2,002 respondents was classified as "motorists" *(Gwartney and Wolf 2001).*

The study used a stratified random sampling approach to ensure a large enough sample in each ODOT Region so that comparisons could be made between regions. To accomplish this with a margin of error of approximately ± 5.0 percentage points, a sample of 400 was needed in each region. The margin of error for the entire sample (n=2,002) is ± 3 percentage points, at the 95% confidence level.

This report uses tables or charts to present the motorist survey results as percentage distributions for each region. For most of the results, in addition to reporting the percentages for the five regions, a statewide percentage distribution based on the total sample (n=2,002) is shown. Because the survey consisted of five independent, regional samples of the same size, the statewide totals have been weighted to account for the differences in regional population. If the region totals were simply summed to calculate a statewide response, it would over-represent the more rural areas (Regions 4 and 5), and under-represent the more densely populated areas. The weighting adjusts the statewide percentages to be more representative of Oregon's population, and allows comparisons between statewide and regional results.

Based on OSRL's records, the survey interviews averaged 16.7 minutes. The questionnaire was designed with significant input from the project Technical Advisory Committee, based on areas of interest identified by the focus groups.. Survey questions focused on six broad areas:

1. The **frequency of travel** through work zones, or avoiding known construction zones.
2. **Delays and inconveniences -** How long a motorist was delayed by a construction project and what they considered to be an acceptable delay with, and without advance notice.
3. Feelings about the **ease and safety of travel through work zones,** including how difficult travel through a zone was and how safe they felt.

4. **Sources of information** about work zones. Also, what are the most used and preferred sources of information about road construction.
5. **Opinions about ODOT** – How well ODOT informs motorists about work zones; how well ODOT manages work zones, and respondents' overall opinion about ODOT.
6. **Basic demographic data**, including years of residence in Oregon, age, sex, education, employment, number of adults in the household, number of vehicles in the household, urban-rural community, presence of children in the household, and household income. *(Gwartney and Wolf 2001)*

## 5.2 DISCUSSION OF SURVEY RESULTS

### 5.2.1 Frequency of Travel

The first question asked if the person had traveled through one or more work zones in the past eight weeks. Table 5.1 summarizes the responses. In Regions 1, 2, 3 and 4, most of the people had traveled through more than one work zone. In Region 5, probably because of its larger area, the majority of motorists had traveled through only one work zone in the last eight weeks.

**Table 5.1: Frequency of Travel through Work Zones**

| In the past eight weeks, have you regularly traveled through just one Oregon state highway construction zone or more than one? | | | |
|---|---|---|---|
| **REGION** | **Sample Size** | **One Work Zone** | **More Than One Work Zone** |
| Region 1 | 401 | 34.8% | 64.9% |
| Region 2 | 400 | 43.3% | 56.7% |
| Region 3 | 401 | 44.2% | 55.8% |
| Region 4 | 400 | 43.3% | 56.2% |
| Region 5 | 400 | 54.1% | 45.9% |
| **Total** | **2,002** | **44.1%** | **55.9%** |

The respondents were asked which work zone they had traveled through the most often. Answers varied widely, and not all of those surveyed could identify by name or specific location an ODOT project work zone. However, the most frequently identified work zones were:

- Bend Parkway Unit 3C
- NB/SB Overcrossing Foster Rd/Woodstock Bridge #13538/13538a
- Pacific Hwy @ Hwy 217/Kruse Way
- North Jefferson Interchange - South Jefferson Interchange (NB)
- Garden Valley Blvd - Roberts Creek
- Interstate Bridge - N.E. Oregon Street (Portland)
- Highway 238 - Jackson Street, Unit 1
- Shogren - Rowena
- Oregon-Washington Hwy/State Line Rd. Traffic Signal
- 10th Street - Eastgate (Pendleton)

Motorists were then asked, on average, how many times they had traveled through the particular work zone (the one traveled most often in the last eight weeks). Figure 5.1 shows the results. The frequency of trips through work zones in Region 5 is less than in the other four regions. In Region 5, 41% respondents said they traveled through the work zone less than once a week compared to only 17% in Region 1.

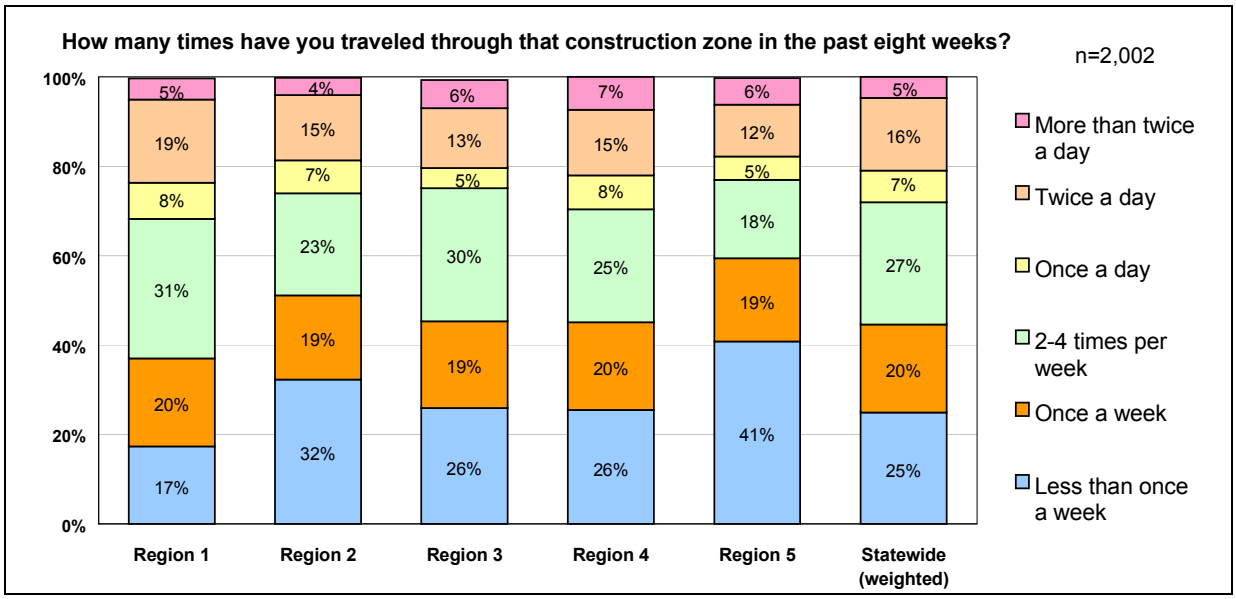



Figure 5.1: Frequency Distribution of Trips through the Identified Work Zone.

The next question asked respondents about the type of work zone they had traveled through. Specifically, they were asked: *"Would you say that the highway construction is a short-term work zone that takes a few hours or a few days to finish; a medium size job that takes several days or weeks; or a major job that takes several months to a year or more to finish?"* The distribution of responses is shown in Figure 5.2.

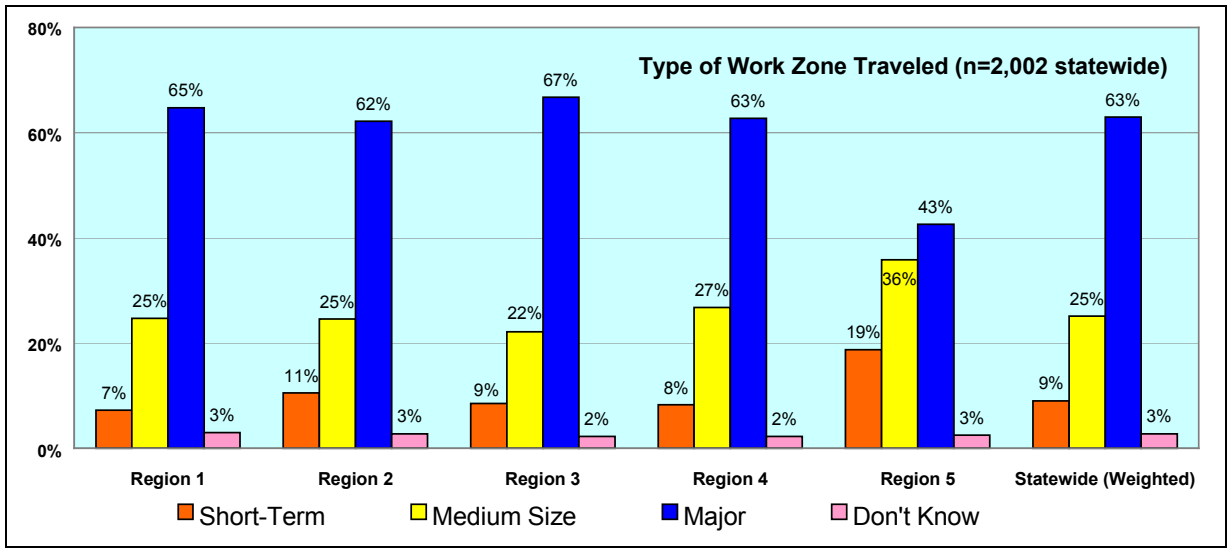



Figure 5.2: Work Zone Type

In Regions 1, 2, 3, and 4, about 60% or more, indicated the work zone they had traveled through the most often was a "major" project, whereas in Region 5, just 42% (170 of 399) classified the work zone as a major one.

People were asked about their trip purpose when traveling through the work zone. Figure 5.3 shows the results. In Region 1, over 27% (109 of 401) of the respondents listed commuting (to work) as their trip purpose. The percentage of commuters in the other regions was less than 20%; in Region 3, only 14% of the respondents identified their trip as commuting.

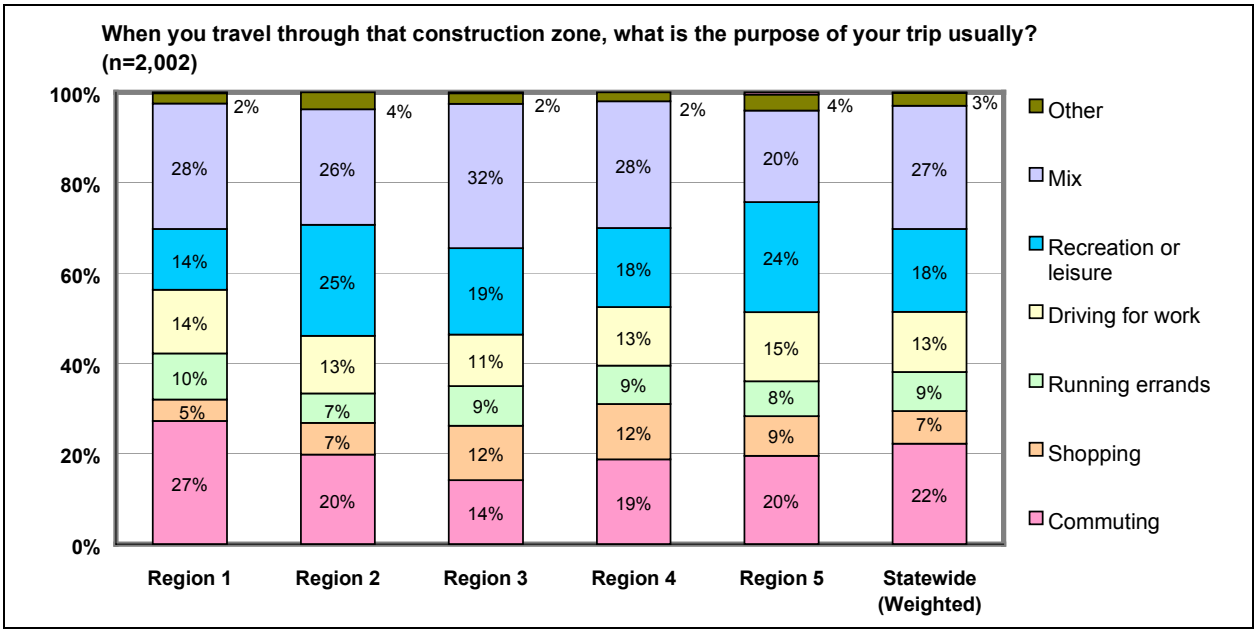



Figure 5.3: Trip Purpose When Traveling through the Work Zone

In all five regions, about the same percentage of respondents (11 to 15%) said that they traveled through the work zone because they were driving as part of their job. Many people (20 to 32%) reported their trip purpose was mixed. For instance, a shopping trip could have been combined with a commute to, or from work. In Regions 2 and 5, almost 25% of respondents listed recreation or leisure as their trip purpose, which was higher than in the other three regions.

The survey also included a group of questions about taking alternate routes to avoid the work zone. When asked, "Is it possible for you to avoid that construction zone by taking an alternate route?" most people (in all five regions) said yes (see Table 5.2). As expected, in Region 1, because of its population density, and more concentrated highway and street network, a greater percentage of people answered yes than in any of the other four regions.

Motorists that had an alternate route were asked how often they took another route instead of traveling through the work zone. As shown in Figure 5.4, more people in Region 1, because of a greater number of available routes, were more inclined to take an alternative route. Over 50% (148 of 273) in Region 1 said that they "always, often, or sometimes" take an alternate route. In

contrast, in Region 5, only 37% (75 of 202) reported taking an alternate route "always, often, or sometimes."

**Table 5.2: Possibility of Alternate Route**

| Is it possible for you to avoid that construction zone by taking an alternate route? | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **REGION** | **YES** | | **NO** | | **DON'T KNOW** | | **TOTAL** | |
| | Count | % of Row | Count | % of Row | Count | % of Row | Count | % of Row |
| Region 1 | 273 | 68.3 | 121 | 30.3 | 6 | 1.5 | 400 | 100 |
| Region 2 | 216 | 54.1 | 175 | 43.9 | 8 | 2 | 399 | 100 |
| Region 3 | 202 | 50.9 | 193 | 48.6 | 2 | 0.5 | 397 | 100 |
| Region 4 | 229 | 57.3 | 168 | 42 | 3 | 0.8 | 400 | 100 |
| Region 5 | 202 | 50.6 | 195 | 48.9 | 2 | 0.5 | 399 | 100 |
| **Total** | **1122** | **56.2** | **852** | **42.7** | **21** | **1.1** | **1995** | **100** |

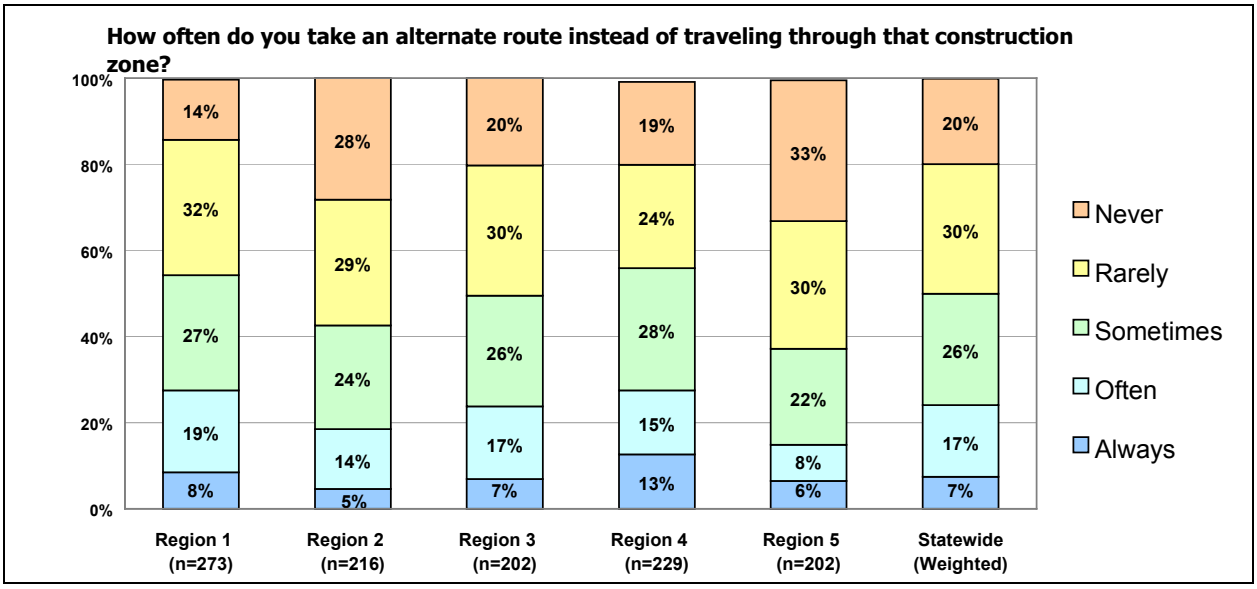



Figure 5.4: Frequency of Taking an Alternate Route

## 5.2.2 Delays and Inconveniences

The survey included questions related to delay and inconvenience. Within this series, respondents were first asked if they had been delayed at all during the past eight weeks traveling through the work zone they most frequently traveled. As seen in Figure 5.5, except for Region 3, the majority of travelers had experienced some delay. In Region 1, 68% (272 of 399) had been delayed, whereas in Region 3, only 48% (195 of 399) said they had been delayed.

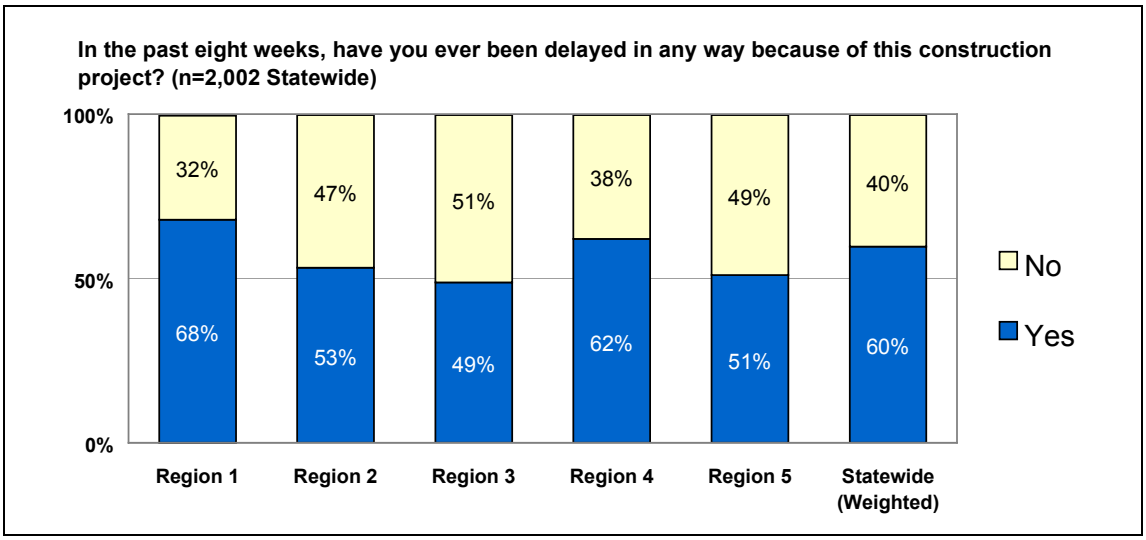



Figure 5.5: Delay in Traveling though the Work Zone

Those who had been delayed were asked about the frequency of delays. Figure 5.6 shows that in all regions, less than 50% reported experiencing the delays "always" or "often." In Region 3, only 34% of the respondents said the delay was "always" or "often". The modal response for the frequency of delay in all regions was "sometimes."

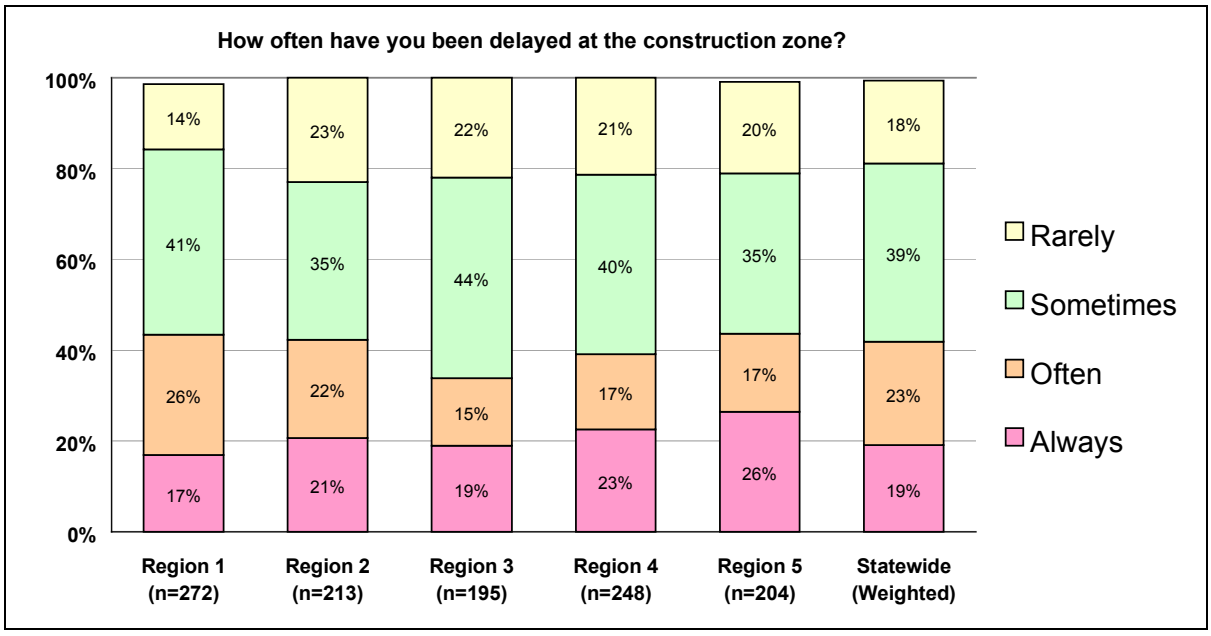



Figure 5.6: Frequency of Delay through the Work Zone

Next, motorists were asked how long they were *usually delayed* through the work zone. Figure 5.7 shows the average reported delay in minutes for each region. In Region 3, the average delay was 7.50 minutes, the lowest among all five regions. Conversely, in Region 1, delay averaged 11.68 minutes, the highest in the state. One factor contributing to longer delays in Region 1 is the higher volumes of traffic that typically travel through those work zones.

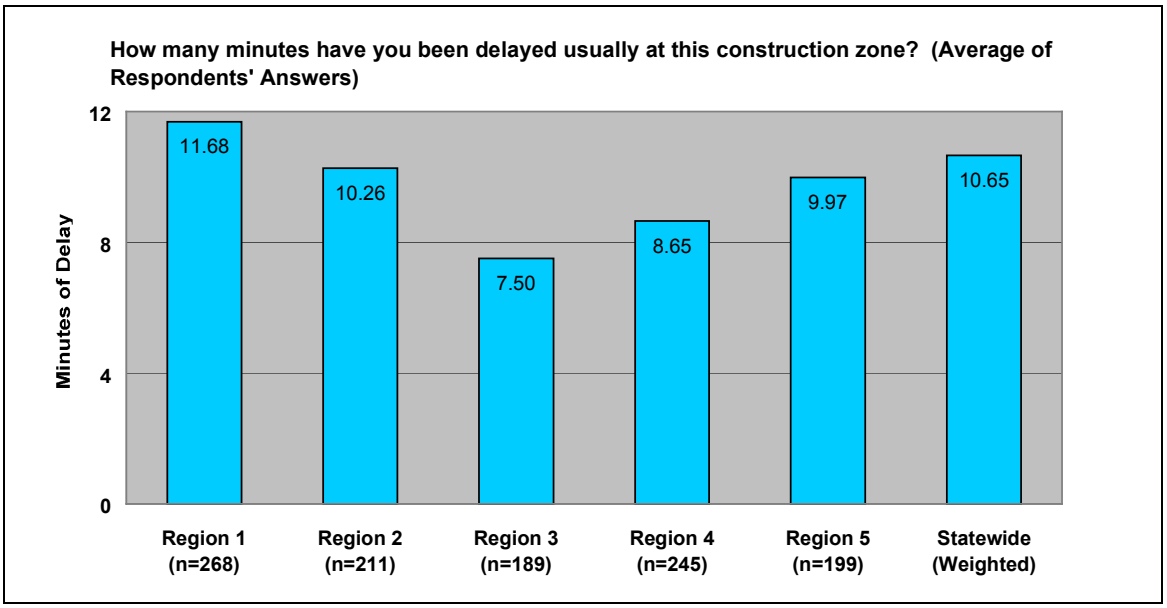



Figure 5.7: Number of Minutes of Delay through the Work Zone

A third question asked motorists about the *longest delay* they had experienced. For all regions, over 65% of the respondents' *longest delays* were under 20 minutes. The average of their responses is shown on in Figure 5.8. Again, higher delays were experienced in Region 1, where the average reported *longest delay* was 20.17 minutes. The average in Region 2 was about two minutes less than Region 1 (18.35 minutes). Reported *longest delays* were significantly lower in the other three regions; the lowest again being in Region 3, with an average *longest delay* of 14.03 minutes.

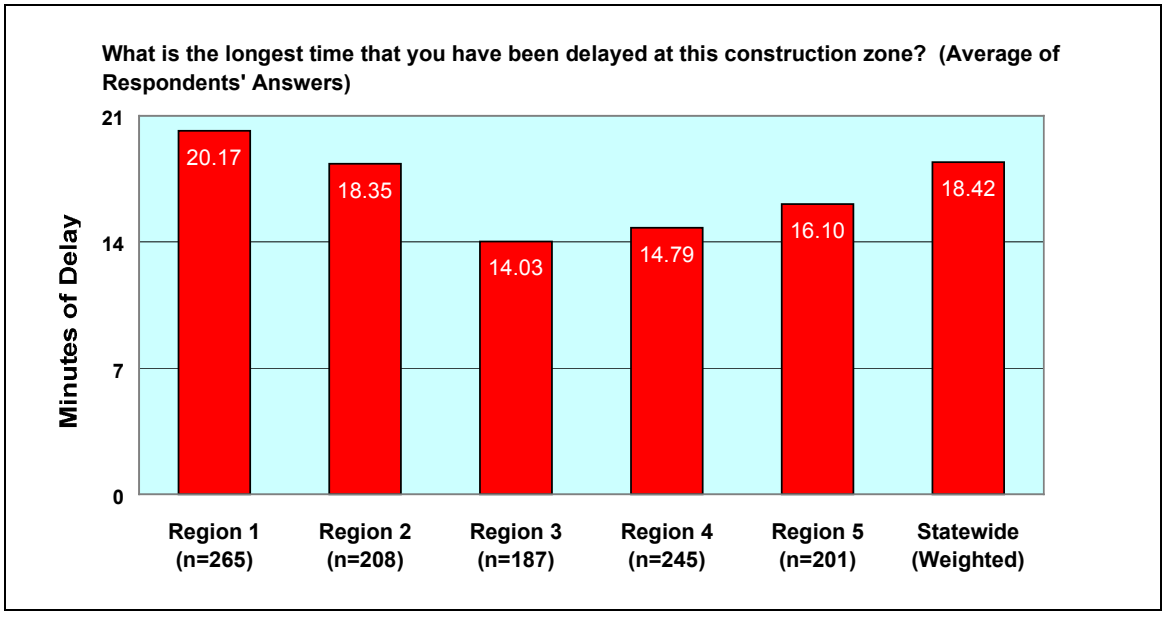



Figure 5.8: Number of Minutes of the Longest Delay through the Work Zone

When asked what caused the longest delay, for those who thought they knew, the most frequently given answers were:

- Too much traffic/congestion;
- Construction equipment being moved around;
- An accident in the work zone;
- Reduced number of lanes;
- Waiting for flagger or pilot car; and
- Paving operations.

The respondents who had been delayed were asked if the *longest delay* was reasonable when considering the project size and complexity. A large majority said yes. In fact, as seen in Table 5.3, at least 74% or more believed the delay was reasonable. In Region 3, over 90% felt the *longest delay* they had faced was reasonable.

**Table 5.3: Reasonable Delay?**

| Do you think that delay was reasonable for the project size and complexity at the construction zone? | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **REGION** | **YES** | | **NO** | | **NO ANSWER** | | **TOTAL** | |
| | Count | % of Row | Count | % of Row | Count | % of Row | Count | % of Row |
| Region 1 | 213 | 78.3 | 44 | 16.2 | 15 | 5.5 | 272 | 100 |
| Region 2 | 159 | 74.6 | 39 | 18.3 | 15 | 7 | 213 | 100 |
| Region 3 | 177 | 90.8 | 10 | 5.1 | 8 | 4.1 | 195 | 100 |
| Region 4 | 213 | 85.9 | 27 | 10.9 | 8 | 3.2 | 248 | 100 |
| Region 5 | 173 | 84.8 | 25 | 12.3 | 6 | 2.9 | 204 | 100 |
| **Total** | **935** | **82.6** | **145** | **12.8** | **52** | **4.6** | **1132** | **100** |

For the next two questions, respondents were asked to think about construction work zones in general. They were then asked:

1. "If **knowing in advance** about a possible delay, what is the longest number of minutes of delay that is acceptable?"
2. "What is the longest (number of minutes) delay that you think is acceptable, if you **do not know in advance** that a delay is possible?"

Figure 5.9 shows, by region, the average number of minutes of delay that is acceptable when there is **advance notice** about the delay, and when there is **no advance notice** about the delay.

The averages for acceptable delay in Region 1 were lower than the other four regions. The results of these two questions showed that with advance knowledge about a possible delay, people were more tolerant of a longer delay. In Region 3, the difference in acceptable delay with advance notice was about 1.6 additional minutes (15.83 to 14.22). However, in Region 5, knowing in advance about a possible delay did not seem to influence people's tolerance of delay. This region had the highest tolerance of delay both with and without advance notice. The difference in the

average number of minutes in Region 5 was only 0.40 minutes. One reason might be because of Region 5's larger area, and the lack of alternate routes or mode choice when making decisions about travel. Consequently, advance notice about potential delay might not have the same effect as in a more densely populated area.

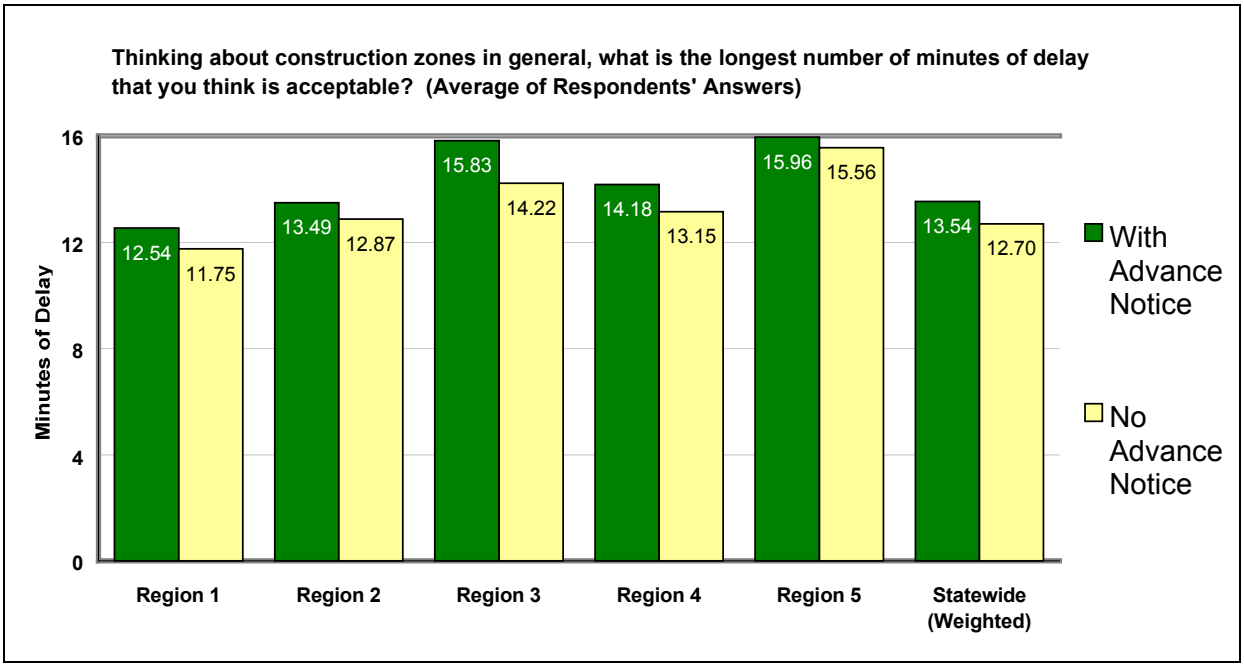



Figure 5.9: Longest Acceptable Delay With and Without Advance Notice

As a comparison, Figure 5.10 shows, by region, the longest delay actually experienced (from Figure 5.8) with the longest number of minutes that is perceived as being acceptable, when there is *no advance notice* (from Figure 5.9). Specifically, it shows a comparison of the average longest delay (actual number of minutes reported by respondent) and the average acceptable delay (perceived by the respondent).

In Regions 3 and 5, actual and acceptable delays are about the same. In Region 4, actual delay is about 1.6 minutes longer than acceptable delay. In Regions 1 and 2, the differences are much greater. In Region 2, the difference between actual and acceptable delay is about 5½ minutes, and in Region 1, the difference is over 8 minutes. Thus, in the more populated and congested regions, two important points can be made:

1. Longer delays are being experienced by motorists traveling through work zones in Regions 1 and 2.
2. The length of an acceptable delay for people traveling through work zones in Regions 1 and 2 is shorter than in the other three ODOT Regions.

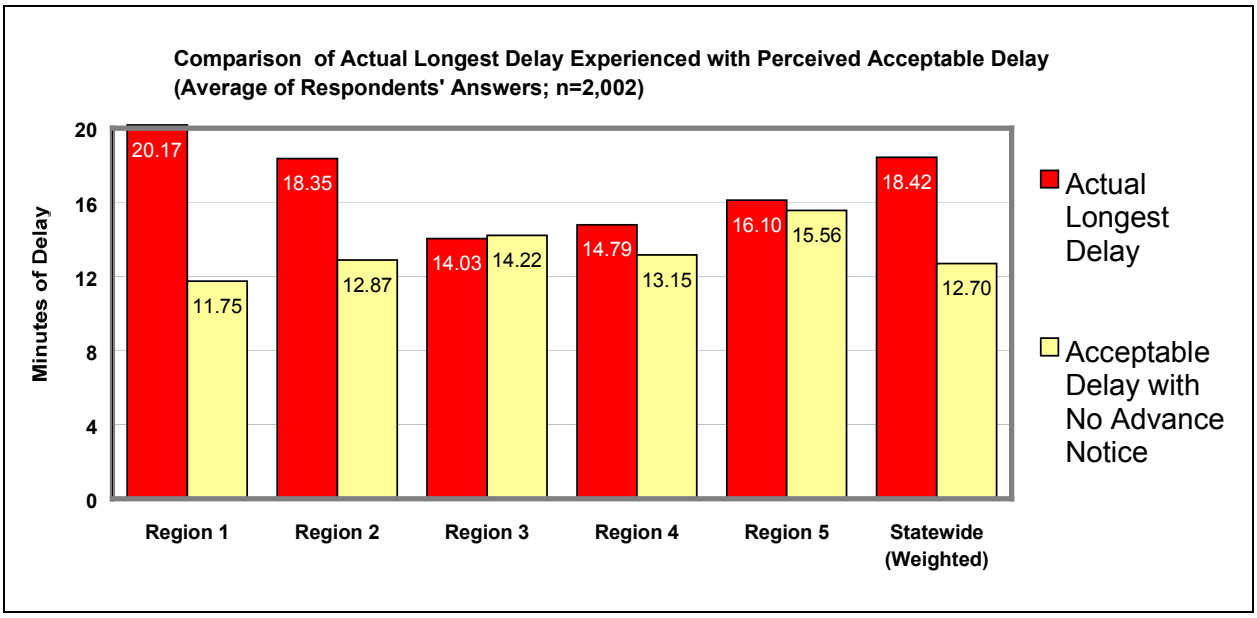



Figure 5.10: Comparison of Actual and Perceived Acceptable Delay

The final question related to delay asked motorists how well they were kept informed by ODOT about delays and road closures. Figure 5.11 provides a distribution of responses. In Regions 1, 3, and 4, at least 65% of the respondents gave ODOT either an excellent or good rating. Regions 2 and 5, gave lower favorable ratings; about 56% indicated ODOT was doing an excellent or good job at keeping them informed.

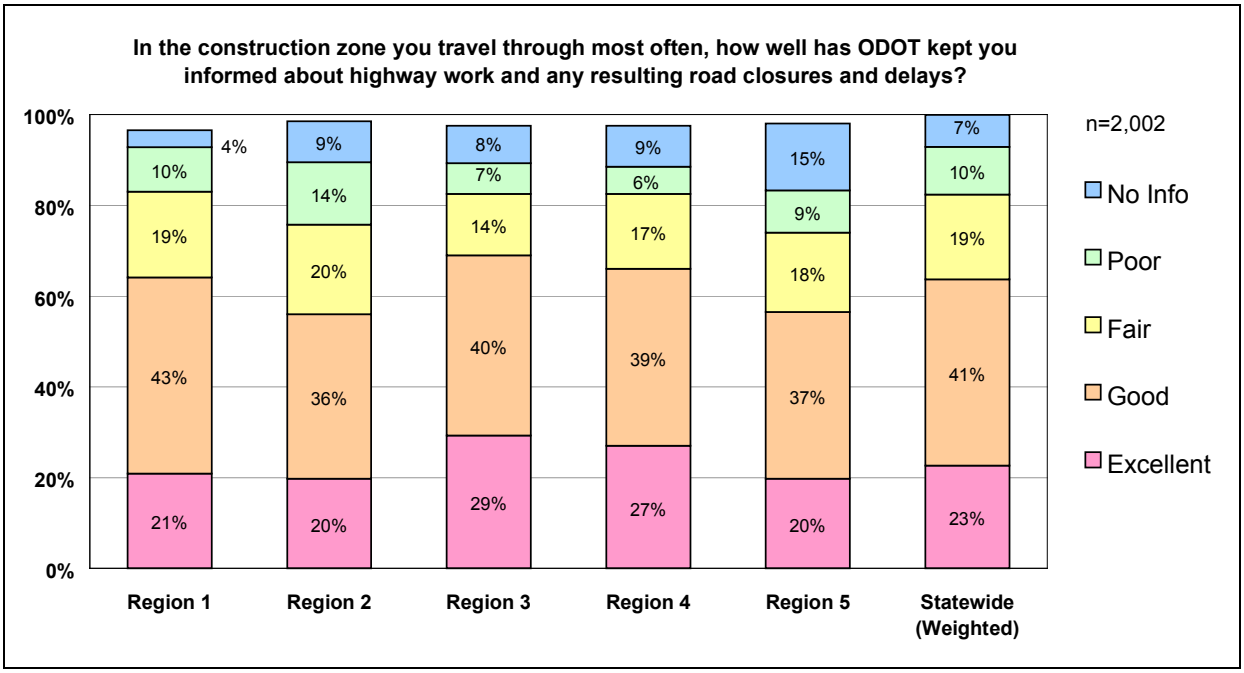



Figure 5.11: How Well ODOT has Kept Motorists Informed about Delays and Road Closures

### 5.2.3 Ease and Safety of Travel through Work Zones

In this series, motorists were first asked, "How easy or difficult has it been for you to understand where you were supposed to travel through that construction zone *(the one most frequently traveled through in the past eight weeks)*?" The distribution of responses is presented in Figure 5.12. In all five regions, at least 80% of the respondents indicated that it was "very easy" or "somewhat easy" to travel through the work zone. Of those who said it was "very easy" to travel through the work zone, there were significant differences in the responses from Regions 1 compared to the other four regions. In Region 1, only 41% said it was very easy to travel through their most frequently traveled work zone, whereas in the other Regions, 55% or more said it was "very easy." One reason for the differences could be because the work zones in Region 1 are most likely to be situated in urban and highly congested areas. There, higher levels of congestion coupled with greater numbers of intersecting side streets create additional traffic conflicts.

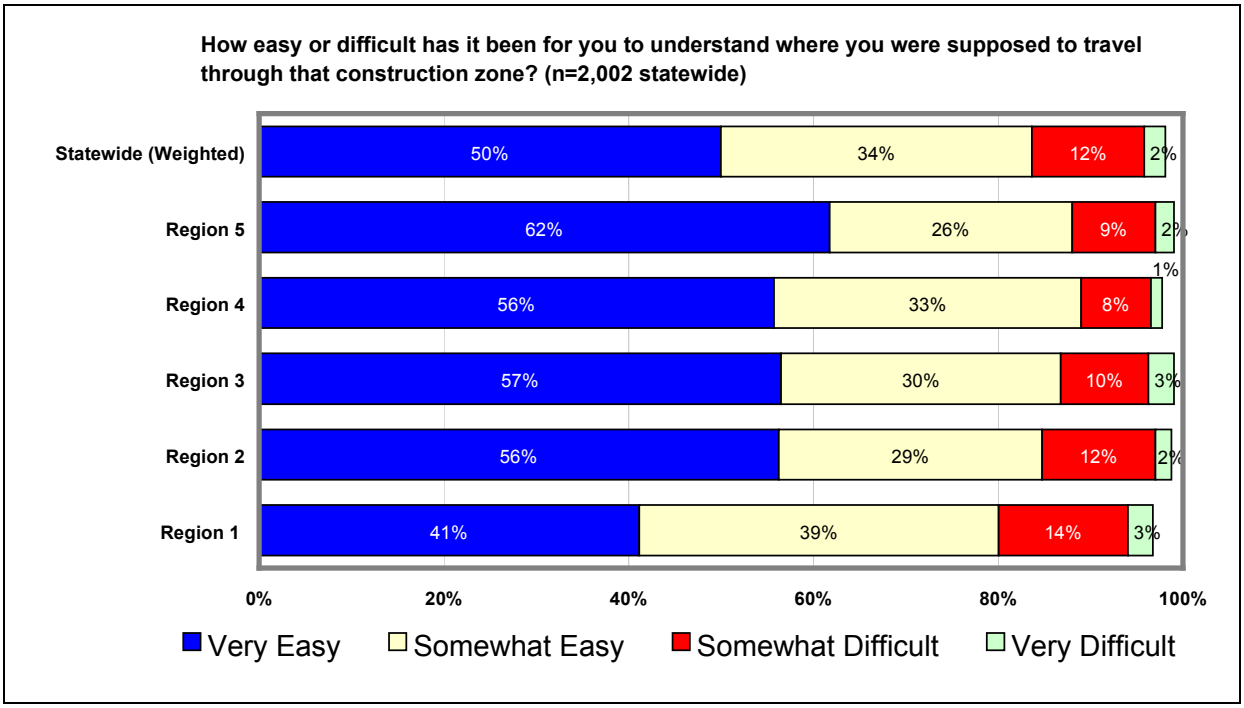



Figure 5.12: Ease in Understanding Where to Travel in the Work Zone

Those respondents who experienced difficulty in understanding where they were supposed to travel were asked: "What made it difficult for you to understand where you were supposed to travel in that construction zone?" There were 263 people (about 12.5% of all respondents) who answered the question; the most frequently occurring responses are contained in Table 5.4. For those who experienced difficulty, the most frequently given reason related to the lack of, or unclear signage.

**Table 5.4: What Made It Difficult When Traveling through the Work Zone**

| Description | Number of Responses |
|---|---|
| Lack of signs, signs moved, improper signs. People get lost because there is nothing to tell them where to go. Exits not clearly marked. | 41 |
| Signs hard to read; print too small; directions unclear/inadequate; not enough time to read; electronic signs blinking too fast. | 27 |
| Markings: inadequate or confusing signs, barricades, cones, and striping. | 16 |
| Stripes not visible or lines not clear; lanes poorly marked, poorly defined. | 14 |
| Routing is confusing or awkward through or around construction area. | 13 |
| Signs poorly located; inadequate lead time or signs too far from zone. | 11 |
| Cones inadequate or poorly placed. | 11 |
| Nighttime visibility poor; inadequate illumination of construction zone. | 11 |

The next question asked, "How easy or difficult has it been for you to get on or off the highway at intersections and driveways in the construction zone?" A substantial portion of respondents said the question did not apply, since the work zone they had traveled was not affected by intersecting driveways or streets.

For those who answered, the distribution of answers, shown in Figure 5.13, reveals that there was not much difficulty getting on or off the highway. Discounting motorists for which this question didn't apply, less than one fourth said it was either "somewhat" or "very difficult" to get on or off the highway at intersections and driveways in the work zone. The lowest proportion of reported difficulty was in Regions 3 and 5.

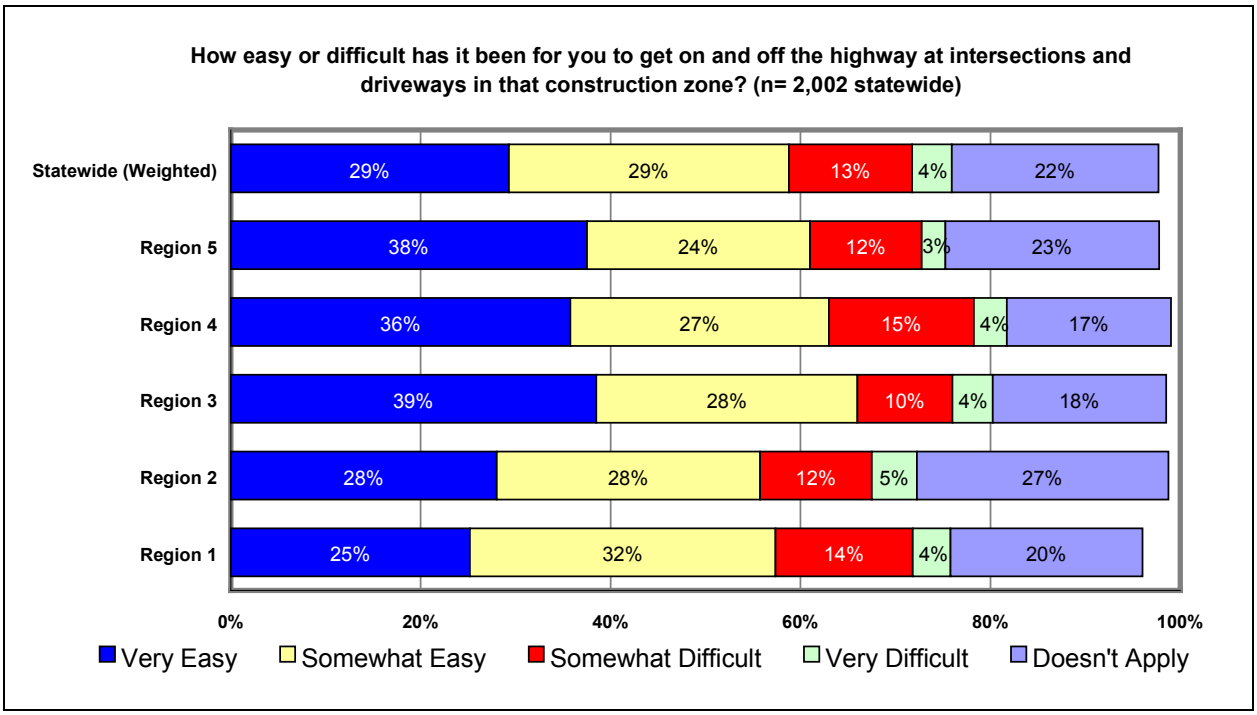



Figure 5.13: Ease in Getting "On or Off" Highway in the Work Zone

The respondents who expressed difficulty in getting on and off the highway were asked, "What made it difficult?" Table 5.5 summarizes the answers. The biggest problem alluded to by respondents in every region was related traffic congestion.

**Table 5.5: What Made It Difficult to Exit the Work Zone at Intersections and Driveways**

| Description of Problem | Number of Responses |
|---|---|
| Traffic congestion, delays, bottlenecks, difficult to enter/exit highway. | 93 |
| Highway exits, on/off-ramps blocked, closed, or absent. | 18 |
| Lack of signs; signs moved; improper signs. People get lost because there is nothing to tell them where to go, exits not clearly marked. | 17 |
| Blocked streets or driveways blocked, closed, or inaccessible. | 14 |
| Roads, driveways, exits, on and off ramps – open one day and closed the next. | 13 |
| Traffic poorly controlled; lack of signals, policing. | 11 |
| Traffic Flow: too much; too fast or too slow; not well controlled. | 10 |

The final question in this series was about other inconveniences in the work zone. It asked "Have you experienced any other inconveniences around that construction zone, such as noise, dust, asphalt on vehicles, glare from construction lighting, or rock chips?" The results were similar for all five regions. Figure 5.14 provides the distribution of responses for the entire survey sample.

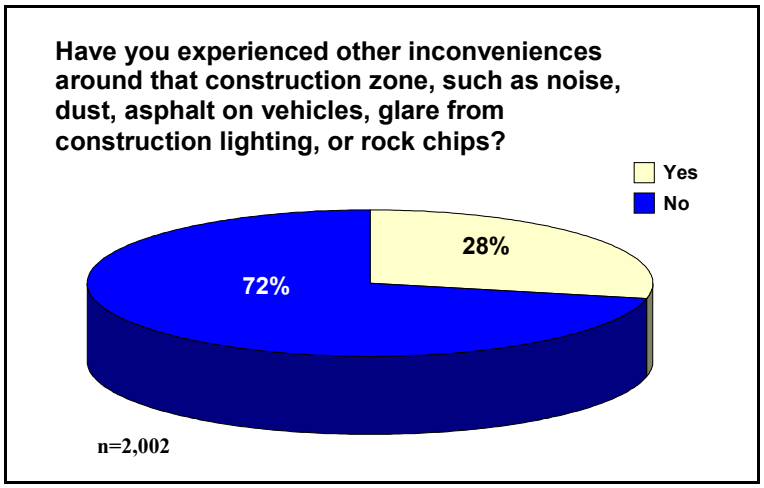



Figure 5.14: Other Inconveniences in the Work Zone

Not considering delay, slightly more than 28% of the respondents indicated that they were inconvenienced when traveling the work zone. Those who answered yes were asked a follow-on question about what those inconveniences were. Almost all who answered this question said the inconveniences were either noise, dust, flying rock chips, or asphalt getting on their vehicles.

### 5.2.4 How Safe People Feel Traveling in the Work Zone

This series of questions asked respondents about traveling safely through the work zone. As shown in Figure 5.15, the vast majority of respondents said it was either "very" or "somewhat easy" to travel safely through the work zone they most frequently traveled. In Region 1, 84% of the respondents indicated it was either "very" or "somewhat easy." In the other four regions, the percentage who favorably responded was even higher; for Region 4, it was over 95%.

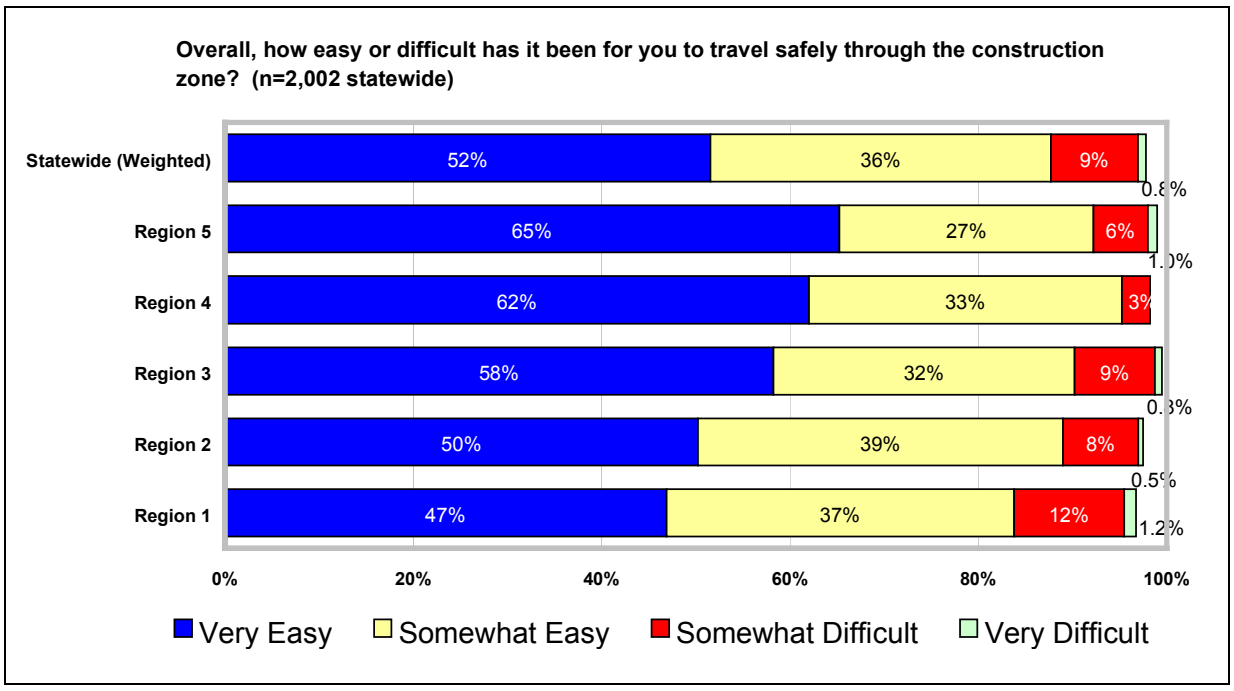



Figure 5.15: Overall Ease of Traveling Safely through the Work Zone

Of the total 2,002 survey respondents, 162 said it was either "somewhat" or "very difficult" to safely travel through the work zone. Table 5.6 lists the most frequently given reasons for why it was difficult. Again, the top reason offered was related to congestion, with other reasons relating to the reckless behavior of other drivers. Another reason listed by 11 respondents refers to the narrowing of lanes in the work zone.

**Table 5.6: What Made It Difficult to Travel Safely through the Construction Zone**

| Description of Problem | Number of Responses |
|---|---|
| Traffic congestion, delays, bottlenecks, difficult to enter/exit highway. | 24 |
| Traffic Flow: too much; too fast or too slow; not well controlled. | 15 |
| Drivers speeding. | 14 |
| Road or lanes narrow, crowded, constricting. | 11 |
| Drivers changing/merging lanes hazardously. | 9 |
| Drivers impatient, rude, angry, aggressive. | 8 |

Next, all respondents (2,002) were asked, "How could the construction work zone *(i.e., the one most frequently traveled)* be made safer?" All respondents were asked this question, because even though the vast majority said it had been either very or somewhat easy to safely travel through the work zone, the authors believed everyone could offer potentially insightful suggestions about making work zones safer. Table 5.7 summarizes the most frequently given types of responses.

**Table 5.7: How Could the Construction Work Zone Be Made Safer?**

| Suggestion | Count |
|---|---|
| Reduce speeds; greater enforcement of posted speeds | 147 |
| Widen lanes | 104 |
| More/better signage | 54 |
| Better delineation -- cones/markings/striping | 43 |
| Improve visibility/positioning/number of flaggers | 39 |
| Earlier/more warning in advance of the work zone | 33 |
| More/better lighting at night | 29 |
| Work during off peak hours | 20 |
| Reduce conflicts with construction equipment/personnel | 17 |
| Increase distance or separation between workers and traffic | 12 |
| Reduce abrupt edges/bumps; make road smoother | 10 |

The next six questions asked respondents to indicate the level of importance of making improvements to various traffic control devices or strategies to enhance safety on Oregon highways. These questions asked respondents to think about Oregon highways in general, *and not* the one particular work zone traveled most often. The distribution for all regions was about the same, so Table 5.8 presents the statewide response.

**Table 5.8: Level of Importance of Traffic Control Devices/Strategies in Work Zones**

| No. | Question | Very Important | Somewhat Important | Not Very Important | Not Important | Don't Know |
|---|---|---|---|---|---|---|
| 1 | How important is it to improve night time visibility on Oregon highways? | 1614 (81%) | 248 (12%) | 79 (4%) | 24 (1%) | 37 (2%) |
| 2 | How important is it to improve signs, stripes, reflectors, and signals on Oregon's state highways? | 1559 (78%) | 303 (15%) | 108 (5%) | 20 (1%) | 12 (1%) |
| 3 | How important is it to improve safety in highway work zones? | 1559 (78%) | 297 (15%) | 96 (5%) | 24 (1%) | 26 (1%) |
| 4 | How important is it to improve guard rails and traffic barriers? | 1298 (65%) | 493 (25%) | 169 (8%) | 28 (1%) | 14 (1%) |
| 5 | How important is it to improve law enforcement on Oregon highways? | 1201 (60%) | 519 (26%) | 181 (9%) | 83 (4%) | 18 (1%) |
| 6 | How important is it to improve traffic flow in highway work zones? | 1100 (55%) | 705 (35%) | 148 (7%) | 24 (1%) | 25 (1%) |

For the six questions in Table 5.8, the majority of respondents said it was either "very" or "somewhat" important to make improvements to:

1. Nighttime visibility;
2. Signs, stripes, reflectors, signals;
3. Safety in work zones;
4. Guardrails and barriers;
5. Law enforcement; and
6. Traffic flow in work zones.

The category with the most "very important" votes was nighttime visibility. Over 80% of the respondents (1,614 of 2,002) felt it was "very important" to improve nighttime visibility on Oregon highways. For category 5, improved law enforcement, there was a slight difference in how Region 1 responded compared to the other regions. In Region 1, 55% said it was "very important" to improve law enforcement, while in the other regions the "very important" category ranged from 61 to 63%. One possible reason for the difference could be because of the widespread presence of multi-jurisdictional police agencies already in place in Region 1.

The next survey question asked motorists to identify which of the six items listed above was most important. Percentage distributions of responses by region are shown in Figure 5.16. The number of respondents is about 400 in each region.

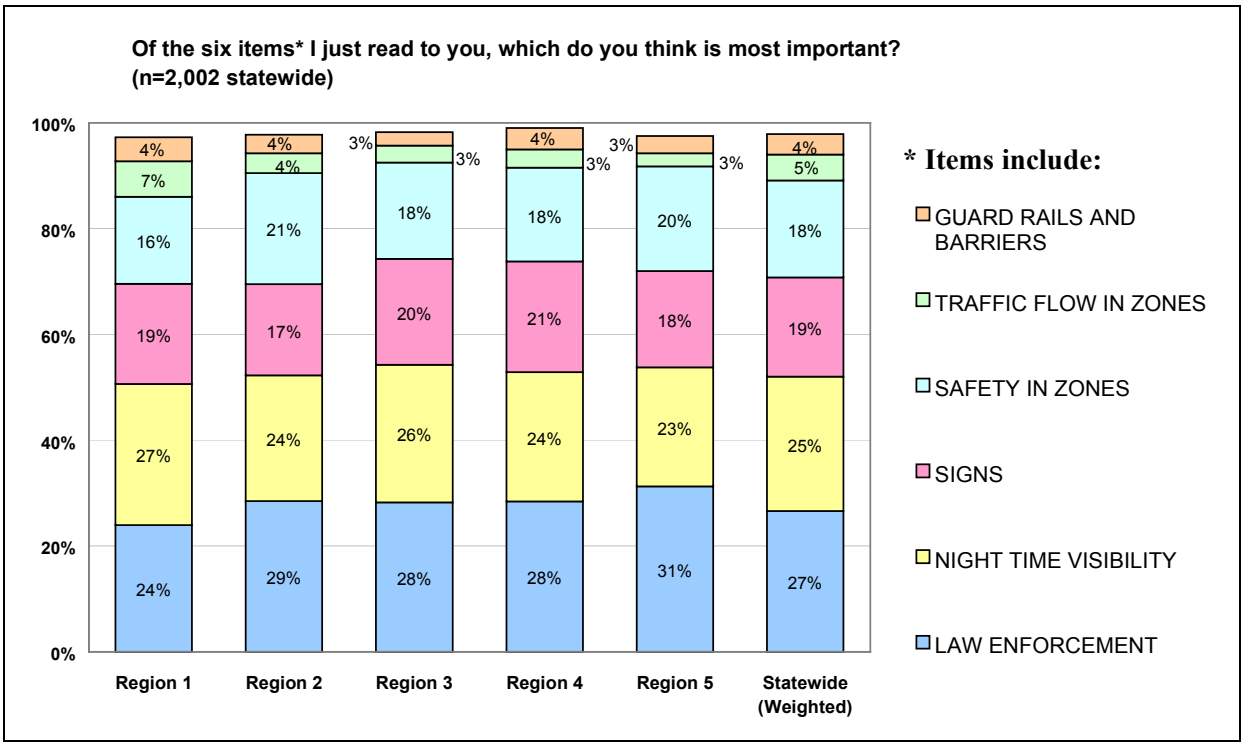



Figure 5.16: Ranking of Most Important Traffic Control Device/Strategy for Work Zones

In Regions 2, 3, 4 and 5, law enforcement was named more frequently as most important, followed by nighttime visibility. The order was reversed in Region 1, where 27% of the 401 respondents picked improving nighttime visibility as the most important, and 24% chose improving law enforcement. Improving safety in work zones was chosen by 17 to 21% of the respondents in each region as most important. A similar distribution chose improving signs, striping, reflectors and signals.

### 5.2.5 Sources of Information

This section of the survey asked about how, and from what sources, people get their information about highway construction work zones. Figure 5.17 shows the distribution of responses to the question, "Where do you get your information about state highway construction work, such as road closures and delays? Do you ever get any information from television?" The distribution shows a greater reliance on television as an information source in more densely populated areas. In Region 1, over 63% of the respondents said they obtain construction related information from television, whereas in Region 5, only 28% answered yes.

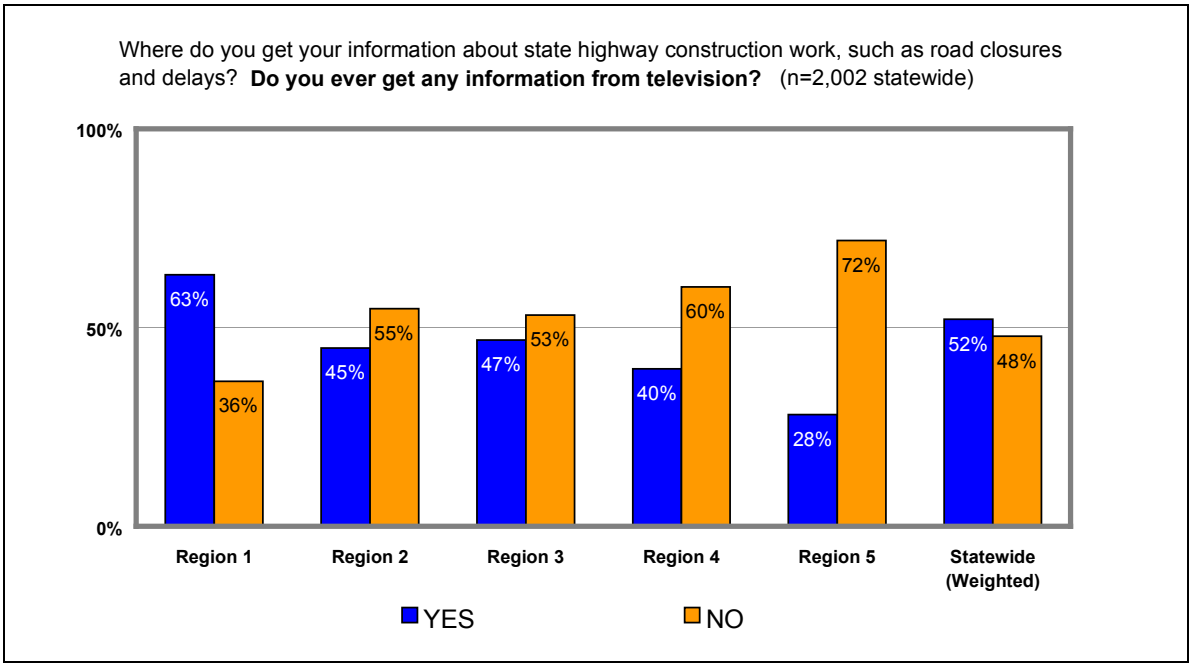



Figure 5.17: Information Source - Television

The next question asked about radio as an information source. The responses, shown in Figure 5.18, indicate considerable reliance on radio as an information source. In Region 1, 73% of the respondents said they use radio as a source for construction-related information, and in Regions 2, 4, and 5, a majority use radio as an information source. However, in Region 3, less than half use the radio to find out about highway construction and work zones.

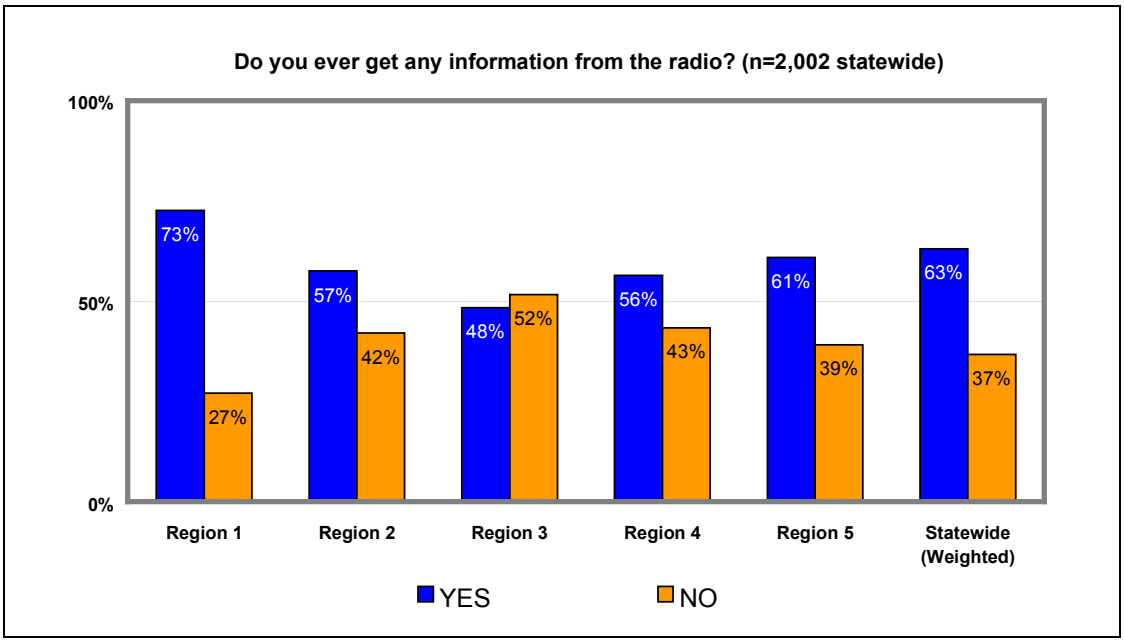



Figure 5.18: Information Source - Radio

When asked if they received construction related information from newspapers (Figure 5.19), less than half of the respondents in Region 1 answered yes, whereas in the other four regions, a majority answered yes. In particular, in Region 3, 63% of the respondents indicated they use newspapers for information about construction.

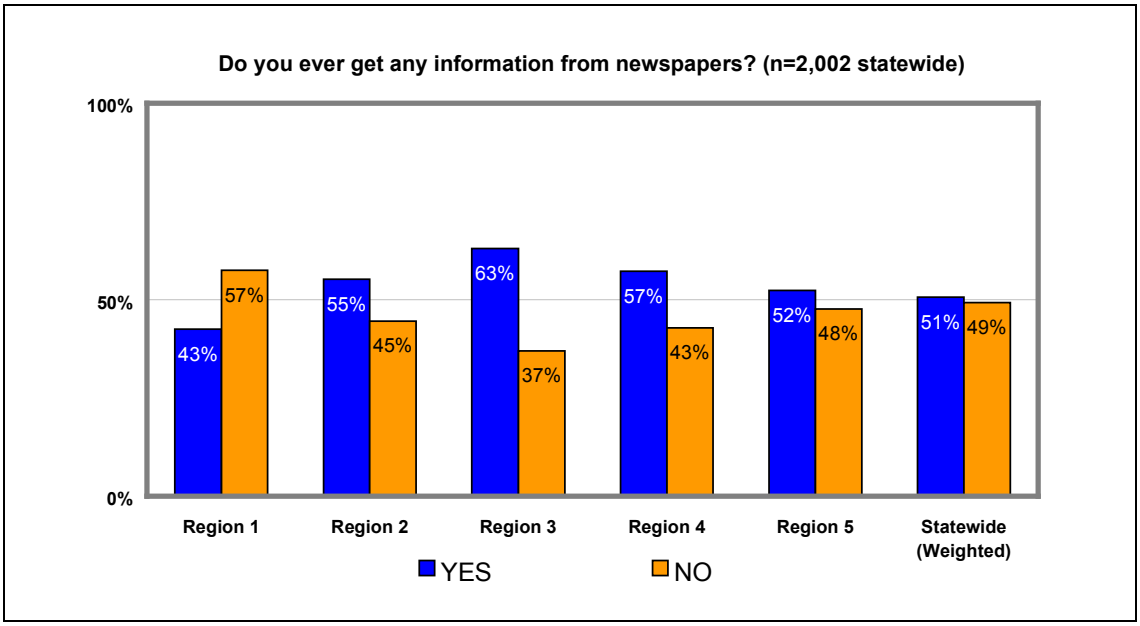



Figure 5.19: Information Source - Newspapers

Respondents were asked if they ever get information from electronic changeable message signs. Throughout all five regions, 80% or more answered yes (Figure 5.20). In Region 1, the

percentage was slightly higher, probably because of the more extensive use of portable and permanent changeable message signs in the Portland Metro area.

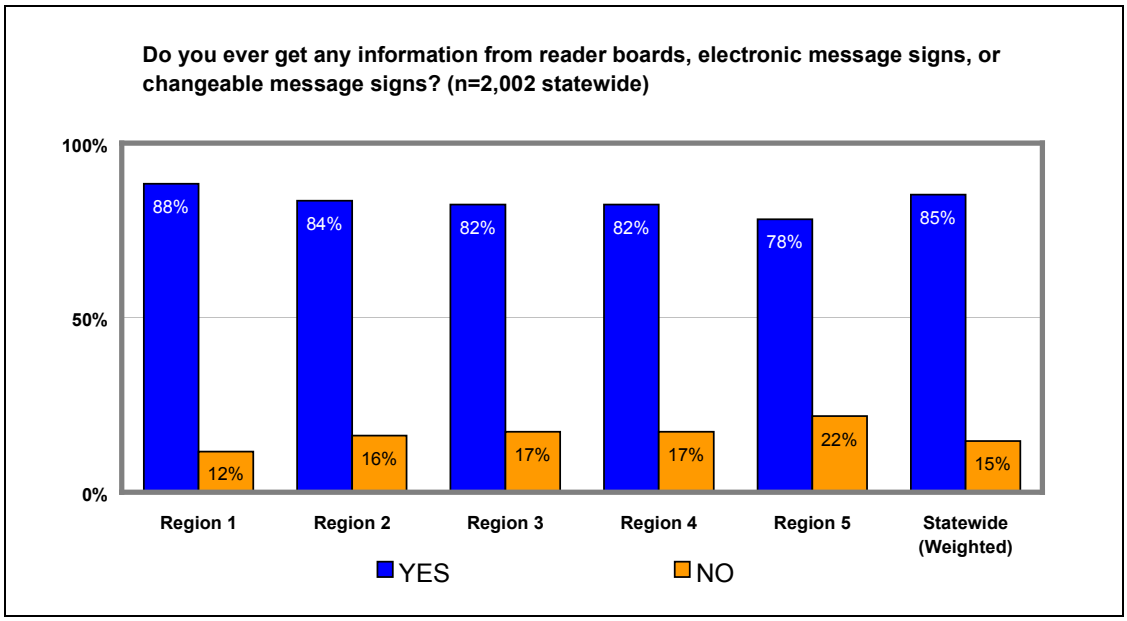



Figure 5.20: Information Source - Changeable Electronic Message Signs

Another source of information was flaggers. Figure 5.21 shows the distribution of responses in each region when people were asked if they ever obtained information from flaggers. More than half in each region said they did, and in Region 5, the percentage of those answering yes was slightly higher (62%) than in the other four regions. The reason it is slightly higher in Region 5 could be because some of the work zones are in very isolated locations with limited information available to motorists about construction.

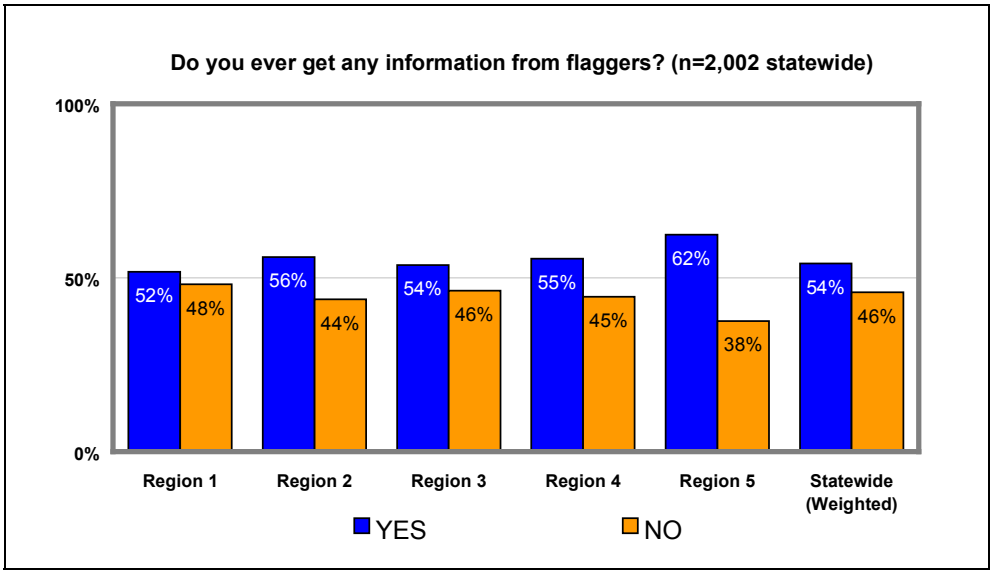



Figure 5.21: Information Source - Flaggers

The next question asked about obtaining highway construction information using the Internet. As Figure 5.22 shows, less than 20% in each region were using the Internet as a construction information source. However, its reported use in Regions 4 and 5 (about 18%) was slightly higher than Region 2, and significantly higher than in Regions 1 and 3.

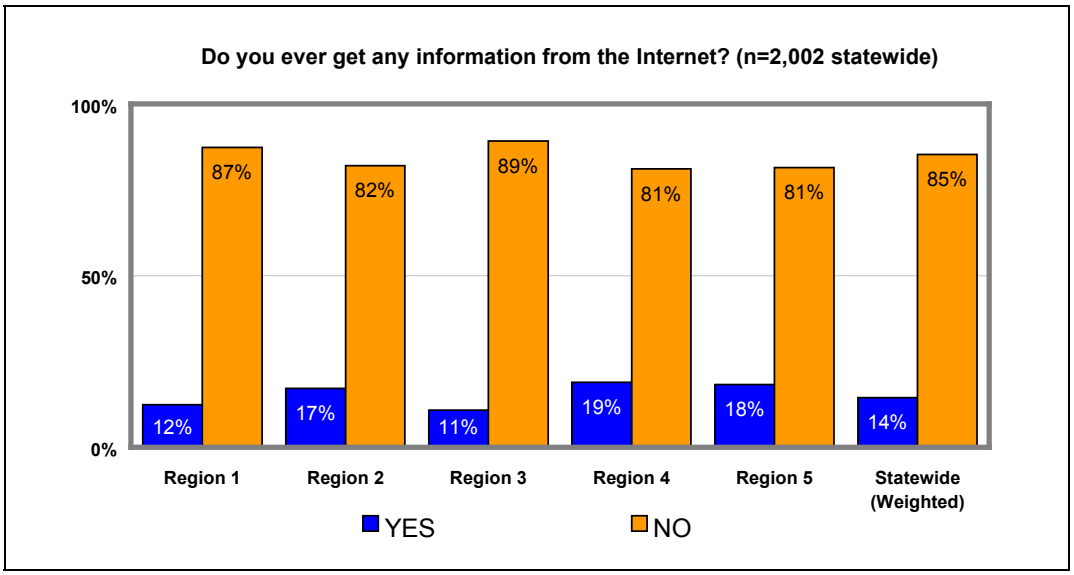



Figure 5.22: Information Source - Internet

Figure 5.23 shows how many people received information on highway construction at public meetings. Between 10 and 12% in all regions received information from public meetings. One could infer based on this distribution, that about 10 to 12% of the population has attended public meetings relating to highway construction.

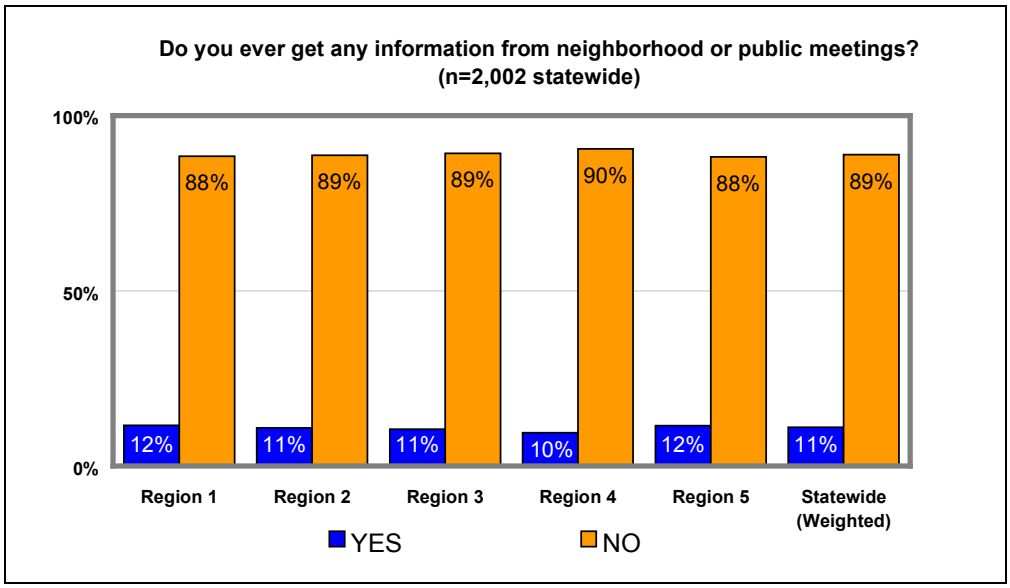



Figure 5.23: Information Source - Public Meetings

The next question asked about public access television. The distribution of responses in Figure 5.24 shows that its use was more prevalent in Regions 3 and 4. In these two regions, over 32% of the respondents had used public access television as a source of information.

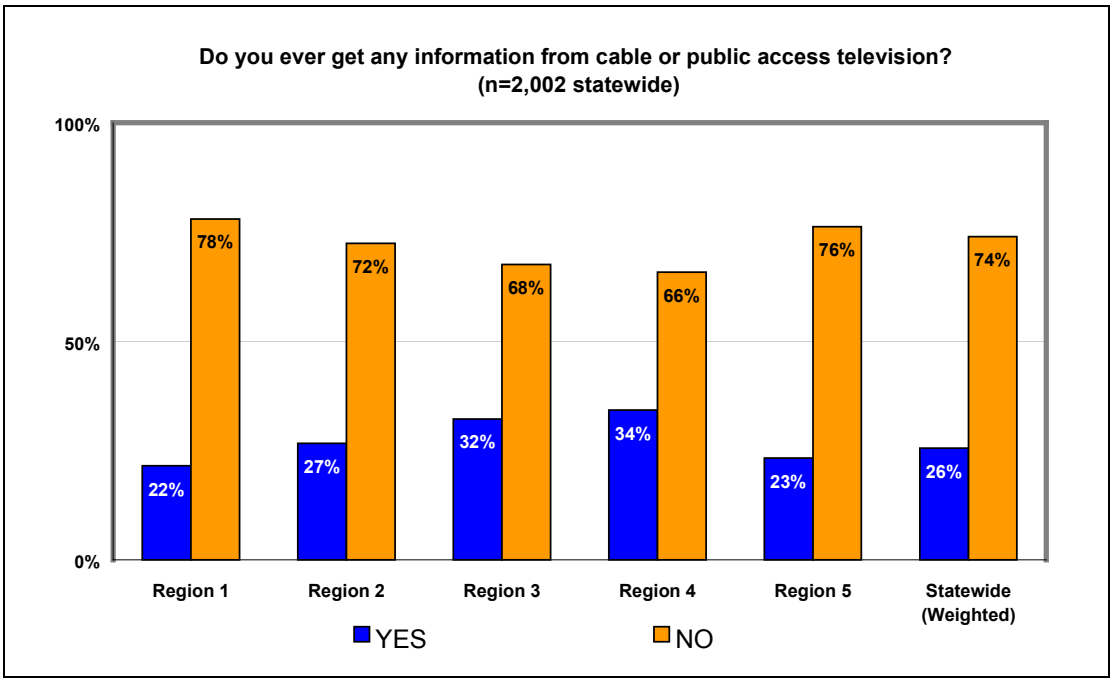



Figure 5.24: Information Source - Public Access Television

Figure 5.25 shows the distributions by region of those who called ODOT directly to obtain construction information. In Region 5, 39% of those surveyed had called ODOT directly, whereas is Region 1, only 12% had contacted ODOT directly about construction information.

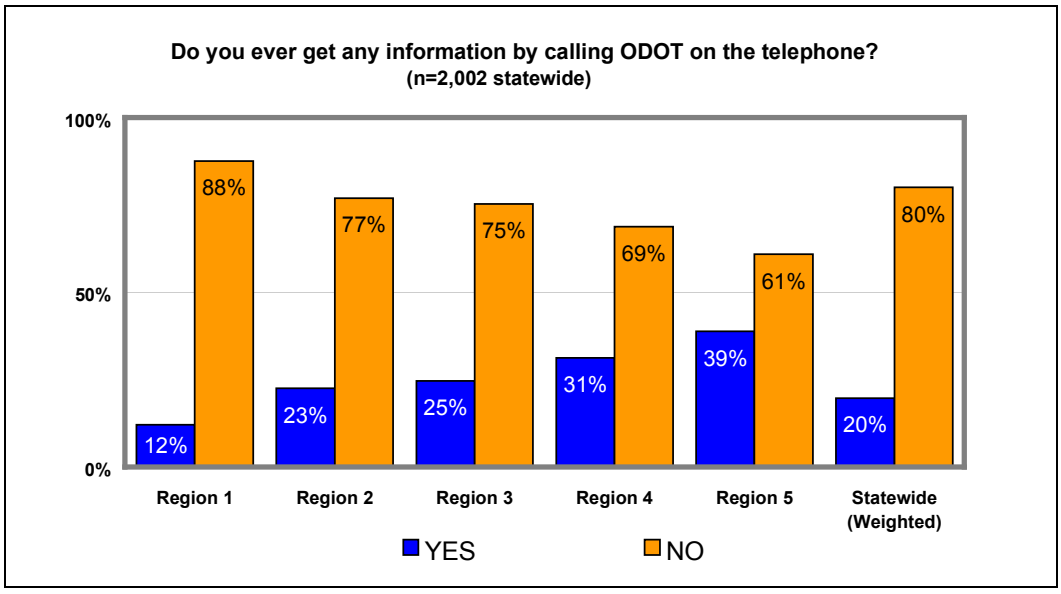



Figure 5.25: Information Source - Calling ODOT

Next, people were asked to consider all sources of information, and were asked, "From which source do you get the *most* information about state highway construction work, such as road closures and delays?" Figure 5.26 summarizes the results. In Region 1, the radio and television were the primary information sources. For Regions 2, 3, 4 and 5, it was construction signs. In these four regions, newspapers were also an important source of information, whereas in Region 1, only about 10% of the respondents picked newspapers as their primary information source.

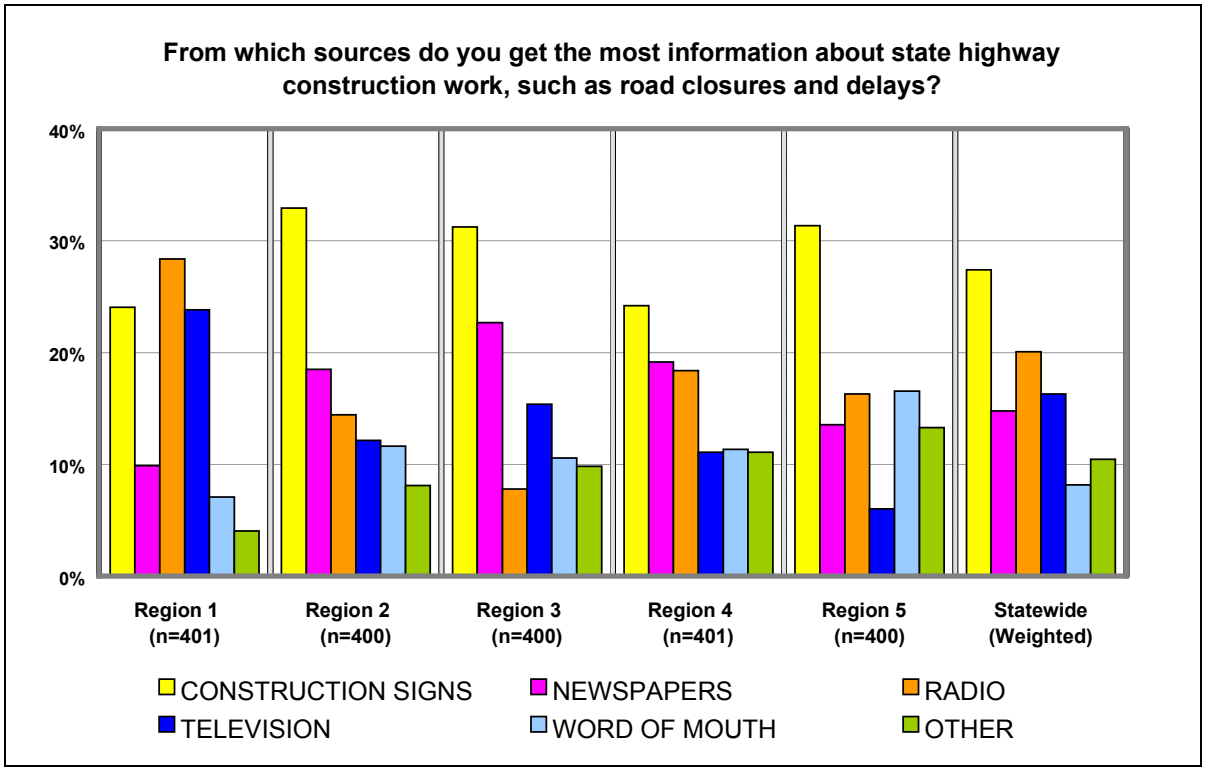



Figure 5.26: The Sources of Construction Information People Rely on the Most.

A follow-on question addressed getting information in advance of the trip. People were asked: "Before making a trip, do you ever try to find advance information about state highway construction work such as road closures and delays?" Figure 5.27 shows that the majorities (from 57 to 62%) in each region do not seek advance information about construction prior to making a trip.

Those who responded "yes" were asked to identify their sources of advance construction information. Figure 5.28 shows that in Regions 1 and 2, the Internet was the number one source of advance information. In other regions, the most frequently given response was "phone calls to ODOT" followed by the Internet.

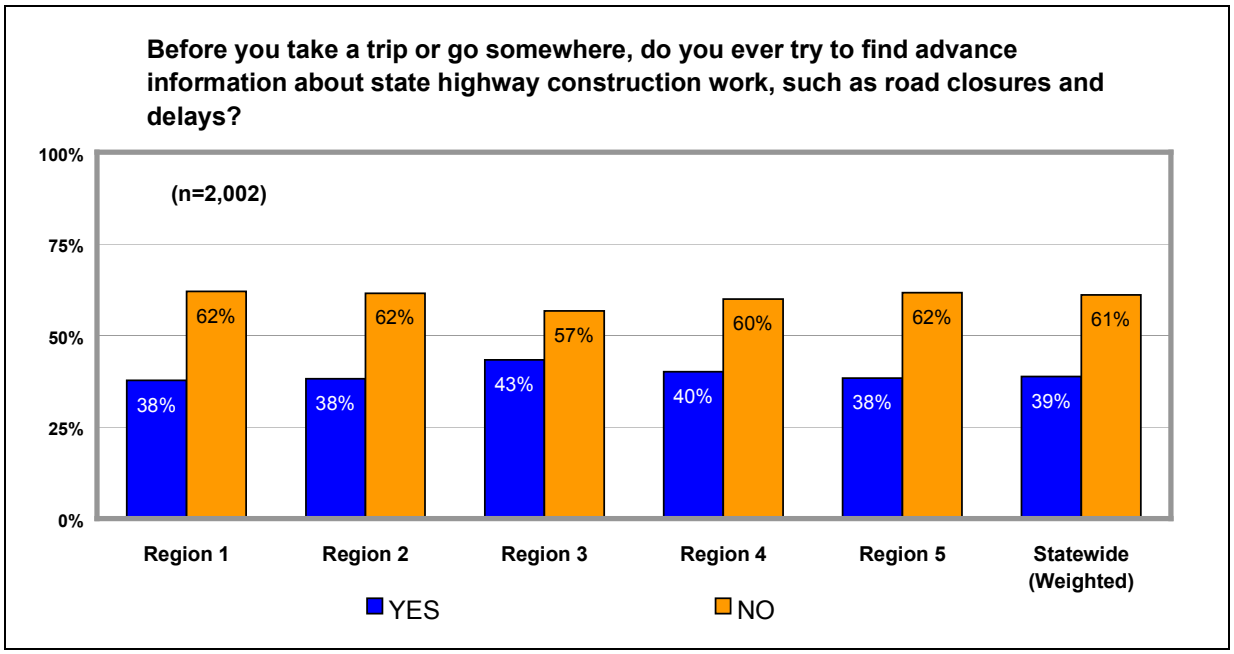



Figure 5.27: Seeking Advance Information about Construction prior to the Trip

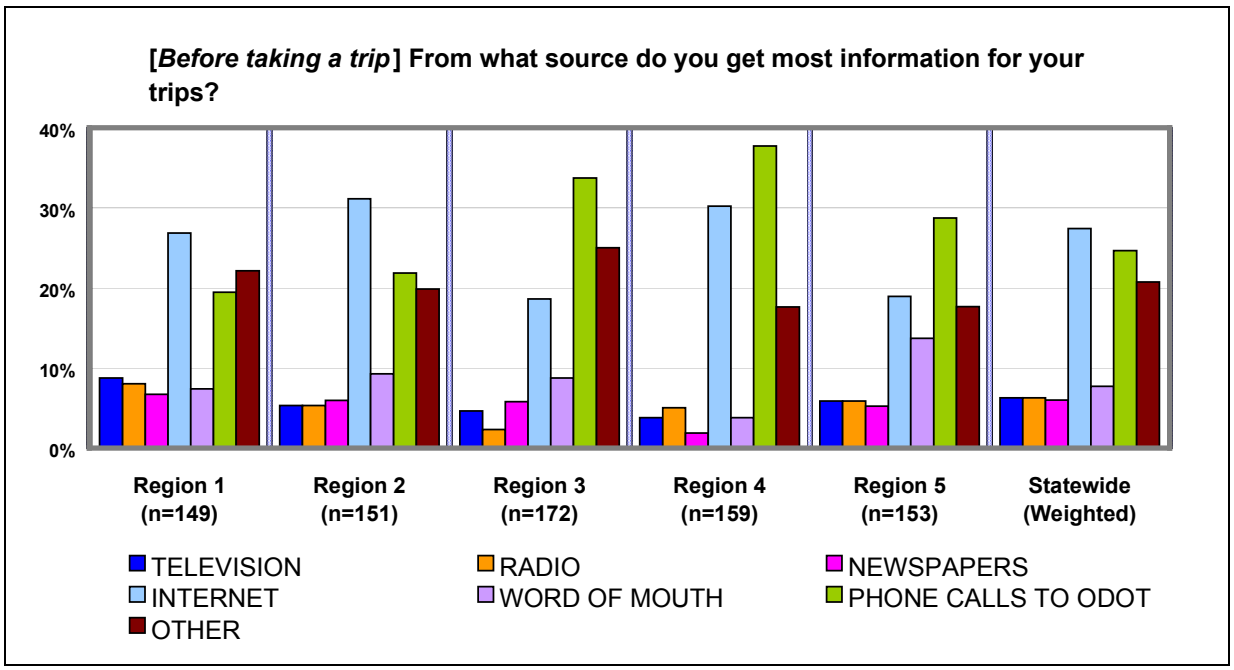



Figure 5.28: The Best Sources of Advance Information about Construction

In the final question related to sources of information, people were asked: "When you are **on a trip**, what is the best way for you to receive information and news about highway construction?" As shown in Figure 5.29, the majority of respondents in all regions utilize construction signs as the best way to obtain information. The second choice was the radio.

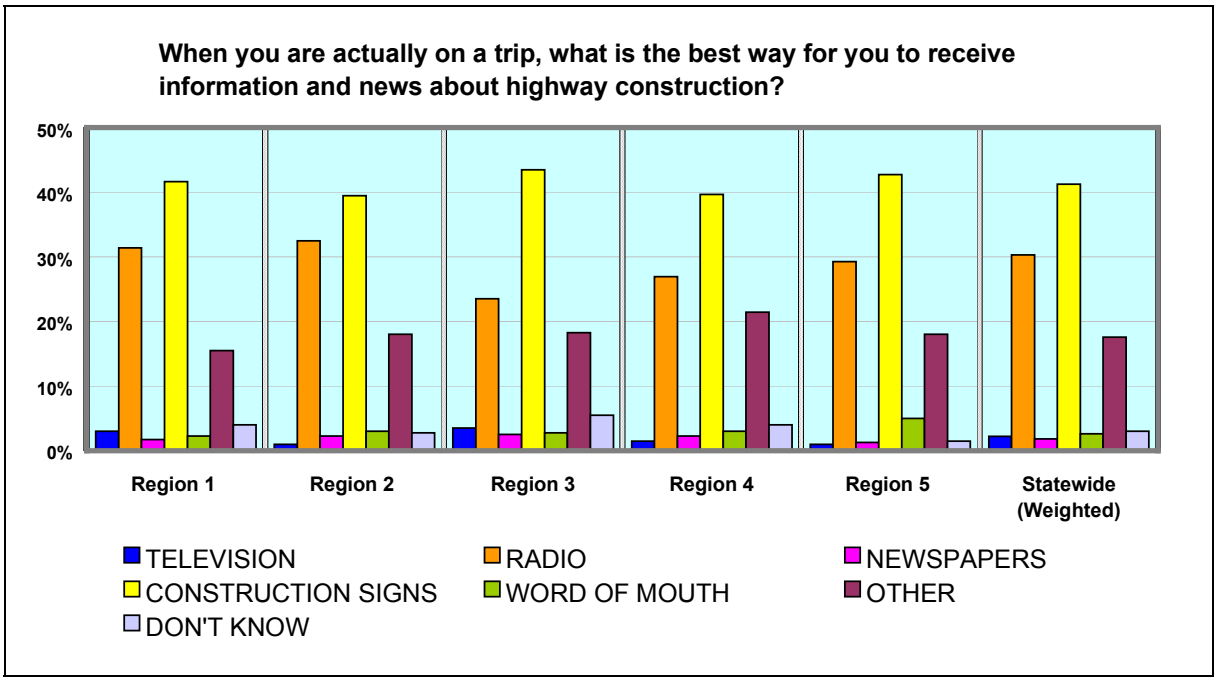



Figure 5.29: The Best Sources of Information about Construction during the Trip

## 5.2.6 Opinions About ODOT

In this section motorists were asked their opinions about how well ODOT has done in managing various work zone features. The first three questions deal with specific aspects of the work zone that the respondents had traveled through the most frequently in the past three weeks. These three questions asked about: (1) striping; (2) visibility of traffic control devices at night; and (3) signs. The first question asked motorists to rate how well ODOT has done in maintaining striping in the work zone. The results, presented in Figure 5.30, show that between 65 and 72% of the respondents in each region rated the work zone striping "good" or "excellent."

The next question asked people to rate how well ODOT has done in maintaining the nighttime visibility of the work zone, specifically the lighting, cones, and reflectors on barrels, so that motorists can see where to go in the work zone. In answering this question, about 90 to 100 people in each region said they did not travel through work zones at night and therefore did not rate ODOT on this subject. Figure 5.31 provides the results. The ratings in each region were again very positive, with between 75 and 79% of the respondents rating ODOT in the "excellent" or "good" category.

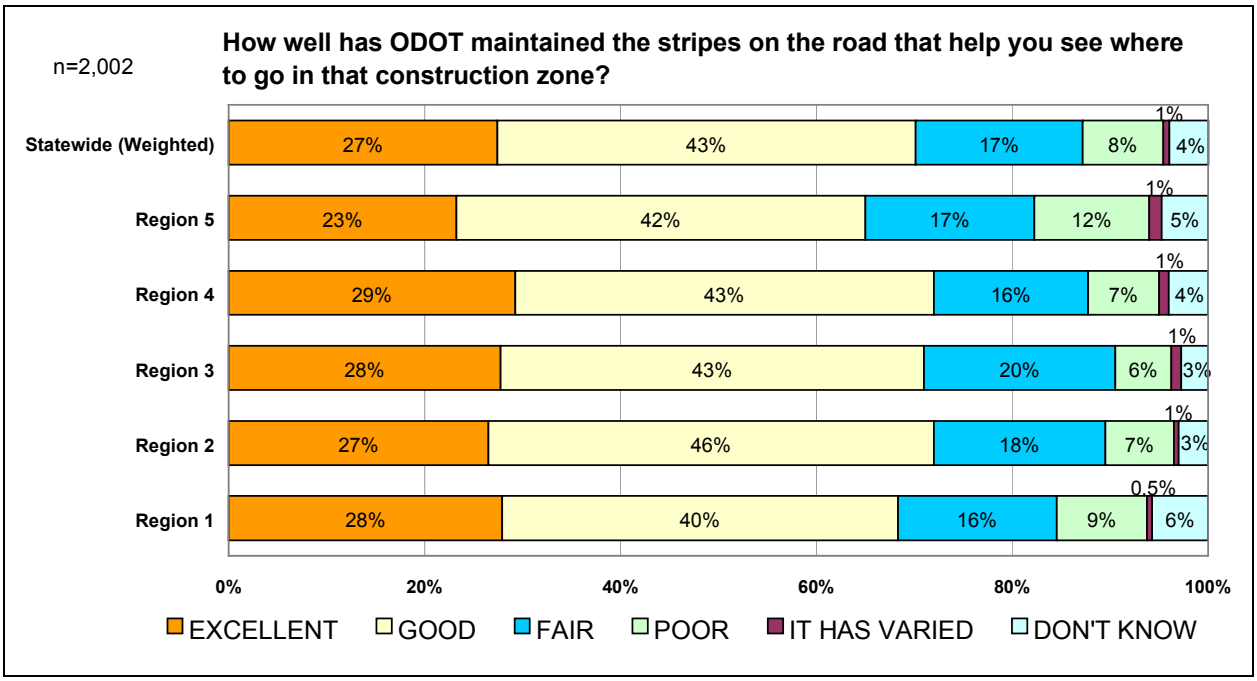



Figure 5:30: Rating of Striping in the Work Zone

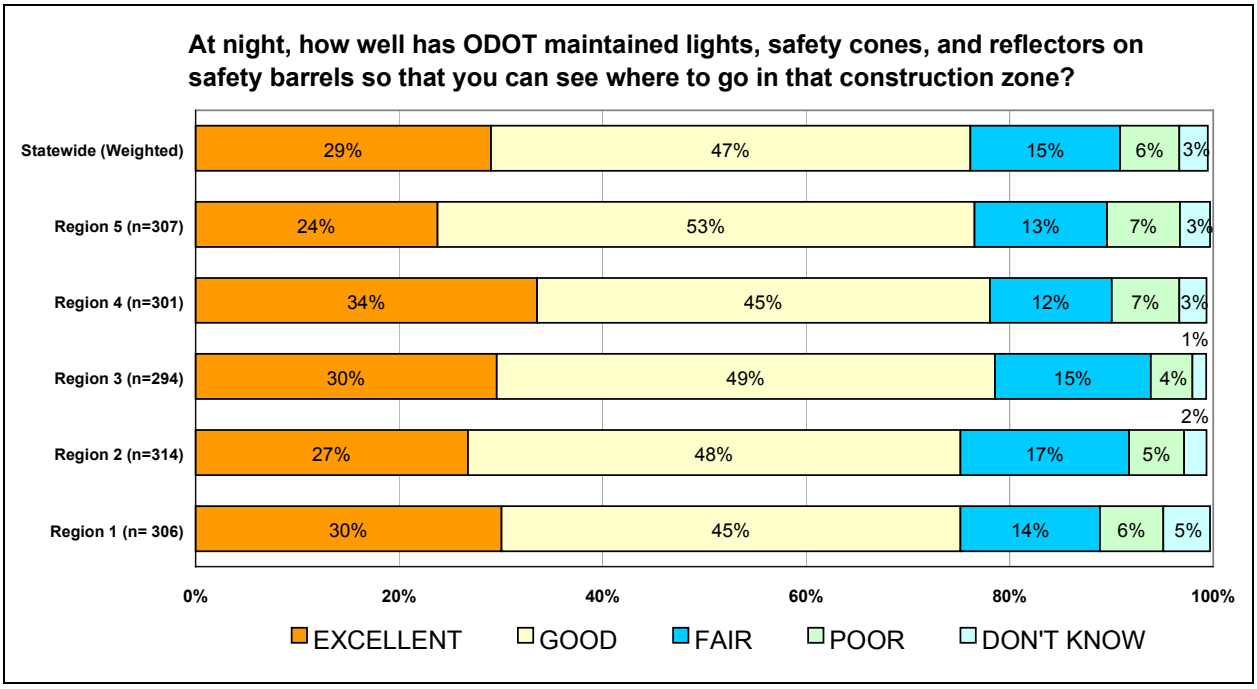



Figure 5.31: Rating of Nighttime Visibility

The third question asked respondents to rate the signing in the work zone most frequently traveled. As shown in Figure 5.32, the ratings were very positive. Ratings in the "excellent" or "good" category ranged from 78% in Region 1, to 88% in Region 4.

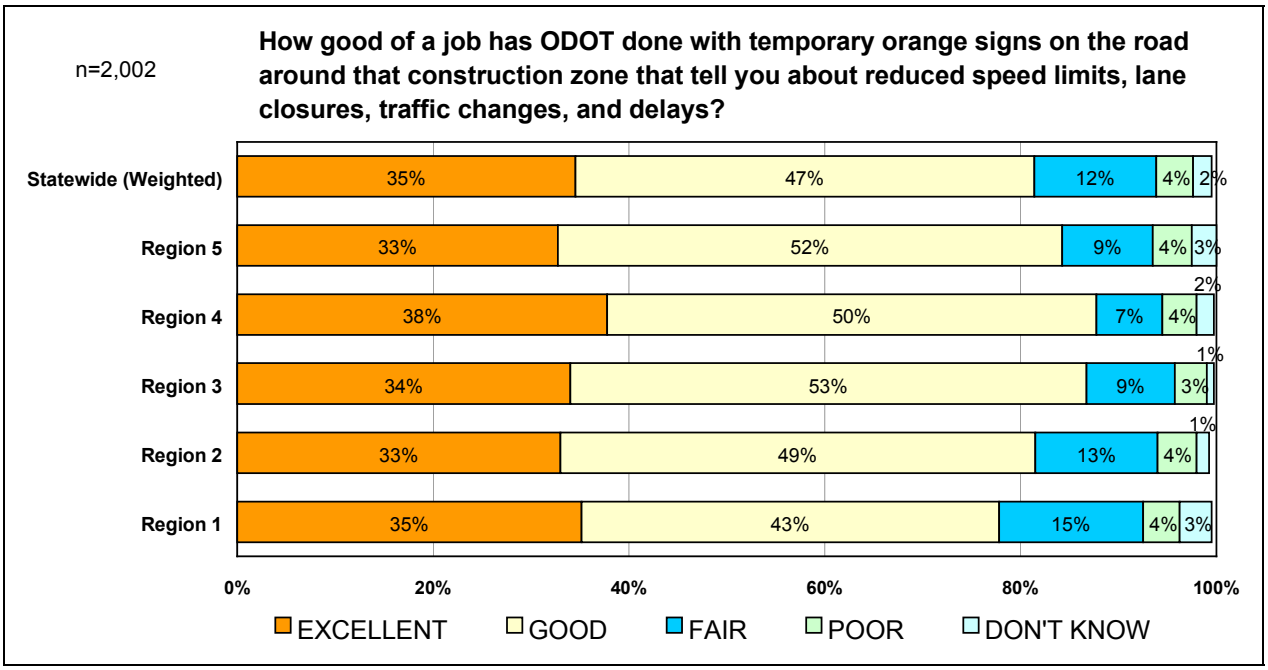



Figure 5.32: Rating of Signs

The next two questions were more general. The first asked about how well ODOT manages construction work zones. Figure 5.33 presents the responses. When offered the choices of excellent, good, fair or poor, most people in each region (81 to 89%) said ODOT was doing a "good" or "excellent" job managing work zones. The range of responses in the "excellent" category was 20-29%, with Regions 3 and 4 having higher "excellent" response rates (29%). In all regions, very few respondents gave ODOT a "poor" rating (2% or less).

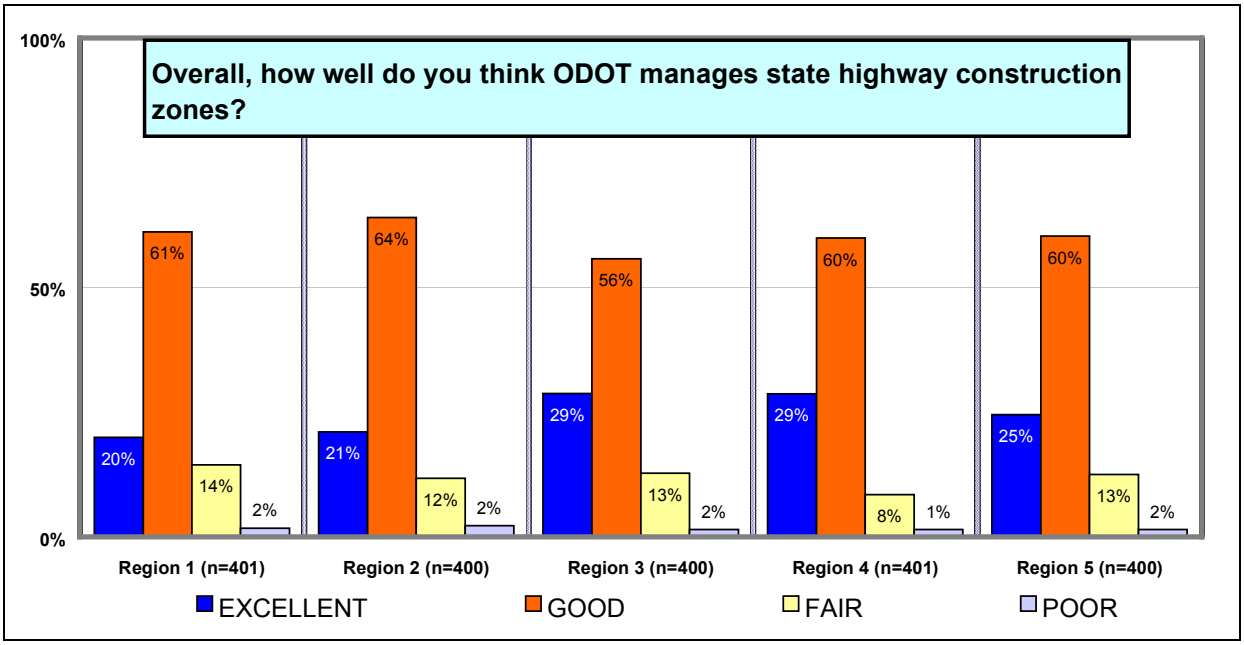



Figure 5.33: How Well ODOT Manages Construction Work Zones

The second general opinion question asked respondents to provide a general impression of ODOT in terms of positive, negative or neutral feelings towards the Department. As presented in Figure 5.34, the majority expressed positive feelings about ODOT. In Region 1, the percentage choosing the "positive" category was slightly lower than in the other four regions. This could be attributed to the higher volumes of traffic and possible added frustration experienced by drivers as they travel on more congested state highways in the region. Again, there were very few (8% or less) who expressed negative views of ODOT.

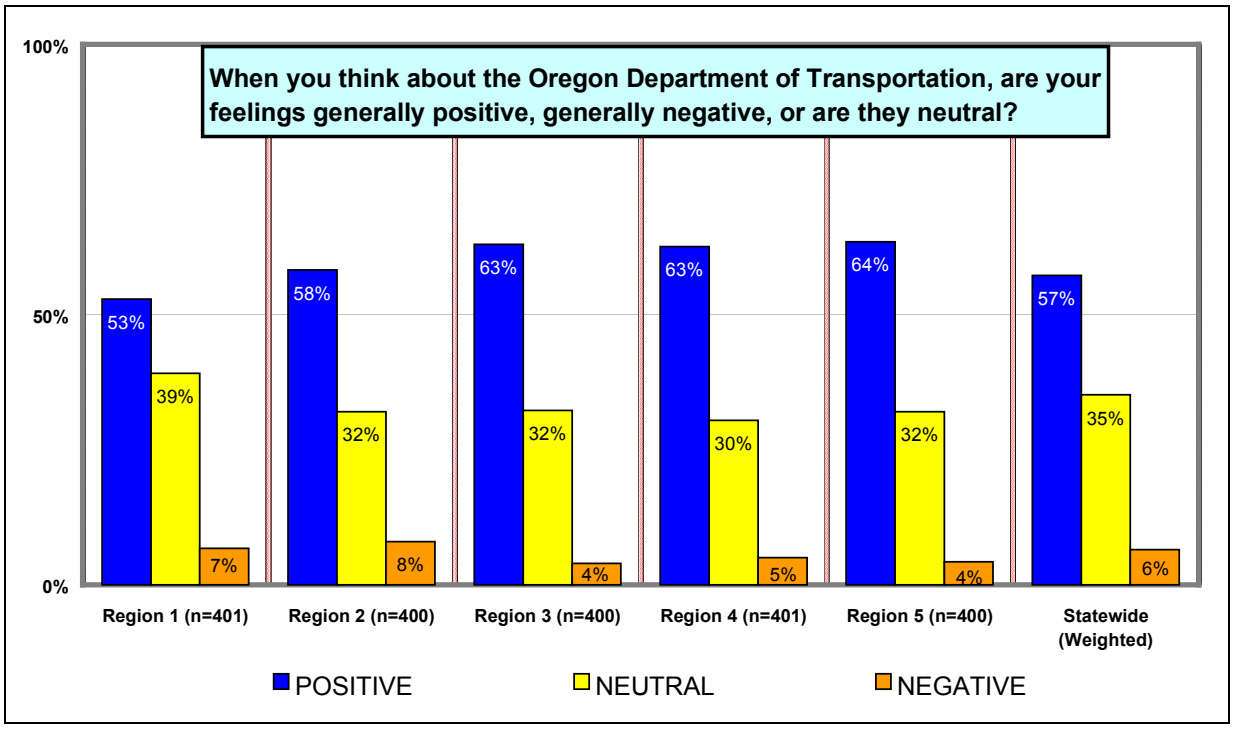



Figure 5.34: General Feelings about ODOT

## 5.2.7 Survey Sample Demographic Data

Demographic data obtained in the survey from the sample of 2,002 respondents includes years of residence in Oregon, age, sex, education, employment, number of adults in the household, number of vehicles in the household, urban-rural community, presence of children in the household, and household income. Regional demographic profiles provided by the OSRL Executive Report *(Gwartney and Wolf 2001)* for this study are presented for each ODOT Region in Tables 5.9 through 5.13.

After the demographic profile tables are presented, a comparison of the survey demographic data is made with United States Census 2000 data in Section 5.2.7.1 to gauge how representative the survey sample (n=2,002) was to the general populations of the five regions.

Additionally, following the survey sample and Census comparisons, Section 5.2.7.2 provides an example of how the sample demographic data can be used to obtain additional information from the survey using cross tabulations.

**Table 5.9: Profile of Survey Respondents – Region 1**

| Region 1 Demographics | |
|---|---|
| **Urban/Rural** | 77% report residing in urban or suburban areas |
| **Age** | 18% ages 18 to 29, 18% ages 30 to 39, 27% ages 40 to 49, 21% ages 50 to 59, 7% ages 60 to 69, and 8% ages 70 and greater |
| **Race/Ethnicity** | 86% white, 4% Asian or Pacific Islander, 2% each African American, Latino/Hispanic, American Indian, and refused, and 1% each mixed race and "other" |
| **Sex** | 56% female and 44% male. The larger percentage female is similar to the population and reflects the population's aging (women outlive men). |
| **Education** | 4% have less than high school, 25% a high school diploma or GED, 29% some college (including Associate's degrees), and 41% a bachelor's degree or more |
| **Income** | Median household income range is $40,000 to $70,000, the modal income category is $70,000-$100,000. Income for 12% was over $100,000 while 4.5% said that they made less than $15,000. Over 9% refused the question. |
| **Employed** | 73% are employed, 13% retired, 5% keeping house, and 3% unemployed |
| **Children** | 32% have children age 12 or under living at home |
| **World Wide Web** | 79% reported having access to the World Wide Web at home, work, or school |
| **Drive for Job** | 31% drove as part of their job duties |
| **Licensed Drivers** | 1% zero drivers, 25% one driver, 57% two drivers, 9% three drivers, and 7% four or more drivers in household |
| **Driving Experience** | 38% driving 31 years or longer, 27% 21 to 30 years, 18% 11 to 20 years and 15% had 10 years or less driving experience |
| **Driving Frequency** | 70% reported driving 7 days a week |
| **Miles Driven** | Miles driven per day varied greatly, with a median of 20 miles and a modal response of 11 to 20 miles. Fifty-eight percent drive 6 to 30 miles per day. |

**Table 5.10: Profile of Survey Respondents – Region 2**

| Region 2 Demographics | |
|---|---|
| **Urban/Rural** | 59% reside in self-reported urban or suburban areas |
| **Age** | 14% ages 18 to 29, 17% ages 30 to 39, 24% ages 40 to 49, 18% ages 50 to 59, 14% ages 60 to 69, and 12% ages 70 and greater |
| **Race/Ethnicity** | 88% were white, 3% Latino/Hispanic, 3% Asian or Pacific Islander, 1% each American Indian, mixed race, "other" and refused, and 1% African American |
| **Sex** | 56% female and 44% male |
| **Education** | 6% not completing high school, 26% a high school diploma or GED, 35% some college (including Associate's degrees), and 30% a bachelor's degree or more |

| Region 2 Demographics | |
|---|---|
| **Income** | Median household income range is $40,000 to $70,000, that was also the modal income category. Eight percent said income was over $100,000 while 5.3% said that they made less than $15,000. Almost 12% refused the question. |
| **Employed** | 61% employed, 20% retired, 7% keeping house, 4% students and 3% unemployed |
| **Children** | 30% have children age 12 or under living at home |
| **World Wide Web** | 76% have access to the World Wide Web at home, work, or school |
| **Drive for Job** | 32% drove as part of their job duties |
| **Licensed Drivers** | 20% one-driver, 62% two drivers, 14% three drivers, and 4% four or more drivers in household |
| **Driving Experience** | 44% driving 31 years or longer, 24% 21 to 30 years, 17% 11 to 20 years and 11% had less than 10 years of driving experience |
| **Driving Frequency** | 64% reported driving seven days a week |
| **Miles Driven** | Miles driven per day varied greatly, with a median of 20 miles and a modal response of 11 to 20 miles. 50% drive 6 to 30 miles per day. |

**Table 5.11: Profile of Survey Respondents – Region 3**

| Region 3 Demographics | |
|---|---|
| **Urban/Rural** | 55% lived in rural areas, 25% in suburban, and 18% in urban areas |
| **Age** | 11% ages 18 to 29, 12% ages 30 to 39, 18% ages 40 to 49, 22% ages 50 to 59, 17% ages 60 to 69, and 19% ages 70 and greater |
| **Race/Ethnicity** | Over 92% were white, 2% Latino/Hispanic, 1% each American Indian, mixed race, "other" and refused. No one said they were Asian or African American. |
| **Sex** | 54% female and 46% male |
| **Education** | 8% not completing high school, 32% a high school diploma or GED, 36% some college (including Associate's degrees), and 23% a bachelor's degree or more |
| **Income** | Median household income range was $25,000 to$40,000, the modal income category was $40,000 to $70,000. 5% said income was over $100,000, 7% said they made less than $15,000. Over 14% refused the question. |
| **Employed** | 61% employed, 20% were retired, 7% keeping house, 4% students and 3% unemployed |
| **Children** | 22% had children age 12 or under living at home |
| **World Wide Web** | 63% have access to the World Wide Web at home, work, or school |
| **Drive for Job** | 29% drove as part of their job duties |
| **Licensed Drivers** | 25% one-driver, 61% two drivers, 8% three drivers, and 6% four or more drivers in household |
| **Driving Experience** | Over 60% driving 31 years or longer, 17% 21 to 30 years, 12% 11 to 20 years and 8% had less than 10 years of driving experience |
| **Driving Frequency** | 68% reported driving seven days a week |
| **Miles Driven** | Miles driven per day varied greatly, with a median of 20 miles and a modal response of 11 to 20 miles. 50% drive 6 to 30 miles per day. |

**Table 5.12: Profile of Survey Respondents – Region 4**

| Region 4 Demographics | |
|---|---|
| **Urban/Rural** | 60% lived in rural areas, 22% in suburban and 15% in urban areas |
| **Age** | 15% ages 18 to 29, 19% ages 30 to 39, 22% ages 40 to 49, 17% ages 50 to 59, 16% ages 60 to 69, and 11% ages 70 and greater |
| **Race/Ethnicity** | Over 95% were white, 1% Latino/Hispanic, 1% each American Indian. No one said they were Asian, Native American or African American. |
| **Sex** | 56% female and 44% male |
| **Education** | 7% not completing high school, 31% a high school diploma or GED, 36% some college (including Associate's degrees), and 24% a bachelor's degree or more |
| **Income** | Median household income range was $40,000 to $70,000, that was also the modal income category. 8% said income was over $100,000 while 5% said that they made less than $15,000. Over 9% refused the question. |
| **Employed** | 63% employed, 25% retired, 8% keeping house, 2% unemployed, less than 1% students |
| **Children** | 31% had children age 12 or under living at home |
| **World Wide Web** | 70% have access to the World Wide Web at home, work, or school |
| **Drive for Job** | 33% said that they drove as part of their job duties |
| **Licensed Drivers** | 18% one-driver, 65% two drivers, 12% three drivers, and 4% four or more drivers in household |
| **Driving Experience** | 48% driving 31 years or longer, 17% 21 to 30 years, 19% 11 to 20 years and 10% had less than 10 years of driving experience |
| **Driving Frequency** | 68% reported driving seven days a week |
| **Miles Driven** | Miles driven per day varied greatly, with a median of 20 miles and a modal response of 11 to 20 miles. 55% drove 6 to 30 miles per day. |

**Table 5.13: Profile of Survey Respondents – Region 5**

| Region 5 Demographics | |
|---|---|
| **Urban/Rural** | 60% lived in rural areas, 22% in suburban and 15% in urban areas |
| **Age** | 17% ages 18 to 29, 12% ages 30 to 39, 22% ages 40 to 49, 22% ages 50 to 59, 13% ages 60 to 69, and 12% ages 70 and greater |
| **Race/Ethnicity** | 90% were white, 5% Latino/Hispanic, 2% American Indian. Less than 1% were Asian, Native American, African American mixed or other races. |
| **Sex** | 51% female and 49% male |
| **Education** | 12% not completing high school, 31% a high school diploma or GED, 35% some college (including Associate's degrees), and 22% a bachelor's degree or more |
| **Income** | Median household income range was $25,000 to$40,000, the modal income category was $40,000 to $70,000. 4% said income was over $100,000 while 8% said that they made less than $15,000. Over 9% refused the question. |
| **Employed** | 67% employed, 21% retired, 3% keeping house, 2% unemployed, and 2% students |
| **Children** | 32% had children age 12 or under living at home |
| **World Wide Web** | 73% have access to the World Wide Web at home, work, or school |
| **Drive for Job** | 26% drove as part of their job duties |

| Region 5 Demographics | |
|---|---|
| **Licensed Drivers** | 21% one-driver, 58% two drivers, 13% three drivers, and 5% four or more drivers in household |
| **Driving Experience** | 48% driving 31 years or longer, 21% 21 to 30 years, 14% 11 to 20 years and 13% had less than 10 years of driving experience |
| **Driving Frequency** | 73% reported driving seven days a week |
| **Miles Driven** | Miles driven per day varied greatly, with a median of 20 miles and a modal response of 11 to 20 miles. Forty-five percent drove 6 to 30 miles per day. |

#### *5.2.7.1 Comparisons with the 2000 Census*

Some of the characteristics in the sample demographic data (e.g., driving experience) are not reported by the U.S. Census. Additionally, there are characteristics such as "children at home age 12 or under" that do not match the corresponding Census parameter, which is "children at home under 18." For these reasons, comparisons between the sample demographic data and the 2000 Census data was limited to those items where there are matching characteristics with the two data sets.

**Population by Age Group**

When the survey sample population distributions by age for each region are compared to the 2000 Census (Table 5.14), it can be seen that the survey sample is under-represented in the younger age categories (18-29 and 30-39) statewide in four of the five regions *(PRC-PSU 2002)*. In Region 4, only the 18-29 age group is underrepresented.

**Table 5.14: Comparison of Survey and Actual Demographic Profiles**

| Region | Data Source | Age Category | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | 18-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70+ | Not Stated | |
| 1 | Survey | 18% | 18% | 27% | 21% | 7% | 8% | 2% | 98% |
| | Census | 23% | 22% | 22% | 15% | 8% | 10% | 0% | 100% |
| 2 | Survey | 14% | 17% | 24% | 18% | 14% | 12% | 2% | 98% |
| | Census | 23% | 18% | 20% | 16% | 10% | 13% | 0% | 100% |
| 3 | Survey | 11% | 12% | 18% | 22% | 17% | 19% | 2% | 98% |
| | Census | 17% | 16% | 20% | 18% | 13% | 17% | 0% | 100% |
| 4 | Survey | 15% | 19% | 22% | 17% | 16% | 11% | 2% | 98% |
| | Census | 19% | 18% | 21% | 17% | 12% | 13% | 0% | 100% |
| 5 | Survey | 17% | 12% | 22% | 22% | 13% | 12% | 2% | 98% |
| | Census | 21% | 18% | 21% | 16% | 11% | 14% | 0% | 100% |
| State | Survey | 15% | 15% | 22% | 20% | 13% | 12% | 2% | 98% |
| | Census | 22% | 19% | 21% | 16% | 9% | 13% | 0% | 100% |

Except for Region 4, the differences in the sample population distribution and the Census distribution are statistically significant. However, these differences are consistent with the likely effects of the screening question that disqualified potential respondents who had not traveled through an active construction work zone in the two months previous to the survey. One reason drivers in the in the younger and older age groups would be less likely to have traveled through work zones than their middle age cohorts is because they drive less. For example, Table 5.15 shows the average miles traveled per day, by age group, for the survey respondents. The highest values are in the 40-49 and 50-59 age groups. Thus, because younger people drive less, the probability of a younger driver traveling through a work zone is less than that of an older driver, who on average is driving more miles each day.

**Table 5.15: Average Miles Driven per Day**

| Age Group | Mean |
|---|---|
| 18 through 29 | 43.5 |
| 30 through 39 | 43.9 |
| 40 through 49 | 50.9 |
| 50 through 59 | 50.6 |
| 60 through 69 | 33.5 |
| 70 or OLDER | 22.2 |

Another reason why younger drivers were underrepresented could be that younger adults are less likely to be available to answer the telephone. This pattern of non-response bias is typical in even well designed and executed telephone surveys *(Jones 2002)*.

## Gender

With regard to gender, compared to Oregon's 2000 population, which is 49.6% male, the survey sample is comprised of slightly less males (46%) *(PRC-PSU 2002)*. That can be attributed to the sample consisting of a slightly older age distribution. At around age 40, females in the older age categories (40-49 and greater) outnumber males.

## Household Income

Survey respondents estimated their total household income by choosing from the following categories:

- <$15,000
- $15,000 to $25,000
- $25,000 - $40,000
- $40,000 - $70,000
- $70,000 - $100,000
- >$100,000

Table 5.16 compares, by region, the median household incomes from the survey sample with the 2000 Census median values *(Hough 2002)*. In Regions 1, 3, and 5, the survey sample median ranges compare favorably with the Census values. In Regions 2 and 5, the Census values are slightly less than the lower end of the survey sample ranges. One possible reason for the difference could be because the survey values were reported in the summer of 2001, one full year after the 2000 Census.

**Table 5.16: Median Household Income**

| Region | Survey Sample | 2000 Census |
|---|---|---|
| Region 1 | $40,000 - $70,000 | $46,895 |
| Region 2 | $40,000 - $70,000 | $38,830 |
| Region 3 | $25,000 - $40,000 | $33,770 |
| Region 4 | $40,000 - $70,000 | $37,239 |
| Region 5 | $25,000 - $40,000 | $33,738 |

## Education

Educational attainment is higher in the survey sample than the 2000 Census. Table 5.17 shows that the percentage or those with a bachelor's degree or higher is in the sample for all regions *(Hough 2002)*.

**Table 5.17: Percent with Bachelor's Degree or Higher**

| Region | Survey Sample | 2000 Census |
|---|---|---|
| Region 1 | 41% | 31% |
| Region 2 | 30% | 23% |
| Region 3 | 23% | 17% |
| Region 4 | 24% | 20% |
| Region 5 | 22% | 16% |

## Race/Ethnicity

The survey sample categories of race/ethnicity do not match the 2000 Census categories. An explanation is offered here. The federal government considers race and Hispanic origin to be two separate and distinct concepts *(U. S. Dept. of Commerce 2001)*. For the 2000 Census, everyone was asked a question on race and a separate question on Hispanic origin. The question on Hispanic origin asked respondents if they were (1) Spanish, Hispanic, or Latino, or (2) not Spanish, Hispanic, or Latino. For the race question, the Census Bureau's categories of race included: (1) American Indian or Alaska Native, (2) Black or African American, (3) Asian, (4) Native Hawaiian or Other Pacific Islander, and (5) White. In addition, the Census Bureau allowed respondents to identify one or more races to indicate their racial identity.

The ODOT survey question about race/ethnicity asked: "What is your race?" The answer categories included: (1) Latino/Hispanic, (2) White, (3) Black/African American, (4)

Asian American/Pacific Islander, (5) Eskimo/Aleut/Alaska Native, (6) American Indian/Native American, and (7) Mixed Race. Since there are differences in how the ODOT survey asked about race and ethnicity with how the Census reports race and ethnicity, it is not practical to compare the two data sets.

**Summary**

Although there is some disparity between the survey sample demographics and the 2000 Census, overall, the differences do not appear to be considerable. The survey sample seems to be slightly older than the general adult population, are more educated and have higher incomes. However, because of the sample size in each region (n~5=400) and statewide (n=2,002), and the random sampling method applied, the survey sample is representative of the general population of eligible adults who had traveled through an active work zone in the previous two months. Therefore, one can conclude (with a slight margin of error) that the motorist survey results can be inferred to the general population.

### *5.2.7.2 Cross Tabulations Using the Survey Sample Demographic Data*

Although not presented in this report, any of the demographic variables can be cross-tabulated with the answers to any of the other survey questions. Cross-tabulations are two-variable frequency distribution tables that present the results of two questions simultaneously in order to see if there are relationships between the two sets of answers.

To illustrate the use of cross-tabulations, an example is presented here. To look at the differences and/or similarities in the response patterns *by years driving experience*, to the question where respondents were asked to chose one of six traffic control devices or strategies as the most important to improve for work zones safety (Figure 5.16). Cross-tabulating the answers to this question by age results in a distribution that is presented in Table 5.18.

**Table 5.18: Cross Tabulation of Most Important Safety Item by Years of Driving Experience.**

| | **Of these six items that I have just read to you *[listed below]*, which one do you think is most important to improve in making work zones safer?** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Years Driving Experience (years)** | **Signs** | | **Guardrails and Barriers** | | **Nighttime Visibility** | | **Traffic Flow in WZ** | | **Safety in WZ** | | **Law Enforcement** | | **Total** | |
| | Count | Row % | Count | Row % | Count | Row % | Count | Row % | Count | Row % | Count | Row % | Count | Row % |
| **5 or Less** | 10 | 11% | 1 | 1% | 31 | 34% | 4 | 4% | 32 | 35% | 14 | 15% | 92 | 100% |
| **6-10** | 25 | 19% | 5 | 4% | 47 | 36% | 7 | 5% | 30 | 23% | 17 | 13% | 131 | 100% |
| **11-20** | 52 | 17% | 19 | 6% | 85 | 27% | 17 | 5% | 68 | 22% | 72 | 23% | 313 | 100% |
| **21-30** | 83 | 19% | 23 | 5% | 129 | 29% | 19 | 4% | 70 | 16% | 114 | 26% | 438 | 100% |
| **30 or More** | 205 | 22% | 22 | 2% | 185 | 20% | 30 | 3% | 157 | 17% | 331 | 36% | 930 | 100% |
| **Total** | 375 | 20% | 70 | 4% | 477 | 25% | 77 | 4% | 357 | 19% | 548 | 29% | 1,904 | 100% |

In reviewing the distribution, there are several noticeable differences between driver experience levels. First, as experience levels increase, so does the percentage of respondents choosing law enforcement as most important. Thirty-six percent of those with 30 or more years experience picked law enforcement, in stark contrast to only 13% in the 6-10 years category. Alternatively, 36% of the respondents in the 6-10 years category chose nighttime visibility, whereas only 20% of those in "30 years or more" category selected this item. A possible reason for the low number of more experienced older drivers picking this category may be because their driving is limited to daytime hours, which would minimize the need for improved nighttime visibility. A third item of interest can be seen in the distribution of answers in the "signs" category. Here, the percentage of respondents selecting signs generally increased with experience, from 11% in the "5 or less" category, to 22% in the "30 years or more" category.

The purpose of this example is to illustrate how cross-tabulations can be used to examine differences and/or similarities in the responses of different segments of the survey population. In this chapter, the cross tabulations have been limited to reporting distribution of responses to questions by region. For brevity, no other cross tabulations using any of the demographic data are presented. However, the authors, upon request, can provide cross-tabulations of the survey responses for those within ODOT who have specific interests in the data.

## 5.3 STATISTICAL TESTING AND ANALYSIS

To check for statistically valid differences in how questions were answered in the five ODOT regions, a chi-square test for independence was performed for each question in the motorist survey. The chi-square test is a statistical test used to determine whether or not there is a relationship between two variables; in this case, (1) the answer distribution to a particular survey question; and (2) the ODOT Region where the respondent lived. When two variables are independent, the distribution for one variable will not be contingent on the categories of the second variable. Thus, if the variables are independent, the distribution of answers to the survey question will be approximately the same for all five regions. If they are not, it is because there are statistical differences in the survey question answer distributions across regions.

To better illustrate the chi-square statistic ($\chi^2$), an example is presented here. In Section 5.2.1, "Frequency of Travel," motorists were asked: "*When you travel through that construction zone [the one most frequently traveled], what is the usual purpose of the trip?*"

The answer distribution is shown in Figure 5.3 (page 26). The distribution of answers between regions appears to be different, but is it statistically significant? The chi-square test evaluates the differences between the actual distribution of responses, and the ***expected distribution*** if there were no relationship between the answer distribution for trip purpose and region. The chi-square statistic is calculated using the following formula:

$$\chi^2 = \sum \frac{(O_j - E_j)^2}{E_j} \qquad \textbf{(5.1)}$$

$O_j$ is an observed cell frequency. The observed cell frequencies, i.e., the number of respondents who chose that answer category, are shown in the grayed portion of Table 5.19a.

**Table 5.19a: Observed Cell Frequencies for the Trip Purpose Question**

| | **When you travel through that construction zone, what is the purpose of your trip usually?** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Commuting | Shopping | Running Errands | Driving for work | Recreation or Leisure | Mix | Other | **Total*** |
| Region 1 | 109 | 19 | 41 | 56 | 54 | 111 | 9 | **399** |
| Region 2 | 79 | 28 | 26 | 51 | 98 | 102 | 15 | **399** |
| Region 3 | 56 | 48 | 35 | 45 | 76 | 127 | 9 | **396** |
| Region 4 | 75 | 49 | 34 | 52 | 70 | 112 | 8 | **400** |
| Region 5 | 78 | 35 | 31 | 61 | 97 | 81 | 14 | **397** |
| **Total** | **397** | **179** | **167** | **265** | **395** | **533** | **55** | **1991** |

* Total does not include those who answered "Don't know"

The other part of Equation 5.1 is $E_j$, or expected cell frequencies. Expected frequencies are the numbers one would expect to occur, based on the assumption that no differences exist between trip purpose across regions. This means that proportionately, the region responses for each answer category (commuting, shopping, etc.) will be the same as in the "Total" row in Table 5.19a. Thus, using the data contained in the "Total" row, the proportion used is:

- Percent answering "commuting" = 397 ÷ 1,991 = 20%
- Percent answering "shopping" = 179 ÷ 1,991 = 09%
- Percent answering "running errands" = 167 ÷ 1,991 = 08%
- Percent answering "driving for work" = 265 ÷ 1,991 = 13%
- Percent answering "recreation/leisure" = 395 ÷ 1,991 = 20%
- Percent answering "mix" = 533 ÷ 1,991 = 27%
- Percent answering "other" = 055 ÷ 1,991 = 03%

Applying these percentages to the row totals for each region produces expected cell frequencies shown in Table 5.19b.

**Table 5.19b: Expected Cell Frequencies for the Trip Purpose Question**

| | **When you travel through that construction zone, what is the purpose of your trip usually?** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Commuting | Shopping | Running Errands | Driving for work | Recreation or Leisure | Mix | Other | **Total** |
| Region 1 | 79.6 | 35.9 | 33.5 | 53.1 | 79.2 | 106.8 | 11.0 | **399** |
| Region 2 | 79.6 | 35.9 | 33.5 | 53.1 | 79.2 | 106.8 | 11.0 | **399** |
| Region 3 | 79.0 | 35.6 | 33.2 | 52.7 | 78.6 | 106.0 | 10.9 | **396** |
| Region 4 | 79.8 | 36.0 | 33.6 | 53.2 | 79.4 | 107.1 | 11.0 | **400** |
| Region 5 | 79.2 | 35.7 | 33.3 | 52.8 | 78.8 | 106.3 | 11.0 | **397** |
| **Total** | **397** | **179** | **167** | **265** | **395** | **533** | **55** | **1991** |

Note that each row in Table 5.19b has the same proportions for each answer category. For example, in the *Commuting-Region 4* cell, the expected frequency is 79.8, which is 20% of the total (400). In the *Commuting-Region 5* cell, the expected frequency is 79.2, which is also 20% of the total (397).

The chi-square statistic can now be calculated using Equation 5.1. The calculated chi-square statistic ($\chi^2$) is **75.73**.

The chi-square square statistic is then compared to the value of the theoretical chi-square to determine if the distributions are statistically different across regions. The theoretical value of chi-square is determined from standard statistical tables using degrees of freedom associated with the "trip purpose" answer table (Table 5.19a) and an assumed significance level ($\alpha$).

Degrees of freedom (*df*) are calculated by multiplying one less than the number of rows in the trip purpose table, times one less than the number of columns in the table. In Table 5.19a, there are five rows that represent an answer distribution for one of the five regions. There are seven columns, each representing one of the "trip purpose" answer categories. Hence, degrees of freedom are:

$$(5\text{-}1) * (7\text{-}1) = 24 \text{ degrees of freedom } (df)$$

The assumed significance level ($\alpha$) is 0.05, which represents the probability of error that is acceptable in making an inference that a statistical relationship exists between the answer distribution among categories of trip purpose and the region. A 5% significance level is conventionally used in physical and social science research.

If the chi-square statistic ($\chi^2$) is greater than the theoretical value of chi-square, it can be inferred (with a 0.05 probability of error) that there are statistical differences between the answer distribution among categories of trip purpose and region. The theoretical value of chi-square with 24 degrees of freedom and a significance level of 0.05 is **36.42**. The calculated chi-square statistic ($\chi^2$) is **75.73**. The $\chi^2$ value is greater than the theoretical value of chi-square. Thus, there are statistical differences between the trip purpose answer distributions across the five regions.

### 5.3.1 Summary Results of Statistical Testing

The results of chi-square testing for each question in the motorist survey are found in Table 5.20. For most questions, the differences in answer distributions between regions were found to be statistically significant. The questions where there were ***NO*** statistical differences include:

1. Of the six items [nighttime visibility; signage and striping; safety in the work zone; guardrail and barriers; law enforcement; and traffic flow], which do you think is most important? (Figure 5.16, page 38).
2. Do you ever get any information from neighborhood or public meetings? (Figure 5.23, page 42).

3. Before you take a trip or go somewhere, do you ever try to find advance information about state highway construction work, such as road closures and delays? (Figure 5.27, page 45).
4. How well has ODOT maintained the stripes on the road that help you see where to go? (Figure 5.30, page 47).
5. At night, how well has ODOT maintained lights, safety cones, and reflectors on safety barrels so that you can see where to go? (Figure 5.31, page 47).
6. Overall, how well do you think ODOT manages state highway construction zones? (Figure 5.33, page 48).

On these six questions, the response distributions were about the same in all five regions. In the first question about the most important item, either nighttime visibility or law enforcement was chosen as the most important in each region. On the second question, it was shown universally that most people did not receive construction information from public meetings. The same can be said about the third question; in every region, the percentage of people seeking advance information about construction before their trip was about the same ($\approx 40\%$). The last three questions, dealing with people's opinions about ODOT, resulted in ODOT receiving similar favorable ratings from respondents across all regions.

For the remaining questions in the survey, there were statistical differences in the answer distributions across the five regions. One could also test for statistical significance between the responses for just two regions; for example, between Region 1 and Region 2. ODOT Regions may be interested in these differences as they "customize" work zones for the traveling public within their particular region.

**Table 5.20: Tests for Statistical Relationships between Motorist Survey Responses and Regions**

| Question Category | Question | Table or Figure No. | α | *df* | Theoretical Chi-Square | $\chi^2$ | Statistical Difference? |
|---|---|---|---|---|---|---|---|
| Frequency of Travel | Have you regularly traveled through just one state highway work zone or more than one? | Table 5.1, page 24 | 0.05 | 4 | 9.49 | 29.04 | Yes |
| Frequency of Travel | How many times have you traveled through that construction zone in the past eight weeks? | Figure 5.1, page 25 | 0.05 | 20 | 31.41 | 78.35 | Yes |
| Frequency of Travel | Type of work zone traveled. | Figure 5.2, page 25 | 0.05 | 8 | 15.51 | 75.16 | Yes |
| Frequency of Travel | When you travel through that construction zone, what is the purpose of your trip? | Figure 5.3, page 27 | 0.05 | 24 | 36.42 | 75.73 | Yes |
| Frequency of Travel | Is it possible for you to avoid that construction zone by taking an alternate route? | Table 5.2, page 27 | 0.05 | 4 | 9.49 | 36.39 | Yes |
| Frequency of Travel | How often do you take an alternate route instead of traveling through that construction zone? | Figure 5.4, page 27 | 0.05 | 16 | 26.30 | 47.61 | Yes |
| Delays and Inconveniences | In the past eight weeks, have you ever been delayed in any way because of this construction project? | Figure 5.5, page 28 | 0.05 | 4 | 9.49 | 43.02 | Yes |
| Delays and Inconveniences | How often have you been delayed at the construction zone? | Figure 5.6, page 28 | 0.05 | 12 | 21.03 | 26.04 | Yes |
| Delays and Inconveniences | Do you think the delay was reasonable for the project size and complexity? | Table 5.3, page 30 | 0.05 | 4 | 9.49 | 21.3 | Yes |
| Delays and Inconveniences | In the construction zone you travel through most often, how well has ODOT kept you informed about highway work and resulting road closures and delays? | Figure 5.11, page 32 | 0.05 | 16 | 26.30 | 66.02 | Yes |
| Ease and Safety of Travel Through Work Zones | How easy or difficult has it been for you to understand where you were supposed to travel through that construction zone? | Figure 5.12, page 33 | 0.05 | 12 | 21.03 | 43.76 | Yes |
| Ease and Safety of Travel Through Work Zones | How easy or difficult has it been for you to get on or off the highway at intersections and driveways in that construction zone? | Figure 5.13, page 34 | 0.05 | 12 | 21.03 | 29.06 | Yes |
| Ease and Safety of Travel Through Work Zones | Overall, how easy or difficult has it been for you to travel safely through that construction zone? | Figure 5.15, page 36 | 0.05 | 12 | 21.03 | 55.28 | Yes |

| Question Category | Question | Table or Figure No. | α | *df* | Theoretical Chi-Square | $\chi^2$ | Statistical Difference? |
|---|---|---|---|---|---|---|---|
| Ease and Safety of Travel Through Work Zones | Of the six items, which do you think is most important? | Figure 5.16, page 38 | 0.05 | 20 | 31.41 | 23.58 | No |
| Sources of Information | Where do you get information about state highway construction work? Do you ever get any information from television? | Figure 5.17, page 39 | 0.05 | 4 | 9.49 | 105.59 | Yes |
| Sources of Information | Do you ever get any information from the radio? | Figure 5.18, page 40 | 0.05 | 4 | 9.49 | 51.64 | Yes |
| Sources of Information | Do you ever get any information from newspapers? | Figure 5.19, page 40 | 0.05 | 4 | 9.49 | 36.1 | Yes |
| Sources of Information | Do you ever get any information from electronic message signs, or changeable message signs? | Figure 5.20, page 41 | 0.05 | 4 | 9.49 | 14.86 | Yes |
| Sources of Information | Do you ever get any information from flaggers? | Figure 5.21, page 41 | 0.05 | 4 | 9.49 | 10.42 | Yes |
| Sources of Information | Do you ever get any information from the Internet? | Figure 5.22, page 42 | 0.05 | 4 | 9.49 | 16.32 | Yes |
| Sources of Information | Do you ever get any information from neighborhood or public meetings? | Figure 5.23, page 42 | 0.05 | 4 | 9.49 | 1.16 | No |
| Sources of Information | Do you ever get any information from public access television? | Figure 5.24, page 43 | 0.05 | 4 | 9.49 | 23.74 | Yes |
| Sources of Information | Do you ever get any information by calling ODOT on the telephone? | Figure 5.25, page 43 | 0.05 | 4 | 9.49 | 82.12 | Yes |
| Sources of Information | From which sources do you get the most information about state highway construction work, such as road closures and delays? | Figure 5.26, page 44 | 0.05 | 36 | 51.00 | 217.72 | Yes |
| Sources of Information | Before taking a trip or go somewhere, do you ever try to find advance information about state highway construction work, such as road closures and delays? | Figure 5.27, page 45 | 0.05 | 4 | 9.49 | 3.39 | No |
| Sources of Information | From what source do you get the most information for your trips? | Figure 5.28, page 45 | 0.05 | 24 | 36.42 | 51.22 | Yes |

| Question Category | Question | Table or Figure No. | α | *df* | Theoretical Chi-Square | $\chi^2$ | Statistical Difference? |
|---|---|---|---|---|---|---|---|
| Sources of Information | When you are actually on a trip, what is the best way for you to receive information and news about highway construction? | Figure 5.29, page 46 | 0.05 | 36 | 51.00 | 64.03 | Yes |
| Opinions About ODOT | How well has ODOT maintained the stripes on the road that help you see where to go? | Figure 5.30, page 47 | 0.05 | 12 | 21.03 | 16.92 | No |
| Opinions About ODOT | At night, how well has ODOT maintained lights, safety cones, and reflectors on safety barrels so that you can see where to go? | Figure 5.31, page 47 | 0.05 | 16 | 26.30 | 17.06 | No |
| Opinions About ODOT | How good of a job has ODOT done with temporary orange signs on the road around that construction zone that tell you about reduced speed limits, lane closures, traffic changes and delays? | Figure 5.32, page 48 | 0.05 | 12 | 21.03 | 22.57 | Yes |
| Opinions About ODOT | Overall, how well do you think ODOT manages state highway construction zones? | Figure 5.33, page 48 | 0.05 | 12 | 21.03 | 20.92 | No |
| Opinions About ODOT | When you think about the Oregon Department of Transportation, are your feelings generally positive, generally negative, or are they neutral? | Figure 5.34, page 49 | 0.05 | 8 | 15.51 | 19.51 | Yes |

# 6.0 TRUCK DRIVER SURVEY

## 6.1 SURVEY PROCEDURE

As described in Chapter 3, the truck driver survey was conducted using two different methods:

1. Two intercept surveys at these Interstate Rest Areas:
   - Oak Grove on I-5 north of Eugene; and
   - Memaloose on I-84 east of Hood River.
2. A computer-assisted-telephone survey.

The same questionnaire was employed for the intercept rest area survey and the computer assisted telephone survey. The 35-question survey was shorter than the motorist survey, but it included many of the same questions. The intercept surveys were conducted by OSRL interviewers on two separate weekdays (one eight-hour day at each location) in July 2001. A total of 141 surveys were completed at both sites, 77 at Oak Grove, and 64 at Memaloose.

In the computer assisted telephone survey, trucking companies were randomly selected from a database of registered trucking firms provided to OSRL by ODOT's Motor Carrier Division for an earlier survey. OSRL contacted the firms and interviewed one driver from each company that agreed to be surveyed. A total of 307 telephone interviews were ultimately completed.

The data sets for both methodologies revealed no significant differences in the distribution of responses. Thus, their results (448 completed interviews) have been pooled for presentation in this chapter.

## 6.2 DISCUSSION OF SURVEY RESULTS

Questions used in the truck driver survey focused on these areas:

1. The **frequency of travel** and what could be done to **improve work zones** for truck drivers.
2. **Delays and inconveniences -** How long a truck driver was delayed by a construction project and what they considered to be an acceptable delay with, and without, advance notice.
3. Feelings about the **ease and safety of travel through work zones,** including how difficult travel through a zone was, and how safe they felt.
4. **Sources of information** about work zones. Also, what are the most used and preferred sources of information about road construction?

5. **Scenario** where drivers were asked to choose one of two possible alternatives for a bridge construction project.
6. **Basic demographic data**, including age, sex, days per week driving, miles driven per day, and percentage of miles in Oregon.

### 6.2.1 Questions about Frequency of Travel and How to Improve Work Zones

The first question asked drivers to estimate their frequency of travel through Oregon state highway work zones in the previous eight weeks. Figure 6.1 presents the distribution of responses, which shows that these truck drivers were frequent travelers through state highway work zones. The modal response category was 21-100 times. Over 60% of the drivers surveyed had driven through at least 11 work zones in the 2 months prior to being surveyed.

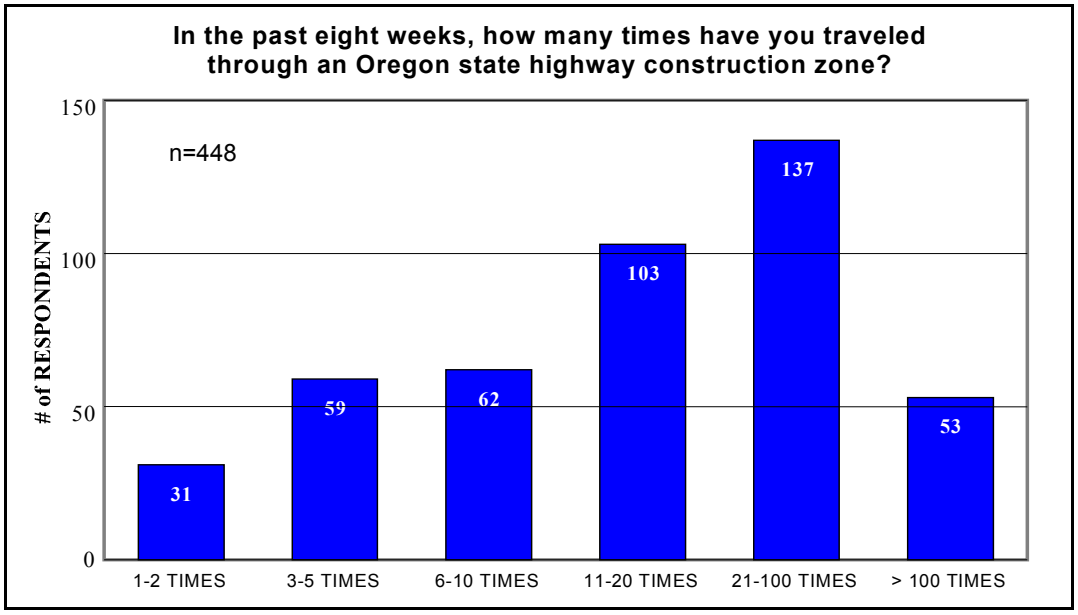



Figure 6.1: Frequency of Travel by Truck Drivers

Next, drivers were asked to identify which highway work zone they had traveled through the most often in the last eight weeks. This was an open-end question and drivers identified work zone locations all around the state. In most of their answers, however, only the highway name or number was given and not a specific location on that highway. For example, about 30 drivers said US 101, but only nine drivers actually cited where along US 101 the work zone was located. Since the location data from the survey is incomplete, a distribution of the responses is not shown here.

The next question asked drivers how many times they had traveled through **that** *(the one traveled most often)* work zone in the last eight weeks. Figure 6.2 displays the results. The highest occurring frequency was "two to four times a week," but over 42% had traveled through the work zone two or more times **a day**. The distribution indicates that most of the truck drivers were very familiar with the work zone they had traveled through most often.

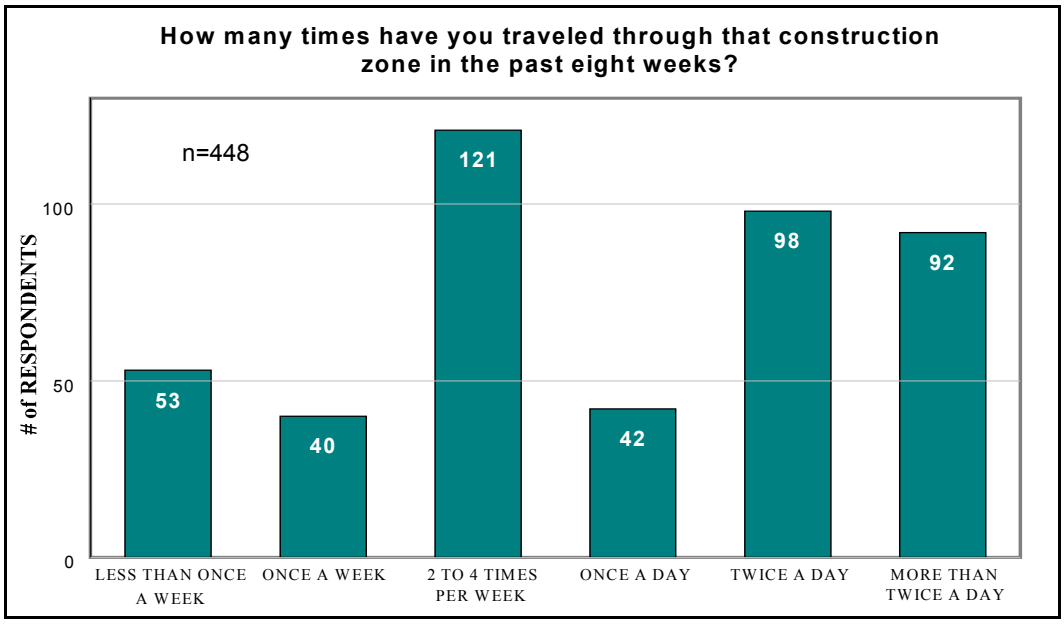



Figure 6.2: Number of Times Driven though the Work Zone Most Often Driven

Another open ended question asked: "If there was one thing you could change or improve about your experiences traveling through **that** construction zone, what would it be?" The largest group of answers (about 50 out of 448) dealt with some aspect of flagging. The following are quoted responses relating to flagging:

1. "To educate the flaggers; they should understand that 100,000 pound rigs can't stop and start on a dime and they [flaggers] should stand in a place where they are easily seen."
2. "The flaggers--teach them how to flag properly for trucks; don't stop them on the hill."
3. "In a truck, when you come up on a flagger and they have a sign on stop and then they flip it just about the time you completely stop, and then you got to re-start your load and it makes it pretty hard."
4. "I noticed in most areas the flaggers tend to blend in with the warning signs; they need different color clothing; there is too much orange."
5. "Some flaggers are alert and you know what they want, and some are looking the other direction and you don't know what they want."
6. "The flaggers were too far from the work, and the signs were too far from the construction. Also, the flaggers placement. They were standing right in the middle of blind corners."

Other suggestions offered by truck drivers varied substantially. Some felt traffic was moving too fast through the work zone, while others suggested the posted speed for the work zone was set too low. Several drivers commented that there were not enough construction speed signs posted in the work zone. One driver noted that in one work zone with multiple lanes in each direction, his truck blocked the view of signs for drivers traveling alongside.

The following are some other direct quotes from drivers offering suggestions about improving work zones.

1. "I would probably never have more than one construction [zone] on a hill. Too much stopping for a big truck when you are loaded."
2. "I'd probably say post the speed limits before you start into it to slow the cars down beforehand, and that would eliminate some of the confusion. Some people don't seem to have much common sense; they go by workers at 65 mph."
3. "It would be the signs. One sign says trucks stay right and the other signs say trucks stay left within a quarter of a mile of each other."
4. "They leave some of the old lines there …. it's harder to know which lines to follow, especially when there is not enough light. They leave the old line which makes it hard to distinguish old lines from the new ones."

### 6.2.2 Questions about Delay and Other Inconveniences

The first question about delay asked drivers if they had ever been delayed (in the last two months) in the highway work zone they had traveled through the most often. About half had been delayed, 240 out of 448. They were asked, "How often have you been delayed at this construction zone (always, often, sometimes, or rarely)?" The response distribution is shown in Table 6.1. Of the 240 who were delayed, about half were delayed only "sometimes" or "rarely."

**Table 6.1: How Often Truck Drivers were Delayed**

| Category | Count | Percent |
|---|---|---|
| Always | 71 | 29.6% |
| Often | 50 | 20.8% |
| Sometimes | 74 | 30.8% |
| Rarely | 44 | 18.3% |
| Don't Know | 1 | 0.4% |
| Total | 240 | 100.0% |

Those who said they were delayed were asked about the longest delay that they had experienced (at the work zone they had most frequently traveled through). Based on their responses, the average *longest delay* was 17.12 minutes, and the median was 12 minutes.

In the previous chapter, the average value for the *longest delay* on the motorist survey ranged (by region) from 14.03 to 20.17 minutes (Figure 5.9). The truck drivers' average *longest delay* is consistent with this range. Further, most truck drivers who had been delayed believed that the delay was reasonable. When asked if the longest delay was reasonable considering the project size and complexity, a considerable majority said yes. (Figure 6.3).

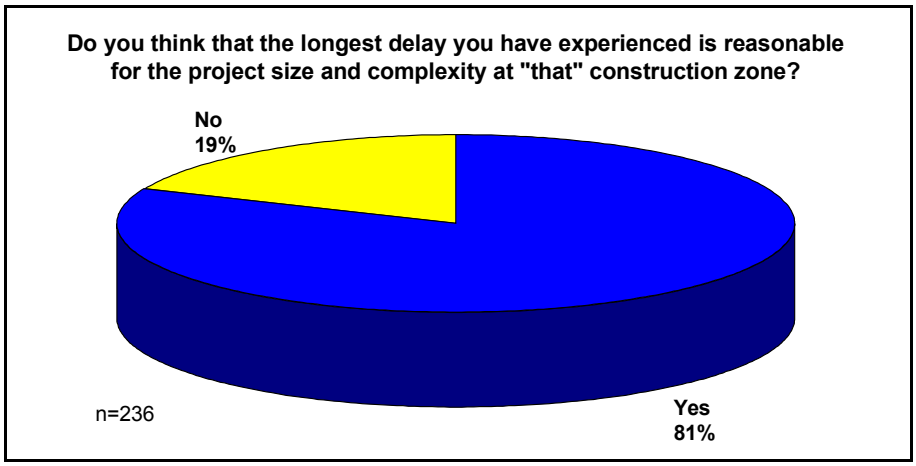



Figure 6.3: Was the Delay Reasonable?

The next question about delay asked ***all*** drivers (*n=448*) to think about construction work zones in general, and then asked, "If you **know in advance** that a delay is possible, what is the *longest* number of minutes that you think is acceptable?" The average number of minutes of *acceptable delay* was 15.08 minutes; the median was 15.0 minutes. In the motorist survey, the range of average acceptable number of minutes of longest delay (**with advance notice**) was 11.75 minutes in Region 1, to 15.56 minutes in Region 5 (Figure 5.10). The truck driver estimate of acceptable delay (15.08 minutes), is within this range.

All truck drivers were then asked, "What is the *longest* number of minutes of delay that is acceptable if **no advance notice** is given?" Based on the respondents' answers, the average *acceptable delay* with **no advance notice** was 15.29 minutes. The median was also 15 minutes. Intuitively, the average number of minutes of *acceptable delay with no advance notice* should be equal to or less than the average value of *acceptable delay with advance notice* ,as was seen in the motorist survey. Why should someone be willing to accept a longer delay if there is no advance warning as opposed to delays when one knows in advance?

Further analysis showed that 86 of the respondents (19.1% of all truck drivers) actually provided a higher value of *acceptable delay with no advance notice*, than their answer to *acceptable delay with advance notice*. Additional analysis did not yield any common characteristics (years of driving experience, miles driven per day, etc.) among these 86 truck drivers. However, although not stated earlier, an equal percentage of motorists (383 of 2,002) also gave higher values of *acceptable delay with no advance notice*, than their answers to *acceptable delay with advance notice*. It may be that the question was misunderstood, or for some unknown reason a percentage of drivers are willing to accept longer delays without advance notice.

The last two questions in this section asked drivers about other inconveniences experienced driving through the work zone they most frequently traveled. The first question asked: "Have you experienced any other inconveniences around **that** construction zone, such as noise, dust, asphalt on vehicles, glare from construction lighting, or rock chips?" Twenty-two percent (99 of 448) said yes. The 99 drivers who answered yes were asked, "What were those inconveniences?" Table 6.2 provides a distribution of the most frequently given responses.

**Table 6.2: What were the Other Inconveniences?**

| Response | Count |
|---|---|
| Glare from construction lighting | 45 |
| Dust | 9 |
| Flying rock/chips | 26 |
| Asphalt on their truck | 6 |
| Other | 12 |
| Total | 99 |

Several of the drivers offered noteworthy comments about the inconveniences they experienced:

1. "They ground the asphalt down 3-4 inches. They didn't make any decent ramp to go over it. And it's 55 both ways. The angle was next to nothing. If you hit it you could lose your steering, shift your load, or blow a tire out."
2. "The DOT trained officers were pulling large trucks over doing safety inspections that were not necessary in that area. It's not only an inconvenience, but also dangerous."
3. "The lighting: should've angled them--they had 'em right in your eyes. They were facing southbound. They should've had them angled down better."

### 6.2.3 Ease of Travel through Work Zones

This part of the survey also focused on the construction work zone drivers had most frequently traveled through in the past two months. The first question asked truck drivers how easy or difficult it was to understand where they were to go when driving through the work zone. Figure 6.4 provides the response distribution. The overwhelming majority (93%) found it either "very" or "somewhat easy" understanding where they were supposed to go in the work zone.

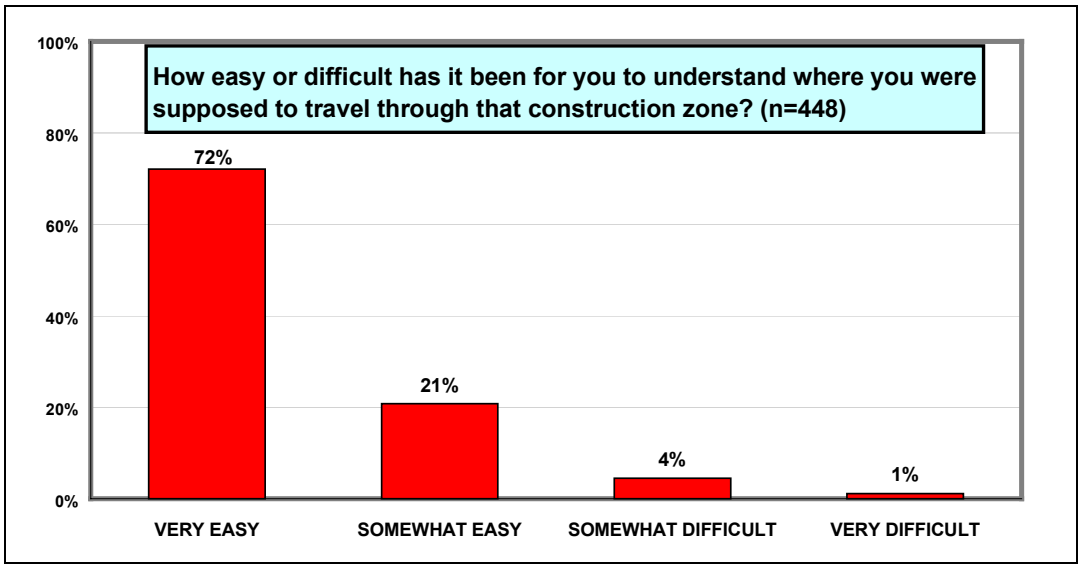



Figure 6.4: Ease in Knowing Where to Go When Traveling through Work Zone

The 25 respondents who said it was either "somewhat" or "very difficult" were asked, "What made it difficult for you to understand were you were supposed to travel in that construction zone?" Several verbatim responses are listed below:

1. "All the lights that were blinking and flashing blinded me and I couldn't see where to go following the pilot car."
2. "Raining and dark; without better striping it is somewhat difficult."
3. "Knowing what lane to stay in was difficult. It was about two miles long. Plus with the side roads coming in, they had to leave cones out for the people using these roads. So with the many cones out there, it was very confusing."
4. "Well, they start you out in one lane and then they want you to go to another lane without putting out cones."

The next question asked, "How easy or difficult was it for you to get on and off the highway interchanges in that construction work zone?" For about 25% of the drivers, this question did not apply because there were no interchanges within the work zone they had most frequently traveled. The distribution of answers for the 300+ drivers who responded is shown in Figure 6.5.

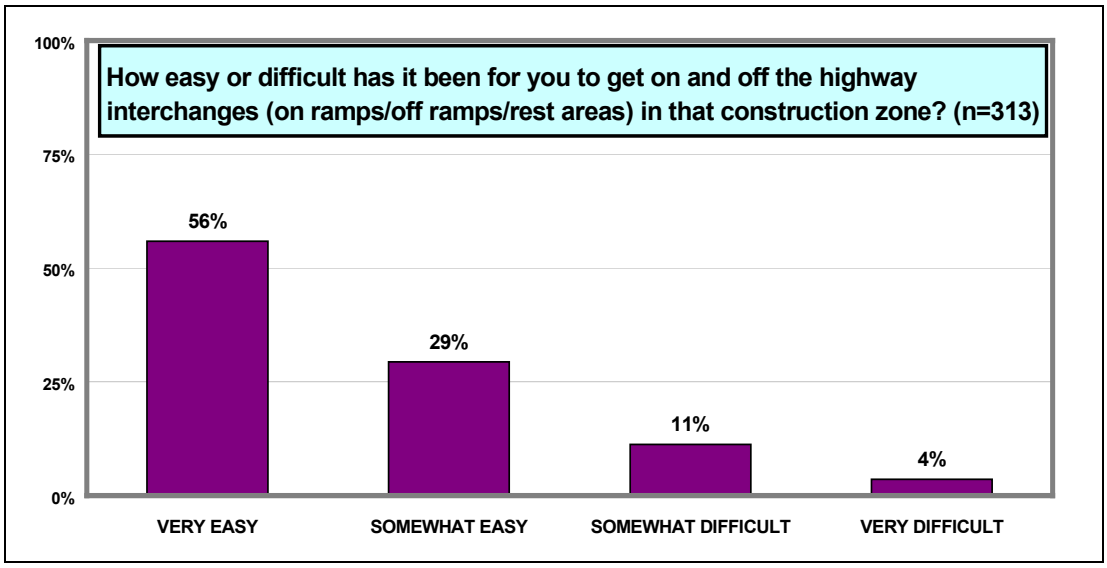



Figure 6.5: Ease in Getting On and Off Interchanges in the Work Zone

A substantial majority did not experience any difficulty. About 15% said it had either been "somewhat difficult" or "very difficult" to get on or off interchanges in the work zone. When asked what made it difficult, the responses focused on the merge area. Some noted the shortness of the on-ramps. Others talked about a poorly delineated on- or off-ramp. Listed below are some representative quoted responses.

1. “Just the short approach. There are a lot of things going on at once, and you have to pay attention. You have a shortened on-ramp and you've got to get into the flow of traffic to merge safely.”
2. “Cones placement was confusing; it was a poorly marked merge area.”
3. “Because the way the traffic was controlled by the flaggers. They were trying to stop traffic on a freeway when they got equipment crossing over that on-ramp; I’ve had some pretty close calls.”
4. “Not enough room to merge.”

The last question of this section was “Overall, how easy or difficult has it been for you to safely travel through that construction zone?” Figure 6.6 shows the distribution of responses.

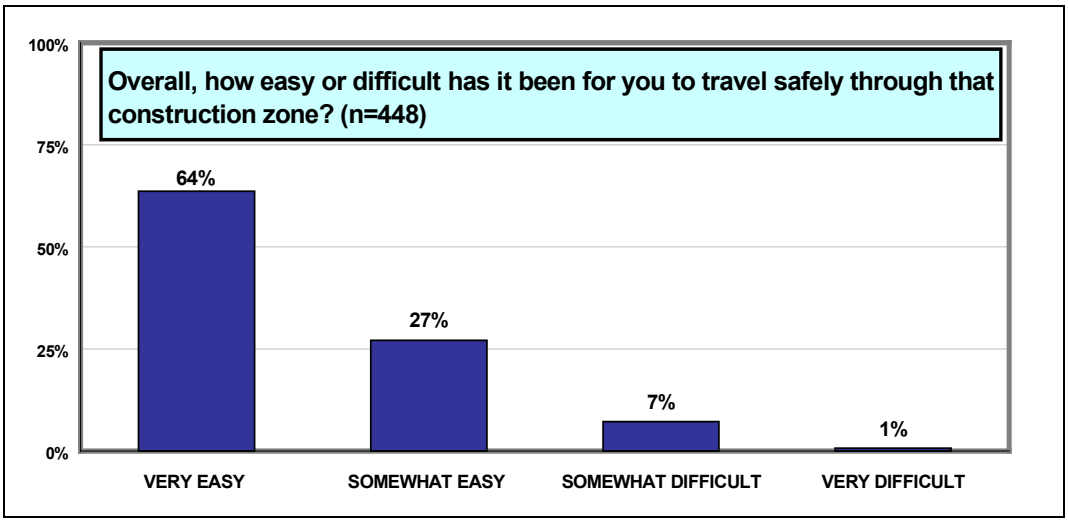



Figure 6.6: Ease in Traveling Safely through Work Zone

A substantial majority of drivers (91%) said it was either “very” or “somewhat easy” to travel safely through the work zone. About 7% indicated it was “somewhat difficult” and only three drivers said it was “very difficult.” Those who had experienced some difficulty were asked what made it difficult. Most of the answers related to speed and conflicts with other vehicles, narrow lanes, congested highways, or the proximity of construction to the travel lane. Some of the quoted responses included:

1. “They tend to cone off the lanes too narrow for trucks. Your mirrors come close to the signs and the cones.”
2. “Just the amount of traffic that goes through that area. There's not much room.”
3. “Required to drive on the shoulder that is slightly inclined, causing the truck to tilt.”
4. “Speed limits. They slow you down to 55 and the traffic is still running 80.”

## 6.2.4 Sources of Information

Truck drivers were given one question to answer about sources of information. They were asked, "As a truck driver, from which of those sources do you get the most information about state highway construction work, such as road closures and delays?" The sources of information and the response frequencies are shown in Table 6.3. The most used information source was the driver's CB radio. Construction signs and commercial radio were other notable sources. In the motorist survey, the television and newspapers were two sources that were used extensively. However, their use by truck drivers is very limited.

**Table 6.3: Information Sources for Truck Drivers about Construction**

| Information Source | Count | Percent |
|---|---|---|
| CB Radio's | 156 | 34.8% |
| Construction Signs | 76 | 17.0% |
| Radio | 66 | 14.7% |
| Other | 44 | 9.8% |
| Mailed Information to Home/Place of Work | 32 | 7.1% |
| Reader Boards | 30 | 6.7% |
| Word of Mouth | 18 | 4.0% |
| Newspapers | 8 | 1.8% |
| Place of Work | 6 | 1.3% |
| Internet | 4 | 0.9% |
| Television | 3 | 0.7% |
| Flaggers | 2 | 0.4% |
| Leaflets | 2 | 0.4% |
| Cell Phones | 1 | 0.2% |
| **Total** | 448 | 100.0% |

## 6.2.5 Scenario about Detour and Delays

Truck drivers were given a scenario and then asked to choose one of two possible alternatives to carry out a bridge construction project. The scenario was:

> *ODOT plans to repair a bridge next year and is considering two different ways to do it. Would you prefer a bridge project that would partially close lanes every day for six months, with up to 15-minute daily delays, or would you prefer a project that would close the bridge, require a 20-mile detour, and finish the project in two months?*

Table 6.4 summarizes their choices. The complete closure and detour option was favored by most drivers (49%). However, a nearly equal number chose the partial closure. The distribution

of responses does not reflect a mandate for one option over another, but shows that when making decisions about closures, even as simple as the one presented in this scenario, clear cut preferences are not easily obtained.

**Table 6.4: Responses to Scenario Involving Partial or Complete Closure**

| Alternative | Count | Percent |
|---|---|---|
| Complete closure with detour and shorter project duration | 219 | 49% |
| Partial closure with daily delays, no detour and longer project duration | 190 | 43% |
| No preference | 39 | 9% |
| **Total** | 448 | 100% |

### 6.2.6 Truck Driver Demographic Data

As noted earlier, basic demographic data was obtained from the truck drivers, including age, sex, days per week driving, miles driven per day, and percentage of miles. The age distribution is shown in Figure 6.7. The average age of the drivers was about 50 years old. Additionally, over 97% of the drivers who were surveyed were male.

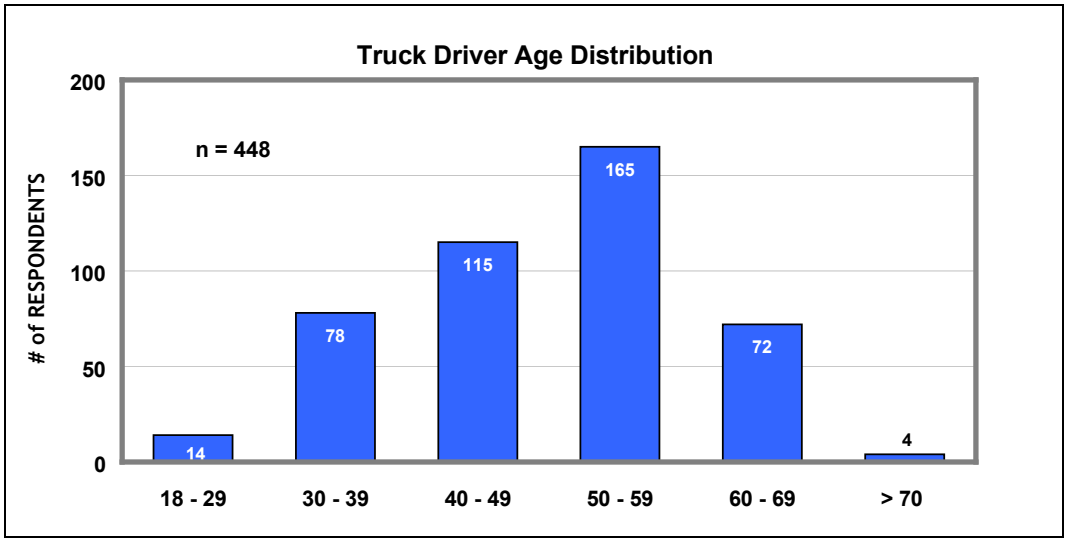



Figure 6.7: Age Distribution of Truck Drivers

The drivers who were surveyed were also very experienced. Figure 6.8 shows the "years of licensed driving" distribution for the drivers. The average value for "years of driving experience" was 23 years.

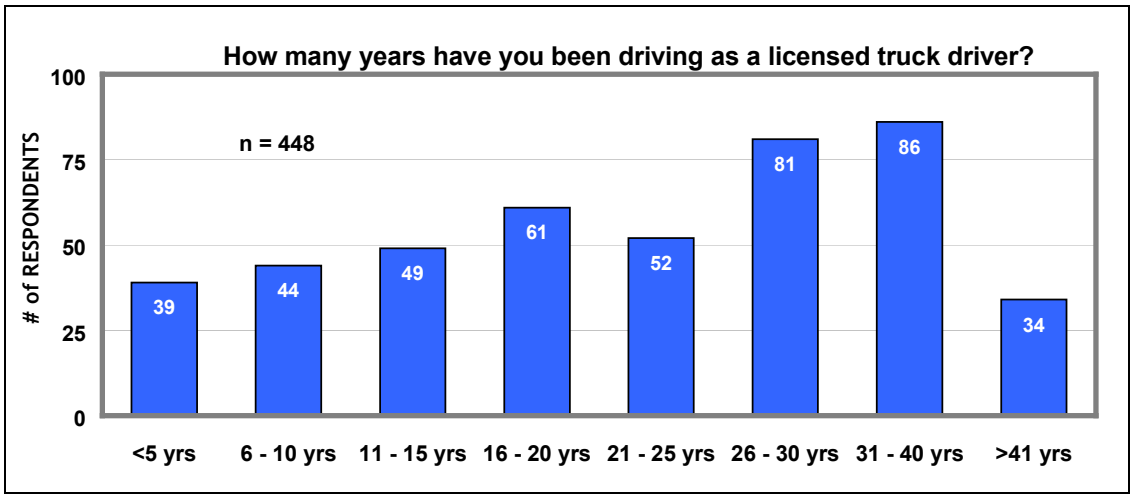



Figure 6.8: Average Number of Years of Driving Experience

In addition, many of the surveyed drivers, as seen in Figure 6.9, were driving long distances each day. Almost 73% of the drivers were driving over 300 miles per day and over 35% were driving in excess of 400 miles per day. Most of the miles driven by truckers were in Oregon. Figure 6.10 shows that 105 of 448 drivers indicated that between 76 and 99% of their driving was in the state. Further, 197 of the 448 drivers (44%) drove completely in Oregon.

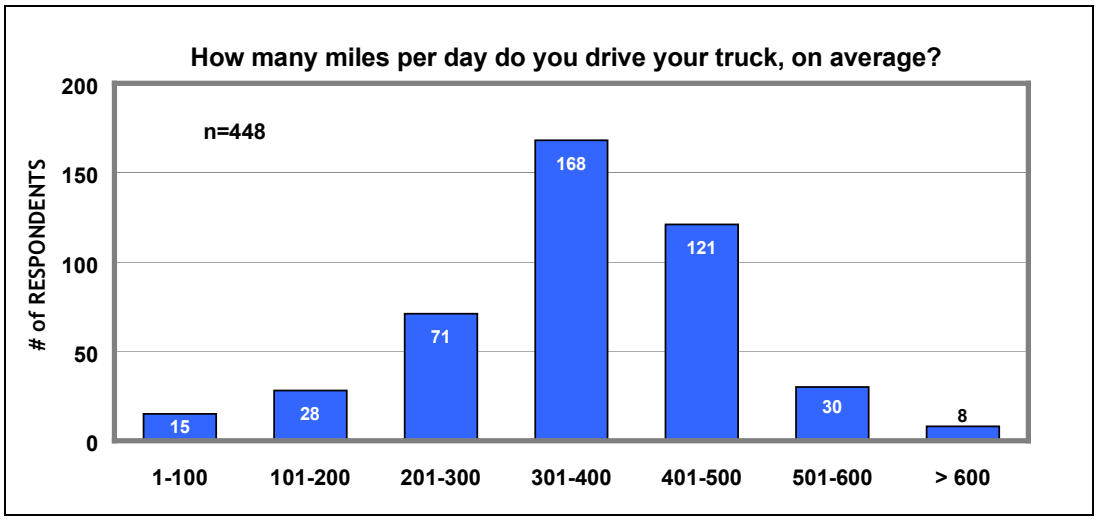



Figure 6.9: Miles Driven per Day by Truck Drivers

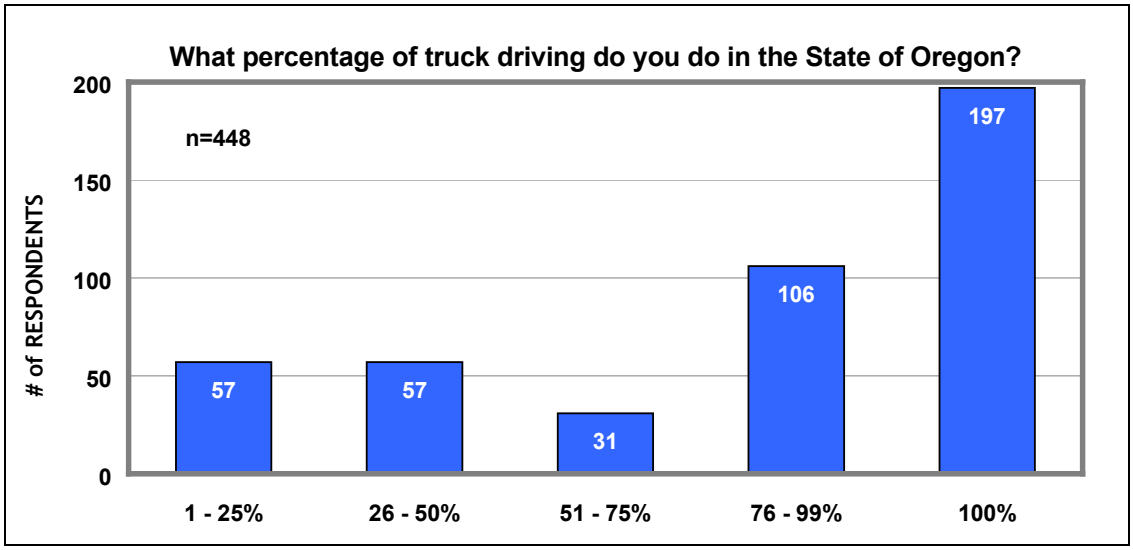



Figure 6.10: Percentage Range for Amount of Driving in Oregon

The last question was not asked in the rest areas, but was added in the telephone survey to find out the size of the trucks the drivers were operating. Truck drivers were asked: "What is the approximate gross vehicle weight of your truck if operating at full capacity?" The distribution in Figure 6.11 shows the vast majority of drivers are operating vehicles with gross loaded weights over 70,000 lbs. The modal category was 70,000 to 80,000 lbs. (222 of 307).

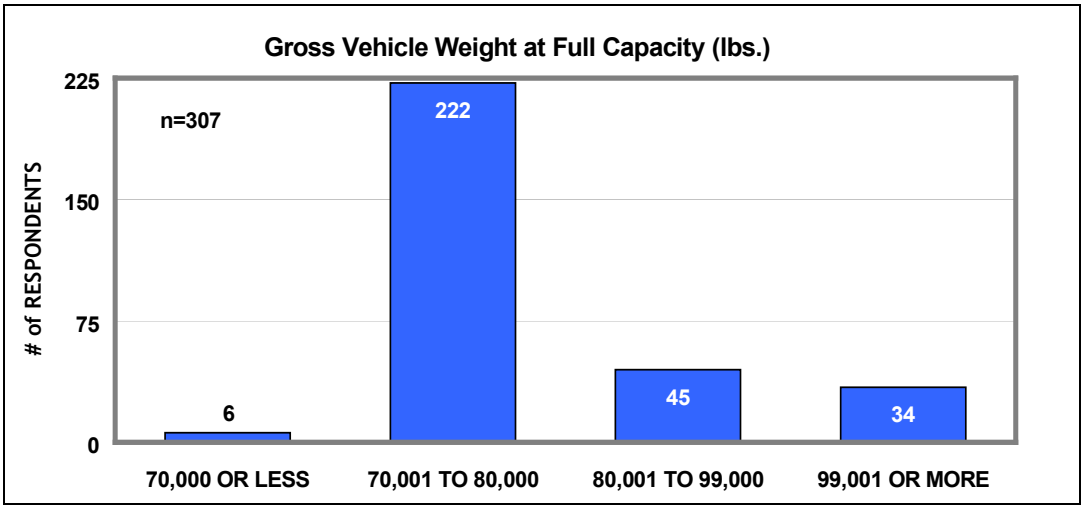



Figure 6.11: Truck Driver's Vehicle Gross Weight at Full Capacity

## 6.2.7 Cross Tabulations

As was discussed in Section 5.2.7.2, any of the demographic variables can be cross-tabulated with the answers to any of the other survey questions. To illustrate their use with the truck survey data, a cross tabulation of the responses to the scenario regarding partial or full closure (section 6.2.5) and miles driven per day is presented here. The cross tabulation is presented in Table 6.5.

**Table 6.5: Cross Tabulation of the Scenario Question by Miles Driven per Day.**

| | **Would you prefer a bridge project that would partially close lanes every day for 6 months, with up to 15 minute daily delays, or would you prefer a project that would close the bridge, require a 20 mile detour, and finish the project in two months?** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Miles Driven per Day** | **Detour with Shorter Project** | | **Longer Project with No Detour** | | **No Preference** | | **Grand Total** | |
| | Count | Percent | Count | Percent | Count | Percent | Count | Percent |
| **1-100** | 6 | 40% | 8 | 53% | 1 | 7% | 15 | 100% |
| **100-200** | 14 | 50% | 13 | 46% | 1 | 4% | 28 | 100% |
| **200-300** | 32 | 45% | 36 | 51% | 3 | 4% | 71 | 100% |
| **300-400** | 75 | 45% | 79 | 47% | 14 | 8% | 168 | 100% |
| **400-500** | 71 | 59% | 40 | 33% | 10 | 8% | 121 | 100% |
| **500-600** | 13 | 43% | 11 | 37% | 6 | 20% | 30 | 100% |
| **> 600** | 4 | 50% | 2 | 25% | 2 | 25% | 8 | 100% |
| **Don't Know** | 4 | 67% | 1 | 17% | 1 | 17% | 6 | 100% |
| **Grand Total** | 219 | 49% | 190 | 43% | 38 | 9% | 447 | 100% |

Overall, the complete closure and detour option was preferred by a slight margin over the partial closure. However, it appears from the cross tabulation that drivers who drive 400 or more miles per day favor the complete closure to a greater extent. This is a significant finding. Long haul drivers are more willing to accept detours if it means a shorter duration construction project. In future decisions about detours or closures, this type of information should be considered.

As was noted in Chapter 5, if additional cross-tabulations of the survey responses are desired by those within ODOT who have specific interests in the data, the authors can provide them upon request.

# 7.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## 7.1 SUMMARY

In general, the focus groups and surveys showed that work zone impacts to the traveling public are in the acceptable range. The responses from those surveyed indicate that their day-to-day trips through state highway work zones are safe, reliable and predictable. However, there are some notable findings resulting from the literature review, focus groups and surveys. In this chapter, those important findings, conclusions, and recommendations are summarized.

### 7.1.1 Literature Review

Recent emphasis by FHWA on reducing work zone related impacts to the traveling public has resulted in the development of "Quick Zone" software. Quick Zone can be a valuable work zone design tool to help reduce construction related impacts to drivers.

FHWA is also playing a major role in technology sharing. In addition to providing tours and information about work zone technologies in other countries, a source of information about U.S. work zone best policies/practices is provided as a link on FHWA's Internet Home Page. FHWA has also been instrumental in establishing the National Work Zone Safety Information Clearinghouse, which includes descriptions and manufacturer's contact information for individual work zone traffic control devices and safety technology. The clearinghouse's Internet site can be found at http://wzsafety.tamu.edu/.

ODOT's *(2001)* guide of techniques for minimizing delays are geared to pre-award activities such as constructability reviews and traffic control plan designs, and contracting activities such as award fees, A+B bidding, and lane rental. These guidelines for reducing work zone induced delays have been incorporated into ODOT's Project Development Guidebook.

A survey by Kane and others *(1998)* in North Carolina showed that most drivers wanted to see an increased presence of law enforcement in the work zone as a means to control speed. In 1995, the National Highway User Survey showed that drivers were not satisfied with traffic flow through construction sites. They were very concerned about highway safety and pavement condition *(Coopers & Lybrand L.L.P)*. These three concerns: (1) traffic flow through work zones, (2) highway safety, and (3) pavement conditions, are ongoing challenges for ODOT.

Illinois survey data, reported on by Benekohal and others *(1995)* are based on surveys conducted in 1993. Their findings, too, are very similar to the results of ODOT's 2001 survey. Their issues included: (1) confusing or unclear signs; (2) excessive speeds; (3) vehicle conflicts in the transition area as lanes are reduced in the work zone; and (4) earlier warnings about work zones and road conditions.

### 7.1.2 Focus Groups

For each of the six focus groups, one of the most frustrating aspects of work zones was not seeing workers present when signs indicated "Workers Ahead." There was also a desire for more consistent day-to-day work hours. The groups felt that advance work zone warning signs should be further upstream from the zone. For professional drivers, the advance warning of construction zones was especially critical, to allow as much time as possible to decide either to detour or to gradually slow their speed.

School bus drivers and truck drivers had concerns about the width of temporary traffic lanes and the difficulties turning because of the length and width of their vehicles. Truck drivers also had observed dangerous situations in the work zone where they had seen workers inadvertently move into the actual traffic lane while working.

Similar to the Benekohal survey *(1995)*, truck drivers were apprehensive about (1) vehicle speeds in the work zone coupled with limited law enforcement presence; and (2) conflicts with other vehicles in the work zones. They also expressed a continual frustration with vehicles failing to merge into a single lane until the last moment, thus bottlenecking traffic at the end of the taper. Motorists wanted to know how much distance they had to merge when a lane was closed ahead, and to have more temporary traffic signal and pilot car usage in the work zone.

Fire and Emergency Response vehicle operators noted the difficulty in seeing traffic delineation devices (tubular markers, barrels, etc.) for lane marking, and signs because of their equipment size. Ambulance drivers also discussed the discomfort to patients caused by rough road surfaces in the work zone.

All groups wanted better marking for temporary lanes, lane changes, and merging. In most cases, the request was for visible solid white lines. In addition, truck drivers felt that too often, removed striping in work zones left a "ghost" mark that was hard to distinguish from the temporary striping, especially at night or under rainy conditions.

All drivers noted the lack of nighttime visibility in work zones and problems seeing construction signs, lane markings, barriers, and construction personnel at night. Many felt that the signs, markers and barrels were often in poor condition and not as reflective as they would like. Also, they felt that flaggers were particularly hard to see at night and their signs were often impossible to read. Truck drivers also complained that the work zone lighting, the construction vehicle lights (rotor beams and headlights), and even at times, the lighted variable message signs, caused temporary impairment of their vision.

Each driver expressed concerns about either a detour or a delay, but all understood that they are a necessary part of road construction. The main issue raised about detours was adequate signage ahead of the detour, and along the detour route. Also, the detour signage should include any height or weight restrictions along the detour route. Generally, motorists and truck drivers were willing to accept construction delays from 10-15 minutes. However, school bus drivers and emergency vehicle operators did not want any delays along their routes. In the scenario given to all drivers about construction alternatives for a bridge project *(total closure with detour versus*

*partial closure with daily delays)*, the total closure with a 20-mile detour was the preferred alternative. However, for fire and emergency responders, the choice was not as clear cut. Their preferred choice was dependent on which construction alternative that would result in the quickest response time.

Most of the focus groups did not use any news or electronic media sources for construction related information. A majority of drivers were aware of the ODOT toll free telephone number for road conditions. Some drivers used sources including AAA, local television, newspapers, ODOT's cable access television station in Bend, and a limited amount of Internet use, including "Trip Check" on ODOT's web site. On a daily basis, school bus drivers used several ODOT sources including web cameras and making contact with local ODOT project managers. Truck drivers made several suggestions for improved access to construction information, including:

- Construction site information broadcast on the radio accessible throughout the state; and
- Increased construction information at truck stops and at state border welcome centers.

### 7.1.3 Motorist Survey

The survey of 2,002 motorists around the state was stratified by ODOT region, with about 400 completed interviews from each region. Because of the random selection of respondents, the distribution of answers in each region sample can be approximated to the general population of each region with a margin of error of ± 4.9 percentage points. In much of the survey, the motorists were asked to base their responses on the work zone they had most frequently traveled in the eight weeks previous to the survey.

**Frequency of Travel.** A greater percentage of motorists in Regions 1 and 2 were traveling through work zones when they are commuting to work. When motorists were asked about availability of alternate routes instead of traveling through the work zone, more people in Regions 1 and 2 said they could take another route. Of those with alternate route choices, 50% in Region 1 were taking alternate routes at least some of the time, whereas in Region 5 only 37% were doing so.

**Delays and Inconveniences.** More motorists experienced delays in Region 1 (68%) than in the other four regions. In contrast, only 48% in Region 3 had experienced delays traveling through work zones. Delays also occurred more frequently in Region 1 and much less in Region 3. The average value for *usual delay* in each Region based on survey responses was:

Region 1 -- 11.68 minutes
Region 2 -- 10.26 minutes
Region 3 -- 7.50 minutes
Region 4 -- 8.65 minutes
Region 5 -- 9.67 minutes

Table 7.1 shows the comparison of the average values for motorist's *acceptable delay* (when there is no advance notice) to actual *longest delay* averages and the differences between the two. Greater differences in values correspond with more disparity between what people perceive as

acceptable and what they are actually experiencing. In Regions 1 and 2, these differences are highest, but are much lower in the other 3 regions.

**Table 7.1: Actual Versus Acceptable Delay in Each Region**

| Region | Longest Delay (min.) | Acceptable Delay with no Advance Notice (min.) | Difference (min.) |
|---|---|---|---|
| Region 1 | 20.17 | 11.75 | 8.42 |
| Region 2 | 18.35 | 12.87 | 5.48 |
| Region 3 | 14.03 | 14.22 | -0.19 |
| Region 4 | 14.79 | 13.15 | 1.64 |
| Region 5 | 16.10 | 15.56 | 0.54 |
| Statewide | 18.42 | 12.70 | 5.72 |

Based on the estimates of delay from the survey responses, three points can be made:

1. *Longer* delays are being experienced by motorists in Regions 1 and 2 work zones.
2. The length of an *acceptable delay* for people traveling through Region 1 and 2 work zones is shorter than in the other three regions.
3. In Regions 3 and 5, motorists' view of *acceptable delay* closely matches what they are actually experiencing. Alternatively, the disparity between acceptable delay and actual delay is greatest in Regions 1 and 2.

Motorists also, for the most part, believe ODOT was keeping them well informed about highway work, and resulting road closures and delays. In Regions 1, 3, and 4, at least 65% gave ODOT an "excellent" or "good" rating. In Regions 2 and 5, it was slightly lower, with about 56% rating ODOT "excellent" or "good" at keeping them informed.

**Ease and Safety of Travel Through the Work Zone.** This series of questions asked motorists about the "ease" or "difficulty" they faced traveling in the work zone they had most frequently traveled through in the last eight weeks. Answer categories included very easy, somewhat easy, somewhat difficult and very difficult.

In all five regions, 80% of motorists said it was "somewhat" or "very easy" to understand where they were supposed to travel in the work zone. Furthermore, over 55% in each region except Region 1, answered "very easy." In Region 1, only 41% said it was "very easy." One reason for the difference could be attributed to the higher levels of congestion and potential vehicle conflicts in Region 1. For those who experienced difficulty (about 12.5% of all respondents), some of the reasons offered included:

- Lack of, or improper, signage;
- Exits not clearly marked;
- Not enough time to read changeable message signs; and
- Confusing delineation (tubular markers, barrels, pavement markings, etc.)

The majority of respondents experienced no difficulty in getting on or off the highway at intersections and driveways in the work zone. In all regions, between 19 and 24% of the drivers had experienced difficulty, with the lowest incidence in Region 3 and the highest in Region 1. The most frequent reason for the difficulty was traffic congestion.

Motorists were asked about how "easy" or "difficult" it had been to travel safely though the work zone. The vast majority of all respondents (1,840 of 2,002) said it was either "somewhat" or "very easy." The number who experienced difficulty was slightly higher in Region 1, again, probably because of the added congestion.

All drivers were asked about how to make work zones safer. The most common response was "Additional police presence – greater enforcement of speeds." People also addressed a need for wider lanes, better signage, better delineation, and improved visibility/positioning of flaggers.

Motorists were also given a list of six work zone related strategies or traffic control devices, and asked which was most important to improve. For each region, Table 7.2 presents the rankings based on the percentage of responses. In every region except for Region 1, speed enforcement received the highest ranking, which is consistent with the earlier question about how to make work zones safer. In Region 1, nighttime visibility was the highest ranked response, which was second in the other four regions.

**Table 7.2: Rankings of Strategies/Devices: "What is Most Important to Improve?"**

| Item | Region 1 | Region 2 | Region 3 | Region 4 | Region 5 | Overall |
|---|---|---|---|---|---|---|
| **Speed Enforcement** | 2 | 1 | 1 | 1 | 1 | 1 |
| **Nighttime Visibility** | 1 | 2 | 2 | 2 | 2 | 2 |
| **Signs** | 3 | 4 | 3 | 3 | 4 | 3 |
| **Work Zone Safety** | 4 | 3 | 4 | 4 | 3 | 4 |
| **Traffic Flow** | 5 | 5 | 5 | 6 | 6 | 5 |
| **Guardrail and Barriers** | 6 | 6 | 6 | 5 | 5 | 6 |

**Sources of Information.** The sources of information used by motorists to find out about highway construction work vary for the five regions. Figure 7.1 shows the utilization of the four primary information sources in each Region and for the entire state.

The electronic media (television and radio) has been widely used in Region 1; less extensively in Regions 2, 3, 4 and 5. In Region 1, reliance on newspapers for construction information is low, but the other four regions use newspapers more widely. In all regions, construction signs (including electronic changeable message) have been a significant source of information for highway users. Not shown in the distribution is Internet use. As was seen in Figure 5.22 (page 42), the use of the Internet as a source for construction information was very low in every region.

The majority of people in each region (57 to 62%) do not seek advance information about construction prior to making a trip. For those who do, the primary source for Regions 3, 4, and 5 were telephone calls to ODOT (29 to 38%). In the two most populated regions, 1 and 2, the

Internet was the primary source (27 to 31%). While this might seem contradictory to what was stated earlier about low Internet usage, it is important to note that calls to ODOT and Internet use were the two most prevalent sources of information among those who are *actively seeking* advance construction information prior to a trip. However, only 38 to 43% have actually tried to obtain information about construction prior to making a trip.

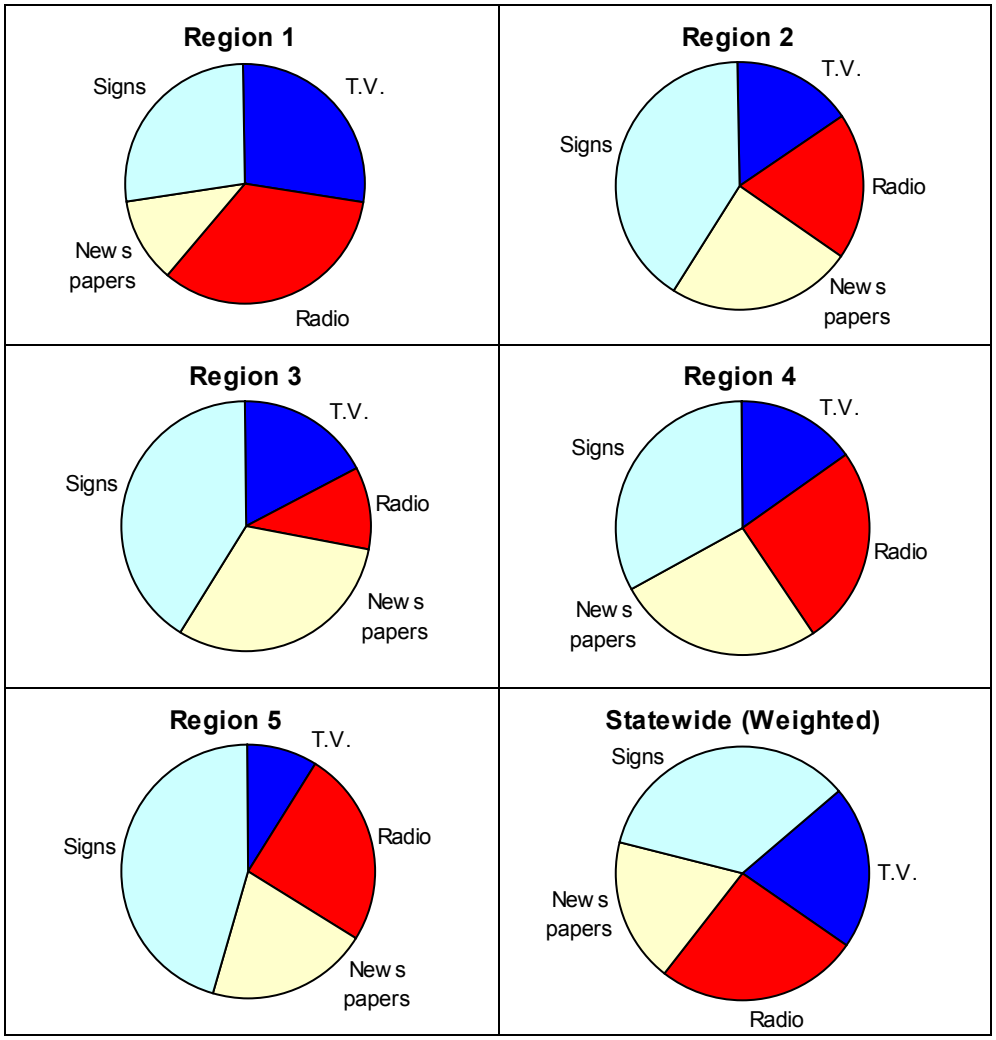



Figure 7.1: Sources of Information about Construction

**Opinions About ODOT.** A majority of motorists in all five regions favorably rated ODOT in terms of how the striping and signage were maintained in the work zone. For striping, those rating ODOT in the "excellent" and "good" categories ranged from 68% in Region 1, to 73% in Region 2. In assessing ODOT's work zone signage, the ratings in the "excellent" and "good" categories were even higher, ranging from 78% in Region 1 to 88% in Region 4. Nighttime visibility of traffic control devices (cones, barrels, etc.) also received high ratings from motorists. Ratings in the "excellent" and "good" categories were between 75% (Regions 1 and 2) and 79% (Regions 3 and 4).

In terms of overall management of work zones, the public's opinions of ODOT were extremely positive. The survey results showed that in each region, 81 to 89% of the respondents gave ODOT an "excellent" or "good" rating when asked, "How well do you think ODOT manages state highway construction zones?" Further, just 2% or less in each region rated ODOT in the "poor" category.

**Demographic Data.** Although there is some disparity between the survey sample demographics and the 2000 Census, overall, the differences do not appear to be considerable. The survey sample seems to be slightly older than the general adult population, and they are more educated and have higher incomes. However, the sampling methods and sample size ensure that the survey results are representative of the traveling population, within a small margin of error.

**Demographic Data and Cross Tabulations.** For the reader's information, any of the demographic data variables (age, sex, driving experience, etc.) presented in this report can be cross-tabulated with the answers to any of the other survey questions. The authors, upon request, can provide specific cross tabulations of the motorist survey responses to those within the Department who have a specific interest in the results. A sample cross tabulation using the motorist survey data can be found in Section 5.2.7.2 (page 56).

**Statistical Analysis.** The results of chi-square testing revealed that for most of the questions, there were statistical differences in the answer distributions between ODOT's five regions. There were only six questions where the answer distributions were <u>not</u> statistically significant among regions (in other words, responses were consistent across the state). These six questions asked about:

- ranking the most important strategy or traffic control device for work zones;
- getting information from neighborhood meetings;
- finding advance information about construction prior to a trip;
- rating ODOT's performance in maintaining stripes in the work zone;
- rating ODOT's performance maintaining night visibility of work zone traffic control devices; and
- rating how well, overall, ODOT manages work zones.

### 7.1.4 Truck Driver Survey

In total, 448 truck drivers participated. Two types of surveys were conducted using the same survey questionnaire; intercept surveys conducted at the Memaloose (I-84) and Oak Grove (I-5) rest areas, and a telephone survey of 307 drivers. The results for both survey types were pooled and presented together as one "statewide" data set.

**Frequency of Travel.** The truck drivers drove extensively through work zones. Over 60% of the drivers had traveled through at least 11 work zones in the previous two months. Truck drivers were asked to consider the work zone they had most frequently traveled through in the previous two months. Eighty percent of the drivers had traveled through **<u>that</u>** work zone at least two to four times a week.

**How to Improve Work Zones for Truck Drivers.** The drivers provided a variety of suggestions for improving work zones. The leading category of comments (about 50 of 448) related to some aspect of flagging, which included:

- Increased awareness by flaggers of trucks' stopping and starting requirements;
- Visibility/location of flaggers; and
- Alertness of flaggers.

**Delay and Inconveniences.** Over half of the truck drivers had been delayed in work zones in the previous two months. Of those who had been delayed, about half said they were "always" or "often" delayed. The average value of the *longest delay* reported by drivers was 17.12 minutes. Drivers were asked to estimate the longest acceptable delay in minutes if (1) there is advance notice, and (2) if there is no notice. The average values based on the driver responses were:

- Know in Advance – 15.08 minutes
- No Advance Notice – 15.29 minutes

It is unknown why there is a higher value for acceptable delay *with no advance notice* than the acceptable delay *with advance notice*. It may be that the question was misunderstood, or for some reason these respondents are willing to accept longer delays without advance notice.

Truck drivers regarded glare from construction lighting (light plants, rotor beams, headlights, etc.) as the principal inconvenience in work zones.

**Ease and Safety of Travel Through the Work Zone.** An overwhelming majority (93%) of the drivers found it either "very" or "somewhat easy" to understand where they were supposed to go in the work zone. A substantial majority (85%) also said it had been "very" or "somewhat easy" to get on and off highway interchanges located in the work zone. Similarly, 91% of the drivers responded that it had been "very" or "somewhat easy" to *safely* travel through the work zone.

**Sources of Information.** The greatest information source for truck drivers about construction was CB radios, followed by construction signs. Commercial radio was also an another important source. Television, newspapers, and the Internet were used very little by truck drivers.

**Scenario About Detour and Delays.** A scenario was presented to truck drivers involving two different alternatives for a bridge construction project. The two alternatives were: (1) complete closure with a 20-mile detour and construction completion in two months; or (2) partial closure with 15 minutes of daily delays and construction completion in six months. The preferred choice among all truck drivers was split with no clear cut preference. The complete closure and detour option was favored by 49%, whereas 43% chose the partial closure option. Nine percent did not have a preference. The results were cross tabulated with distance driven per day by truck drivers. The cross tabulation showed that truckers who drove 400 or more miles per day were more inclined to favor the complete closure option.

**Truck Driver Demographic Data.** Demographic data (age, sex, driving experience, miles driven per day, etc.) was collected and is presented in this report. The demographic data can be

used for additional cross tabulations with the answers to any of the other truck driver survey questions. As previously noted, the authors, upon request, can provide specific cross tabulations of the truck driver responses to those within the Department who have a specific interest in the results.

## 7.2 CONCLUSIONS

Highway users are generally satisfied with how ODOT is managing construction and maintenance work zones. As seen in Figure 7.2, people gave ODOT fairly high ratings for the management of its work zones.

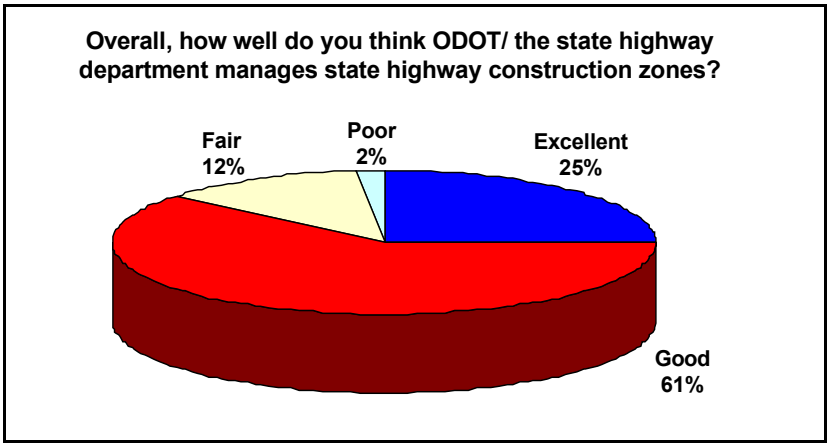



Figure 7.2: How Well ODOT Manages Construction Work Zones – Statewide Responses

Furthermore, the focus groups and survey results were very favorable towards current ODOT practices and policies. Public frustration in traveling though work zones was relatively low. However, there were several prevailing themes from the focus groups and surveys that possibly need to be further addressed by ODOT.

1. **Nighttime visibility**. In Region 1, drivers rated this as the number one area for improvement. The focus groups commented about the difficulty seeing signs, lane markings, and construction personnel at night. Truck drivers had similar issues, in addition to the blinding effect at night caused by portable lighting units and other construction lighting.
2. **Striping/Delineation/Signage**. Although striping in the work zone was rated favorably by motorists (Figure 5.30, page 47), 25% of the respondents rated striping in the "fair" or "poor" categories. Lack of, or difficult to read signs, as well as hard to see striping were also noted by motorists when they were asked why it was difficult to travel through the work zone.
3. **Delay**. Actual delays experienced by highway users were higher in Regions 1 and 2. Alternatively, in those regions, drivers' estimate of acceptable delay was also lower. Thus, there is a clear difference in what people perceive as acceptable delay and what

they were actually experiencing in Regions 1 and 2. Additionally, truck drivers were also experiencing higher delays than what they feel are acceptable.

4. **Speed enforcement**. Greater enforcement of speeds was cited by all groups as an essential change needed in work zones.
5. **Flaggers**. Although there were no specific questions in the focus groups or on the surveys about flaggers, they were discussed in response to the open ended questions. Truck drivers wanted to see improvements in flaggers' visibility and alertness. They also expressed concerns that flaggers did not understand the stopping and starting requirements of a large tractor-trailer.
6. **Sources of information about construction**. Most respondents indicated they do not seek advance information about construction prior to making a trip. Reported Internet use was relatively low. The most widely used sources of information were construction signs, television, radio and newspapers. Truckers also relied heavily on their CB radios.
7. **Traveling safely through the work zone**. The vast majority of motorists and truck drivers (about 90%) found it "easy" or "somewhat easy" to safely travel through the work zone. Those who experienced difficulty addressed issues such as narrow lanes, other drivers speeding or driving aggressively, and difficulties entering and exiting the highway. Suggested improvements included better delineation and signage, greater enforcement of posted speeds, and wider lanes.
8. **Complete closure versus partial closure**. Given the options of a complete closure with 20-mile detour or a partial closure with 15-minute delays, a slight majority of truck drivers surveyed (49% vs. 43%), chose the complete closure option. Although motorists were not given a similar scenario question in the telephone survey, the two focus groups of motorists were given this scenario. Like the truck drivers, the majority of motorists chose the complete closure option. Although hypothetical and rather simplistic, these results help support the notion that the public wants the highway agency to "get in, get out, and stay out."
9. **Statistical differences across regions**. For nearly all of the questions on the motorist survey, there were statistical differences in the answer distributions between ODOT's five regions. Generally, the regional disparity could be attributed to the answer distributions of the two more heavily-populated regions (Regions 1 and 2) contrasting with the three more rural regions.

## 7.3 RECOMMENDATIONS

Specific recommendations to address individual conclusions are not offered here. However, the authors, with assistance from the Research Technical Advisory Committee, have developed an implementation strategy that will engage and inform ODOT senior management about the results of this study. This will include formal presentations to key ODOT management groups, such as at the Highway Division Staff Meeting.

Additionally, it is recommended that a working group(s) of technical experts, with authority from senior management, be established to review the prevalent problems and trends in order to make corrections or mitigate with an ODOT policy or procedural change. It is envisioned that one of the outcomes of the technical expert working group(s) will be a list of recommended products for ODOT to test in actual work zones as part of the FHWA- sponsored Experimental Features research program.

Implementation will also include informational presentations to construction and maintenance personnel around the state to ensure there is widespread awareness about the research findings.

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