IMPROVING GUIDANCE FOR SPEED SAFETY CAMERA

Final Report

SR 873

Oregon Department of Transportation

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by

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16. Abstract

This report synthesizes speed safety camera elements, issues, best practices, and evidence-based results identified from a national and international review of jurisdictions employing speed safety cameras. Using these findings, this report provides recommendations to ODOT on changes and additions to the statewide speed safety camera program, as well as potential legislative changes and future research. This report serves as a basis for revised statewide speed safety camera guidelines.

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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 squared	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	(F-32)/1.8	Celsius	°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
m^2	meters squared	1.196	square yards	yd^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	1.8C+32	Fahrenheit	°F

*SI is the symbol for the International System of Measurement

ACKNOWLEDGEMENTS

DISCLAIMER

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1.0 INTRODUCTION

There is strong evidence that speed safety camera (SSC) systems can reduce both crash frequency and severity, but the Oregon Department of Transportation (ODOT) requires evidence-based guidance on how and when to deploy speed safety camera (SSC) systems.

The key objectives of this research are to: (a) to develop agency knowledge for speed safety camera systems by compiling SSC performance data and summarizing best practices for SSC deployments, (b) to develop a data driven approach to assist in determining optimal locations for the placement of these systems, and (c) understand how SSC systems can be deployed while ensuring broad public acceptance without exacerbating existing social disparities.

This report synthesizes speed safety camera elements, issues, best practices, and evidence-based results identified from a national and international review of jurisdictions employing speed safety camera. Using these findings, this report provides recommendations to ODOT on potential changes and additions to its SSC guidelines, as well as potential legislative changes and future research.

It is important to emphasize that this report does not constitute a standard, specification, or regulation. It contains information about SCC effectiveness, best practices from existing programs, and potential recommendations that may be useful for agencies considering implementing SSCs. The goal of the report is to collect relevant information for agencies to consider as they develop SSC programs.

1.1 DEFINITIONS AND SCOPE

The following classification and definitions are used throughout the report.

Speed Safety Camera (SSC): The use of a device that employs radar or lidar technology to detect the passage of a vehicle and its speed. If a vehicle is exceeding a preset speed, the device will record pictures of the vehicle, license plate, and driver. Using this information, citations can be issued and sent to the driver.

Automated Traffic Enforcement (ATE): The use of any type of enforcement that employs cameras or other technology to detect violations. This umbrella term includes speed safety camera, red-light enforcement, bus lane enforcement, stop sign enforcement, and more.

Average Speed Cameras: Refers to the use of multiple SSC devices or cameras to capture the average speed of vehicles along a corridor and predetermined distance. These are usually stationary cameras installed along roadways or main arterials.

Covert Enforcement: The use of unmarked SSC units with no advance warning to drivers.

Fixed Speed Safety Camera: Refers to the use of permanent SSC devices placed along corridors to monitor vehicle speeds and capture images of vehicles exceeding the speed limit or above a threshold over the posted speed limit.

Fully Automated: The device or system can operate without the need for manual intervention by law enforcement officers or other officials.

Mobile Speed Safety Camera: Unlike fixed cameras, mobile speed cameras are portable and can be moved to different locations as needed but require more staff time for deployment and operation. They operate similarly to fixed cameras, capturing images of speeding vehicles and are typically attached to law enforcement vehicles.

Overt Enforcement: The use of visible SSC units with advance warning to drivers.

Point-to-Point Speed Cameras: Like average speed cameras, point-to-point cameras measure a vehicle's average speed over a specified distance. However, instead of using multiple cameras, they use two cameras positioned at different points along a roadway to calculate the vehicle's speed over that distance.

Red-Light Enforcement/Traffic Light Cameras: While primarily used for enforcing red-light violations, some traffic light cameras also have speed enforcement capabilities. These cameras detect vehicles speeding through intersections and issue citations accordingly.

Specific Jurisdictions: In some states, SSC is permitted in all jurisdictions in the state. However, in others, state law only grants permission for specified jurisdictions to operate ASE.

Traffic Light Cameras: While primarily used for enforcing red-light violations, some traffic light cameras also have speed enforcement capabilities. These cameras detect vehicles speeding through intersections and issue citations accordingly.

1.2 SPEED SAFETY CAMERA PROGRAMS IN OREGON

1.2.1 Legislative History

Previously, ORS 810.438 (Oregon State Code, 2024f) specified the use of municipal SSC programs in operation. The law originally allowed only the cities of Albany, Beaverton, Bend, Eugene, Gladstone, Medford, Milwaukie, Oregon City, Portland, and Tigard to operate mobile photo radar devices. In addition, ORS 810.443 and ORS 810.444 (Oregon State Code, 2024a; Oregon State Code, 2024c) granted the City of Portland permission to run fixed photo radar for urban high crash corridors in 2015. ORS 810.443 stipulated that fixed photo radar devices were only allowed in Portland and could only be used on urban high crash corridors.

However, two new pieces of legislation were recently passed to amend both mobile and fixed photo radar operations in Oregon. HB2095 (Oregon HB2095, 2023) amends 810.438 to allow any city, at their own cost, to operate mobile SSC systems. This bill was signed in the 2023 legislative section and made effective on January 1, 2024. Figure 1-1presents a graphic of how mobile SSC legislation has changed. Grey cells indicate that the legislation has been repealed or amended.

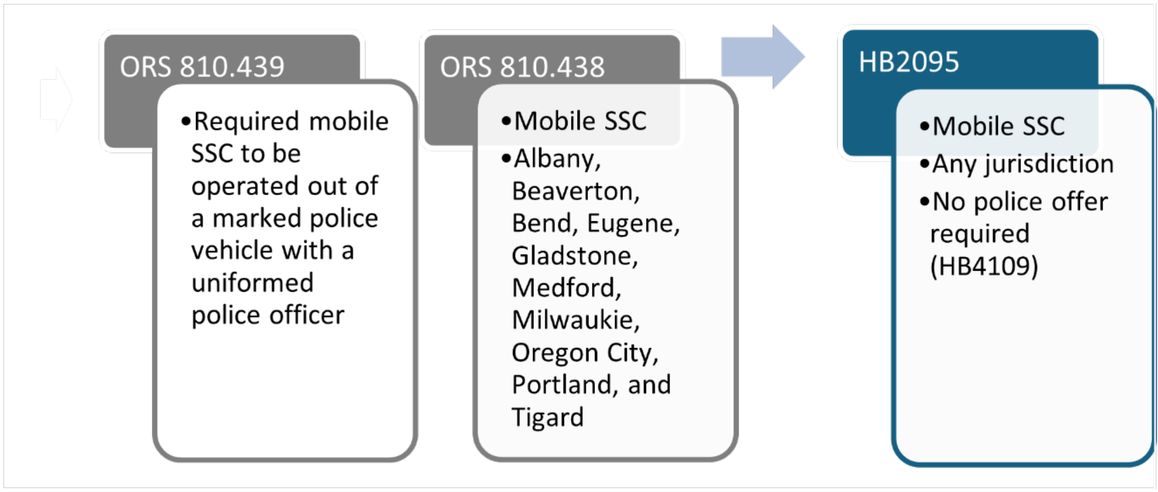

Figure 1.1 Mobile SSC Legislation

Note: While ORS 810.439 was repealed by HB4109, it pertains to mobile SSC.

HB4109 (Oregon HB4109, 2024, p. 4) effective in June 2024, repeals ORS 810.443, thus removing the requirement for the City of Portland to only operate fixed radar on urban high crash corridors. It also amends ORS 810.444 to reflect that any city may use fixed SSC and that a police officer or duly authorized traffic enforcement agent may review citations, while previously only a police officer could.

HB4109 also repeals ORS 810.439, which removes the requirement for mobile SSC systems to be accompanied by a police officer. Finally, the bill repeals ORS 810.445, which required the City of Portland to only use SSC revenue on (a) costs of the SSC program and (b) improving traffic safety. Figure 1.2 presents a graphic of how mobile SSC legislation has changed. Grey cells indicate that the legislation has been repealed or amended.

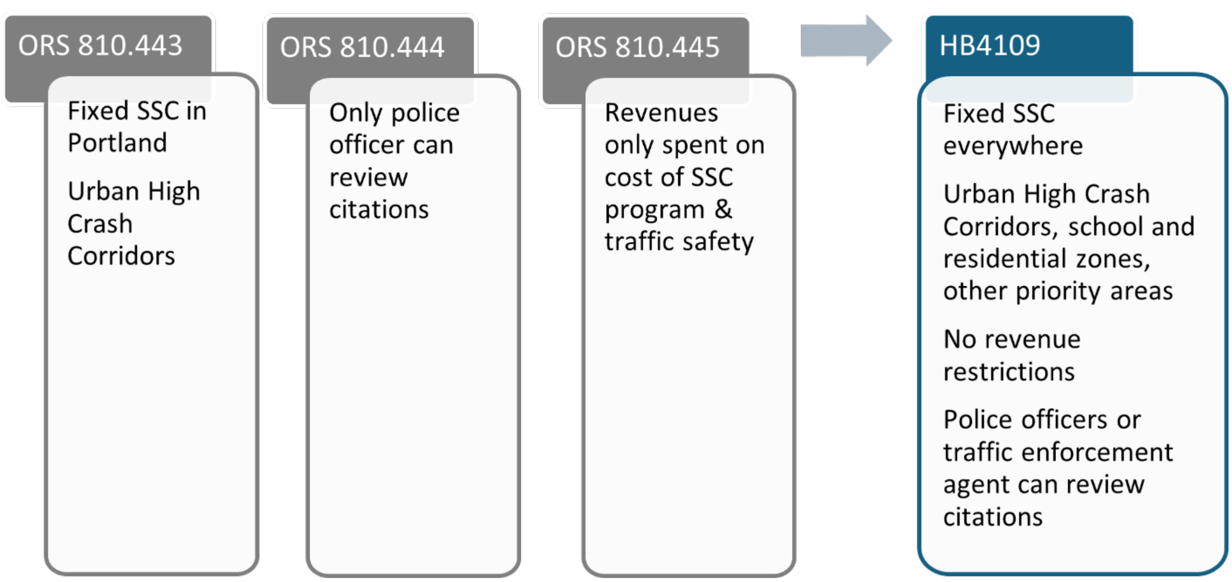

Figure 1.2 Fixed SSC Legislation

1.2.2 Red Light and Speed Cameras

ORS 810.434, ORS 810.435, and ORS 810.436 specify the use of red-light cameras in Oregon (Oregon State Code, 2024d; Oregon State Code, 2024h; Oregon State Code, 2024i). ORS 810.434 stipulates that these cameras may be used to issue violations for drivers who run a red light and drivers who violate the speed limit by 11 MPH or greater. The law also mandates that cities operating red light cameras must conduct a public information campaign and perform an evaluation. Further, ORS 810.437 mandates the use of signs in advance of the red light camera if citations are issued for speeding (Oregon State Code, 2024e). Citations must be issued by a police officer or a duly authorized traffic enforcement agent, per HB4105.

1.2.3 Mobile SSC Programs

The passage of HB2095 allowed mobile SSC to be used in all jurisdictions. Further, mobile SSC is no longer required to be accompanied by a uniformed police officer or operated out of a marked police vehicle. In addition, the following criteria are mandated for mobile SSC programs (Oregon HB2095, 2023):

- The devices may be used on streets in residential areas or school zones. They could also be used in other areas of the city if the governing body of the city makes a finding that speeding has had a negative impact on traffic safety in these areas.
- The devices cannot be used on controlled access highways.
- Signage is required 100 to 400 yards upstream of the location of the SSC device.
- Citations must be issued by a police officer or a duly authorized traffic enforcement agent, per HB4105.

The previous law had a requirement that mobile SSC devices could not be used for more than four hours per day in any one location; however, HB2095 removed this requirement.

1.2.4 Fixed SSC Programs

While fixed SSC has historically only been authorized in Portland, HB4109 will allow all jurisdictions to operate fixed programs as of June 2024. The same general criteria are mandated for fixed SSC programs as for mobile SSC programs (Oregon HB4109, 2024):

- The devices may be used on streets in residential areas or school zones. They could also be used in other areas of the city if the governing body of the city makes a finding that speeding has had a negative impact on traffic safety in these areas.
- The devices cannot be used on controlled access highways.
- Signage is required 100 to 400 yards upstream of the location of the SSC device.

- Citations must be issued by a police officer or a duly authorized traffic enforcement agent, per HB4105 and HB4109.

A police officer or a duly authorized traffic enforcement agent is required to review a citation before it is issued.

1.2.5 Highway Work Zones

ORS 810.441 and ORS 810.442 specify the use of SSC in highway work zones (Oregon State Code, 2024b; Oregon State Code, 2024g). ORS 810.441 authorizes ODOT to use mobile SSC in highway work zones where highway workers are present. Signage is required both on the state highway where SSC is being used and before the location of the SSC unit. The law also allows ODOT to ask local jurisdictions to operate SSC in a highway work zone on a state highway. ORS 810.442 requires that the SSC unit be operated by a uniformed police officer out of a marked police vehicle.

1.3 ORGANIZATION OF THE FINAL REPORT

This report is organized into eleven chapters. Chapter 2 provides an overview of SSC, including classifications of speed enforcement and relevant guidelines. Chapter 3 outlines key elements of an SSC program and synthesizes the current state of the practice in the United States. Chapter 4 provides more detail on SSC programs in the United States through selected, detailed case studies. Chapter 5 presents a summary of international SSC programs. Chapter 6 summarizes evidence-based SSC outcomes, including on speeds and crashes. Chapter 7 summarizes the panel-based survey results, analysis, and implications. Chapter 8 provides recommendations for existing ODOT SSC guidance. Chapter 9 concludes the report and synthesizes potential legislative changes and future research needs related to recommended changes. References are also included at the end of the report, in Chapter 11.

2.0 SPEED SAFETY CAMERA OVERVIEW

According to the National Highway Traffic Safety Administration (NHTSA) there were 1.18 traffic fatalities per 100 million VMT in 2016, of which 27% were speeding related (NHTSA, 2017). NHTSA also reports that speeding-related fatalities increased by 17% between 2019 and 2020, with an estimated 310,000 people injured in speeding-related crashes on American roadways in 2020.

In Oregon, there was a sharp decrease in all crashes and injury crashes post-COVID (-25% and -30%, respectively). While 2021 crash data does show an increase, as of 2022 crashes and injuries are still below pre-COVID rates (ODOT, 2022) (see Figure 2-1).

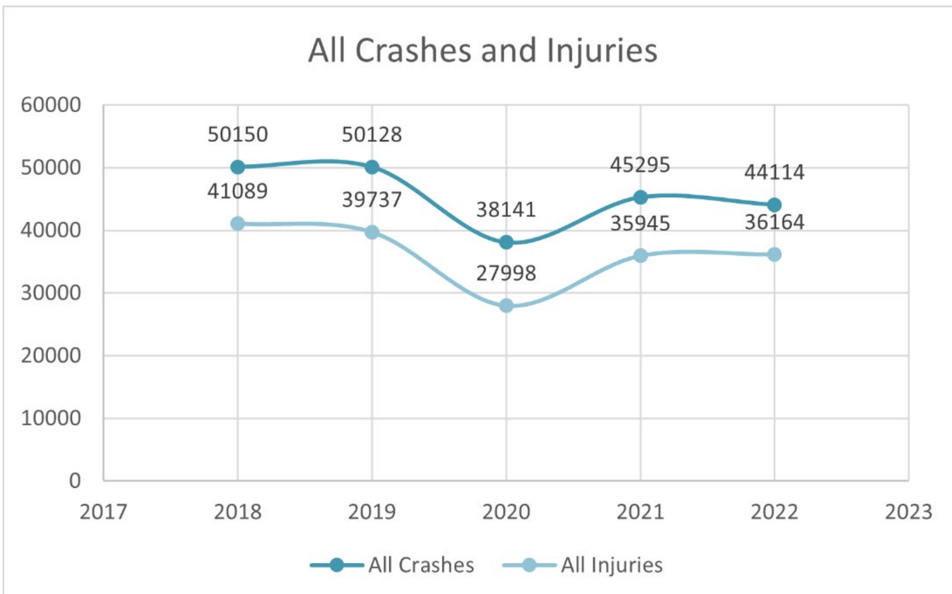

Figure 2.1 Oregon Crashes and Injuries

However, fatalities have been on the rise in the past five years of crash data for vehicles and pedestrians. Concerningly, there was a 42% increase in pedestrian fatalities between 2021 and 2022. While bicycle fatalities did decrease between 2020 and 2022, there are still more bicycle deaths in 2022 than there were in 2018 (see Figure 2-2). Further, pedestrian and bicycle injuries have been steadily increasing since a pre-COVID dip, with 760 pedestrian injuries and 507 bicycle injuries in 2022 (ODOT, 2022) (see Figure 2-3).

This alarming fatality trend is seen in Portland as well. Within the city, 69 people were killed in traffic crashes in 2023, the highest death toll in at least three decades and surpassing 2021's record high (PBOT, 2024a).

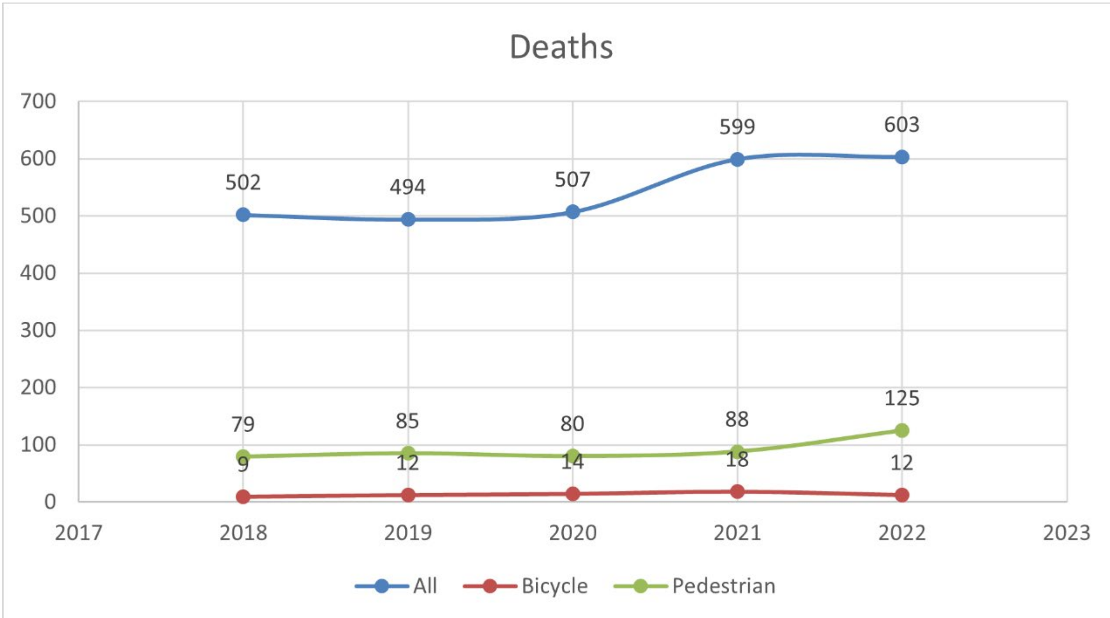

Figure 2.2 Oregon Traffic Deaths

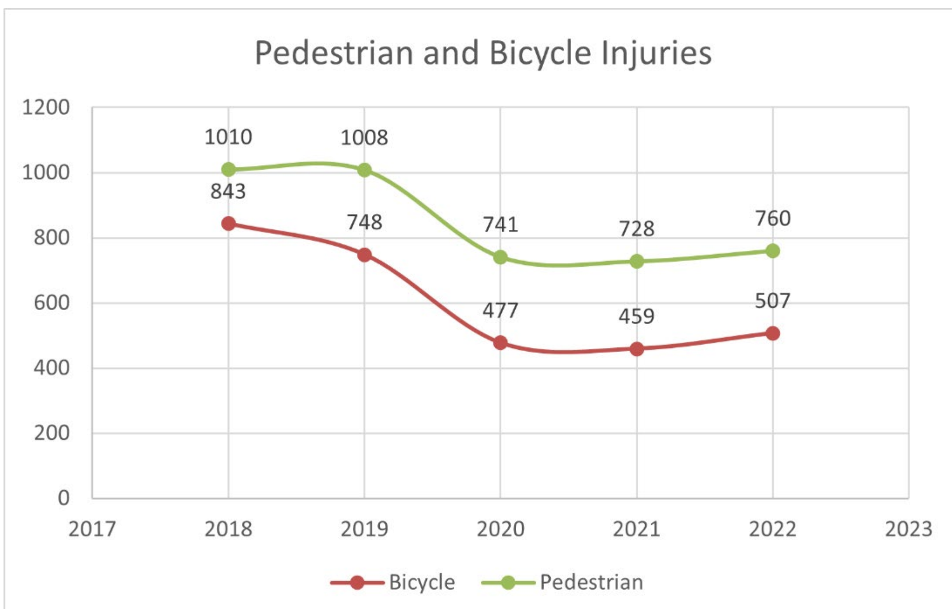

Figure 2.3 Oregon Pedestrian and Bicycle Injuries

In 2022, 30% of all fatal crashes and 26% of fatal pedestrian crashes in Oregon involved speeding. Speed safety camera is an important countermeasure in targeting these speed-related crashes. This chapter provides a general overview of the purpose of SSC and types of cameras and enforcement. It also outlines guidance in the United States related to SSC programs (ODOT, 2022).

2.1 SPEED SAFETY CAMERA CLASSIFICATIONS

Speed safety camera (SSC) refers to the use of a device that employs radar or LiDAR technology to detect the passage of a vehicle and its speed. If a vehicle is exceeding a preset speed, the device will record pictures of the vehicle, license plate, and driver. Using this information, citations can be issued and sent to the driver. These devices are often targeted at high-crash corridors, school zones, work zones, or other safety areas to reduce speeds and speed-related crashes.

SSC systems can be mobile, fixed, or point-to-point. Fixed systems are permanent SSC devices placed along corridors to monitor vehicle speeds and capture images of vehicles exceeding the speed limit or above a threshold over the posted speed limit. They are best used to counter specific, systemic issues at problematic locations. These are often used at high-crash locations or locations that require lower speeds (such as school zones) to reduce speeding at a particular location.

Mobile systems are portable SSC devices and can be moved to different locations as needed but require more staff time for deployment and operation. They operate similarly to fixed cameras, capturing images of speeding vehicles and are typically attached to law enforcement vehicles. They provide flexibility in placement and are best used in locations where speed is a network- or corridor-wide issue, allowing agencies to move the devices along the corridor when needed to cover a larger area.

Average speed enforcement systems, which have not yet seen wide deployment in the United States, use multiple SSC devices or cameras to capture the average speed of vehicles along a corridor and predetermined distance. These are usually stationary cameras installed along roadways or main arterials. Like average speed cameras, point-to-point cameras measure a vehicle's average speed over a specified distance. However, instead of using multiple cameras, they use two cameras positioned at different points along a roadway to calculate the vehicle's speed over that distance. These systems, common in Europe, are effective in lowering the speed along a stretch of roadway without encouraging rapid deceleration and acceleration right before a unit, as may occur with fixed or mobile systems. Table 2-1 presents the Federal Highway Administration (FHWA) guidance on selection for SSC deployment (FHWA, 2024b).

Table 2.1 FHWA Selection Considerations for SSC Deployment

Considerations for Selection	Mobile	Fixed	Point to Point
Problems are long-term and site-specific.		X	X
Problems are network-wide, and shift based on enforcement efforts.	X		
Speeds at enforcement site vary largely from downstream sites.	X		X
Overt enforcement is legally required.	X	X	X
Sight distance for the enforcement unit is limited.		X	X
Enforcement sites are multilane facilities.		X	X

Enforcement can be overt (using highly visible enforcement practices with advance warning to drivers), or covert (using unmarked SSC units with no advance warning to drivers). Covert enforcement is not often used in the United States because of negative public perceptions of "speed traps", and most jurisdictions have laws that explicitly forbid covert operations. Typically, SSC units are made visible with signage before the unit notifying drivers of photo enforcement and their speed. SSC deployment in urban environments is also generally paired with other traffic calming and safety measures and is part of a toolkit of solutions to increase safety.

SSC has been used in Europe since the 1990s and in the United States since the early 2000s. To the best of our knowledge, as of February 2024, 21 states permit SSC by state law and 23 states permit red light cameras by state law. Specific legislation varies significantly by state, as well as the type and location of SSC systems. Details on the various aspects of SSC programs are provided in Chapter 3.

2.2 SPEED SAFETY CAMERA NATIONAL GUIDANCE

2.2.1 Speed Safety Camera Program Planning and Operations Guide

The Federal Highway Administration released the Speed Safety Camera Program Planning and Operations Guide (FHWA, 2023) on speed safety cameras, also known as speed safety cameras, in January 2023. This document updated the previous Speed Enforcement Camera Systems Operational Guidelines (FHWA & NHTSA, 2008). The update adds new information on program practices, technologies, such as speed-over-distance or point-to-point enforcement, and case study examples from jurisdictions using SSC.

The Speed Safety Camera Program Planning and Operations Guide (herein called "FHWA Guide") helps jurisdictions plan, deploy, and operate SSC programs to improve safety and maintain program reliability. The FHWA Guide provides information on determining the legality of deploying SSC systems in a jurisdiction and outlines recommendations for program planning, enforcement planning, violation structure, program startup, and program evaluation. The components of the guide are shown in Figure 2-4.

Figure 2.4 FHWA Speed Safety Camera Program Planning and Operations Guide Overview

2.2.2 NHTSA Safety Countermeasures Guide

The National Highway Traffic Safety Administration (NHTSA) lists automated enforcement as a speed management countermeasure in their 2023 Countermeasures that Work guide (Kirley et al., 2023). It rates automated enforcement with an effectiveness of 5 out of 5, and provides information on the use, effectiveness, and cost of SSC programs. It also discusses issues related to SSC, such as legality, covert vs overt enforcement, enforcement thresholds, public acceptance, and the halo effect.

2.2.3 FHWA Countermeasures

FHWA also lists speed cameras as part of their Proven Safety Countermeasures. FHWA recommends SSC as a key part of the Safe Speeds portion of the Safe Systems approach, and provides information on the application and considerations of SSC programs (FHWA, 2024b).

2.3 SUMMARY

This chapter provided an overview of SSC, including relevant U.S. based national guidance. Key findings include:

- **SSC Types:** SSC systems can be covert, overt, mobile, fixed, average speed, or point-to-point.
- **National Guidance:** The primary national guidance is the Federal Highway Administration's 2023 Speed Safety Camera Program Planning and Operations Guide. Additional guidance includes the NHTSA 2020 Highway Safety Countermeasure Guide for State Highway Safety Offices. In these guidance

documents, FHWA recommends developing goals and an evaluation plan, as well as creating an enforcement plan and field operations plan. Further, the FHWA Guide provides strategies for vendor contracts, data management, and program roll-out.

3.0 SSC PROGRAMS IN THE USA

The SSC programs in the United States vary significantly by state and jurisdiction. This chapter aggregates information from SSC programs across the United States, specifically on criteria and requirements related to device placement; fines and revenue; signage and speed requirements; public acceptance; and selection criteria.

3.1 SSC AND RED-LIGHT CAMERAS LEGISLATION

There are 21 states that permit SSC by law and 23 states that permit red light cameras by law. In addition, Iowa permits SSC by local jurisdiction, though there is no state law. Eight states specifically prohibit SSC by law and 15 have no state or local legislation related to SSC. Four states have pilot programs, which allow SSC on a limited basis for a set amount of time. Two additional states have feasibility studies or task forces on the subject.

Table 3-1 shows the SSC and red-light camera legislation for all 50 states and the District of Columbia.

Table 3.1 SSC and Red-Light Cameras in the United States

	Speed Safety Camera (SSC)	Red Light Cameras
Permitted by State/District Law	21 (Alabama, Arizona, Arkansas, Colorado, Connecticut, District of Columbia, Florida, Georgia, Illinois, Louisiana, Maryland, Nevada[1], New Mexico, New York, Ohio, Oregon, Rhode Island, Tennessee, Utah, Virginia, Washington)	23 (Alabama, Arizona, California, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Louisiana, Maryland, Nevada[1], New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, Tennessee, Virginia, Washington)
Prohibited by State Law	8 (Maine, Mississippi, New Hampshire, New Jersey, South Carolina, Texas, West Virginia, Wisconsin)	11 (Maine, Minnesota, Mississippi, Montana, New Hampshire, Oklahoma, South Carolina, South Dakota, Texas, Utah, West Virginia)
No State Legislation, No City Ordinances	15 (Alaska, Hawaii, Idaho, Kansas, Kentucky, Massachusetts, Michigan (bill in progress), Missouri, Montana, Nebraska, North Carolina, North Dakota, Oklahoma, South Dakota, Wyoming)	15 (Alaska, Arkansas, Idaho, Indiana, Kansas, Kentucky, Massachusetts, Michigan, Missouri, Nebraska, New Jersey, North Dakota, Vermont, Wisconsin, Wyoming)
No State Legislation, Permitted by City Ordinance	1 (Iowa)	1 (Iowa)
Pilot Program	4 (California, Delaware, Indiana, Pennsylvania)	1 (Hawaii)
Feasibility Study/ Task Force	2 (Minnesota, Vermont)	0

Note: Those states listed in the "Permitted by State/District Law" row include states who have only allowed certain types of SSC, such as school or work zone SSC.
[1]SSC and red-light cameras are only allowed if a law enforcement agent is present.

3.2 SSC PURPOSES

While some states permit SSC statewide for more general purposes, many others either specify jurisdictions that can employ SSC, or designate a specific application of SSC, such as work zones or school zones. It is common to focus SSC on more vulnerable users or areas with a high number of crashes to more effectively target fatal/serious injury crashes and to garner more public support. Appendix A includes a table that describes the SSC types for each state. General SSC systems can be placed at most locations, though selection criteria may prioritize high-crash or safety corridors. Specific purposes include the following:

- **Work Zone**: SSC systems can be placed in work zones, typically only when the work zones are active.

- **School Zone**: SSC systems can be placed at or near school zones and can either be active all day or during specified school zone hours.

Note that states that have general SSC (as Oregon does) may also permit school and work zone SSC (as Oregon does, as well).

The following states have additional restrictions on where SSC can be used:

- In Colorado, SSC is not used to enforce traffic laws on state highways (Colorado SB23-200, 2023).

- In Louisiana, SSC is not permitted on interstate highways except as operated by the state in construction zones when workers are present (Louisiana State Code, 2024).

- In New Mexico, SSC is not permitted on state and federal roadways. A bill was proposed in 2023 to remove this requirement, but it was not passed (Cardinale, 2023).

- In Tennessee, SSC is not permitted on federal interstates (Tennessee State Code, 2014).

- In Arizona, SSC systems may not be placed within 600 feet of a posted speed limit change, except in school crossing zones, and speed limit signs must be placed in specified locations within the photo radar zone (Arizona State Code, 2022).

Iowa is the only state that has a permanent SSC device on the federal interstate (I-235) (Webber, 2018) though other states do permit SSC on the federal interstate at work zones. Note that in Oregon, SSC systems have been used on interstates for work zones (ORS 810.441 and ORS 810.442), but general SSC is not permitted on controlled access highways.

Some states have legislation allowing SSC to be implemented in any jurisdiction, while others only allow specified jurisdictions to operate SSC – for example, in New York, only New York City can operate the school zone SSC program (NYCDOT, 2022).

3.3 SSC FINES

Fine systems vary state by state and there are many variations:

- Some states have established flat fees for first and subsequent violations, others vary fines by the speed limit.
- Other states use the same fine system for speed safety camera as for speed violations issued by a police officer, Oregon included.
- Some states specify that stated fines double when in school or work zones, such as Colorado.
- Several states waive fines for the first violation, issuing warnings instead (such as Illinois and Connecticut).

- Similarly, some states and cities issue warnings in lieu of fines in the first 30 days of system operation (such as Illinois; Washington; and Portland, Oregon).
- Many states specify that points may not be deducted from driver's licenses as a result of a ticket from SSC, a driver's license may not be suspended as a result of a ticket from SSC, and violations cannot be used against an individual's insurance. However, Arkansas, Arizona, and Nevada issue points on driver's licenses as a result of SSC violations.
- California law stipulates that community service must be offered in lieu of paying the fine (California AB-645, 2023). In addition, violators can choose to pay the fine in monthly installments of $25. Fines are reduced by 90% for indigent persons and by 50% for individuals up to 250 percent above the federal poverty level.

In lieu of the citation appearing on a violator's driving record a violator may take the diversion class in Oregon. In some cases, drivers in Arizona may choose to take a defensive driving class in lieu of paying the citation. Drivers in Albuquerque, New Mexico may do 4 hours of community service in lieu of paying the $100 fine (City of Albuquerque, 2022).

The following states have restrictions on how citations are issued:

- In Nevada, SSC devices can only be installed within a vehicle or facility of a law enforcement agency. A law enforcement officer must be present (NVACTS Legislative Task Force Working Group, 2023).
- In Arkansas, a citation must be issued in person by a law enforcement officer (Kienlen, 2023).
- In Ohio, SSC is allowed only if a law enforcement officer is present at the location of the device at all times during the operation of the device (Ohio State Code, 2023).

Appendix A includes a table with the fines for first and subsequent violations for each state.

3.4 SSC REVENUES

Many states provide clear rules on how revenue must be spent. This creates transparency around where money is spent and, in many cases, directs the profits from SSC programs to safety projects. Providing a process for spending the money, as well as clear guidelines around paying for vendors, can help increase public support for SSC programs.

In Oregon, most of the fine revenue generated by the cameras and paid through the Court goes to the State of Oregon's General Fund (approximately 70%). The fines are disposed as follows (PBOT, 2022):

- Section 153.633 (1) states that $60 (or the amount of the fine if the fine is less than $60) is initially payable to the state prior to any other distribution of the fine.
- Section 153.640 (2)(a) further directs that the $60 (or less) amount be deposited in the Criminal Fine Account.

- Of the remaining fine amount, Section 153.640(2)(b) and (c) state that 50% is payable to the local government and 50% is payable to the state.

Other revenue processes vary state by state and there are many variations:

- For several states, including California, Connecticut, Delaware, New York, and Pennsylvania, revenues are first used to cover costs of the programs, and then are used for traffic safety initiatives.
    - In Washington, after expenses are paid, half of the revenue is remitted to the state and half is for cities to spend on initiatives to increase access for people with disabilities.
- Similarly, in Illinois, Florida, and Virginia, revenues are first used to cover costs of the program, and then are used for social initiatives such as schools or literacy programs.
- In other states, revenues are directed to law enforcement, such as in Maryland and Georgia.
- In Ohio, revenues for each jurisdiction are deducted from state contributions to that jurisdiction, so that the net income is zero.
- Others direct all or a portion of the funds to state agencies, such as Delaware, Indiana, and New Mexico.
- In Indiana, revenues are deposited into the state general fund.
- In Louisiana, the revenue rules vary by jurisdiction.

Appendix A includes a table with the revenue stipulations for select states, where information was publicly available.

3.5 SSC PROGRAM REQUIREMENTS

Specific requirements and elements of SSC programs vary by state and jurisdiction. In most cases, state law dictates requirements for SSC programs. Jurisdictions may also have local ordinances outlining city-specific requirements. The elements of typical SSC programs include:

- **Speed thresholds**: Figure 3.1 presents a count of the speed thresholds for states with general, school zones, and work zone SSC. States and jurisdictions typically have a speed threshold over which violations are issued for, which falls at 10 MPH or above in many states. In some states, the speed threshold depends on the speed limits, with lower thresholds for areas like school zones. Other states do not specify thresholds. The FHWA Guide recommends that an enforcement speed threshold should be set prior to system implementation, with a goal of reducing the data collected by the SSC device.

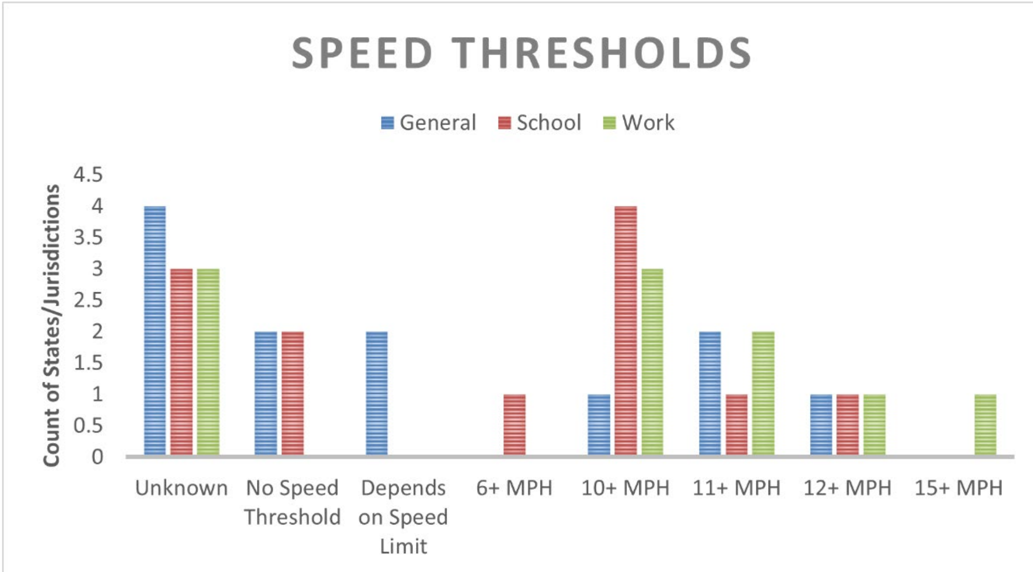

Figure 3.1 SSC Speed Thresholds

- **Signage**: Most states require signage in advance of an SSC device warning drivers that an SSC system is in use, as well as speed feedback signs alerting drivers of their current speed. Some states also require signage leading into jurisdictions that have SSC to inform drivers that SSC is present in that jurisdiction in general.

- **Verification of Citation**: Some states specify that authorized personnel, such as law enforcement agents, must verify each citation (by reviewing footage) before the citation is issued.

- **Presence of Law Enforcement Officer**: A couple of states require that a law enforcement agent is present when SSC is in use. These states typically have more limited implementation.

Appendix A also includes a table with the SSC requirements in states that allow general SSC, work zone SSC, and school zone SSC. Many states require signage and a public awareness campaign. Several have speed enforcement thresholds of over 10 or 11 MPH, while others have no published enforcement speed, or it varies by speed limit.

3.5.1 Public Awareness

Public awareness and outreach are important elements of SSC programs. AAA's Traffic Safety Culture Index (AAA, 2023) showed fewer than half of respondents (43%) supported using cameras to automatically ticket drivers operating more than 10 mph over the speed limit on residential streets.

The FHWA Proven Countermeasures (FHWA, 2024b) fact sheet for SSC states that public trust is essential for any type of enforcement, and that programs should be planned with community input and equity impacts in mind. The FHWA Guide (FHWA, 2023) recommends that publicity of a pending SSC program should begin well before the program startup or the program warning period. The FHWA Guide discusses a comprehensive communications campaign to maintain positive public relations and promote the goal of improving safety.

Many states require a public information campaign prior to SSC implementation, as well as information about the program and device locations to be made public online. In addition, some issue warnings in lieu of fees for the first 30 days of implementation. Trust with the public can be built with public websites and/or open data that allows residents to see where cameras are located and how many citations are issued. Per the Washington Speed Safety Camera Readiness Guide (WTC, 2023) there are five elements to a successful public outreach program:

1. **Pilot Project**: Consider starting SSC programs as a pilot project and establish an evaluation process to measure the efficacy of the system and iron out any difficulties.

2. **Justification:** Provide clear reasoning for the purpose and locations of SSC devices and be transparent about revenue.

3. **Community Input:** Include residents or common visitors of areas where SSC systems are being considered, such as parents for school zones or frequent visitors to parks.

4. **Data and Transparency:** Establish what data will be shared with the public and how it will be distributed, and update on a regular basis.[1]

5. **Public Reporting:** Make reports publicly accessible and easy to read.

There have been several academic studies that have investigated the importance and efficacy of public outreach in SSC programs. One study (Ralph et al., 2022a) investigated whether public support for SSC can be increased by framing SSC as a tool for reducing interpersonal racial bias. Through a survey, the study sought to investigate views of racial profiling; how support for cameras was related to views on racial profiling and policing; and whether a racial justice framing increased support for speed cameras.

The majority of respondents believe that racial profiling of Black and Hispanic drivers occurs and most disapprove or strongly disapprove of the practice (Ralph et al., 2022a). Respondents were more likely to support cameras if they agreed racial profiling occurs. However, there was not a clear pattern of support based on approval of profiling. Some respondents viewed cameras as a way to reduce policing and counter racial bias. For others that distrusted the police, there was concern that speed cameras would be misused by the police. Other respondents opposed

[1] **Public Forums + Drones:** The pilot program for SSC along Roosevelt Boulevard in Philadelphia conducted a public forum prior to SSC implementation to gather community input and feedback, including discussing other ideas for improving safety. After the implementation of the program, a press release was announced and a public-facing website was created to present information on the program, allow users to pay the fine, view drone footage of the SSC systems, see the locations of the SSC devices, and download annual reports (PSTAC, 2023).

cameras due to concerns that they would be used as a tool for surveillance by the government. However, some approved of the use of surveillance to help with crime investigations.

Finally, the study (Ralph et al., 2022a) found that a racial justice framing of SSC programs increased stated support for SSC, even when controlling for personal characteristics, political ideology, and views on policing. There was no “backlash” observed against the framing, though it was ineffective for groups who do not believe that racial profiling occurs. Overall, the study concluded that a racial justice framing could be helpful in garnering public support for SSC.

A study in British Columbia (Beaton et al., 2022) investigated the degrees of support for speed safety camera and the influence of informative statements or suggested SSC policies on levels of acceptance and support. In a survey with 802 respondents, it was found that most British Columbians demonstrated acceptance of the use of SSC. Fixed speed cameras in school/playground zones were the most supported SSC measure (82%), while 88% supported traditional police enforcement. In addition, 72% of respondents approved of SSC where police officers cannot safely operate. For 62%, clear reports of the SSC program impacts were likely to affect support.

Per this study (Beaton et al., 2022), the following factors should be considered to increase credibility, legitimacy, and support of SSC programs:

- **Education:** Create a non-political acceptance program that centers around the relationship between speeding and collisions. Frame speeding as a socially unacceptable behavior.

- **Revenue:** Set clear rules around the use of revenues towards specific road safety programs and be transparent in how revenue is used.

- **Assignment of Liability:** Issue speeding tickets to the driver of the vehicle, instead of the owner, when the violation occurs. This requires that a clear frontal photograph be taken of the driver (to be matched with drivers’ license photos on record), in addition to the license plate.

- **Location:** Focus SSC deployment on school/work zones and other high-risk areas for crash injury and death.

3.6 SSC STRATEGIC PLANNING AND EVALUATION

Several states establish strategic plans with clear goals prior to the implementation of their SSC systems. These plans can also help guide jurisdictions within a state looking to implement a local SSC program. These plans establish key outcomes and goals for SSC within a state, both to serve as a basis for evaluations of SSC programs and to document to the public the purpose of SSC.

Per the World Bank (Job et al., 2020) there are three reasons to establish an evaluation procedure for SSC programs:

1. Convincing decision makers of the value of speed management and SSC;

2. Communicating safety improvements to the public; and
3. Expanding and refining the SSC system.

The program evaluation chapter of the FHWA Guide (FHWA, 2023) describes elements of the evaluation procedure. This includes "Basic Program Monitoring" which involves collecting key data such as speed, crash history, demographic data, citations, and equipment maintenance. The FHWA Guide also recommends creating an evaluation plan and developing evaluation procedures for speed and crash data. This helps ensure that the proper data is collected in an easy-to-use format for periodic evaluation.

Several examples of strategic plans and evaluation programs are provided below.

3.6.1 Washington

The Washington Traffic Safety Commission published a Speed Safety Camera Readiness Guide in February 2023 (WTC, 2023), specifically focused on introducing SSC systems to local leadership, law enforcement, and transportation engineers. It includes ten sections:

- **Why Speed Safety Cameras?**: Establishes the context and purpose behind SSC systems.
- **Authorized Speed Enforcement Locations**: Presents authorized locations for SSC based on Washington state law.
- **Building the Team**: Provides guidance to which groups should be involved in SSC system implementation.
- **Crafting an Ordinance:** Advises jurisdictions on requirements for local ordinances.
- **Equity Analysis:** Establishes the process to include equity in the SSC program.
- **Partnering with the Community:** Provides guidance on public outreach.
- **Choosing Camera Locations:** Discusses the requirements for site selection and additional considerations, such as community input.
- **Deploying the Cameras:** Identifies key deployment considerations, including signage, warning notices, enforcement tolerance threshold, and due process.
- **Program Evaluation**: Lays out elements of the evaluation process.
- **Additional Resources and References:** Provides additional information on local ordinances and equity.

In addition, the state of Washington requires the following elements for each jurisdiction's evaluation (WTC, 2023):

- Analysis of vehicle speeds.
- Crash statistics in SSC locations and jurisdiction-wide.
- Changes in public awareness and acceptance.
- Data on citations issued, including disaggregation of demographic data on drivers receiving citations and patterns regarding times and days when citations are issued.

3.6.2 New York City

New York City's SSC annual report is a public-facing, graphic heavy document that summarizes the current state of the SSC program and key program achievements (NYCDOT, 2022). It includes an overview of the City's Vision Zero and SSC program, as well as key facts about camera technology, fines, and relevant state laws. It then presents an evaluation chapter, which includes injury data, speeds, equity, violations, repeat violations, and hours. Note that the State law requires New York City to report on injury crashes using State-issued crash data. The report includes the following analyses:

- Changes in injuries in new school speed zones before and after camera installation for all modes, as well as broken out by pedestrian, cyclists, and motor vehicle occupants. The analysis also includes control corridors.
- Decline in average daily speeding violations by corridor.
- An analysis on correlation between neighborhood income/ neighborhood non-white percentage and citations, as well as on where violators come from (inside vs. outside New York City).
- Violations by speed limit.
- Sufficiency of speed camera hours.
- Number of repeat violators.

The report also summarizes revenues and expenses from both the SSC and Vision Zero programs.

3.7 LOCATION SELECTION CRITERIA

Some states specify in their legislation where SSC devices may be placed, while others allow local jurisdictions to employ selection processes. Processes vary by state:

- In **California,** SSC devices may be placed on high-injury streets, in school zones, or on streets with a documented history of sideshows[2]. In San Francisco, the cameras

[2] A sideshow is an informal and often illegal demonstration of automotive stunts now often held in vacant lots, and public intersections, originally seen in the San Francisco Bay Area

will all be located on the High Injury Network, the 12% of San Francisco streets that account for more than 68% of traffic-related severe injuries or fatalities. The cameras will be geographically dispersed among all 11 districts, in areas with a wide range of socioeconomic characteristics (Coplon, 2017).

- **Connecticut** selects work zone SSC locations by analyzing highway and work zone characteristics, speed limits, and if data sensors are present to measure system performance (CTDOT, 2024).

- In the **District of Columbia**, residents can request a site for SSC via the Traffic Safety Input Form. Requests are processed through the Traffic Safety Inputs Prioritization Model, which is also used for other transportation safety concerns (DDOT, 2024c).

- In **Chicago, Illinois**, SSC is deployed in Children's Safety Zones, which are defined as areas within a 1/8th mile from parks or schools. There are 1,500 Safety Zones, but the City has capped the number of locations to 20% of all Safety Zones, so there are approximately 300 with SSC devices. Within these Zones, Chicago chooses locations based on available data and analysis related to traffic, speeding, and crashes. The City has established six geographical regions wherein no fewer than 10% of all speed enforcement safety zones will be located. This is to ensure a geographically equitable distribution of the program (City of Chicago, 2024).

- In **New York City, New York** all 750 school zones have at least one SSC device to ensure equitable distributions. Additional locations are based on serious crash incidence and frequency of speeding, as well as by requests from residents via an online form (NYCDOT, 2022).

- In **Philadelphia, Pennsylvania** the Roosevelt Boulevard corridor was chosen due to its status as one of the highest crash corridors in the state. Specific locations along the 14-mile-long corridor were selected via methodology that balanced consistent camera spacing throughout the corridor with concentrated enforcement in areas experiencing the greatest cluster of fatal or serious injury crashes. In addition, data on crashes, speeds, and aggressive driving were considered. After the locations were identified, site inspections and analyses were conducted to confirm the construction and operational feasibility of the site (PSTAC, 2022).

- In **Seattle, Washington** school zones are selected for SSC placement based on vehicle speed, opportunity to place additional traffic calming measures, volume of traffic, geographic balance, and engineering considerations (City of Seattle, 2024).

- In **Washington state,** sites for general SSC are selected based on crash frequency data, rate of speeding drivers; pedestrian and bicycle use around the site; previous efforts to reduce speeding; difficulty to do in-person traffic enforcement; and equity considerations (WTC, 2023).

Other jurisdictions may have a vaguer or case-by-case methodology, or have no clear process outlined for how to choose sites. Still others, such as Maryland, authorize specific intersections for general SSC at the state-level (Prince George's County, 2024). Georgia, which currently just uses SSC in school zones, requires a school to apply for and secure a permit from the Georgia Department of Transportation to install an SSC device (GDOT, 2024). In Rhode Island, which also just uses SSC in school zones, requires approval by the director of the state DOT for each device (Rhode Island State Code, 2024).

3.8 KEY SSC ISSUES

Based on a review of SSC programs in the United States, the project team identified several key issues related to SSC for further exploration. These include:

- **Equity:** Including equity in SSC site selection, fines, and evaluation is a burgeoning topic. There are arguments that SSC is more equitable than police-based enforcement, but there is also a need to ensure that no one community or group is being unequally targeted.
- **Revenue:** While some states deposit revenues into a traffic safety fund, others argue that this creates a perverse incentive for agencies to collect more citation revenue. There is a need to understand the benefits and drawbacks of different revenue options.
- **Vendor Relations:** There are a number of different contracting methods and vendor services offered in the automated enforcement realm. There is a need to understand what these different options are and how different agencies utilize the services.

A summary of some of these issues is included in Appendix B. This information helped inform the structure and direction for the transportation agency interviews, summarized in Chapter 4.

3.9 UNITED STATES SUMMARY

Most jurisdictions in the United States have largely similar requirements and SSC programs. Similarities include:

- **Purpose**: Many SSC programs focus on school/residential zones or work zones only.
- **Fines**: Most programs have a set fee, which can differ between first and subsequent offences. Others use the same fee structure as for traditional (e.g., police-issues) speeding offenses, or vary the ticket by speed.
- **Revenues**: Most programs stipulate how revenue will be spent. In many cases, the revenues are mandated to be spent on traffic safety projects.
- **Public Awareness**: Most jurisdictions conduct public outreach campaigns, have informational websites, and introduce SSC to their communities via pilots or warning periods.

- **Speed Thresholds**: Many general SSC systems have speed thresholds of 10 MPH or greater. However, some have lower thresholds for areas such as school zones; have thresholds that vary by speed limit; or do not publish set thresholds.

- **Signage**: Most, if not all, jurisdictions require signage indicating an SSC device is upcoming, as well as a speed feedback sign. Some also require signs at key roadways entering a jurisdiction to let travelers know that SSC is used in that jurisdiction.

- **Selection Criteria**: Generally, jurisdictions focus their selection on crash and speed history, but may also incorporate equity, public input, and roadway characteristics.

4.0 UNITED STATES CASE STUDIES & INTERVIEWS

This chapter reviews and summarizes the interview design and implementation for five selected agencies in the United States. For each agency, a case study is constructed based on information from the interview and other available documents. A synthesis of the findings and outcomes is provided at the end.

4.1 INTERVIEW DESIGN LITERATURE

The research team conducted a literature review to understand best practices related to semi-structured interview design. This type of interview is focused on a more conversational and open-ended approach; while questions are designed in advance, the interview itself should be open to changes according to the direction of the conversation.

According to Bearman (Bearman, 2019), a semi-structured interview has three basic steps:

1. Articulating questions around a core event and providing specific events within a specific timeframe. Open-ended questions are preferred.
2. Finding an intuitive conversational structure. Specifically, a three-part structure is recommended, with an introduction, exploration of core phenomenon, and final recommendations. The interview should start with concrete and easy-to-answer questions.
3. Refining the interview through practice and a pilot group.

The author provides ten heuristics for interviews, shown in Figure 4.1.

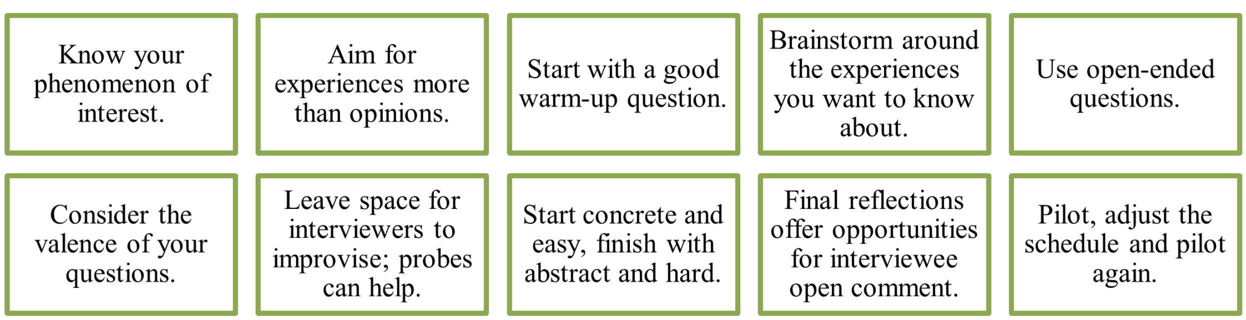

Figure 4.1 Ten Heuristics for Semi-Structured Interviews

The project team included these recommendations in the survey design by grouping questions into (1) introduction or background questions, which were more fact-based, (2) then followed by specific ‘groups’ focusing around different areas of SSC, and (3) finally by an open-ended, final reflection question. In addition, a pilot interview was first performed with the Portland Bureau of Transportation, who is involved in the development of this study, and who provided valuable feedback. The researchers also incorporated valuable feedback from the Research Coordinator and Technical Advisory Committee for SPR 873 before conducting the interviews.

Another key reference regarding semi-structured interviews (Adams, 2015) supported these suggestions, but additionally emphasized asking ‘what if’ questions, probing on interesting topics, and focusing on learning about attitudes and beliefs. The research team employed these findings by focusing on different topics for each agency as more information emerged on certain topics. In addition, the team aimed to understand the success of certain SSC program elements, expansion plans, and the desires of agencies staff for changes to their programs.

4.2 INTERVIEW DESIGN

The interview included 18 questions in six categories. These questions formed a base structure to the interview, but as per the flexible nature of the interview process, the focus of each interview depended on the specific agency. The questions are shown in Table 4-1.

Table 4.1 Semi-Structured Interview Questions

Category	Questions
Background	1. What is your experience and current role regarding your jurisdiction's Speed Safety Camera (SSC) program? 2. Where is guidance and policy described for your agency, including engineering manuals or separate guidance documents? 3. How many SSC devices are currently employed, and which type (red light/speed cameras, speed-only, etc.)?
SSC Program Elements	4. What are the future expansion plans for the SSC programs? How are expansion plans justified? 5. What are the selection criteria for determining the locations of SSC devices? 6. How is the fine revenue spent? Are there any limitations? 7. Do you have any kind of graduated fee structure for the fines or fine diversion program? 8. What is the citation issuance process?
Public Acceptance	9. What is the public outreach process? What are the passive (e.g., website) and active (e.g., community meetings or targeted flyers) outreach methods used? Are there examples available of your outreach that you can share? 10. What strategies have been successful and what challenges have you faced in conducting public outreach? 11. Have you received any feedback or suggestions on how to increase public acceptance based on fine revenues, safety, or equity?
Data and Evaluation	12. How do you measure effectiveness of the SSC devices? What performance measures are used, including public outreach and traffic diversion? 13. Do you use a private vendor for any part of your ASE, and if so, which firm? What is your contracting and payment structure? 14. What is the process to obtain useful data from SSC devices? How difficult is it? 15. What type of data is publicly available and what data is secure or protected for privacy concerns? Any rules or limitations?
Equity and Law Enforcement	16. How are you considering equity in fines, camera placement, or other ways (if it all)? 17. What is the current involvement/role of the police? What have been the discussion points (pros/cons) regarding different levels of police involvement?
Open and Final Questions	18. Do you have any suggestions or lessons learned that can inform other jurisdictions that are planning to implement updates to their SSC systems?

Prior to each interview, a case study of each jurisdiction was built to understand publicly available information. The interviews helped clarify, confirm, and expand on information available online, as well as discuss bigger picture issues and lessons learned by each agency. All interviews were conducted virtually over Zoom and were limited to 45 minutes total. Initially, some questions were asked in advance of the interview, but these were ultimately combined into the interview questions to increase efficiency and reduce the time commitment for interviewees.

Note that SPR 873 semi-structured interviews are different from the National Highway Traffic Safety Administration's (NHTSA) surveys (NHTSA, 2024). NHTSA's survey fulfills the requirement from the Fixing America's Surface Transportation Act that states with SSC must conduct a biennial survey that:

- Lists the automated enforcement systems in the state;
- Provides adequate data to measure the transparency, accountability, and safety of each system; and
- Provides a comparison of each automated traffic enforcement system with the Speed Enforcement Camera Systems Operational Guidelines and the Red-Light Camera Systems Operations Guidelines.

The interviews in this study have focused more on challenges, lessons learned, and specific components of an SSC program based on feedback provided by TAC members and the research coordinator of SPR 873.

4.2.1 Interview Results

Potential agencies were contacted through online forms, publicly available email addresses, and references from previously interviewed agencies. It often took several weeks to contact an agency, and then additional time to identify the right person for the interview and to schedule a time for a Zoom meeting. In some cases, this involved coordinating schedules of several interviewees representing different stakeholders for an agency's SSC program.

Candidate jurisdictions were selected from the USA-based case studies completed for Task 2 (literature review) of this research project. Of the eight case studies, two were not chosen for further study as the programs were heavily work zone based. In addition, California was not interviewed as their program has not begun yet. Finally, multiple attempts were made to contact Chicago through online means and contacts from other interviewees, but no contact was established.

In total, five agencies were interviewed: Portland, Oregon; New York City, New York; Philadelphia, Pennsylvania; Seattle, Washington; and the District of Columbia.

The first interview was conducted on February 12, 2024 (Portland) the last interview on June 14, 2024 (Washington, DC). The following sections describing the agencies' practices are not ordered alphabetically but instead follow the temporal order of the interviews.

4.3 PORTLAND, OREGON

An interview with the Portland Bureau of Transportation (PBOT) was conducted on February 12, 2024, and included Dana Dickman (PBOT's Safety Section manager) and Clay Veka (PBOT's Vision Zero Program Coordinator). Herein, it is assumed that information that is not explicitly referenced was obtained during the interview.

4.3.1 Background

As part of PBOT's Vision Zero efforts, both speed and red-light cameras are used to target high-crash corridors. The program includes both fixed speed cameras and intersection cameras, which have both speed and red-light capabilities. The program began in 2016 with two cameras on SW

Beaverton-Hillsdale Highway, and expanded in 2017 to an additional three locations (SE 122nd Avenue, SE Division Street, and NE Marine Drive) (PBOT, 2022).

There are currently 14 fixed speed cameras on seven corridors, as well as four cameras in construction (on SE Powell and NE 82nd) and two in design (on SW Barbur Boulevard). In addition, there are currently twelve intersection safety cameras, with four in construction and one in design. The current expansion will have 20 speed safety cameras and 20 intersection safety cameras installed by the end of 2024. At that point, PBOT will assess the next steps for a possible future expansion. Figure 4-2 shows the locations of the cameras (PBOT, 2024b).

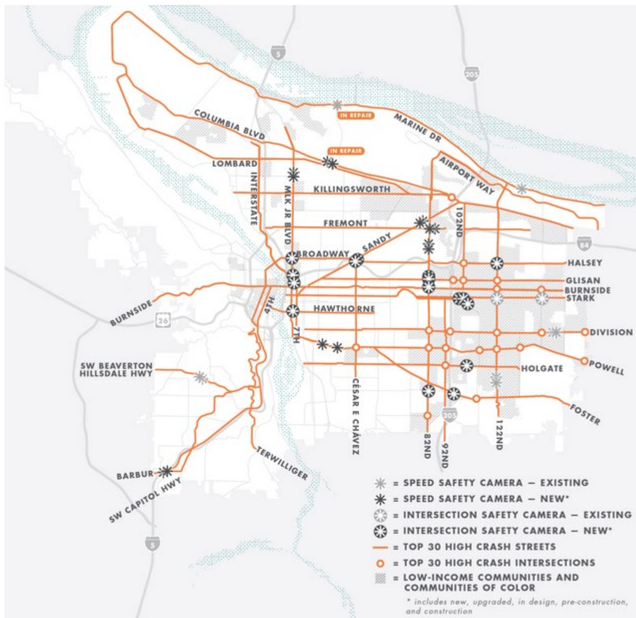

Figure 4.2 Portland SSC Locations (Source: (PBOT, 2024b))

4.3.1.1 Legislation

In 2015, ORS 810.443 and ORS 810.444 (Oregon State Code, 2024a; Oregon State Code, 2024c) granted the City of Portland permission to run fixed photo radar for urban high crash corridors. ORS 810.443 stipulated that fixed photo radar devices were only allowed in Portland and could only be used on urban high crash corridors.

However, HB4109 (Oregon HB4109, 2024, p. 4) effective June 2024, repeals ORS 810.443, thus removing the requirement for the City of Portland to only operate fixed radar on urban high crash corridors. It also amends ORS 810.444 to reflect that any city may use fixed SSC and that a police officer or duly authorized traffic enforcement agent may review citations, while previously only a police officer could. The same general criteria are mandated for fixed SSC programs as for mobile SSC programs (Oregon HB4109, 2024):

- The devices may be used on streets in residential areas or school zones. They could also be used in other areas of the city if the governing body of the city makes a finding that speeding has had a negative impact on traffic safety in these areas.

- The devices cannot be used on controlled access highways.
- Signage is required 100 to 400 yards upstream of the location of the SSC device.
- Citations must be issued by a police officer or a duly authorized traffic enforcement agent, per HB4105 and HB4109.

4.3.2 SSC Program Elements

4.3.2.1 Organization

The Portland Bureau of Transportation oversees the selection of camera locations, installation, maintenance, and communication with the vendor. The Portland Police Bureau (PPB) is charged with having a police officer review the photographic evidence and sign off on each citation. Further, PBOT and the PPB run a traffic diversion class jointly for first-time offenders.

4.3.2.2 Selection Criteria

Previously, state law mandated that speed cameras were to be placed on high crash network streets; initially, only ten select high crash streets were approved for SSC. The recent passage of HB4109 (2024) removed the requirement for SSC to be placed on high crash network streets, but as of now, all current and future planned sites will still be located on these corridors to prioritize the most dangerous roads. PBOT crash data points to high crash networks being the highest safety concern, representing 70% of fatal and serious crashes, and will likely continue the cameras on these corridors to most effectively target safety and maintain public confidence.

While PBOT has considered school zone cameras, there is an equity concern as fines are higher in school zones; a school zone program may be best if paired with a graduated fine structure.

Specific locations along the corridors are chosen based on three main criteria: overall crash history, speeds and speed related crash history by segment, and equity data (race and income). In addition, PBOT also considered geographical distribution to ensure no one neighborhood is overburdened, and technical feasibility.

4.3.2.3 Fines and Revenue

A speeding citation in Oregon may range from a Class C to Class A violation resulting in fines from \$170 to \$440. A red-light running citation in Oregon is a Class B violation resulting in a \$265 fine. Penalties are the same as a violation initiated by any other means (PBOT, 2022).

The Portland Police Bureau began to offer a traffic safety class option in September 2016 for red light running photo enforcement violations and photo radar speeding violations. The class option expanded and incorporated fixed speed safety camera speeding violations starting July 2018. The traffic safety class option for photo enforcement violators is available to those who have not received a red light running or speeding violation in the last three years and have not previously attended the photo enforcement traffic safety class. The per person class registration fee varies depending on the type of moving violation but is typically less than the presumptive fine (PBOT, 2022).

In Oregon, the distribution of fine revenue is mandated by law: $60 (or the amount of the fine if the fine is less than $60) is initially payable to the state prior to any other distribution of the fine, which should be deposited in the Criminal Fine Account. Of the remaining fine amount, 50% is payable to the local government and 50% is payable to the state (PBOT, 2022). The passage of HB4109 removed the requirement for the City of Portland to only spend its portion of revenues on the costs of the program and improving traffic safety; therefore, there are currently no revenue restrictions. Note that most revenues from the program are currently being directed into program costs and program expansions. If more substantial revenue is raised in the future, PPB and PBOT will decide on which safety projects to spend the money on, document the decision, and make it public.

4.3.3 Public Acceptance

When fixed speed cameras were first installed, PBOT conducted outreach to notify and inform community members. Materials used include postcards in English and ten other languages[3], a Fixed Speed Camera Frequently Asked Questions info sheet, and a map of city-wide safety project scheduled for construction. In addition to mailing out the postcard, PBOT staff walked to businesses in the vicinity of the cameras in advance of activation and the initial 30-day warning period. The face-to-face outreach allowed the sharing of information of not only the fixed speed safety cameras, but also other safety projects planned along the corridor (PBOT, 2022).

As part of the outreach, PBOT provided postcards to the East Portland Neighborhood Office and Asian Pacific American Network of Oregon. A quarter page advertisement in The East Portland Neighborhood Association News reached 7,000 households. The initial SW Beaverton-Hillsdale Highway cameras were advertised in PBOT's Safe Routes to School newsletter. PBOT public venues also offered opportunities to share information about the fixed speed safety cameras, including an East Portland town hall meeting and a meeting of the Portland Freight Committee (PBOT, 2022).

Throughout the program, PBOT has shared information at local community events and neighborhood association meetings, as well as through online news releases and newsletters. In addition, social media, media, and the PBOT website have continued to inform the public about speed cameras and other Vision Zero efforts. In particular, the 2024 expansion plans were widely

[3] Postcards were mailed to residences within ten blocks of each camera system. Postcards were also hand delivered to local businesses and community organizations in the vicinity of the camera locations.

publicized through online channels and press releases. When a new location is being installed, PBOT sends a direct mailer to nearby addresses (PBOT, 2022).

Several existing and potential challenges with public acceptance identified by PBOT include:

- Despite numerous information campaigns and communication channels, individuals often do not pay attention to outreach efforts until they are personally impacted, such as receiving a citation.
- It can be difficult to communicate the program to non-English speakers; these communities are the target of focus groups described below.
- Some nearby residents of cameras have expressed concern with visual disturbances from the camera flashes at night.
- PBOT expressed a concern that with the passage of HB4109 (2024) allowing speed cameras anywhere, there may be an erosion of public confidence and an increase in the view of speed cameras as 'cash grabs.'

4.3.3.1 Surveys

In December 2018, PBOT contracted with DHM Research to conduct a telephone survey to measure the acceptance of photo enforcement of speeding. Four hundred Portlanders participated in the 12-minute telephone survey. Overall, the survey found that while most Portlanders are aware of automated enforcement, they are much more familiar with red-light running cameras and mobile speed vans. The survey also found that three-quarters of Portlanders across all income levels support using fixed speed safety cameras on streets with high crash rates, citing that they are reliable, unbiased, and help reduce speeding and crashes (PBOT, 2022).

In 2021, PBOT conducted an online survey in five languages to further understand Portlanders' attitudes toward photo enforcement and how they want to hear about photo enforcement. A total of 1,160 Portlanders responded to the survey (PBOT, 2022). Key findings include:

- Signage is the best way to communicate about the location of cameras (52% of respondents), though social media and traditional media are also utilized (13% and 12%).
- Most respondents wanted to see revenue be spent on infrastructure (58%), with others supporting increased police presence (12%) and adding more traffic cameras (11%).

In November 2020, PBOT partnered with OPAL Environmental Justice to host two small focus groups exploring perceptions around the use of automated enforcement cameras in Portland. A majority of the focus group participants expressed support for PBOT's use of automated enforcement cameras, despite having some reservations about transparency and privacy (PBOT, 2022).

4.3.4 Data and Evaluation

Oregon state law requires a biannual report for jurisdictions employing fixed speed cameras, including information on the effect of the operation of the fixed photo radar system on traffic safety; the degree of public acceptance of the operation of the fixed photo radar system; and the process of administering the use of the fixed photo radar system (PBOT, 2022).

For PBOT, the main performance measure is vehicular speeds, and PBOT measures speeds before and after camera placement. While PBOT should be able to get speed data from the vendor, it has proven to be difficult. Therefore, they must gather data themselves using traffic tubes.

PBOT also evaluates crashes at the camera sites, but this analysis has a longer lead time. Finally, PBOT has been analyzing zip code data to understand who is being impacted by the cameras.

Finally, the Vision Zero dashboard[4] is public, which aggregates statistics such as the number of citations per camera and speed data per camera. However, no individual citation data is shared publicly.

4.3.4.1 Vendor

Conduent is the current vendor, though the camera portion of the business is being sold to another company. They have been the vendor for PBOT since 2016, though the camera operation has been sold a couple of times during that tenure. It has been a difficult relationship and PBOT will be posting an RFP in the next year or two to solicit other vendors for system expansion.

In theory, data collection from the vendor should be easy - the vendor has a backend system where PBOT should be able to pull citation, speed, and zip code data. However, due to vendor reporting issues, PBOT has been collecting its own speed data and has been having difficulty getting the other data. Vendor relations has been one of the biggest challenges for PBOT.

4.3.5 Equity and Law Enforcement

4.3.5.1 Law Enforcement

Previously, the Portland Police Bureau (PPB) was responsible for having a police officer review the photographic evidence and sign off on each citation. However, with HB4109 (2024), both PBOT and PPB have the power to review citation data, representing a potential decrease in the role of the police. However, both agencies still share vendor data, as well as run the traffic diversion class jointly.

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[4]See: https://public.tableau.com/app/profile/portland.bureau.of.transportation/viz/VisionZeroDashboard_16179023789280/VisionZeroDashboard

4.3.5.2 Equity

PBOT has approached equity in several ways. First, PPB and PBOT run a traffic diversion class for first time offenders, which eliminates the need to pay the citation or go through court. In addition, a new program is being considered to provide a free or reduced fee class if you are eligible for public assistance. You must still be a first-time offender. According to PBOT's 2021-22 report, about 39% of violations were dismissed, with 33% of these dismissals coming from individuals who were eligible for and elected to take the traffic diversion class. In addition, a little under half of the SSC revenue came from the class, as opposed to fines collected through the court.

PBOT is also using zip code data to conduct an equity analysis. Specifically, PBOT wants to make sure that cameras located in a variety of areas are not disproportionately located in one community. 80% of drivers getting a citation from a camera are from zip codes not adjacent to the camera, indicating that the cameras affect people passing through a corridor more than they do people living near the corridor.

In addition, PBOT is interested in seeing the state explore a graduated fine. Currently, the fine is mandated to be the same as for a regular speeding ticket.

The hardest challenge per the interview is balancing equity with safety. PBOT does not want to withhold safety resources from communities, while also being mindful of the disproportionate impact of fines and fees on these communities.

4.3.6 SSC Results

The 2021-2022 Portland Bureau of Transportation Fixed Photo Radar System report (PBOT, 2022) provides an overview of speed, crash, and public acceptance outcomes for the fixed camera locations. Note that data is from 2020, as the camera vendor failed to provide data in a timely manner for the 2022 study.

4.3.6.1 Speed

PBOT observed the following speed results:

- A **71%** decreased in speeding (1 mph or more over the speed limit)
- A **94%** decrease in top end speeding (11 mph or more over the speed limit)

A chart of the number of daily speeding vehicles across four speed studies is shown in Figure 4-3 and Figure 4-4. The before study was conducted directly before a camera was installed. The first after study was conducted immediately after installation and then for every subsequent year. Exact dates vary by camera site (PBOT, 2022).

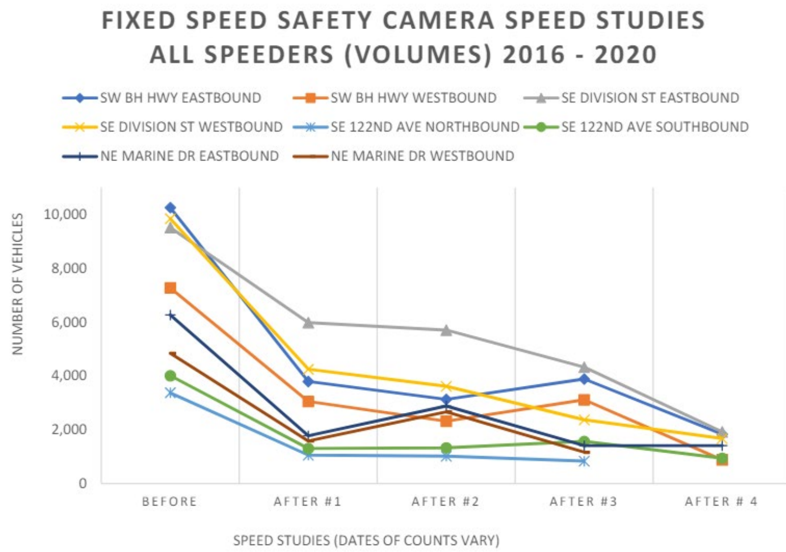

Figure 4.3 Portland Fixed SSC Speeder Volumes

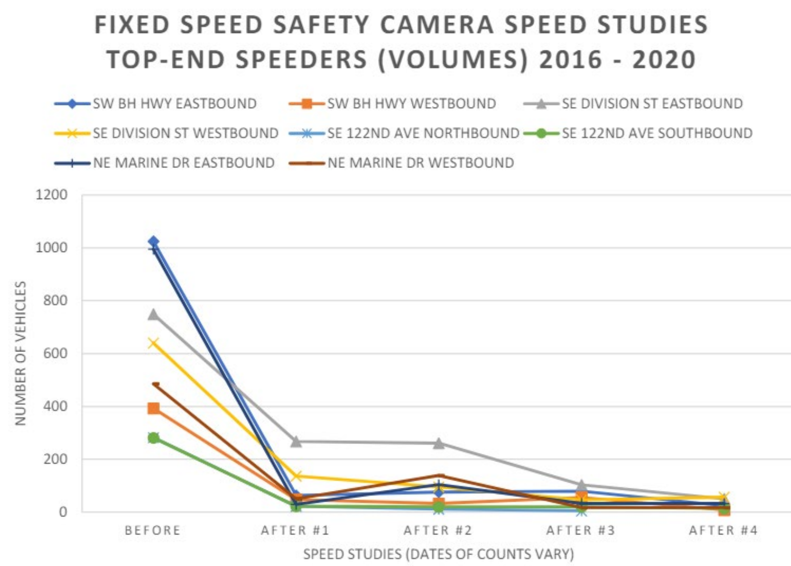

Figure 4.4 Portland Fixed SSC Top-End Speeder Volumes

4.3.6.2 Crashes

For crashes, PBOT observed a 43% reduction in all crashes along the four segments where speed safety cameras were installed, and a 43% reduction in speed-involved crashes. Speed-involved crashes capture crashes where speed is identified as a cause, as well as crashes with other causes that often involve excessive speed, including failure to stay in lane and fixed object crashes. Relative to Portland as a whole, the speed-related crash reduction was 17% (PBOT, 2022). Table 4-2 provides the overall crash numbers and changes.

Table 4.2 Overall Reported Crashes (2011-2020)[1]

	Before	After	% Change	Relative % Change[2]
All crashes	33.9	19.3	-43%	-19%
Speed-involved crashes	3.45	2.0	-43%	-17%

[1]Exact time periods vary by site.
[2]Relative % change indicates the observed crash reduction on SSC corridors in comparison to crash reductions in the city as a whole. So, a 43% decrease in all crashes on SSC corridors and a 24% decrease in all crashes in Portland indicate a 19% relative change.

It is of note that 2020 was an anomalous year. Reported crashes in Portland were about half of what is reported in a typical year, which may be due to traffic pattern changes related to the COVID pandemic, reporting system limitations, and other irregularities associated with the pandemic.

Table 4.3 provides a breakdown of reported crashes by site. Speed limits were reduced on three corridors during the data collection period. Relative change for individual locations includes data citywide and from a buffer around the segment to reflect crash trends in the area (PBOT, 2022).

Table 4.3 Reported Crashes by Site

SW Beaverton-Hillsdale Highway, SW 30th to SW 39th	2011-2015 vs 2017-2020 average annual crashes			
	Before 2011-2015	**After 2017-2020**	**% change**	**Relative % change**
All crashes	7.2	2.5	-65%	-53%
Speed-involved crashes	1.2	0.25	-79%	-72%

SE 122nd Ave, SE Foster to SE Holgate	2012-2016 vs 2018-2020 average annual crashes			
	Before 2012-2016	**After 2018-2020**	**% change**	**Relative % change**
All crashes	36.4	22.3	-39%	-10%
Speed-involved crashes	3	2.3	-22%	+13%

SE Division St, SE 148th to SE 162nd	2012-2016 vs 2018-2020 average annual crashes			
	Before 2012-2016	**After 2018-2020**	**% change**	**Relative % change**
All crashes	57.8	34.3	-41%	-17%
Speed-involved crashes	3.2	2.3	-27%	-4%

NE Marine Drive, NE 33rd to NE 138th	2013-2017 vs 2019-2020 average annual crashes			
	Before 2013-2017	**After 2019-2020**	**% change**	**Relative % change**
All crashes	34.2	18	-47%	-24%
Speed-involved crashes	6.4	3	-53%	-30%

4.3.7 Key Takeaways

Key takeaways learned from the interview with PBOT include:

- Challenges related to public acceptance include the perception of SSC as a 'cash-grab'; communication with non-English speakers; and visual disturbances from camera flashes for nearby residents.

- Vendor relations has been an ongoing issue and has resulted in significant delays in collecting and reporting data.

- PBOT is considering equity via (1) the diversion class option for first-time offenders, (2) a zip-code analysis to understand where violators come from, and (3) considering the spatial distribution of devices.

- In addition, PBOT is interested in exploring a more graduated fine system to lessen the economic burden from speeding tickets, especially as more cameras are installed but this requires a change of the legal framework at the state level.

- 80% of drivers getting a citation from a camera are from zip codes not adjacent to the camera.

4.4 NEW YORK CITY

An interview with Erin LaFarge, Director of Safety Policy at the New York City Department of Transportation (NYCDOT) was conducted on April 30, 2024.

It is assumed that information that is not explicitly referenced was obtained during the interview.

4.4.1 Background

In 2013, the New York State Legislature granted New York City the authority to pilot an speed safety camera program in 20 school speed zones. In June 2014, the pilot was expanded to a total of 140 school speed zones as part of the Vision Zero program. In 2019, the number of school speed zones and the program's hours were expanded, which were previously limited to one hour before, after, or during school hours, or a half hour before, after, or during school activities. NYCDOT thereby became authorized to deploy speed cameras in 750 school speed zones on all weekdays between 6 AM and 10 PM (NYCDOT, 2022).

NYCDOT completed the expansion of at least one camera in each of the 750 zones in June 2020 and as of May 2022, had over 2,200 SSC devices throughout the 750 school zones. Cameras may be located on any street within a quarter-mile radius of a school. In June 2022, the State Legislature passed a new law permitting NYCDOT to operate the cameras 24 hours a day, seven days a week (NYCDOT, 2022). Note that no signage is required, and the locations of the cameras are not published. This is an example of "covert" enforcement and is designed to encourage drivers to lower speeds everywhere in the city, rather than just at known speed camera locations.

In addition, NYCDOT has operated red light cameras since 1994, and currently has 200 cameras and 150 locations. NYCDOT hopes to increase the program as red-light camera legislation comes up for reauthorization.

4.4.2 SSC Program Elements

4.4.2.1 Organization

The NYCDOT administers the entire program.

4.4.2.2 Selection Criteria

State law permits SSC in 750 school zones, so at least one camera is placed in each one. Additional locations are prioritized in school zones with the highest incidence of speeding and serious crashes. In addition, NYC has a public input form where residents can request an SSC camera.

4.4.2.3 Fines and Revenues

Fines are $50 for each violation, with no escalation of fines for repeat offenders. This is far less than the cost of a summons issued by a police officer for speeding in a school speed zone, which could range on the first offense from $90-$600, depending on the motorist's speed and prior record, plus an $88 State surcharge. Fines are assessed to the registered owner of the vehicle; there are no point deduction on drivers' licenses nor consequences for vehicle insurance (NYCDOT, 2022). This is in alignment with recommendations from the Fines and Fees Justice Center (FFJC, 2024).

All revenues go to the New York City general fund. As NYCDOT does not directly benefit from the revenue, there is no incentive to increase revenues. NYCDOT believes it is important to decouple the safety purpose of SSC and the revenue benefits and has no specific program benefiting from the SSC profits. However, the City does have a separate program with separate funding that funds transportation projects in historically underinvested communities.

Between 2014 and 2021, the camera generated $555 million in revenue and spent $327 million on operating and capital costs, netting $228 million that went to the General Fund (NYCDOT, 2022).

4.4.2.4 Covert Enforcement

NYCDOT's SSC program is 'covert,' meaning that the locations of the cameras are not published, and signage is not placed to warn drivers of the program. This helps lower speeds throughout all school zones and corridors surrounding the school zones, as drivers may not know where cameras are located.

4.4.2.5 Additional Enforcement

NYCDOT previously ran a dangerous vehicle abatement program, where registered owners of vehicles that received 15 or more finally adjudicated speed camera violations or five or more finally adjudicated red light camera violations within a twelve-month period were required to take a safe driving class or else risk having their vehicles impounded by the New York City Sheriff (NYCDOT, 2022). However, this program was discontinued due to the high cost of the program, as well as due to difficulties enforcing it – as violations are issued to a vehicle rather than a driver, it can be difficult to track down the owner of the vehicle if a license plate changes or the vehicle is sold.

NYCDOT has been considering other programs to target dangerous vehicles, though no legislation has been passed or introduced regarding new programs. One idea is to suspend vehicle registration for vehicles with more than a certain number of violations, helping prevent future dangerous driving. Another idea is to require vehicles to install intelligent speed assist if they have acquired a certain number of violations. The NYC city fleet already has these installed on their vehicles. NYCDOT also supports implementing an escalating fine regime to address this population of dangerous drivers, though such changes would need to be legislatively approved.

A report by an urban think tank evaluated crashes in relation to multiple-violation SSC offenders; this report is described in the SSC Results section (Gelinas, 2024). The authors recommended the following actions to target dangerous vehicles.

- **Escalating fines after the first two tickets**. The state legislature should allow the city to levy an escalating fine after the first two camera tickets: for example, $100 for the third ticket, $200 for the fourth, $400 for the fifth, and so forth, to reach the top level of $600, comparable with a police-issued ticket.

- **Revocation of registration**. The state legislature should allow for the revocation of New York State vehicle registration after five red-light or speed tickets within 12 months, with warnings transmitted to the vehicle owner after the first ticket.

- **Revival and reform of the dangerous vehicle abatement program under state control**. The state Department of Motor Vehicles, as the body responsible for regulating vehicles and drivers, should take responsibility for a revived dangerous vehicle abatement program, reducing the threshold of tickets to five per year, and reviving and restructuring the program to pass the $1,000 cost to the owner of the vehicle. The state could consider working with the local sheriff's office—which regularly impounds vehicles for nonpayment of tickets without incident—to impound the vehicles that are in violation of a revamped dangerous vehicle abatement act.

- **Explore market signals to deter dangerous driving**. The state and city should explore how insurance companies could use ticket data to adjust their insurance rates. Although drivers may accumulate fines in their driving records, it is vehicles that are insured. A vehicle that habitually accumulates red-light and speed camera tickets is an unsafe vehicle, regardless of the identity of its operator. That vehicle's owner should suffer a financial penalty for failing to keep their property out of the hands of reckless drivers.

- **Education**. The city should launch an outreach campaign to make parents and other relatives aware of the fact that the driver of a vehicle with a history of red-light and speed camera tickets is disproportionately likely to become involved in a fatal crash, including a crash that might kill that driver.

4.4.3 Public Acceptance

NYCDOT ran an extensive public outreach campaign when cameras were first installed, as well as when cameras switched to 24/7 operations. However, NYCDOT is not required to give notice to community boards about new speed cameras, and they are also not required to publicize locations of cameras or post signage. Therefore, the public outreach program is focused around generally informing the public of the program, as well as communicating the safety benefits of SSC.

NYCDOT works closely with legislators and elected officials on changes and extensions to the program, who in turn represent their constituents.

4.4.4 Data and Evaluation

State law requires that NYCDOT reports on injuries in speed camera enforced school speed zones using State-issued data to the extent to which such data is available from the New York State Department of Motor Vehicles. The NYCDOT's annual report includes a "before" and "after" analysis examining the corridors with speed cameras and comparing them to New York City at large. NYCDOT also looks at where cameras and violators are located, the extent of speeding (how many miles per hour a vehicle was speeding over the speed limit), repeat violators, and adjudication of speed camera violations. Other key metrics include the reduction in violations and reduction in injury crashes as compared to the wider City (NYCDOT, 2022).

Aggregated SSC related data is available on the NYC open data portal[5].

4.4.4.1 Vendor

NYCDOT employs Verra Mobility as their vendor. Verra Mobility runs and maintains the cameras, as well as provides violation and speed data. All violations are reviewed and issued by NYCDOT.

New York City does not have, and has never had, a contractor take any proportion of revenue from violations. NYCDOT believes such systems create perverse incentives to issue greater number of violations rather than focusing on the behavioral changes to make driving safer, and thus do not align with the ethics of Vision Zero. Vendors are paid for each camera being used in the SSC program.

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[5]See: https://opendata.cityofnewyork.us/

4.4.5 Equity and Law Enforcement

4.4.5.1 Equity

As fines are assessed on vehicles, there is no points on a driver's license or negative impact to insurance, lessening the burden on lower-income individuals. Cameras are widely dispersed, and NYCDOT looks at high minority and low-income areas to make sure they are not unfairly burdened. One specific metric used is the correlation between neighborhood income or neighborhood percentage non-white population and the number of speed camera violations issued per lane mile. However, the overall focus of the program is to reduce speeds and crashes.

New York City has a separate program to invest in infrastructure and safety programs in historically underinvested communities.

4.4.5.2 Law Enforcement

Law enforcement is not involved at all in the SSC program; however, the NYC Police Department is closely involved in wider Vision Zero efforts.

4.4.6 SSC Results

New York City published a report on its school zone SSC systems in 2022 (NYCDOT, 2022). This report focused on speeding and crash results from the program.

4.4.6.1 Speed

The 2022 report found that the speed camera program has been effective in reducing both dangerous speeding and its consequences. As of December 2021, speeding at fixed camera locations had dropped by about 73% on average**,** measured as the reduction in the number of violations between 2021 data and the first month of operation for each corridor. Many large corridors saw even greater decreases: there were nine corridors that saw decreases of 78% or greater, with the top corridor seeing a 91% decrease in violations (NYCDOT, 2022).

NYCDOT also measured the extent of speeding by evaluating top-end speeding. Speed cameras do not issue a violation unless the vehicle is traveling at least 11 miles per hour above the posted speed limit. In practice, this means that at most locations, a vehicle must be traveling at least 36 miles per hour in a 25 MPH zone. Citywide, almost all notices of liability – 97.7 percent – went to vehicles traveling at least 11 but less than 20 miles per hour above the limit. However, 2% of vehicles were between 20 and 30 MPH over the speed limit, which are highly dangerous speeds that greatly increase the likelihood of a more serious injury or fatality in a crash (NYCDOT, 2022).

4.4.6.2 Crashes

A "before" and "after" crash analysis was conducted wherein the corridors of 2019 camera installations were compared to New York City at large between 2018 and 2020.

A corridor is defined as the street where the camera is located, for a distance of one-quarter mile from the camera itself (NYCDOT, 2022).

Table 4.4 presents the results of the crash analysis. When compared to similar roads outside school speed zones, corridors that received cameras after 2019 program expansions showed greater decreases in deaths and serious injuries in 2020, including for pedestrians. While injuries for cyclists increased for all roads from 2018 to 2020, the increase was less in corridors that had SSC devices. The 'relative' change[6] for all modes is -6.7%, -1.1% for pedestrians, and -3.6% for cyclists (NYCDOT, 2022).

Table 4.4 NYC Changes in Injuries in New School Speed Zones, Before and After Camera Program Expansion

Mode	New Camera Corridors 2018	New Camera Corridors 2020	New Camera Corridors Change	Control Corridors 2018	Control Corridors 2020	Control Corridors Change
All Modes	2116	1369	-35.30%	23606	16857	-28.60%
Pedestrians	414	272	-34.30%	5021	3354	-33.20%
Cyclists	122	125	2.50%	1719	1823	6.10%
Motor Vehicle Occupants	1580	972	-38.50%	16866	11680	-30.80%

Source: (NYCDOT, 2022)

Further, the Manhattan Institute, an urban think tank, published a report on the relationship between speed camera violators and crashes (Gelinas, 2024). Using police fatal crash data from 2022, the report found that vehicles involved in deadly crashes are disproportionately likely to have accumulated a long record of red-light and speed camera violations in the years and months before the fatal crash.

Most drivers receive just one or two tickets – between 2014 and 2021, 46% of total violators received just one ticket and 19% received two tickets. However, there is a minority of drivers who rack up multiple tickets, with about 14% of ticketed New York State (NYS) vehicles receiving more than 46% of violations, as shown in Figure 4-5 (Gelinas, 2024).

[6] Calculated as the difference between the crash change on the corridors and the crash change of NYC at large.

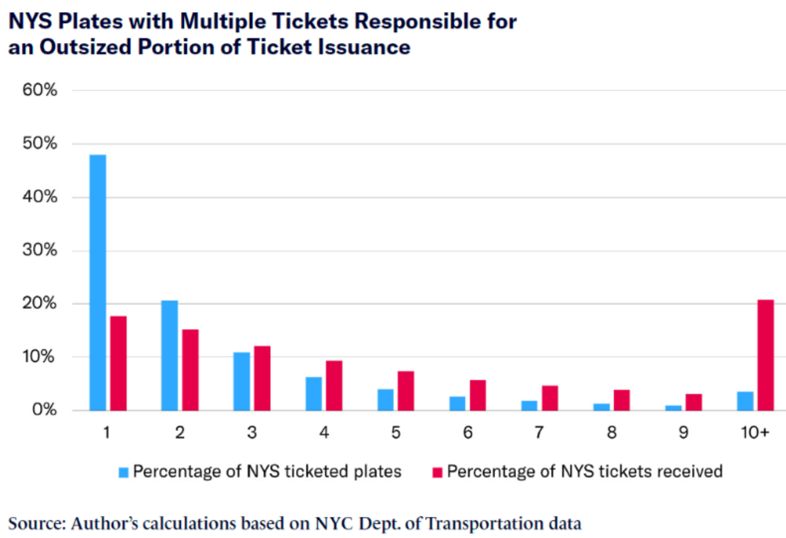

Figure 4.5 New York State Plates with Multiple Tickets Responsible for an Outsized Portion of Ticket Issuance (Source: (Gelinas, 2024))

Of the 142 fatal crashes occurring in NYC in 2022, 63% involved at least one vehicle with at least one red-light or speed camera ticket preceding the crash[7]. Ticketed vehicles involved in fatal crashes had received, on average, seven tickets prior to the incident. But the average by itself is misleading: a disproportionate number of vehicles involved in fatal crashes accumulated disproportionate tickets. Red-light and speed camera tickets per vehicle involved in a fatal crash ranged from a high of 124 to a low of one. Of the 111 vehicles with tickets involved in one of the 89 fatal crashes with such a ticket history, 23% had received 10 or more tickets in the months and years preceding the crash. An additional 24% had received between five and nine tickets. In contrast, among all ticketed vehicles—not just those subsequently involved in fatal crashes—only 3% had 10 or more speed and red-light violations, and only 10% received between five and nine tickets (Gelinas, 2024).

The author concludes based on the data set of 142 crashes and 142 fatalities, keeping motor vehicles with five or more red-light or speed camera violations within one year off the road would have saved 26 lives (Gelinas, 2024).

4.4.6.3 Other Analyses

An analysis by the Manhattan Institute of all speed camera violations issued in October 2021 found that 41% of violations – two out of five – were issued to a vehicle with a registered address located outside New York City. Two-thirds of all violations were issued to a vehicle with an address located more than three miles away from the camera. According to the author of the study, these figures show that overwhelmingly, it is not

[7] While data was not available on what percentage of drivers receive a ticket, a rough analysis shows that the average driver received far less than one ticket per year (Gelinas, 2024).

local residents who are receiving violations, but local vulnerable road users are receiving benefits (Gelinas, 2024).

In the eight full calendar years New York City's speed camera program has been in operation, 46% of plates receiving a violation have not received a second. An additional 19% received no more than two over this period. In 2021, 55% of vehicles receiving violations only got one, even as the number of cameras (and therefore the odds of any speeding vehicle being captured on camera) increased (Gelinas, 2024).

While most drivers are deterred from speeding by one or two camera violations, there is a group of recidivist speeders who continue to drive unsafely despite receiving multiple violations. These habitual speeders will require a stronger penalty in order to change their dangerous driving behavior.

4.4.7 Key Takeaways

Key takeaways learned from the interview with NYCDOT include:

- A 'covert' approach is used and has been effective in reducing speeds at the camera sites.
- NYCDOT employs a low, flat fine to help address equity concerns that a study suggested that the state legislature should allow the city to levy an escalating fine after the first two camera tickets.
- All revenues from the SSC program are directed into New York City's general fund, which reduces perceived incentives to increase ticketing.
- Information on 'dangerous drivers' (e.g., drivers with a high number of SSC violations) can feed into other programs to remove these drivers from the road. NYCDOT piloted a dangerous vehicle abatement program and is interested in exploring other options such as installing intelligent speed assist on high-violation vehicles.
- NYCDOT hopes to increase the SSC program as red-light camera legislation comes up for reauthorization.
- Two-thirds of all violations were issued to a vehicle with an address located more than three miles away from the camera.

4.5 PHILADELPHIA

An interview was conducted with Corrine O'Connor (Philadelphia Parking Authority), Casey Wech (Philadelphia Parking Authority), Christina Rumbaugh (Philadelphia Parking Authority), and Christopher Puchalsky (City of Philadelphia Office of Transportation, Infrastructure, and Sustainability) on May 30, 2024.

It is assumed that information that is not explicitly referenced was obtained during the interview.

4.5.1 Background

Philadelphia launched a pilot SSC program on Roosevelt Boulevard in June 2020 as part of its Vision Zero program. Roosevelt Boulevard is a state route, and the SSC program is focused on a 14-mile stretch with a posted speed limit of 40 to 45 MPH. The corridor accounted for 14% of all crashes in Philadelphia between 2013 and 2017, comprising over 2,800 crashes with 81 severe injuries and 62 fatalities in this time period (Wech, 2023).

While Pennsylvania already had a work zone SSC pilot, the SSC pilot on Roosevelt Boulevard was implemented to evaluate the potential effectiveness of SSC in reducing speed related fatalities on high-crash corridors. The Pennsylvania General Assembly passed Act 86 in 2018 as a response to the high occurrence of severe and fatal crashes on Roosevelt Boulevard to establish a pilot program on the roadway. Eight camera locations with 32 cameras were initially identified and approved by the Pennsylvania Department of Transportation (PennDOT), and camera installation began in January 2020. Currently, Roosevelt Boulevard includes a total of 40 cameras at ten locations. Roosevelt Boulevard is 12 lanes wide, so each camera is placed to capture three lanes at a time (Wech, 2023). Figure 4-6 below provides an illustration of the geometry of this wide boulevard and the presence of 45 mph speed limit signs with a lower sign that states “Photo Enforced”.

Figure 4.6 Roosevelt Boulevard Geometry (Source: Google Street View)

With the success of the Roosevelt Boulevard pilot, the City of Philadelphia is expanding the program to other corridors with high levels of speed-related crashes. HB 1284 was signed into law in December 2023, reauthorizing the SSC pilot to be permanent on the Roosevelt Boulevard and permitting expansion of the program to five additional corridors. The law also authorized a five-year pilot program for SSC in up to five designated school zones (Vision Zero Philadelphia, 2024).

4.5.1.1 Legislation

The Pennsylvania General Assembly enacted legislation through Act 86 of 2018 that formally introduced speed safety camera in the state through a five-year pilot involving Roosevelt Boulevard in the City of Philadelphia between Ninth Street and the Bucks County line (Wech, 2023). HB 1284 expanded this pilot to be permanent, as well as authorized an additional five corridors in Philadelphia for SSC (Vision Zero Philadelphia, 2024).

In June 2019, the City of Philadelphia passed Ordinance 190184, which added Chapter 12-3400 to The Philadelphia Code. The Ordinance allowed for the use of automated cameras along Roosevelt Boulevard and established a system of enforcement and administration. It also specified additional criteria on the SSC program (Wech, 2023):

- The fine amount is a sliding scale dependent on the vehicle's speed:
    - 11 to 19 mph over the posted speed limit: $100;
    - 20 to 29 mph over the posted speed limit: $125;
    - >30 mph over the posted speed limit: $150.
- The warning period shall be 60 days (exceeding the 30-day minimum in Act 86).
- No more than three violation notices shall be issued for violations occurring within a 30-minute period, provided the notices issued are for violations with the highest fine amounts.
- Additional penalties for failure to answer a notice of violation.
- Any vehicle parked on a public street that has any combination of three or more delinquent parking tickets, Automated Red-Light Enforcement (ARLE) violation notices, or SSC violation notices may be towed or immobilized.

4.5.2 SSC Program Elements

4.5.2.1 Organization

The program involves a number of agencies and stakeholders, as evinced in Table 4-5. Of note is that Pennsylvania defines a system administrator, who is tasked with coordinating the process, managing personnel, producing an annual report, managing the vendor, and determining the locations of SSC devices. The Philadelphia Parking Authority (PPA) was named as system administrator in the state law (Wech, 2023).

Table 4.5 Roosevelt Boulevard SSC Involved Agencies

Agency	Roles and Responsibilities
PennDOT	Approves SSC equipment and SSC location requests; administers the Transportation Enhancement Grants Program based on generated revenue.
City of Philadelphia Office of Transportation, Infrastructure, and Sustainability (OTIS)	Approves the locations based on known crash concerns as well as other factors being considered along the corridor.
City of Philadelphia - Department of Streets	Provides input on and approval of SSC deployment locations.
City of Philadelphia – Police Department	Reviews and verifies speed limit violations.
Philadelphia Parking Authority (PPA)	• System Administrator of the SSC program as defined in 75 Pa. C.S. §3370. • Responsible for program reporting, including an annual report, and management of the automated enforcement vendor. • Determines locations of SSC deployments. • Coordinates the entire process. • Dedicates personnel to the SSC programs and currently includes 17 full-time employees.
Verra Mobility (SSC Vendor)	Responsible for equipment maintenance, enforcement software, annual calibrations, processing of violations, and ensuring and tracking of payments.
City of Philadelphia Department of Finance Office of Administrative Review	Conducts hearings to determine the liability of SSC violations.
Duncan Solutions	Processes overdue SSC violations and manages the system that tracks delinquent SSC violation notices.
PRWT Services	Payment processing service; provides the Customer Service Center and call center.
Harris and Harris; Professional Account Management; and TSI	Debt collection agencies that are assigned debt from unanswered violations.

Note that this system includes a three-fold 'check' system on citations – the vendor provides the initial violations; the Philadelphia Parking Authority confirms the citations; and the City of Philadelphia Police Department reviews and verifies the violations.

4.5.2.2 Selection Criteria

Roosevelt Boulevard was chosen because it is one of the most dangerous high-crash corridors in Philadelphia, with 55% of crashes being either speeding related or result of aggressive driving (Huerta, 2022). To select the specific locations on the Boulevard, data on crashes, speeds, and aggressive driving were considered, along with a methodology that balanced consistent camera spacing throughout the corridor with concentrated enforcement in areas experiencing the greatest cluster of fatal or serious injury crashes. After the locations were identified, site inspections and analyses were conducted to confirm the construction and operational feasibility of the site (Wech, 2023).

The five new corridors will be selected through a standardized corridor scoring methodology. Per State law, potential corridors for expansion are state or local routes within the borders of Philadelphia. The corridor must begin and end on the same state or local route. To be selected for the program, the following conditions must be met for each corridor (Vision Zero Philadelphia, 2024):

1. Analysis of speed and speeding related crashes involving vehicles and pedestrians in consultation with PennDOT (not relevant for school zones)
2. An engineering and traffic investigation on the posted speed limit
3. At least one opportunity for public comment
4. Passage of a local ordinance authorizing expansion to the selected corridor

Specifically, the City of Philadelphia developed a scoring system that considered crash history. Among the highest rated corridors, the Delaware Valley Regional Planning Commission's (DVRPC) Indicators of Potential Disadvantage (IPD) tool and Replica data were used to understand how different populations are impacted by the crash trends and would be impacted by SSC. To generate a score for a corridor, the City of Philadelphia looked at the last five years of crashes on state and local routes within the city limits. Crash data was limited to those that included one or more of the following (Vision Zero Philadelphia, 2024):

- Whether someone was killed or seriously injured.
- Whether speed contributed to the crash.
- Whether a pedestrian was involved.

A corridor received five points for each crash resulting in a fatal or serious injury, three points for a crash where speed was a contributing factor, and one point for each crash involving a pedestrian. The highest scoring corridors are all PennDOT State Routes (Vision Zero Philadelphia, 2024).

Among the five corridors with the highest scores, the project team then worked to understand who lives near the route, as well as those who travel along the route to help better understand who would benefit from reductions in crashes and who would be impacted by SSC violations. DVRPC's IPD tool was used to understand the sociodemographic distribution of people who live along the route, incorporating race, ethnicity income, age, gender, disability, foreign-born, and limited English proficiency into the analysis. Replica data was used to understand whether drivers are using the corridors for shorter local trips vs. longer commuter trips (Vision Zero Philadelphia, 2024).

4.5.2.3 Fines and Revenues

The violation fine structure is based on a sliding scale, dependent on the margin of speed registered in excess of the posted speed limit (Wech, 2023):

- 11 to 19 mph over the posted speed limit: $100;
- 20 to 29 mph over the posted speed limit: $125;
- >30 mph over the posted speed limit: $150.

Fine revenue is deposited into PennDOT's Transportation Enhancement Grants Program, which provides funding to projects focusing on improving the safety and mobility, such as traffic signal improvements, bicycle and pedestrian improvements, and roadway safety improvements. While the grants are competitive, priority is given to jurisdictions that have operational SSC systems. 22.1 million dollars' worth of projects was awarded to Philadelphia in the first round of funding (Wech, 2023).

The program collected almost $23 million in revenue from April 2021 to March 2022. It had costs of about $3.5 million dollars in this period, with about 1 million dollars in program costs and collection fees, $850,000 to the camera vendor, and the remaining for administrative and other expenses. Therefore, the program netted over 19 million dollars, which was all remitted to PennDOT (Wech, 2023).

4.5.3 Public Acceptance

When Roosevelt Boulevard was first implemented, the PPA conducted an extensive advertising campaign to inform the public of the program, with the focus of the messaging being on safety. The PPA also conducted three town halls and a press release, as well as provided information on the website. While the PPA has not measured public acceptance, interviews with key individuals indicate that in general, public acceptance has been high with few complaints. Of the complaints, many come from one organization (The National Motorist Association) or focus on diversion concerns to other corridors. Preliminary analysis does not show diversion to parallel routes, but the PPA is investigating further.

With the new five corridors, the PPA will conduct another round of outreach, including advertising and bus banners. The PPA also communicates that the goal is not to collect revenue and that the agency does not directly benefit from fine revenues.

4.5.4 Data and Evaluation

Per State law, the City of Philadelphia is required to collect data and report on the following (Wech, 2023):

- The number of violations and fines issued and data regarding the speeds of motor vehicles in the enforcement area.
- A compilation of penalties paid and outstanding and violations contested.
- The amount of money paid to a vendor or manufacturer.
- The number of vehicular and pedestrian crashes and related serious bodily injuries and deaths.

4.5.4.1 Vendor

The SSC program currently uses Verra Mobility, which provides the citations and data on speeds. The PPA meets with the vendor every two weeks to exchange data, and maintains tight oversight, including an additional two layers of citation verification.

Per State law, the compensation paid to the vendor of the speed safety camera system may not be based upon the number of traffic citations issued or a portion or percentage of the fine generated by the citations. The compensation paid to the vendor of the equipment can only be based on the value of the equipment and the services provided or rendered.

4.5.5 Equity and Law Enforcement

4.5.5.1 Law Enforcement

Law enforcement is only used to issue violations. Other stakeholders (the PPA, City of Philadelphia, and PennDOT), are tasked with selecting locations, running the program, and evaluating the results. This is codified into state law.

4.5.5.2 Equity

For the five future expansion corridors, the City of Philadelphia analyzed demographic data to understand how speed-related crashes impact marginalized populations and to identify who would benefit from expansion of SSC on the top scoring corridors. The City used DVRPC's equity analysis tool for the greater Philadelphia region called "Indicators of Potential Disadvantage" (IPD). The purpose of the resource is to provide a foundational start to identifying historically marginalized populations. The following was considered when evaluating the impact of speeding on marginalized populations (Vision Zero Philadelphia, 2024):

- Low-income neighborhoods in Philadelphia have higher rates of pedestrian and cyclist fatalities due to lower rates of car ownership, inadequate infrastructure, and speeding vehicles.

- Speeding contributes to air and noise pollution, which disproportionately affects low-income communities residing along busy streets like the proposed SSC corridors.

- Inadequate pedestrian infrastructure and highspeed traffic create barriers to accessing jobs, services, and amenities.

- High-speed traffic fragments communities and creates physical barriers that have adverse effects on community well-being, social capital, and collective efficacy.

Many of the proposed SSC corridors touch some of the densest areas with marginalized populations. These areas will benefit from safety improvements on those high-crash corridors (Vision Zero Philadelphia, 2024).

While the IPD tool provided an initial equity screening, the project team also worked to examine specific populations that are most at-risk to the impacts of speeding and severe crashes in Philadelphia. When looking at race and ethnicity, traffic deaths occur more among Black and Hispanic Philadelphians compared to their share of the city’s population. Additionally, fatal or serious injury crashes are 30% more likely to occur in areas of the city where most residents are people of color compared to areas where most residents are white. A person’s age also affects if they will be involved in a severe injury crash. Every week, five school-aged children are struck by vehicles in Philadelphia. Older adults (50 and older) are at greater risk of having a serious injury in a crash than younger adults (Vision Zero Philadelphia, 2024).

Another demographic that the project team looked at was zero-car households. Zero-car refers to households that lack access to a vehicle and these households are more likely to walk, bike, or take transit. Zero-car households are also more likely to be non-white as well as low-income. The project team found that 63% of the proposed SSC corridors pass through areas where more than 30% of the population live in zero car households (Vision Zero Philadelphia, 2024).

In sum, most corridors recommended for SSC expansion run through areas with significant at-risk populations who inequitably share the burden of speed-related crashes while being less likely to be drivers on the corridors.

4.5.6 SSC Results

4.5.6.1 Speeds

In fiscal year 2020-2021 there were 761,188 violations, dropping down to 225,387 violations in fiscal year 2021-2022. From June 2020 to November 2022, violations fell 88.5%. About 90% of violations occur with speeds 11 to 19 MPH over the speed limit (Wech, 2023).

4.5.6.2 Crashes

Total crashes declined by 36% on Roosevelt Boulevard between 2019 and 2021, whereas there was just a 6% decrease in the rest of the city. The relative change in crashes is therefore -30% (Wech, 2023).

Crashes along Roosevelt Boulevard are also becoming less severe, as crashes with fatalities or suspected serious injuries decreased 11%, whereas they increased 16% throughout Philadelphia. The relative change in serious injury crashes is therefore -27%. In addition, the economic value of crash reduction was measured. It was found that the reduction in speeding-related crashes from 2019 to 2021 resulted in an economic benefit of almost $15 million, and that SSC played a major role in this benefit (Wech, 2023).

4.5.6.3 Other Analyses

About 60% of violations from March 2021 to February 2023 were issued to Philadelphia-registered plates (Wech, 2023). In the beginning of the program (June 2020), 1.56% of drivers were issued a citation. In Feb 2022, .07% were issued a citation (PPA, 2020).

4.5.7 Key Takeaways

Key takeaways learned from the interview with Philadelphia Parking Authority and City of Philadelphia staff include:

- A multi-stakeholder organization structure can be very effective, capitalizing on the unique knowledge and resources of different entities.
- A strong 'check' system for verifying citations is important for Philadelphia's SSC program to ensure trust and confidence in the system.
- The City of Philadelphia has developed a standardized corridor scoring methodology to select new corridors, which provides a very transparent and unbiased approach to the selection process. This also includes a robust equity screening.
- The fine amount for speeding is a sliding scale dependent on the vehicle's speed.
- 40% of violations were issued to vehicles registered outside of Philadelphia.

4.6 SEATTLE

An interview with Chris Steel, the SSC program manager for the City of Seattle, was conducted on June 11, 2024.

It is assumed that information that is not explicitly referenced was obtained during the interview.

4.6.1 Background

In December 2012, the City of Seattle began using fixed cameras to enforce the 20 MPH school zone speed limit at four elementary schools. The program expanded in September 2014 to an additional five schools and in September 2015 to five more schools for a total of 14 schools with speed photo enforcement. After a hiatus of several years, during the 2021/2022 and 2022/2023 school years, an additional 5 schools received or will receive school zone speed photo enforcement. There is now a total of 19 schools with 35 speed cameras (City of Seattle, 2024).

The speed cameras only operate when the school zone flashing beacons are in operation. The flashing beacon schedule is set by the Seattle Department of Transportation (SDOT) based on when students will be arriving and leaving school grounds. Seattle uses point-to-point loop detectors to make multiple measurements of a vehicle as it passes through the school speed zone. The vehicle's speed is calculated based on the time it takes to travel between the loop detectors. The cameras are connected to the school zone beacons and only operate when the beacons are flashing. If the beacons are not flashing, then drivers will not be issued citations (City of Seattle, 2024).

With recent legislation allowing speed cameras outside of school zones, SDOT is exploring an expansion of the program, beyond school zones. The Seattle City Council adopted a Statement of Legislative Intent (City of Seattle Municipal Code, 2023) in the 2023 budget process directing SDOT to report on a plan to double the number of school safety enforcement cameras, and further develop “an evaluation of the costs and benefits for expanding other automated traffic safety camera programs, including red light cameras, block-the-box/transit-lane enforcement cameras, speed zone cameras, and other traffic camera authority provided under state law.”

4.6.1.1 Legislation

The state of Washington established legislation, RCW 46.63.170 (Washington State Code, 2024), to authorize jurisdictions to operate automated enforcement to detect red light, railroad crossing, and (in limited cases) speed violations. The placement of SSC devices was limited to school speed zones and school walk areas, public park speed zones, hospital speed zones, and certain priority road safety locations. In addition, there were restrictions on how many cameras any city could operate based on their population.

However, new legislation effective in June 2024 repealed this legislation and allowed traffic cameras to be used on portions of state routes in city limits that are classified as city streets, and in work zones on city and county roads, including those that are state highways. It also permits use of traffic cameras to cite vehicles that fail to stop at crosswalks, or travel in lanes reserved for buses and other forms of public transportation. Cameras can be mounted on the front of a bus to photograph vehicles traveling in or blocking the designated transit lane (HB 2384, 2024). Seattle already has some bus lane enforcement and bridge enforcement cameras.

Each City with SSC in Washington, including Seattle, copies this legislation into their municipal code.

4.6.2 SSC Program Elements

4.6.2.1 Organization

The Seattle Police Department manages the vendor contract and the violation process, while SDOT works on the location selection of all automated enforcement programs, as well as integrating data into the decision-making process and selecting other traffic calming measures.

The vendor provides an initial review of the citations and puts together a 'packet' with the vehicle plate number and registered owner information. Trained and authorized civilian employees, Washington law enforcement agents, or employees in the Department of Public Works or the Department of Transportation can then review those infractions. Finally, the Seattle Police Department issues the violation.

4.6.2.2 Selection Criteria

School zones are selected by the following criteria (City of Seattle, 2024):

- Vehicle Speed - SDOT monitors speed at arterial school zones across the City. They prioritize school zones where 85th percentile speeds are more than 5 mph over the school zone speed limit.
- Additional Traffic Calming - SDOT evaluates school zones for additional calming options prior to installing photo speed enforcement.
- Number of Vehicles - SDOT measures the volume of traffic to determine the impact photo speed enforcement would have if installed.
- Geographic Balance - Ensuring no neighborhood is over or under served by photo speed enforcement.
- Engineering - Each potential new location is assessed for feasibility of photo speed enforcement installation. Not all locations allow for photo enforcement due to environmental conditions.

The 2024 Vision Zero Action Plan Update calls for the development of a comprehensive policy to identify and implement new traffic safety camera measures that prioritize locations and penalties based on safety, equity, and inclusive community input (SDOT, 2024).

4.6.2.3 Fines and Revenues

The maximum penalty amount for violations captured by a traffic camera cannot exceed $145 per incident, adjusted for inflation every five years. This maximum penalty amount can be doubled for a traffic camera-enforced school zone speed infraction (HB 2384, 2024).

The new legislation includes a provision in which the penalty will be cut in half for registered owners of vehicles who are recipients of state public assistance, other than Medicaid, if they request such a reduction. This is applicable to the first violation only (HB 2384, 2024).

Revenues are first directed to administration, installation, operation, and maintenance costs. After expenses, revenues are then directed to construction and preservation projects and maintenance and operations purposes including, but not limited to, projects designed to implement the complete streets approach, changes in physical infrastructure to reduce speeds through road design, and changes to improve safety for active transportation users, including improvements to access and safety for road users with mobility, sight, or other disabilities (HB 2384, 2024).

4.6.3 Public Acceptance

All automated enforcement locations are published on the Seattle Department of Transportation's website. When cameras are placed in a school zone, SDOT mails information about SSC to neighborhoods around the school zone. There is also a 30-day warning period for each new camera.

As the program has been in place for over a decade, it is fairly ingrained into the community. The program manager publicizes their contact information so anyone who has questions can easily get in contact and provide feedback.

4.6.4 Data and Evaluation

Each jurisdiction with SSC in Washington is required to prepare an analysis of the locations within the jurisdiction where SSC systems are proposed to be located both before enacting an ordinance allowing for the initial use of automated traffic safety cameras and before adding additional cameras or relocating any existing camera to a new location within the jurisdiction. In addition, jurisdictions using SSC must post an annual report of the number of traffic crashes that occurred at each location where an automated traffic safety camera is located as well as the number of notices of infraction issued for each camera and any other relevant information about the SSC cameras that the city or county deems appropriate on the city's or county's website (Washington State Code, 2024).

4.6.4.1 Vendor

The vendor is Verra Mobility, who provides all-inclusive services including installation, maintenance, and upgrades to the system. The vendor is paid a monthly fee for each camera location. The Seattle Police Department has access to a reporting portal (not publicly available), where they can easily pull data from each location by period.

The Seattle Police Department establishes a set of rules with the vendors, like how to handle certain instances of a violation (e.g., emergency vehicles speeding). These rules act as a formal guide for violation issuance.

4.6.5 Equity and Law Enforcement

4.6.5.1 Equity

The SDOT leads the equity analysis for the SSC program, as they are charged with the location selection process. An equity analysis is developed for new locations, including impacts of camera placement on livability, accessibility, economics, education, and environmental health. A 'common sense' approach is also used to ensure locations are not clustered.

Per Washington state law, for a city with SSC, some revenue must be spent in census tracts of that city that have household incomes in the lowest quartile and in areas that experience rates of injury crashes that are above average for the city. Funding contributed from traffic safety program revenue must be, at a minimum, proportionate to the share of the population of the city who are residents of these low-income communities and communities experiencing high injury crash rates. Revenue expenditure must be informed by the Department of Health's environmental health disparities map.

A Vision Zero Report recommended the following actions to make speed cameras more equitable (SDOT, 2023):

- When implementing automated enforcement, develop a site-specific plan for additional physical traffic calming improvements and eliminate the need for enforcement in the future.
- Increase cameras in wealthier areas of the city with fewer people of color to address equity concerns.
- All cameras should issue warnings instead of tickets for first-time violations. This is likely to be effective, as 95% of Seattle residents never receive a second ticket at a specific camera location.
- Work with Seattle Municipal Court to set ticket fines based on income or ability to pay and create additional and more accessible alternative options for those who cannot afford to pay for a ticket.

4.6.5.2 Law Enforcement

The Seattle Police Department holds the contract with the vendor and is charged with managing the contract, reviewing citations, and serving as the point of contact for the public.

4.6.6 SSC Results

SDOT's 2023 Vision Zero Report (SDOT, 2023) found that 95% of drivers who receive a ticket at a specific location never receive a second ticket at the same location and 80% of those who receive a ticket never receive another ticket at any other camera within the system. The report also stated that about half of the revenue generated by the fines collected from automated citations goes to SDOT safety projects, and the other half goes to the City general fund to administer the program.

In 2022, there were 56,630 citations over the 35 camera locations, netting a gross revenue of $9,662,727. Note that out of all citations issued under automated enforcement, only about 67% were actually paid (Seattle Police Department, 2023).

4.6.7 Key Takeaways

Key takeaways learned from the interview with SDOT include:

- In Washington, new legislation has been passed, effective in June 2024, to widen the scope of SSC in the state and evaluate costs and benefits of expanding other automated traffic safety camera programs, including red light cameras, block-the-box/transit-lane enforcement cameras, speed zone cameras, and vehicles that do not stop at pedestrian crossings.
- The new legislation will include a 50% fine reduction for first-time violators who are recipients of state public assistance, other than Medicaid.
- The City of Seattle is currently evaluating an expansion of the currently school-zone based system to a broader system that is now allowed under the new legislation.
- The City of Seattle has an open communications line with the public, providing a direct email for residents to ask questions or express concerns.

4.7 DISTRICT OF COLUMBIA

An interview with Sayed Sarchasmah, Deputy Director of the SSC program for the District Department of Transportation (DDOT) was conducted on June 14, 2024.

It is assumed that information that is not explicitly referenced was obtained during the interview.

4.7.1 Background

The District of Columbia (DDOT, 2024b) runs an speed safety camera program as part of their automated traffic enforcement program, “DC StreetSafe”. Red light cameras were first implemented in 1999, with speed cameras added in 2012 (Farrell, 2018).

D.C. completed a camera expansion in March 2024, and now has 466 total cameras, with 213 of those being speed cameras. The program also includes 140 bus lane cameras, 45 red light cameras, 33 stop sign cameras, 25 school bus arm cameras, and 10 truck restriction cameras. There is a desire to increase stop sign cameras. An additional 11 red-light cameras will be installed to reach a total of 477 cameras (DDOT, 2024a).

The District Department of Transportation (DDOT) will assess whether each camera is meeting expected outcomes such as reductions in crashes, speeds, violations, and repeat offenses between

April 2024 and April 2025. DDOT will rotate cameras to optimize their effectiveness and prioritize safety in all parts of the District from April 2025 and onwards (DDOT, 2024a).

4.7.1.1 Legislation

The program is strictly guided by the District of Columbia City Code, which includes provisions on the violation process, revenues and fines, reporting criteria, and expansion.

4.7.2 SSC Program Elements

4.7.2.1 Organization

Initially, the program was run by the Metropolitan Police Department (MPD). During the pandemic, the program was financially supported by MPD but managed by DDOT. There was a strong desire from the mayor's office to move the whole program to DDOT, which was completed in 2021. Now, DDOT administers the program fully. This change was considered a success, as the MPD did not have the technical resources for camera location selection and lacked the ability to implement other traffic calming measures.

The camera vendor provides an initial review of violations and sends those to DDOT. DDOT has 35 certified examiners who look at each ticket and issue a final violation.

4.7.2.2 Selection Criteria

DDOT uses both proactive and reactive sources to determine locations for new or relocated automated traffic enforcement (ATE) cameras (DDOT, 2024a). ATE includes speed, red-light, bus lane, and other enforcement cameras.

Proactively, DDOT examines District-wide data by screening the roadway network to determine where cameras can be most effective, using factors such as (DDOT, 2024a):

- School zones along high-volume roadways
- Vision Zero High Injury Network (shown on the dashboard of ATE locations) that accounts for nearly 50% of DC's injury crashes
- Both signalized and stop sign-controlled intersections with a high rate of injury crashes.

Reactive sources include reviewing 311 requests for a Traffic Safety Input (TSI), post-fatal crash reviews, routine engineering studies and site reviews, as well as inputs from DC Council, Advisory Neighborhood Commissions (ANCs), and the Metropolitan Police Department (MPD). Figure 4-7 presents diagrams of the selection methodologies (DDOT, 2024a).

Figure 4.7 DDOT Selection Methodologies

As part of the location identification process, the vendor also provides input from an operations perspective.

4.7.2.3 Fines and Revenues

Fines for traffic violations captured by SSC are the same as the fines for violations issued by a police officer and range from $100 to $500 (DDOT, 2024b).

From October 1, 2021 to March 31, 2022, DDOT issued over 614,000 citations with $78,926,250 in fine revenue. The camera with the highest number of citations issued 51,800 citations worth $13,810,500 (DDOT, 2022).

Per City law, fines first go to the General Fund which supports DC's overall budget, in excess of the following amounts (§ 50–921.25. ATE System Revenue Designation, 2024):

- For Fiscal Year 2024, $116,989,000;
- For Fiscal Year 2025, $299,467,000;
- For Fiscal Year 2026, $287,541,000; and
- For Fiscal Year 2027 and each fiscal year thereafter, $277,341,000.

Money in the General Fund is required to be used on the following, ordered by priority (§ 50–921.25. ATE System Revenue Designation, 2024):

1. To implement the Vision Zero Enhancement Omnibus Amendment Act of 2020.

2. To implement the Safer Streets Amendment Act of 2022.

3. To implement §§ 38-3102 through 38-31112 [Not Funded], including to pay recurring costs.

4. To enhance the safety and quality of pedestrian and bicycle transportation, including education, engineering, and enforcement efforts designed to calm traffic and provide safe routes.

4.7.2.4 Fine Collection

ATE ticket payment rates have been decreasing since 2014. District drivers pay ATE tickets the most in comparison to violators from other states, but on average, roughly 30% of all ATE citations go unpaid. Multiple factors can contribute to whether vehicle owners pay their tickets, but the primary one is the more citations a vehicle owner receives, the less likely they are to pay them. Among vehicle owners who had only one citation in 2019, more than 80% were paid. In 2019, approximately 70% of vehicles that received a citation only received one. Among the small group who had five citations or more, only about half of the citations were paid (District of Columbia Mayor's Task Force, 2024).

The significant backlog of outstanding ATE tickets presents several problems. First, and most importantly, a driver's failure to pay fines contributes to the growing perception that drivers can speed and ignore traffic safety laws in the District without consequence. Second, the large number of contested tickets means the District Government must allocate more staff to the DC DMV's Adjudication Services division to address the backlog in a timely manner. Currently, the District Government does not have interstate agreements with other jurisdictions for the enforcement of ATE tickets. Reciprocity could improve ticket payment rates by out-of-state vehicle owners and would address the current enforcement inequity.

Under the current system, DDOT only has authority to enforce non-payment against drivers registered in D.C., or, less commonly, against out-of-state drivers when parked in a public space within the District. DC DMV and the Office of the Deputy Mayor for Operations and Infrastructure (DMOI) have engaged in discussions with both Maryland and Virginia motor vehicle administrators on ticket reciprocity for ATE violations. Neither state wanted to pursue reciprocity for ATE tickets (District of Columbia Mayor's Task Force, 2024).

The Mayor's Task Force (described in a later section) recommends the following to address this issue (District of Columbia Mayor's Task Force, 2024):

- The mayor's office should collaborate with Maryland and Virginia to work on reciprocity at a higher level.

- The District Government should study whether lower fines would improve compliance.

- Explore reduced fines for drivers who admit fault prior to the initial 30-day window. Under this system, early compliance would be rewarded with a lower fine.

- Consider lowering the base fine amount to be more consistent with fines imposed in Maryland and Virginia. In addition to achieving higher payment rates, lowering fines to match Maryland and Virginia could help push back against the narrative that the ATE system is primarily focused on revenue collection.

- The District Government's ATE program should consider piloting interventions to study the effect of different types of messages regarding ticket payment rates.

4.7.2.5 Additional Enforcement

A major topic in D.C. includes additional enforcement for the relatively small subset of high-risk drivers who repeatedly fail to obey traffic rules and are not deterred by existing compliance measures (i.e., fines), either because they can afford to pay the tickets, or — more commonly — because they do not pay them.

Currently, the Department of Public Works (DPW) has authority to immobilize (boot) or impound (tow) any parked vehicle "against which there are 2 or more unpaid notices of infraction." Further, the Council passed the STEER Act, which if enacted and funded, would allow the District Government to tow and impound vehicles based on the number of tickets accrued over a six-month period, regardless of payment. However, currently the District Government's booting, towing, and impound capacity is significantly limited by existing resources. Namely, there is limited impound lot capacity and limited tow truck and boots (District of Columbia Mayor's Task Force, 2024).

To do this, the Mayor's Task Force on ATE (described in a later section) recommends increasing the impound lot capacity and adding in-house booting and towing resources or contracting out to private contractors. In the short-term, operational changes can be made within DPW to better prioritize dangerous vehicles for booting, towing, and/or impoundment, such as freeing up existing tow trucks dedicated to rush hour lane enforcement and streamlining communication between parking enforcement officers and booting/towing teams (District of Columbia Mayor's Task Force, 2024).

To specifically target dangerous vehicles, the Task Force recommends that the District Government consider coordinating with private towing firms for this group of high priority vehicles and pay the firms for each high-priority vehicle towed to a DPW facility. The District Government should prioritize towing and impoundment of vehicles that have two or more unpaid citations for driving 21 MPH or more over the speed limit and/or running a red light (District of Columbia Mayor's Task Force, 2024).

4.7.3 Public Acceptance

D.C. maintains constant communication with the public, providing frequent information sessions through different channels and gathering feedback. Each ward in D.C. has a representative from DDOT that communicates directly with that ward, liaising with local neighborhood groups. DDOT also provides open houses for the City Council to share results from the automated enforcement programs.

The DDOT Public Information Office is charged with running the public outreach campaigns. New cameras are publicized through press releases, and all cameras include signage and a 45-day warning period. New cameras are heavily publicized, with media engagement and open houses. The locations of the cameras are available on a dashboard on DDOT's website.

4.7.4 Data and Evaluation

Per D.C. Official Code § 50-2209.01 DDOT is required to report to the Council on a semi-annual basis the following information: (1) the top 15 ATE locations by value of citations generated in the District; (2) the breakdown of the jurisdictions where those receiving ATE citations and with outstanding ATE citation debt have their vehicles registered; (3) the locations where cameras have been added in the last 6 months and the reasons why those locations were chosen; and (4) the amount of ATE citations issued in total and by location. This data is publicly available.

DDOT also analyzes crashes, speeds, violations, and repeat offenses, though this data is not readily available to the public. With the new expansion, DDOT plans to evaluate these metrics monthly and publicize these results, and then provide a comprehensive analysis and list of recommendations after 18 months of operations.

DDOT has pledged to provide all data publicly on an easily accessible dashboard[8] which shows camera locations and number of violations by camera type and status. A screenshot of this dashboard is shown in Figure 4-8. DDOT plans to release a more comprehensive dashboard that includes additional data.

[8] See: https://dcgis.maps.arcgis.com/apps/dashboards/0f587a34bdf34c5495c26482f6277f35

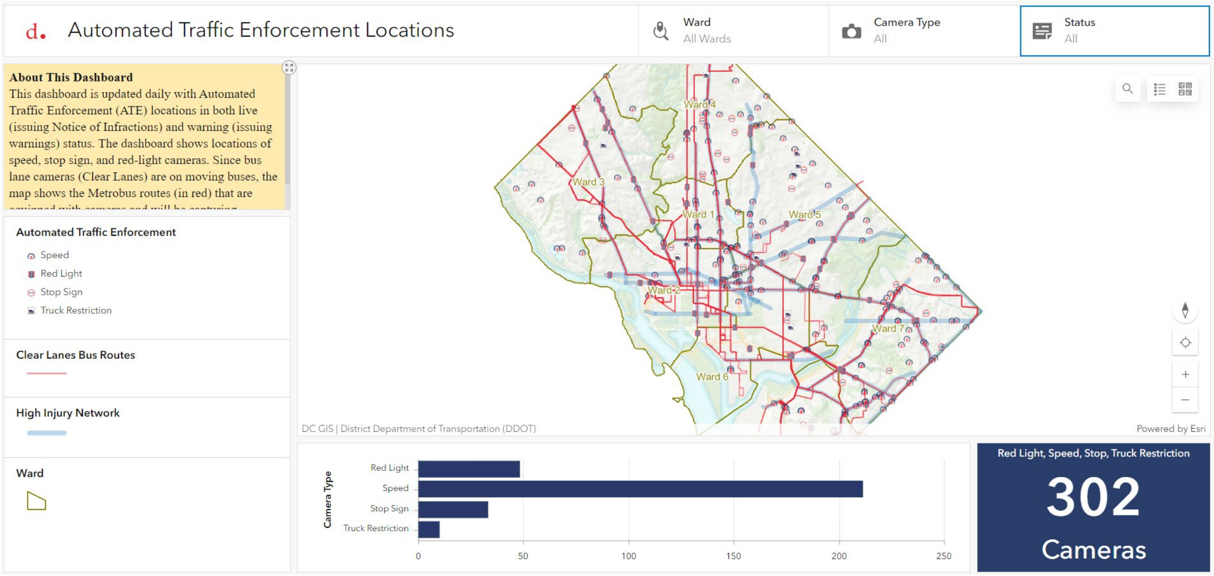

Figure 4.8 DDOT SSC Dashboard (Source: (DDOT, 2024a))

4.7.4.1 Vendor

D.C. uses Verra Mobility for SSC and red-light programs. For other programs (stop sign, bus-arm, etc.), DDOT uses NovoaGlobal. All vendors are paid fees for each camera installed.

The SSC vendor is all-inclusive and manages the installation and maintenance of cameras and the processing of tickets. Initially, DDOT had some difficulty in obtaining data from the vendor. In a new RFP, they required the vendor to provide data with time limits. The vendor that D.C. uses is state-of-the-art, with a dashboard that provides 24/7 access to data. These dashboards allow D.C. to build their own dashboards on top of them.

4.7.5 Equity and Law Enforcement

4.7.5.1 Equity

The District created the "Mayor's Task Force on Automated Traffic Enforcement" (DMOI, 2024) in March 2023 to investigate and provide recommendations on the District's SSC program and other moving violation laws, including fines. The goal of the task force is to mitigate against the potentially inequitable effects of the fine, penalty, and enforcement systems on individuals of varying household incomes while maintaining the public safety effectiveness of SSC and other moving violation programs. The Task Force will have a final report by September 2024 that includes recommendations on key changes designed to make automated enforcement and other moving violation programs and their fines, penalty, and enforcement aspects, more equitable.

A preliminary report was released in 2024 (District of Columbia Mayor's Task Force, 2024) detailing a list of the Task Force's priorities for research and review, a workplan with a timeline of planned activities and meetings, and recommendations to be evaluated by executive leadership in advance of the Task Force continuing the second phase of its work. Several key recommendations are provided below.

4.7.5.2 Fines and Fees

The report includes a recommendation for an income based fine pilot as an alternative to the current fixed-fines system for automated enforcement violations. The pilot aims to achieve greater ATE fine equity by providing financial relief to certain lower-income District residents. The proposed income-based fine pilot provides a fixed, but lower, fine amount for eligible residents. DC residents or ATE ticket recipients whose households receive Supplemental Nutrition Assistance Program (SNAP) benefits would be eligible for a 50% fine reduction. Only first-time offenders and minor violations are eligible. This program will be implemented in FY2024 with a $2 million budget.

The report also describes four other pilot programs that are being considered, including:

- **Escalating Fines**, where the fine amount for certain ATE violations would be reduced by 50% for a first violation. The fines for each repeat offense would then increase for offenses within an allotted time frame. This program would not target relief and instead would reduce the financial burden associated with ATE tickets for most recipients, who only receive one ATE ticket.

- **Up-Front Payment Plans**, which aims to achieve greater ATE fine equity by reducing the initial payment burden of ATE fines and distributing it into smaller, more manageable installments over time.

- **Fine Alternatives**, which would offer lower income violation recipients a chance to complete an alternative “penalty” instead of paying a fine. Specifically, the task force proposes offering the alternative of participating in a driving course and/or a program designed to highlight the consequences of risky driving behavior.

The Report also recommends lowering fine amounts to be consistent with surrounding jurisdictions, studying the impact of late fees and developing payment plans for overdue violations.

4.7.5.3 Driver Behavior Change and Public Education

In addition, the Task Force provided specific recommendations related to equity in public education and behavior changes, including:

- **ATE and Racial Equity:** In the mid- to long-term, the Task Force recommends a continued focus on engineering changes (roadway modifications and hardscaped calming measures) for their effectiveness in shaping driver behavior and as a step toward redressing historical underinvestment in infrastructure in racially segregated communities.

- **Location Selection**: In the short term, more community engagement and communications campaigns are necessary to make the public aware of the increase in the number of cameras in FY 2024, to help explain DDOT's rigorous, unbiased placement methodology, and to share ways in which residents can request traffic safety measures in their communities. In the mid-to-long term, the District Government should continue to research the role of racial segregation in past infrastructure investments as one factor to weigh and address in future roadway redesign and investment.

- **Supplements to ATE:** The Task Force recommends exploring increased use of sobriety checkpoints.

- **High Risk Drivers:** A high-risk driver study was conducted in the Spring of 2024. The District should use the initial results of the messaging pilot to determine whether to scale the messages to all risky drivers, experiment with other behavioral nudges (e.g., different message content or frequency), or discontinue the program.

- **Public Information Campaign**: The District's Highway Safety Office has budgeted $250,000 for a public education campaign focused on ATE and speeding, which targets 24–39-year-olds.

4.7.5.4 Law Enforcement

Law enforcement is no longer involved with automated enforcement programs. DDOT feels that the program is far more successful under DDOT management, as there is more integration with engineering safety measures and safety studies.

4.7.6 SSC Results

The Lab @ DC, a research department of the District government, conducted a risky driver study in partnership with Vision Zero and DDOT. The study found that among vehicles that receive any ATE citations, most vehicles only receive one. Vehicles with red light citations and/or speeding citations of 21 MPH or more over the limit are substantially more likely to be involved in crashes in the District. Both citations and crash data refer only to occurrences in the District, but include vehicles registered outside of the District. Specifically (The Lab @ DC, 2024):

- Nearly 10% of vehicles that received at least one red light citation since 2016 were involved in at least one crash from 2016 to 2021.
- Compared to all vehicles that received a camera ticket in the District since 2016:
    - Twice as many vehicles ticketed for going more than 21 MPH over the speed limit have been involved in a crash.
    - Nearly three times as many vehicles with red light violations have been involved in a crash.

A 2022 report found that 45% of citations were issued to vehicles with licenses from Maryland, and 20% were issued to vehicles with license plates from Virginia, and 21% were issued to vehicles with license plates from the District (DDOT, 2022).

4.7.7 Key Takeaways

Key takeaways learned from the interview with DDOT include:

- DDOT is committed to a transparent and robust information sharing process for its new camera locations. This will include monthly updates to a dashboard for a year of evaluation, including expected outcomes such as reductions in crashes, speeds, violations, and repeat offenses.

- The SSC program was effectively fully moved from the police to the Department of Transportation, allowing greater autonomy and more integration with engineering and planning efforts.

- DDOT has a formal proactive and reactive selection process, which includes both network-wide analysis and inputs from the public and recent crashes.

- There is a backlog of outstanding tickets and a high number of drivers that do not pay repeated tickets. DDOT is working on a program to target dangerous drivers by towing vehicles with a high number of violations or unpaid tickets.

- DDOT has a robust public communications strategy, with a specific SSC representative for each ward.

- A range of new ASE-related initiatives were recommended by Mayor’s Task Force on Equity, including income-based fines.

4.8 INTERVIEW SUMMARY

In sum, the five case studies provide detailed insight into the current operations and future expansion plans of established SSC programs. Many of these cities are innovating in the realm of new types of enforcement; targeting dangerous drivers; providing open data; and establishing equity criteria and considerations into their programs.

The interviews were highly valuable in understanding the different ways agencies across the United States operate their SSC programs. Each jurisdiction faces unique challenges and circumstances, leading to different SSC program structures, constraints, and extents. The interviews provided a greater depth of information than what was found through publicly available websites and reports, as well as provided insight on informal challenges and ideas for the future. These insights will be valuable for the project team and ODOT to understand and consider for future changes to Oregon’s program.

The following sections outline qualitative and quantitative results from the case studies.

4.8.1 Summary of Findings

The following is a synthesis of fundings from the interviews and city materials:

- **Legislation:** All programs are based on state legislation, and then cities may implement local ordinances to codify the state law into City law. Cities generally need to encourage changes in state bills to drive major changes in their programs, such as expansions or new fine and revenue rules.
- **Types of Enforcement:** Some jurisdictions are implementing more novel types of automated enforcement, such as stop sign cameras; bus stop arm cameras; bus lane enforcement; and truck enforcement.
- **Organization**: Both D.C. and NYC have completely detached their SSC programs from the police, with the programs run fully by their departments of transportation. The other cities include the police primarily for violation issuance, though in Seattle, the police manage the vendor contract as well.
- **Selection Criteria**: All cities look at speeds and crashes; New York City and D.C. also have a 'reactive' component in which they respond to citizen requests and/or incoming fatal or serious injury crashes.
- **Fines and Revenues**: New York City is the only studied City that has a flat fee; all other agencies vary fines by speed.
    - Portland offers a traffic safety class in lieu of payment (though the class has its own, smaller fee).
    - Seattle offers a fee reduction for eligible drivers.
    - D.C. will be piloting an income-based fee system, overlaid on its existing speed-based fine system.
- **Covert Enforcement:** Most programs must include a publicized list of SSC locations and signage before cameras, informing drivers that a camera is upcoming. However, New York City does not publicize camera locations in order to create a more 'general deterrence' and with the aim to lower speeds throughout the city.
- **Additional Enforcement:** Both D.C. and New York City have piloted or are considering implementing programs focused on dangerous driving, including towing, safe driving classes, and intelligent speed assistance.
- **Public Acceptance:** Most cities run traditional public outreach programs with press releases, focus groups, media campaigns, public meetings, and websites. D.C. has eight specified information officers for each of its wards, which are charged with communicating information on automated enforcement to residents.
- **Data and Evaluation**: Some cities, such as Portland and Philadelphia, include extensive annual or bi-annual studies that report on speed, crash, and other violation outcomes. Other cities, such as D.C. and Seattle, publish more basic information on violations.
    - D.C. has pledged to become more transparent, with monthly reports on SSC outcomes.
- **Vendor:** Most cities have no issues with their vendors and have access to a portal where speed and violation data is available by date. Vendors are typically paid per camera.
    - Portland is the only City interviewed that currently has issues with vendor communications and reporting. D.C. shared it previously had issues with data collection, but these issues were solved after an RFP that specified time limits and fines.
- **Equity:** All cities are addressing equity through both fine considerations (reduced or income-based fines) and geographical equity analyses. D.C. has a comprehensive Task Force that has provided recommendations for equity-related issues.

- **Ticket Distribution:** Studies in New York City, Portland, Philadelphia, and D.C. indicate that most violators are not nearby residents to the camera locations and come from different parts of the city or even different states.

Table 4.6 provides a summary of the five interviewed jurisdictions' SSC programs.

Table 4.6. Summary of Findings by Jurisdiction

Jurisdiction	Type	# Cameras	Program Duration[1]	Manager	Vendor	Fines	Performance Measures	Equity	Other
Portland	General	14	8	City (PBOT)	Conduent	$170 - $440	Speeds, crashes, public acceptance	Traffic diversion class; zip code & demographic analysis	
New York City	School Zone	2,200	11	City (NYCDOT)	Verra Mobility	$50	Injury crashes, repeat violators, distribution of violators	Zip code & demographic analysis; low fines	Covert enforcement; targeting dangerous drivers
Philadelphia	General	40	4	City and Philadelphia Parking Authority	Verra Mobility	$100 - $150	Violations/fines issued; pedestrian & vehicular crashes and injuries	Zip code & demographic analysis	Large program expansion in development
Seattle	School Zone	35	12	City (SDOT) and Police (SPD)	Verra Mobility	Max $290	Violations; crashes	Reduced fines; equity analysis	Potential expansion into general SSC
D.C.	General	213	12	City (DDOT)	Verra Mobility	$100 - $500	Top 15 camera locations by citations; locations where cameras have been added in the last 6 months; amount of ATE citations issued	Equity task force; income-based fine pilot	Targeting dangerous drivers

[1]As of 2024, in years

4.8.2 Key Outcome Results

Portland measured reductions in speeding (1+ MPH over the speed limit) and found a 71% reduction in speeds across all fixed SSC systems. Other programs, such as New York City and Philadelphia, focused on top-end speeding (11+ MPH) over the speed limit, and found reductions of 73% to 94%.

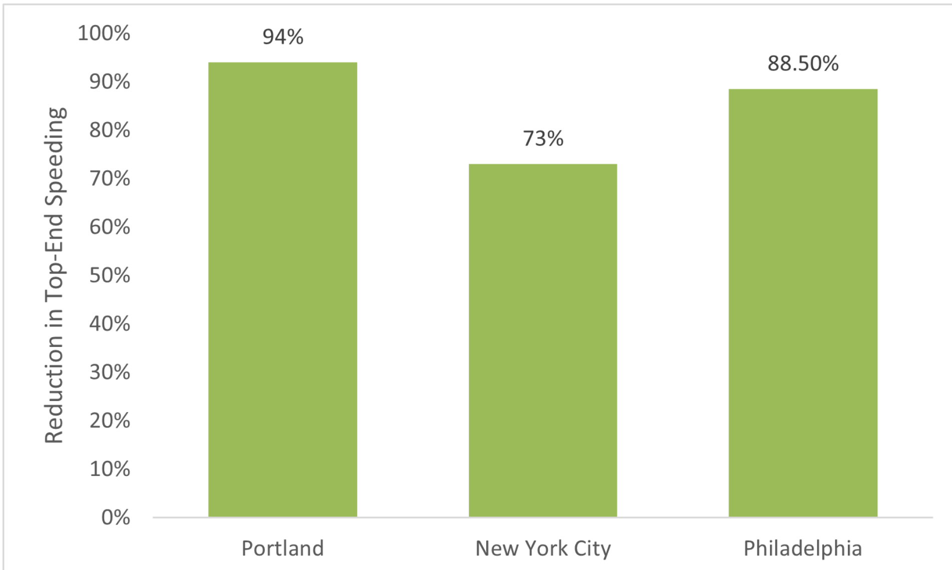

Figure 4.9. Reduction in Top-End Speeding

For crashes, PBOT observed a 17% reduction in speed-related crashes relative to the wider City, while New York City observed a 6.3% decrease in injury crashes relative to non-SSC sites in the city. In Philadelphia, the relative decrease in crashes was 30% for all crashes and 27% for fatal and serious injury crashes as compared to non-SSC sites. While these numbers cannot be directly compared as they measure different crash metrics, they all point to a decrease in crashes and indicate that speed cameras are effective at reducing speed-related and injury crashes.

4.8.3 Jurisdictional Findings

Most of the interviewed jurisdictions' SSC programs are governed by state law, with the exception of Washington, D.C. Typically, state law is codified into jurisdictional law, with some cities mentioning that they include additional restrictions or stipulations in their city code. For example, Philadelphia extends the required warning period from 30-days (in the state law) to 60 days in their municipal code.

New York City works closely with the New York State Legislature every year to amend and expand both their speed and red-light programs. As NYC has no mandate to inform the public of SSC locations or selection processes (as they practice covert enforcement), NYCDOT considers state legislators as representing their constituents when making law changes. In addition, PBOT mentioned that the agency is interested in exploring a fixed, graduated fine system, but is currently limited by state law.

4.8.3.1 Small Cities

All agencies interviewed were larger cities and were chosen due to their robust SSC programs; most small-city programs are very limited and have little publicly available information. Washington state used to have different requirements for cities with a population under 10,000. Previously, the law stated that each city may operate at least one SSC device, plus an additional device for every 10,000 residents. However, this law was rescinded in 2024 (HB 2384, 2024), so there are no longer any restrictions on the number of SSC cameras.

Other states, such as Maryland, Georgia, and Rhode Island allow any city to apply for permission to run an SSC program. Others, such as New York, specifically only permit one city (New York City) to run an SSC program and in California the number of cameras allowed in each City is proportional to the city's population, and ranges from 9 to 125 systems (California AB-645, 2023)

5.0 INTERNATIONAL CASE STUDIES

SSC programs outside the United States, especially in Europe, have been in place for decades and are often more developed and widespread than those in U.S. states. As of a 2023 inventory (SCDB, 2024), there are at least 15 countries in Europe that employ SSC. Many programs are highly centralized and automated, leading to a very complete system with minimum overhead on issuing citations. In some cases, there is a specific department tasked with leading SSC, with minimal to no police involvement. In addition, countries such as France implement a more network-wide approach, instead of a city-by-city approach, to cover a wide range of areas and routes. This creates the idea of an omnipresent enforcement system for drivers (Carnis, 2011).

While ODOT operates in the US context, it is important to recognize the advancements achieved abroad. Further, programs abroad can be a source of inspiration, though many of the lessons or advances found abroad cannot be directly transferred to the US due to political, legal, and/or cultural differences.

Key case studies of France and New South Wales are detailed below. Additional case studies are presented in Appendix C.

5.1 FRANCE

A 2011 study (Carnis, 2011) provides an overview of the French speed safety camera program and lessons learned for other countries. France first installed speed cameras in November 2003, and as of 2017 has 2,026 fixed speed cameras, 501 mobile speed cameras, 209 autonomous cameras, 383 new-generation mobile cameras, and 101 road section cameras. France has seen a significant decrease in the number of fatalities and injuries since the implementation of SSC. The number of fatalities has reduced by over 30% between 2003 and 2009. Fines depend on speed and vary from 68 euros (<20 km/h over the speed limit in a 50+ kph speed limit) to 1500 euros (more than 50 km/h over the speed limit).

5.1.1 Logistics

Since 2010, the national SSC program has been run by the Direction Contrôle Automatisé (DCA, or Speed Safety Camera Department), and handles responsibilities such as monitoring of the installation and functioning of the devices; determining the number and location of devices; and issuing contracts. It also heads public communication and coordinates with local jurisdiction and members of Parliament. The DCA includes advisors from the National Police and expert analysts (Carnis, 2011).

The Interdepartmental Speed Safety Camera Project (DPICA) is responsible for the logistics of the SSC program. It manages the National Processing Centre (CNT) and the Automated Centre for Observation of Traffic Offences (CACIR). These organizations ensure observance of due process for offenses detected by the radar devices and maintenance of detection devices (Carnis, 2011).

5.1.2 Strategy

Speed cameras are installed on county roads and national roads. The choice of location is mainly dependent on the number of road fatalities and injuries collected by road authorities, as well as on excess speed problems and difficulty of using traditional enforcement methods at a particular location (Carnis, 2011).

The French government uses a strategy combining both signed, visible devices and hidden devices (mobile devices inside unmarked police cars), in order to achieve both general (deterring the committing of offenses) and specific (detecting the offense and punishing the offender) deterrence. Locations of fixed cameras are publicized online and are preceded by signs intended to reduce speeds of individual drivers. The purpose of this strategy is to educate drivers on speeding laws and prevent speeding from occurring. Mobile, unsigned devices are used to detect and punish offenders. Their mobility allows for numerous random checkpoints on the road network and generates a situation of widespread uncertainty (Carnis, 2011).

In addition, France employs a "network-centric" strategy, which involves a progressive gridding of the road network with SSC devices. This ensures that whatever route a driver takes, that driver must at some point encounter a speed enforcement device. The omnipresence of the devices on France's roads and freeways leads to a perception of a nationwide detection network, which deters speeding. Finally, as all the devices are centralized, data regarding the program can be analyzed efficiently (Carnis, 2011).

5.2 NEW SOUTH WALES

New South Wales (NSW) in Australia has implemented SSC as part of NSW's 2026 Road Safety Action Plan to achieve vision zero. Automated enforcement in NSW began in 1988, with both speeding and red-light cameras at high-risk locations and across the network (Transport for NSW, 2022). Currently, there are four types of speed cameras in NSW (Transport for NSW, 2023):

1. **Fixed speed cameras** provide site-based enforcement by addressing localized risk at high-risk locations. These cameras are marked with advanced warning signs and their locations are publicized online. There are currently 140 cameras at 109 locations.
2. **Mobile speed cameras** provide network-based enforcement by detecting speeding across the network by moving around to different locations at different times. Mobile speed cameras can be moved around at different times and locations. These cameras are marked with advanced warning signs and their locations are publicized online. There are currently 1,024 locations delivering 7,000 enforcement hours per month.
3. **Red-light speed cameras** provide site-based enforcement at high-risk intersections to help enforce both red-light running and speed violations. These cameras are marked with advanced warning signs and their locations are publicized online. There are currently 222 cameras at 201 intersections.
4. **Average speed enforcement cameras** are placed in 25 regional locations to enforce heavy vehicle speeding. Only heavy vehicle speeds are enforced by these cameras. These cameras are marked with advanced warning signs and their locations are publicized online. Average speed enforcement lengths have been selected using criteria developed

by the Centre for Road Safety in Transport for NSW. Site selection is based upon several factors including the frequency and severity of heavy vehicle crashes, heavy vehicle speeds and road conditions (Transport for NSW, 2024). There are currently 29 lengths.

The automated enforcement program also includes detection of fatigue compliance among heavy vehicle drivers and detection of unregistered driving. In 2020, NSW introduced the first Mobile Phone Detection Camera program to enforce illegal mobile phone use while driving, following a pilot of the technology. These same cameras will also begin enforcing seatbelt non-use as part of the 2026 Road Safety Action Plan (Transport for NSW, 2022).

The NSW Automated Enforcement Strategy (Transport for NSW, 2022) outlines the aim, benefits and principles for the SSC program; details five key action areas for the program. The SSC program falls in the Safe System approach for safety, and is coupled with police presence to achieve two types of deterrence[9], similar to France:

- **Specific deterrence** – occurs when a motorist who has been penalized for an offense no longer engages in that behavior for fear of incurring additional penalties.

- **General deterrence** – occurs when a motorist refrains from illegal behaviors as a result of observing others being penalized or is warned of the penalties for illegal behaviors or likelihood of being caught.

The five key action areas are their associated actions are summarized in Table 5.1.

Fines vary by speed and range from $123 (less than 10 km/h over the speed limit) to $2,520 (over 45 km/h over the speed limit). New South Wales also has a program to help disadvantaged individuals who received a violation. The measures include the ability to have the penalty reviewed, and where eligible, payment plans or orders to complete unpaid work, courses or treatments in place of payment.

All fine revenue from enforcement cameras goes to the Community Road Safety Fund. This fund supports priority road safety programs. NSW publishes an annual report documenting the impact of speed cameras. The latest document (Transport for NSW, 2022) found that NSW speed camera programs continued to provide substantial road safety benefits to the NSW community. Overall, road trauma rates were considerably lower at fixed, red-light, and average speed camera locations, compared to pre-installation. The reduction in road trauma observed at camera

[9] **Positive Reinforcement in NSW**

- Currently in NSW, fully licensed motorists can receive a half price license if they have had no demerit points recorded over the last five years. This rewards good behavior, rather than punishing bad behavior, however the reward is not an immediate or regular one.
- Other existing benefits for positive road behaviors are somewhat ‘unseen’, such as not having to pay fines and lower insurance costs because insurers can access speed violation records.
- The NSW Automated Enforcement Strategy proposes the exploration of any additional or more immediate, positive rewards or reminders that may help motivate and reinforce safe behaviors on the road.

locations across these three NSW speed camera programs represented a savings of $1.1 billion to the NSW community over the five-year period 2016 to 2020.

Table 5.1: NSW Automated Enforcement Strategy - Key Areas and Actions

Key Area	Actions
Automated Enforcement Solutions	• Actively explore new and improved automated enforcement solutions considering: o Enhancement of existing technology and policies; o Expansion of the capabilities of existing enforcement technology to detect additional risky behaviors; and o Innovation, including seeking out new solutions. • Establish an expert advisory group to provide advice on automated enforcement developments. • Identify and implement the most appropriate solution for speed enforcement in road work zones
Enforcement Locations	• Use the criteria outlined in this Strategy for selecting locations for automated enforcement, and make this publicly available. • Continue to allow the community to nominate locations for speed and red-light cameras, along with road network managers (including local councils) and NSW Police for all camera types. • Integrate automated enforcement into road planning and design, and upgrades of key routes.
Communication and Education	• Engage the community to increase understanding of, and support for, the different ways automated enforcement is used in NSW to improve safety, to foster greater support and acceptance. • Increase community awareness of the Community Road Safety Fund through enhanced information and communication, outlining where the funds are invested throughout the year. • Continue to publish the locations of site and route based automated enforcement designed to address high risk locations, as well as the broad locations of mobile speed camera enforcement. • Consider extending public nominations for locations for automated enforcement, beyond speed and red-light cameras. • Develop public education campaigns to support any new, expanded or enhanced automated enforcement.
Ensuring Fair Enforcement	• Explore additional positive rewards or reminders for motorists to help motivate and reinforce safe road behaviors. • Review existing penalty related policies and develop new policies where relevant, to ensure fair and transparent enforcement processes. • Work with Revenue NSW to determine the suitability of including the relevant offense image on infringement notices. • Work with Revenue NSW and Service NSW to expand the electronic delivery of infringements, and notifications of infringements, for broader implementation. • Work with Revenue NSW and Service NSW to appraise the current process for requesting a review of an infringement to ensure it is straightforward and transparent.

Key Area	Actions
Research and Evaluation	• Continue to monitor community attitudes toward automated enforcement. • Complete an evaluation of the Strategy and its enforcement programs. • Continue to monitor the effectiveness of individual camera programs and make this information publicly available.

6.0 EMPIRICAL EVIDENCE-BASED SSC RESULTS

A wide range and variety of studies have been conducted on speed safety camera devices in the U.S. and abroad, both on speed and crash impacts. These studies cover a variety of contexts, such as fixed vs. mobile SSC, land classification, roadway type, SSC purpose, and different road users. Most studies show at least some speed and crash improvements, with average speeds decreasing by 0.5 to 7 mph and the proportion of speeding drivers decreasing by upwards of 50%. In addition, most studies found decreases in crashes, especially for injuries, in the 15% to 25% range.

In addition, a growing number of studies have looked at the halo effect, which measures how long speed and crash benefits last, both in terms of distance and time. The results are more mixed, but there is evidence that both a distance and time halo exist, though safety benefits are most pronounced at a camera site.

The most common analysis methodology was a before-after analysis with comparison groups, which allows the study to control for exogenous factors (like traffic volumes) that may otherwise affect speed or crash data. Some studies also employed more rigorous analysis procedures to account for regression-to-the-mean and time-correlated effects.

This chapter provides a summary of the evidence on the benefits of SSC, as well as provides an overview of the type of methodologies commonly employed for speed and crash analyses. It also reveals an opportunity for more research and analysis, as many U.S. studies are older or employ simple analysis techniques. A full review of SSC-related academic research is provided in Appendix D.

A summary of key worldwide studies on fixed SSC is provided in Table 2-1. Mobile SSC studies are described in Table 2.2. Studies are shown in chronological order. In the tables, the following color convention is used for percentages: **<0%**, **0-20%**, **20% - 40%**, **>40%**. Values recorded in other units, such as miles per hour, are in bold.

Table 6.1. Speed and Crash Outcomes Summary: Fixed SSC

Study	Site	Characteristics	Method	Speed Results	Crash Results
(Luoma et al., 2012)	Finland *Rural two-lane road*	Rural	Simple before-after analysis with comparison groups	**-1.5 mph** average speed **-11.8%** proportion of speeding vehicles	None
(De Pauw et al., 2014a)	Flanders, Belgium *65 cameras*	Highways	Simple before-after analysis with comparison groups	None	**-29%** fatal + serious injuries
(De Pauw et al., 2014b)	Flanders, Belgium *253 signalized intersections*	Intersections	Empirical Bayes before-after analysis with comparison groups, with a modification for regression-to-the-mean	None	**+44%** rear-end crashes **-24%** severe crashes
(Vanlaar et al., 2014)	Winnipeg, Canada *48 intersections*	Urban Seasons	Speed: the autoregressive, integrated, moving average (ARIMA) time series analysis Crashes: Matched case quasi-experiment with comparison group	No impact on average speeds **9%** to **38%** reduction in speeding violations as compared to control	No significant impact
(Blais & Carnis, 2015)	France *General SSC program throughout the country*	Comprehensive (Whole Country) Road Users	Simple before-after analysis Interrupted time-series using the ARIMA intervention time-series approach	None	**-41%** fatal crashes (no control) Public announcement of SSC and the introduction of SSC are associated with significant declines in traffic fatalities

Study	Site	Characteristics	Method	Speed Results	Crash Results
(Rogers et al., 2016)	D.C., USA *29 SSC locations*	Urban	Simple before-after crash counts (no comparison group) Simple before-after speed study (no comparison group)	Citation percentage was 1.18% of all vehicles in the first month of installation and steadily declined to 0.79% after 12 months Before installation, 5% vehicles 11+ MPH over the speed limit; after installation, <1% vehicles	Over three years, the average year-to-year reduction in crashes in the vicinity of the cameras was **9.35%, 13.16%,** and **30.30%**
(Martínez-Ruíz et al., 2019)	Cali, Colombia *38 cameras*		Quasi-experimental difference-in-differences study with before and after measurements and a comparison group Mixed negative binomial model	None	**-4.2%** relative to comparison in all crashes (-19.2% cameras vs -15% control)
(Santos et al., 2019)	Lisbon, Portugal *19 cameras*		Simple before-after analysis with comparison groups	None	**-42%** fatal crashes first year **-64%** fatal crashes second year
(Quistberg et al., 2019)	Seattle, USA *Four cameras*	School Zone	Interrupted time series approach using multilevel mixed linear regression	**-50%** driver speed violation rates in the citation period compared with the warning period **- 2.1 mph** maximum violation speed **-1.1 mph** average hourly speed	None

Study	Site	Characteristics	Method	Speed Results	Crash Results
(Sutton & Tilahun, 2022)	Chicago, USA *101 SSC locations*	Urban	Empirical Bayes method for before-after crash analysis	None	**-15%** fatal + severe injury crashes
(Guerra et al., 2023)	Philadelphia, Pennsylvania *Roosevelt Boulevard*	State Highway Pedestrian Crash Analysis	Bayesian negative binomial and Poisson models Control segments using k-means clustering	None	**100%** increase in fatal crashes on comparison sites as compared to experimental site **1.83** higher rates of pedestrian injuries and **2.53** times higher rates of pedestrian fatalities on comparison sites relative to the experimental site

Table 6.2. Speed and Crash Outcomes Summary: Mobile SSC

Study	Site	Characteristics	Method	Speed Results	Crash Results
(Freedman et al., 2006)	Portland, Oregon, USA *Five school zones*	School Zone	Before-after analysis with comparison groups	**-5 mph** average speeds (when SSC present) **-66%** proportion of vehicles exceeding speed limit	None
(Cunningham et al., 2008)	Charlotte, North Carolina, USA *19 corridors*	Urban Arterials Day vs. Night	Before-and-after study with comparison groups for crashes Random effects model w/ temporal correlation for speeds	**-0.82 mph and -0.67 mph** average speeds for two subsequent after periods % of speeding in the before period was 1.55 times the % of speeding in the after1 period and 1.23 times the after2 period	-10% all crashes
(Benekohal et al., 2009)	Illinois, USA	Work Zones Heavy Vehicles	Simple before-after study w/ tests of statistical significance	**-3.2 to -7.3 mph** average speeds **-32%** proportion of cars exceeding speed limit -13% proportion of heavy vehicles exceeding speed limit	None
(Moon & Hummer, 2010)	Charlotte, North Carolina, USA *19 corridors*	Urban Arterials	Before-and-after study with comparison groups for crashes Autoregressive integrated moving average (ARIMA) intervention analysis	None	First intervention (publicity campaign): -8% to -10% all crashes Second intervention (SSC deployment): -15% to -18% all crashes Post-intervention: -17% to **-21%** all crashes

Study	Site	Characteristics	Method	Speed Results	Crash Results
(Hajbabaie et al., 2011)	Illinois, USA	Work Zones Heavy Vehicles	Simple before-after study w/ tests of statistical significance	-9% proportion of drivers exceeding speed limit by 10+ mph	None
(Hu & McCartt, 2016)[10]	Montgomery County, Maryland, USA	School Zone	Simple before-and-after study (no comparison groups)	-10% average speeds **-62%** likelihood of a vehicle traveling more than 10 mph above the speed limit	**-39%** likelihood that a crash resulted in a fatal or serious injury
(Alamry & Hassan, 2020)	Saudi Arabia *Madinah-Makkah Expressway (210 km)*	Freeway	Negative binomial regression model and an observational empirical-bayes before-after study		**+36%** to **+75%** for all collisions
(H. Li et al., 2020)	Edmonton, Canada *206 urban, arterial roadway segments*	Urban Arterials	Empirical Bayes method for before-after crash analysis	None	-14% to -20% all crashes, highest reductions observed for severe collisions More reductions were found at segments that had more collisions during the before period and longer deployment hours

[10] This analysis includes both mobile and fixed cameras.

6.1 SSC LITERATURE

Appendix D documents the existing literature on speed safety camera, with a focus on speed and crash outcomes for different types and contexts of SSC. There were two meta-analyses conducted between 2008 and 2010 that selected and summarized the most methodologically sound literature on SSC from around the world. Since then, there has been additional research conducted, especially in the United States. Recent studies have spanned urban and suburban contexts; general, school zone, and work zone SSC; and varying roadway classifications. Some studies focused on a handful of roadways, while others were able to analyze a whole city (H. Li et al., 2020; Sutton & Tilahun, 2022) or even a whole country (Blais & Carnis, 2015). Table 7.1 summarizes key studies by characteristic.

Table 6.3 SSC Studies by Characteristic or Context

Characteristic	Studies
Urban	(Cunningham et al., 2005, 2008; Diamantopoulou, 2002; H. Li et al., 2020; Montella et al., 2015; Moon & Hummer, 2010; Pérez et al., 2007; Rogers et al., 2016; Sutton & Tilahun, 2022; Tay, 2000; Vanlaar et al., 2014)
Rural	(Chen et al., 2000; Goldenbeld & van Schagen, 2005; Høye, 2015; Luoma et al., 2012; Oei, 1996; Vaa, 1997)
School Zone	(Freedman et al., 2006; Hu & McCartt, 2016; Quistberg et al., 2019; Retting et al., 2008; Retting & Farmer, 2003)
Work Zone	(Benekohal et al., 2009; Hajbabaie et al., 2011; Medina et al., 2009)
Freeways	(Alamry & Hassan, 2020; Retting et al., 2008; Shin et al., 2009)
Arterials/ 'Trunk' Roads/ Highways	(Cameron et al., 1992; Champness et al., 2005; Chen et al., 2002; Cunningham et al., 2008; De Pauw et al., 2014a; Guerra et al., 2023; Hung-Leung, 2000; H. Li et al., 2020; LNCS, 1997; Maekinen, 1994; Moon & Hummer, 2010; Pérez et al., 2007)
Intersections	(De Pauw et al., 2014b; Izadpanah et al., 2015; Vanlaar et al., 2014)
Covert Enforcement	(Alamry & Hassan, 2020; Cameron et al., 1992; Chen et al., 2000, 2002; Gains et al., 2004)

Some specific studies looked at factors that affected SSC outcomes. Of note are:

- Cameron et al., 1992 evaluated urban versus rural crashes in Australia.
- Chen et al., 2002 analyzed daytime crashes only, while Cunningham et al., 2008 studied daytime vs. nighttime crashes.
- Diamantopoulou, 2002 investigated the differences between overt and covert enforcement.
- Gains et al., 2004 and Guerra et al., 2023 looked at pedestrian crashes.
- Retting et al., 2008 investigated the effects of warning signs without enforcement and with enforcement on SSC outcomes.

- De Pauw et al., 2014b and Izadpanah et al., 2015 evaluated rear-end crashes at intersections.

- Blais & Carnis, 2015 and De Pauw et al., 2014a evaluated outcomes for different road users (e.g. pedestrians, heavy vehicles, mopeds). Benekohal et al., 2009 and Hajbabaie et al., 2011 separated results for heavy vehicles, as their studies focused on work zones on freeways.

6.2 SSC METHODS

A variety of methods were used to analyze speed and crash outcomes. Key factors of a methodologically sound study include:

- Analyzing both speeds and crashes to provide a causal link between the treatment and effect.

- Accounting for crash severity, if crashes are analyzed.

- Selecting a method that controlled for traffic volume changes, possible time trend effects (e.g., general trends in crashes, seasonal changes, or changes in the motoring population, vehicle fleet, weather), or other exogenous factors (1.g., concurrent treatments, changes in data measures). This can be controlled via a comparison group.

- Accounting for regression toward the mean (RTM).

Many studies used a simple before-after study with comparison groups to estimate speed and crash outcomes (Benekohal et al., 2009; De Pauw et al., 2014a; Freedman et al., 2006; Hajbabaie et al., 2011; Luoma et al., 2012; Santos et al., 2019). Another common, more advanced technique is the empirical Bayes before-after study with comparison groups, which allows a study to control for exogenous factors and correct for regression to the mean (Alamry & Hassan, 2020; De Pauw et al., 2014b, 2014b; Elvik, 1997; Høye, 2015; H. Li et al., 2020; Montella et al., 2015; Mountain et al., 2004; Sutton & Tilahun, 2022).

Before-After Comparison with Control Groups: This approach compares crash and/or speed data from before and after SSC implementation in both the treatment areas (where SSC is implemented) and the control areas (where SSC is not implemented). The goal is to see if the treatment areas show a greater reduction in crashes and/or speeds compared to the control areas, assuming that any changes in the control areas reflect broader trends unrelated to SSC.

Empirical Bayes Method: This method enhances the analysis by using historical data from both treatment and control areas to estimate the expected number of crashes and/or speeds in the absence of SSC. It then compares these expected values to the observed values after SSC implementation. By incorporating data from multiple areas and time periods, it accounts for random fluctuations and underlying trends, providing a more accurate estimate of SSC's impact. This method accounts for regression to the mean and is more sophisticated but requires more data.

Other methods include:

- An ARIMA (AutoRegressive Integrated Moving Average) approach, a popular time series forecasting method used to understand and predict future points in a time series. This method captures temporal dynamics, smooths out random 'noise' in the data, and allows for quantitative forecasting (Blais & Carnis, 2015; Moon & Hummer, 2010; Vanlaar et al., 2014).

- A regression model, a statistical tool used to examine the relationship between one dependent variable and independent variables, is used to determine the extent of the impact of SSC on speed/crash outcomes. Negative binomial regression models were the most common (Alamry & Hassan, 2020; Guerra et al., 2023; Martínez-Ruíz et al., 2019), but other regression techniques such as linear, logistic, and polynomial were also used (H. Li & Graham, 2016; Quistberg et al., 2019; Vanlaar et al., 2014).

Finally, some studies used a simple before-after study with no comparison groups. The results of these studies should be interpreted with caution, as they do not provide evidence for a causal relationship between SSC and speed/crash outcomes (Chen et al., 2000; Hu & McCartt, 2016; Rogers et al., 2016).

6.3 SSC OUTCOMES

Overall, both speed and crash outcomes are positive (reduced speeds and crashes) for most studies in varying contexts. Results for the halo effect are more mixed.

6.3.1 Speed

Studies used varying metrics to measure speed changes, including changes in average speed; 85^{th} percentile speed; proportion of drivers exceeding the speed limit; and proportion of drivers receiving violations. Key results are below:

- **Average speeds** were shown to decrease by 3% to 14% , but were most commonly reduced by around 10% (Diamantopoulou, 2002; Hu & McCartt, 2016; Montella et al., 2015; Retting et al., 2008; Retting & Farmer, 2003).

- Average speeds typically fell by 0.5 to 7 mph (Agustsson, 2001; Bar-Gera et al., 2017; Benekohal et al., 2009; Cairney et al., 1993; Cunningham et al., 2008; Freedman et al., 2006; Keall et al., 2002; Luoma et al., 2012; Oei, 1996; Pauw et al., 2014; Retting et al., 2008; Vaa, 1997).

- **85^{th} percentile speeds** were shown to decrease by 2 to 5 mph in multiple studies (Champness et al., 2005; Cunningham et al., 2008; Freedman et al., 2006; Keall et al., 2002; Oei, 1996), and by 14% on one study (Montella et al., 2015).

- The **proportion of drivers exceeding the speed limit** varied from 10% to 80%, but results were relatively divided between a lower proportion of 10% to 30% (Agustsson, 2001; Gains et al., 2004; Luoma et al., 2012; Oei, 1996; Retting et al., 2008; Vaa, 1997) and a higher proportion of 60% or more (Diamantopoulou, 2002; Freedman et al., 2006; Gains et al., 2004).

- The **proportion of drivers exceeding the speed limit b**y to 6 to 15 mph over the speed limit varied a bit more, from about 5% to 85% (Agustsson, 2001; Freedman et al., 2006; Gains et al., 2004; Hajbabaie et al., 2011; Montella et al., 2015; Retting et al., 2008; Retting & Farmer, 2003)

- The **percentage of drivers receiving violations** dropped from between 9% and 50% (Gouda & El-Basyouny, 2017; Quistberg et al., 2019; Rogers et al., 2016; Vanlaar et al., 2014).

Vanlaar et al., 2014 showed no impact on average speeds and some mixed results on other speed measures, but all other studies looking at speed showed improvements as compared to comparison sites.

6.3.2 Crashes

Many of the selected studies looked at crash outcomes, both for all crashes and for fatal and injury crashes.

- Studies looking it **all crashes** saw reductions of between 4% and 55% (ARRB Group Project Team, 2005; Chen et al., 2002; Cunningham et al., 2005, 2008; Jones et al., 2008; Keall et al., 2002; H. Li et al., 2020; LNCS, 1997; Martínez-Ruíz et al., 2019; Shin et al., 2009; Tay, 2000). As seen in Figure 7-1 most reductions are between 4% and 27%.

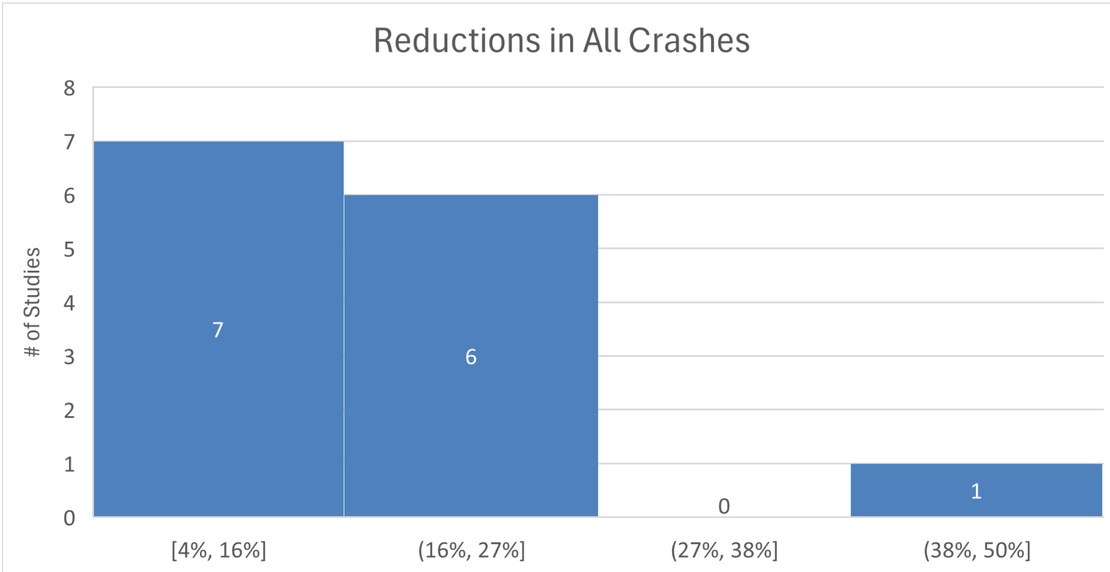

Figure 6.1 Reductions in All Crashes

- Studies looking at **fatal and/or serious injury crashes** found reductions between 15% and 90%, but was most commonly between 13% and 51%, as shown in Figure 7-2 (ARRB Group Project Team, 2005; Blais & Carnis, 2015; Cameron et al., 1992; Chen et al., 2000; De Pauw et al., 2014b; Diamantopoulou, 2002; Gains et al., 2004; Goldenbeld & van Schagen, 2005; Hu & McCartt, 2016; Jones et al., 2008; LNCS, 1997; Luoma et al., 2012; Newstead & Cameron, 2003; Santos et al., 2019; Sutton & Tilahun, 2022; Tay, 2000).

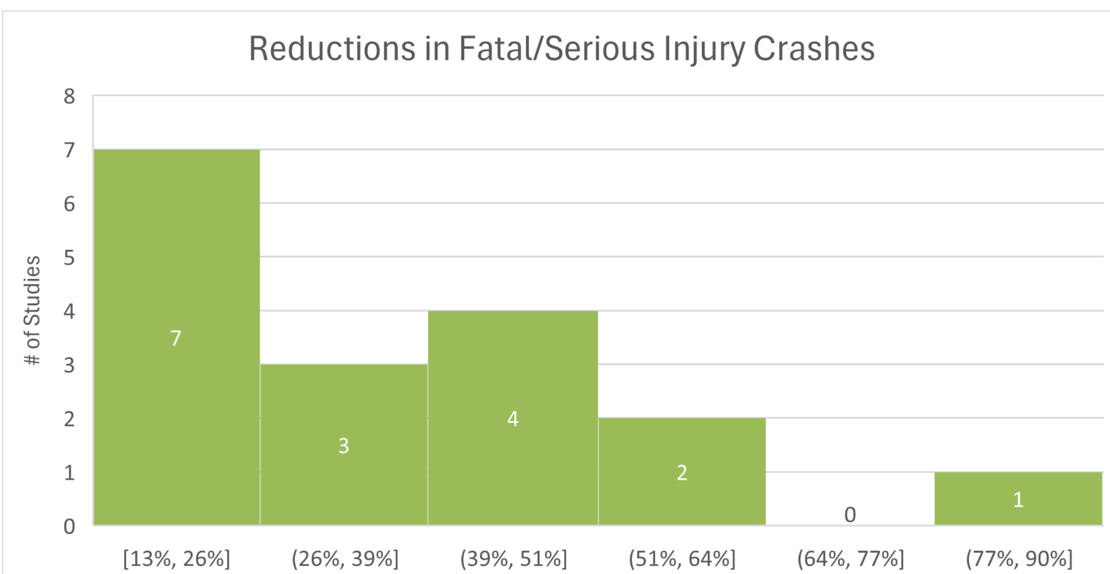

Figure 6.2 Reductions in Fatal/Serious Injury Crashes

- Studies looking at **injury crashes** found reductions between 5% and 71%, but was most commonly between 16% and 27%, as shown in Figure 7-3 (Agustsson, 2001;

ARRB Group Project Team, 2005; Christie et al., 2003; Diamantopoulou, 2002; Elvik, 1997; Goldenbeld & van Schagen, 2005; Hess, 2004; Hung-Leung, 2000; Keall et al., 2002; Mountain et al., 2004; Shin et al., 2009; Sutton & Tilahun, 2022).

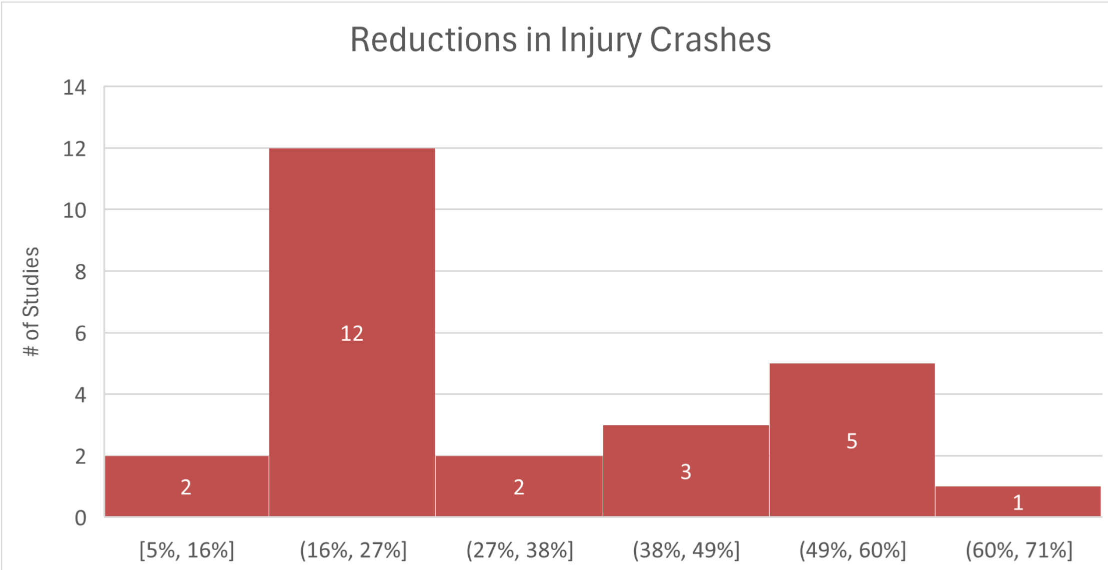

Figure 6.3 Reductions in Injury Crashes

(Alamry & Hassan, 2020) showed increases in crashes in Saudi Arabia, and a couple other studies showed increases in rear-end crashes (De Pauw et al., 2014b; Izadpanah et al., 2015).

6.3.3 Halo Effect

Studies on the distance and time halo effects were mixed. For the distance halo, halos of 250 meters to 500 meters were found (Hess, 2004; Mountain et al., 2004), with some studies indicating a bigger halo effect for downstream areas (ARRB Group Project Team, 2005; Fu & Liu, 2023). An older study found a 2-3 km halo effect, with a larger upstream halo effect (Maekinen, 1994).

Results on the time halo were even more mixed, with some studies indicating time halos of weeks or years (Beilinson et al., 2004; Talebpour et al., 2014) while others only observed halos in the days or hours after enforcement (Benekohal et al., 2009; Champness et al., 2005; Gouda & El-Basyouny, 2017).

7.0 LOCATION SELECTION CRITERIA AND PUBLIC OUTREACH STRATEGIES TOWARDS OBTAINING BROAD PUBLIC ACCEPTENCE

7.1 SURVEY DESIGN METHODOLOGY

ODOT is conducting a research project to better understand how the best practices of deploying Speed Safety Camera (SSC) in Oregon. A key issue for deployment of SSC systems includes public acceptance, therefore this project will conduct a public opinion survey of Oregonians to understand current sentiments on the following categories of questions:

- Privacy
- Ticketing guidelines and transparency
- Placement and location strategies
- General policy,
- Population belief on the outcomes of the systems
- Revenue from the systems

By understanding more precisely how Oregonians feel about SSC across the above dimensions, ODOT can work to support a more equitable and acceptable implementation of these systems in Oregon.

7.1.1 Challenges with online panel-based surveys and pathways forward

The research team is proposing using the widely known survey platform Qualtrics. Qualtrics eases survey design and implementation and will allow the team to specify the number of individuals surveyed based on zip codes throughout Oregon with the additional constraint that those responding to the survey match predefined criteria. To be eligible to participate potential survey respondents must fit predefined socio demographic categories to ensure the survey is representative of the broader population. This zip code or ZIP code Tabulation Area (ZCTA) and demographic based quota is a common strategy employed by online, panel based, surveys in order to reduce population biases. An overview of ZCTAs is shown in Table 7.1

While the utilization of online panel-based survey strategies allows for the ability to capture a large and diverse population of respondents, it does have its drawbacks. Survey biases arise in any population that is meant to represent a random, sub-set of the larger population. This is broken down into major areas and described in the following sections.

Table 7.1: Zip Code Tabulation Areas

Overview of ZIP Code Tabulation Areas (ZCTA
ZCTAs (ZIP Code Tabulation Areas) are area representations of ZIP Codes, created using 2020 Census blocks. As the Census Bureau is restricted to Title 13 limiting individual address data.
Purpose: ZCTAs are created by the U.S. Census Bureau for statistical purposes, primarily for tabulating census data
Definition: ZCTAs are approximate area representations of ZIP Code service areas. They are more stable and are defined by aggregating U.S. Census blocks that share the same predominant ZIP Code.
Stability: Unlike ZIP Codes, ZCTAs are more static and do not necessarily change as frequently since they are used for data collection and analysis rather than mail delivery

7.1.1.1 Sampling Bias

The core feature for both selection and sampling bias is the lack of an accurate representation of the target population. In the case of Qualtrics, which utilizes various methods on the selection of panel members within their process, panel members may not be a random sample even if quotas are taken into effect.

For instance, specific inclusion criteria were investigated within (Miller et al., 2020) and found that having less stringent geographical quotas (quota being a required number of individuals survey that match specific socioeconomic, demographic or geographic constraints) still lead to a diverse geographical representation and furthermore having a less restrictive quota decreased survey sample acquisition reducing expenses and selection bias. Without any inclusion or sampling criteria 67% of the respondents were females, and further with no race/ethnicity quota the majority of the sample was white/caucasian. When specifying highly constrained socio-demographic quotas, more affluent or high-income participants were difficult to obtain.

7.1.1.2 Coverage Bias

Similar to sampling bias, coverage bias exists when large portions of the target population lack the ability to access the survey. For instance, online surveys will not reach those without internet access, and of course those that are not already informed of the presence of online survey panels.

As this will be an online survey, there is not a process to account for coverage bias however information exists by ZCTA about the percentage of households without access to the internet and it ranges from 5% to 10% in Oregon and can be expanded to include different socioeconomic/demographic proportions that were missing as a post survey process. Furthermore, portions of Oregon's population not captured from the ACS survey would not be identified through this methodology and therefore is an additional missing population group that would not be observed through Qualtrics.

7.1.1.3 Approaches to Counter Known Survey Bias

Given the above potential for survey bias, the below summarizes potential approaches to minimizing the effects of biased sampling strategy. These strategies include true random sample, stratified and Quota sampling, and post-process weighting. More details are presented below on each of these strategies.

7.1.1.3.1 True random sample

In this case the use quotas of the survey population is not conducted. The idea is to form a completely random sample, although as mentioned above there is a possibility to have overrepresentation. An example of how this would be conducted, leading towards a subset of geographic zones for Qualtrics to consider is discussed.

Every zip code in Oregon is eligible for being randomly selected with the number of respondents from each selected respondent proportional to the number of people in that zip code relative to the Oregon population with no extra demographic or socio-economic consideration. Figure 7.1 demonstrates how this would apply, specifically for households, however our total population would be in relation to the subset of random ZCTAs selected and not the entire subset of Oregon.

Past research (Miller et al., 2020) has noted this approach can impact representation of some groups. This is further extended with considering post weighting of the results discussed in section 7.1.1.3.2, and an example of the process within Scenario 1 in section 7.1.2.1.

Figure 7.2: Example on proportional sampling (Futri et al., 2022)

No	Province	Total Household Population	Proportion: % of Total Population	Total sample: Proportion x 1,500	Final Sample (Rounded)
1	DI Aceh	1,231,058	0.023	33.917	34
2	North Sumatera	3,453,874	0.063	95.158	95
3	West Sumatera	1,291,397	0.024	35.579	36
4	Riau	1,522,700	0.028	41.952	42
5	Riau Island	521,100	0.01	14.357	15
6	Jambi	901,838	0.017	24.847	24
7	South Sumatera	2,052,499	0.038	56.548	57
8	Bangka Belitung Island	349,500	0.006	9.629	10
9	Bengkulu	509,000	0.009	14.023	14
10	Lampung	2,060,500	0.038	56.769	57
11	Banten	3,168,512	0.058	87.296	87
12	DKI Jakarta	2,758,709	0.051	76.005	76
13	West Java	13,231,615	0.243	364.545	364
14	Central Java	9,365,959	0.172	258.042	258
15	DI Yogyakarta	1,120,477	0.021	30.87	31
16	East Java	10,905,696	0.2	300.463	300

7.1.1.3.2 Quota and Stratified Sampling

Quota sampling or controlled quotas (Futri et al., 2022) is an attempt to require the selection of the survey group meet the socioeconomic/demographic characterization of the greater population. The process includes defining specific socioeconomic or demographic characteristics of the entire population and requires the percentage of these variables found within the full population be explicitly captured when selecting survey respondents. How this is provided to Qualtrics is as an output table from the research team. The research team will randomly choose a set of ZCTA's from the entire population, following this the proportion of respondents within each ZCTA will be scaled to the proportion that specific socioeconomic/demographic variables are present from the specific ZCTA. The full description and example of this are shown within Scenario 2 in section 7.1.2.2 One drawback of this method is the inability to always satisfy certain socioeconomic/demographic proportions from the population.

While the true random sample above removes any selection bias, there is the risk of oversampling. Further extensions of this are both stratification and quota-based sampling. Stratification being the closest to random sampling, this involves predetermined splits of the population for some specific set of socioeconomic/demographic variables, to which we would randomly sample from this subset. An example of this is shown later in example Scenario 3 in section 7.1.2.3, where all the ZCTAs which had a certain population, or percent of the total population within the ZCTA that were African American, were subset from the entire sample. From this point, there was a preceding random sample of that subset. This approach still incorporates randomness while providing a higher probability for certain sections of the population to be chosen.

7.1.1.3.3 Post Survey Weighting

With the above approaches to deal with known bias from online panel-based surveys, one last methodology can be applied towards representing the entire population. Post survey weighting can be utilized when sampling bias or response rates lead towards an un-diverse or under representative sample. The general idea is to utilize statistical weights on those respondents that are under-represented to increase their representation in the survey data.

The first step would be to utilize the ACS measures of socio-economic/demographic data for the entire state of Oregon, this also sets the benchmark or distribution of the greater population that the survey is attempting to capture from with its sub-population sample. Preceding this a calculation on initial weights is conducted. In general, this would consider the baseline probability of being selected as a survey candidate given the split of socioeconomic/demographic characteristics with respect to the specific ZCTA. Following this, their response are multiplied by this weight, which effectively moves the mean of the responses.

Lastly, post-stratification can occur which adjusts the initial weights attempting to meet specific population group goals and may be consideration for the broader population of Oregon or meant to better represent that individual ZCTA. This can further be classified into more specific groupings as well or combinations, such as a race and income category combination. However, this is usually left to isolated categories, such as age, race, and income.

7.1.2 Example of selected scenarios

7.1.2.1 Scenario 1 Outputs: Random Selection with Weighting– $11.10 per sample

1. Randomized selection of a set of ZCTAs (25% of the entire set of ZCTA for Oregon 96/428)

2. Each ZCTA would meet a respondent quota based on the number of expected respondents proportional to its population with respect to the survey population size with no other consideration for quotas.

The outputs for scenario 1 are shown in the following Figures and Tables. Within Figure 7.2 and Figure 7.3, the selected set of random ZCTAs, 25% of the entire 428 ZCTAs that represent Oregon were chosen resulting in 96 individual ZCTAs. In a general sense the geographic representation, even from a random selection process, captured some of the dense population centers of Oregon such as Portland, Eugene, and Salem as well as more rural areas. Following the selection on the specific ZCTAs, the first approach would simply consider the total population within the ZCTA, to the entire sample population and require a percentage of that value to then be sampled from the ZCTA, which is shown in Table 7.2. Only several ZCTA values were shown, however the proportion desired to be surveyed from that specific ZCTA would match the same ratio from the broader sample.

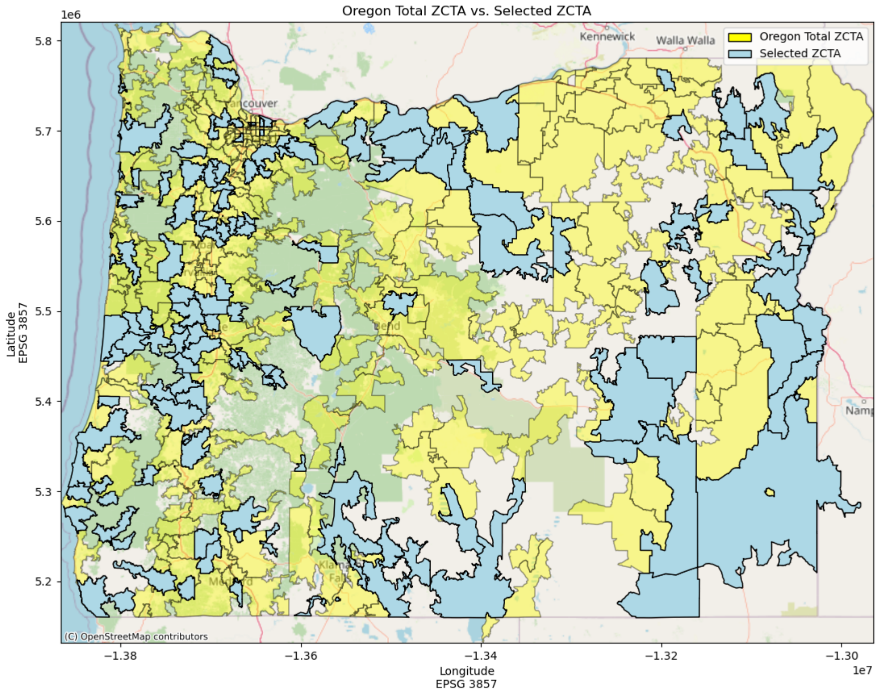

Figure 7.2: Combined Oregon Filtered ZCTA vs. Randomly Selected ZCTA

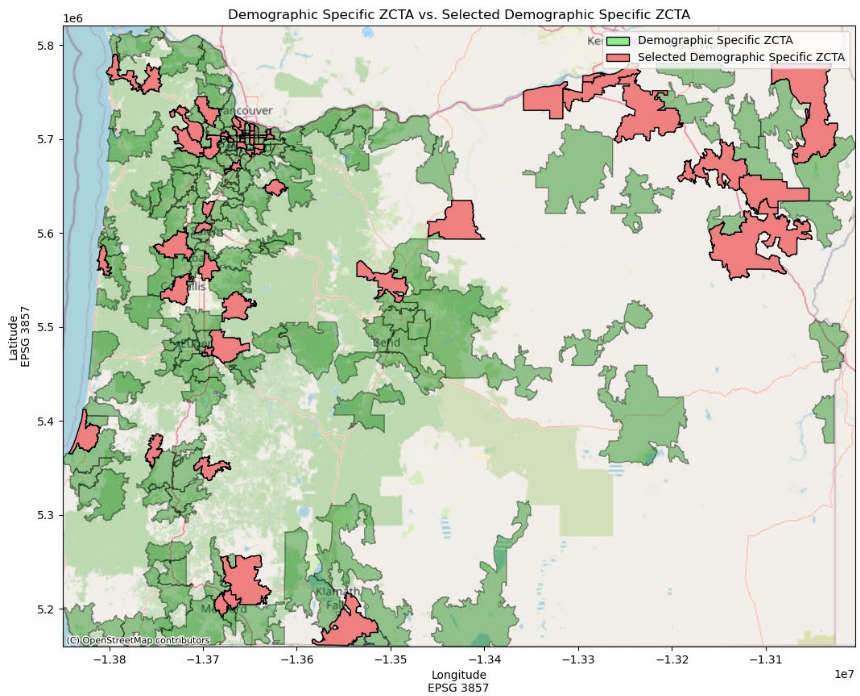

Figure 7.3: Demographic Filtered ZCTA vs. Randomly Selected Demographic ZCTA

Table 7.3: Example Population Proportion Table Output

ZCTA	Total Sample Population by ZCTA	Proportional Sub-Sample Population by ZCTA	Total Sample Population	Total Sub-Sample Population
97231	3642	3	1081554	1000
97034	20688	19		
97024	11195	10		
97113	14530	13		
…	…	…		
97913	5139	5		

While this base process would be the quickest, there would be a high probability of over sampling certain predominant population groups such as those that are White/Caucasian, this leads to weighting considerations which occur post-survey and is as follows:

- Split the initial observations down into the corresponding percentages from the full population versus what the true population percentage should be for every response given the socio-economic/demographic characteristic of the respondent, of which an example is shown in Table 7.3.

Table 7.4: Example Post-Survey Weighting Strategy

ID	Race	Income	Binary Quest.	Likerk Quest.	Race Weight	Income Weight	Total Weight	Binary Weight	Likert Weight
1	Black	low	1	4	1.25	0.83	1.04	1.04	4.17
2	White	medium	0	5	0.99	1.10	1.09	0.00	5.47
3	Black	high	1	3	1.25	1.00	1.25	1.25	3.75
4	White	medium	0	2	0.99	1.10	1.09	0.00	2.19
5	Black	low	1	4	1.25	0.83	1.04	1.04	4.17
6	White	high	0	5	0.99	1.00	0.99	0.00	4.97

7.1.2.2 Scenario 2: Random Selection of ZCTAs With Quotas - Cost will be greater than random

1. Similar to potential Scenario 1, a percentage of the entire set of ZCTAs are chosen at random.

2. Use American Community Survey Oregon specific and ZCTA specific socio-economic/demographic proportions to obtain a distribution from the randomized sample that matches the broader proportion of Oregon as a whole.

Table 7.4 gives an example of two additional variables that would be considered amongst the other remaining socio-economic/demographic variables that would be leveraged on a quota basis. The sociodemographic elements that would be covered in the approach would be race, gender, education, age, and income, to which the specific zip code would have the representative percentage corresponding to the broader sample set. This comparison to the anticipated number of respondents by percentage compared to the larger sample and the entire population of Oregon are demonstrated in Table 7.5, where example samples from each category are shown. The full set of these variables are provided in project documentation and specific graphs are shown to provide the percentage of these variables in relation to Oregon as a whole in Figure A.1 and Figure A.2.

Table 7.5: Example Quotas per ZCTA and Variables Output Scenario 2

ZCTA	Total Sample Population by ZCTA	Proportional Sub-Sample Population by ZCTA	Total: Black or African American alone	Total: $200,000 or more: Households	Total Sample Population	Total Sub-Sample Population
97231	3642	3	0	1	1081554	1000
97034	20688	19	0	7		
97024	11195	10	1	1		
97113	14530	13	0	1		
…	…	…				
97913	5139	5	0	0		

Table 7.6: Example Population Proportion Table Output Scenario 2

	Total Population	AGE: 25-64 (%)	RACE: People who are Asian alone (%)	EDUCATION: Bachelor's degree: Population 25 years and over (%)	INCOME: Total: $200,000 or more: Households (%)
Sub-Sample	1000	52.4	4.3	14.9	8.5
Sample	1081554	52.9	4.4	15.7	8.7
Oregon Total	4207044	53	4.4	15.3	8.4

7.1.2.3 Scenario 3: Stratified Sampling of Key Demographics

1. Subset the entire Oregon ZCTA sample based on minimum thresholds for key demographics.

2. Randomly select from this subset and assign half the population sample from this specific subset and utilize the other half from the remaining full ZCTA list

The stratified approach attempts to address the limitations on meeting specific quotas from ZCTAs while still maintaining randomness to the survey sample set. While we are aiming for 1000 survey respondents, we specifically require half, 500, to be randomly chosen from ZCTAs that have high proportions of diverse populations. A scenario provided in Figure 7.4, Figure 7.5 and Figure A.3, randomly selects 50% of the ZCTAs where there is at least 100 African Americans or African Americans make up at least 1% of the total population in that ZCTA. This process was repeated with variations in the splitting approach and total proportion of sample set desired. These results are best summarized by comparing the summary statistics between different run on the sample demographic variables and can be found in Figure 7.6.

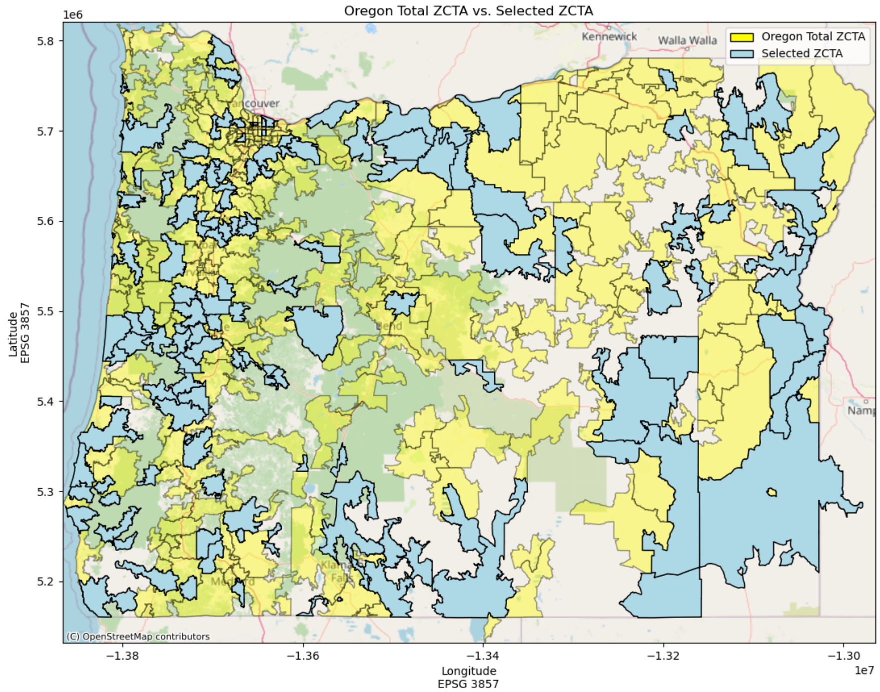

Figure 7.4: Combined Oregon Filtered ZCTA vs. Randomly Selected ZCTA

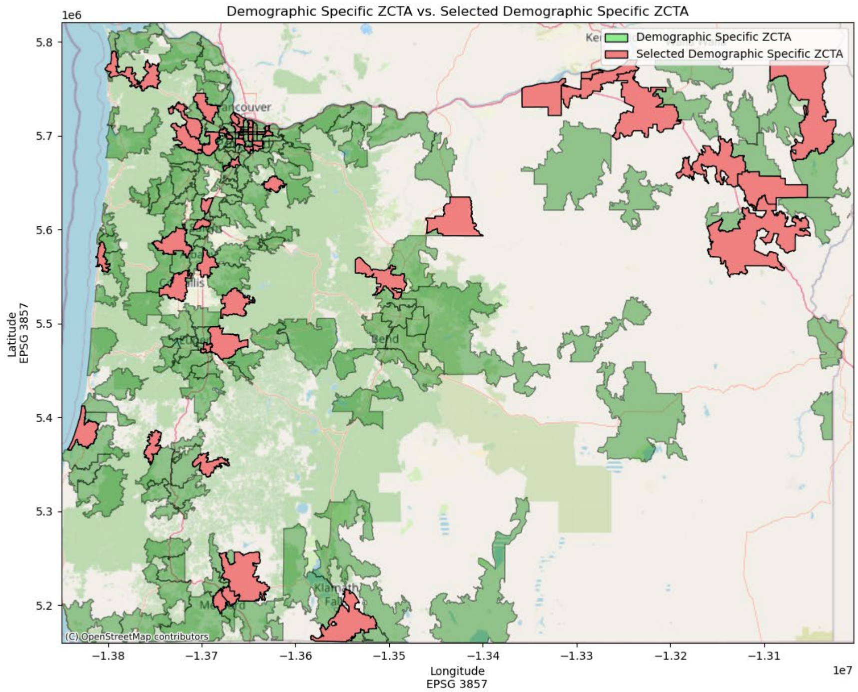

Figure 7.5: Demographic Filtered ZCTA vs. Randomly Selected Demographic ZCTA

Table 7.7: Example Population Proportion for Specific Demographic Scenario 1 African American

Random Selection		
Diverse Demographic Split	Scenario	Output Sample %
100 or 1% of Total ZCTA	500/500	2.2%
	750/250	2.7%
	1000	2.2%
Sorted Selection		
Diverse Demographic Split	Scenario	Output Sample %
100 or 1% of Total ZCTA	500/500	2.6%
	750/250	2.7%
	1000	3.4%

While these values are meant to provide an example on how to arrive at a higher selection rate towards obtaining a more diverse sample, this can be further increased by reducing the total number of ZCTAs allowed to be sampled and only choosing those with the highest rates. What is apparent, however, when conducting this approach is that only urban areas are selected, at the highest point to where no rural areas get chosen. This is shown in Figure 7.6 where the majority of the ZCTAs selected were located in Portland, Salem, Albany, Corvallis, Medford and Eugene, resulting in a specific demographic split for African Americans to reach 3.4% compared to the 1.9% that comprises all of Oregon.

The final benefit of this approach as well, would be the relaxed requirement on specific socio-economic and demographic quotas instead by first filtering towards a diverse sample, the random selection of individuals from these ZCTAs would have a much high chance of also being diverse.

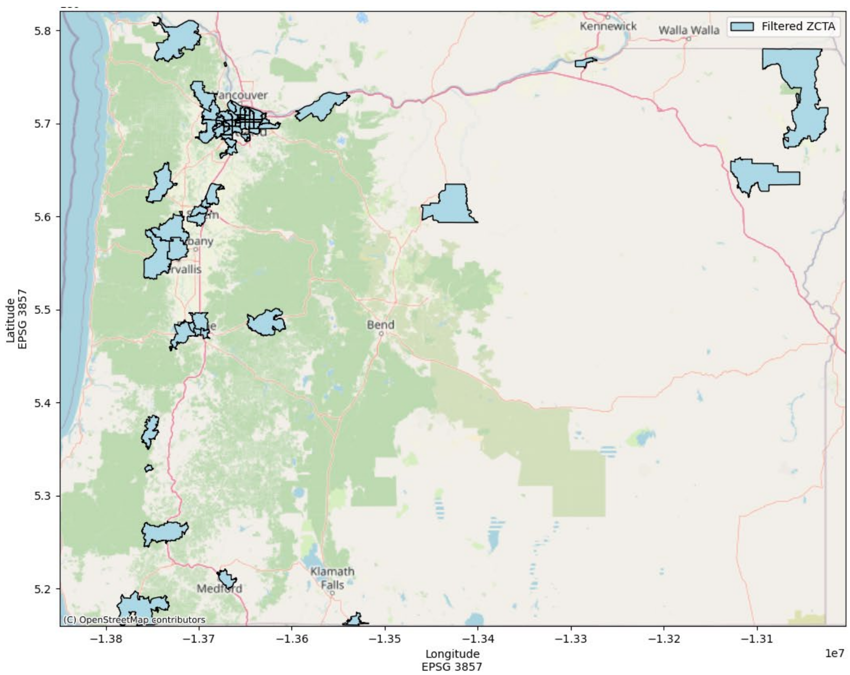

Figure 7.6: Demographic Sorted ZCTA Selection 1000 sample

7.2 QUALTRICS SURVEY RESULTS

The research team utilized Qualtrics, a platform that captures and analyzes customer, employee, product, and brand experiences. In our case, we utilized Qualtrics for panel-based surveys, to gather targeted feedback from specific demographic groups in the state of Oregon. By using panel-based surveys, we could reach predefined audiences and obtain high-quality data tailored to our research objectives. Qualtrics' interface, in combination with Oregon States partnership allowed for a streamlined process from developing the survey, identifying the respondents and resulting in a final survey dataset on Oregonian perceptions of speed safety camera systems, with 1000 vetted respondents. From a geospatial perspective, shown in Figure 7.7 and Figure 7.8, there is ample coverage across Oregon, with specific hot spots occurring in Portland, Salem, Albany, Corvallis, Eugene, Bend, Medford, and Ashland. Furthermore, there is also rural coverage across the state. The remainder of this chapter will analyze the descriptive statistics of the survey, and the corresponding outputs on how to best obtain public acceptance of these systems through different policy and implementation approaches found through the surveys.

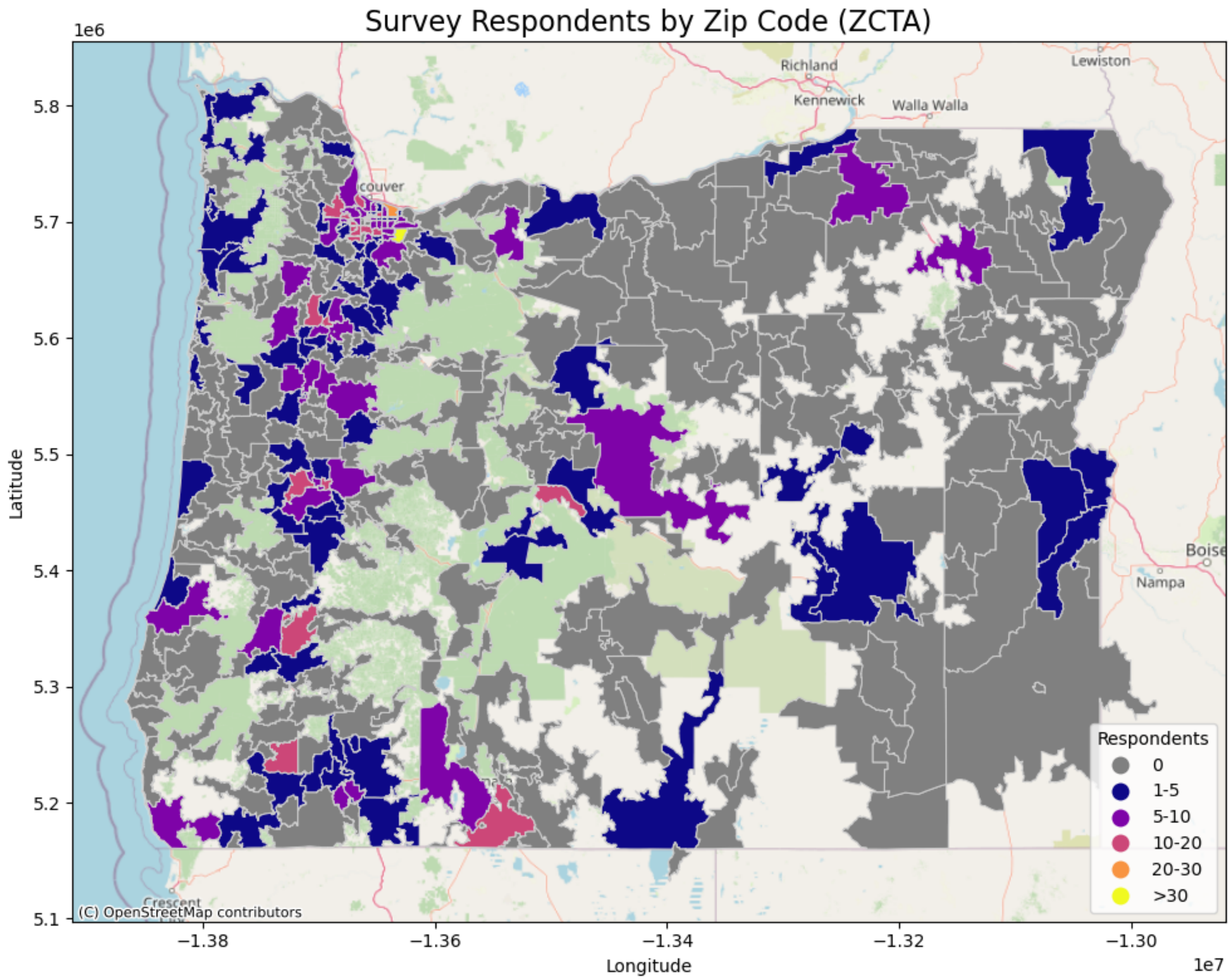

Figure 7.7: Survey results number of respondents per ZCTA

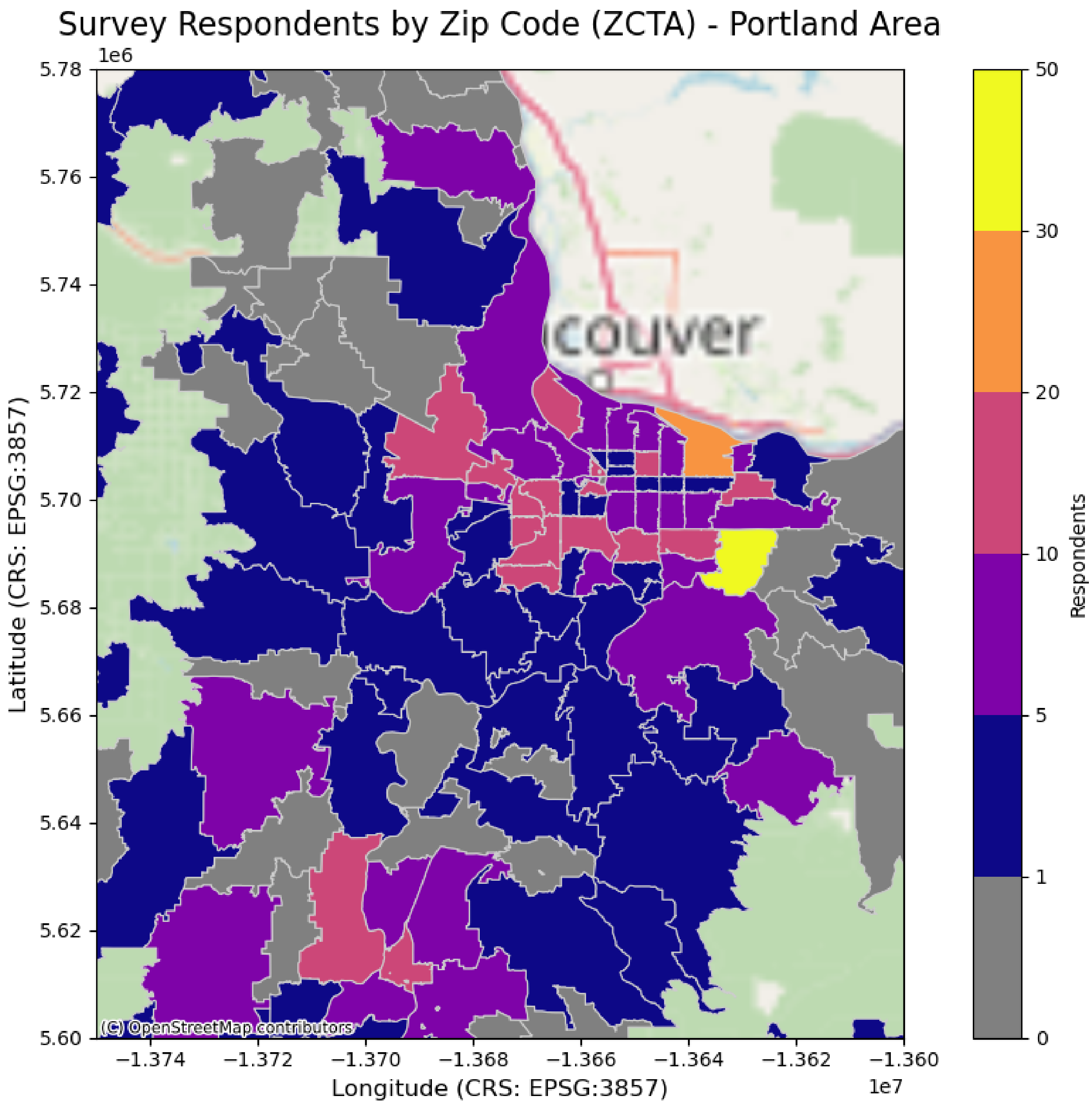

Figure 7.8: Survey results number of respondents per ZCTA - Portland area

7.2.1 Survey Descriptive Statistics

With the assistance of Qualtrics, specific demographic quotas were initially set to ensure statistical significance within the final output dataset. As such the final demographic outputs of the survey resulted in the desired oversampling of certain population groups as to obtain statistical significance.

7.2.1.1 Socio-economic and demographic results

For the socio-economic and demographic survey outputs, comparisons were made to the American Community Survey 5-year dataset for Oregon. Starting with demographics information the survey results obtained and are compared against household data in Oregon and are shown in Figure 7.9. While it is evident some of the demographic categories are over and underrepresented this allows the research team to follow up with random screening of these samples for more statistical processing. What is beneficial is the larger volume of demographics categories that have low representation within the broader population but are captured from the survey.

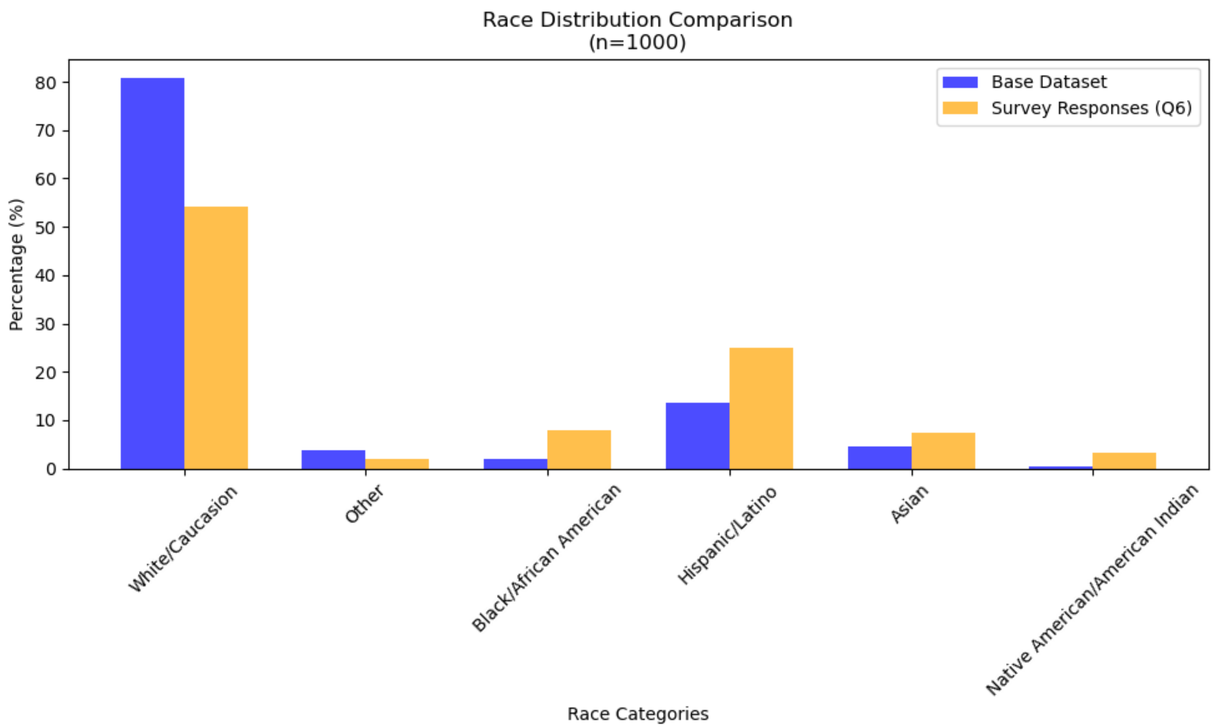

Figure 7.9: Demographic comparison of survey outputs versus state of Oregon demographics

Turning to the age results from the survey in Figure 7.10 and Figure 7.11; while ACS gave large ranges for the age brackets, within the over 64 and 18-24 ranges in age the survey was close to that observed within the ACS while the 25-64 bracket received extra responses. Looking more closely at the age breakdown from the survey results, into their more finite brackets shown in Figure 7.11, there is over 5 percent in every bracket, or over 50 individuals. While the 35-39 bracket has a large number of respondents, and the over 64 as well, the populations age component was captured effectively from the survey approach.

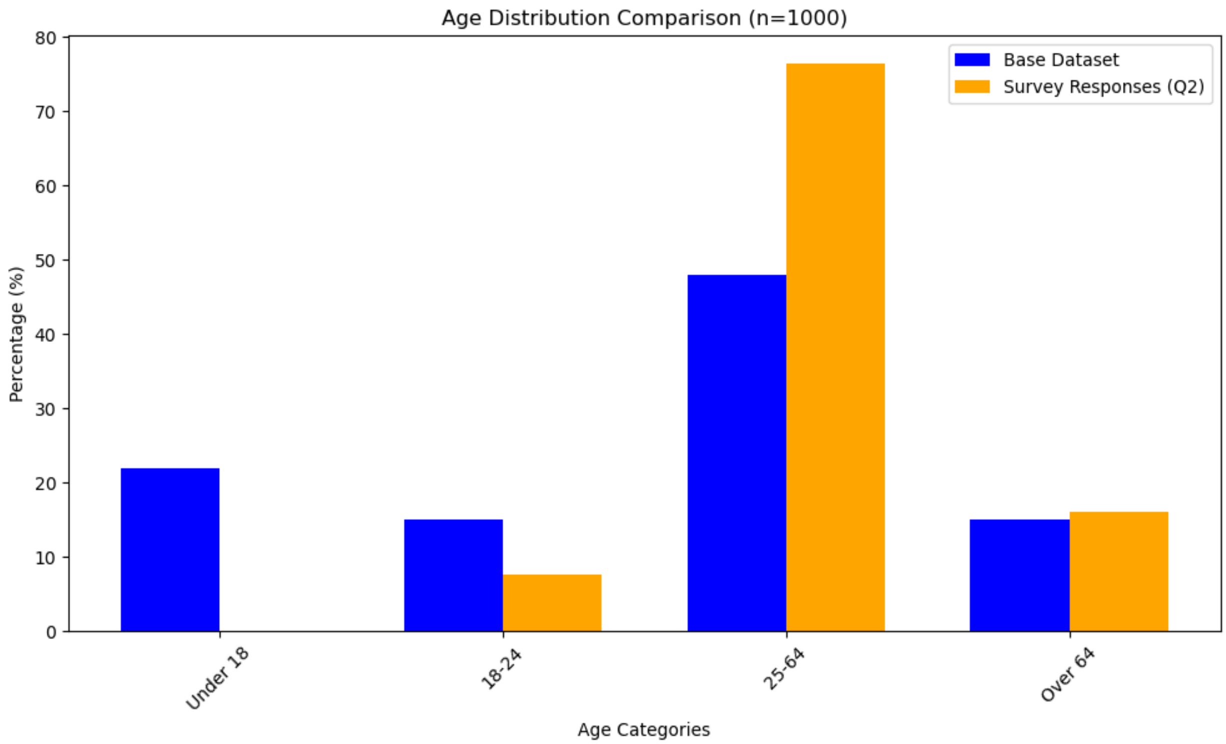

Figure 7.10: Age comparison of survey results versus state of Oregon age

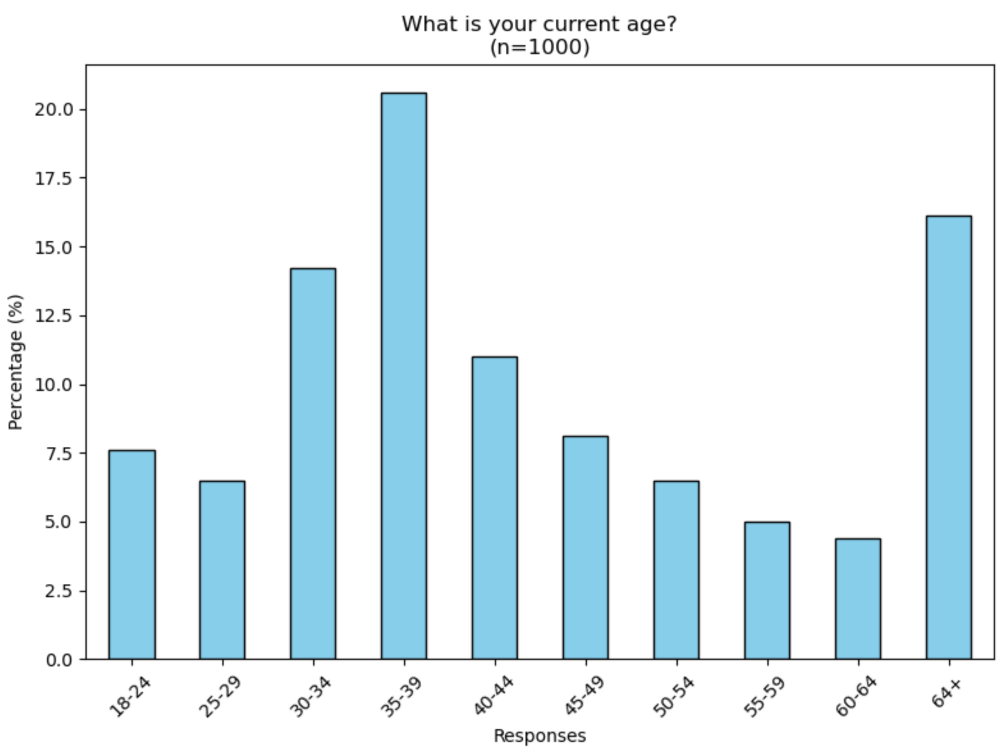

Figure 7.11: Age survey results

Income was also compared across the survey outputs and against the ACS household data for Oregon and is in Figure 7.12. What was expected and also considered in the literature was an under-representation at the higher income brackets from the surveys and slight over representation for the lower income brackets. However, there is an ability to combine those under-represented income brackets, after t-tests are performed on specific questions. While the $150k-200k bracket has enough samples for significance the over $200k bracket would need sample merging.

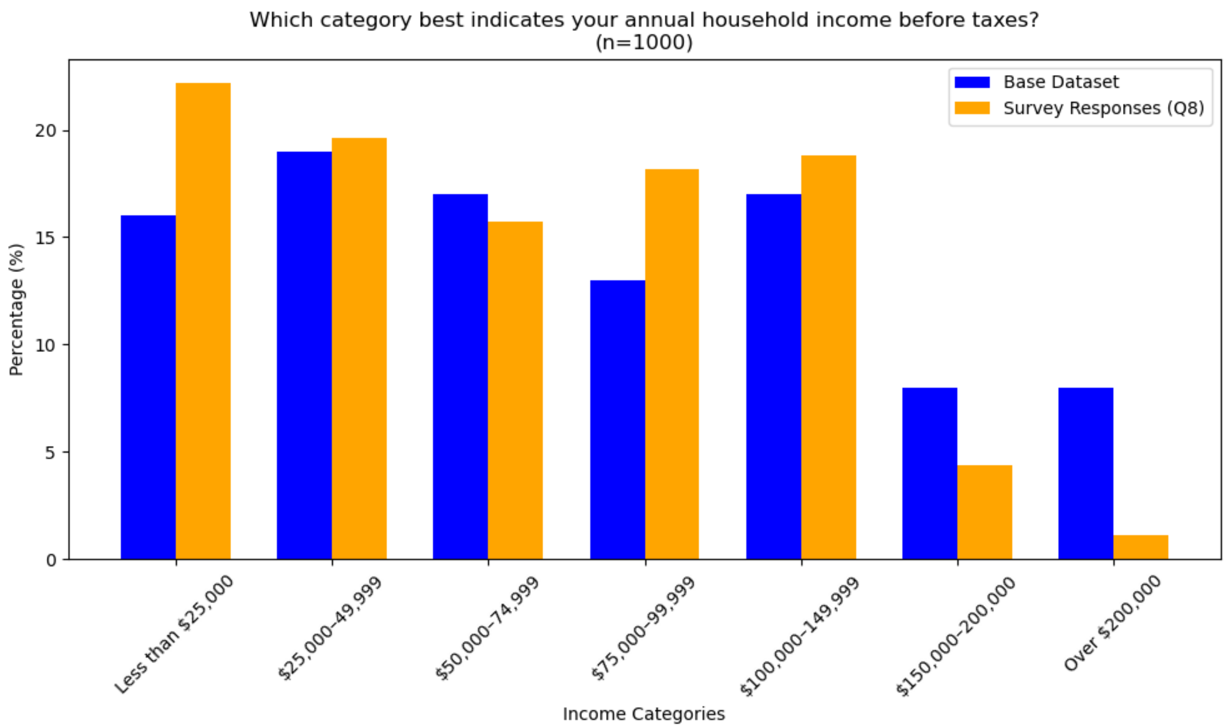

Figure 7.12: Income comparison of survey results versus state of Oregon

Following income was education, shown in Figure 7.13, where the majority of participants fall into two categories: those who have completed high school or obtained a GED just over 30% and those who hold a bachelor's degree approximately 30%. A smaller proportion of respondents have completed graduate degrees, accounting for roughly 20%. The remaining categories, including some grade/high school, technical school, and trade school, represent smaller segments of the population, each comprising less than 10%.

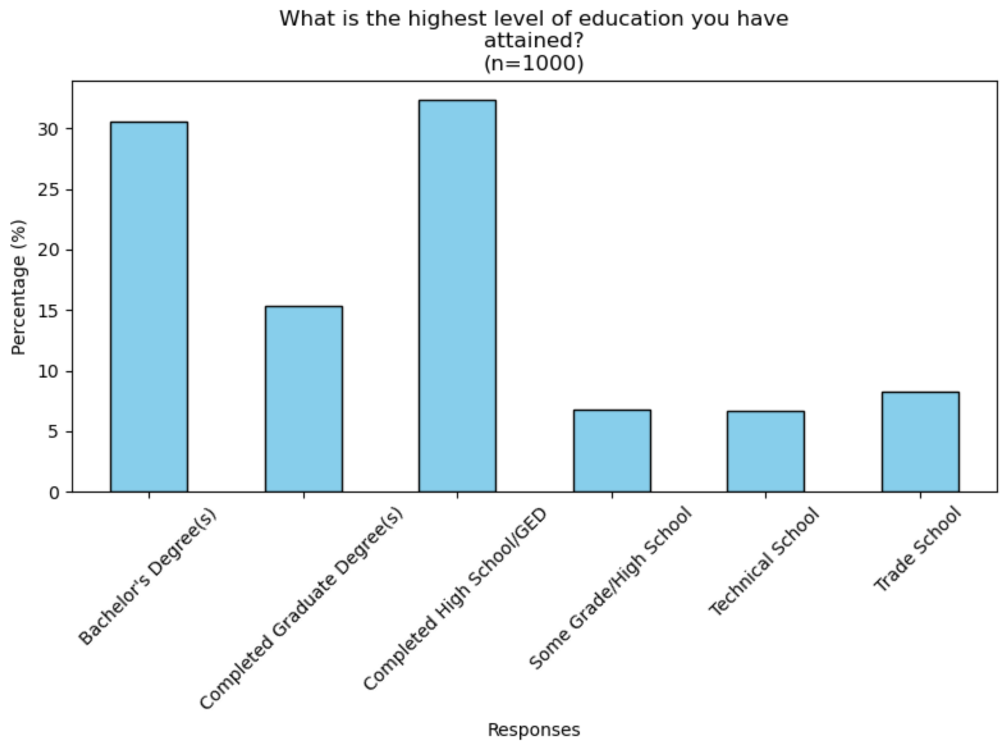

Figure 7.13: Survey results education

Looking at the number of individuals in the household, in different age brackets, nearly half of the households have no children, and over 40% have between 1 and 2 children as shown in Figure 7.14. While Figure 7.15 demonstrates the number of adults under the age of 65 within the household predominately include 2 adults, most likely indicating a childless household. This is followed by a single person household or 3-person household where the 3 person is likely the result of roommates. As for households with members 65 years of age or older, in Figure 7.16 the vast majority, nearly 70%, do not have any members 65 years of age or older, Depicting a fairly young response group for the survey which is also shown in Figure 7.11 with over 80% being under the age of 65.

Lastly, Figure 7.17, demonstrates the typical range of total individuals within the household where the predominant categories are between 1 and 4 household members. In combination with the other household member figures, these values most likely correspond to family households with children, as Figure 7.14, 2 children is nearly 20% and within Figure 7.17 this is also near 20%, and single children households are similar as well. There may be further explanations and or statistical significance in these specific households, those with children and their specific policy outputs that arise in relation to speed safety camera strategies.

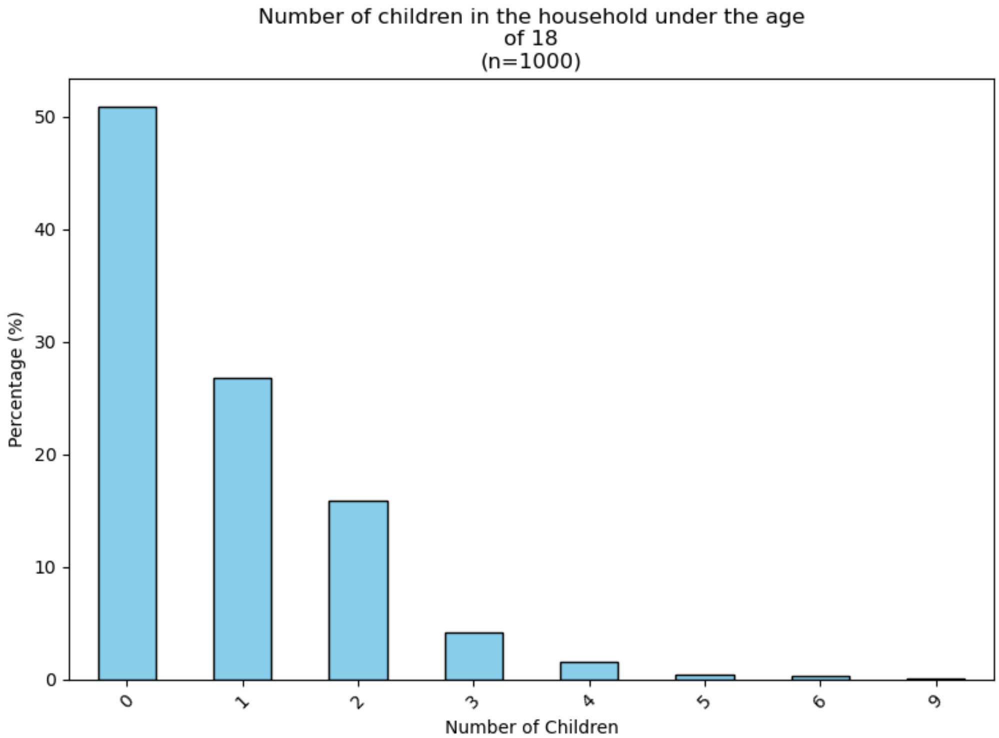

Figure 7.14: Survey results number of children in household

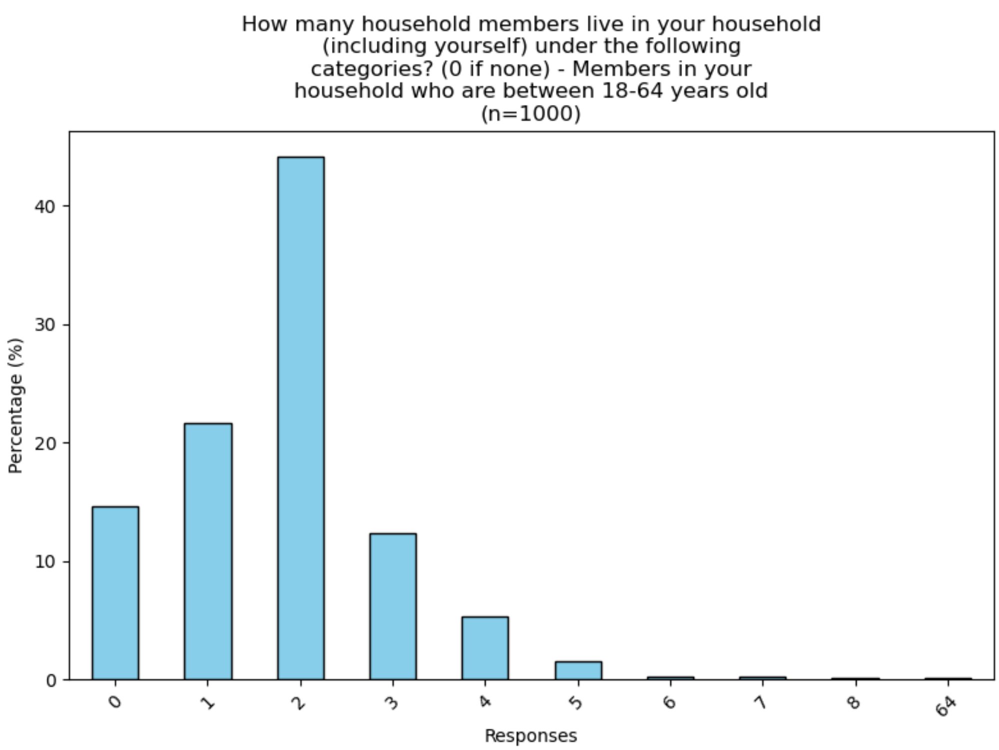

Figure 7.15: Survey results number of adults under the age of 65 in the household

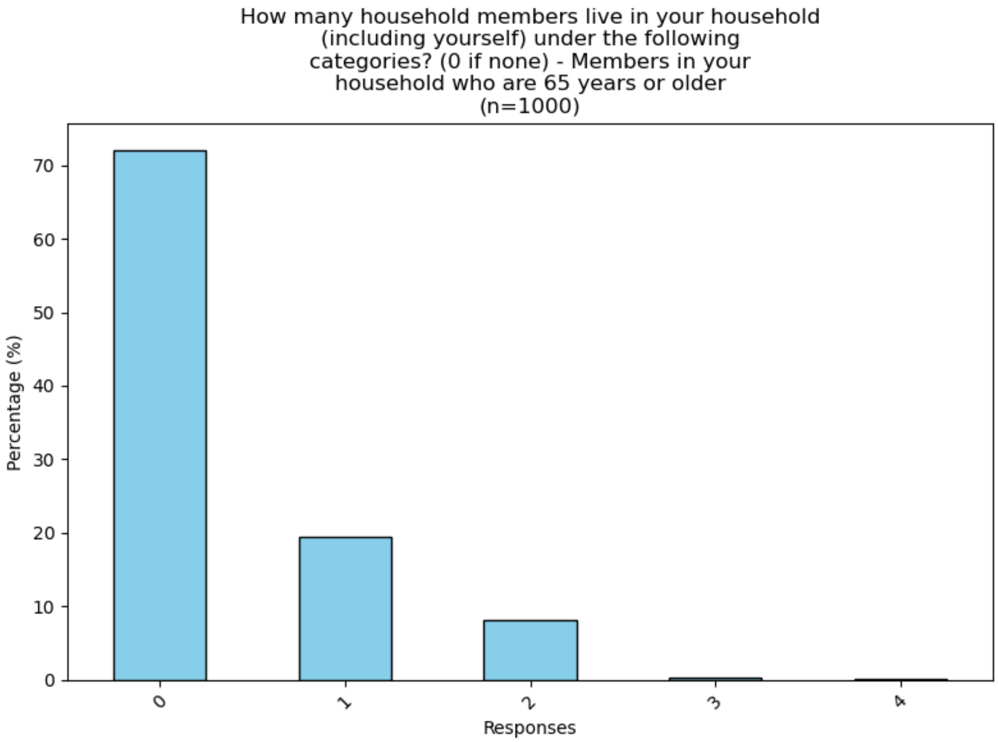

Figure 7.16: Survey results number of households members who are 65 years or older

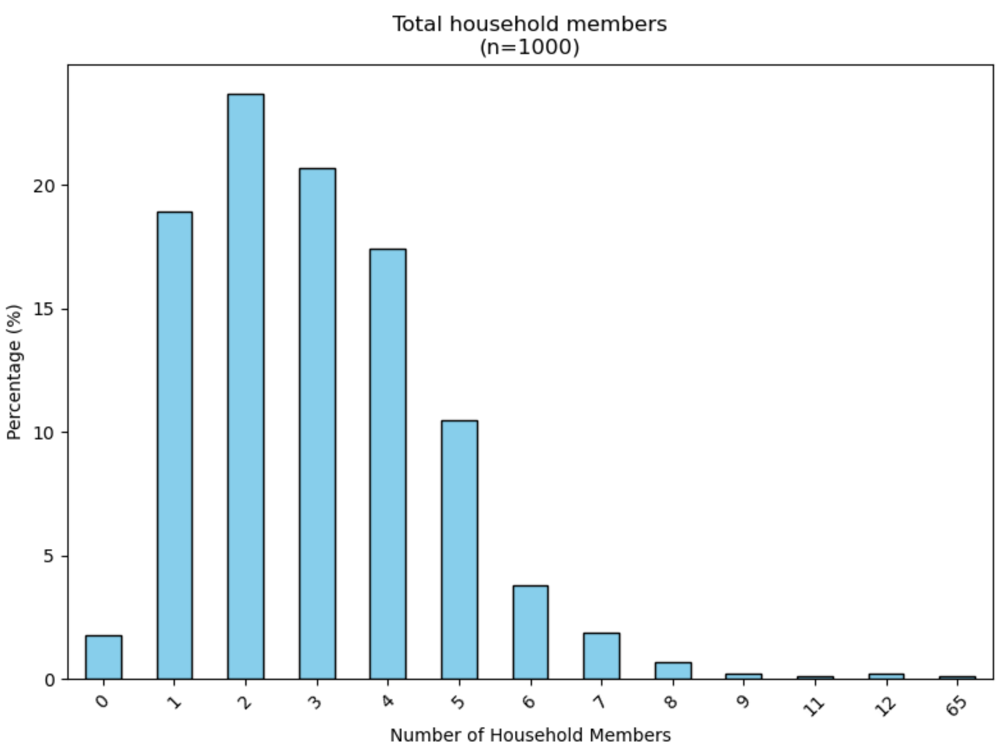

Figure 7.17: Survey results total number of household members

From the household perspective on the number of vehicles in Figure 7.18, a significant majority of households report having 1 or 2 cars, with over 40% owning a single vehicle and around 30% owning two. The prevalence sharply declines beyond two vehicles, indicating that larger numbers of cars are uncommon in most households. This trend suggests that the majority of respondents rely on a modest number of vehicles, likely reflecting typical household transportation needs.

Looking closely on household employment, employees under the age of 18, in Figure 7.19, within the household where the overwhelming majority of respondents (over 80%) report having no employed household members under 18, reflecting age-related employment limitations. This suggests that employment among individuals under 18 within these households is rare, aligning with expected labor and schooling norms for this age group. For household members between 18-64 years old in Figure 7.20 the proportions are evenly distributed across households reporting 0, 1, or 2 employed approximately 30%. Interestingly, however, is the large volume of individuals with no workers in this age bracket that are working indicating unemployment, public assistance or potentially disability. Lastly, Figure 7.21 household members 65 or older who are employed saw the majority (over 80%) report no employees in this age group, which is expected as most individuals in this age range are likely retired. Following the base demographic information is travel frequencies.

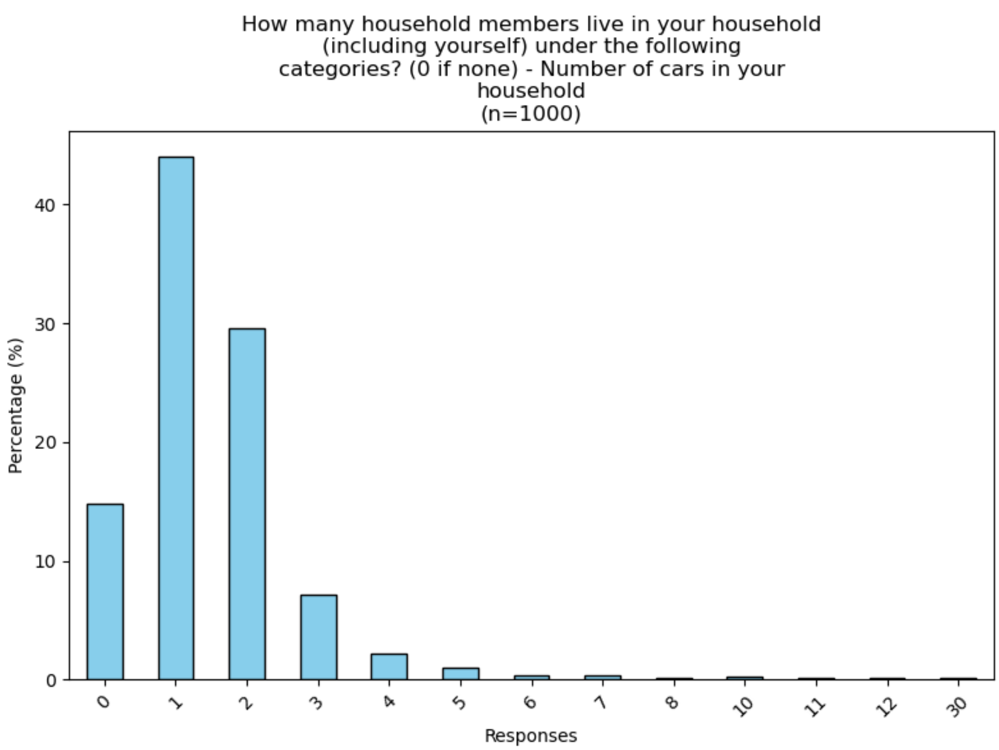

Figure 7.18: Survey results number of vehicles in household

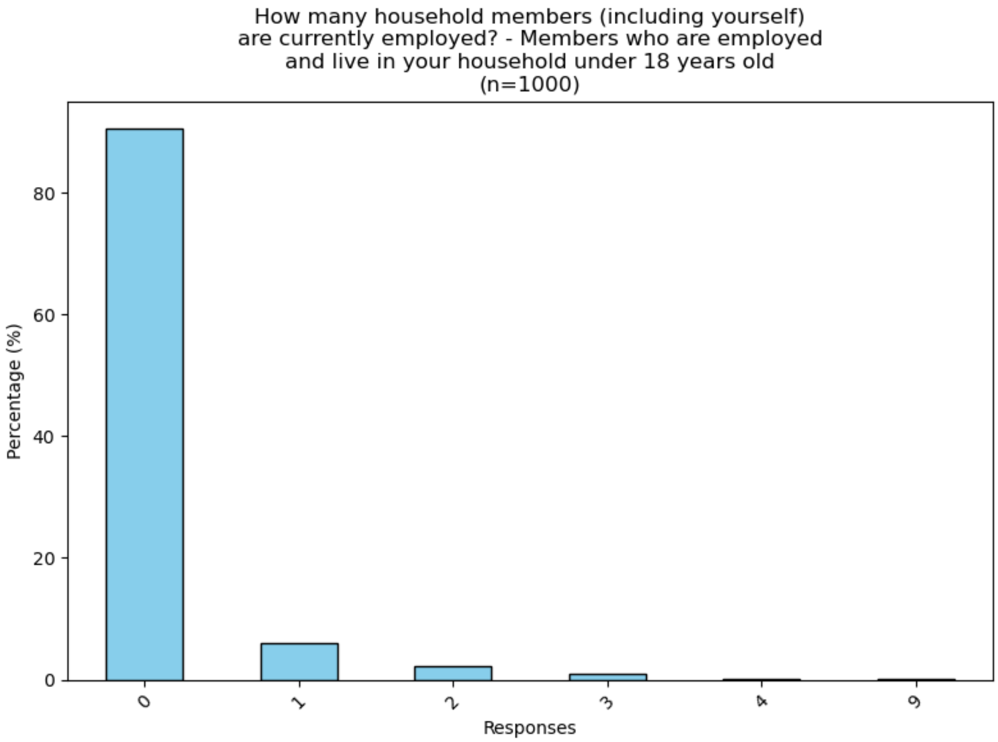

Figure 7.19: Survey results employees in household under 18 years old

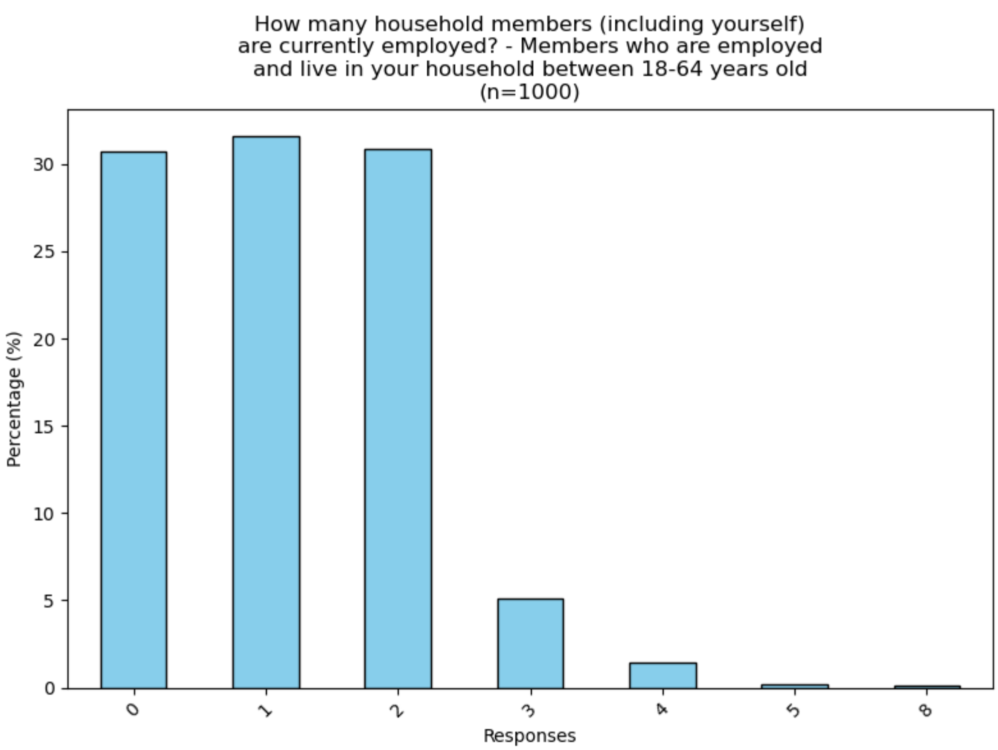

Figure 7.20: Survey results household employees 18-64 years old

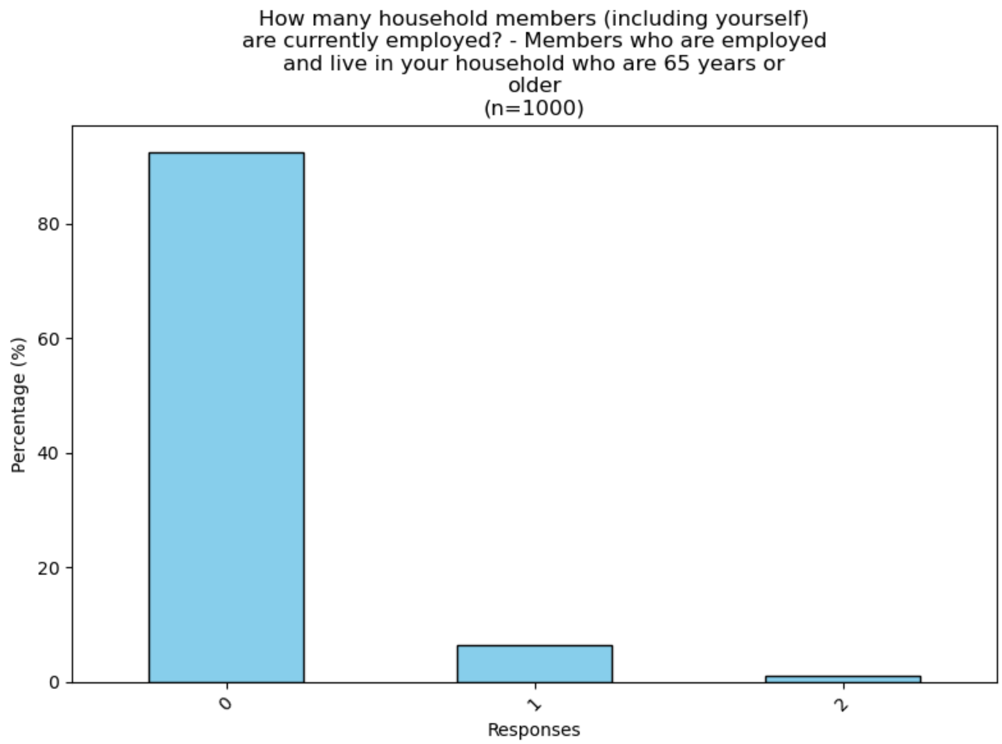

Figure 7.21: Survey results household employees over 64 years old

7.2.1.2 Travel behavior

The next set of survey responses are in relation to the travel behavior of the individual, including trip type, estimated miles driven and other travel choice decisions. Within Figure 7.22, 84% of the survey respondents indicated having a driver's license. While not specifically informative, when combined with Figure 7.23, there is a depiction on the number of typical drivers in relation to those who have driver's license, which can be used to infer that 92% of the population typically drives on a weekday, who can legally drive. Furthermore, within Figure 7.24 the largest proportion of respondents, approximately 30%, drive more than 50 miles per day. This is followed by around 25% of respondents who drive between 12-25 miles. The 26–50-mile category represents a slightly smaller group, while fewer respondents fall into the 5-10 mile and less than 5-mile categories. The significant number of participants at the high mileage driven areas, indicating reliance on vehicles for commuting or daily activities.

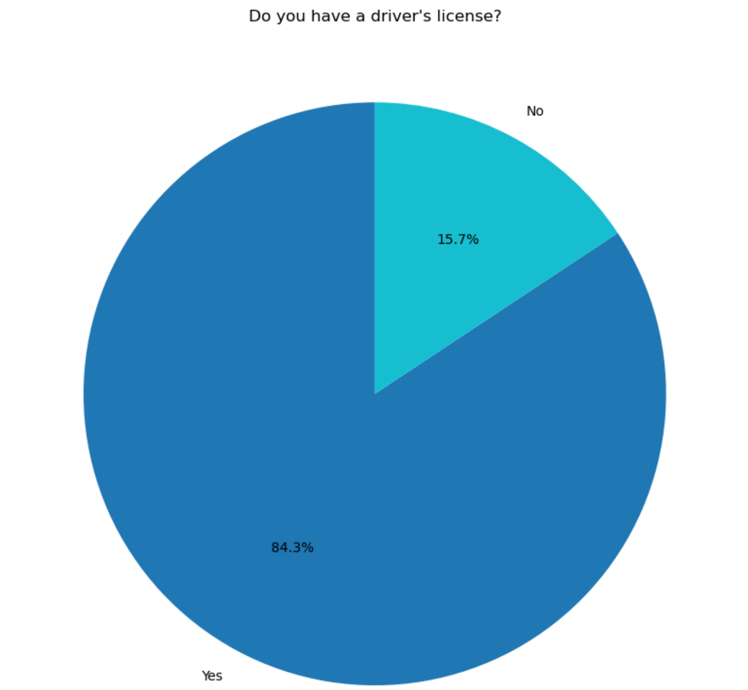

Figure 7.22: Survey results driver's license holder

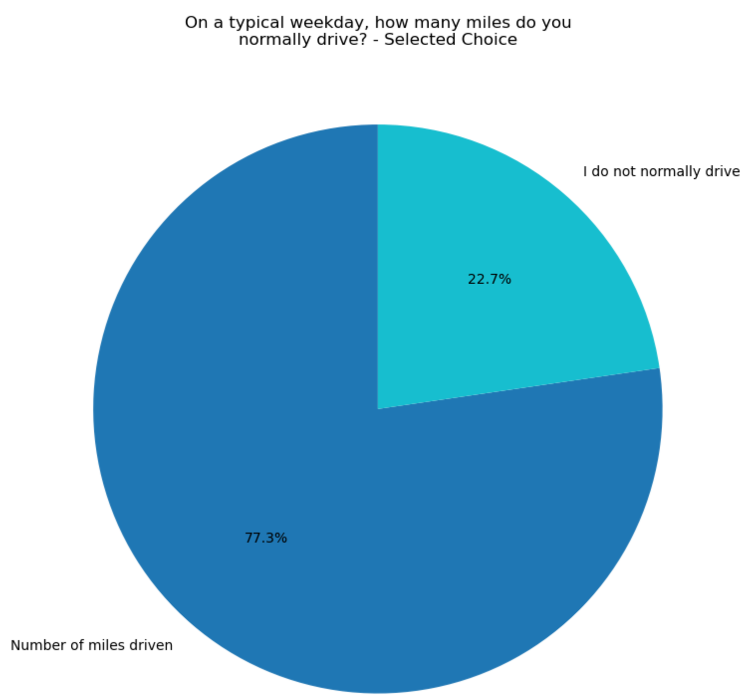

Figure 7.23: Survey results typical vehicular driver or not

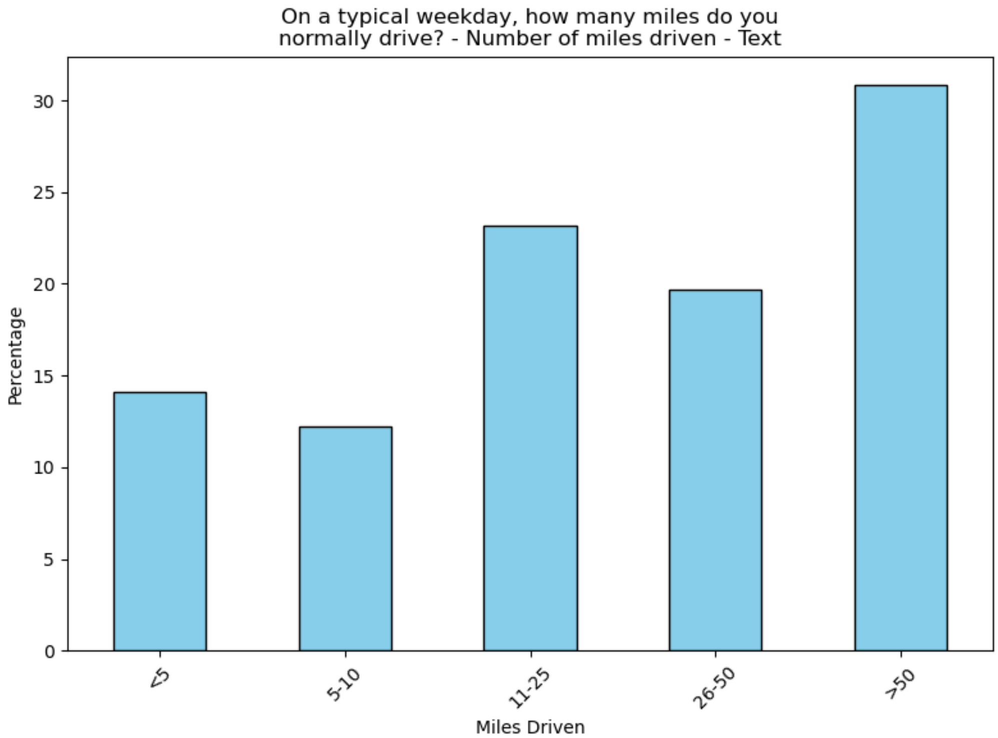

Figure 7.24: Survey results number of miles driven on a typical weekday

Following specific trends on car-based travel, the discussion delves into travel mode. Figure 7.25 demonstrates the frequency of commuting to work by car among respondents. The largest group, approximately 45%, reports commuting by car three or more days a week, indicating a high dependency on personal vehicles for work-related travel. In contrast, about 30% of respondents never commute to work by car, displaying alternative transportation methods or remote work arrangements. Smaller percentages are observed for occasional car use, with minimal representation for those commuting 1-2 days a week or less frequently.

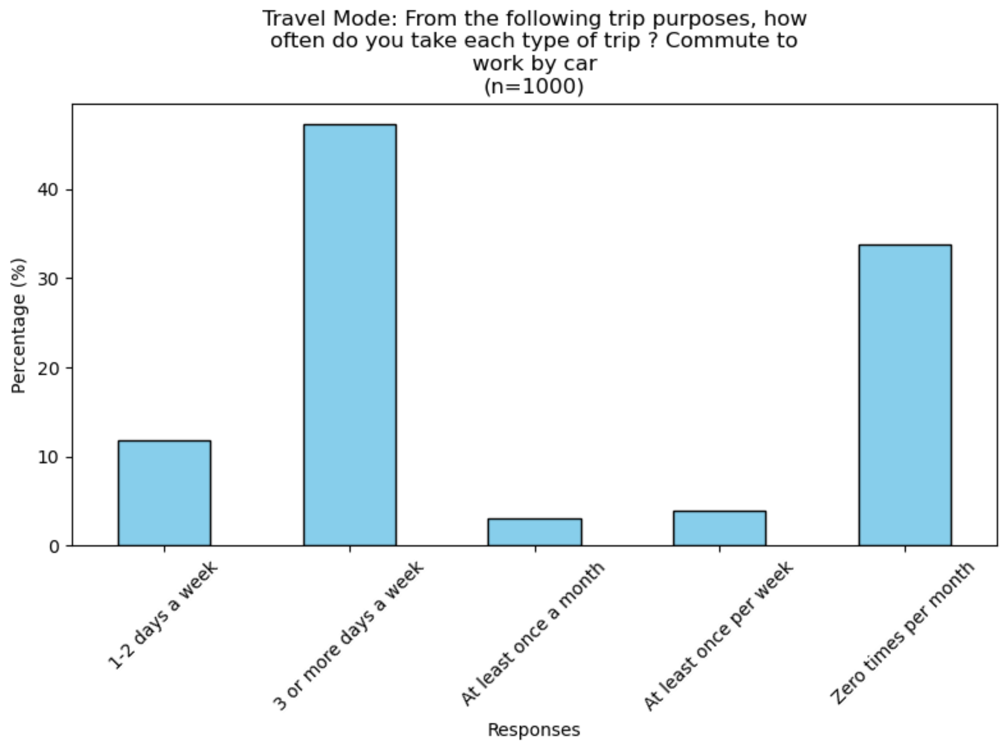

Figure 7.25: Survey results commute to work by car frequency

Figure 7.26 illustrates the frequency with which individuals take trips to a park and ride lot. The majority of respondents, approximately 60%, reported using the park and ride lot zero times per month. A smaller proportion, around 10%, indicated that they use the lot 1-2 days a week, while even fewer respondents, roughly 5-6%, reported using it 3 or more days a week or at least once a month. This chart suggests that park and ride lots are not frequently used for commuting or travel purposes by most respondents. Figure 7.27 reveals that a significant majority, around 60%, reported commuting by car zero times per month. Smaller portions of the respondents indicated that they commute 1-2 days a week (about 10%), 3 or more days a week (roughly 5%), or at least once a month (around 6%). specifically look at the commuting patterns at least once per week 15% were in this category, while their differences can be attributed to classes being offered every day of the week versus singular class offerings such as once per week. This suggests that the majority of the respondents either do not attend school or use alternative methods to commute to school, though the questions was not specifically asked if the individual is enrolled in any school or not.

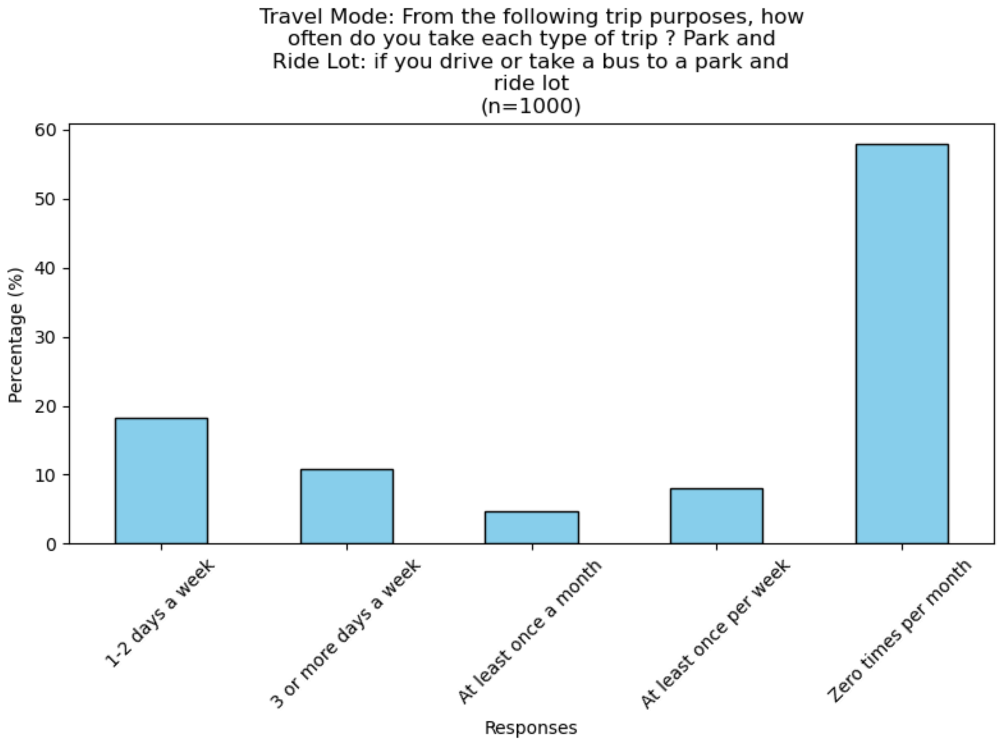

Figure 7.26: Survey results park and ride lot usage

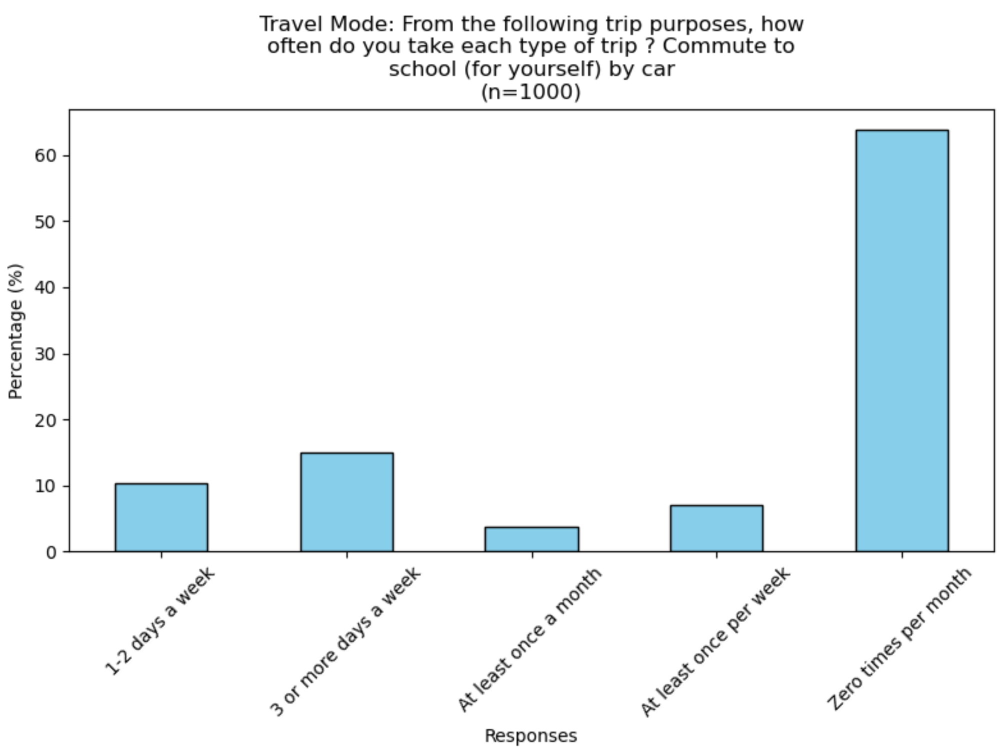

Figure 7.27: Survey results commute to school by car

For micro-mobility use for most trip purposes outside of recreation an commuting to work, shown in Figure 7.28 where the majority of respondents, nearly 40%, indicated that they never use these modes for such trips, as reflected in the zero times per month category. The next largest group, over 20%, reported using non-vehicular modes 1-2 days a week and also a significant portion, around 15%, stated that they use these modes 3 or more days a week. Smaller percentages, around 5% or less, indicated using them at least once per week or at least once per month. This distribution suggests that while many people infrequently use non-vehicular modes for non-recreational purposes, a noticeable portion uses them regularly, which demonstrates the usefulness of micro-mobility-based investments into transportation infrastructure.

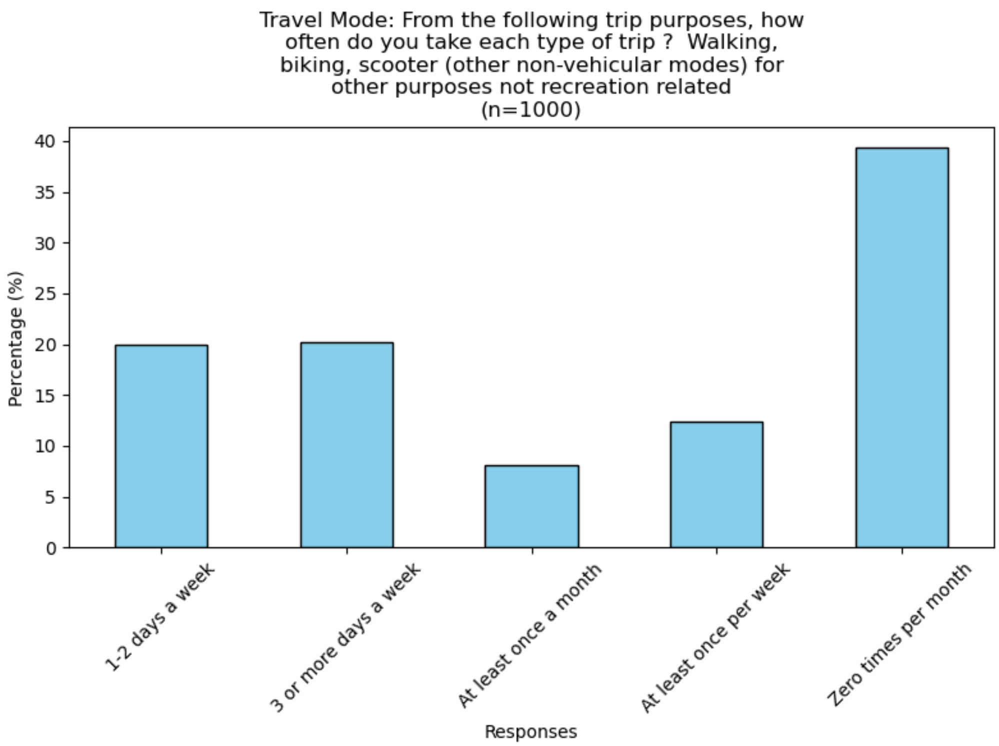

Figure 7.28: Survey results micro-mobility non-commuter

Figure 7.29 shows the frequency of trips taken using non-vehicular modes like walking, biking, and scooters for commuting to work. The majority of respondents, nearly 45%, indicated that they never use these modes for commuting, as reflected in the zero times per month category. The next largest groups, at least once per week, accounts for nearly 40% of the responses. This portrays a substantial section of the population in Oregon utilizes micro-mobility to commute to work, outside of car-based travel. Furthermore, Figure 7.30 displays nearly 45%, reported using public transit zero times per month. Smaller proportions of respondents indicated using public transit 1-2 days a week (around 15%), 3 or more days a week (roughly 20%). While not extracted from the data, it is evident the same individuals who did not use micro-mobility to commute also did not use public transportation to commute.

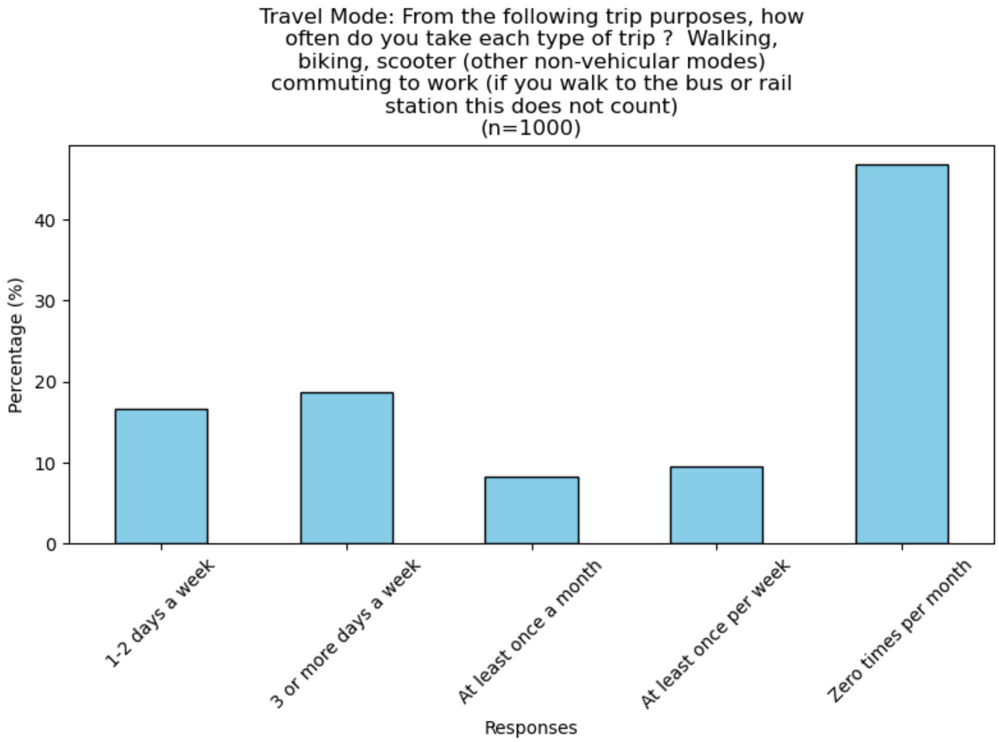

Figure 7.29: Survey results micro-mobility commuting to work

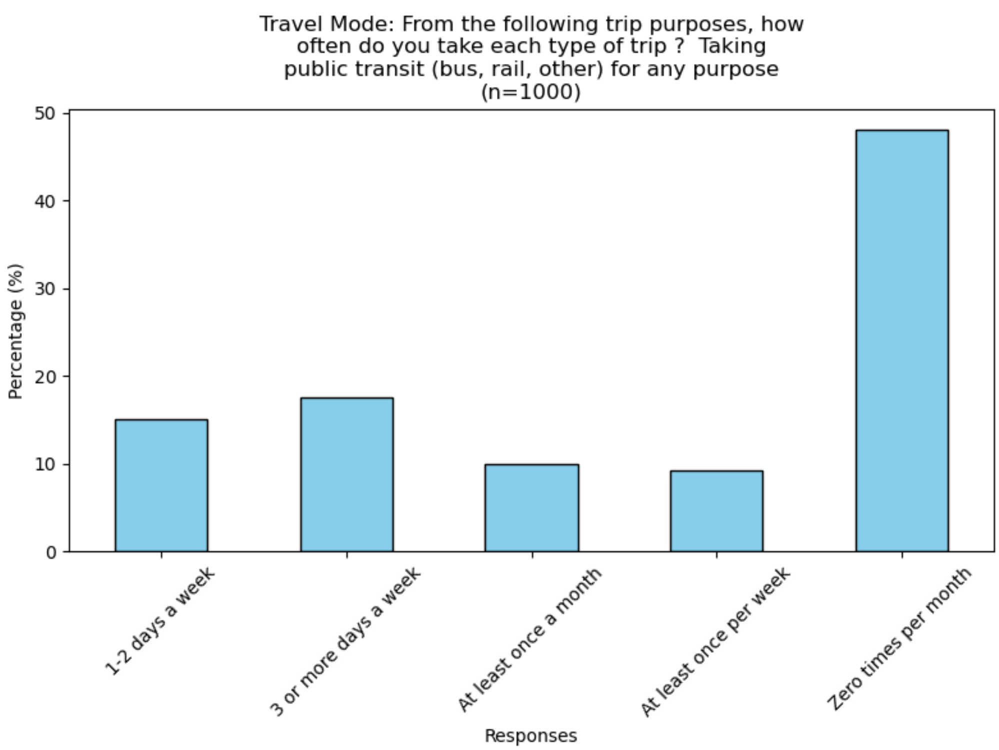

Figure 7.30: Survey results public transit usage

While the previous figures displayed two predominant categories, either utilizing micro-mobility for commuting, public transit, or car, Figure 7.31, driving by car for recreation sees a high splits for car usage, for both frequent use such as at least once a week and infrequent use. This suggests that while individuals do not use their micro-mobility or transit for commuting, they both have access to a car and perhaps travel distances to remote areas for recreation where micro-mobility and public transport do not make it feasible.

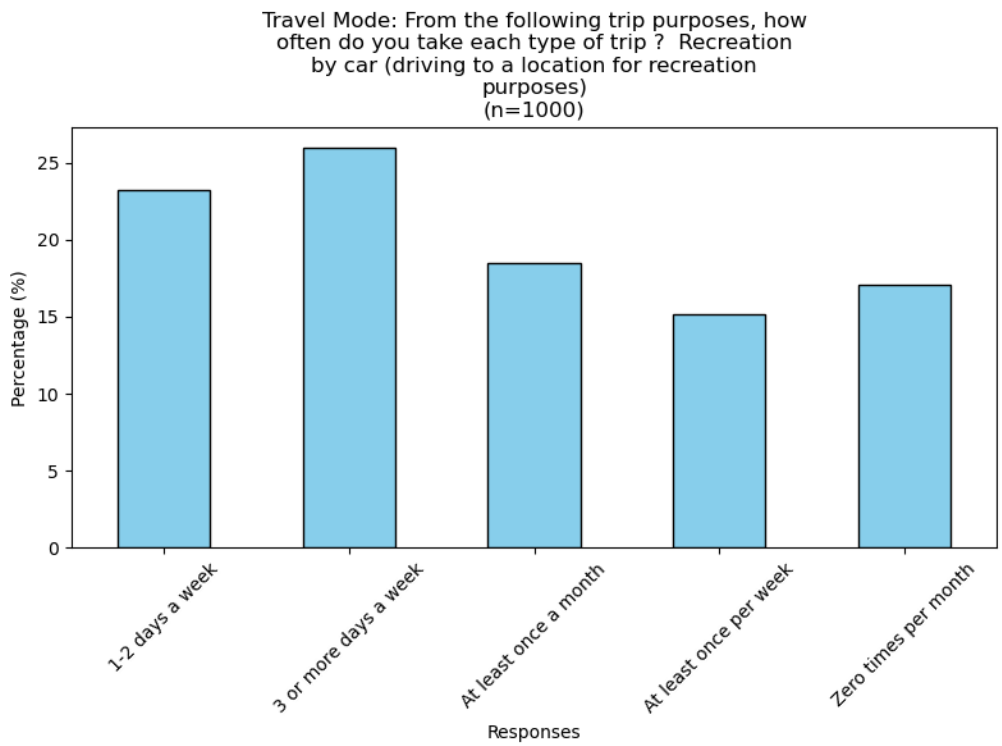

Figure 7.31: Survey results recreation by car

What is even more prevalent for car usage is the trip purpose of errands, shown in Figure 7.32. There is the highest proportion of car utilization with nearly 70% using a car at least once a week for errands. This demonstrates that while individuals might use non vehicular based means to commute to work, when it comes to errands, which usually requires space, or carrying items having access to a car is important and highly utilized.

Within Figure 7.33 over 50% of respondents report that they never drive children to school, indicating a high the majority of the respondents do not have children and can be Among those who do, around 20% report driving children three or more days a week, while smaller proportions indicate 1-2 days a week or less frequent usage. This distribution highlights that a notable portion of the population relies on alternative modes of transportation or does not participate in school-related car travel. This is even more clarified by considering Figure 7.14 where nearly 50% of the respondents indicated no children in their household.

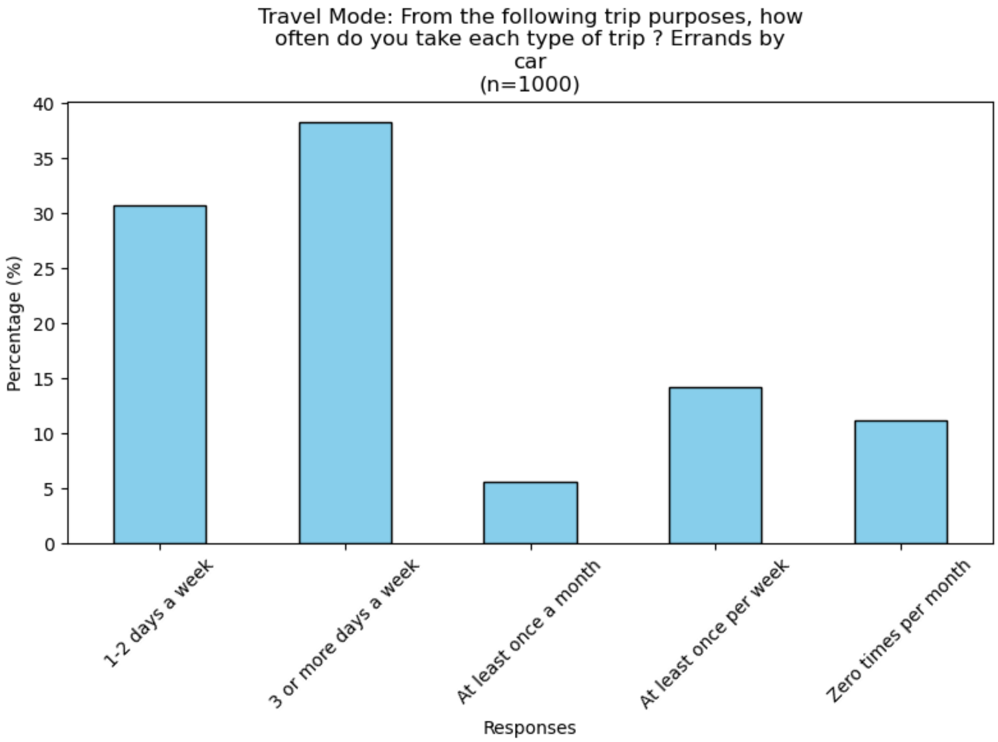

Figure 7.32: Survey results errands by car

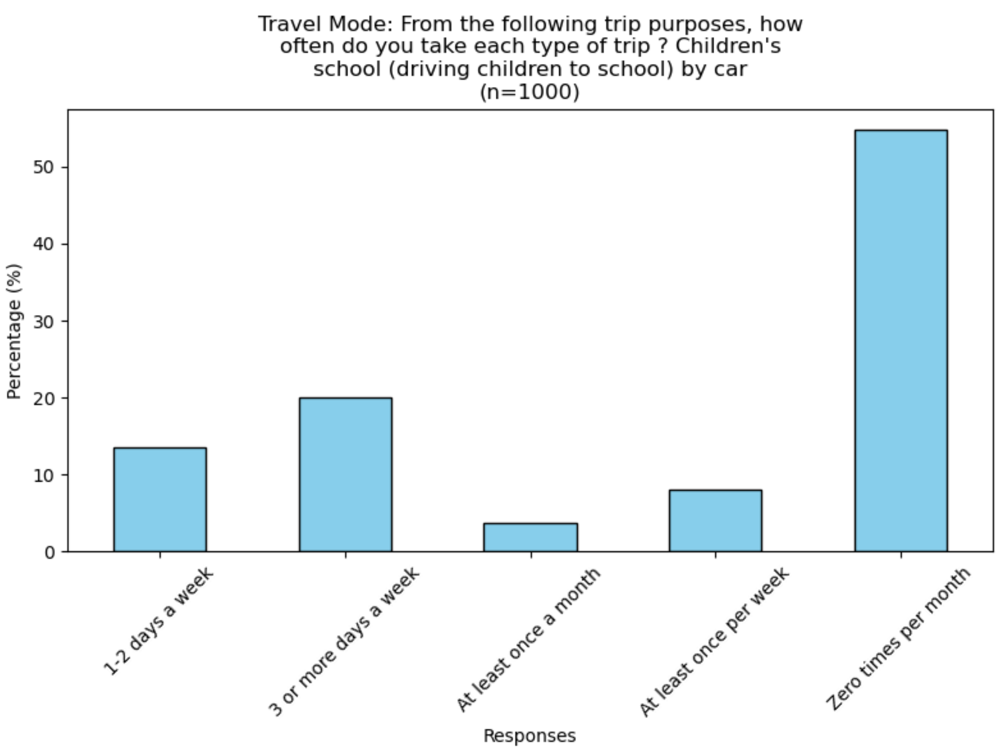

Figure 7.33: Survey results driving to children's school by car

7.2.2 Survey speed safety camera policy results

While the previous section explored socio-economic and demographic results, and travel behavior, this section reviews questions in relation to speed safety camera policy. This is broken down into several sections: expected outcomes, location guidance, existing conditions and current beliefs, transparency and accountability, ticketing guidance which includes when a ticket should be issued and monetary penalties, and lastly how agencies should deal with revenue of SSC systems.

7.2.2.1 Survey results expected outcomes

This section reviews the individual's perception of the potential outcomes an SSC system would have. Starting with Figure 7.34, if SSC systems will increase speeding in other locations where the cameras are not installed, referred to as the halo effect. Among respondents, the largest groups either "Somewhat Agree" or hold a "Neutral" stance, each making up a significant share of the responses. A smaller yet notable portion "Somewhat Disagree" or "Strongly Agree," reflecting concerns about this outcome. Meanwhile, "Not Sure" and "Strongly Disagree" represent the smallest response categories, indicating relatively less certainty or opposition to this view. This distribution suggests a spectrum of opinions with a leaning toward agreement or neutrality on the issue, and through education and proper enforcement placement strategies might calm the negative sentiment of the SSC system, and their biproducts on roadway facilities such as the halo effect.

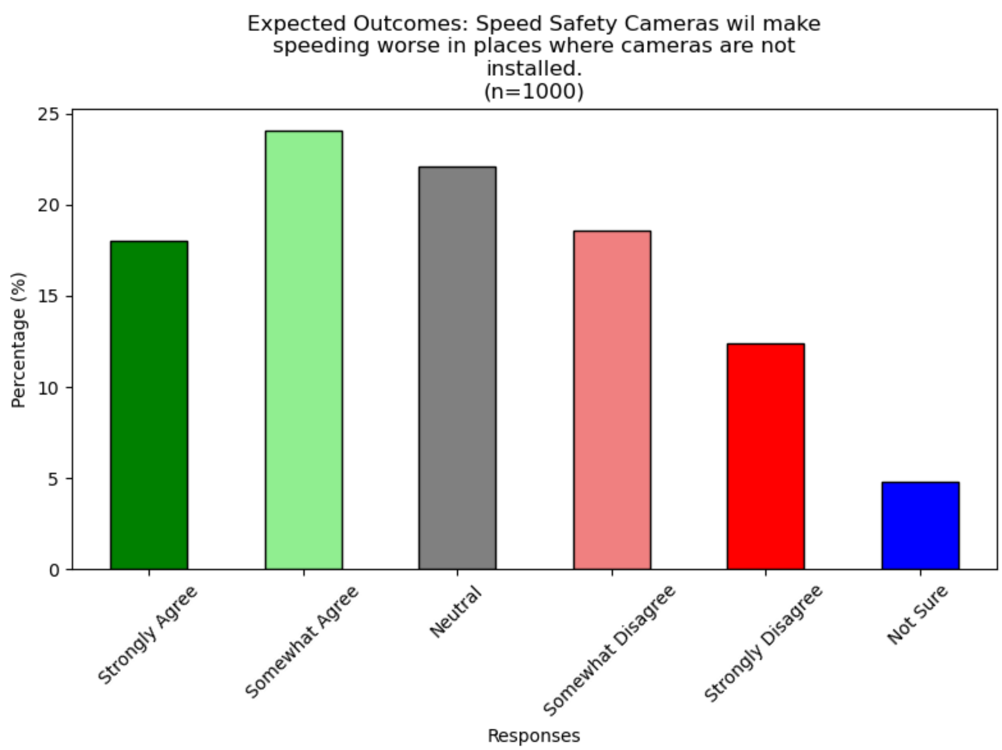

Figure 7.34: Survey results expected outcomes of SSC systems: halo effect

For Figure 7.35, the sentiment towards travel time was questioned. The majority of participants either "Somewhat Agree" or remain "Neutral," indicating mixed perceptions on the issue. A notable portion "Somewhat Disagree" or "Strongly Agree," reflecting varying levels of concern. "Strongly Disagree" and "Not Sure" responses represent the smallest groups, highlighting a minority of strong opposition or uncertainty. This suggests a diverse range of opinions, with a slight tendency toward agreement or neutrality regarding potential traffic impacts, and may be alleviated with education of SSC systems and literature countering the presumption that travel times will increase as a result of the systems.

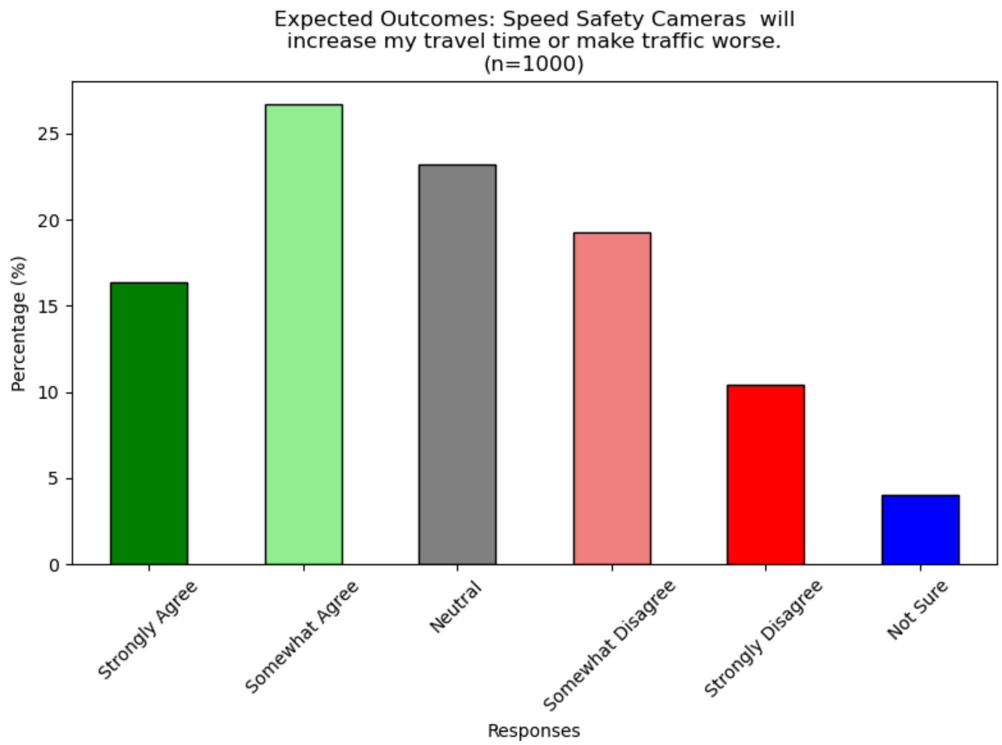

Figure 7.35: Survey results expected outcomes of SSC systems: travel time increase

Following travel time is the expectation for the safety implications of SSC systems. While Figure 7.34 and Figure 7.35 demonstrated the traffic operations perception of SSC systems, Figure 7.36 reveals potential traffic safety insights, whereby a significant majority of respondents either "Strongly Agree" or "Somewhat Agree" with this outcome, together accounting for more than two-thirds of the responses. Providing evidence that the majority of respondents believe these systems will increase the safety of Oregon roadways within their utilization.

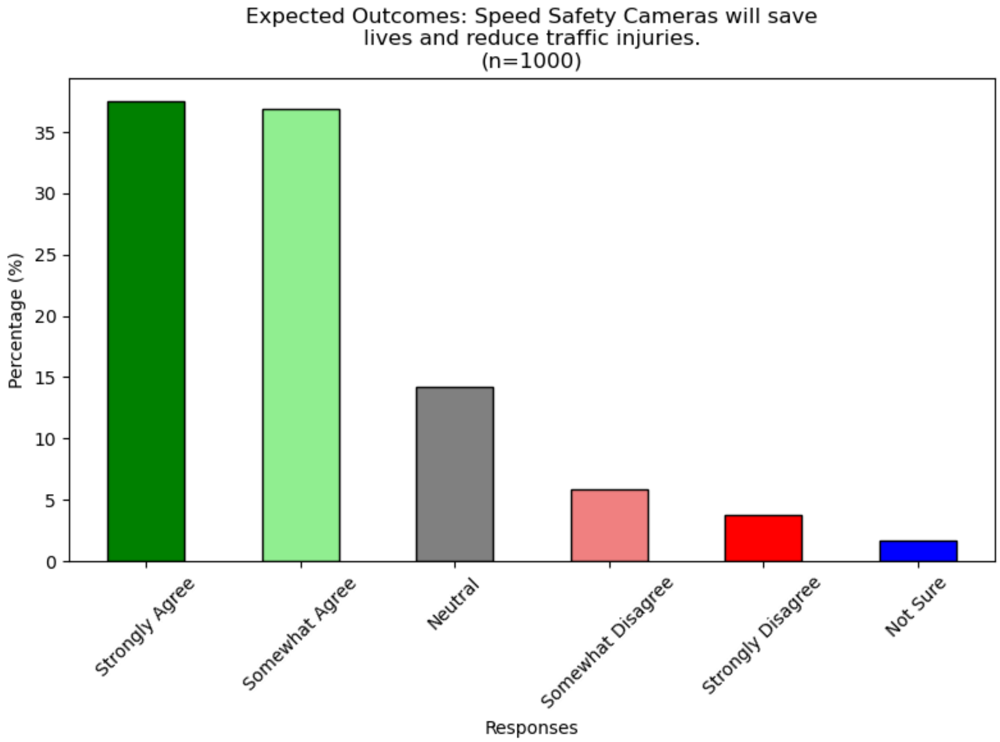

Figure 7.36: Survey results expected outcomes of SSC systems: traffic safety impacts

Through another safety lens, Figure 7.37, reveals the survey results on increased micro-mobility safety from SSC implementation. Where again over two-thirds of the respondents "Somewhat agree" or "Strongly agree" the systems will make walking and cycling safer and comfortable on Oregon roads.

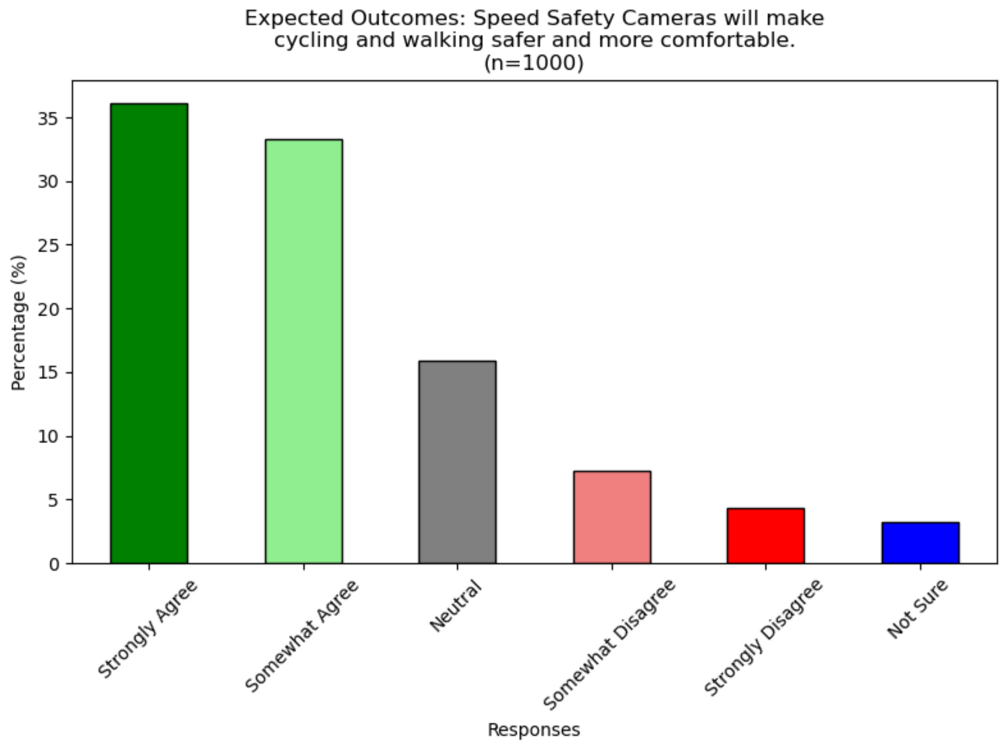

Figure 7.37: Survey results expected outcomes of SSC systems: micro-mobility safety

7.2.2.2 Survey results location guidance

While the previous section asked questions on individuals' existing perception on the potential outcomes of SSC systems, this section reveals sentiment on where the systems should best be placed. Figure 7.38 displays an overwhelming attitude towards placing SSC systems within work zones with over 70% of the responses in this category. This may also be capturing driver experience in work zones when other drivers are speeding causing unsafe operating and working environments for the driver and worker alike.

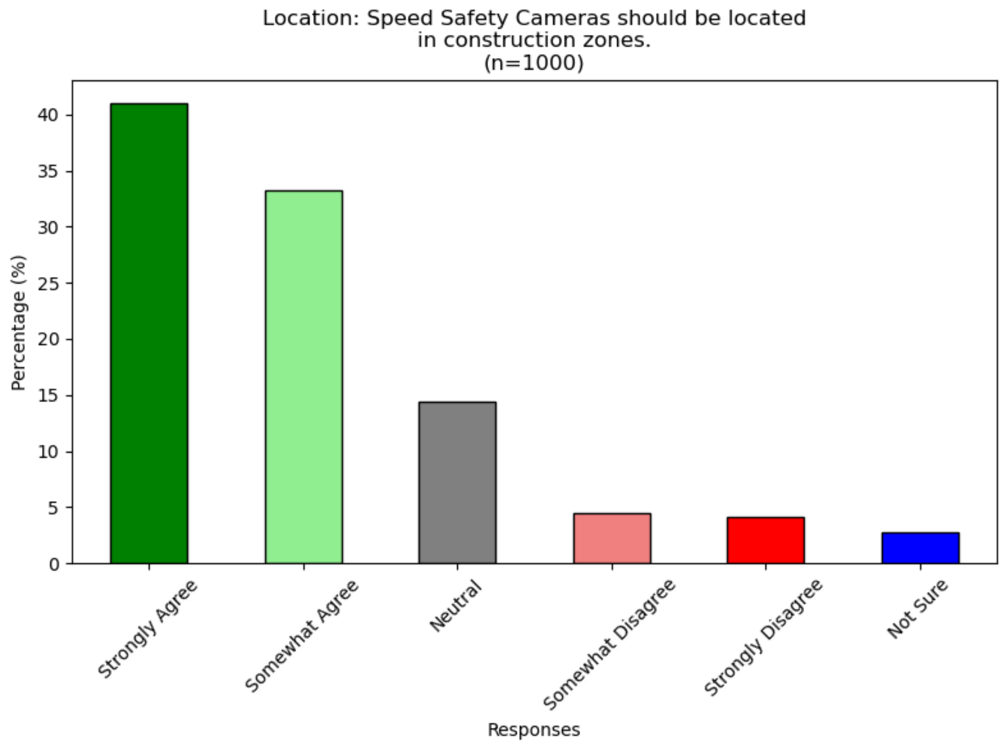

Figure 7.38: Survey results location guidance: located in work zones

Similar to Figure 7.38, Figure 7.39 has incredibly high response rates on the belief that SSC systems should be placed in or near schools/school zones, with almost a 90% response rate in the "Strongly Agree" and "Somewhat Agree" categories. As for addressing public acceptance of such systems, work zones and in close proximity to schools would have the highest acceptance for communities. Lastly, there was also overwhelming support for local communities to decide themselves where to best place SSC devices, demonstrating general trust in their neighbors and community leaders as shown in Figure 7.40. An output of which might be for local communities to decide on a plan to best locate these systems.

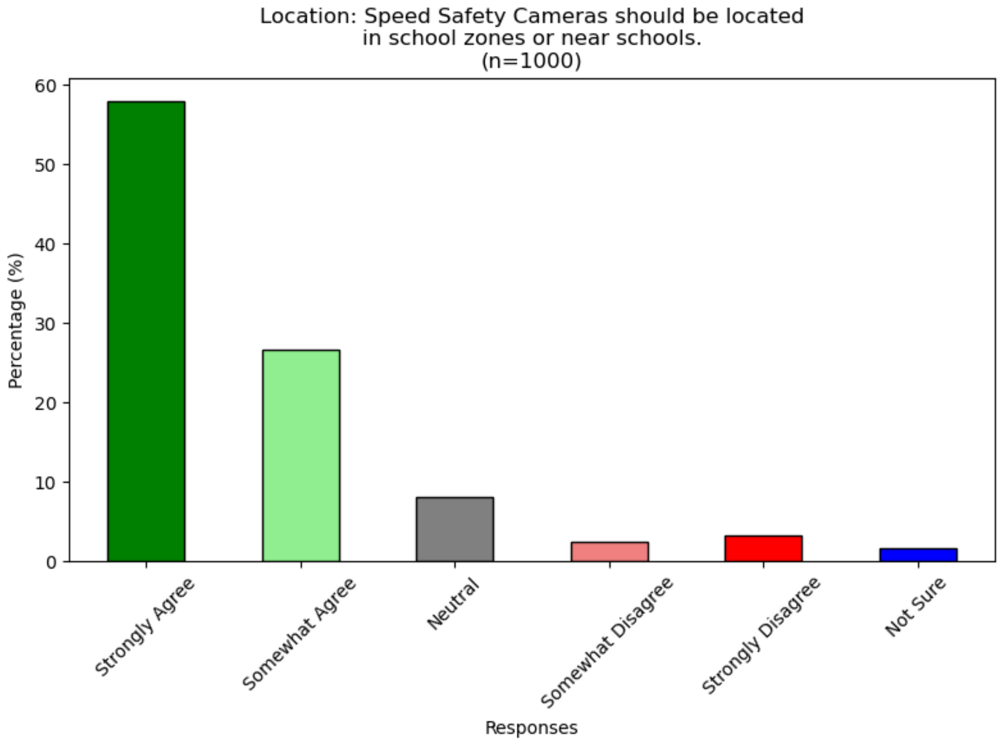

Figure 7.39: Survey results location guidance: school zones or near schools

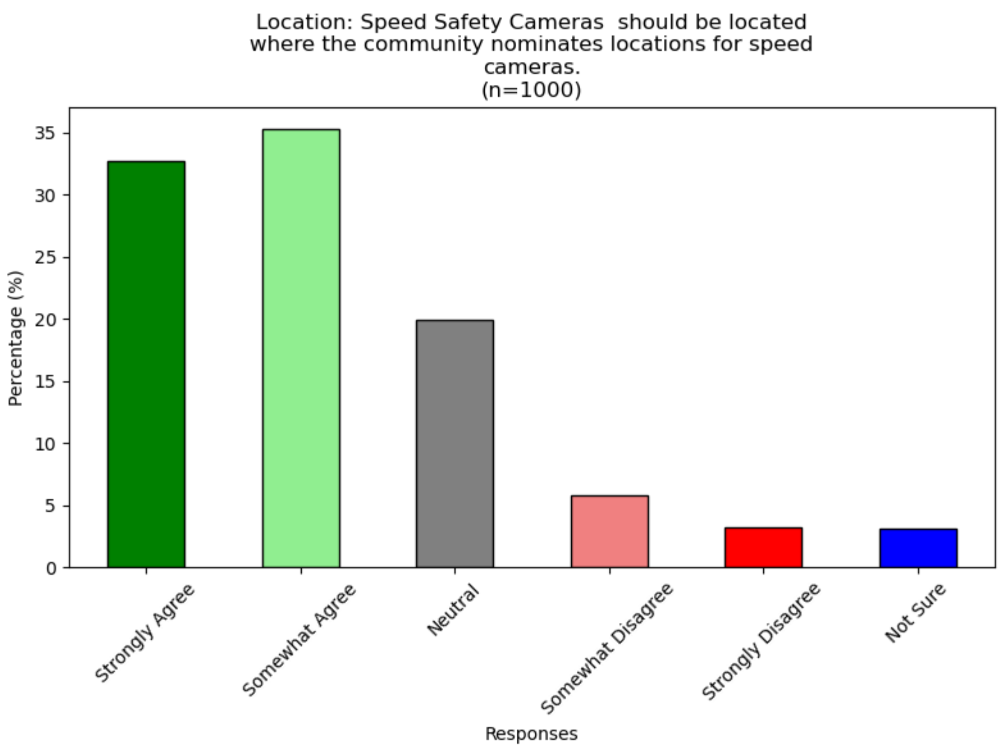

Figure 7.40: Survey results location guidance: community driven location selection

Further, location-based results from the survey looking into the potential disproportionate effects these systems may have on minority communities. Figure 7.41 displays concern across the survey respondents on considering location guidelines that would not disproportionally target minorities, while 30% were neutral in this stance. This demonstrates a desire by the community to consider this within placement guidelines, however they may not understand or interpret the potential of these systems to do so, requiring additional literature on the subject.

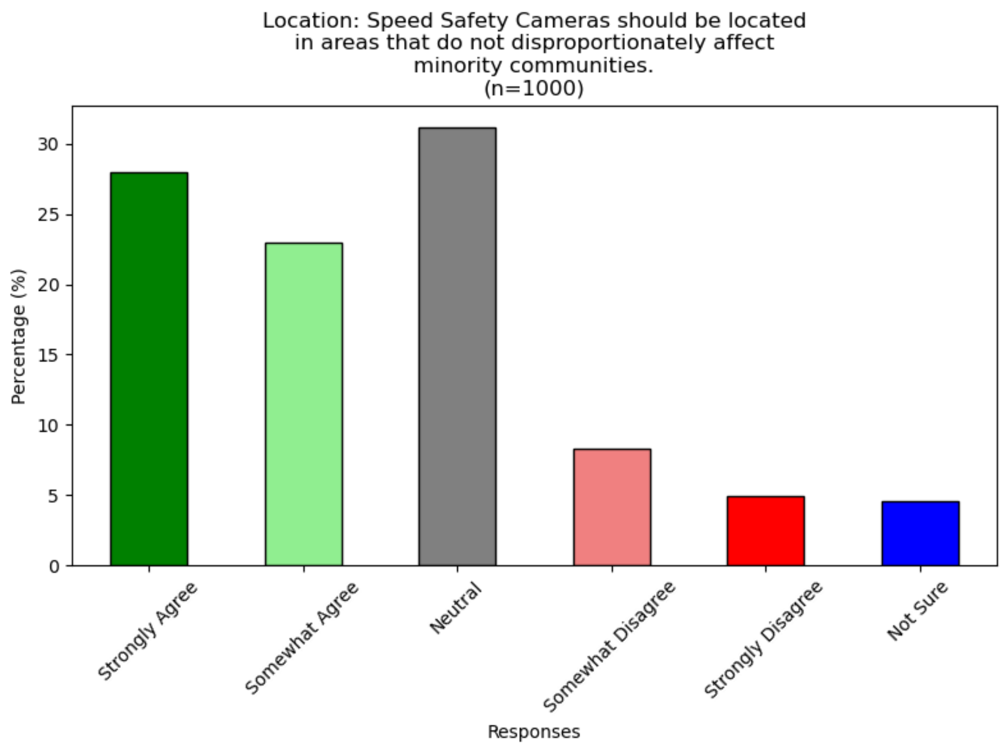

Figure 7.41: Survey results location guidance: minority disproportionality

Figure 7.42, discusses the respondents' opinions on locating SSC systems in locations where fixed policy officers are unable to operate safely. While the specifics of this require additional consideration on if these is road classification or roadway geometric conditions, there is ample evidence that the general public has high regard for officer safety, and should be a cornerstone for their deployment and operation that any community should consider.

Lastly, for this section, Figure 7.43 asks if SSC systems should be used at all in Oregon with no clear dominant choice. This suggests that through targeted campaigning or with consideration for the other aspects about SSC operations from this survey, more individuals may lean towards accepting the systems in their communities.

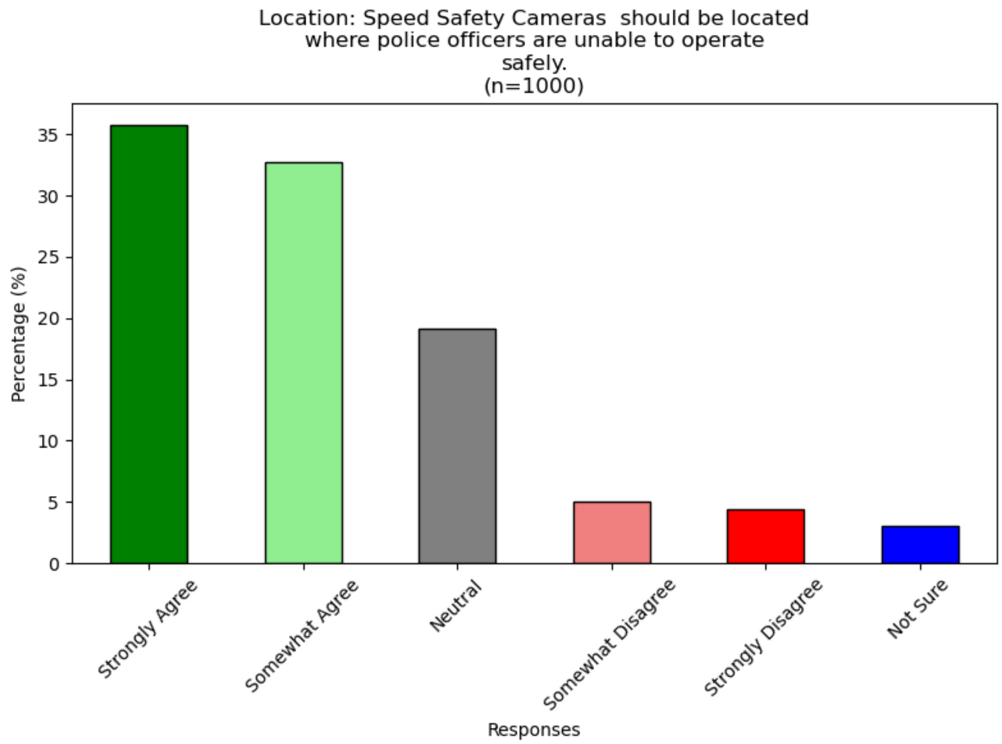

Figure 7.42: Survey results location guidance: police officer safety consideration

Figure 7.43: Survey results location guidance: should SSC systems be used in Oregon

7.2.2.3 Survey results for existing conditions and current beliefs

While the previous section explored location guidelines, informed through the survey outputs, this section reveals how individuals feel about the existing condition of speeding in their local areas, and beliefs on SSC systems. Figure 7.44 and Figure 7.45, demonstrate the survey respondands understanding of existing roadway operation conditions on the roads they operate on or interact with, both their commute, work area, and local areas. With resounding support, both questions see an over 60% response rate in the Agree categories, which indicates that improvements could be made on these classificaitons of roadways with SSC systems.

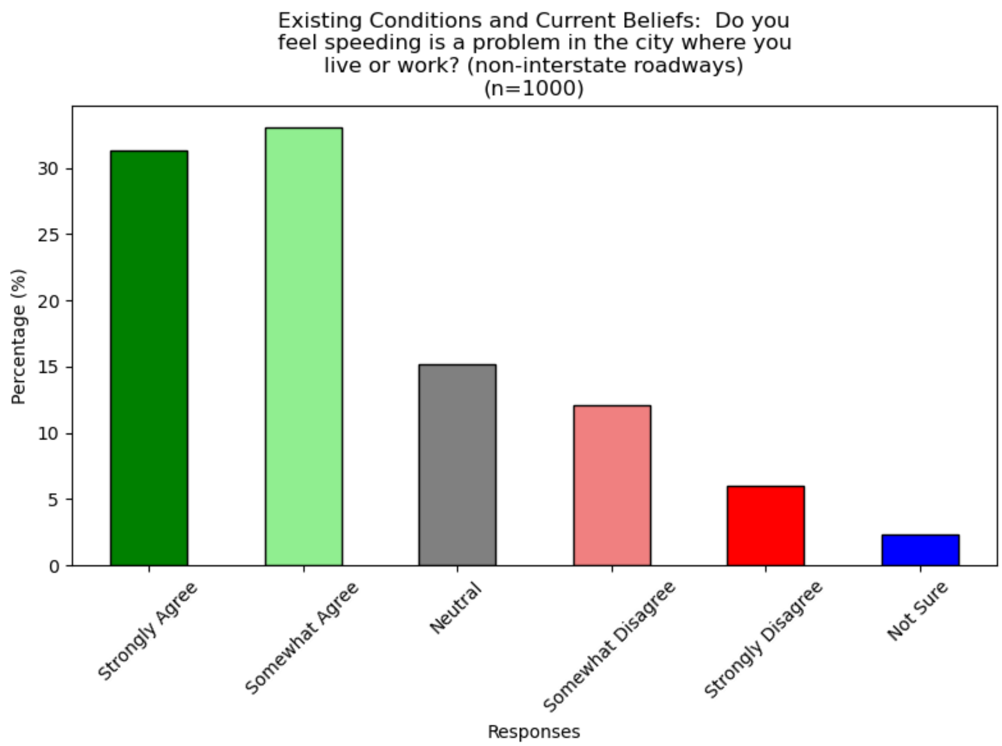

Figure 7.44: Existing conditions and current beliefs: speeding in city (non-interstates)

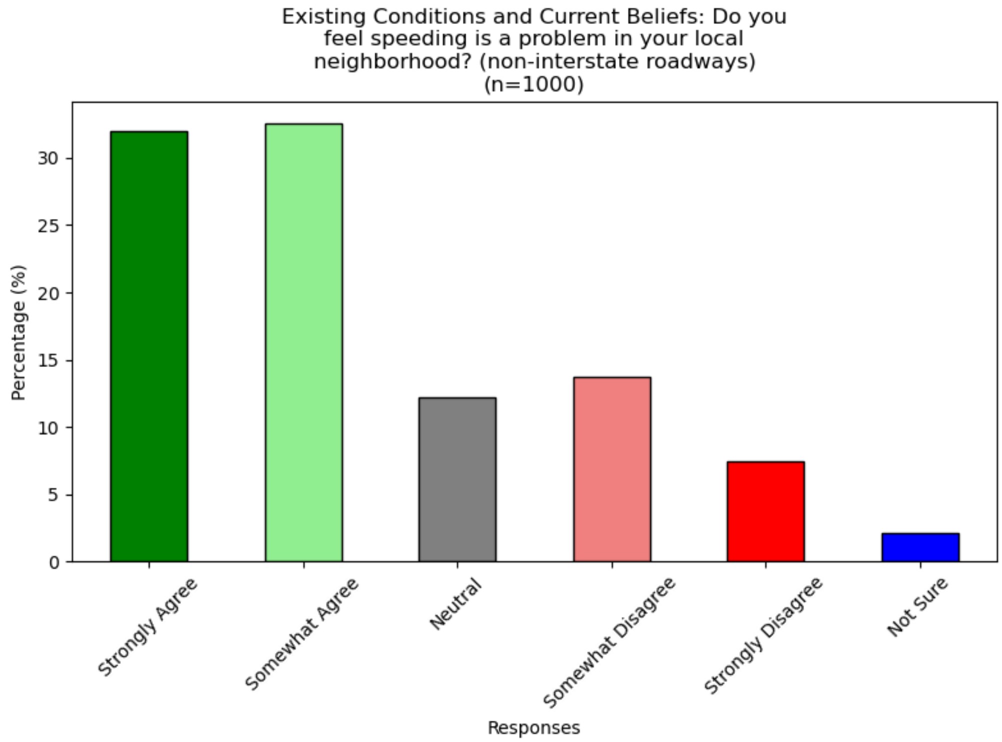

Figure 7.45: Existing conditions and current beliefs: speeding on local roads

Figure 7.46 investigates a potential countermeasure to the halo effect which was shown in Figure 7.34, whereby there is also strong support or neutral thoughts on having these devices hidden or the ability to move their operations to provide reduced speeds across roadways in a dynamic manner. That is to say there is substantial support to not make the location of these systems specifically known, in order to provide speed reductions across all the roadways in the city, however this will compare with another question in the Transparency and Accountability section.

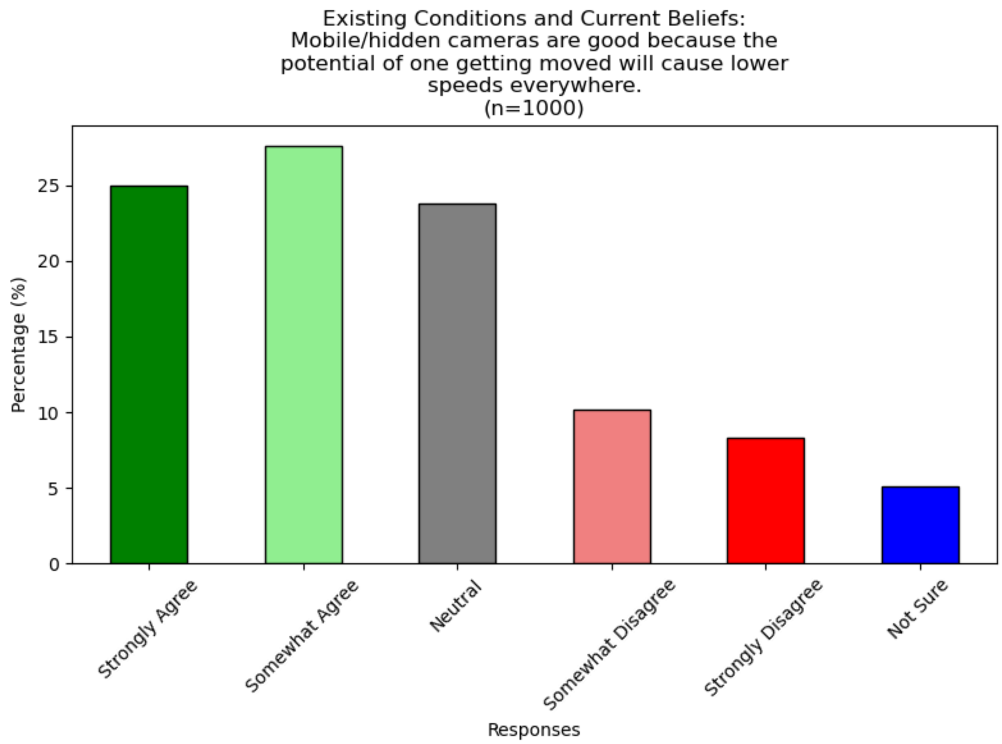

Figure 7.46: Existing conditions and current beliefs: mobile/hidden camera usage halo effect countermeasure

Lastly, Figure 7.47, whether or not the utilization of SSC is an invasion of privacy even if facial recognition is not used, where there is no specific consensus on this question. Albeit “Somewhat Agree” had the highest response rate, there is still substantial responses that disagree. This question in particular will be later compared to a question asking if facial recognition should be used and also a question on ticketing policy and if the ticket should go to the driver or vehicle owner, which would require facial recognition.

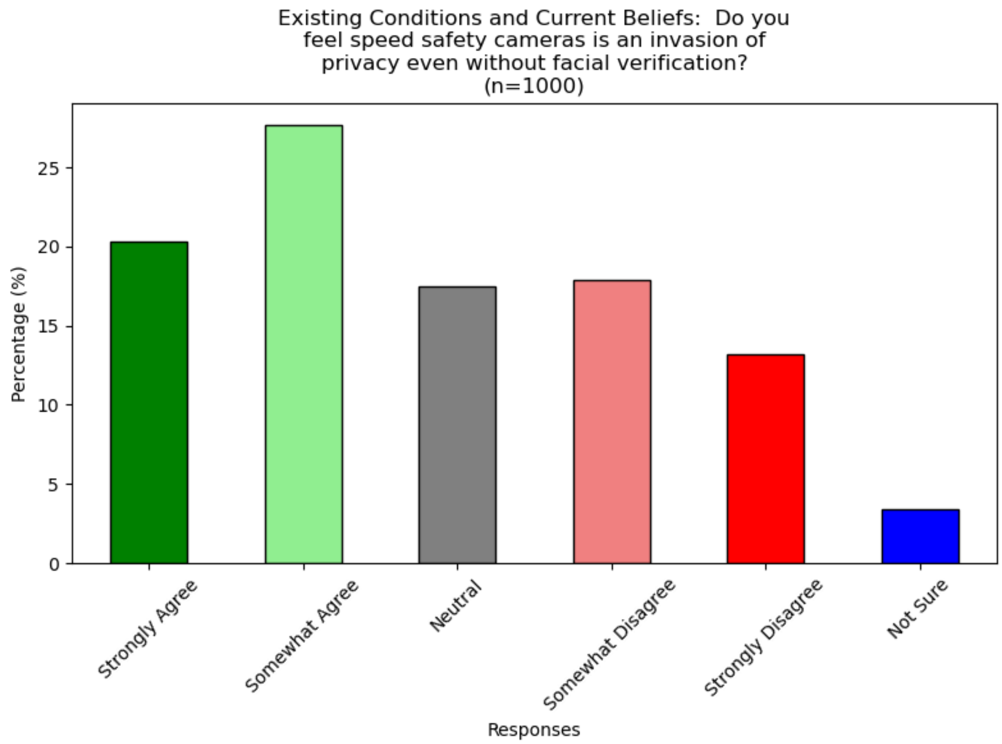

Figure 7.47: Existing conditions and current beliefs: SSC system invasion of privacy

7.2.2.4 Survey results for transparency and accountability

Looking specifically into how the agencies should report their findings and approaches agencies should consider, transparency and accountability of the deploying agency is investigated. Figure 7.48, shows if the agency should publish the locations they plan to operate SSC systems before their deployment. With resounding support nearly 70% of the respondents indicated they would want this information before the system becomes operational. While this has high support, it is also countered by Figure 7.46, where a large majority had the feeling that if the systems were hidden, they would have much more effect at reducing speed on the entire roadway network. Perhaps, a combination of both would produce desired results, those that are known locations such as school zones and work zones, and moving devices to reduce speeds across a communities roadway network.

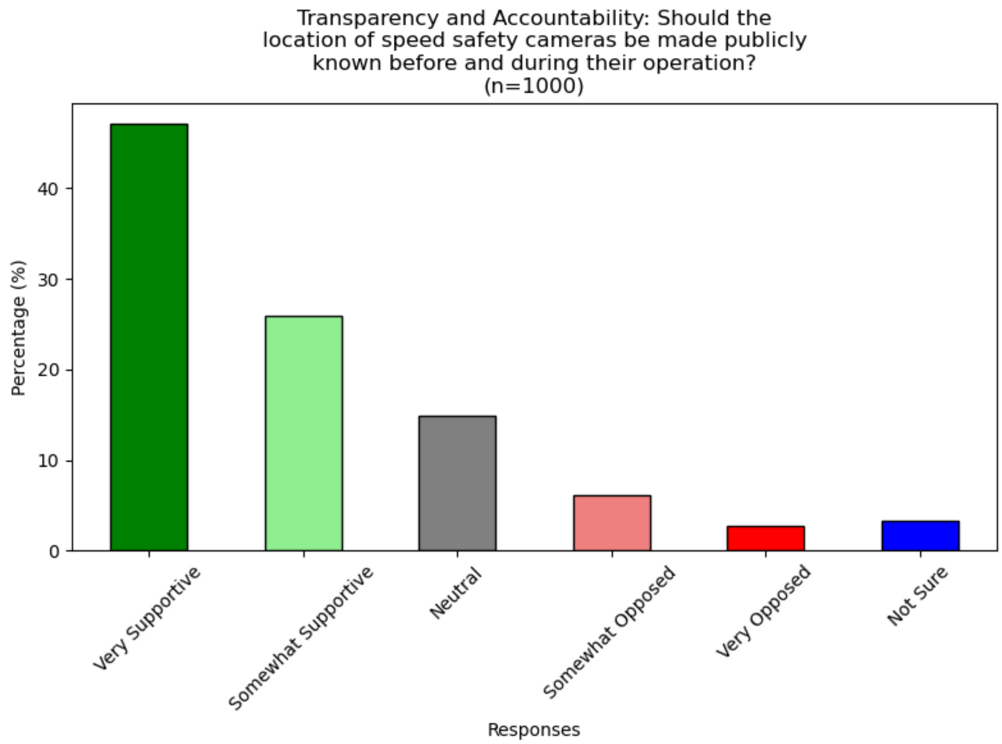

Figure 7.48: Survey results transparency and accountability: SSC system locations be made public and known during their operation

Other questions for transparency and accountability include Figure 7.49 and Figure 7.50 where respondents were asked how the agencies who deploy these devices would handle specific program information such as how revenue is used or other intrinsic characteristics of the systems operation. Furthermore, on what to do with transportation operating statistics data and the relevant network wide reductions in speed or crashes while the system is in operation, providing a continual examination on the benefits the system brings. In general both Figure 7.49 and Figure 7.50 represent a desire from individuals in Oregon to require the agency who operates the system to be transparent in their operation and accountable on the benefits and results of the systems.

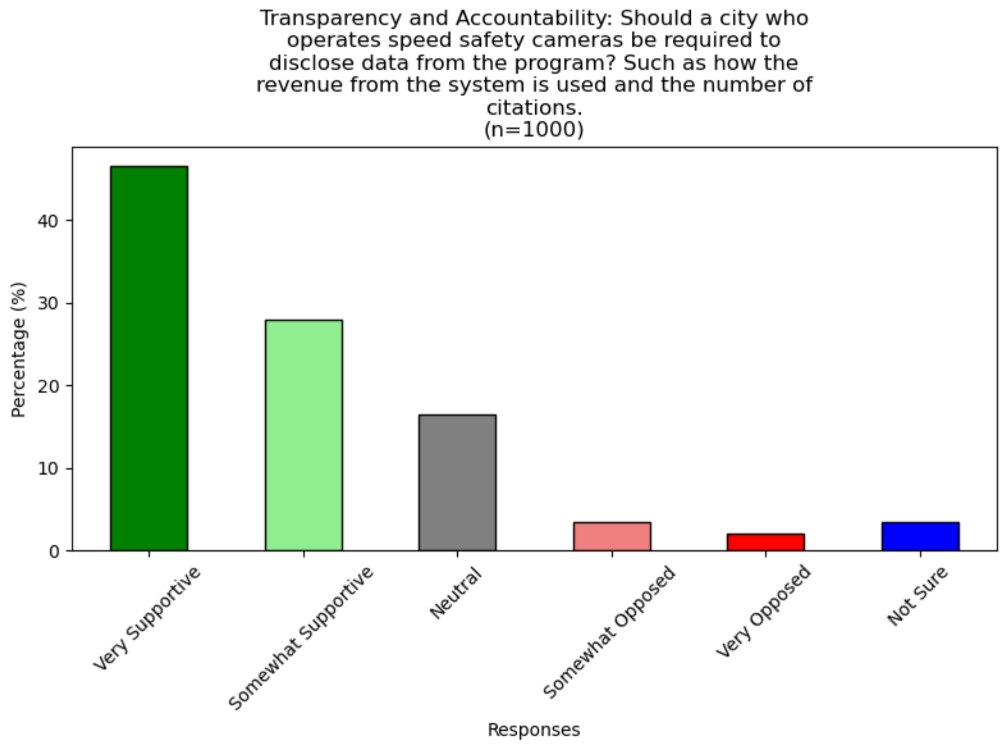

Figure 7.49: Survey results transparency and accountability: SSC operating data publishing

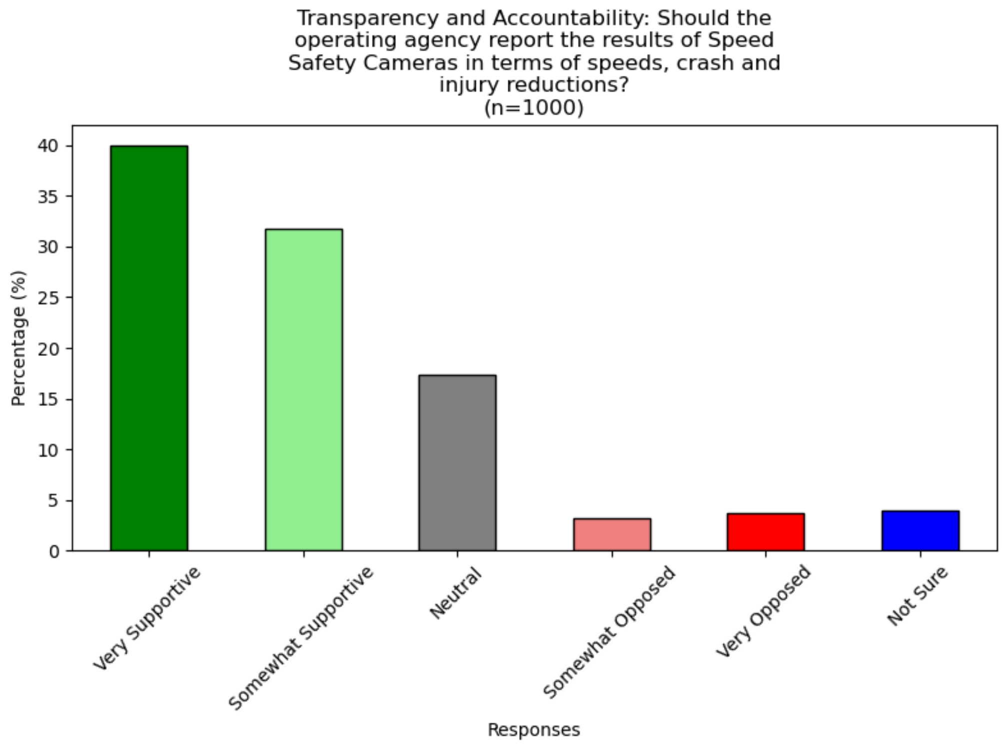

Figure 7.50: Survey results transparency and accountability: SSC road safety statistics reporting

7.2.2.5 Survey results for ticketing

The previous section identified the importance of transparency and accountability from the operating agency for SSC systems, this section reviews a major component of transparency with respect to how Oregonians perceive ticketing procedures for the systems. Starting with Figure 7.51, there is heavy support to ticket the driver of the vehicle and not the owner, however, for this to occur there would need to be facial recognition software. While Figure 7.47, questioned if the use of these systems was an invasion of privacy to which there was a relatively equal split between agreement and disagreement, the utilization of facial software might greatly increase the number of individuals who believe that is an invasion of privacy. This specific question, on who should be ticketed, requires much further investigation, as one solution is facial recognition, and the other hinders the ability for the agency to administer citations as there would need to be proof the owner was in the vehicle that was caught speeding.

Figure 7.52 reports on the respondents' opinions for income-based citations. While there is two primary response categories that dominate, "Very Supportive" or "Very Opposed", when filtering household income there is no specific trend on those with higher incomes being opposed or supportive, and vice versa. However, on the lower income there was more support for being "Very Opposed" for income-based citations, which may lead towards a mis-understanding on this format of SSC systems and requires further information dissemination to the public.

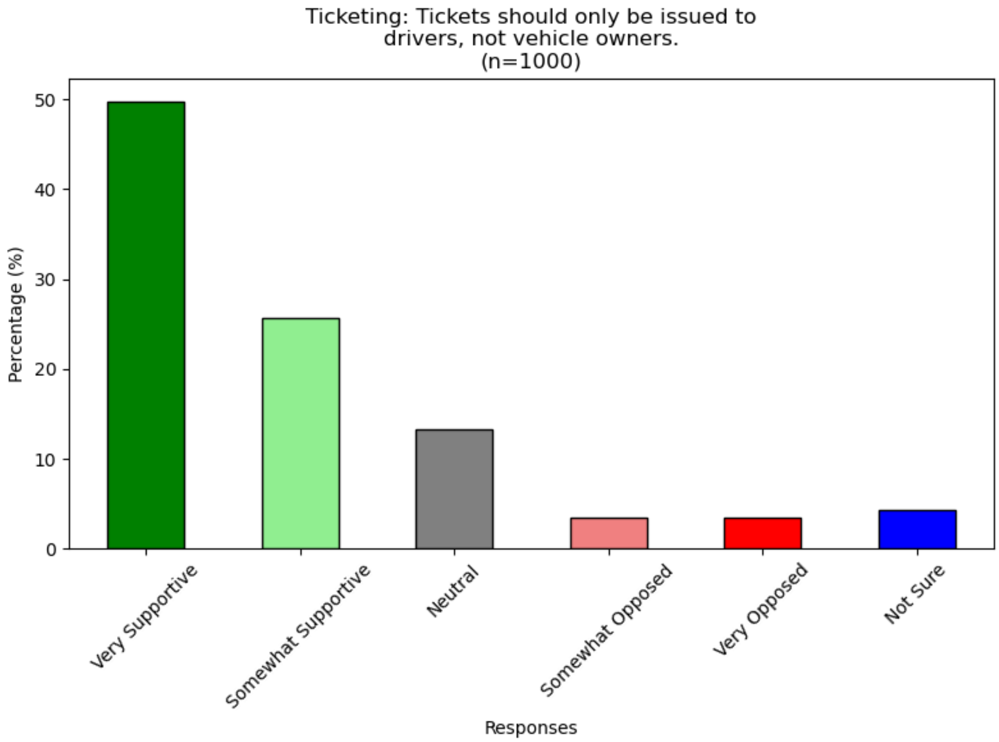

Figure 7.51: Survey results ticketing: ticket issued to driver not vehicle owner

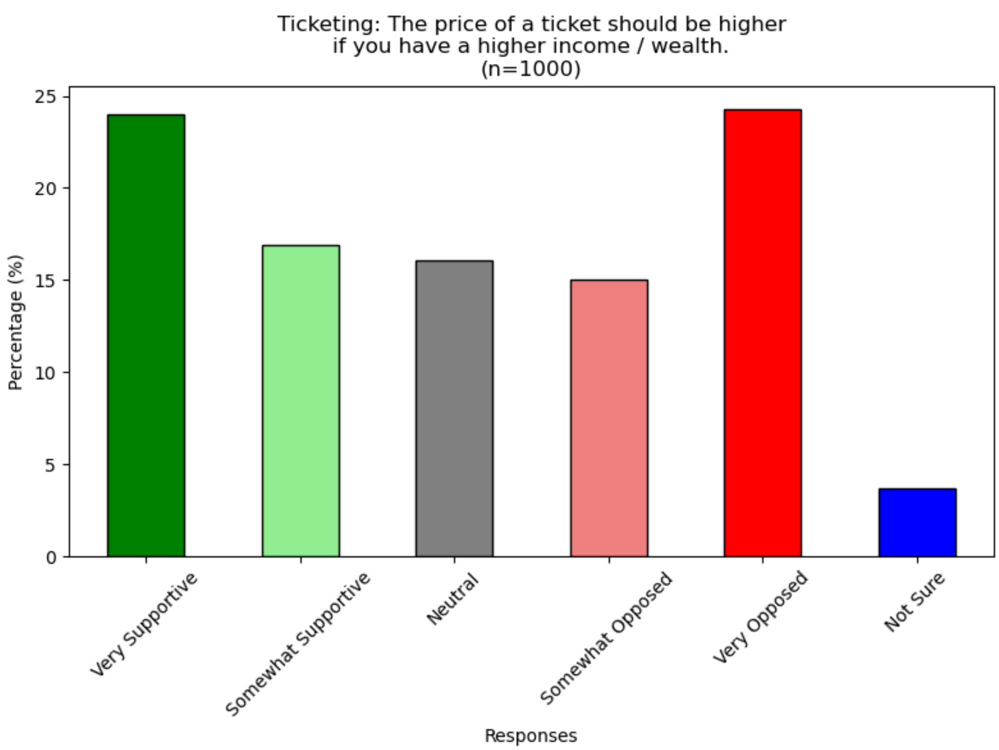

Figure 7.52: Survey results ticketing: income-based fines

For Figure 7.53, there is overwhelming support for having education courses be an option for first time offenders of SSC systems. As such this should be considered for every agency who plans to operate SSC systems and or be imbedded into existing programs that offer this as an alternative.

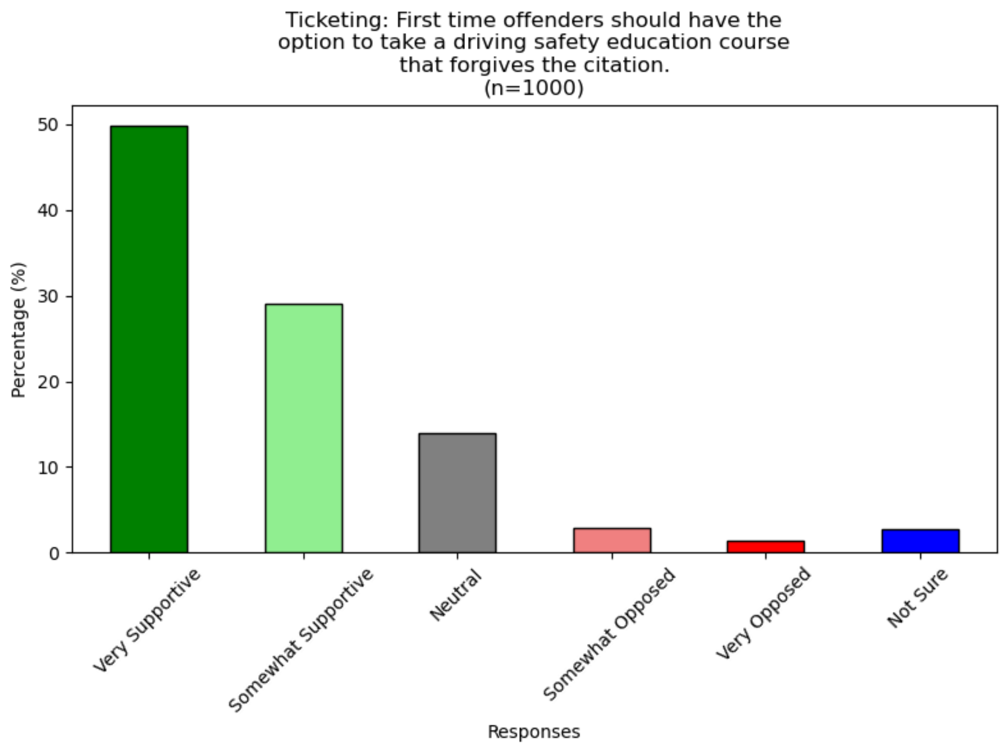

Figure 7.53: Survey results ticketing: first time offender forgiveness program

Figure 7.54 reviews if recurrent offenders should receive higher citations compared against first time offenders, with substantial support as well. This may indicate general consensus across Oregonians that increases in citation amounts for repent offenders will reduce those drivers speeds, thereby making Oregon roadways safer.

Figure 7.55 and Figure 7.56 delve into location-based citation pricing and speed thresholds. While the speed threshold does not have as much consistency in being supported as the citation amount, there may be difficulties in addressing the local population on when the speed threshold exists for the SSC systems. This is further discussed in the following figures on when a speed threshold above the post speed limit should occur and if it should also be a function of roadway classification and or the speed of the facility itself.

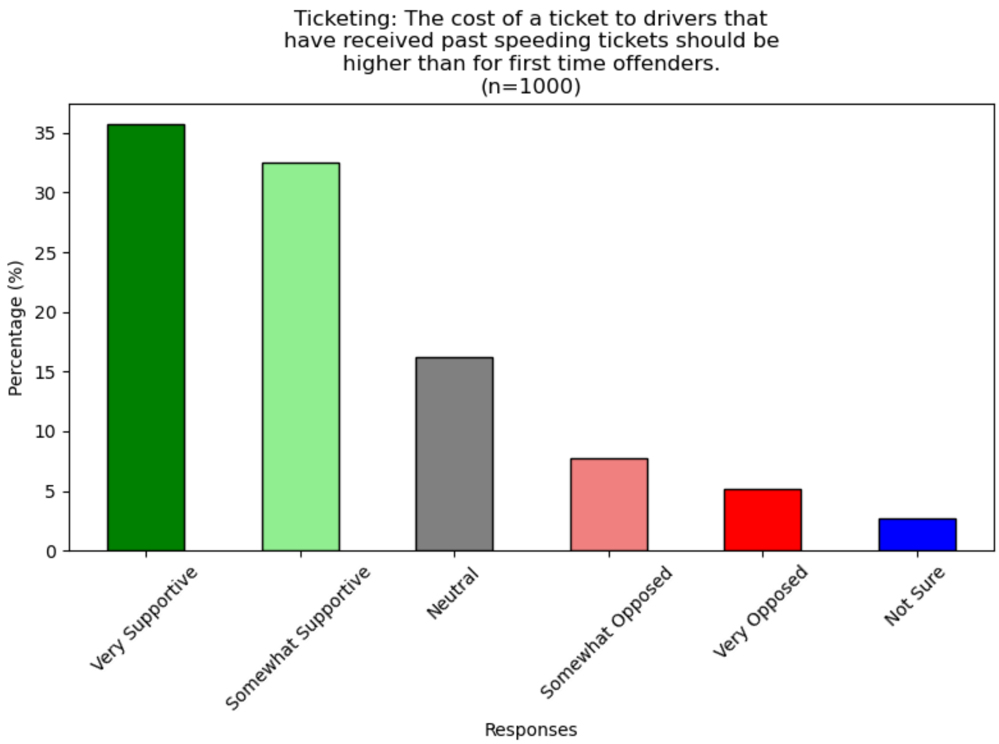

Figure 7.54: Survey results ticketing: recurrent offenders

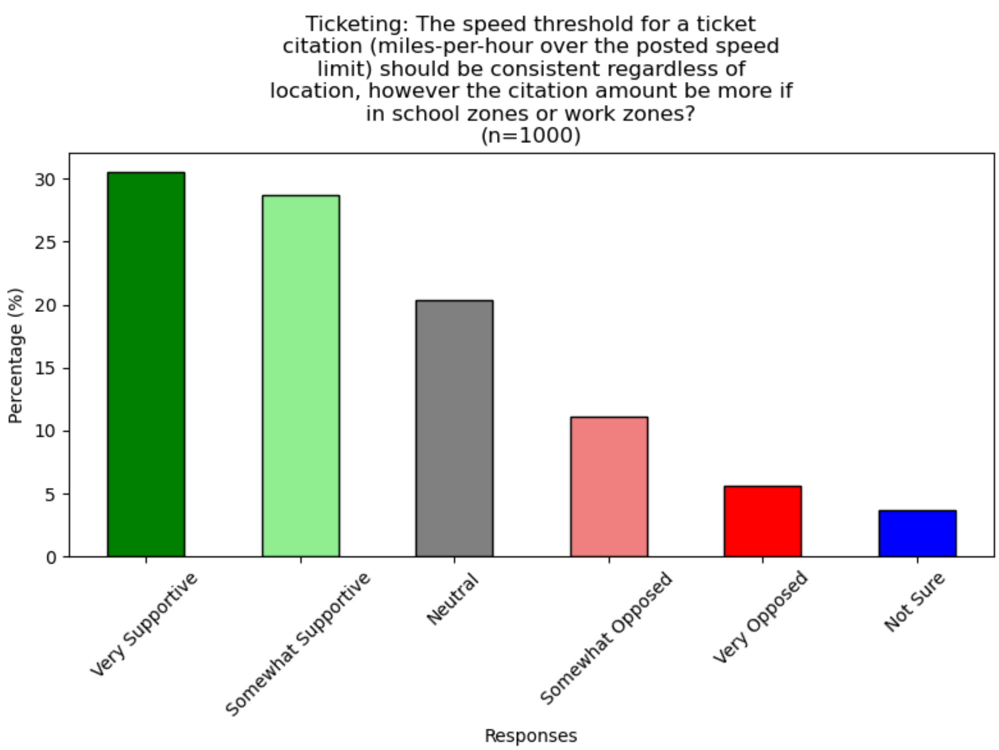

Figure 7.55: Survey results ticketing: location-based ticket pricing

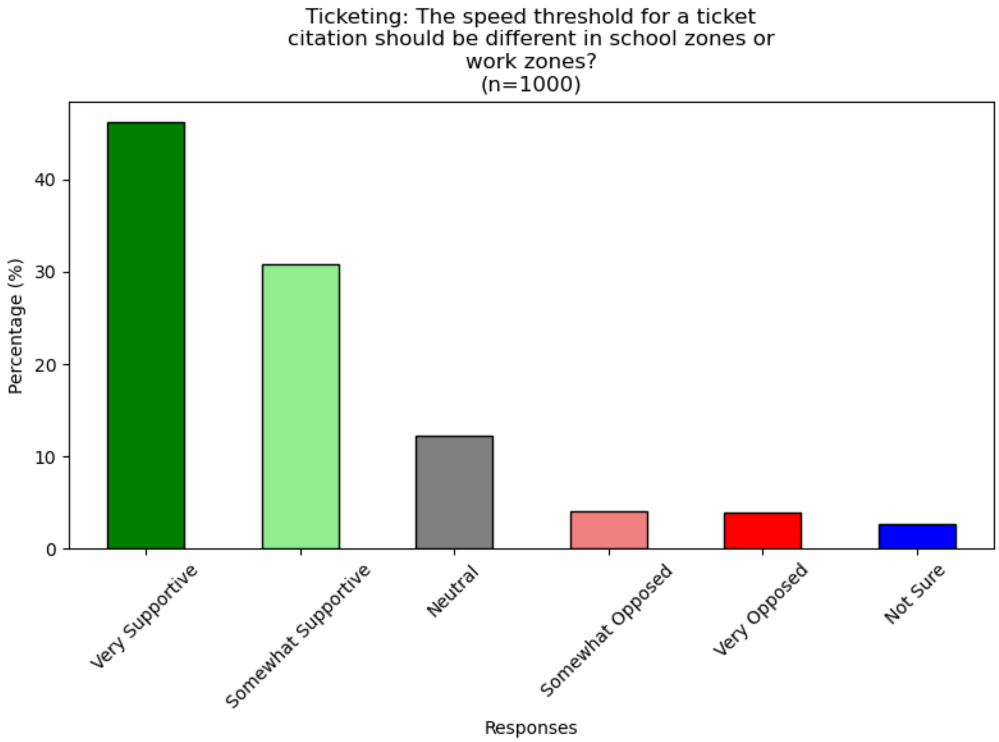

Figure 7.56: Survey results ticketing: location-based speed threshold

Figure 7.57, Figure 7.58, Figure 7.59, and Figure 7.60 ask the survey respondents the threshold at which citations should be administered for high-speed state roads, in excess of 45 miles per hour. The results reveal substantial support for 15 miles per hour over the speed limit and even more at 20. While 10 miles per hour over also has almost half of the respondents agreeing the ticket should be administered, this is something the deploying agency can consider, but should be made clear for their residents, as the change in opinion for these range of questions depicts the level of concern Oregonians have on the citation speed threshold.

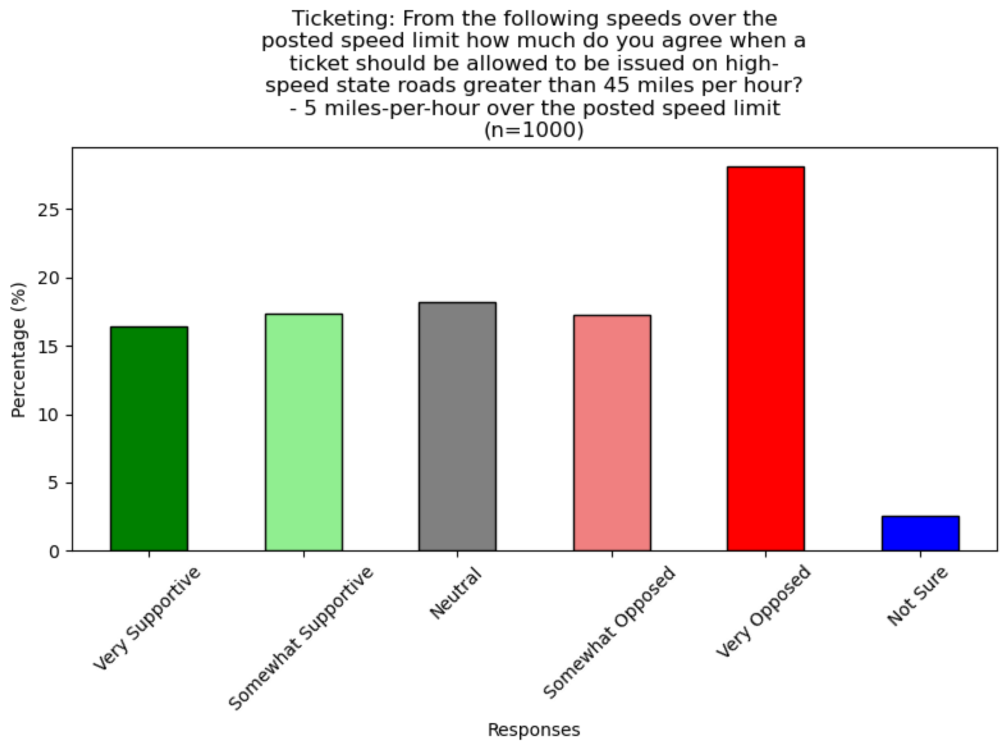

Figure 7.57: Survey results ticketing: 45 mph roads with 5-mph over ticketing threshold

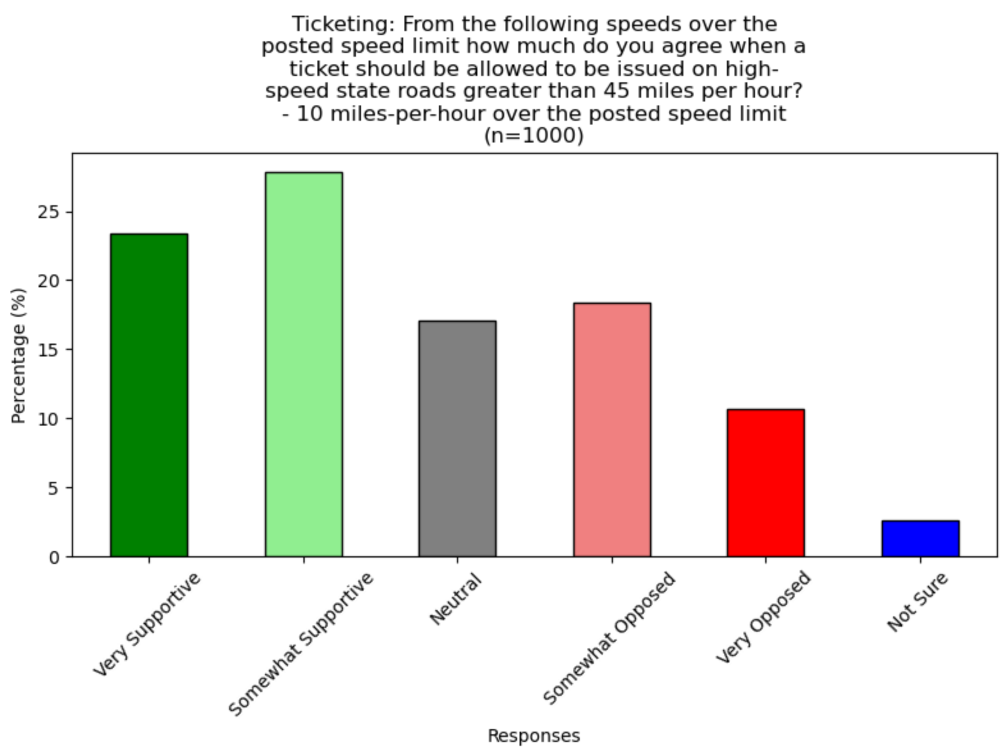

Figure 7.58: Survey results ticketing: 45 mph roads with 10-mph over ticketing threshold

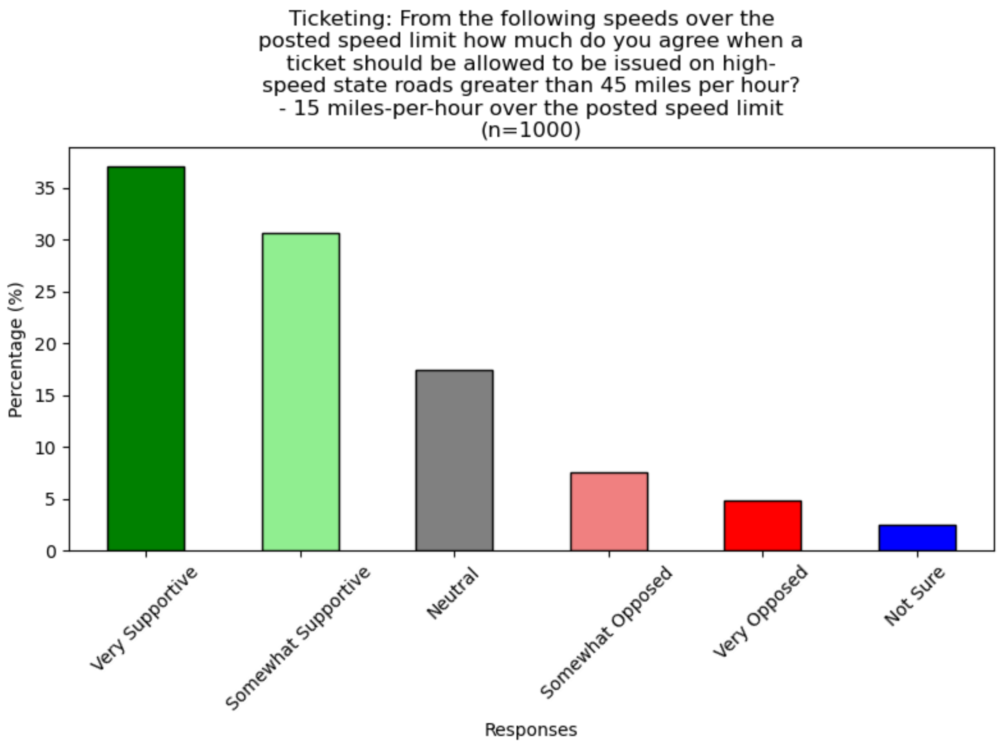

Figure 7.59: Survey results ticketing: 45 mph roads with 15-mph over ticketing threshold

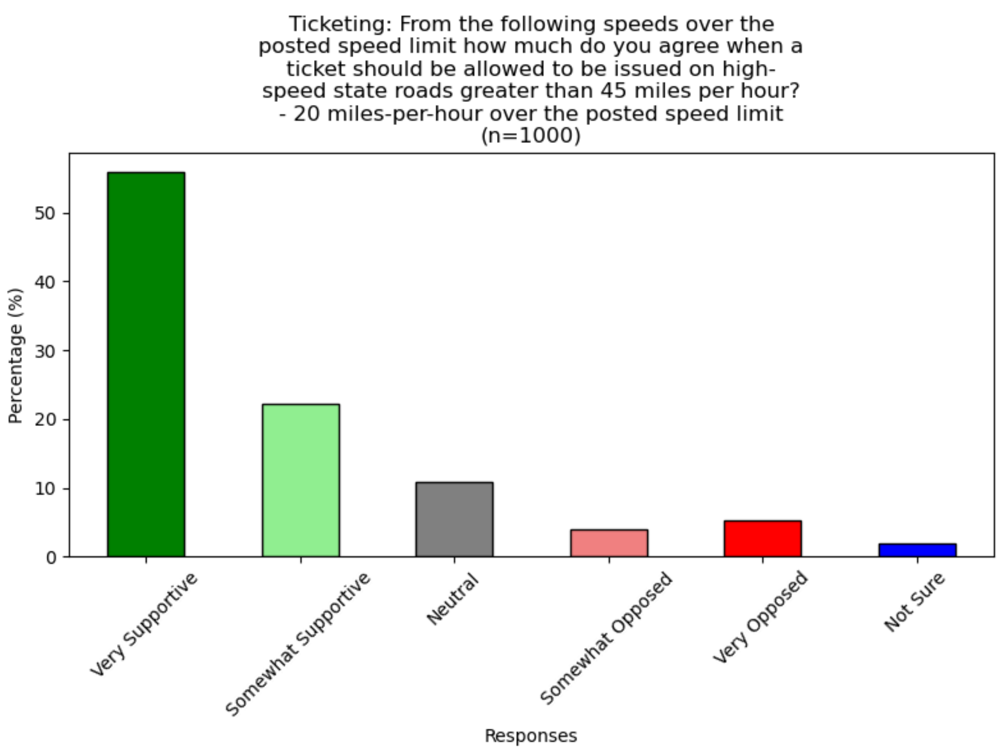

Figure 7.60: Survey results ticketing: 45 mph roads with 20-mph over ticketing threshold

Furthermore, Figure 7.61 Figure 7.62 Figure 7.63, and Figure 7.64 ask what the speed thresholds should be when operated on local roads that are lower speeds. Compared to the higher speed roads there is more consensus on have the thresholds start at 10 miles per hour over the speed limit, and the higher thresholds receive even more support. What is consistent from both situations is that 5 miles per hour over the posted speed limit is too small of threshold for broad public acceptance.

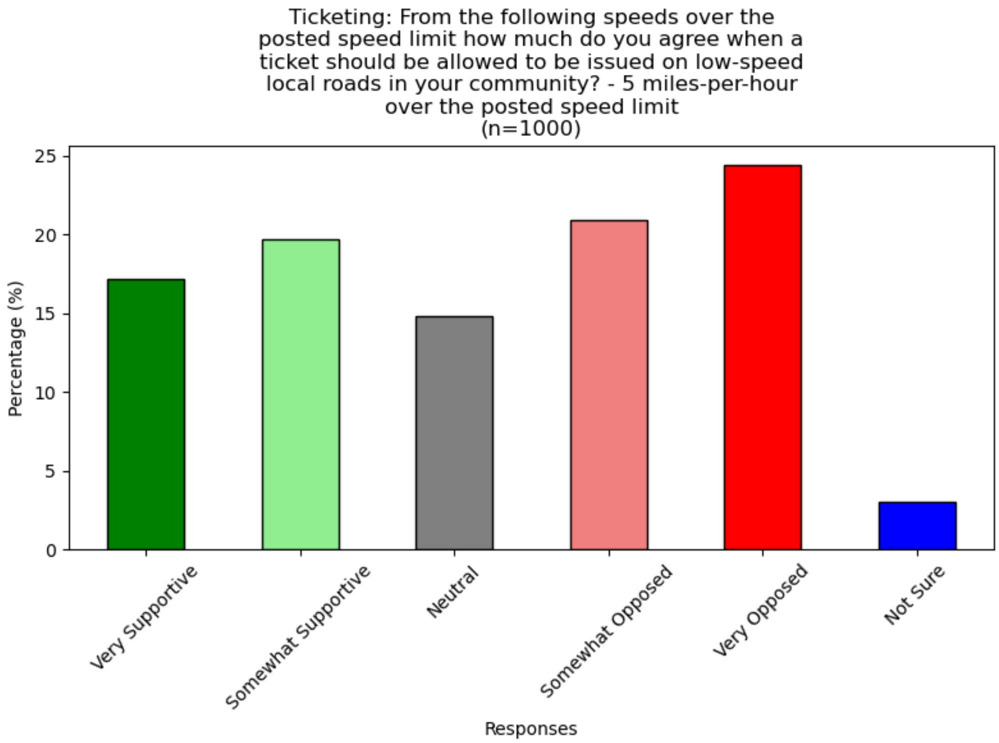

Figure 7.61: Survey results ticketing: local roads with 5-mph over ticketing threshold

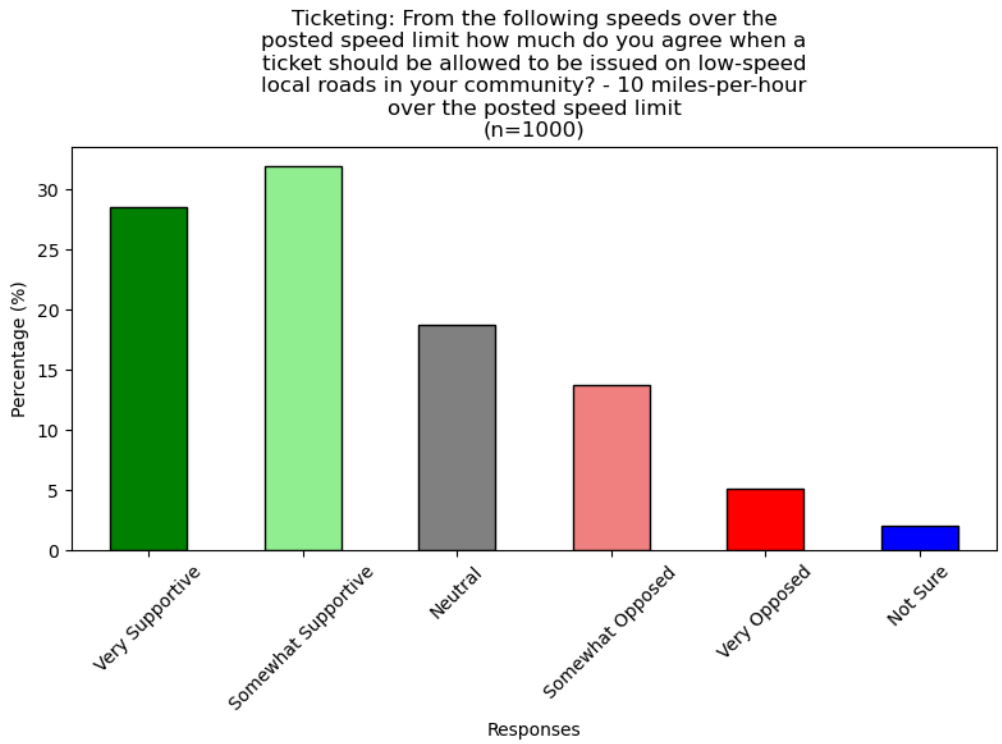

Figure 7.62: Survey results ticketing: local roads with 10-mph over ticketing threshold

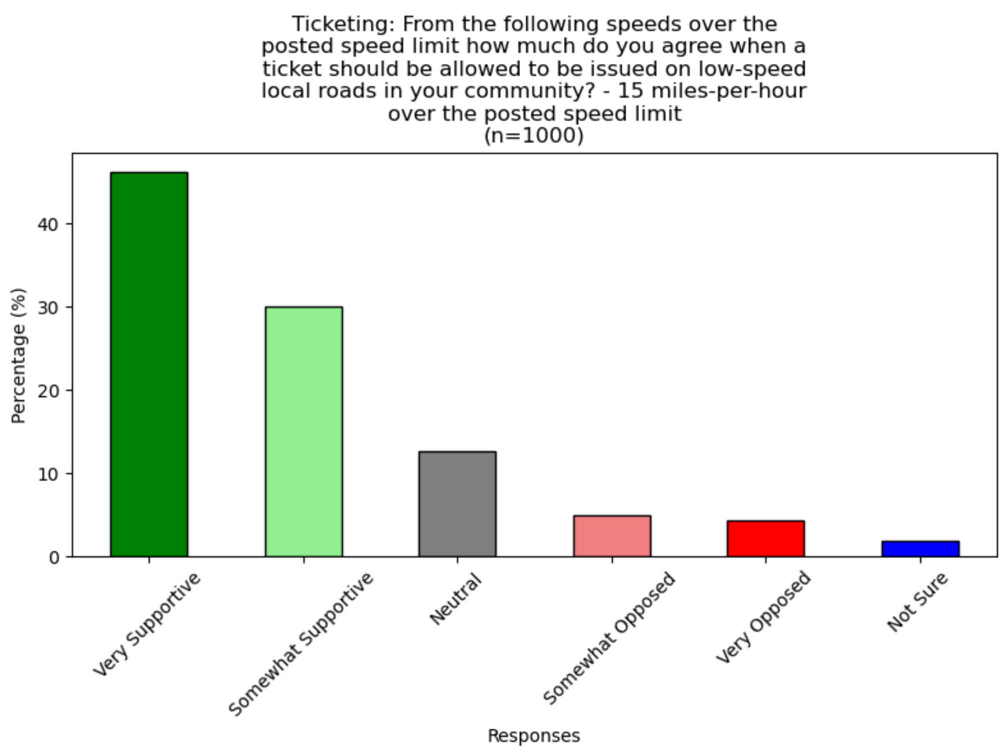

Figure 7.63: Survey results ticketing: local roads with 15-mph over ticketing threshold

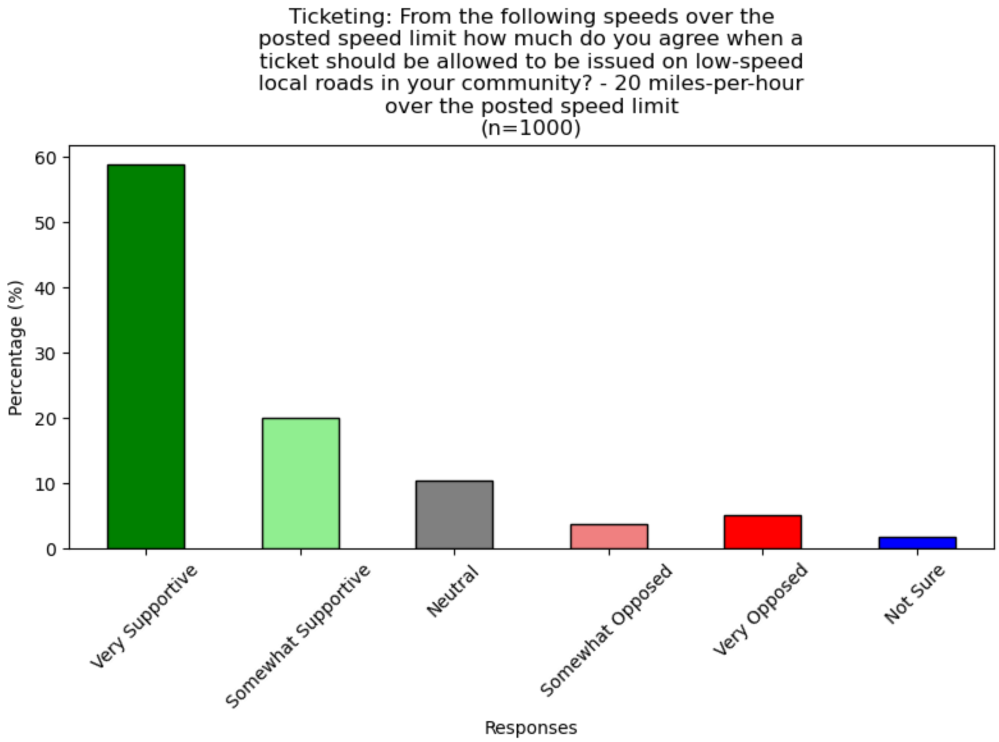

Figure 7.64: Survey results ticketing: local roads with 20-mph over ticketing threshold

7.2.2.6 Survey results revenue

Ticketing or citation information for the agency who plans to operate SSC systems will be a staple towards gaining broad public acceptance of these systems. Another area of concern is how agencies plan to deal with the revenue of SSC systems and the results for this line of questions is revealed in this section. Figure 7.65 demonstrates survey respondents' belief that SSC systems will produce more revenue than their operational costs. With nearly an equal split between "Strongly Agree", "Somewhat Agree", and "Neutral", there is evidence that Oregonians believe the operation of these systems will bring in revenue. This underlines the importance of transparency on what the operating agency plans to do with the revenue generated from the systems, if the systems indeed produced revenue.

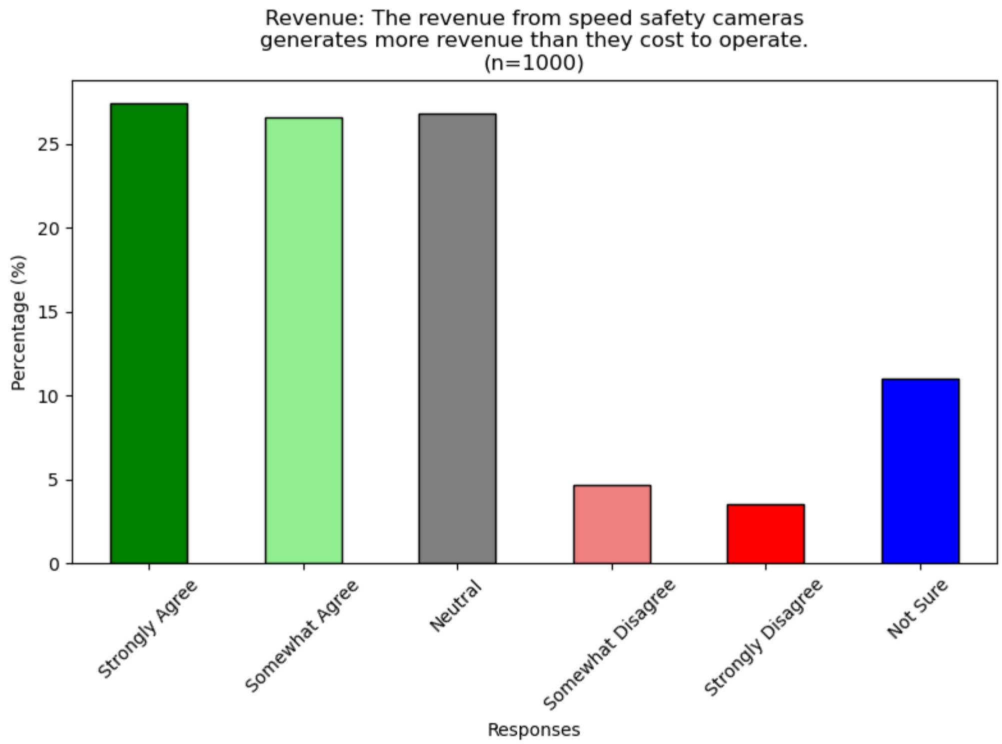

Figure 7.65: Survey results revenue: SSC systems will generate more revenue than their operating costs

Figure 7.66 reveals the survey respondents' opinions on if the revenue from SSC systems has the potential to improve micromobility modes if the revenue is used for them. While the majority of respondents agreed, there is a trend to which if dollars are invested there will be improvements for the system and is displayed by the responses to this question.

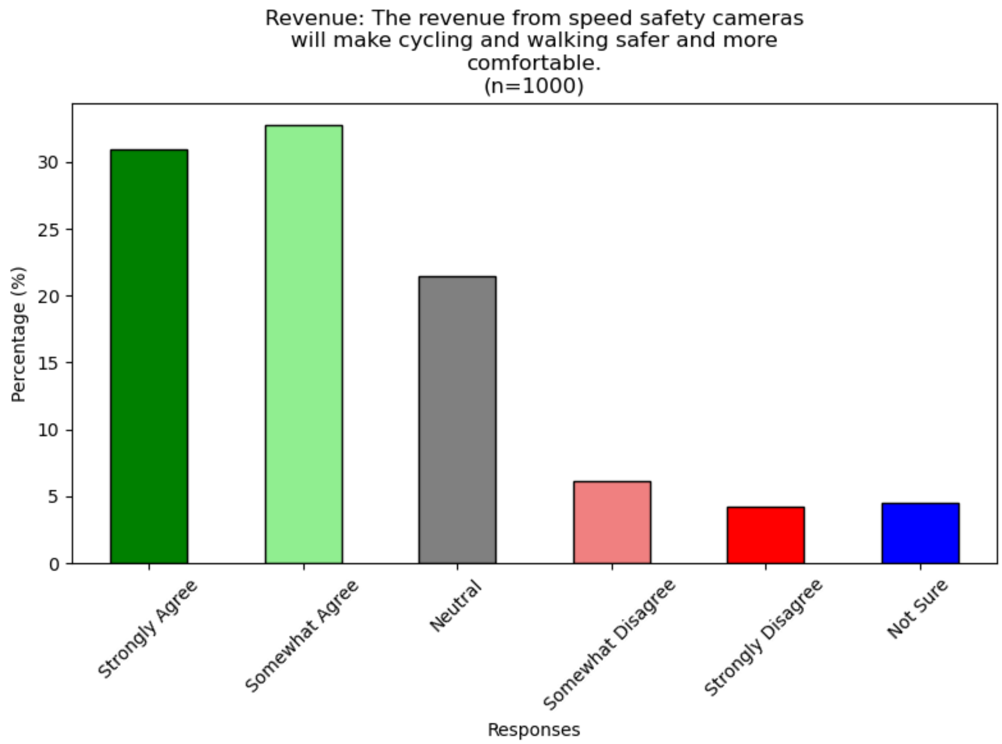

Figure 7.66: Survey results revenue: revenue from SSC systems has the potential to make microbility options safer

The proceeding questions ask where revenue should be spent and begins with Figure 7.67, where respondents are asked if revenue from SSC systems should be utilized outside of transportation. While there is slightly more responses that agree, there is still a substantial volume of Oregonians that feel it should not be used for non-transportation applications.

Figure 7.68, while not specifically for transportation, has high acceptance, and may reveal a general desire for more funds to reach into policing. This might not be used for police-based traffic safety but for increased safety of communities from police departments. While true, there is still a substantial percentage of Oregonians who disagree with this approach as well.

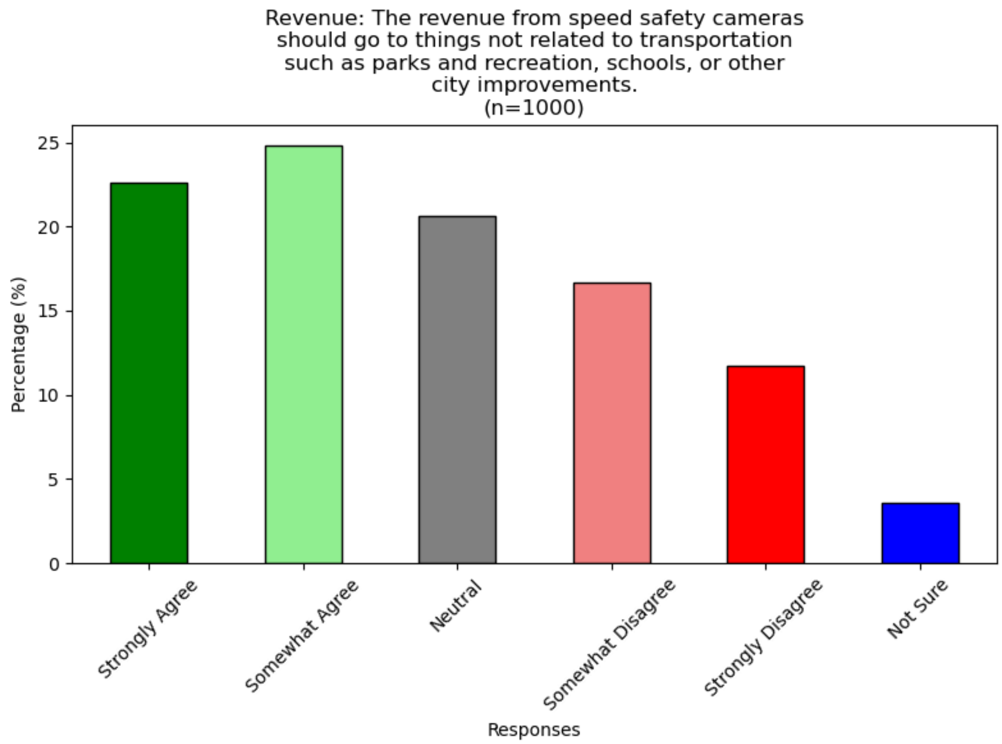

Figure 7.67: Survey results revenue: should SSC revenue go to non-transportation initiatives

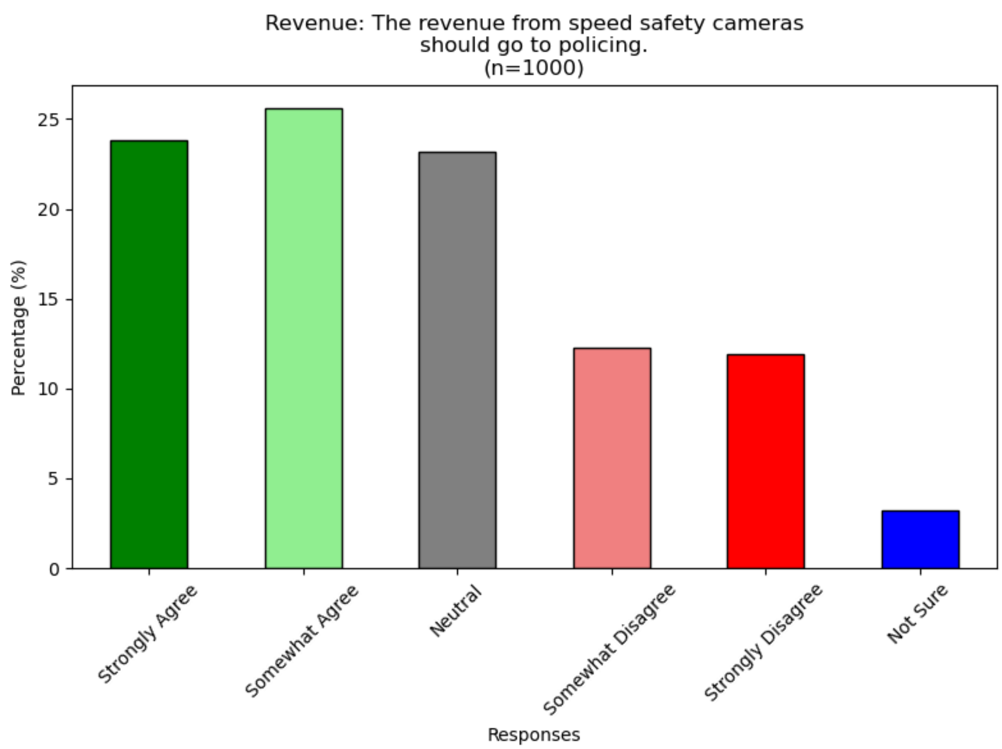

Figure 7.68: Survey results revenue: should revenue from SSC system go to policing

More specifically for transportation operations, Figure 7.69 displays the results on if revenue should be used on roadway repair, to which almost 80% of respondents agreed, and even more telling less than 5% disagreed. This result depicts the importance for the operating agency of SSC systems to be transparent on where revenue will go, if they exist, and roadway repair is a good option to obtain public acceptance.

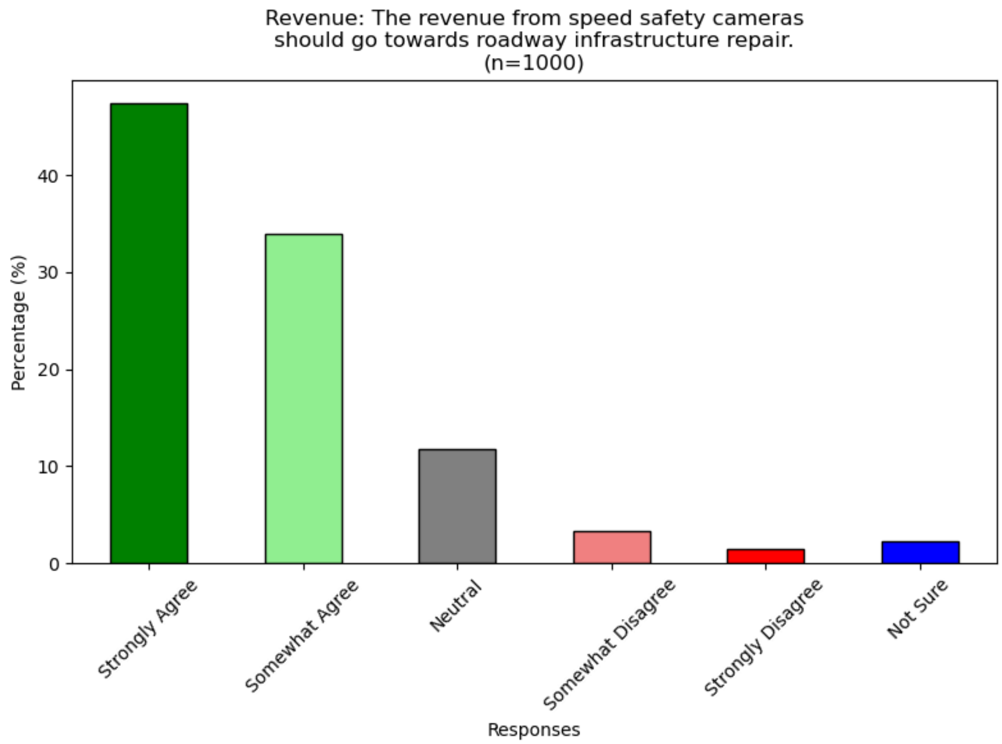

Figure 7.69: Survey results revenue: should the revenue from SSC systems go towards roadway repair

An alternative question that depicts revenue sentiment from Oregonians is presenting in Figure 7.70. Figure 7.70 demonstrates a desire from Oregonians to have revenue from SSC systems to be used on existing high crash or high-speed corridors, where data has proven there is safety concerns on that segment. From a data driven perspective this may be the first or second option an agency can consider on where revenue should go if it exists from the operation of SSC systems.

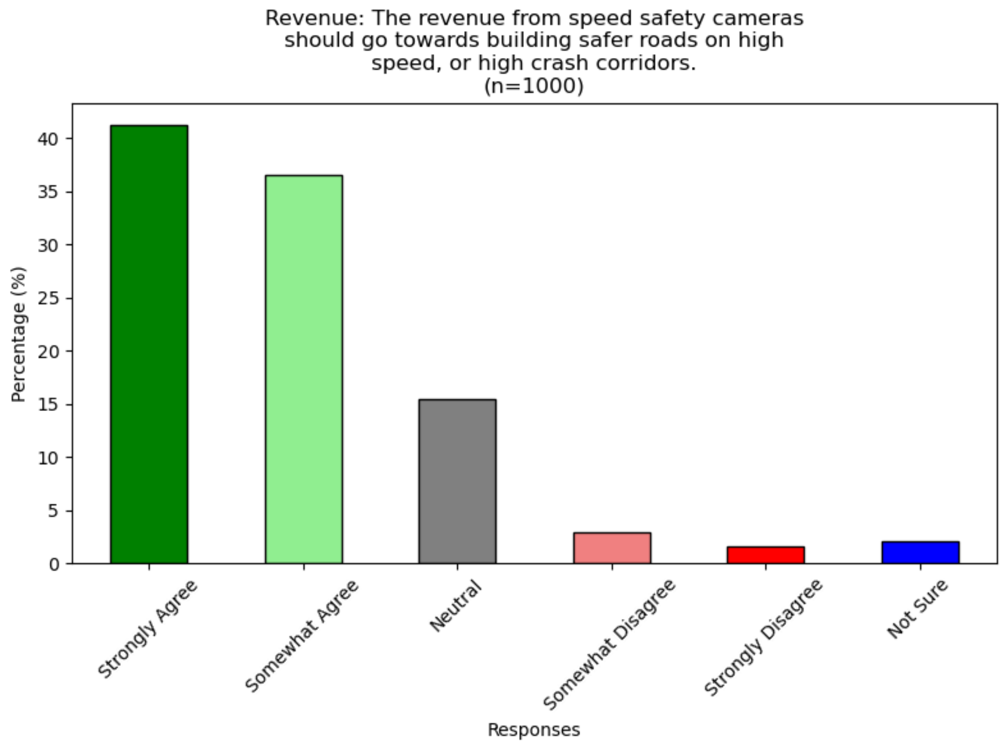

Figure 7.70: Survey results revenue: should SSC revenue go to specific roadways or corridors that have existing safety issues

Lastly, a general question is asked of the respondents on if they believe SSC systems is mainly about producing revenue and not improving transportation safety and is shown in Figure 7.71. While there is strong support that Oregonians trust these systems are for safety there is some doubt as well. This result provides agencies with the ability to initially provide information campaigns on their specific goals of operating, and when considering the previous questions on where revenue will go, may alleviate this sentiment among Oregonians.

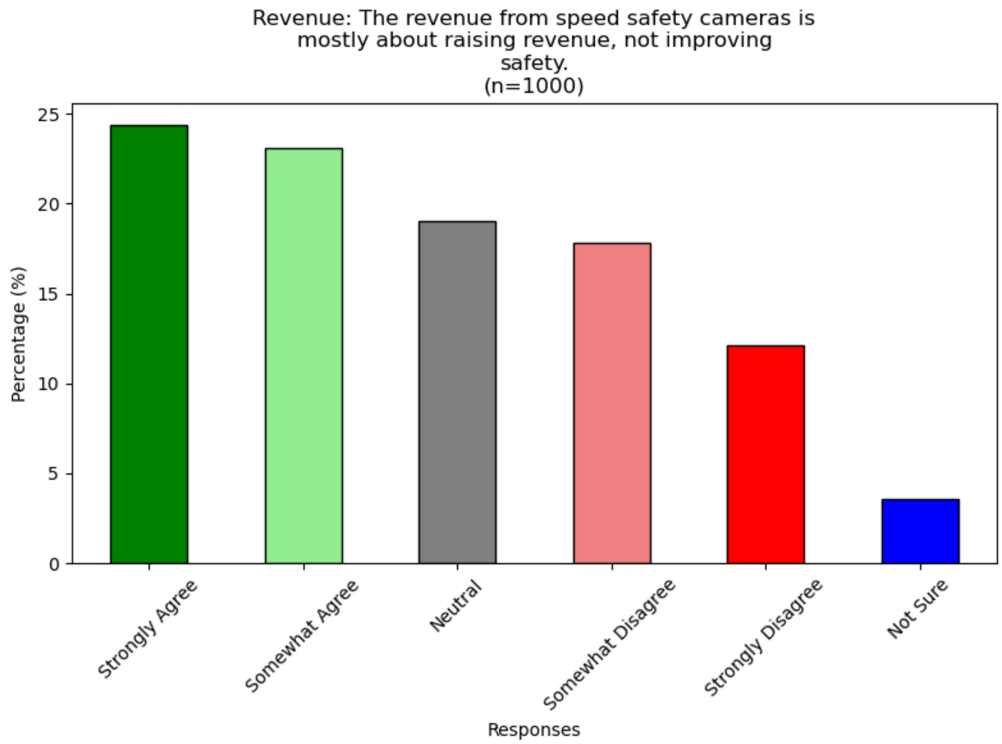

Figure 7.71: Survey results revenue: utilization of SSC systems is meant to raise revenue and not improve safety

7.2.2.7 Survey results text responses

Lastly, from the survey's outputs, two additional questions were asked as a written response to see opinions on where revenue should be used that was not covered int the questions, and if they have any comments or suggestions. These written responses were categorized into an array of themes for agencies to consider on the deployment of these devices. Table 7.7, Table 7.8, and Figure 7.72 display the results for the written result themes on where SSC revenue should go. To arrive at a larger set of themes, specific text needed to also be captured as a result of spelling errors or specific phrases. Table 7.7 captures the general keywords for most of the themes, whereas Table 7.8, has longer phrases. As can be seen in Figure 7.72, most of the responses were in relation to roadway repairs followed by safety which can be specifically targeted by agencies who desire to operate SSC systems.

Table 7.8: Written response themes: where should the revenue from SSC systems go or be used for

Theme	keywords
Road Repair	“road", "repair", "pothole", "infrastructure", "roads", "pave", "maintenance", "highways", "street"
Education	"education", "school", "training", "learning", "license", "driving classes", "driver education"
Safety	"safety", "safe", "enforcement", "crosswalk", "signage", "light", "guardrail", "intersection", "campaigns", "accident", "victims", "traffic control", "calming"
Public Transportation	"transit", "bus", "public transport", "train", "subway", "public transportation", "cars"
Law Enforcement	"police", "officer", "enforcement", "law", "wages", "protection", "cameras", "first responders", "regulations"
Community Welfare	"community", "welfare", "homeless", "support", "programs", "housing", "parks", "pets", "resources"
Environmental	"environment", "green", "eco", "bike", "pedestrian", "emissions", "trees", "pollution", "carbon"
Healthcare	"health", "hospital", "ambulance", "trauma", "mental", "emergency", "medical bills"
Public Safety	"fire", "ambulance", "emergency", "disaster", "security", "noise barriers", "wildlife crossing"

Table 7.9: Written response themes: additional manually assigned themes

Manual assignment
""rodes": "Road Repair",
"Filling pot holes.": "Road Repair",
"Street improvements": "Road Repair",
"more cameras": "Law Enforcement",
"Activities for kids or pets": "Community Welfare",
"Accident victim assistance": "Safety",
"Campaigns against driving while distracted": "Safety",
"Financing trucks used for street sweeping.": "Public Works",
"Fund traffic-calming measures in high-risk areas.": "Safety",
"barriers to noise near freeways": "Public Safety",
"speed bump construction": "Safety",
"First responder funding": "Law Enforcement",
"EV purchases should be subsidized in order to cut pollution": "Environmental",
"Creative advertising ideas": "Community Welfare",
"Improve capacity for traffic enforcement": "Law Enforcement",

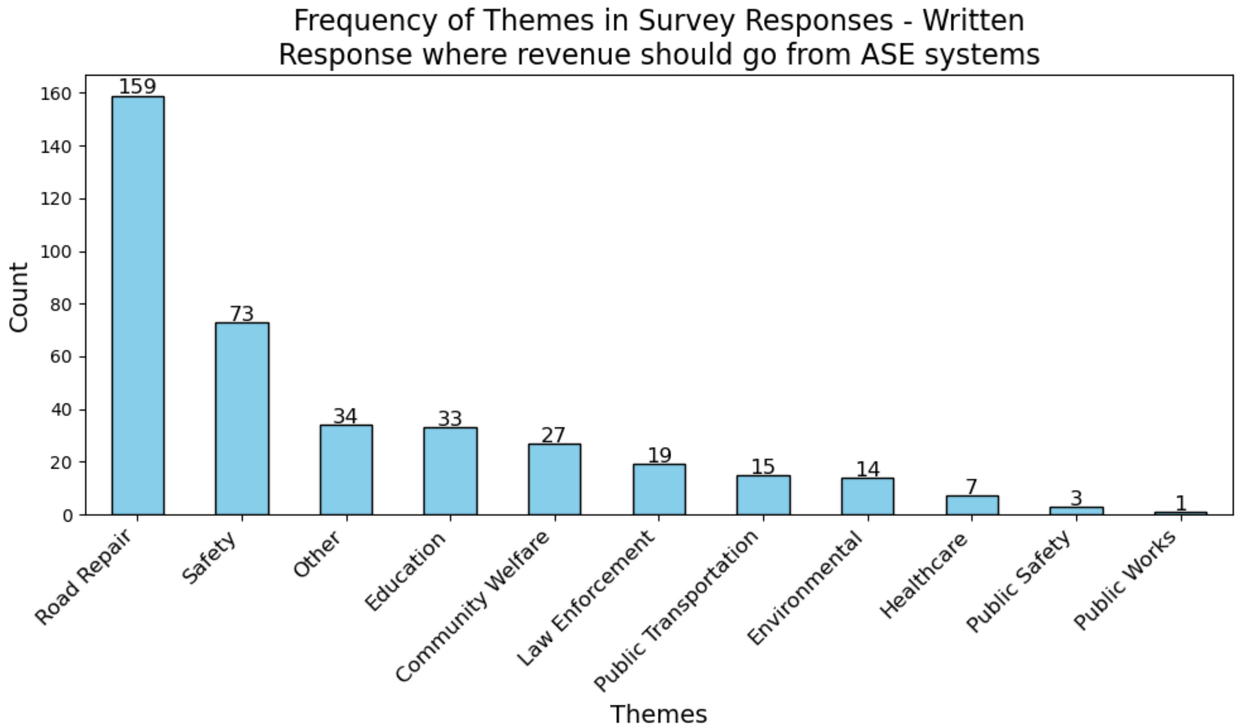

Figure 7.72: Survey responses written response themes: where SSC revenue should go or be used for

Lastly, Figure 7.73 and Table 7.9, reveal any additional comments the respondents may have had on SSC systems. Using the previous themes as before, with the addition of those in Table 7.9, the overwhelming response was good and bad public sentiment towards the operation of the systems, other, safety, and law enforcement. Specifically, within the public sentiment this ranged from agree, yes, strong support, to no, and negative comments on the deployment of the systems. While not added into this report, other responses were individual specific and did not have a tailored theme.

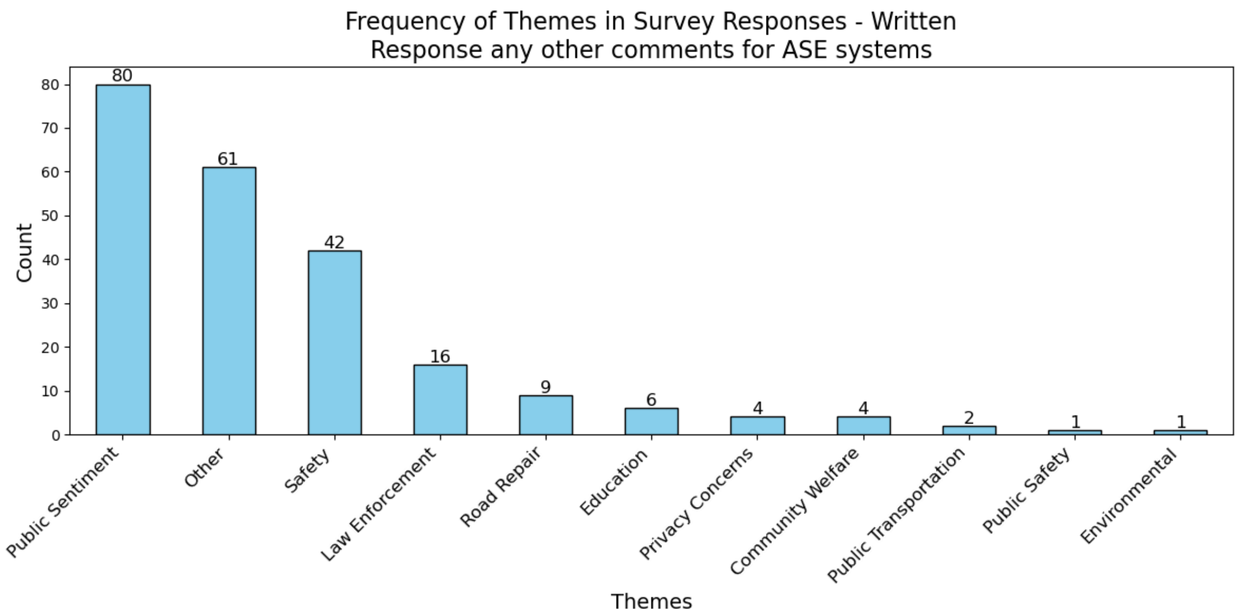

Figure 7.73: Survey responses written response themes: any other comments on SSC systems

Table 7.10 Written response themes: additional manually assigned themes specific for Public Sentiment

Manual assignment
"I'm not impressed one bit": "Public Sentiment",
"I strongly support": "Public Sentiment",
"Yes": "Public Sentiment",
"No thank you": "Public Sentiment",
"Great ideas, but there will be public opposition": "Public Sentiment",
"No": "Public Sentiment",
"Nah...they are serving their purpose in IIRC": "Public Sentiment",
"Nope": "Public Sentiment",
"Its a very good idea": "Public Sentiment",
"Na": "Public Sentiment",
"See above": "Public Sentiment",
"I see the strong need for them.": "Public Sentiment",
"I think it's just a trap so they can stuff their pockets. Greedy politicians and over simulated police": "Public Sentiment",
"Thank you!!": "Public Sentiment",
"no comments": "Public Sentiment",
"They are necessary I think": "Public Sentiment",
"Good deal right there we need them": "Public Sentiment",
"Agree": "Public Sentiment",
"agree": "Public Sentiment",
"AGREE": "Public Sentiment",
"I'm not sure if they should exist.": "Public Sentiment",
"This is a revenue generator.": "Public Sentiment",
"I strongly oppose them.": "Public Sentiment",
"The system must be fair.": "Public Sentiment"

7.2.3 Implications of survey results for the deployment of speed safety camera systems in Oregon

Looking specifically at section 7.2.2 an array of questions were assembled and asked of the survey respondents that was meant to capture policy categories for deploying SSC systems. This included:

1. Expected outcomes - which were designed to reveal the existing opinions of Oregonians on SSC systems.

2. Location guidance – meant to capture where Oregonians feel the placement of SSC systems would have the highest effect on traffic safety and personal safety.

3. Existing conditions and current beliefs – identified if Oregonians felt speeding was a problem on the roadways they drive and live near. This also captured privacy and operating strategies that might be considered by agencies.

4. Transparency and accountability – delving into how agencies should disseminate results of SSC operations

5. Ticketing – specific questions on pricing, speed thresholds, and other monetary aspects of citation procedures for SSC systems

6. Revenue – which captured existing opinions on the revenue SSC systems may produce, and what potential sources the revenue should go to for agencies to consider.

With the combination of these categories that were asked of the survey respondents, there is an opportunity to consider their responses towards obtaining public acceptance of these SSC systems to which agencies may include. The remaining sections delves into the specific categories from the survey response outputs and the overarching summative themes from those sections, that can be considered by any agency towards a successful deployment of SSC systems.

7.2.3.1 Implications of expected outcomes

While there was not any strong consensus on some of the questions in relation to expected outcomes, Figure 7.36 and Figure 7.37 received strong support on the safety implications of SSC systems where Oregonians felt the systems would increase the safety of the vehicular network for drivers, and micromobility users alike. Furthermore, Figure 7.34, halo effect, had uncertainty between support and disagreement, while the literature shows the implications of the halo effect. Agencies that deploy these devices will need to devise a strategy to inform the public of this effect, providing their own support on taking other precautions such as dynamic placement of the systems as to obtain network wide safety improvements instead of just corridors.

7.2.3.2 Implications for location guidance

For location guidance, even though the last question in that section, Figure 7.43, did not have large agreement on the existence of SSC systems, other questions in relation to locations did receive heavy support. This includes Figure 7.38, Figure 7.39, Figure 7.40, and Figure 7.42, where they are specific for certain zones such as school zones, work zones, locations where police officers are unable to operate or where the community nominates. The spectrum of results and agreement from Oregonians should inform agencies on placement strategies, that obtain broad public acceptance like work zones, or school zones, and data driven locations, however including the local community into their deployment is desired as well. Though the drawback to this goes back to the halo effect.

7.2.3.3 Implications for existing conditions and current beliefs

Some existing conditions were revealed from the survey respondents, indicating that there can be speed improvements on high speed roadways, and local roadways depicting a very relevant use case for the deployment of SSC systems. While there was not a consensus on if facial verification of the systems was an invasion of privacy, the potential solution to the halo effect, mobile or hidden SSC systems were generally accepted.

7.2.3.4 Implications for existing transparency and accountability

The three questions in this section Figure 7.48, Figure 7.49, and Figure 7.50 overwhelmingly supported transparency on the operating agency of these systems. Including ongoing result reporting, citation and revenue dissemination, and if the systems should be made present before operation starts. This section mapped out how important transparency of the operation of SSC systems is for Oregonians and should be a cornerstone on any agency's operation.

7.2.3.5 Implications for ticketing

This section first explored specific ticketing pricing and speed scenarios such either price increases or speed thresholds changes in specific operation environments like work zones. The ability for educational courses as an alternative to a citation, whether or not the tickets should go to the driver or vehicle owner, and income-based ticketing. There is support for increased prices for speeding in select locations, but should not adjust the threshold for a ticket to be issued. Having the option to take educational classes as an alternative was highly supported. While there was support for citations to go to the vehicle driver, there was not support for driver facial recognition, so this particular point would need to be more investigated by the deployment agency. Lastly ranges of speed thresholds for tickets to be issued, Figure 7.57-Figure 7.64, were investigated and in general thresholds starting at 10 miles per hour over the speed limit had the most consensus.

7.2.3.6 Implications for revenue

For revenue of SSC systems, the most agreement lied in the use of funds to go towards infrastructure repair, towards safety installments on existing high speed or high crash corridors, policing, and micro-mobility improvements. While also Oregonians agreed that there would indeed be revenue created from these systems, there was not overall agreement that the use of the systems would not lead towards improving safety but increasing the capture of revenue from the systems.

8.0 ODOT CURRENT GUIDANCE & RECOMMENDATIONS

This chapter provides an overview of the current ODOT guidance on speed safety camera (photo radar) and as well as a set of potential recommendations based on the findings from this research report. The goal of the report is to improve recommendations for SSC deployment and not to discuss the size or expansion of SSC programs nor to compel transportations authorities in Oregon to install SSCs.

8.1 EXISTING ODOT GUIDANCE

The 2024 Fixed Photo Radar (FPR) Camera Guidelines for State Highways report was prepared to assist Oregon cities in the deployment of SSC on state highways. Currently, the scope of this document is limited to fixed SSC on state highways. The guidance includes:

- **Introduction:** Introductory sections stating the purpose of the report; supporting legislation; and the justification for fixed SSC.

- **Implementation:** A paragraph regarding the equipment, installation, and cost structures for fixed SSC.

- **Requirements:** A section indicating the requirements for a public information campaign and signage.

- **Selection Criteria:** Guidance on selecting sites, as well as what roadways are not permitted to have SSC.

- **Operational Considerations:** A list of engineering and operations considerations for fixed SSC. The following section also details the requirement for speed zone orders.

- **Safety and Operations Report:** A section documenting the required reporting prior to camera installation, including crash history; safety concerns; design, operations, and maintenance issues; public information campaign; budget; and PE certification.

- **Future Changes**: A section documenting SSC operations in relation to future changes on a corridor.

- **Biennial Report**: Requirements for an outcome evaluation to be completed every two years. The report should focus on the effectiveness of SSC on traffic safety; the degree of public acceptance; and the process of administrating the SSC program.

- **Approval and Removal**: Two sections outlining the process for approval of a speed camera and removal of a speed camera.

- **Documentation**: At the end of the report, an installation checklist and conditions of approval are included.

Note that ODOT also has guidance for red-light cameras. The following subsections detail recommendations and potential changes or additions to the current guidelines.

8.2 RECOMMENDATIONS

The research team consulted national guidance; key agency insights from Tasks 2 and 3; and the effectiveness review from Task 4 to understand key elements of an SSC program and what could be included in state guidance. In particular, the FHWA Speed Safety Camera Program Planning and Operations Guide (FHWA, 2023) was used to ensure that ODOT's guidance is in alignment with key recommendations from the Guide.

The passage of HB4109 (Oregon HB4109, 2024, p. 4) effective June 2024, allows any city in Oregon to use SSC and it also removed the requirement for a city to only use SSC on urban high crash corridors. Thus, there is an opportunity to provide more guidance for cities, both big and small, to help achieve improved safety outcomes. Though ODOT only has jurisdiction over state roadways, ODOT can still provide recommendations and a process to follow, especially for smaller jurisdictions that may not have adequate support from local engineering or police staff.

Table 8.1 provides an overview of potential changes, additions, and extensions to the existing FPR guidelines. In the sections below, these recommendations are detailed, as well as supplemented by information from existing SSC programs in the United States and national guidance documents.

Note that most of the current elements of the existing guidance should be retained, such as the purpose of the report; an overview of SSC effectiveness; SSC requirements; authorized SSC locations; and site selection.

ODOT Jurisdiction
Note that ODOT only has jurisdiction over ODOT-owned roadways. Therefore, ODOT can only provide recommendations (not requirements) to local jurisdictions unless requirements are given by state law(s).

Most of the proposed changes to ODOT guidance outlined in the sections below will comprise of recommendations that ODOT can give to jurisdictions but would not be requirements.

Table 8.1 Summary of Potential ODOT SSC Guidance Additions

Topic	Potential Recommendations
General	Expand scope ODOT's guidance to fixed and mobile SSC on state highways, statewide. Current scope focuses only on fixed SSC on state highways.
	Develop guidance and recommendations for non-state facilities.
	Consider setting a recommended limit on the number of SSC devices based on population
Introduction	Update using latest relevant legislation.
Planning	Strategic Planning: Safety Needs Assessment; legal and policy review; identification of stakeholders; expand Safety & Operations reporting.
	Program Planning: Set goals for the program; determine the scope, scale, and type of program; develop an SSC program plan
	Equity: Include guidance for equity in site selection, operations, and evaluation
Enforcement & Field Operations	Enforcement: Provide guidance to jurisdictions on how to conduct enforcement operations
	Field Operations: Provide a guidance or template for jurisdictions on establishing a Field Operations Plan, which would provide clear internal guidance on personnel and equipment logistics
Administration & Violation Structure	Outline the violation structure, including options for distribution of responsibilities, steps in a violation issuance process, options for citation recipients, status tracking and follow-up procedures, and handling violation notices issues to government vehicles.
Program Start-Up	Provided guidance on program start-up tasks, including equipment procurement; vendor agreements; coordination with DMV; data management; public educations; program roll-out and warning period
Evaluation	Evaluation: Describe data collection for basic program monitoring; outline reporting requirements and an evaluation procedure.
	Dangerous Drivers: Discuss procedure for identifying dangerous drivers and strategies to change these behaviors.
Resources	Provide additional documentation and resources for jurisdictions

8.2.1 General

This topic focuses on the scope of potential changes to SCC ODOT guidance, as well as special considerations for small cities.

8.2.1.1 Background

Currently, Washington is one of the best examples of a state that provides clear guidance to its cities on SSC. Its Speed Safety Camera Readiness Guide (WTC, 2023), authored by the Washington Traffic Safety Commission, is a guide is for local leadership, law enforcement, transportation engineers, and community members looking for an introduction to SSC and what it takes to establish a successful program. It is a primer intended to help local communities assess their readiness to implement an SSC program. While all jurisdictions are bound to state law, this document provides a clear step-by-step process for jurisdictions to implement SSC, as well as some recommendations that are not mandated by law.

Regarding limitations to SSC coverage for smaller cities, there are two primary examples:

- Washington used to have legislation that mandated the number of SSC units allowed in each city based on population, though new legislation passed in 2024 removed these requirements. The older legislation allowed each city to operate one SSC device, plus an additional device for every 10,000 residents. The old law also allowed cities to request additional units as pilot projects, but only for cities west of the Cascade Mountains that have populations of more than 195,000 in a county of less than 1,500,000 (Washington State Code, 2024).

- California will only allow SSC in six major cities for its SSC program; however, the number of cameras allowed in each city is proportional to the city's population, and ranges from 9 to 125 systems (California AB-645, 2023).

8.2.1.2 Recommendations

Currently, the FPR guidance is targeted for fixed SSC on state highways. The project team recommends that ODOT expand the scope of the guidance to include (a) all cities; (b) all roadways; and (c) both mobile and fixed SSC to better prepare small and large jurisdictions for SSC. The guidance would still be based on state law, but could include additional detail, recommendations, or resources for agencies to get started with SSC.

In addition, the project team recommends that ODOT works with local jurisdictions to establish a recommended number of SSC locations for cities by population. With recent legislation expanding SSC in scope and location, there may be a need to ensure a reasonable amount of SSC locations are being established to limit the perception of SSC as a 'money grab.'

8.2.2 Guidelines Introduction

The introduction of the guidelines would focus on the purpose of the report, supporting legislation, and an overview of SSC effectiveness.

8.2.2.1 Recommendations

The current FPR guidelines already have clear information on the purpose of the report and the supporting legislation for SSC. This existing information should be amended to (a) reflect any new legislation and (b) clarify that the guide is for all roadway facilities, though ODOT only has jurisdiction over state highways.

ODOT also currently has some information on SSC effectiveness. This information could be amended to reflect the findings from this report. Example text could include:

Speed Safety Camera (SSC) is a nationally recognized countermeasure for speed-related crashes. The National Highway Traffic Safety Administration (NHTSA) lists automated enforcement as a speed management countermeasure in their 2020 Highway Safety Countermeasure Guide for State Highway Safety Offices (Venkatraman et al., 2021). *The Federal Highway Administration (FHWA) also lists speed cameras as part of their Proven Safety Countermeasures.*

Speed is a crucial factor in both the probability of a crash occurring and crash severity. Higher speeds reduce the ability of a driver to stop in time; decrease the ability of a driver to maneuver out of a dangerous situation; and make it difficult to negotiate curves. For each 1% increase in speed there is a 4% increase in deaths (Nilsson, 2004).

The risk to vulnerable road users from speeding is even greater. The average risk of severe injury for a pedestrian struck by a vehicle reaches 10% at an impact speed of 16 mph, 25% at 23 mph, 50% at 31 mph, 75% at 39 mph, and 90% at 46 mph (Teft, 2011). Therefore, reducing speeds is critical in combatting pedestrian fatalities and injuries, especially as pedestrian deaths are at a 40-year high (Macek, 2023).

Therefore, SSC is an important tool to help reduce speeding and thus reduce crashes for all users. A number of academic studies have investigated the effects of both mobile and fixed speed safety camera on safety outcomes, including speeds and crashes. These studies cover a wide range of contexts both in the United States and abroad, including studies on urban and rural communities. Studies looking at speeds show a decrease in average speeds of around 10% and a decrease in 85th percentile speeds of between 1 and 7 mph. The decrease in the proportion of drivers exceeding the speed limit varies from 10% to 80%. Studies looking at fatal and/or serious injury crashes found reductions most commonly between 13% and 51%, while studies looking at all injury crashes found reductions most commonly between 16% and 27%.

SSC is also shown to have benefits as a crash modification factor (CMF): SSC systems have CMFs of 0.60 to 0.95 along segments for all crashes, indicating a 5% to 40% reduction in all crashes. SSC may be less effective for rear-end crashes.

When published, the final SPR 873 report could be cited to support these figures.

8.2.3 Requirements

The requirements chapter may outline state-mandated requirements (from the legislation), including authorized locations.

8.2.3.1 Background

Washington state has a chapter in their Speed Safety Readiness Guide on 'authorized SSC locations', which clarifies where jurisdiction can and cannot implement SSC. This chapter is illustrated in Figure 8.1. This guide also includes a separate chapter that describes requirements from Washington state law.

2 | Authorized Speed Safety Camera Locations

Effective July 1, 2022, Washington law has expanded the types of locations where speed safety cameras can be used.[9] Consistent with the goal of protecting vulnerable road users, automated speed cameras are authorized in the following locations:

School speed zones: 20 mph zones within 300 feet of a school or playground border.

School walk areas: The area designated around a school with an adequate roadway configuration to provide students access to school with a walking distance of less than one mile.

Public park speed zones: The marked area within public park property and extending 300 feet from the border of the park consistent with active park use.

Hospital speed zones: The marked area within hospital property and extending 300 feet from the border of hospital property consistent with hospital use.

Other locations: Cities may operate one automated speed camera, plus one additional camera for every 10,000 residents. Cameras used under this provision must complete an equity analysis (see section 5: Equity and Enforcement). These cameras must be placed in locations that comply with one of the following:

- Priority locations where other speed reduction measures are not feasible or have not been effective
- Locations with significantly higher rate of collisions than the city average
- Locations designated by local ordinance subject to restrictions and penalties on racing

Effectiveness of Automated Speed Safety Cameras

When properly implemented, automated speed cameras can have a significant positive effect on driver behavior. Across the US and in many countries around the world, studies reviewing the effectiveness of speed safety cameras have consistently found positive results. The National Highway Traffic Safety Administration (NHTSA) evaluated eight speeding countermeasures and gave SSC its highest rating for effectiveness.[10]

As cities in Washington have begun deploying speed safety cameras, local assessments have proved effective as well. The cities of Seattle and Kirkland have used speed safety cameras for several years, and have seen the following outcomes:

90% Seattle drivers who receive a ticket do not receive a second one[11]

67% Seattle - Reduction in tickets issued by cameras since 2012[12]

89% Kirkland drivers who receive a ticket do not receive a second one[13]

47% Kirkland – Reduction in speeding vehicles[14]

|4 | Automated Speed Enforcement Readiness Guide

Figure 8.1 Washington State - Authorized Speed Safety Camera Locations Source: (WTC, 2023)

8.2.3.2 Recommendations

ODOT already includes text about signage and public outreach requirements, and this should be retained as it contributes to limit the perception of SSC as arbitrary or a 'money grab'. In addition, a separate section could be created to outline authorized locations, as defined by HB4109: "The devices may be used on streets in residential areas or school zones. They could also be used in other areas of the city if the governing body of the city makes a finding that speeding has had a negative impact on traffic safety in these areas." ODOT could elaborate on recommendations for how a city could document negative impacts to traffic safety, including the Safety & Operations report.

8.2.4 Planning

The planning chapter would advise jurisdictions on how to effectively plan for an SSC program, including strategic planning; program planning; and an equity analysis. Note that this chapter would largely consist of recommendations rather than requirements, and some recommendations may be more appropriate for larger cities than small jurisdictions.

8.2.4.1 Strategic and Program Planning

In the FHWA Speed Safety Camera Program Planning and Operations Guide (FHWA, 2023), there are two major planning processes that are recommended for states and jurisdictions prior to SSC system implementation. Strategic planning involves a Safety Needs Assessment, which uses a system-level crash analysis to evaluate speed-related safety problems. The outcomes from this analysis include the extent, location types, times of data, and affected users of speeding in the jurisdiction. Other safety partners can also provide valuable information for speeding problems and resources available for addressing them. Strategic planning also includes a legal and policy review to determine if SSC devices are legally authorized within the jurisdiction. This includes identifying the legality of key program elements, as well as the state traffic laws and penalties.

Finally, strategic planning includes identifying and engaging community partners to develop the SSC program, including law enforcement, traffic engineering and transportation agency officials, state or municipal DOT attorneys, the motor vehicle departments, the courts, public health agencies, communications experts, elected officials, members of the public, and researchers. The guide recommends setting up a communications framework to properly gather public input and respond to public concerns.

According to FHWA, in SSC program planning, states and jurisdictions should set goals and evaluation methods for the program. Specific steps include:

- Setting goals for the program, which generally include safety goals, but may also target issues around congestion, speeding enforcement bias, or other community concerns related to speeding.
- Determining the scope, scale, and type of program, such as the jurisdiction eligible for SSC, types or location or road types, or the users of the road by location type or road type.
- Developing an SSC program plan, which includes:
    - Determining the administration and coordination needs.
    - Setting a communication and publicity process.

- Developing an enforcement plan, which includes site selection; the enforcement speed threshold; the enforcement strategy and equipment type (mobile, fixed, or point-to-point); signing and feedback strategies; scheduling; coordination with other enforcement and safety efforts; engagement with public health and community organizations; monitoring; and other special concerns.

- Developing a violation processing and adjudication plan, which is a process for citation issuance from receipt of enforcement unit data through the resolution of citations.

- Planning the startup of operations, procuring the SSC system, and executing inter-agency agreements.

- Planning the safety and program evaluation, which includes the program monitoring needs and performance measures; elements of the program evaluated; data collection and analysis plan; and reporting methods.

8.2.4.2 Equity

The FHWA guide states that equity must be considered in the implementation of safety programs to determine if SSC is a suitable countermeasure or if other speed management countermeasures may be needed to complement or be used instead of SSC. The guide states that local governments who explore or are implementing the use of SSC need to consider equity, civil rights, and civil liberties concerns in all stages, from planning to operation to evaluation. While equity is not mandated in Oregon's legislation, it is already being implemented in Portland, as well as cities and states throughout the country. Key points include:

- The Portland Bureau of Transportation (PBOT) has approached equity in several ways. Firstly, the Portland Police Bureau (PPB) and PBOT run a traffic diversion class for first time offenders, which eliminates the need to pay the citation or go through court. In addition, a new program is being considered to provide a free or reduced fee class if you are eligible for public assistance. You must still be a first-time offender. Secondly, PBOT uses zip code data to conduct an equity analysis. Specifically, PBOT wants to make sure that cameras located in a variety of areas are not disproportionately located in one community.

- In New York City, NYCDOT employs a low flat fine ($50) to reduce economic burden, as well as widely disperses cameras. NYCDOT looks at high minority and low-income areas to make sure they are not unfairly burdened (NYCDOT, 2022).

- In Philadelphia, new SSC locations were selected in part by an equity analysis that aimed to understand how speed-related crashes impact marginalized populations and to identify who would benefit from expansion of SSC on the top scoring corridors (Vision Zero Philadelphia, 2024).

- In Seattle, the Seattle Department of Transportation leads the equity analysis for new SSC locations, including impacts of camera placement on livability, accessibility, economics, education, and environmental health. A 'common sense' approach is also used to ensure locations are not clustered. In addition, revenue must be spent proportionate to the low-income communities and low-income communities experiencing high crashes Revenue expenditure must be informed by the Department of Health's environmental health disparities map.

- The Washington state guidance includes a chapter on equity in their guidance, including information on site selection and managing fines (WTC, 2023).

8.2.4.3 Recommendations

To align with the FHWA Guide, ODOT could provide recommendations or a template for jurisdictions to develop a strategic and SSC program plan on their own.

For strategic planning, ODOT could run its own Safety Needs Assessment (like the Safety & Operations report already included in FPR guidance) on state highways to determine where SSC could be most effective, as well as gather input from local jurisdictions, to provide a state-wide picture of SSC needs. ODOT already has conducted a legal/policy review and identified stakeholders, but continued communications could be maintained with interested and involved parties. For jurisdictions, ODOT could continue to require a Safety & Operations report, as well as provide insight into potential stakeholders and community partners. ODOT could also include some information on how to 'build a team', similar to that in the Washington state guidance (WTC, 2023).

For program planning, ODOT could set statewide goals related to SSC, such as speed reductions; crash reductions; or reductions in speed-related violations. However, as ODOT does not have jurisdiction over local roadways, the completion of these goals would rely on local agencies adopting them. ODOT could also recommend that cities set their own goals, tailored to the individual jurisdiction. The SSC program plan elements from FHWA are included throughout the recommended guidance changes.

Finally, an equity section could layout options for jurisdictions to consider equity, including traffic diversion classes (such as Portland's), a site selection equity-driven process, and how to evaluate equity. This section could be more informative than prescriptive, allowing each city to develop their own equity processes if desired.

8.2.5 Enforcement & Field Operations

The enforcement & field operations chapter would discuss some details regarding how jurisdictions operate SSC. This would also align with the FHWA's guidance to provide an enforcement plan.

8.2.5.1 Background

The FHWA Guide recommends that jurisdictions establish an Enforcement Plan and a Field Operations Plan prior to SSC system implementation, which should provide clear internal guidance for conducting enforcement operations, addressing public concerns, and operating the system. The Enforcement Plan includes site selection. The FHWA Guide specifies that sites for SSC programs can be selected to support jurisdiction-wide deterrence of speeding or site-specific problems, depending on the goals and program scope. Some jurisdictions may focus on certain types of locations such as school and/or neighborhood zones, work zones, or specific types of roads that meet legal requirements and were defined in the planned scope of the SSC program. Sites may be defined as specific sections of roadway, as corridors where multiple sites may be enforced (intermittently or continuously), or as areas (such as residential neighborhoods). To select appropriate sites, agencies will need to collect and analyze relevant data (e.g., speeding related crashes, speed data, social and demographic data), and conduct more detailed site reviews to diagnose the type of problems.

The FHWA Guide also recommends that jurisdictions establish a Field Operations Plan prior to SSC system implementation, which should provide clear internal guidance on personnel and equipment logistics. The Field Operations plan could include information about:

- Operator staffing and training. Discusses considerations for staffing for equipment operations and citation issuance. While it is common for law enforcement officers to staff SSC operations, other agencies can also take the lead. In addition, agencies may employ third-party vendors for installation and ongoing operation.

- Unit location and set-up procedures. SSC deployment sites should be clear of sight obstructions, should allow cameras or other devices to scan all intended lanes of traffic, and should not distract drivers.

- Event documentation. To preserve the transparency of SSC operations and maintain public trust in the program, operators should keep logs of ongoing operations.

- Data transfer. The data collected through SSC operations and as part of event documentation are critical to both ongoing evaluation and public approval of the SSC program. Therefore, data security is critical to a successful operation. Collected data should abide by the program’s privacy policy and data confidentiality requirements.

- Equipment maintenance and calibration. Equipment involved in the SSC operation should be regularly maintained and calibrated, especially speed-measuring equipment. This equipment is critically important to the operation, as the public should remain assured of the accuracy of the equipment and the fairness of the enforcement speed threshold. Agencies should use accurate equipment and should perform the required maintenance to continue this accuracy. Vendors may also be employed in the initial and ongoing calibration of SSC devices as part of the staffing plan.

8.2.5.2 Recommendations

For the enforcement section, ODOT could outline the following recommendations:

- Site selection, based on the selection criteria and operational & site considerations from the existing FPR guidelines.
- Types of SSC locations, including school and work zone, and their appropriate application.
- Site reviews, and how a jurisdiction could provide a detailed assessment of an intersection or corridor being considered for SSC, if that jurisdiction desires.

For the field operations section, ODOT could outline the following (see details above):

- Operator staffing and training.
- Unit location and set-up procedures.
- Event documentation.
- Data transfer.
- Equipment maintenance and calibration.

8.2.6 Administration & Violation Structure

The administration & violation structure chapter could provide detail on administration needs for an SSC program and how to process violations.

8.2.6.1 Background

The violation structure, processing, delivery, and adjudication chapter of the FHWA Guide recommends that agencies consider the following:

- **Distribution of Responsibilities:** Discuss options for processing staff (law enforcement officers, DOT or City employees, equipment vendors) and the benefits of having a supervisor to oversee violation processing.
- **Steps in Violation Issuance Process:** Summarize the procedure for evaluating citations, including violation documentation, vehicle owner identification, and citation issuance.

- **Options for Citation Recipients:** Presents the options to recipients of tickets, including accepting responsibility and paying the fine; denying responsibility; and contesting the citation.
  - The section states that jurisdictions could consider options for extending payment deadlines or providing a payment plan if payment is a financial burden. Additionally, jurisdictions can provide alternative options, including the ability to pay reduced fines or community service.
- **Status Tracking and Follow-Up Procedures:** Recommends that agencies develop procedures for tracking violations. Vendors may provide a proprietary computer system to track violations, but jurisdictions should confirm that the vendor's system meets the needs of the program and is consistent with all applicable laws, regulations, and data security policies.
- **Violation Notices Issued to Government and Business Vehicles:** Outlines considerations for government and business fleet vehicles.

Not many states clearly outline administration and violation structures, but a report from the Pennsylvania State Transportation Advisory Committee includes a chapter on SSC program administration and roles (PSTAC, 2022).

8.2.6.2 Recommendations

In this chapter, ODOT could provide details on the administration and violation processing considerations in Oregon. Information could be gathered from Portland on PBOT's experience with administration and violation processing, some of which is already reported on in PBOT's biennial reports. Most jurisdictions will work with their vendor to establish violation review and issuance processes.

In addition, this section could include details on the speed zone orders and approval procedures for state highways from the existing FPR report.

8.2.7 Program Start-Up

The program start-up chapter will provide details on equipment, vendor, and public campaign elements.

8.2.7.1 Background

Per the FHWA, jurisdictions should document final program startup steps, including information on setting up the physical infrastructure, staffing, and procedures needed to implement the planned enforcement. Elements of program start-up include:

- **Equipment Procurement:** Summarizes considerations related to initial equipment procurement and costs; operations and maintenance of the equipment; staffing and expertise; and compatibility with other parts of the system and existing jurisdictional infrastructure.

- **Vendor Agreements:** Discusses types of vendor services, contract considerations, compensation, and oversight and monitoring.

- **Coordination with DMV and Other Agencies:** Touches on the need to coordinate responsibilities with the DMV or other agency that manages registration and or driver license data and with other agencies that may be involved in processing or adjudicating citations.

- **Data Management:** Emphasizes the importance of a rigorous and secure data management program due to the sensitive nature of the data collected. This section includes information on data security, data retention, and data compatibility.

- **Marketing/Communications and Public Education:** Reviews strategies for a successful public outreach program.

- **Program Rollout and Warning Period:** Provides recommendations for program rollout, including a one-month warning period with no fines and a pilot program option.

8.2.7.2 Recommendations

In this chapter, ODOT could provide some key information to cities regarding vendors & equipment; coordination with the DMV; data management; public outreach; and a warning period. Of note is public outreach, which is required by state law: ODOT could provide additional detail on how to frame a successful public outreach campaign.

This chapter could be supplemented with insights from PBOT, especially on vendor contracts and public outreach. A well-written, informative chapter on these logistics would help smaller jurisdictions get started with SSC and be able to effectively contract with a vendor.

8.2.8 Evaluation

The evaluation chapter will review requirements for biennial reporting, as well as provide recommendations for how to best evaluate SSC effectiveness. Further, it will discuss options for identifying dangerous drivers using SSC data.

8.2.8.1 Evaluation Program

The FHWA Guide recommends two elements to a program evaluation. Basic program monitoring includes collecting data for speed, crashes, demographics, citations, and equipment maintenance. Evaluation of safety involves developing evaluation procedures for speed and crash data. FHWA recommends that jurisdictions and states develop an evaluation plan, including:

- Comparison groups, such as using reference sites

- Data collection area, including what areas are considered enforced
- Study periods, including appropriate before and after timeframes
- Phasing, such as analysis of pre-installation, approach (after the marketing and media campaign), warning period, full implementation, post-enforcement feedback (optional period during which SSC units may be removed but feedback signs and messaging remain), and post-implementation.
- Crash data recommendations, such as which types of crashes, required number of years, crash severity, and the methodology
- Speed data recommendations

D.C. has committed to making their data and evaluation very public, with a data dashboard updated frequently so that the public can view to understand where SSC is located and where violations occur. Per an interview (Task 3), D.C. shared it is planning to evaluate new cameras on a monthly basis and make these reports available publicly (DDOT, 2024a).

New York City and Pennsylvania also have comprehensive evaluation programs with comparison groups.

Washington State Reporting Requirements
In Washington, cities and counties using traffic cameras must post an annual report on their websites showing the number of traffic crashes that have occurred at each camera's location, and the number of infraction notices generated from each camera. Starting January 1, 2026, this required annual report must also indicate the percentage of traffic camera revenue used to pay the jurisdiction's camera program costs, and how the jurisdiction used any revenue that exceeded those costs.

8.2.8.2 Dangerous Drivers

A few cities in the U.S. are looking at how to address dangerous drivers, or individuals or vehicles who have accumulated a large number of SSC violations. While this is still a burgeoning topic, there has been some thought on how to implement such a program.

NYCDOT previously ran a dangerous vehicle abatement program, where registered owners of vehicles that received 15 or more finally adjudicated speed camera violations or five or more finally adjudicated red light camera violations within a twelve-month period were required to take a safe driving class or else risk having their vehicles impounded by the New York City Sheriff (NYCDOT, 2022). However, this program was discontinued due to the high cost of the program, as well as due to difficulties enforcing it – as violations are issued to a vehicle rather than a driver, it can be difficult to track down the owner of the vehicle if a license plate changes or the vehicle is sold.

NYCDOT has been considering other programs to target dangerous vehicles, though no legislation has been passed or introduced regarding new programs. One idea is to suspend vehicle registration for vehicles with more than a certain number of violations, helping prevent future dangerous driving. Another idea is to require vehicles to install intelligent speed assist if they have acquired a certain number of violations. The NYC city fleet already has these installed on their vehicles. NYCDOT also supports implementing an escalating fine regime to address this population of dangerous drivers, though such changes would need to be legislatively approved.

In the District of Columbia, the Department of Public Works has authority to immobilize (boot) or impound (tow) any parked vehicle "against which there are 2 or more unpaid notices of infraction." Further, the Council passed the STEER Act, which if enacted and funded, would allow the District Government to tow and impound vehicles based on the number of tickets accrued over a six-month period, regardless of payment.

8.2.8.3 Recommendations

ODOT already has a section on evaluation in the FPR guidelines detailing the required evaluation per state law (effectiveness of SSC on traffic safety; the degree of public acceptance; and the process of administrating the SSC program) and this should be retained. However, ODOT could also consider providing recommendations for additional evaluation or more detail on what 'effectiveness' entails.

First, ODOT could recommend that cities and counties using traffic cameras collect and publicize certain metrics about their SSC programs, such as:

- The number of traffic crashes that have occurred at each camera's location
- The number of infraction notices generated from each camera
- The percentage of traffic camera revenue used to pay the jurisdiction's camera program costs
- How the jurisdiction used any revenue that exceeded those costs

Further, ODOT can provide recommendations on additional data to be regularly collected and how to collect it. For example, the vendor should provide speed, violation, and equipment data; crash data can be acquired from ODOT's crash database; and demographics can be evaluated using census data.

ODOT should develop recommendations for an effective evaluation plan for jurisdictions. These are the project team's recommendations based on the review of literature in this Task and the FHWA Guide:

- **Methodology**: At minimum, the methodology should use comparison groups. If possible, an empirical Bayes or similar methodology should be used to best isolate the effects of SSC on speed and crash outcomes. A basic methodology would include the following steps:
  1. Gather crash and speed data for relevant phases for SSC treatment and comparison sites.

2. Compile with other relevant data about sites and comparison sites (roadway variables and volume data by year). If changes are made to the roadway, these changes may also need to be factored into the analysis by year of implementation.
3. Evaluate those data in comparison to the data before installation and in comparison, to similar sites without SSC installations.
4. Determine if SSC has impacted speed-related crashes at the site by lowering crash frequency, frequency of severe crashes or speeding-related crashes, proportion of severe crashes, or other measures as previously identified.
5. Shift enforcement efforts to other sites if they become higher priorities based on crash and speed data.
6. Continue to monitor crash data at enforced sites.

- **Study Periods**: Agencies should aim for at least two years of before and after data, though three is required for more advanced methodologies.
- **Phasing**: Agencies may use whatever phasing suits them best, but should label them as the following: pre-installation, approach (after the marketing and media campaign), warning period, full implementation, post-enforcement feedback (optional period during which SSC units may be removed but feedback signs and messaging remain), and post-implementation.
- **Crash Evaluation**: Agencies are advised to focus on speed-related or injury crashes. Crashes should be compiled annually.
- **Speed Evaluation**: Speed evaluations could consider time of day in the evaluation to understand the SSC unit's effectiveness under different conditions. If possible, mean speed, 85th percentile speed, and proportion of vehicles speeding (or speeding excessively) should be monitored.
- **Spillover**: If possible, agencies could collect crash and speed data on neighboring roadways to assess any impact or spillover effect.

Following D.C.'s lead, ODOT could (a) compile a public dashboard that aggregates state-level data, or (b) recommend that larger cities compile such a dashboard. This would be dependent on the vendor agreement, as these dashboards are typically built on top of vendor-provided resources and dashboards.

For dangerous drivers, the project team recommends that (a) ODOT develops a study to evaluate the relationship between SSC violators and crashes or (b) ODOT provides guidance for cities to conduct this evaluation. With the results of this study, ODOT could decide whether it would be effective to develop a program to target dangerous drivers. Such a program would likely need to be passed into state law.

8.2.9 Resources

In this final chapter, ODOT can provide links to state law; examples of local ordinances; previous PBOT reports; and other documents that may be helpful for agencies. This is modelled after the Washington Speed Safety Camera Readiness Guide (WTC, 2023).

9.0 CONCLUSIONS

In this report, the project team provided a comprehensive overview of existing SSC programs around the United States and the world; identified key issues related to SSC and varying approaches to these issues; provided a review of the effectiveness of various SSC types and purposes on speeds and crashes; identified factors related to public acceptance; provided location selection criteria; and outlined recommendations to ODOT on updating the state's existing SSC guidance and on potential legislative changes and new research opportunities.

Key findings from this report are:

- **SSC Types:** SSC systems can be covert, overt, mobile, fixed, average speed, or point-to-point.

- **National Guidance:** The primary national guidance is the Federal Highway Administration's 2023 Speed Safety Camera Program Planning and Operations Guide. Additional guidance includes the NHTSA 2020 Highway Safety Countermeasure Guide for State Highway Safety Offices. In these guidance documents, FHWA recommends developing goals and an evaluation plan, as well as creating an enforcement plan and field operations plan. Further, the FHWA Guide provides strategies for vendor contracts, data management, and program roll-out.

- **United States SSC Programs & Case Studies**

  - **Legislation:** The vast majority of programs are based on state legislation, and then cities may implement local ordinances to codify the state law into City law. Cities generally need to encourage changes in state bills to drive major changes in their programs, such as expansions or new fine and revenue rules.

  - **Purpose**: Many SSC programs focus on school/residential zones or work zones only.

  - **Types of Enforcement:** Some jurisdictions are implementing more novel types of automated enforcement, such as stop sign cameras; bus stop arm cameras; bus lane enforcement; and truck enforcement.

  - **Organization**: Both D.C. and NYC have completely detached their SSC programs from the police, with the programs run fully by their departments of transportation. Other cities include the police for violation issuance, though in Seattle, the police manage the vendor contract as well.

  - **Covert Enforcement:** Most programs must include a publicized list of SSC locations and signage before cameras, informing drivers that a camera is upcoming. However, New York City does not publicize camera locations in order to create a more 'general deterrence' and with the aim to lower speeds throughout the city.

- **Signage**: Most jurisdictions (other than New York City) require signage indicating an SSC device is upcoming, as well as a speed feedback sign. Some also require signs at key roadways entering a jurisdiction to let travelers know that SSC is used in that jurisdiction.

- **Selection Criteria**: Generally, jurisdictions focus their selection on crash and speed history, but may also incorporate equity, public input, and roadway characteristics. New York City and D.C. also have a 'reactive' component in which they respond to citizen requests and/or incoming fatal or serious injury crashes.

- **Fines**: Most programs have a set fee, which can differ between first and subsequent offences. Others use the same fee structure as for traditional (e.g., police-issues) speeding offenses, or vary the ticket by speed.

    - New York City has a flat fee.

    - Portland offers a traffic safety class in lieu of payment (though the class has its own, smaller fee).

    - Seattle offers a fee reduction for eligible drivers.

    - D.C. will be piloting an income-based fee system, overlaid on its existing speed-based fine system.

- **Revenues**: Most programs stipulate how revenue will be spent. In many cases, the revenues are mandated to be spent on traffic safety projects.

- **Speed Thresholds**: Many general SSC systems have speed thresholds of 10 MPH or greater. However, some have lower thresholds for areas such as school zones; have thresholds that vary by speed limit; or do not publish set thresholds.

- **Additional Enforcement:** Both D.C. and New York City have piloted or are considering implementing programs focused on dangerous driving, including towing, safe driving classes, and intelligent speed assistance.

- **Public Acceptance:** Most cities run traditional public outreach programs with press releases, focus groups, media campaigns, public meetings, and websites. D.C. has eight specified information officers for each of its wards, which are charged with communicating information on automated enforcement to residents.

- **Data and Evaluation**: Some cities, such as Portland and Philadelphia, include extensive annual or bi-annual studies that report on speed, crash, and other violation outcomes. Other cities, such as D.C. and Seattle, publish more basic information on violations.

    - D.C. has pledged to become more transparent, with monthly reports on SSC outcomes.

- **Vendor:** Most cities have no issues with their vendors and have access to a portal where speed and violation data is available by date. Vendors are typically paid per camera.

    - Portland is the only City interviewed that currently has issues with vendor communications and reporting. D.C. shared it previously had issues with data collection, but these issues were solved after an RFP that specified time limits and fines.

- **Equity:** All cities are addressing equity through both fine considerations (reduced or income-based fines) and geographical equity analyses. D.C. has a comprehensive Task Force that has provided recommendations for equity-related issues.

- **Ticket Distribution:** Studies in New York City, Portland, Philadelphia, and D.C. indicate that most violators are not nearby residents to the camera locations and come from different parts of the city or even different states.

Speed safety camera has been a highly effective tool in reducing speeds and speed-related crashes in almost all contexts and by a wide variety of methodologies. While the approaches to SSC may vary between jurisdictions, states, and countries, a clear goal is shared by all: to reduce speed-related injuries and deaths, especially for more vulnerable road users. The project team identified a range of best practices and solutions from national guidance, detailed case studies, and a review of international SSC programs. Specifically, recommendations were made related to guidance to local jurisdictions; equity; public outreach; location selection criteria; vendor relations; program planning; and evaluation procedures. In addition, legislative changes related to fines, equity, and SSC device limitations were also explored.

9.1 CONCLUSIONS AND RECOMMENDATIONS FROM SURVEY RESULTS

The survey results provide key insights into public perceptions of speed safety cameras in Oregon, highlighting areas of strong consensus and points requiring further consideration by transportation authorities in Oregon.

- **Safety and Expected Outcomes:**
    - Strong support for SSC systems improving safety for both drivers and micromobility users.
    - The "halo effect" remains a debated topic, despite its recognition in the literature.
    - Agencies should educate the public about the halo effect and consider dynamic placement strategies for system-wide safety benefits.
- **Location Guidance:**
    - Public support for SSC deployment in high-risk areas such as school zones, work zones, police-limited areas, and community-nominated locations.

- While data-driven placement is essential, community involvement in site selection is also valued.
- Potential conflicts arise between community preferences and mitigating the halo effect.

- **Existing Conditions and Public Beliefs:**
  - SSC systems are perceived as effective for speed control on both high-speed and local roadways.
  - General acceptance of mobile or hidden SSC systems as a solution to the halo effect.
  - No strong consensus on whether facial verification for SSC enforcement constitutes a privacy invasion.

- **Transparency and Accountability:**
  - Overwhelming public support for transparency regarding:
    - The operating agency.
    - Public reporting on system performance and citations.
    - Clear revenue dissemination.
  - Notification before systems become operational.
  - Transparency must be a foundational principle for SSC system implementation.

- **Ticketing and Penalties:**
  - Support for higher fines in certain areas (e.g., work zones) but opposition to lowering speed thresholds for ticket issuance.
  - Strong preference for offering educational courses as an alternative to citations.
  - Support for issuing tickets to the driver rather than the vehicle owner, but resistance to facial recognition technology for enforcement.
  - The most commonly supported speed threshold for ticketing was 10 mph over the posted speed limit.

- **Revenue Allocation:**
  - Strong agreement that SSC-generated revenue should fund:

- Infrastructure repairs.
- Safety improvements on high-speed and high-crash corridors.
- Law enforcement and micromobility enhancements.
- Mixed opinions on whether SSC systems are primarily for safety improvements or revenue generation.

The survey demonstrated Oregonians are aware of the potential safety capabilities of SSC systems. Their successful implementation from the population's perspective would need to consider fairness, transparency, and privacy. This includes supporting deployment initiatives that accessing public awareness towards building public trust in SSC systems.

9.2 RECOMMENDED LEGISLATIVE CHANGES AND RESEARCH OPPORTUNITIES

Based on a review of key agencies, policies, and laws in Task 2 and Task 3, there are a number of issues that are recommended to be explored further for legislative action in order to provide support for additional ODOT SSC guidelines.

- **Equity:** Oregon could study recommending or mandating a geographical distribution of cameras and violations to ensure no one community is unfairly targeted. Exploring a flat or income-dependent fine structure as cameras become more prominent could help reduce the financial burden on lower-income individuals. This would consist of general legislation mandating an equity analysis as part of site selection and/or legislation authorizing an income-based fine pilot in a specific city, such as Portland.
  Additional Research Opportunity: ODOT could study and develop an equity analysis methodology specifically tailored for SSC location selection or evaluation and/or identify how existing ODOT demographic and equity tools can be applied for SSC programs.

- **Fines:** Oregon could consider developing a more tailored fine structure with fine amounts specifically set for speed safety camera. Fines can vary by speed, by number of offenses, or by income. In addition, many jurisdictions with widespread SSC systems (such as Chicago or New York City) have a flat fee for violations.

  - Additional analysis should be conducted to determine the fine amount and scale of the fine. One option is to have a fine that varies by speed or number of violations, and then have an option for a reduced fine based on income, as mentioned in the equity recommendation.

  - Changes to the fine structure would consist of amending ORS 810.439 to explicitly allow fines that are different from fines for speeding violations issued by a police officer. This fine could range from $50 to $100 for an initial violation, and be escalated for subsequent violations or for excessive speeds.
    Additional Research Opportunity: ODOT could conduct research to (a) develop a new fine structure, (b) design a pilot study, and (c) evaluate the pilot.

- **Covert Enforcement:** Oregon could consider piloting more covert, non-signed camera locations to investigate the effectiveness of these devices on decreasing speeds over a wider area or range of time. This would consist of legislation allowing a temporary pilot that does not require signage. The pilot could run for a specified amount of time and undergo an evaluation process to determine its efficacy.
  Additional Research Opportunity: ODOT could conduct research to (a) design a pilot study with covert enforcement (b) evaluate the pilot to understand the efficacy of various covert enforcement techniques, such as no signage.

- **Dangerous Driving:** Oregon could consider piloting a dangerous driving program that impounds vehicles or installs intelligent speed assist on vehicles with excessive SSC violations. This would likely require more extensive research on the relationship between SSC violators and crashes.
  Additional Research Opportunity: ODOT could conduct research to link SSC violations and crashes to understand if individuals who receive more violations and/or high-speed violations are more likely to be involved in injury crashes. This could inform the need for a program to target dangerous drivers.

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APPENDIX A

Table A-1 SSC Purposes

	Statewide	Specific Jurisdictions
General	**6** Arizona Connecticut (must be approved by DOT) District of Columbia Nevada (LEO must be present) New Mexico Ohio Oregon	**5** Alabama *(only in Midfield)* California *(LA, San Jose, Oakland, Glendale, Long Beach, SF)* Iowa *(no state law; permitted by city ordinance)* Louisiana *(state grants permission to specified jurisdictions)* Maryland *(state grants permission to specified jurisdictions)*
Construction/ Work Zone	**10** Arkansas Colorado Connecticut Delaware (pilot) Illinois Indiana (Pilot) Maryland New York (Pilot) Tennessee Virginia	0
School Zone	**10** Arkansas Colorado Connecticut Florida Georgia Maryland Rhode Island Tennessee Utah Virginia	**2** Illinois *(only in Chicago)* New York *(New York City)*
Railroad Crossings	**2** Arkansas; Washington	**0**
Residential Neighborhoods	**2** Colorado; Delaware *(pilot)*	**1** Maryland *(Montgomery County)*
Near Parks	**2** Colorado; Washington	**1** Illinois *(only in Chicago)*
Other	**5** Colorado *(specified safety corridors)*	**0**

	Statewide	Specific Jurisdictions
	Connecticut *(Pedestrian Safety Zones, specified areas)* Tennessee *(S-Curves)* Utah *(Areas with speed limits < 30 MPH)* Washington *(hospitals, intersections of 2+ arterials)*	

Table A-2 SSC Fines

	First Violation	Subsequent Violations
No Fine, Written Notice	**4** Connecticut Illinois Indiana Pennsylvania AWSZE	**0**
<= $50	**4** Colorado Maryland New York City Tennessee	**3** Colorado Maryland New York City Tennessee
$50 to <= $75	**2** Georgia Washington	**1** Washington
$75 to <= $100	**4** Alabama Florida New Mexico Virginia	**5** Alabama Florida New Mexico Virginia
> $100	**0**	**4** Connecticut *($75 2nd, $150 subsequent)* Georgia Indiana *($75 2nd, $150 subsequent)* Pennsylvania AWSZE *($75 2nd, $150 subsequent)*
Depends on Speed	**8** Arkansas California *(first violation between 11 and 15 MPH is a warning, otherwise $50 - $500)* Delaware *($75+)* DC *(same as normal speeding violation, $50 - $500)* Iowa *($65+)* Louisiana *($100 - $300)*	**9** Arkansas California *($50 - $500)* Delaware ($75+) DC *(same as normal speeding violation, $50 - $500)* Illinois *($35 - $100)* Iowa *($65+)* Louisiana *($100 - $300)*

	First Violation	Subsequent Violations
	Nevada *(same as normal speeding violation, $100-$420)* Oregon *(same as normal speeding violation, $85 - $1,150)* Pennsylvania General *($100 - $150)* Rhode Island *($95+)*	Nevada *(same as normal speeding violation, $100-$420)* Oregon *(same as normal speeding violation, $85 - $1,150)* Pennsylvania General *($100 - $150)* Rhode Island *($95+)*
Unknown	**3** Arizona Ohio Utah	**3** Arizona Ohio Utah

Other revenue processes vary state by state and there are many variations:

Table A-3 SSC Revenues

State	Revenue Rules
California	• Revenues are first used to cover expenditures related to the program. • The balance of any excess revenues is used for traffic-calming measures within three years of the end of the fiscal year in which the excess revenue was received.
Connecticut	• Revenues are first used to cover expenditures related to the program. • The balance of any excess revenues is used for transportation safety purposes.
Delaware	• Revenues are first used to cover expenditures related to the program. • The balance of any excess revenues is sent to the Office of Highway Safety for education, enforcement, engineering, and expenses.
Florida	• $60 from each citation goes to the local government to administer the speed detection system and other public safety initiatives. • $12 from each citation goes to county school districts for school security initiatives, student transportation, or improve student walking conditions.
Georgia	Revenues are used to fund local law enforcement or public safety initiatives.
Illinois	Revenues are used for programs that enhance the safety of children, including after-school, anti-violence and youth employment programs; crossing guards and police officers around schools; and infrastructure improvements.
Indiana	Revenues are deposited into the state general fund.
Iowa	• For the SSC systems on the interstate, most revenue goes into the city budget, but about 35 percent goes to the private company that operates the camera. • For the SSC systems in Cedar Rapids, revenue directed to public safety.
Maryland	• Revenues are first used to cover expenditures related to the program. • The balance of any excess revenues is distributed to the Maryland State Police to purchase replacement vehicles and related motor vehicle equipment.
New Mexico	• Half of the revenues are remitted to the State and the other half is retained by the municipality to offset costs directly related to administering the program. • Any remaining funds will be used for Vision Zero safety initiatives.
New York (Work Zone)	• Revenues are first used to cover expenditures related to the program. • The balance of excess revenues is used for work zone safety initiatives.
Ohio	• Revenue cities make from SSC is deducted from state contributions.
Oregon	• $60 of the revenue goes to the state Criminal Fine Account. • Of the remaining revenue, 50% goes to local government and 50% to the state.

Pennsylvania (Work Zone)	• Revenues are first used to cover expenditures related to the program. • The balance of any excess revenues is disbursed to the transportation agency where the violation occurred or motor license fund.
Pennsylvania (General SSC Pilot)	• Revenues are first used to cover expenditures related to the program. • The balance of any excess revenues is remitted to the Transportation Enhancement Grants Program. All municipalities are eligible to apply for assistance, although priority must be given to applications from Philadelphia.
Virginia	Localities will receive revenues from violations they issue. Revenues from violations issued by the State Police will be deposited into the Literary Fund for low-interest loans for schools.
Washington	• Revenues are first used to cover expenditures related to the program. • Of the remaining revenue, 50% of revenues is remitted to the state. The remaining 50% retained by the city must be used only for improvements to transportation that support equitable access and mobility for persons with disabilities.

Table A-4 General SSC Program Requirements

State	Speeds	Public Outreach	Signage	Verification of Citation	Law Enforcement Officer (LEO)
Statewide					
Arizona[1]	Unknown	Unknown	Required near SSC devices	Required	Not Required
Connecticut	11+ MPH	Period of public education (no fines) during first month	Required near SSC devices	Not Required	Not Required
District of Columbia	None	Period of public education (no fines) during first month	Not Required	Not Required	Not Required
Nevada	Unknown	Unknown	Unknown	Required by on-site LEO	
New Mexico	Unknown ("set enforcement speed")	Unknown	Unknown	Required	Not Required
Ohio	6+ MPH in school zones; 10+ MPH in other zones	Unknown	Unknown	Required by on-site LEO	
Oregon	None[3]	Public outreach campaign is recommended	Required near SSC devices	Required	Not Required
Specified Jurisdictions					

Alabama	Unknown	Public information campaign	Required near SSC devices	Unknown	Not Required
California	11+ MPH	Public information campaign	Required near SSC devices	Not Required	Not Required
Iowa	11+ MPH for interstates; varies for cities	3 months of public notice prior to ASE; Period of public education (no fines) during first month	Permanent signs on access roads to cities with ASE; temporary signs for mobile ASE	Unknown	Not Required
Louisiana	Depends on speed limit, starts at 6+ MPH	Period of public education (no fines) during first month	Warning signs and radar signs	Unknown	Not Required
Maryland[2]	12+ MPH	Period of public education (no fines) during first month	Signage and real-time speed feedback	Required	Not Required

[1]SSC is school zone only in some jurisdictions
[2]General SSC is by state authorization only
[3]11+ MPH for combined red-light/speed cameras only

Table A-5 Construction/Work Zone SSC Program Requirements

<table>
<tr><th>State</th><th>Speeds</th><th>Public Outreach</th><th>Signage</th><th>Verification of Citation</th><th>Presence of LEO</th><th>Time</th></tr>
<tr><td colspan="7">Statewide</td></tr>
<tr><td>Arkansas</td><td>Unknown</td><td>Unknown</td><td>Unknown</td><td colspan="2">Required - LEO must write ticket and deliver in-person</td><td rowspan="4">During Active Work Zone Hours</td></tr>
<tr><td>Colorado</td><td>10+ MPH for first violation; none for subsequent violations</td><td>Period of public education (no fines) during first month</td><td>Required near SSC devices</td><td>Not Required</td><td>Not Required</td></tr>
<tr><td>Connecticut</td><td>15+ MPH</td><td>Period of public education (no fines) during first month</td><td>Required in advance and after leaving work zone</td><td>Required - verification by two trained speed safety operators</td><td>Not Required</td></tr>
<tr><td>Delaware (Pilot)</td><td>11+ MPH</td><td>Period of public education (no fines)</td><td>Unknown</td><td>Required</td><td>Not Required</td></tr>
</table>

State	Speeds	Public Outreach	Signage	Verification of Citation	Presence of LEO	Time
Statewide						
		during first month				
Illinois	Unknown	Public information campaign	Required near SSC devices	Not Required	Not Required	
Indiana (Pilot)	11+ MPH	Public information campaign	Required near SSC devices	Not Required	Not Required	
Maryland	12+ MPH	Period of public education (no fines) during first month	Required near SSC devices	Required	Not Required	
New York (Pilot)	10+ MPH	Period of public education (no fines) during first month	Required near SSC devices	Required	Not Required	
Tennessee	Unknown	Unknown	Required near SSC devices	Required	Not Required	
Virginia	10+ MPH	Unknown	Required near SSC devices	Required	Not Required	

Table A-6 School Zone SSC Program Requirements

State	Speeds	Public Outreach	Signage	Verification of Citation	Presence of LEO	Time
Statewide						
Arkansas	Unknown	Unknown	Unknown	Required - LEO must write ticket and deliver in-person		Unknown
Colorado	10+ MPH for first violation; none for subsequent	Period of public education (no fines) during first month	Required near SSC devices	Not Required	Not Required	Unknown
Connecticut	Unknown			Required	Not Required	Unknown

State	Speeds	Public Outreach	Signage	Verification of Citation	Presence of LEO	Time
Statewide						
Florida	10+ MPH			Not Required	Not Required	School days, 30 minutes before/after classes
Georgia	11+ MPH			Not Required	Not Required	School days, one hour before/ after classes
Maryland	12+ MPH			Required	Not Required	School zones and designated higher education sites, 6 AM to 8 PM M-F
Rhode Island	None			Not Required	Not Required	School days from 7 AM to 6 PM
Tennessee	None	None		Required	Not Required	School days, 30 minutes before school/15 minutes after
Utah	Unknown	Unknown		Unknown	Required	Unknown
Virginia	10+ MPH	Not Required		Required	Not Required	When school zones are active
Specified Jurisdictions						
Illinois (Chicago)	6+ MPH	Ongoing outreach activities	Required near SSC devices	Not Required	Not Required	School days: M-F 7:00 AM to 4:00 PM: 20 mph speed limit 7:00 AM to 7:00 PM: posted speed limit
New York (New York City)	10+ MPH	Not Required	Required near SSC devices	Required	Not Required	24/7

APPENDIX B

Based on the review of academic literature and national guidance in Chapter 2, national SSC programs in Chapter 3, and in-depth case studies in Chapter 4, this chapter provides a deeper look into key issues that emerged. These include equity, revenue, vendors, and privacy.

EQUITY AND POLICING

SSC can counteract selective and biased policing by issuing violations to all drivers who exceed a set speed, regardless of sociodemographic status. Studies have shown that Black drivers are stopped disproportionately (Pierson et al., 2020; Ralph et al., 2022b) and cities with larger Black populations have higher rates of ticketing and revenue collection per capita than cities with smaller Black populations (Sances & You, 2017). Black men are two to three times more likely to be targeted for a traffic stop than white men (Pierson et al., 2020). In Portland, while 6% of the residents are Black, Black people account for 18% of traffic stops within the city (Cline, 2021). As SSC encounters are based on speed thresholds, they can reduce racial bias in traffic stops. Proponents of SSC technology cite that the technology reduces racially disproportionate stops and reduces the risk of violent encounters with police (Sutton & Tilahun, 2022).

However, traffic safety cameras have some equity concerns. Cameras may exacerbate inequity if they are installed predominantly in Black or low-income neighborhoods, exposing these communities to more enforcement and fines. This issue requires careful consideration, as many lower income communities have historically had underinvestment in transportation infrastructure and thus may have more unsafe roads that meet crash or speed criteria for SSC placement. However, these criteria must be balanced with geographical distribution of the cameras. In addition, revenue from SSC devices can be used to fund safety projects in those underinvested communities. Thus, automated enforcement must consider the location of cameras; the volume of tickets issued and potential for over policing; and the burden of fines, fees, and forfeitures, which are disproportionately harder on disadvantaged communities.

A report from the Fines & Fees Justice Center (FFJC, 2024) maintains that using money as a means of enforcement creates inequality and exacerbates racial and economic disparities. The report urges jurisdictions to assess the effectiveness of using monetary sanctions to improve safety, as well as identify the harms and costs of using money as a means of enforcement. The recommendations from this report include:

- If SSC is in use, prioritize non-financial sanctions.
- In extreme cases, develop graduated responses based on the frequency and severity of the behavior.
- If fines are assessed, ensure they are proportionate to the individual’s ability to pay.
- Do not use SSC with a goal of raising revenue. If fines are assessed, designate any revenue generated by SSC programs for discretionary, onetime expenses.
- Do not impose sanctions for failure to pay fines.
- End the practice of adding fees, surcharges, penalties or interest to fines.

- Invest in street design, engineering, and infrastructure changes before adding or increasing enforcement.

- If SSC is used at all, it must be temporary.

- Develop clear and consistent policies for determining whether the SSC technology captured a true violation and how it should be sanctioned.

ASE, Vision Zero, and Equity

Several academic studies have explored the connection between equity and SSC implemented within a vision zero program. One study (Marco, 2017) examined the role of traffic enforcement in Vision Zero effort and analyzed its efficacy to deter dangerous driving. It argues that the primary goal of Vision Zero-related traffic enforcement must be to create long-lasting general deterrence of dangerous driving behavior if cities are to reduce crashes and eliminate traffic fatalities and serious injuries. The study found that SSC may be the most effective tool to achieve widespread and consistent traffic enforcement and should be applied broadly. It states that while visible traffic enforcement has positive effects on deterring dangerous driving, the size and resources of most police forces limit enforcement. Especially in cases of traffic violation, barriers to effective traditional enforcement are numerous, and include the willingness of police to apprehend dangerous drivers, officers' considerations of disruptions to traffic flow, safety issues related to stopping a driver, and responsibilities related to ticketing a driver. In addition, implicit racial bias and use of force with potential lethal consequences are downsides to increased interactions of the public with the police.

The study lauds SSC as the only viable tool currently available to achieve the type of widespread, uniform, and sustained enforcement necessary to deter the most prevalent and dangerous traffic safety violations, and allow police resources to be redirected towards other public policy measures. In addition, it argues that SSC can prevent the racial disparities and potentially lethal use of force that are inherent risks of traffic stops by police officers. Finally, it maintains that SSC can address the racial inequities that result from the negative socioeconomic effects of traffic-related penalties, and the race-based disparities of who is struck, injured, and killed in traffic incidents (Marco, 2017).

The sections below outline the equity measures jurisdictions in the United States are taking to address issues around geographic distribution and fines.

Oregon Context

Currently, there are no specific equity stipulations for SSC programs in statewide legislation in Oregon. However, in Portland, the Portland Police Bureau has offered a traffic safety class since September 2016 for red light running photo enforcement violations and photo radar speeding violations. The class option expanded and incorporated fixed speed safety camera speeding violations starting July 2018. The traffic safety class option for photo enforcement violators is available to those who do not have a not received a red light running or speeding violation in the last three years and have not previously attended the photo enforcement traffic safety class. The per person class registration fee varies depending on the type of moving violation but is typically less than the presumptive fine.

In addition, Oregon does run the Statistical Transparency of Policing (STOP) program, which analyzes data regarding officer-initiated traffic and pedestrian stops for evidence of racial or ethnic disparities on an annual basis (OCJC, 2022). The program began in 2017, when it was mandated by HB2355. To examine the traffic and pedestrian stop data acquired by the STOP Program for racial/ethnic disparities, STOP Program researchers utilized three methods:

- **Decision to Stop Analysis:** This analysis takes advantage of natural variations in daylight and darkness throughout the year, and is based on the assumption that it is easier for an officer to discern the race/ethnicity of an individual during the day when it is light versus the night when it is dark. Accordingly, the analysis compares stop rates for minority individuals to those for white individuals during the time windows surrounding sunrise and sunset.

- **Stop Outcomes Analysis**: Examines matched groups using a statistical technique called propensity score analysis to explore whether disparities exist in stop outcomes (i.e., citations, searches, or arrests).

- **Search Findings Analysis**: Compares relative rates of successful searches (i.e., those resulting in the seizure of contraband) across racial/ethnic groups. It is based on the assumption that if search decisions by officers are made based on race/ethnicity neutral criteria, then success rates should be similar, if not identical, across different racial/ethnic categories.

To determine if disparities warrant additional in-depth analysis and/or technical assistance, STOP Program researchers reviewed the results of each of the three analyses conducted on the STOP Program data. For each individual analysis, an estimated disparity must meet the 95 percent confidence level for it to be statistically significant. Further, following best practices, for a law enforcement agency to be identified as one requiring further analysis and technical assistance, it must be identified as having a statistically significant disparity in at least two of the three analytical tests performed on the STOP data. No agency was identified as having a statistically significant disparity in two or more tests performed on the STOP data in the latest report published in 2022 (OCJC, 2022).

Chicago

In Chicago, the City established six geographical regions wherein no fewer than 10% of all speed enforcement safety zones will be located. This is to ensure a geographically equitable distribution of the program. Locations of cameras are based on a model that ranks safety zones based on total crashes, crashes involving a pedestrian or bicyclist, speed related crashes, serious/fatal crashes, and crashes involving a person 18 years or younger. The location is further determined by speed studies and other equity considerations (City of Chicago, 2024).

A 2022 study (Sutton & Tilahun, 2022) for Chicago from the University of Illinois Chicago analyzed equity in relation to the city's automated enforcement program. The study looked at the spatial and social distribution of camera tickets; economic burden of camera ticket fines and fees; and safety impacts of speed cameras. Key findings include:

- The rate of red-light and speed camera tickets per household was highest in predominantly Black and Hispanic areas in the city. A higher level of ticketing is associated with higher jobs per household, children per household, and percent multi-person households, but not associated with median household income. Higher levels of ticketing are also associated with exposure to the camera systems and built environment issues such as lower access to groceries.

- After controlling for camera exposure, built environment variables, and household structure variables, ticketing rates for Black areas are higher for both red-light and speed cameras. The study suggests that there may be systematic differences in travel patterns for residents in Black areas that the study was unable to control for, such as routes used and amount of travel.

- There is a small difference in ticketing rates for Hispanic and White areas for speed cameras, and no difference for red-light cameras.

- Black, Hispanic, and low-income residents pay a disproportionate amount of fines and fees. Fees are specifically harmful for low-income residents, with residents of low-income tracts incurring fees on 46% of tickets received (vs 17% for those living in upper-income tracts).

District of Columbia

A 2013 report on racial equity in Washington D.C. (WLCCRA, 2013) found that almost 70% of all traffic arrests were of black residents, despite only accounting for less than 50% of the population. The study indicated that needless arrests lead to negative outcomes for those arrested and reduce trust in the police and criminal justice system. This study helped bolster the idea of automated traffic enforcement as a strategy for reducing the number of police interactions and their potential for violent escalation by shifting traffic enforcement to cameras.

A 2018 study (Farrell, 2018) from the D.C. Policy Center demonstrated that SSC units are disproportionately distributed in areas that have more people of color and lower incomes. Further, census tracts with higher proportions of black residents were associated with a higher incidence of traffic fines, despite not experiencing a greater number of crashes. The District also collected more fines per capita than any other city. The study recommended the following for DDOT:

- Implementing a more design-based response to unsafe speeding, especially in areas that have historic underinvestment, in addition to enforcement.

- Use revenues to fund systematic safety projects.

- Incorporate equity and racial disparity in selection criteria.

- Implement a progressive fining scheme.

The District created the “Mayor’s Task Force on Automated Traffic Enforcement” (DMOI, 2024) in March 2023 to investigate and provide recommendations on the District's SSC program and other moving violation laws, including fines. The goal of the task force is to mitigate against the potentially inequitable effects of the fine, penalty, and enforcement systems on individuals of varying household incomes while maintaining the public safety effectiveness of SSC and other moving violation programs. The task force is tasked with the following:

- Review ways to maximize the efficacy of the SSC program in reducing the frequency and severity of crashes and traffic fatalities.
- Study fine amounts and penalties for SSC and other moving violations and explore options for making them more equitable.
- Investigate the feasibility of creating an “ability-to-pay” pilot program and a temporary or targeted amnesty program for SSC tickets and other moving violation fines.
- Examine the equity of current and future SSC camera locations.
- Explore incentives to get other jurisdictions to collect outstanding fines from the owners of vehicles registered outside the District.
- Looking at fine amounts, payment plans, and other best practices from other governments locally, nationally, and internationally.

Washington

The Washington state law indicates that cities may operate one speed safety camera, plus one additional camera for every 10,000 residents (Washington State Code, 2024). Cameras used under this provision must complete an equity analysis that considers the following:

- **Context:** Jurisdictions should consider the history of under-investment in transportation infrastructure in historically marginalized communities and how the existing infrastructure may facilitate faster speeds and a more vehicle-centric community. Care should be taken to not further penalize residents of those neighborhoods with cameras, and to ensure investment in street design is accompanying SSC implementation.
- **Location:** Jurisdictions should assess who is impacted and who benefits from a chosen SSC site. If a location is chosen with a high rate of crashes, but is in a historically marginalized community, effort should be made to redesign the roadway to discourage speeding.
- **Fines:** Jurisdictions should consider options for low-income violators, including due date extensions, payment plans, ticket reduction hearings, community service, and

traffic safety educations. In addition, revenues from fines should be used to implement long-term safety improvements.

In addition, Seattle has a Racial Equity Toolkit (City of Seattle, 2012) to guide the development, implementation and evaluation of policies, initiatives, programs, and budget issues to address the impacts on racial equity. There are six steps, summarized in Figure 5.1. The Washington Traffic Safety Commission recommends this toolkit as an additional resource for SSC implementation as part of their Speed Safety Camera Readiness Guide.

Figure B-1 Washington Racial Equity Process (Source: City of Seattle, 2012)

California

To tackle the issue of economic burden, California has stipulated in recent legislation (California AB-645, 2023) that cities are required to offer community service in lieu of paying the fine from SSC violations. In addition, violators can choose to pay the fine in monthly installments of $25. Fines are reduced by 90% for indigent persons and by 50% for individuals up to 250 percent above the federal poverty level. In addition, the law also specifically designates that SSC systems are to be placed in locations that are geographically and socioeconomically diverse.

New York City

New York City (NYCDOT, 2022) has specified that each of the 750 school zones approved ro SSC must have at least one SSC device. The City also has stated that their cameras cannot identify an individual driver and do not look at anything other than the speed of the vehicle. NYCDOT chooses additional locations based solely on serious crash incidence and frequency of speeding, therefore directing resources to where they have the most benefit while also ensuring that no individual community lacks protection or has an over-concentration of cameras. The City has stated that there is no correlation between neighborhood income or neighborhood percentage of non-white population and the number of speed camera violations issued per lane mile.

REVENUE

Oregon Context

In Oregon, most of the fine revenue generated by the cameras and paid through the Court goes to the State of Oregon's General Fund (approximately 70%). The fines are disposed as follows (PBOT, 2022):

- Section 153.633 (1) states that $60 (or the amount of the fine if the fine is less than $60) is initially payable to the state prior to any other distribution of the fine.
- Section 153.640 (2)(a) further directs that the $60 (or less) amount be deposited in the Criminal Fine Account.
- Of the remaining fine amount, Section 153.640(2)(b) and (c) state that 50% is payable to the local government and 50% is payable to the state.

Revenue Barriers and Opportunities

A barrier to reaching public acceptance can be the perception of SSC systems being a "money grab" by jurisdictions. One study (Ralph et al., 2022a) conducted a survey of the US public to evaluate public support of SSC. The study found that concerns about revenue are associated with greater opposition to cameras and greater distrust of the government, and recommended re-framing SSC as a tool to prevent revenue-oriented ticketing to increase public support.

Key findings include:

- **Revenue Concerns Are about Ticketing More Broadly**: Nearly 60 percent of the weighted sample agreed that traffic tickets are mostly about raising revenue, rather than public safety. This sentiment was more strongly supported by BIPOC and liberal respondents.
- **Revenue Concerns Are Associated with More Opposition to Cameras**: Many respondents exhibited a deep distrust of cameras linked to their money-making potential. Another concern is the involvement of private vendors in the deployment of cameras. Respondents who agree that traffic tickets are primarily for raising revenue

were more distrustful of local government and more concerned about government interference.

- **Re-framing Increases Support for Cameras**: The study found that including a message addressing concerns about revenue had nearly 2.5 times the odds of supporting cameras compared with those who received the control message.

The study recommended the following to help re-frame SSC in the public eye (Ralph et al., 2022a):

- Set reasonable fines.
- Target repeat offenders.
- Spend revenues on safety programs and projects.
- Locate cameras at sites with high crash histories, but consider impacts to low-income and minority neighborhoods. One strategy to help ameliorate equity concerns in the long-term is to prioritize safety investments in low-income and minority neighborhoods that have suffered from systematic disinvestment.
- Consider alternatives to police to operate the program, such as the department of transportation or other civil agencies. This may help acceptance of SSC, but must be weighed with individual agencies' capabilities to deploy an SSC program.
- Cities should design effective contracts with private vendors; in particular, contracts should ensure that the firm's revenues are based on the cost of operating the cameras rather than the number of tickets collected. This dispels the notion that private companies are incentivized to issue more tickets.

However, a study from UC Berkeley (Rodier et al., 2007) found that there are only a few programs in the United States that actually generate revenue, Washington D.C. being one of them. Many other programs either make minimal revenue or require a subsidy, such as Pennsylvania's Work Zone SSC Program. Still, it is important to create transparency around how revenue is spent. As discussed in Section 3.4, many states legally designate that fund be spent on traffic safety efforts either generally in the jurisdiction or for the specific corridors where SSC is implemented. In addition, revenue from SSC provides an opportunity for cities to invest in infrastructure in historically underinvested communities to create safer street designs that discourage speeding.

For small jurisdictions, start-up costs can be a barrier to implementation. Costs for SSC include capital, operation, and maintenance costs of the equipment; administrative costs to courts, police, and departments of motor vehicles; and costs of processing the violations. However, financial benefits can be more than just revenues - a study of British Columbia's SSC program found that the avoided costs of prevented fatalities and injuries lead to an annual savings of over 38 million Canadian dollars (Chen et al., 2000).

The public has reason to be skeptical of "money grabs" via ticketing practices because many cities use revenue from ticket fines and associated fees to fund police and municipal operations. There has been evidence of many municipalities setting up "speed traps" - or police officers hiding from view, waiting to catch speeders - as a method to raise funds. However, this is different from how most SSC systems are implemented today, which is as a high-visibility enforcement effort concentrated in higher crash or more vulnerable (e.g. school zones or work zones) locations.

There is considerable evidence that cities respond to budgetary shortfalls by ramping up ticketing. One study (Garrett & Wagner, 2009) analyzed panel data of ticketing by police officers in North Carolina from 1990 to 2003. The authors found that counties that experienced a decline in revenues in one year went on to issue more tickets in the following year. The practice of raising municipal funds via traffic tickets raises deep equity concerns. Another study (Sances & You, 2017) observed that cities with larger Black populations tend to have higher ticketing rates and raise more revenue from tickets per capita than cities with smaller Black populations. Another study (Su, 2020) found that low-income and Hispanic-majority counties in California raised relatively more money from traffic fines.

SSC can instead be seen as a tool to reduce revenue-oriented ticketing practices in three ways (Ralph et al., 2022b):

1. Traffic safety cameras are, in reality, poor sources of long-term revenues because ticketing tends to decrease with time as drivers begin complying with the law.
2. Since, in many cases, cameras are already operating twenty-four hours a day, SSC is difficult to ramp up in response to budget shortfalls.
3. Cities could dedicate ticket revenues to improving traffic safety rather than using it to fund police budgets or the general fund.

VENDORS

A vendor typically provides physical equipment and may also control the data and issue citations. Some agencies enter an agreement with vendors to provide needed expertise and operate some or most aspects of their SSC program. Jurisdictions may also choose to purchase or lease equipment for a flat fee and operate the system themselves. Vendor services include (FHWA, 2023):

- Supplying (purchase or lease), maintaining, calibrating, and monitoring the equipment needed to implement the planned operations.
- Processing citations based on criteria established by the jurisdiction.
- Mailing citations once approved by the oversight agency.
- Managing fine collection.
- Transferring, securing, and managing data.

- Supplying data and performance reports to the jurisdiction.
- Legal support.
- Public outreach, including a website, publicity, or replying to public concerns.

The approach most often used in the United States compensates vendors for equipment and services on a flat-fee basis, regardless of numbers of citations issued. The flat fee can be for the entire program, or per camera. This arrangement may be accepted by the public since a flat fee payment structure avoids payment per citation issued, which may help reduce the appearance of financial incentives in selecting sites and issuing citations (Douma et al., 2012; Eccles et al., 2005; Maisel, 2013). However, these arrangements may not incentivize the vendor to perform the most efficient and timely work, as vendors are paid the same amount no matter how quickly they process citation, speed, and other data. Thus, this arrangement can lead to slow response times and poor communication from the vendor.

One example of the “flat fee” approach is New York City. The City does not have, and has never had, a contractor take any proportion of revenue from violations. NYC DOT believes such systems create perverse incentives to issue greater number of violations rather than focusing on the behavioral changes to make driving safer, and thus do not align with the ethics of Vision Zero (NYCDOT, 2022).

Vendor Options

The following section describes some popular vendors that operate in the United States. Note that the information provided has been obtained from vendors’ websites and may be biased or prone to exaggerate benefits/capabilities and minimize issues or limitations of the systems.

Trafficlogix provides cameras that capture images of speeding drivers in multiple lanes simultaneously and can be used in cities of all sizes. Precise license plate recognition captures images of speed violators which can be included in mailed tickets along with fines for speeding infractions. The technology allows a jurisdiction to set the local speed limit, violation speed limit, and how many images to capture per violator. Trafficlogix provides an ‘end to end’ service, which means that the company provides the cameras, analyzes the data, and issues tickets (Traffic Logix, 2023).

Conduent offers automated enforcement for red light, speed, block the box, illegal turn, restricted lane, and license plate recognition via its DriveSafe Enforcement System. The technology includes both video tracking and radar to track vehicles through an enforcement zone, and captures images and videos if enforcement criteria are met. It also provides ‘end to end’ services including software, hardware, video analytics, and back office operations. Each citation is checked by two independent reviewers and the police, and then sent via mail or email to the violator (Conduent, 2024).

Verra Mobility provides fixed camera, transportable camera, and mobile camera options. The fixed speed technology includes both video tracking and radar to track vehicles through an enforcement zone, and captures images and videos if enforcement criteria are met. It also offers live intersection video streaming. Verra also offers end-to-end services, including site surveys, construction, maintenance & field services, program training, event processing, citation printing & mailing, payment support, court support, and public awareness (Verra Mobility, 2022).

Jenoptik is a European company that provides laser speed enforcement, combined red light and speed enforcement, and speed enforcement by induction loops. The laser speed enforcement systems include stand-alone laser and camera systems that do not require any modifications to the roadway. The laser technology offers precise simultaneous speed measurement in both directions while differentiating between cars and trucks. The combined red light and speed enforcement uses cameras and a radar sensor to measure and take images of violators, and can also be configured to check whether vehicles stop at pedestrian crossings, make illegal turns, or jump red lights. No modification to the road surface is necessary to install the systems. The equipment detects traffic light signals either optically or via a cable. The induction loop technology is the most robust and uses induction loops installed on the roadway to measure vehicle speed or red light violations. The technology can distinguish between classes of vehicles, and can be paired with camera systems to capture images of violators (Jenoptik, 2024).

Vitronic is a European company that offers fixed, semi-stationary, and mobile speed enforcement systems. For its fixed system, the POLISCAN Speed technology automatically captures all vehicles in two directions for up to four lanes. It uses LiDAR technology to accurately measure speeds without any in-road equipment. The fixed speed cameras come in three different housings, and offer options for monitoring from road shoulders or medians, housing a vehicle classification sensor, and slimmer options for tight spaces. The same technology is offered for mobile speed enforcement, but in the form of a tripod, in-car installation, or enforcement trailer. Vitronic also offers average speed enforcement, monitoring of driving bans, and detection of tailgating (VITRONIC, 2024).

Finally, NovoaGlobal provides Speed-Safe, a speed enforcement solution that captures speed violations with camera technology. The company also provides school speed zone cameras, red-light cameras, and enforcement of drivers entering the crosswalk (NovoaGlobal, 2019).

PRIVACY

Privacy in relation to the data collected by speed cameras can also be an issue with the public. The FHWA Guide includes a section on data management, recommending that agencies carefully construct a data management program that efficiently and securely documents, transfers, processes, and stores data collected through SSC operations. Processes for data sharing with violators should also be developed to ensure transparency, while maintaining privacy and following legal requirements. For example, New York City provides violators with a video of their vehicle when a citation is issued (FHWA, 2023). There is a tradeoff between transparency and potential errors or perceived arbitrariness of the system.

The lead agency should determine data linkage procedures for the data documenting the violation event, and additional processing steps including citation determination, registration information, citation issuance, payment status, or other outcomes. The hardware and software systems should be compatible with existing data systems in the jurisdiction. Computer and network security experts should be involved in the implementation of security procedures and selection of technologies (FHWA, 2023).

The lead agency should also ensure adequate security and privacy protection at all steps. Violation data and images should be electronically encrypted at the time of their capture to prevent unauthorized access or tampering. Any identifying data for non-infracting vehicles, such as license plate information, should not be stored. Only authorized and trained program staff should have access to the data. These precautions can help reduce public or legislative concerns about privacy (Eccles et al., 2005).

The lead agency should determine data retention requirements. A state may specify data elements to be retained for different purposes and timeframes. Driver identification is a matter of State law, so agencies in driver liability States should comply with those laws while maintaining privacy and data confidentiality (FHWA, 2023).

APPENDIX C

The following sections provided an overview of international guidance on SSC, as well as selected SSC programs in Canada and Europe. These programs, especially in Europe, have been in place for decades and are often more developed and widespread than those in U.S. states. However, the best practices from these programs can help inform ultimate goals for SSC programs in the United States.

INTERNATIONAL GUIDANCE DOCUMENTS

The European Union established a commission recommendation in 2004 regarding road safety and enforcement, where the Union recommended that member states set up a national enforcement plan and to use speed safety camera as part of the plan (European Commission, 2004).

The World Bank released its Guide for Determining Readiness for Speed Cameras and Other Automated Enforcement in 2020 (Job et al., 2020). This guide provided an overview of the need for SSC and summarized key issues to consider for SSC, including political and legal concerns, data security, organization and funding, site selection, and camera maintenance.

Otherwise, most individual countries have their own legislation and guidance documents regulating the specifics of their SSC programs.

EUROPE

As of a 2023 inventory (SCDB, 2024), there are at least 15 countries in Europe that employ SSC, with the top countries being Russia (around 18,500 cameras), Italy (around 11,000 cameras), Great Britain (around 7,500 cameras), Germany (around 4,500 cameras), and France (around 3,500 cameras). In general, speed cameras have been around as early as the 1990s for many of these countries, so SSC is much more widely implemented and accepted than in the United States. Many countries have centralized systems that employ a variety of different cameras, including fixed and point-to-point devices. Cameras are often placed on high-speed and volume roadways, instead of on local streets. European countries also often employ some 'covert' enforcement with unmarked units.

Figure C-1 shows the road deaths per million inhabitants in the US versus select countries in Europe. As evinced, road deaths are much higher per capita in the United States, indicating the success many European countries have had in lowering traffic fatalities. Programs such as speed safety camera, which have been in place longer in Europe than in the United States, are examples of countermeasures that may contribute to less fatalities.

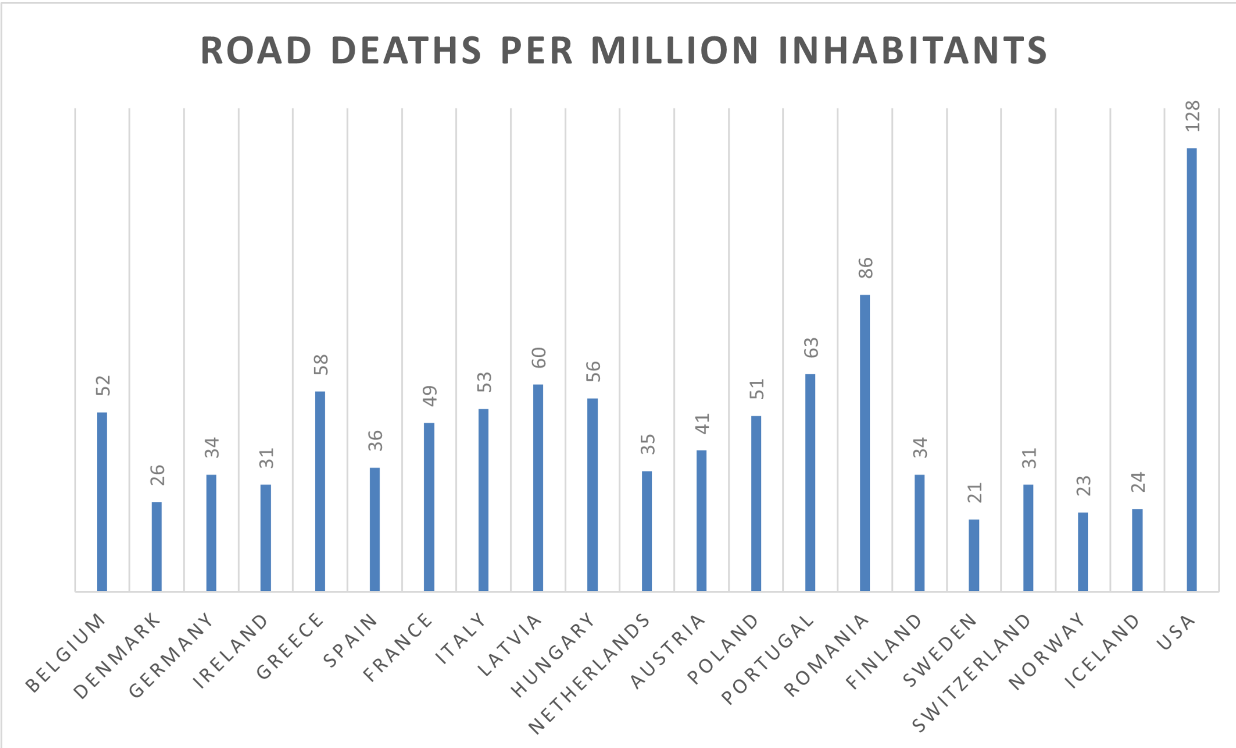

Figure C-1 Road Deaths per Million Inhabitants, EU vs USA Source: (European Commission, 2023; NHTSA, 2023)

Several SSC programs in Europe are described below, listed in alphabetical order.

France

A 2011 study (Carnis, 2011) provides an overview of the French speed safety camera program and lessons learned for other countries. France first installed speed cameras in November 2003, and as of 2017 has 2,026 fixed speed cameras, 501 mobile speed cameras, 209 autonomous cameras, 383 new-generation mobile cameras, and 101 road section cameras. France has seen a significant decrease in the number of fatalities and injuries since the implementation of SSC. The number of fatalities has reduced by over 30% between 2003 and 2009.

Fines depend on speed and vary from 68 euros (<20 km/h over the speed limit in a 50+ kph speed limit) to 1500 euros (more than 50 km/h over the speed limit).

Logistics

Since 2010, the national SSC program has been run by the Direction Contrôle Automatisé (DCA, or Speed Safety Camera Department), and handles responsibilities such as monitoring of the installation and functioning of the devices; determining the number and location of devices; and issuing contracts. It also heads public communication and coordinates with local jurisdiction and members of Parliament. The DCA includes advisors from the National Police and expert analysts (Carnis, 2011).

The Interdepartmental Speed Safety Camera Project (DPICA) is responsible for the logistics of the SSC program. It manages the National Processing Centre (CNT) and the Automated Centre for Observation of Traffic Offences (CACIR). These organizations ensure observance of due process for offenses detected by the radar devices and maintenance of detection devices (Carnis, 2011).

Strategy

Speed cameras are installed on county roads and national roads. The choice of location is mainly dependent on the number of road fatalities and injuries collected by road authorities, as well as on excess speed problems and difficulty of using traditional enforcement methods at a particular location (Carnis, 2011).

The French government uses a strategy combining both signed, visible devices and hidden devices (mobile devices inside unmarked police cars), in order to achieve both general (deterring the committing of offenses) and specific (detecting the offense and punishing the offender) deterrence. Locations of fixed cameras are publicized online and are preceded by signs intended to reduce speeds of individual drivers. The purpose of this strategy is to educate drivers on speeding laws and prevent speeding from occurring. Mobile, unsigned devices are used to detect and punish offenders. Their mobility allows for numerous random checkpoints on the road network and generates a situation of widespread uncertainty (Carnis, 2011).

In addition, France employs a "network-centric" strategy, which involves a progressive gridding of the road network with SSC devices. This ensures that whatever route a driver takes, that driver must at some point encounter a speed enforcement device. The omnipresence of the devices on France's roads and freeways leads to a perception of a nationwide detection network, which deters speeding. Finally, as all the devices are centralized, data regarding the program can be analyzed efficiently (Carnis, 2011).

Great Britain

Speed cameras have been in use in Great Britain since 1992 (RAC Drive, 2024). Both fixed and mobile cameras are employed, but the locations are not publicized. Great Britain employs fixed speed cameras; point-to-point or average speed cameras; combined speed and traffic cameras; and mobile speed cameras within vans.

The locations of cameras are not publicized, but as of 2016, the Department for Transport required that all fixed cameras be painted yellow to make them more visible to drivers (RAC Drive, 2024).

There is no published speed enforcement threshold, so the issuance of a fine is up to the discretion of a police officer. The National Police Chiefs' Council recommends giving drivers a '10% plus 2' leeway, in other words, 10% over the speed limit plus 2 kilometers per hour. However, this is just a recommendation. The minimum penalty for speeding is generally a £100 fine and three points on a driver's license. Local authorities can keep a portion of the revenue generated from SSC systems to fund regional projects (RAC Drive, 2024).

Italy

In Italy, the SSC program is run by the state police. There are several types of speed cameras in use: "orange" cameras can only issue fines when police are nearby, and "blue" cameras are digital infrared and can be remotely monitored. In addition, Italy employs point-to-point cameras that monitor average speeds, covering 166 segments spanning over 950 miles. Fines for speeding start at €143 and drunk driving charges start at €1,500 (Polizia di Stato, 2024).

Scotland

Scotland implements SSC as part of its Intelligent Transport Systems (ITS) program, which manages travel time reliability and road safety. ITS allows for variable speed limits to control the flow of vehicles when a road is congested or there is a collision on a roadway. SSC devices are placed at locations that have the highest potential to reduce injury collisions, and must meet criteria related to the number of injury collisions, vehicle speeds, and suitability of the site. Devices may be deployed in the short-term as mobile deployments, or as permanent devices. Average speed cameras may also be deployed in work zones, if coupled with other speed management systems (Transport for Scotland, 2022).

In addition, a 6-camera spot speed system HADECS (Highway Agency Digital Enforcement and Compliance System) system has been deployed on a major roadway to enforce variable speed limits. All cameras must have visible signage (Transport for Scotland, 2022).

Sweden

SSC was initialized in Sweden through a 2004 agreement between the Swedish Road Administration and the National Police Board (STA & SPA, 2023). Since the program began in 2006, Sweden has installed over 2,300 fixed SSC devices covering about 3,700 miles of roadway. It also has 15 mobile units.

Sweden requires a public information campaign to be conducted before new SSC units are deployed on a roadway, as well as visible signage. SSC devices are placed on roadways with a speed limit above 70 km/h (about 45 mph), high average speeds, and average daily traffic above 4,000 vehicles (STA & SPA, 2023).

Sweden's annual report revisits key goals that have been previously set and determines whether it is meeting those goals. The 2022 report found that SSC reduced the number of fatalities by about 20–30%; reduced the number of severe injuries by about 20%; reduced noise and CO_2 emissions; and has a high public acceptance rate (70%) (STA & SPA, 2023).

AUSTRALIA

New South Wales (NSW) in Australia has implemented SSC as part of NSW's 2026 Road Safety Action Plan to achieve vision zero. Automated enforcement in NSW began in 1988, with both speeding and red-light cameras at high-risk locations and across the network (Transport for NSW, 2022). Currently, there are four types of speed cameras in NSW (Transport for NSW, 2023):

1. **Fixed speed cameras** provide site-based enforcement by addressing localized risk at high-risk locations. These cameras are marked with advanced warning signs and their locations are publicized online. There are currently 140 cameras at 109 locations.
2. **Mobile speed cameras** provide network-based enforcement by detecting speeding across the network by moving around to different locations at different times. Mobile speed cameras can be moved around at different times and locations. These cameras are marked with advanced warning signs and their locations are publicized online. There are currently 1,024 locations delivering 7,000 enforcement hours per month.
3. **Red-light speed cameras** provide site-based enforcement at high-risk intersections to help enforce both red-light running and speed violations. These cameras are marked with advanced warning signs and their locations are publicized online. There are currently 222 cameras at 201 intersections.
4. **Average speed enforcement cameras** are placed in 25 regional locations to enforce heavy vehicle speeding. Only heavy vehicle speeds are enforced by these cameras. These cameras are marked with advanced warning signs and their locations are publicized online. Average speed enforcement lengths have been selected using criteria developed by the Centre for Road Safety in Transport for NSW. Site selection is based upon several factors including the frequency and severity of heavy vehicle crashes, heavy vehicle speeds and road conditions (Transport for NSW, 2024). There are currently 29 lengths.

The automated enforcement program also includes detection of fatigue compliance among heavy vehicle drivers and detection of unregistered driving. In 2020, NSW introduced the first Mobile Phone Detection Camera program to enforce illegal mobile phone use while driving, following a pilot of the technology. These same cameras will also begin enforcing seatbelt non-use as part of the 2026 Road Safety Action Plan (Transport for NSW, 2022).

The NSW Automated Enforcement Strategy (Transport for NSW, 2022) outlines the aim, benefits and principles for the SSC program; details five key action areas for the program. The SSC program falls in the Safe System approach for safety, and is coupled with police presence to achieve two types of deference, similar to France:

- **Specific deterrence** – occurs when a motorist who has been penalized for an offense no longer engages in that behavior for fear of incurring additional penalties.

- **General deterrence** – occurs when a motorist refrains from illegal behaviors as a result of observing others being penalized or is warned of the penalties for illegal behaviors or likelihood of being caught.

The five key action areas are their associated actions are summarized in Table C-1.

Fines vary by speed and range from $123 (less than 10 km/h over the speed limit) to $2,520 (over 45 km/h over the speed limit). New South Wales also has a program to help disadvantaged individuals who received a violation. The measures include the ability to have the penalty reviewed, and where eligible, payment plans or orders to complete unpaid work, courses or treatments in place of payment.

All fine revenue from enforcement cameras goes to the Community Road Safety Fund. This fund supports priority road safety programs. NSW publishes an annual report documenting the impact of speed cameras. The latest document (Transport for NSW, 2022) found that NSW speed camera programs continued to provide substantial road safety benefits to the NSW community. Overall, road trauma rates were considerably lower at fixed, red-light, and average speed camera locations, compared to pre-installation. The reduction in road trauma observed at camera locations across these three NSW speed camera programs represented a savings of $1.1 billion to the NSW community over the five-year period 2016 to 2020.

Positive Reinforcement in NSW

- Currently in NSW, fully licensed motorists can receive a half price license if they have had no demerit points recorded over the last five years. This rewards good behavior, rather than punishing bad behavior, however the reward is not an immediate or regular one.

- Other existing benefits for positive road behaviors are somewhat 'unseen', such as not having to pay fines and lower insurance costs because insurers can access speed violation records.

- The NSW Automated Enforcement Strategy proposes the exploration of any additional or more immediate, positive rewards or reminders that may help motivate and reinforce safe behaviors on the road.

Table C-1 NSW Automated Enforcement Strategy - Key Areas and Actions

Key Area	Actions
Automated Enforcement Solutions	• Actively explore new and improved automated enforcement solutions considering: o Enhancement of existing technology and policies; o Expansion of the capabilities of existing enforcement technology to detect additional risky behaviors; and o Innovation, including seeking out new solutions. • Establish an expert advisory group to provide advice on automated enforcement developments. • Identify and implement the most appropriate solution for speed enforcement in road work zones
Enforcement Locations	• Use the criteria outlined in this Strategy for selecting locations for automated enforcement, and make this publicly available. • Continue to allow the community to nominate locations for speed and red-light cameras, along with road network managers (including local councils) and NSW Police for all camera types. • Integrate automated enforcement into road planning and design, and upgrades of key routes.
Communication and Education	• Engage the community to increase understanding of, and support for, the different ways automated enforcement is used in NSW to improve safety, to foster greater support and acceptance. • Increase community awareness of the Community Road Safety Fund through enhanced information and communication, outlining where the funds are invested throughout the year. • Continue to publish the locations of site and route based automated enforcement designed to address high risk locations, as well as the broad locations of mobile speed camera enforcement. • Consider extending public nominations for locations for automated enforcement, beyond speed and red-light cameras. • Develop public education campaigns to support any new, expanded or enhanced automated enforcement.
Ensuring Fair Enforcement	• Explore additional positive rewards or reminders for motorists to help motivate and reinforce safe road behaviors. • Review existing penalty related policies and develop new policies where relevant, to ensure fair and transparent enforcement processes. • Work with Revenue NSW to determine the suitability of including the relevant offense image on infringement notices. • Work with Revenue NSW and Service NSW to expand the electronic delivery of infringements, and notifications of infringements, for broader implementation. • Work with Revenue NSW and Service NSW to appraise the current process for requesting a review of an infringement to ensure it is straightforward and transparent.
Research and Evaluation	• Continue to monitor community attitudes toward automated enforcement. • Complete an evaluation of the Strategy and its enforcement programs. • Continue to monitor the effectiveness of individual camera programs and make this information publicly available.

CANADA

Unlike European countries or Australia, in Canada SSC programs are somewhat similar to the programs found in the US.

Ontario

The province of Ontario, Canada has an SSC program that is implemented in a similar manner to SSC programs in the United States. In Toronto (Toronto, 2018) a pilot SSC program was administered between September and December 2018 to better understand the processing and administrative requirements of the enforcement program. No tickets were issued during this pilot. The SSC program then began in 2020. SSC systems are placed on local, collector, and arterial roads in Community Safety Zones. To ensure equitable distribution, three (3, number or "these") mobile systems are installed per ward. The SSC systems are mobile and rotate every three to six months within each ward. This provides an opportunity to address a greater number of areas with safety concerns and generates a wider-ranging deterrent effect.

Toronto implements a systematic selection process to choose SSC device locations. First, an initial screening of all Community Safety Zones are identified and prioritized based on the following data (Toronto, 2018):

- Collisions involving children;
- Collisions where a vulnerable road user was killed or seriously injured;
- Vehicle speed data;
- 24-hour traffic volume;
- Percent of students within walking distance; and
- Requests from Police and the public.
- Second, a manual review of each site is conducted to consider the following:
- Necessary regulatory and advisory signage (Community Safety Zone, Speed Limit, and SSC):
    - No obstructions or impediments to the equipment;
    - Adequate boulevard space to accommodate the equipment;
    - No planned road work;
    - No sharp curves or extreme grading changes;
    - No speed limit reductions planned;

- Adequate distance from speed limit transitions; and
- Cannot have the presence of a flashing 40km/h speed limit reduction sign.

Finally, operational considerations may result in minor adjustments to site prioritizations.

Toronto launched a multilingual public education campaign to remind residents of the presence of SSC systems and the dangers of speeding. In addition, a warning period was conducted between January 20, 2020 and March 31, 2020. During this period, Toronto issued over 25,000 warning letters to the registered owners of speeding vehicles. This was part of the City's education campaign to inform residents about the new program and the implications of speeding. No tickets were issued during this period. "Coming soon" warning signs are posted 90 days before ticketing begins at any new SSC location (Toronto, 2018).

A study was conducted on SSC data from 2020 to 2022 (The Hospital for Sick Children Research Institute, 2023). The study highlighted the following findings:

- The proportion of people speeding in areas with SSC devices dropped by 45%.
- The introduction of SSC devices reduced the operating speed of vehicles or the speed at which most vehicles travel in free-flowing conditions, helping to mitigate the potential risks associated with high-speed traffic. On average, vehicle speeds dropped by 4 MPH in vehicle operating speeds in areas with an SSC device.
- The percentage of drivers exceeding the speed limit decreased at 80% of locations with an SSC device. Excessive speeding – driving over the speed limit by 12 MPH or more – was also reduced by 87% after the placement of an SSC device.

The fine is $128 in community safety zones, plus additional fees. This is the same as the fine a driver would receive from a police officer. Toronto also has a Red Light Camera program (Toronto, 2018).

British Columbia

The province of British Columbia employs both red-light and combination red-light and speed cameras at intersections (Province of British Columbia, 2021). The cameras take a picture of a vehicle if it is detected going over the speed limit. The program began in 2019 and currently has cameras at 140 locations that run 24/7.

Violations are verified by two Intersection Safety Camera Program officers and then a notice is sent via mail. The province transfers ticket fine revenue to municipalities to support policing and public safety programs (Province of British Columbia, 2021).

INTERNATIONAL SUMMARY

International SSC programs, especially in Europe and Australia, are more developed and centralized than U.S. programs. Key findings include:

- Many programs are highly centralized and automated, leading to a very complete system with minimum overhead on issuing citations.
- Many of these countries, such as France, implement a more network-wide approach, instead of a city-by-city approach, to cover a wide range of areas and routes. This creates the idea of an omnipresent enforcement system for drivers.
- Both France and New South Wales, Australia have both specific and general deterrence, where they aim to change behavior to discourage speeding behavior in general, as well as reduce speeding in specific locations.
    - This concept is related to the use of both covert and overt enforcement. Covert, hidden enforcement is effective at changing driver behavior to slow down in general, while overt, visible enforcement helps control speeds in specific, marked locations.
- In countries such as France, there is a specific department tasked with leading SSC, with minimal to no police involvement.

While these characteristics are not currently implemented in the United States, they offer some inspiration for different approaches to SSC around the world.

APPENDIX D

Speed is a crucial factor in both the probability of a crash occurring and crash severity. Higher speeds reduce the ability of a driver to stop in time; decrease the ability of a driver to maneuver out of a dangerous situation; and make it difficult to negotiate curves. For each 1% increase in speed there is a 4% increase in deaths (Nilsson, 2004).The risk to vulnerable road users from speeding is even greater. The average risk of severe injury for a pedestrian struck by a vehicle reaches 10% at an impact speed of 16 mph, 25% at 23 mph, 50% at 31 mph, 75% at 39 mph, and 90% at 46 mph (Teft, 2011). Therefore, Speed Safety Camera (SSC) is an important tool to help reduce speeding and thus reduce the number and severity of crashes for all users. There are several academic studies exploring the effect of SSC on vehicle speeds, for both specific locations and as cross-study comparisons.

SSC is also a nationally recognized countermeasure for speed-related crashes. The National Highway Traffic Safety Administration (NHTSA) lists automated enforcement as a speed management countermeasure in their 2020 Highway Safety Countermeasure Guide for State Highway Safety Offices (Venkatraman et al., 2021). It rates automated enforcement with an effectiveness of 5 out of 5 and cites a study (Decina et al., 2007) that suggests a reduction of 20 to 25% of injury crashes at locations with fixed camera sites. The Federal Highway Administration (FHWA) also lists speed cameras as part of their Proven Safety Countermeasures. Speed cameras are estimated to reduce roadway fatalities and injuries by 20% to 47% (FHWA, 2024b).

The following sections describe the academic studies and methodologies evaluating speed and crash outcomes of SSC, both in the United States and abroad.

SSC SPEED AND CRASH OUTCOMES WITHIN NORTH AMERICA

Fixed SSC

Winnipeg, Canada

Background: A 2013 study in Winnipeg, Canada evaluated the impact of Winnipeg's photo enforcement safety program on speeding and crashes. 48 camera intersections throughout the city are included in this evaluation, installed in four distinct time periods (Vanlaar et al., 2014).

Design: The study used an autoregressive integrated moving average (ARIMA) time series analysis for crashes related to speeding, injury crashes and property damage only (PDO) crashes, occurring at intersections using monthly crash counts from 1994 to 2008. Comparison group data of comparable crashes at comparable times came from the province of New Brunswick (Vanlaar et al., 2014).

In addition, a quasi-experimental intersection camera experiment (matched case) was also conducted using roadside data on speeding at intersections. For each of four chosen intervention sites, two comparison sites were matched; these comparison sites are intersections in Winnipeg that do not have speed cameras. Logistic regression analysis was used to investigate the impact of the cameras on speeding violations for the intervention sites as compared to the comparison sites (Vanlaar et al., 2014).

Results: For the time series analysis of injury crashes, the authors found no significant effects of speed cameras on crashes. The exception is for cameras installed in the fourth time period, which was associated with a 23.5% decrease in injury crashes. For the time series analysis of Property damage only (PDO) crashes, results were mixed between an increase and decrease in crashes across the four time periods, but netted out to no effect of cameras on PDO crashes (Vanlaar et al., 2014).

For the matched case analysis, the authors found that for most cases, there was a decrease in speeding violations at the experimental sites as compared to the comparison sites (Vanlaar et al., 2014):

- **Average Speed:** No significant effect of speed cameras on average speeds.
- **Speeding Violations, 50 km/h winter camera sites**: 57% decrease in speeding violations at experimental sites vs. 19% decrease at comparison locations over study period.
- **Serious Speeding Violations, 50 km/h winter camera sites** (13 km/h over the speed limit): 54% decrease in speeding violations at experimental sites vs. 37% decrease at comparison locations over study period.
- **Speeding Violations, 60 km/h winter camera sites**: 12% decrease in speeding violations at experimental sites vs. 13% increase at comparison locations over study period.
- **Serious Speeding Violations, 60 km/h winter camera sites** (13 km/h over the speed limit): 83% increase in speeding violations at experimental sites vs. 13% increase at comparison locations over study period.
- **Speeding Violations, 60 km/h summer camera sites**: 22% decrease in speeding violations at experimental sites vs. 13% increase at comparison locations over study period.
- **Serious Speeding Violations, 60 km/h winter camera sites** (13 km/h over the speed limit): 3% increase in speeding violations at experimental sites vs. 18% increase at comparison locations over study period.

District of Columbia

Background: A 2021 study from the Virginia Polytechnic Institute and the Washington, D.C. District Department of Transportation analyzed traffic crash, SSC camera locations, and speed data to identify patterns and trends in crashes, speed limit violations, and speeding behavior before and after the SSC camera installation (Abdelhalim et al., 2021). This study builds upon a 2016 effort to evaluate SSC effectiveness, which showed substantial reductions in the District's vehicular crash frequency and in the severity of crashes (Rogers et al., 2016).

Design and Results: 29 SSC locations were deployed between 2017 and mid-2018. Crash data from January 2016 to June 2019 was used, with a minimum of one year of before and after crash data. The study focused on three main analyses:

- **Before and After Crash Counts:** The analysis of the before and after crash statistics at the selected camera locations shows a downtrend in all crash types. For all 29 locations, the average year-to-year reduction in crashes in the vicinity of the cameras was 9.35%, 13.16%, and 30.30% respectively.

- **Speed Limit Violations and Citations:** For the 29 locations of study, the average citation percentage was 1.18% of all vehicles in the first month of installation and steadily declined to 0.79% after 12 months.

- **Speeding Behavior:** The authors further investigated speeding behavior on the Anacostia freeway, which contains one SSC site. The speed threshold for ticket issuance is 11+ mph over the speed limit. Before installation, 5% of vehicles met this threshold. In the first month of installation, 2.2% of vehicles met this threshold. By the end of the study period, less than 1% of drivers exceeded 11 mph over the speed limit and the average speed is equal to the posted speed limit of 50 mph. A kernel density estimate (KDE) of the average speed is shown in Figure D-1. As shown in the plot, the mean speed was clearly reduced, and the distribution of top-end speeds was also significantly lowered.

Note that this study used a simple statistical analysis, and did not account for comparison groups, confounding factors (such as other variables that may have led to crash and speed reductions), or regression to the mean.

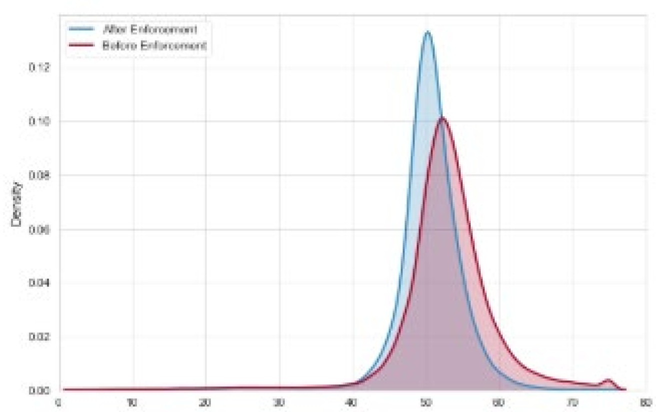

Figure D-1 KDE of Speed in the Vicinity of SSC Location

Chicago

Background: A 2022 study from the University of Illinois Chicago (Sutton & Tilahun, 2022) analyzed equity and safety impacts from speed cameras in Chicago.

Design: The authors used the empirical Bayes method to analyze 101 speed camera locations. Changes in the count of crash incidents within 250 meters on either side of the camera on instrumented roads over a three-year period are used as a basis for evaluating safety. The analysis uses a before-after approach to estimate safety based on comparing the after-period crash counts against what would have happened if cameras were not installed at the treated sites. Since most speed cameras in Chicago were installed in 2013 and 2014, the 2010-2012 period is taken as the before treatment period and the 2015-2017 period is used as the post treatment period to evaluate safety (Sutton & Tilahun, 2022).

Results: Key results include:

- **Overall Crashes:** The deployment of cameras reduced the expected number of fatal and severe injury crashes by 15%.
  Moderate injury crashes were reduced by 9%.
  Minor injury crashes were reduced by 14%.

- **Camera-Specific Results:** About 70% of the 101 sites had an estimated positive safety improvement. There was little relationship between the number of tickets issued and the safety impact of cameras.
  At a 90% confidence interval, 37% of sites had a decline of crashes and 13% had an increase in crashes.

Pennsylvania

Background: A recent study from the University of Pennsylvania examined the effectiveness of speed cameras at reducing crashes, injuries, and fatalities on and immediately around Roosevelt Boulevard in Philadelphia, Pennsylvania (Guerra et al., 2023). Roosevelt Boulevard is a state route and the SSC program is a pilot focused on a 14-mile stretch with 10 camera locations (Wech, 2023).

Design: The report produced models to examine whether traffic crashes and injuries on Roosevelt Boulevard decreased after camera installation relative to crashes on the five most similar roadways segments in Philadelphia from 2018 to 2022. The models use Bayesian negative binomial and Poisson methods. To choose control locations, k-means clustering was used. Figure D-2 maps the speed camera locations, selected treated roadway segments, and control roadway segments. The treated roadway segments include all segments along Roosevelt Boulevard that are treated, including about 1 kilometer north and south of the last cameras and side streets within 200 meters of the treated segments (Guerra et al., 2023).

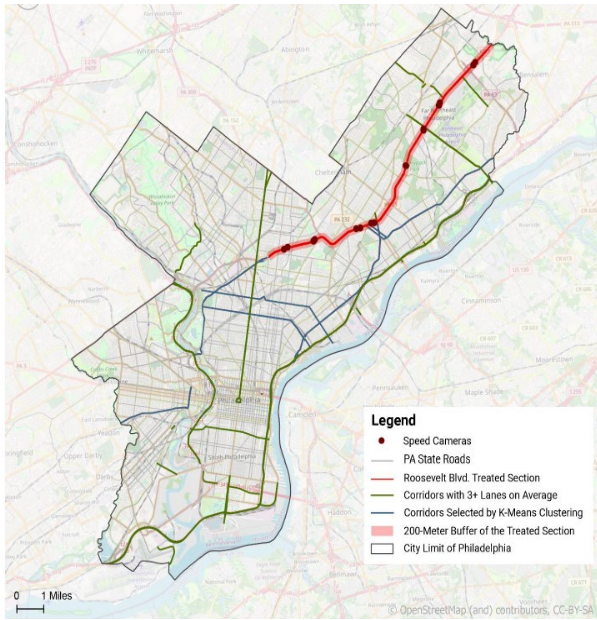

Figure D-2 Location of Roosevelt Boulevard Speed Cameras and Control Segments

The model separates arterials with three or more lanes, untreated sections of Roosevelt Boulevard, and remaining local roads in Philadelphia. The model also controls for month of the year to account for seasonal factors. The model does not include any traffic or roadway feature data (Guerra et al., 2023).

Results: Table D-1 presents the average monthly crashes and fatalities (2018-2022) before and after installation in each of the geographies modeled. Reported crashes on the treated section of the Boulevard decreased by 33% compared to an increase of 0.4% on the most similar roadways and 14% on other arterials. Monthly traffic fatalities increased across all geographies except for the Boulevard which saw a 3% decrease. These increases were substantial (between 40% and 103%), and traffic fatalities doubled on the five roadways that are most similar to Roosevelt Boulevard (Guerra et al., 2023).

Table D-1 Average monthly reported crashes and traffic fatalities (2018-2022) before and after speed camera installation on 6/1/2020

	Pre	Post	Percent Change
Reported Collisions			
Roosevelt Boulevard with cameras (200m)	50.2	33.5	-33%
Untreated sections of Boulevard	11.9	10.1	-15%
Most similar roadways	80.4	80.7	0.4%
Other 3+ roadway segments	184.7	210.4	14%
Rest of Philadelphia	569.3	484.4	-15%
Traffic Fatalities			
Roosevelt Boulevard with cameras (200m)	1.10	1.06	-3%
Untreated sections of Boulevard	0.07	0.10	40%
Most similar roadways	1.21	2.45	103%
Other 3+ roadway segments	1.62	2.81	73%
Rest of Philadelphia	4.17	6.45	55%

All Crashes and Injury Crashes: The authors developed estimates of the differences in crashes and injuries on control geographies relative to differences on treated sections of Roosevelt Boulevard after camera installation in June 2020. Increases in crashes, injuries, and fatalities are statistically significant across most of the control geographies. After camera installation, the five most similar roadways experienced a strong and statistically significant increase in crashes relative to Roosevelt Boulevard. The rate of crashes on the five most similar roadways increased 1.5 times relative to the rate of incidents on the Boulevard after camera installation. The non-fatal traffic injury rate was 1.71 times higher after camera installation. A smaller difference in crashes and injuries between the treated and untreated sections Boulevard suggests that there may be some spillover safety effects outside of the treated segments (Guerra et al., 2023).

All Fatalities: Relative to the treated sections of the Boulevard, the rate of traffic fatalities on the five most similar roadways doubled after camera installation. Despite the low total number of fatalities per month and high variance, these differences are statistically significant at the 95% confidence level (Guerra et al., 2023).

Pedestrian Fatalities and Injuries: Differences in pedestrian injuries and fatalities tend to be slightly larger. The most similar roadways experienced 1.83 higher rates of pedestrian injuries and 2.53 times higher rates of pedestrian fatalities relative to the Boulevard after speed cameras were installed. The difference in pedestrian injuries is different from zero with 95% confidence, while the difference in pedestrian fatalities is statistically significant with 90% confidence (Guerra et al., 2023).

Based on all these findings, the authors recommend that Pennsylvania and City of Philadelphia extend and expand the speed safety camera pilot (Guerra et al., 2023).

Mobile SSC

North Carolina - 2008

Background: Two consecutive studies looked at the effects of mobile speed safety camera in Charlotte, North Carolina. They build upon the 2005 paper included in the Thomas et al. meta-analysis, which looked at a pilot mobile SSC program in 2003. The first (Cunningham et al., 2008) updates the results from the previous study (Cunningham et al., 2005) by analyzing a deployment of three speed safety cameras along 14 corridors in 2004. In addition, five heavily enforced corridors that contributed 90% of all citations were analyzed separately. The total study period was from 2000 to 2005.

Design: To measure the effectiveness of the mobile SSC units on collisions, the authors employed a before-and-after study with comparison groups to account for confounding variables, including seasonal patterns, weather and special events, changes in traffic volumes, changes in driver and vehicle mixes, and changes in laws or driving customs. The comparison group comprised of eleven pre-selected corridors from the City. The sample odds ratio test was used to ensure that the crashes at the treatment sites and comparison sites had similar characteristics before the treatment occurred. In addition, regression-to-the-mean was considered, but the effect was negligible. As shown in Figure D-3, collision frequency for treatment sites decrease significantly after the SSC installation in 2004, specifically in the daytime (Cunningham et al., 2008). Note the high impact of seasonality, with lower frequencies in the winter and higher in the summer in both the before and after periods.

Results: The collision analysis seems to provide evidence that speed safety camera reduced collisions along treated corridors by around 10% on average. The collision reductions were lower in the second year of program operation and were 3igher in corridors that were more heavily enforced (Cunningham et al., 2008).

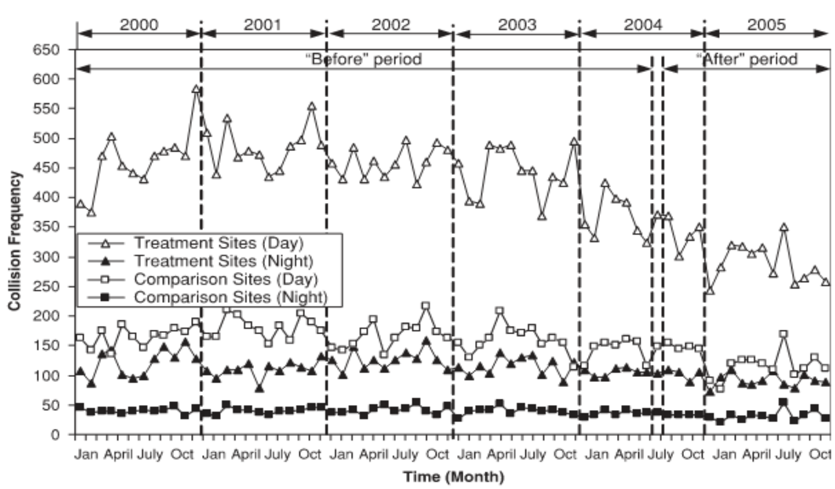

Figure D-3 Collisions Frequency for Treatment and Comparison Sites Source: (Cunningham et al., 2008)

In addition, the authors looked at changes in mean, median, and 85th percentile speed using the Proc Mixed procedure in SAS that is designed for random effect models and incorporates temporal correlation. The authors also looked at the percentage of drivers speeding over 10 mph over the speed limit using the Proc GENMOD procedure in SAS[11]. This study collected speed data at each site during three periods: August 2003 (before the program), September to October 2004 (just after the program began, called "first after period"), and September to October 2005 (more than 1 year after the program began, called "second after period"). Key findings include (Cunningham et al., 2008):

- Average speeds significantly decreased by 0.82 mph and 0.67 mph during the first after and second after periods, respectively, compared with the before period. However, there was no difference in average speeds when comparing the first after period with the second after period.
    - For the comparison sites, the changes in average speed were not significant in average between the before period and the first after period.
- The results for median speed and 85th percentile speeds are very similar to those for average speed.
- The percentage of speeding in the before period was 1.55 times the percentage of speeding in the first after period and 1.23 times the percentage of speeding in the second after period at the treatment sites.
    - For the comparison sites, the changes in percentage of speeding vehicles were not statistically significant between the three time periods.

Overall, while mean, median, and 85th percentile speeds did decrease after the SSC deployment, the speed reduction was minimal.

North Carolina - 2010

Background: The second study studies the same key 14 corridors as the 2008 study (Cunningham et al., 2008), but looked at SSC cameras deployed between 2004 and 2006 (Moon & Hummer, 2010).

Design: The study looked at collision data from 1994 to 2008 to estimate long-term collision patterns from the speed enforcement program with the carryover safety effects after its termination. The authors employed an autoregressive integrated moving average (ARIMA) intervention analysis as well as a before–after analysis with comparison sites (Moon & Hummer, 2010).

Results: The authors found that the speed camera program appeared to have significant carryover effects into the postintervention period, but collisions slowly returned to original

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[11] The PROC GENMOD procedure in SAS is used for fitting generalized linear models to data, allowing for analysis of data with various distributions (e.g., normal, binomial, Poisson). It is commonly used for regression analysis of data that may not meet the assumptions of traditional linear regression models.

levels. In addition, the before–after analysis with comparison sites also provided evidence that the effect of the speed camera program was to decrease collisions in the postintervention period (Moon & Hummer, 2010).

The observed and forecasted total collisions on the 14 treatment corridors are shown in Figure D-4. The first intervention was an aggressive media campaign to alert the public of speed safety camera, and the second intervention was SSC deployment itself. As shown in Figure D-4, the campaigns had a modest drop in observed collisions, but the camera implementation led to a sizeable drop in collisions. Furthermore, the ARIMA models suggested that the speed enforcement camera program retained some safety effectiveness several months into the postintervention period, before collisions gradually begun to return to their original levels (Moon & Hummer, 2010).

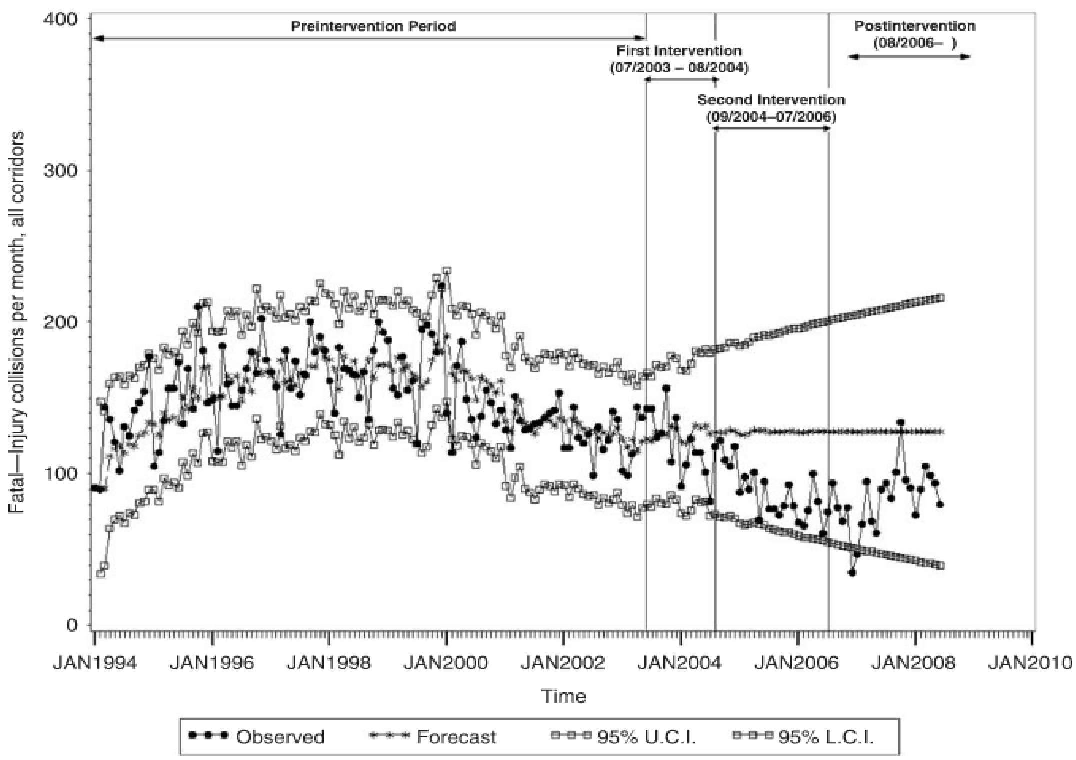

Figure D-4 Forecast of Total Collision Counts through ARIMA Intervention Analysis

In addition, the authors employed a before-and-after study with comparison groups. Key results include:

- **First intervention (campaign):** The program appeared to have led to slight decreases in total, PDO, and fatal injury collisions of 8% to 10% in the first intervention period as compared with the before period.

- **Second intervention (SSC deployment):** The speed camera program was associated with a decrease in total collisions of 15% to 18% in the second intervention period relative to the preintervention period.

- **Post-intervention:** The safety effects of the speed safety cameras carried over into the postintervention period with a decrease in total, PDO, and fatal injury collisions of 17% to 21% compared with the before period.

Edmonton, Canada

Background: A study in Edmonton, Canada used the before-and-after empirical Bayes method to evaluate the effectiveness of automated mobile photo enforcement on urban arterial roads (H. Li et al., 2020). The study evaluated eight years of data on 206 urban, arterial roadway segments and controlled for possible confounding variables. In addition, the study evaluated the effectiveness of deployment hours and enforcement strategies.

Results: The study findings include (H. Li et al., 2020):

- **Crash Severity:** Consistent reductions for all collision severities were found. The reductions ranged from 14% to 20% for all crashes, with the highest reductions observed for severe collisions.

- **Crash History:** More reductions were found at segments that had more collisions during the before period and longer deployment hours.

- **Deployment Hours:** More reductions were found in segments with more yearly deployment hours of the SSC system. For example, for crashes resulting in a fatality or serious injury, having over 70 deployment hours was associated with a 27.4% reduction in crashes, versus 22.9% for 15 to 70 yearly deployment hours.

- **Enforcement Strategies:** Some locations were enforced continuously in the study 'after' period, and some were not due to limited resources. The study found that continuous enforcement achieved more reductions across all severities and types of collisions. For example, for crashes resulting in a fatality or serious injury, continuous enforcement was associated with a 32.1% reduction in crashes, versus 17.9% for discontinuous enforcement.

- **Halo Effect:** A 'halo effect' or spillover was found on unenforced adjacent segments, where these segments had less PDO collisions than expected. See Chapter 4 for more information about the halo effect.

School and Residential Zones

Maryland

Background: A study on SSC in Montgomery County, Maryland (Hu & McCartt, 2016) looked at the impacts of SSC on speed, public opinion, and crash data. In May 2007, the County implemented an SSC program on residential streets with speed limits of 35 mph or lower and in school zones. In 2009, state law increased the enforcement threshold from 11 to 12 mph over the speed limit and restricted school zone enforcement hours. In 2012, the county began using a corridor approach, in which cameras are moved throughout a specific segment of a corridor.

Design: The research was based on data from May 2007 to December 2014, with the program expanding from 18 mobile cameras when the program began to 56 fixed cameras, 30 portable cameras, and 6 mobile speed camera vans in 2014. Selection of camera sites was based on several factors including crash data, vehicle speed data, and input from citizen advisory boards. The county implemented a "Safe Speed" publicity campaign that focused on the dangers of speeding and then informed drivers that SSC was in use. The program received considerable news coverage. In addition, signage is required to inform drivers of upcoming SSC locations (Hu & McCartt, 2016). The study compared speed and crash data in September and October 2006 (before SSC implementation) to data in November 2014.

Results: In the study period, speed cameras were associated with a 10% reduction in average speeds and a 62% reduction in the likelihood that a vehicle was traveling more than 10 MPH above the speed limit at camera sites. In addition, there was a 39% reduction in the likelihood that a crash resulted in a fatal or serious injury (Hu & McCartt, 2016).

Seattle

Background: Another study (Quistberg et al., 2019) looked at the impact of speed safety camera in school zones on driver speed and speeding violation rates in Seattle, Washington.

Design: The study evaluated four cameras during the citation period (December 2012 to January 2015) and the warning period (November 2012 to December 2012). The authors used an interrupted time series approach using multilevel mixed linear regression.

Results: The authors found that driver speed violation rates decreased by nearly half in the citation period compared with the warning period. The hourly maximum violation speed decreased by 2.1 MPH and the average hourly speed decreased by 1.1 mph.

Portland

Background: A 2006 NHTSA study investigated the use of mobile SSC at five school zones in Portland, Oregon over a two-month period. SSC was deployed at each school zone an average of two to three times per week during this period (Freedman et al., 2006).

Design: Speeds were measured at the five treatment school zones and at five comparison school zones before, during, and after the speed camera demonstration. Public awareness was measured before and during the SSC demonstration (Freedman et al., 2006).

Results: Major findings include (Freedman et al., 2006):

- Mean and 85th percentile speeds at demonstration school zones were reduced by approximately 5 mph when SSC was present. When SSC was not present (mobile units were moved) SSC still had an effect, although reduced to 1 to 2 mph.
- The proportion of traffic that exceeded the speed limit by more than 10 mph was reduced by about two-thirds when SSC was present, and by about one-quarter when SSC was not present.

- Maximum speed reduction was obtained with the combination of SSC and a flashing beacon, which is used during certain hours at many Portland school zones.
- The speed reduction effects observed at the demonstration school zones were still present one month after SSC operations ceased in May 2005.
- Speeds at most of the comparison locations were unchanged during this test, indicating that the speed reductions at demonstration schools were attributable to the SSC program.

Work Zones

Illinois

One study in Illinois studied the effectiveness of SSC in freeway work zones (Hajbabaie et al., 2011). It found that the proportion of drivers travelling with speeds over 10 mph was reduced by almost 9% with work zone ASE, similar to the reduction seen when using both a patrol car and speed feedback trailer.

Another study (Benekohal et al., 2009) evaluated the effectiveness of SSC in work zones on reducing speeds and increasing speed limit compliance in Illinois. The study looked at speed data both at the location of the SSC unit and 1.5 miles downstream. The study found that SSC is effective in reducing the average speed and increasing compliance with the work zone speed limit, with the following key results:

- The reduction of the average speed varied from 3.2 to 7.3 mph.
- The SSC device reduced speed in the median lane more than in the shoulder lane.
- The speed of free-flowing vehicles was reduced more than for platooned vehicles.
- The percentage of vehicles exceeding the speed limit near SSC was reduced from about 40% to 8% for free-flowing cars and from 17% to 4% for free-flowing heavy vehicles.
- Near the SSC location, none of the passenger vehicles exceeded the speed limit by more than 10 mph, and none of the heavy vehicles exceeded it by more than 5 mph.

Key Takeaways

There have been several general, school, and work zone SSC studies conducted in the United States, though several of these studies are somewhat old (before 2010) and/or utilize simple methodologies. Most studies, however, show decreases in speeds or crashes; more recent studies in Chicago, Philadelphia, and Seattle confirm these trends. A reduction in crashes between 10% and 20% was common, with the highest reductions seen for injury and pedestrian-related crashes. Speed studies varied in scope and measurement, but showed consistent reductions in average speed, proportion of drivers speeding, and violation rates.

SSC SPEED AND CRASH OUTCOMES OUTSIDE NORTH AMERICA

Speed safety camera has long been applied internationally, especially in Europe. Automated enforcement has been an important component of Europe's efforts to improve traffic safety and prevent traffic fatalities. Most countries in Europe have been successful in reducing roadway fatalities, and continue to see decreases in fatalities for all road users and vulnerable road users. Per a 2023 report (ITF, 2023), the vast majority of European countries studied had a decrease in roadway fatalities between 2012 and 2022, while the United States experienced over a 20% increase (Figure D-5).

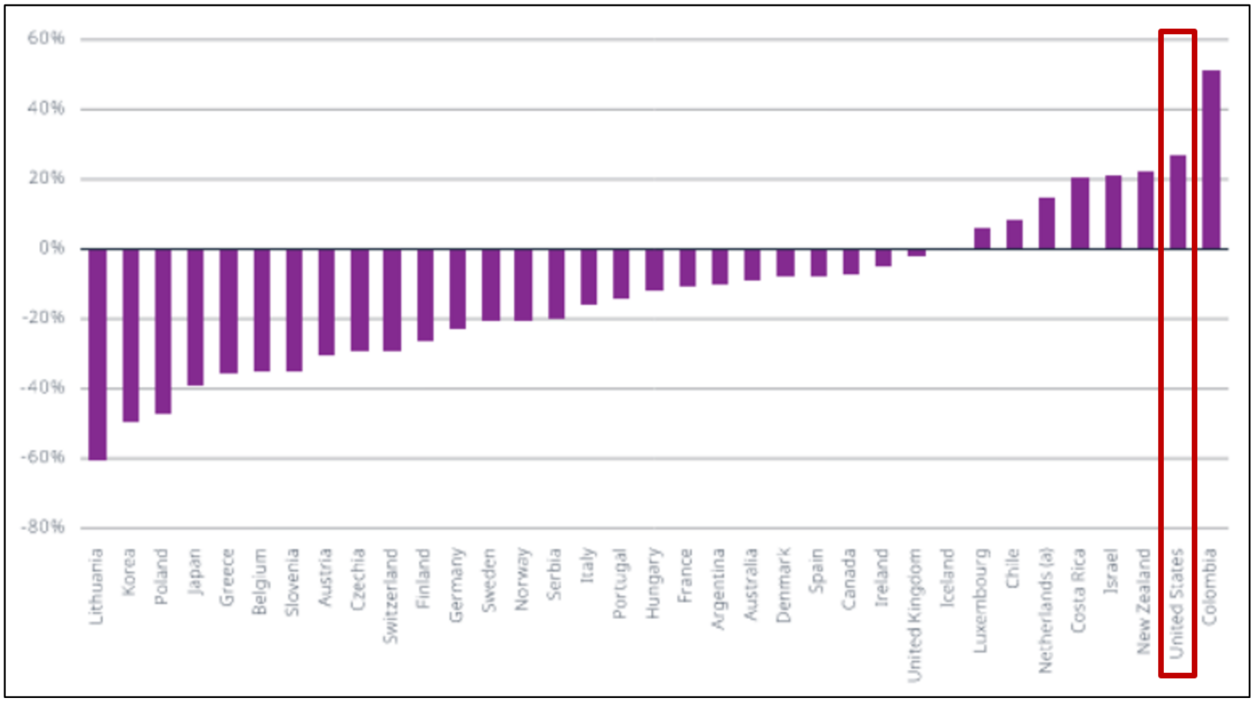

Figure D-5 Percentage Change in the Number of Road Deaths, 2012-2022 Source: (ITF, 2023)

When looking at roadway fatalities per capita and by other measures of exposure, the United States has much higher rates of roadway fatalities. The United States has 12 roadway fatalities per 100,000 residents, while most western European (especially Scandinavian countries) and other highly developed countries (like Japan) have between two and six per 100,000 residents, as shown in Figure D-6. This trend is similar when looking at vehicle miles travelled as the exposure metric, with the United States far exceeding Europe, Canada, Australia, Israel, and Japan, shown in Figure D-7.

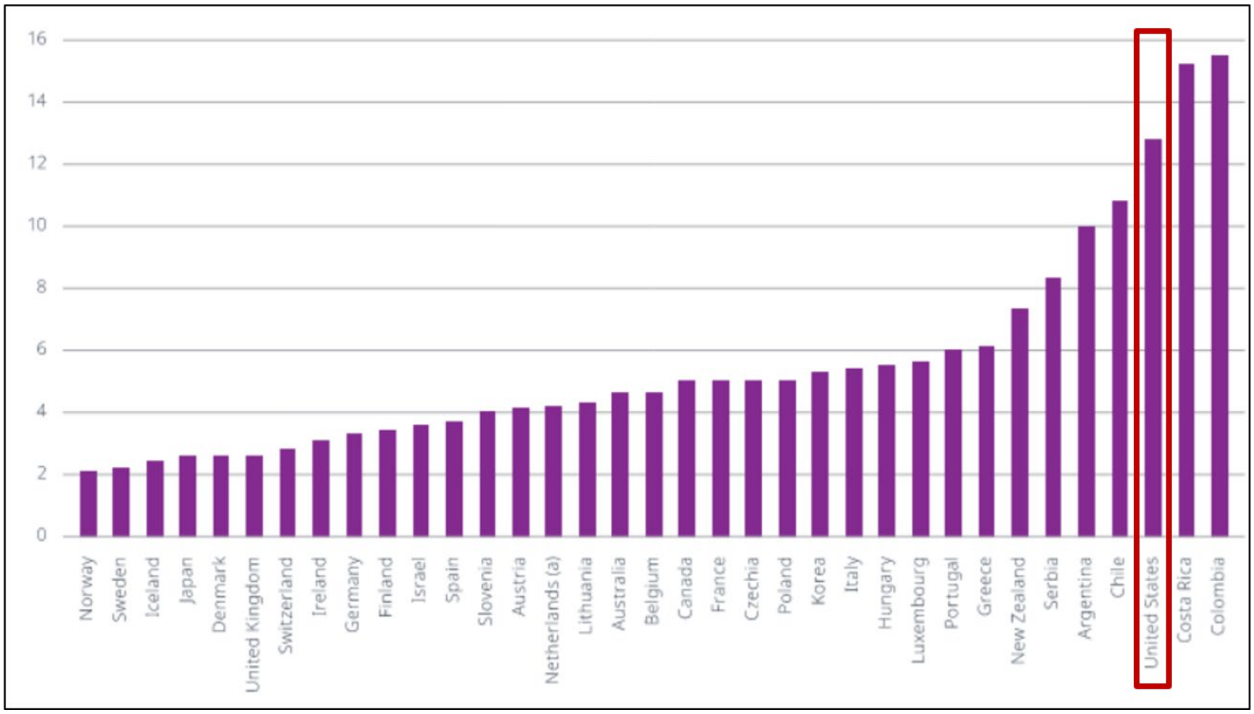

Figure D-6 Road Fatalities per 100,000 Residents, 2022 Source: (ITF, 2023)

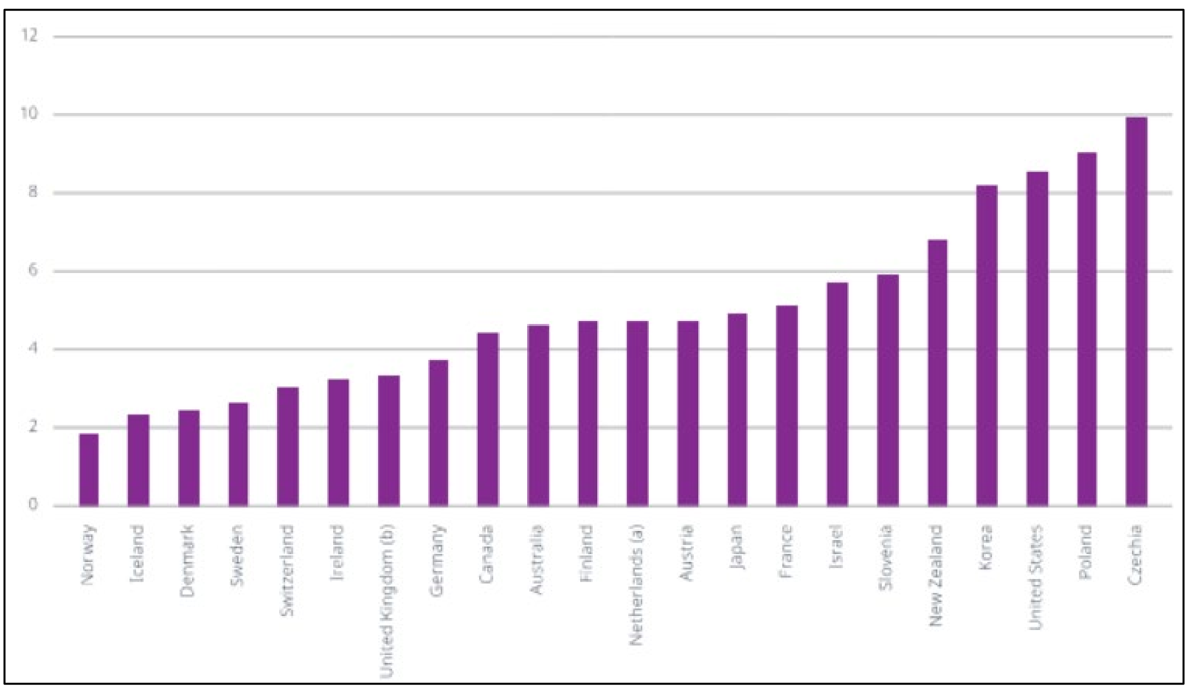

Figure D-7 Road Fatalities per Billion Vehicle-Kilometers, 2021 Source: (ITF, 2023)

Due to Europe's success in improving traffic safety, history of implementing innovative technological solutions, and longer experience with speed safety camera, studies from European countries and beyond offer important insights on the safety benefits of ASE, though some lessons or results may not be directly transferable to the US context. In addition to ASE, Europe has been implementing other technological solutions to target unsafe driving. For example, all new passenger vehicles in Europe are now required to be equipped with Intelligent Speed Assist (ISA). This technology will warn drivers if they're exceeding the speed limit and possibly even slow them down. If that happens, though, the driver will always be able to override the limiter by accelerating. These systems will help target speeding, while still allowing the driver to be in control. ISA is not yet common in the U.S., though California is working on a bill that would require passive ISA warnings in new vehicles.

Various studies from around the world have produced results that corroborate evidence found in the United States on speed and crash outcomes. This section will focus on studies conducted after the meta-analyses (2008) and on urban applications. Studies are shown by category and then by chronological order.

Fixed ASE

Colombia

In Cali, Colombia, fixed cameras were installed in March 2012, with 40 by 2018. To measure effects on the effect of these fixed SSC units on crash outcomes, a 2019 study employed a quasi-experimental difference-in-differences study with before and after measurements and a comparison group (Martínez-Ruíz et al., 2019). Comparison sites were selected based on road and urban characteristics to match them with their respective treatment areas. For each treatment site, two comparison sites were selected and included in the study. Some comparison sites were used for multiple treatment sites. Overall, the study looked at 38 treatment sites and 50 comparison groups during 42 months before and 34 months after the installation of cameras.

Effects on total crashes and fatal/injury crashes were estimated with mixed negative binomial regression models. For both models, the installation of cameras and the time since the beginning of the study period were significant (Martínez-Ruíz et al., 2019).

Further, the authors measured the monthly and yearly crash trends for the pre-treatment and post-treatment period. For all crashes, the estimated annual reduction was 19.2% in intervention areas with cameras compared with an annual reduction of 15.0% in areas without cameras with a 95% significance. However, the difference between treatment and control groups (20.5% vs 17.1%) was not significant for fatal/serious injury crashes. The authors posit that this could be because the comparison sites were located within 250 meters of the treatment sites, and that there was a halo effect that led to improved driver behavior at the comparison sites (Martínez-Ruíz et al., 2019).

Finland

A study in Finland (Luoma et al., 2012) evaluated the effects of a reduced enforcement threshold of a fixed SSC system on speed and safety on a two-lane rural road in Finland. The threshold was lowered from about 12 mph to about 2.5 mph and the public was informed about the change. Driving speeds on the experimental and control road before and after the change were compared. The main results showed that the reduced threshold decreased the average speed by 1.5 mph and decreased the proportion of exceeding vehicles by 11.8 percent. The authors concluded that lowering the threshold of speed safety camera combined with an appropriate information campaign can bring about a significant speed reduction that could contribute to substantial safety benefits.

Belgium

A 2014 study analyzed the effects of 65 fixed speed cameras on various highways in Flanders, Belgium. The authors employed a before-after study with comparison groups, in which the comparison group was all crashes in Flanders. The analysis showed a non-significant 8% decrease in injury crashes, a significant decrease of 29% in fatal and serious injury crashes. This effect is similar for all road user categories (De Pauw et al., 2014a).

Another study by the same researcher looked at 253 signalized intersections in Flanders, Belgium between 2002 and 2007. The authors employed an empirical Bayes before-after analysis with comparison groups, with a modification that allows an estimation of the regression-to-the-mean effect. The key findings include a 44% increase in rear-end crashes and a 24% decrease in severe crashes (De Pauw et al., 2014b). This paper was included in the Crash Modifications Clearinghouse (see Chapter 5).

France

A 2015 paper evaluated the effects of the French SSC program on fatalities involving different types of road users. The study used collision data from between 2003 and 2011, allowing for a long-term evaluation. The authors employed both descriptive statistics and an interrupted time-series using the autoregressive, integrated, moving average (ARIMA) intervention time-series models to look at various automated camera interventions, including introduction of the cameras, updated technologies to the cameras, and public communication campaigns (Blais & Carnis, 2015).

When looking at the descriptive statistics, the authors found that the fatality rate fell by 41.4% since the introduction of SSC, while crashes with injuries and the severity index[12] dropped by 32.8% and 14.3%, respectively. The highest reductions in fatalities and crashes with injuries are observed for trucks (−32.9% and −17.4%, respectively). The lowest reductions in fatalities and crashes with injuries are observed for motorcyclists (−21.4% and −13.1%, respectively).

The monthly fatality trends in France are shown in Figure D-8. As evinced, fatalities decreased immediately after the public communication campaign (‘Chirac’s Announcement’) and continues to decrease after the introduction of SSC (‘Introduction of the ASEP’).

[12] The severity index is defined as traffic fatalities per 100 crashes with injuries.

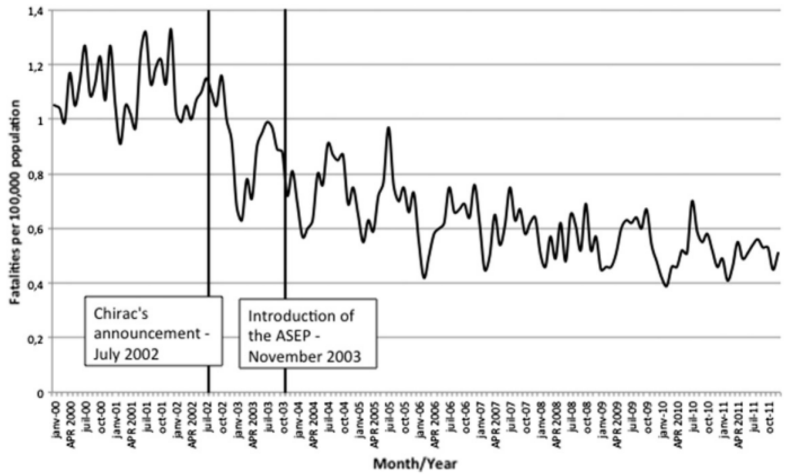

Figure D-8 Monthly Traffic Fatalities per 100,000 Population Source: (Blais & Carnis, 2015)

The authors further assessed the significance of the public announcement and introduction of SSC on fatalities. The time-series model shows that the public announcement and the introduction of SSC are associated with significant declines in traffic fatalities. However, for injury crashes, only the public announcement is significant. In addition, the model indicates that the effect of the announcement on crashes with injuries decays with time. However, results also show that the severity of crashes progressively diminishes through time (Blais & Carnis, 2015).

Slightly different results are seen for models with different road users: traffic safety measures did not have any effect on fatalities and crashes with injuries involving vulnerable road users. A decline in the severity index following the introduction SSC, however, suggests that speed cameras have yielded a beneficial effect on the severity of injuries in the event of a crash (Blais & Carnis, 2015).

Overall, the authors concluded that the introduction of SSC—alongside the public announcement—appears to be associated with significant decreases in fatalities and injury crashes. While the effect of SSC is stable through the whole intervention period for the fatality rate, a decaying effect is observed for crashes with injuries. Results also indicate that since the public announcement and the introduction of the speed camera program, crashes are less likely to result in fatal injuries. Results were different for different categories of road users, with motorcycles, mopeds, and vulnerable road users indicating little to no significant impact of SSC on fatal and injury crashes (Blais & Carnis, 2015).

Norway

A study in Norway (Høye, 2015) analyzed the safety effects of 223 fixed speed cameras that were installed between 2000 and 2010 in a before–after empirical Bayes study. The study controlled for regression to the mean, as well as for the effects of trend, volumes, and speed limit changes. Overall, the study found a reduction of 22% in injury crashes on roadway sections between about 300 feet upstream and 0.6 miles downstream of cameras. The study found no statistically significant drop in the number of crashes resulting in fatalities or serious injuries. However, speed cameras that were installed in 2004 or later were found to reduce the number of crashes resulting in fatalities and injuries. Larger effects were found for crashes resulting in fatalities or serious injuries than for injury crashes and the effects decrease with increasing distance from the speed cameras.

England

A 2016 study in England evaluated 771 fixed SSC camera sites and 4,787 potential control sites over a period of 9 years (H. Li & Graham, 2016). The study accounted for road characteristics such as road class, crash history, and site length via a single index referred to as the propensity score. This score is then used to match treatment sites to one or multiple control sites. Then, the average speed and crash effects are estimated at each treatment site using propensity score matching. These effects can then be estimated as a function of propensity scores using local polynomial regression.

The authors determined the effects of SSC-treated sites on personal injury collisions (PICs) and fatal serious collisions (FSCs) based on different treatment-control matching methodologies. Overall, the results show that the reduction in personal injury collisions ranges from 10% to 40% while the average effect is 25.9%. The reduction in fatal serious collisions is not significant when using matching methods (H. Li & Graham, 2016).

Another study (Graham et al., 2019) quantified the effect of speed cameras on road traffic collisions in England using an approximate Bayesian doubly-robust causal inference estimation method. It was found that SSC leads to significant reductions in the number of collisions at speed cameras sites, with a mean reduction of 15%.

Portugal

A 2019 study in Lisbon, Portugal evaluated the effects of 19 fixed speed cameras on crashes between 2004 and 2011. The study employed a before-after with control groups design, allowing the authors to account for exogenous factors that were identical in the control group and experimental areas. For this study, the control group was the Lisbon municipality as a whole (Santos et al., 2019).

Due to a low sample size of crashes, the authors analyzed the number of crashes for all 19 sites together and were unable to perform a robust statistical model. For fatal crashes, it was found that there was a 42% decrease in crashes in the first year and a 64% decrease in crashes in the second year after camera installation, as compared to the control group. There is a greater difference between the control and experimental data for all crashes/light injuries, especially in the first years after camera implementation (2007-2008) (Santos et al., 2019).

Mobile SSC

Saudi Arabia

A 2020 study (Alamry & Hassan, 2020) evaluated the effectiveness of Saudi Arabia's mobile speed cameras on crashes, using a 210 kilometer stretch of the Madinah-Makkah Expressway as a case study. These units are mobile, but covert, and are typically placed about every 30 kilometers. The study used six years of collision data.

The authors employed two techniques to evaluate the effects of the mobile speed cameras on crashes: a negative binomial regression model and an observational empirical Bayes before-after study. The expected change in the safety performance associated with the speed enforcement program was in both approaches by estimating Crash Modification Factors (CMFs, see Chapter 5). Negative binomial regression models were developed to predict the annual collision frequency for each collision type using a sample size of 522. The CMF for each collision type can then be calculated using the regression coefficient for the variable of speed camera (MSECs). All of the estimated coefficients for the MSEC variable exhibited positive signs and were statistically significant at the 1% level of significance. This means that the CMFs are greater than 1.0, which indicates lower safety with the presence of mobile speed cameras.

The empirical Bayes before-after study showed similar results, with speed cameras showing significant effect of an increase in collision frequency on the treated segments ranging from 36% to 75% for all collisions. The authors posit the following explanations for these results, which are not in line with other literature:

- The studied segment is a multilane divided expressway with a 120 km/h speed limit, which is a road type underrepresented in the literature.
- The cameras are owned and operated by a private institution, so the placement of cameras may have been motivated by profit (e.g., high volume locations) instead of potential to reduce collisions.
- There is a lack of other roadway safety measures, education campaigns, or more stringent punishments that would decrease speeding, so speed cameras alone are not enough in the context of the study area.

Average Speed Enforcement

A review of the literature on average speed enforcement in Australia and Europe, which averages a vehicle's speed between two devices, found that there are a number of road safety benefits associated with average speed enforcement for both speed and crashes. Speed related findings based on 15 studies, mostly in Europe, include (Soole et al., 2013):

- **Compliance**: Average speed enforcement is associated with very high rates of compliances with posted speed limits. Offense rates are typically reported as less than 1%, even for roadways with high volumes.

- **Speeds**: Studies on average speed enforcement have reported reductions of up to 90% in the proportion of vehicles exceeding the speed limit.

- **Speed Variation**: Due to the high rate of compliance with average speed enforcement, the variability between driver speeds is low, which is associated with a decreased likelihood of crash involvement.

Findings related to crashes include (Soole et al., 2013):

- **Fatal and Serious Injuries:** Average speed enforcement devices were found to reduce crashes resulting in a fatality or serious injury by between 33% and 85% in studies conducted in the United Kingdom.
    - Further, fatal and serious injury crashes were found to be reduced by 50% in Italy and Austria and 25% in the Netherlands.
- **Minor Injuries:** Some reductions in minor injury crashes were noted across a number of those same studies.

Italy

A study in Naples, Italy evaluated the effects of point-to-point speed cameras on an urban motorway on speed and crashes. To evaluate the speed effects, the authors employed a before–after analysis of speed data investigating also effects on non-compliance to speed limits. To evaluate the safety effects, the authors conducted an empirical Bayes observational before-and-after study (Montella et al., 2015).

The authors found decreases in speeds by various metrics (Montella et al., 2015):

- Average speeds decreased by 10%; speed reductions were greater in the daytime than in the nighttime.
    - Effectiveness for heavy vehicles (weight > 3.5 ton) was lower than for light vehicles: 5% vs. 10% the reduction in the average speed
- 85^{th} percentile speed decreased by 14%.
- The standard deviation of speed decreased by 26%.
- The proportion of light vehicles and heavy vehicles exceeding the speed limit (80 km/h) was reduced respectively by 45% and 16%.
- The proportion of light and heavy vehicles exceeding the speed limits more than 20 km/h was reduced respectively by 84% and 77%.

The authors also found that the cameras yielded to a 32% reduction in the total crashes. The greatest crash reductions were in rainy weather (57%), on wet pavement (51%), on curves (49%), for single vehicle crashes (44%), and for injury crashes (37%). It is noteworthy that the system produced a statistically significant reduction of 21% in total crashes also in the part of the motorway where it was not activated, thus generating a significant spillover effect (Montella et al., 2015).

Key Takeaways

Studies outside North America encompass a broad swath of roadway types, urban contexts, and SSC types. Some studies, such as the one conducted in France (a highly centralized country), were even able to evaluate the impact of SSC on crashes across the whole country, as SSC was rolled out all at once. These studies generally confirm the crash and speed reductions seen in the United States, though the studies abroad were more focused on crashes. In general, crash reductions were between 20% and 40%, with several key exceptions: one study showed an increase in rear-end crashes (De Pauw et al., 2014b), while another in Saudi Arabia showed increases in all crashes (Alamry & Hassan, 2020) but infrastructure, cultural, and law-abiding differences may explain the latter result.

HALO EFFECTS

This section details studies related to the halo effect as related to SSC. The "halo effect" has two components:

- The **time halo** refers to the length of time that the effects of enforcement on drivers' speed behavior continue after the enforcement operations have been ended.
- The **distance halo** refers to the distance over which the effects of an enforcement operation last after a driver passed the enforcement site (European Commission, 2004).

A related concept, the "spillover effect", refers to the reduction of offences or crashes in the surrounding non-enforcement network. A graphic of these concepts is shown in Figure D-9.

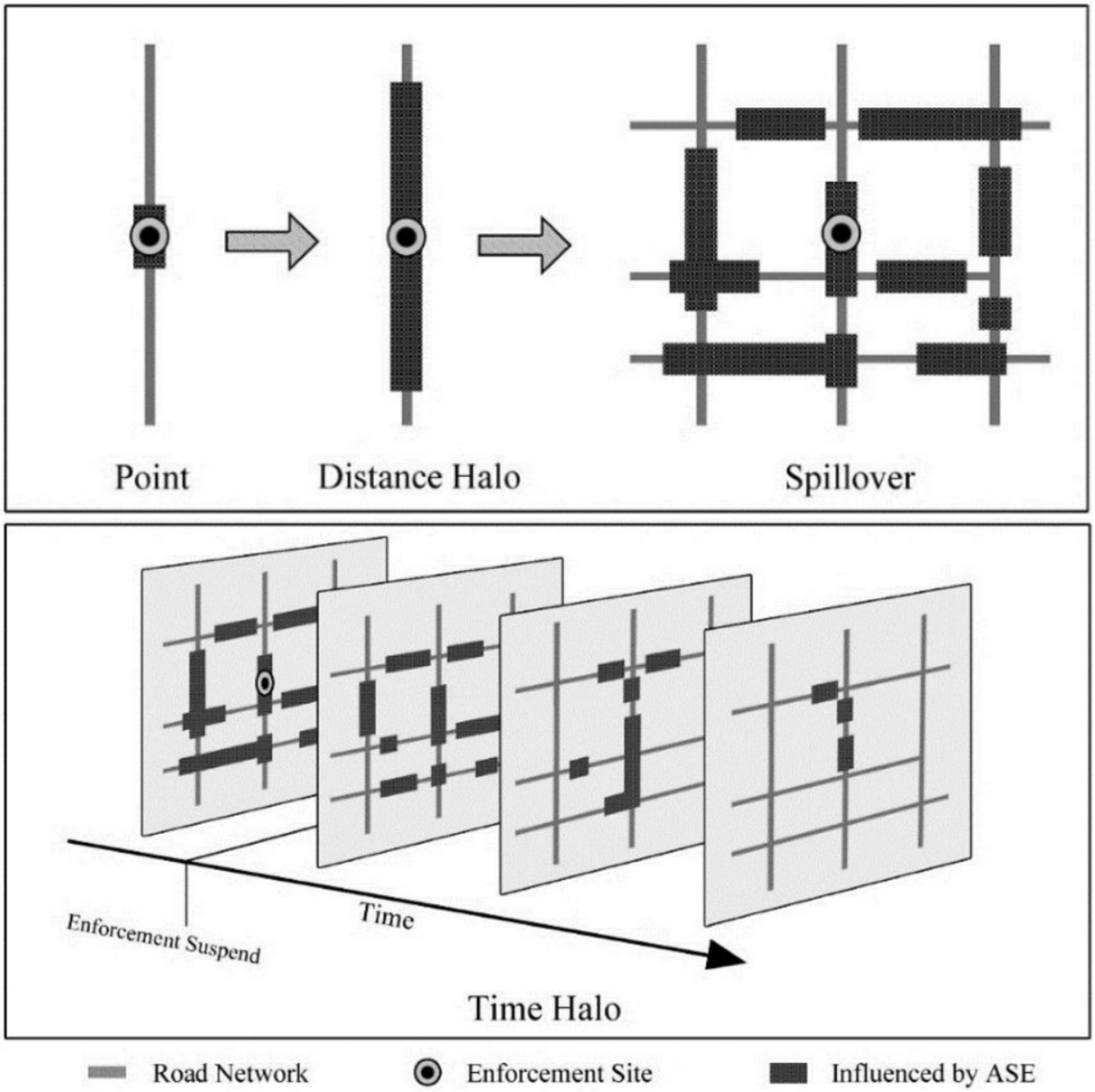

Figure D-9 Halo Effect Schematic Source: (Zhou et al., 2019).

This section details meta-analyses conducted on the halo effect, as well as individual academic studies. Note that most studies are centered around Europe and Asia.

Distance Halo

Two meta-analyses conducted on SSC outcomes (see Chapter 5) include studies on the halo effect, specifically the distance halo. Key outcomes are shown in Table D-2. In general, the studies found halo effects of up to 3 km, though the strongest effects were within 1 km of the camera site.

In the tables in this report, the following color convention is used for percentages: **<0%**, **0-20%**, **20% - 40%**, **>40%**. Values recorded in other units, such as miles per hour, are bolded.

Table D-2 Thomas et al. and Wilson et al. Distance Halo Effect Studies

Study	Location	Key Reported Halo Effect Outcomes
(Maekinen, 1994)	Finland	Distance halo of 3km upstream and 2km downstream
(Hess, 2004)	Cambridgeshire, United Kingdom	Weighted Injury Crashes • Within 250 m of camera: **−45.7%** • Within 500 m of camera: **−41.3%** • Within 1,000 m of camera: **−31.6%** • Within 2,000 m of camera: **−20.9%**
(Mountain et al., 2004)	United Kingdom	Within 500 m either direction **−25%** injury crashes Within 1 km either direction **−24%** injury crashes
(ARRB Group Project Team, 2005)	New South Wales	Average Speed (24 months after camera install) • At camera sites: −5.8 km/h • Upstream (1-2 km): +1.5 km/h % of Vehicles Exceeding Speed Limit (12 months after camera install) • Upstream (1-2 km): −5.3% • At camera sites: **−70%** • Downstream (1-2 km): **−20.9%** All Reported Crashes (24 months after camera install) • At camera sites: −19.7% • Combined lengths (upstream + downstream): −7.6%[1]

[1]This result was borderline to being statistically significant (p=0.056)

The European Commission summarized a compilation of studies relating to the halo effect in Speed Safety Camera (European Commission, n.d.). This literature was cited in a recent congressional brief on speed and red light cameras (Peterman, 2020):

- For the distance halo, it was found that the effects of visible traditional policing on driving speeds are halved for every half of a mile downstream of the enforcement site. The effects of police presence on driving speeds typically last between 1.5 and 5 miles (Elliott & Broughton, 2005).

- For speed cameras, Elliot and Broughton found that some studies cited distance halo ranges at around 0.3 miles, while others suggest up to 6 miles, depending on the chosen site.

- In general, physical policing seems to generate a larger distance halo effect than speed cameras.

A more recent meta-analysis from China (Zhou et al., 2019) conducted a literature review of 24 papers looking at the distance and time halo effects, as well as the spillover effect. Twelve of the reviewed studies included the distance halo effect, shown in Table D-3. Of these studies, the authors found that many studies reported a distance halo of between 0 and 2 miles, with equal distances at both sides or shorter distance at downstream (Y. Li et al., 2016; Pauw et al., 2014). Key finding include:

- The distance halo was associated with a significant speed differential before and after the vehicles pass the camera site. In a couple of studies, it was found that average speeds fell by about 0.85 mph to about 11 mph upstream of the camera location, and then recovered to their original levels within several hundred yards downstream of the camera site (Ha et al., 2003; Hajbabaie et al., 2011).

- In some cases, the downstream speeds even raised beyond original speeds after vehicles passed the enforcement points (Hajbabaie et al., 2011; Pauw et al., 2014)

- One study found while there was a decrease of 7.6% in crashes at the camera sites, there was an increase of 11% upstream of the camera sites due to sudden braking (Shim et al., 2015).

- The downstream distance halo of mobile camera sites was slightly longer than that of fixed camera sites (Champness et al., 2005).

- The length between warning signs and cameras was highly correlated to the effectiveness of distance halo, with longer distances associated with more of a distance halo (Pauw et al., 2014; Retting et al., 2008).

- A study in New Zealand also investigated the distance halo by comparing speeds of vehicles every 0.3 miles for a section of multilane highway (Champness et al., 2005). The study found that at the camera sites, there was a 4 mph reduction in 85th percentile vehicle speeds, and the number of vehicles exceeding the speed limit fell from 53% to 16%. However, these effects completely disappeared by about one mile downstream of the cameras.

Table D-3 Zhou et al. Distance Halo Effect Studies

Study	Location	Metric	Key Reported Halo Effect Outcomes
(Chin, 1999)	Hong Kong	Average speeds and proportion of speeding vehicles	Halo effect (reduced speeds) observed as far as 500 m (**0.3 miles**) away from camera Higher speed-limit compliance within 200-3000 m (**0.12 to 1.86 miles**) of speed camera.
(Ha et al., 2003)	South Korea	Average speeds	Minor speed reduction 3 km (**1.86 miles**) before camera; significant speed reduction 1 km (**0.6 miles**) before station
(Champness et al., 2005)	New Zealand	Average speeds	No halo effect upstream of camera speeds Some halo effect 500 m (**0.3 miles**) downstream, diminishing by 1 km, and disappearing by 1.5 km (**0.93 miles**)
(Medina et al., 2009)	Illinois, USA	Average speeds	1.5 miles downstream: **-1.1 to -2.9 mph** car average speed **-0.9 to -3.3 mph** truck average speed
(Liu et al., 2011)	China	Average and 85th percentile speeds	Upstream halo effect (deceleration) 300 m to 400 m (**0.19 to 0.25 miles**) Downstream halo effect of 400 m (**0.25 miles**)
(H. Li et al., 2013)	United Kingdom	Injury crashes	Halo effect within 200 m Within 200 m (0.12 miles): **-27.5%** annual injury crashes per km Within 500 m (0.3 miles): **-25.2%** annual injury crashes per km Within 1 km (0.62 miles): -16.6% annual injury crashes per km
(Pauw et al., 2014)	Belgium	Odds of drivers exceeding the speed limit	At camera site: strong effects (average speed: -6.4 km/h (2.98 mph); odds of drivers exceeding the speed limit: -80%; odds of drivers exceeding the speed limit by more than 10% : -86%) 3-2.5 km (**1.86 to 1.55 miles**) upstream: slightly increased odds (+0.70km/h; +12%; +9%) At information sign: slightly decreased odds (-0.65 km/h; -3% and -4%) Downstream: no significant effects
(Shim et al., 2015)	South Korea	Crashes	-7.6% change in crashes at camera sites **+11%** upstream due to suddenly braking of vehicles
(Bar-Gera et al., 2017)	Israel	Average speed	At camera sites: -7.3 km/h **(-4.55 mph)** 1300-1500 m upstream: -1.7 km/h **(-1.05 mph)** 1300-1500 m downstream: -0.84 km/h **(-0.53 mph)**

United Kingdom

A 2004 study on 62 fixed SSC devices throughout the United Kingdom evaluated impacts to SSC on injury crashes using the Empirical Bayes method to account for regression-to-the-mean (Mountain et al., 2004). Three distance bands were defined for each site: up to 250 meters from the camera, 250-500 meters from the camera, and 500-1,000 meters from the camera. The authors calculated the change in all observed crashes and fatal and serious injury crashes attributable to speed safety camera.

For all crashes, the crash reduction was the highest within 250 m, with most of the crash change attributable to speed cameras. For other distances, the crash reduction is lower, but almost all the change is attributable to the speed cameras (Mountain et al., 2004).

For fatal and serious crashes, the results are less conclusive. Though there are similar crash reductions as for all crashes, only a fraction is attributable to speed cameras. A high regression to the mean effect indicates there is significant variability in these types of crashes, and a low sample size leads to less reliable results (Mountain et al., 2004).

For all crash types and distances, there is a reduction in traffic flow that contributes to reduced speed camera crashes, indicating that there is evidence of traffic diversion. However, most of the crash effects are attributed to lower speeds (Mountain et al., 2004).

As shown in Table D-4, the crash reduction attributable to speed cameras was between 11% and 25%. Most of this reduction was attributable to a reduction in speed, but about 5% was attributable to reduced flow due to diversion of traffic.

Additional studies are needed to fully understand traffic diversion due to speed cameras, and whether speeds and crashes are seen on diversion routes.

Table D-4 United Kingdom: Halo Effect Results

Accident Type	Distance from Camera	Observed Change in Crashes	Attributable to Speed Cameras			Attributable to Other Effects	
			Overall Speed Camera Effect	*Reduction in Speed*	*Reduction in Flow*	Crash Trend	RTM
All Crashes	Up to 250m	-34%	-25%	*-20%*	*-5%*	0%	-9%
	250m – 500m	-15%	-15%	*-10%*	*-5%*	+8%	-8%
	500m – 1,000m	-13%	-12%	*-9%*	*-4%*	+3%	-4%
	Up to 500m	-26%	-25%	*-19%*	*-5%*	+4%	-5%
	Up to 1km	-18%	-24%	*-19%*	*-5%*	+8%	-4%
Fatal & Serious Injury Crashes	Up to 500m	-34%	-11%	*-6%*	*-4%*	-5%	-18%
	Up to 1,000m	-28%	-13%	*-9%*	*-4%*	-1%	-25%

New South Wales

A 2005 study in New South Wales, Australia (ARRB Group Project Team, 2005) evaluated speed and crash outcomes for 28 fixed SSC sites for four time periods: prior to SSC, six months after, 12 months after, and 24 months after. The study looked at three segments: downstream (1-2 km), upstream (1-2 km), and at the camera sites (within 1km of cameras). The study evaluated speed outcomes, and generally found significant reductions in speed at camera sites but mixed results upstream and downstream of the cameras:

- **Average Speed:** At combined lengths (upstream, downstream, and at the camera sites) there was a statistically significant reduction in mean speed of **6.3 kph** and **5.8 kph** 12 months and 24 months after camera installation.
    - Upstream**:** There were generally no changes in speed in the adjacent lengths, but a small but statistically significant increase of **1.5 km/h** was detected in the upstream length at the 24-month 'after' survey.
- **Percentage of Vehicles Exceeding the Speed Limit**: The 12-month speed data revealed statistically significant reductions across all lengths of **5.3%** (upstream length), **70%** (camera length) and **20.9%** (downstream length).
    - While the 24-month 'after' data show that statistically significant reductions were maintained along the camera site and the downstream length; the upstream length increased to a statistically significant degree of **3.4 kph**.

- **Percentage of Vehicles Exceeding the Speed Limit by at Least 10 km/h**: At camera sites, significant reductions of **85.6%** and **87.9%** were seen 12 months and 24 months after the cameras became operational. At adjacent lengths, after 12 months the downstream proportion reduced by **8.2%** while the upstream length increased by **7.6%**.
    - 24 months 'after' there were increases of **24.8%** in the upstream length and **10.5**% in the downstream length.

Additionally, crash outcomes were investigated at camera sites (within 1km of the camera) and at combined lengths (upstream, downstream, and the camera site). Overall, the study found crash reductions at camera sites, but non-significant crash reductions at combined lengths. Key findings include (ARRB Group Project Team, 2005):

- **All Reported Crashes:** At camera sites, there was a statistically significant reduction in all reported crashes of 19.7%. For the combined lengths there was a total reduction in all reported crashes of 7.6%, which is borderline to being statistically significant (p=0.056).

- **Fatal Crashes:** At camera sites, there was a statistically significant reduction in fatal crashes of 89.8% two years after camera installation. For the combined lengths there was a total reduction in fatal crashes of 57.6%, which is borderline to being statistically significant (p=0.054).

- **Fatal + Serious Injury Crashes**: At camera sites, there was a statistically significant reduction in fatal/serious injury crashes of 22.8%. For the combined lengths there was non-significant reduction of fata/serious injury crashes (7.8%).

- **Injury Crashes**: At camera sites, there was a statistically significant reduction in injury crashes of 20.1%. For the combined lengths there was non-significant reduction of injury crashes (6.2%).

Chengdu, China

A study in China (Fu & Liu, 2023) investigated the distance halo effect of fixed SSC on taxis in Chengdu, China. The researchers collected more than 1.34 million taxis' GPS trajectory data, specifically looking at the delta speed (defined as the difference between the traveling speed and the speed limit).

The study found that downstream delta speed is smaller than the upstream one. The upstream halo effect lasts between 25 feet and 1.3 miles from the SSC location and the downstream halo effect lasts between 30 feet and 0.35 miles from the SSC location (Fu & Liu, 2023).

Spillover Effect

As an extension of distance halo, spillover effect refers to the plane extension of enforcement effects from camera sites to larger area (Zhou et al., 2019). Spillover effects are generally seen with the combination of mobile cameras and police presence. Other factors that can lead to a spillover effect include using hidden cameras (Keall et al., 2002) and employing various warning measures, even the warnings without real enforcement (Retting et al., 2008).

Time Halo

One of the meta-analyses considered in Chapter 5 also looked at the time halo. Key outcomes are shown in Table D-5. The study found a time halo of 3 to 6 weeks.

Table D-5 Thomas et al. and Wilson et al. Time Halo Effect Studies

Study	Location	Key Reported Halo Effect Outcomes
(Vaa, 1997)	Oslo, Norway	60 kph roadways: Continuous time halo of 3 weeks for 9 AM to 3 PM; 2 weeks for 3 PM to 12 PM 80 kph roadways: Continuous time halo of 6 weeks for 3 PM to 7 PM

In addition, Table D-6 shows the time halo studies from the 2019 meta-analysis (Zhou et al., 2019). The results were mixed, with some studies indicating time halos of weeks or years (Beilinson et al., 2004; Talebpour et al., 2014) while others only observed halos in the days or hours after enforcement (Benekohal et al., 2009; Champness et al., 2005; Gouda & El-Basyouny, 2017).

Table D-6 Zhou et al. Time Halo Effect Studies

Study	Location	Analysis	Key Reported Halo Effect Outcomes
(Beilinson et al., 2004)	Finland	Average speed	Enforcement start: **-**1.5 to -4.4 kph **(-0.93 to -2.73 mph**) One year later: -1.1 to -3.3 kph **(-0.69 to -2.05 mph**)
(Champness et al., 2005)	New Zealand	Average speed	Change of -0.53 kph (**-0.33 mph**) two hours before vs. two hours after deployment (average speed of 100.55 kph to 100.02 kph)
(Benekohal et al., 2009)	Illinois, USA	Temporal variation of speeds (five-minute average speeds)	Time halo of **-1.8 to -2.7 mph** on free-flowing trucks one hour after enforcement ended
(Talebpour et al., 2014)	Illinois, USA	Average speeds measured for three weeks after enforcement ended	**Two-week** time halo
(Gouda & El-Basyouny, 2017)	Alberta, Canada	Time series intervention analysis that used percentages of speed limit violations	If a mobile SSC unit was deployed eight times during a week for 22 h (approximately 2.7 h per visit) at an urban location, it would produce a time halo effect that would extend for approximately **5 days** and reduce speed limit violation rates by almost 19%

Key Takeaways

The literature on the halo effect is relatively limited and inconsistent; many studies were conducted pre-2010 and are varied in their methodology and metrics. For the distance halo effect, authors generally looked at speeds or crashes at certain intervals away from the camera site, but the distances chosen and metrics analyzed varied. In general, the studies found distance halo effects of up to 2 miles, though the strongest effects were within half of a mile of the camera site. However, one study identified an increase in crashes upstream of the camera site, possibly attributable to sudden braking downstream (Shim et al., 2015). In other cases, studies showed that speeds raised beyond original speeds after vehicles passed the enforcement points (Hajbabaie et al., 2011; Pauw et al., 2014).

The time halo had similar variability, with some studies indicating time halos of weeks or years (Beilinson et al., 2004; Talebpour et al., 2014) while others only observed halos in the days or hours after enforcement (Benekohal et al., 2009; Champness et al., 2005; Gouda & El-Basyouny, 2017). It is clear that the SSC halo effect is an area where more research is needed, especially in the United States.

SSC OUTCOMES META-ANALYSES

There have been several academic meta-analysis studies that have outlined key outcomes of SSC and investigated the sample size, methodology, and relevancy of selected studies. In this chapter the results of these meta-analyses are summarized but note that the most recent meta-analysis is from 2010 and therefore do not include post 2010 papers mentioned in previous chapters.

One study (Thomas et al., 2008) employed a critical review process of 90 international papers to determine the most likely range of probable safety effects of fixed and mobile speed safety camera programs. The authors evaluated the studies based on the following seven criteria:

1. Did the study design and analysis document changes in driving speeds as well as crashes to provide a causal link between the treatment and effect (safety outcome)?
2. Did the study account for crash severity?
3. Did the study methods and analysis control for or account for changes in traffic volumes before and after the implementation?
4. Did the study design and analysis account for possible time trend effects (e.g., general trends in crashes, seasonal changes, or changes in the motoring population, vehicle fleet, weather)?
5. Did the study account for other possible confounding factors such as concurrent treatments or enforcement, changes in data measures (such as reporting thresholds), or other factors that may overlap with before and after periods?
6. Did the study examine possible crash migration caused by the treatment, either to nonenforced sections of the same roadways or to nonenforced alternate roads?
7. Did the study account for regression toward the mean (RTM)[13]?

Among the 90 studies from 16 countries that were initially identified as potential safety evaluation studies, 13 met the criteria for detailed methodological review. Four studies reported on fixed camera enforcement programs, 8 studies looked at mobile SSC, and one study looked at multiple types of enforcement. Table D-7 provides a summary of the selected studies. Table D-8 and Table D-9 provide a summary of the study results.

All of the studies, for both fixed and mobile SSC, estimated significant reductions in outcome measures of crashes or injuries at camera sites or systemwide after-program implementations.

[13] RTM describes the statistical tendency for high-crash trends to decrease toward the mean in subsequent time periods independent of any treatment. If not controlled for, RTM may explain a significant portion of observed changes, possibly resulting in an overstatement of safety improvement attributed to the treatment.

- For fixed, overt camera locations, injury crash reductions in the range of 20% to 25% appear to be a reasonable estimate.

- For mobile, overt enforcement programs, injury crash reductions in the range of 21% to 51% and all crash reductions of 9% to 18% appear to be a reasonable estimate.

- For mobile, covert enforcement programs, a 14% to 16% reduction in all crashes is estimated at treated sites and corridor-wide, respectively. System- and city-wide, reductions of 20% to 25% seem reasonable for daytime fatality and unsafe speed-related crashes.

Table D-7 Thomas et al. Meta-Analysis Studies

Reference	Location of Intervention	General Location Types	Type of Deployment	Measured Speed Effects
(Cameron et al., 1992)	Victoria, Australia	Rural and urban	Mobile	No
(Elvik, 1997)	Norway	Rural and urban	Fixed	No
(Chen et al., 2000)	British Columbia, Canada	Rural and urban	Mobile	Yes
(Tay, 2000)	Christchurch, New Zealand	Urban	Mobile	Summary trends
(Chen et al., 2002)	British Columbia	Rural	Mobile	Yes
(Christie et al., 2003)	South Wales, United Kingdom	Rural and urban	Mobile	No
(Newstead & Cameron, 2003)	Queensland, Australia	Rural and urban	Mobile	No
(Gains et al., 2004)	United Kingdom	Rural and urban	Fixed, mobile, and speed over distance	Yes
(Hess, 2004)	Cambridgeshire, United Kingdom	Rural and urban	Fixed	No
(Mountain et al., 2004)	Great Britain, United Kingdom	Rural and urban	Fixed	Yes
(ARRB Group Project Team, 2005)	New South Wales, Australia	Rural and urban	Fixed	Yes
(Cunningham et al., 2005)	Charlotte, North Carolina, United States	Urban	Mobile	Yes
(Goldenbeld & van Schagen, 2005)	Friesland Province, Netherlands	Rural	Mobile	Yes

In the tables in this report, the following color convention is used for percentages: **<0%**, **0-20%**, **20% - 40%**, **>40%**. Values recorded in other units, such as miles per hour, are bolded.

Table D-8 Thomas et al. Meta-Analysis Studies – Fixed, Conspicuous SSC Results

Study	Location	Treatment and Comparison	Key Reported Outcomes
(Elvik, 1997)	Norway	64 sections on variety of roads/speed limits. Comparison using empirical Bayes procedures and county crashes for each location to account for general trends and volumes and RTM.	Average segments of 5.2 km **−20%** injury crashes Sections conforming to crash rate and crash density warrants **−26%** injury crashes Sections not conforming to either warrant −5% injury crashes Data for only one section −12% property damage only crashes
(Gains et al., 2004)	United Kingdom	24 areas with fixed and mobile speed cameras along urban and rural roads. Simple before-after analysis	**-71%** proportion of vehicles speeding **-80%** proportion of vehicles speeding excessively (15 mph +) **-51%** fatal + serious injuries **-46%** pedestrians killed/seriously injured
(Hess, 2004)	Cambridgeshire, United Kingdom	49 sites on rural trunk roads and urban roads Time-dependent coefficients were derived using all crashes in the county (including at camera sites). These were then used to remove time-dependent components including RTM, trend, and seasonality.	Area within 250 m (if linked by road) of camera sites **−45.7%** weighted injury crashes Area within 500 m of camera sites **−41.3%** weighted injury crashes; effects higher on major roads and trunk roads Area within 1,000 m **−31.6%** weighted injury crashes Area within 2,000 m **−20.9%** weighted injury crashes
(Mountain et al., 2004)	Great Britain, United Kingdom	62 sites on 30 mph roads with reported severe speeding problems throughout country. Comparison using empirical Bayes and comparison group of national crashes and traffic flows used to account for general trends and traffic flow changes.	Within 500 m either direction **−25%** injury crashes (−20% attributed to speed/behavior changes, and −5% attributed to traffic diversion) Within 1 km either direction

Study	Location	Treatment and Comparison	Key Reported Outcomes
			−24% injury crashes (−19% attributed to changes in speed and −5% to traffic diversion)
(ARRB Group Project Team, 2005)	New South Wales, Australia	28 camera sites of 111 implemented 17 local government areas served as comparison group for 14 sites. 13 sections matched for roadway characteristics, used as comparison for 10 sites.	−19.7% all crashes **−20.1%** injury crashes **−22.8%** injury + fatal crashes **−89.8%** fatal crashes −16.9% non-injury crashes

Table D-9 Thomas et al. Meta-Analysis Studies – Mobile SSC Results

Study	Location	Treatment and Comparison	Key Reported Outcomes
		Overt	
(Tay, 2000)	Christchurch, New Zealand	24 sites in city of Christchurch. Cameras increased from 3 to 24 during the study period. Comparison group included all non speed camera zones in the city.	−9.2% reduction in all crashes **−32.3%** reduction in serious injury crashes
(Christie et al., 2003)	Queensland, Australia	101 sites; majority on 30 mph (48.3 km/h) roads; about 1/4th on higher speed roads. Matched comparison sites from neighboring police enforcement district.	Within 500 m either direction **−51%** injury crashes all roads **−51%** injury crashes 30 mph roads **−59%** injury crashes 60–70 mph roads
(Newstead & Cameron, 2003)	Queensland, Australia	1,500 high crash zones throughout state. Comparison group of sites intended to reflect effects of other enforcement programs and general trends.	Within 2-km area −17.5% all severity crashes −15.6% fatal & medically treated crashes **−21.9%** hospitalization crashes **−20.3%** no-injury crashes Also reported significant crash reductions in various categories within 2 to 4 km, and 4 to 6 km.

Study	Location	Treatment and Comparison	Key Reported Outcomes
(Cunningham et al., 2005)	North Carolina, USA	14, 35–50 mph (56–80 km/h) high volume, urban corridors. Comparison group of 11 corridors within the City (lower volume but similar crash trends).	Corridor wide: −12% all crashes
(Goldenbeld & van Schagen, 2005)	Friesland Province, Netherlands	28 segments on 50–62 mph rural single carriageway roads. Comparison group included all other rural roads in the province, approximately 5,200 km total length.	Average of 4.1-km segments **−21%** injury crashes **−21%** serious traffic casualties
		Covert	
(Cameron et al., 1992)	Victoria, Australia	54 cameras used on 60 and 100 km/h (37 and 62 mph) urban (Melbourne, 70%) and rural (30%), mostly arterial, roads. Comparison group: Comparable areas from neighboring state (New South Wales). Time series models controlled for seasonal and time trends.	Systemwide **−20.9%** daytime casualty crashes (injury and fatality) **−27.9%** in crash severity (ratio of fatal + serious injury–minor injury crashes) Citywide (Melbourne) **−21.1%** daytime casualty crashes Rural areas (Victoria) −19.5% daytime casualty crashes
(Chen et al., 2000)	British Columbia, Canada	Provincewide deployment of 30 cameras operated primarily during daytime at high crash sites or sites with perceived speeding problem. No comparison group. Time series models to control for seasonal and time-trend effects.	System (province) wide **−25%** daytime unsafe speed-related crashes −11% daytime traffic collision injured carried by ambulance −17% daytime traffic collision fatalities
(Chen et al., 2002)	British Columbia, Canada	12 radar locations along a single 22-km segment of an 80 to 90 km/h (50 or 56 mph) rural, divided highway. Empirical Bayes method with comparison group of 3 police jurisdictions in study area.	Corridor wide −16% all (police-reported) crashes At treated locations (within 1 km either direction): −14% all crashes

Study	Location	Treatment and Comparison	Key Reported Outcomes
			At non-treated inter-leaving sites along corridor (> 1 km from camera sites) −19% all crashes
(Gains et al., 2004)	United Kingdom	24 areas with fixed and mobile speed cameras along urban and rural roads. Simple before-after analysis	**-21%** proportion of vehicles speeding **-28%** proportion of vehicles speeding excessively (15 mph +) **-28%** fatal + serious injuries **-28%** pedestrians killed/seriously injured

A similar report (Wilson et al., 2010) assessed whether the use of speed cameras reduces the incidence of speeding, road traffic crashes, injuries, and deaths via a review of existing studies that met the following criteria:

- Employed a randomized controlled trial, controlled before-after study, or interrupted time series research design.
- Analyzed automated or semi-speed safety camera programs.
- Measured speeding and crash and injury outcomes.

Thirty-five studies met the criteria and were selected for further analysis. They are presented in Table D-10 and Table D-11. However, several studies just looked at police-based, manual enforcement, and these are not included in the table and discussion below. In addition, several studies were also included in the Thomas meta-analysis, including studies by (ARRB Group Project Team, 2005; Cameron et al., 1992; Chen et al., 2000, 2002; Christie et al., 2003; Cunningham et al., 2005; Elvik, 1997; Gains et al., 2004; Newstead & Cameron, 2003; Tay, 2000).

Twenty-eight studies measured the effect of speed cameras on crashes. All 28 studies found a lower number of crashes in the speed camera areas after implementation of the program. In the vicinity of camera sites:

- For all crashes, the reductions ranged from 8% to 49%, with reductions for most studies in the 14% to 25% range.
- For injury crashes, the decrease ranged between 8% to 50%.
- For crashes resulting in fatalities or serious injuries, the reductions were in the range of 11% to 44%.

For speeds:

- The reduction in average speeds ranged from 1.3km/h in New Zealand to 5.8 km/h in New South Wales, with most countries showing reductions in the 2 to 4 km/h range.
- For countries expressing speed in miles per hour, the average speed reduction ranged from 6% in the United Kingdom nationwide to 14% in Washington D.C.
- Median speeds were reported by two studies with one reporting a speed reduction of 5km/h and the other recording reductions in median speeds of 40km/h and 28 km/h in car lanes after 10 years of automated enforcement.
- An absolute reduction in the proportion of speeding vehicles over the accepted posted speed limit, ranged from 8% in Finland to 70% in New South Wales, with most of the twelve countries reporting this outcome, in the 10 to 35% range.

The studies of longer duration showed that these positive trends were either maintained or improved with time. The authors concluded that the consistency of reported reductions in speed and crash outcomes across all studies show that speed cameras are a worthwhile intervention for reducing the number of road traffic injuries and deaths. However, the magnitude of the effect cannot be accurately determined due to the heterogeneity and lack of methodological rigor in the selected studies (Wilson et al., 2010).

Table D-10 Wilson et al. Meta-Analysis Studies – Fixed SSC Results

Study	Location	Treatment and Comparison	Key Reported Outcomes
(Diamantopoulou & Corben, 2002)	Melbourne, Australia	Domain tunnel Melbourne, three-lane urban road with 80 km/h speed limit. The control was a second three-lane road upstream of the tunnel. Fixed position speed camera operating continuously.	-3.4% average speed 80km/h posted speed limit **-66%** proportion of drivers exceeding speed limit 90 km/h posted speed limit **-79%** proportion of drivers exceeding speed limit 110km/h posted speed limit **-76%** proportion of drivers exceeding speed limit -13% fatal crashes -10% serious injury crashes -7% injury crashes
(Maekinen, 1994)	Helsinki, Finland	Experimental area was a 50km length of a two-lane stretch of highway No. 1, leading west of Helsinki. Control area was Highway No 6 leading east of Helsinki. Speed limits of 80km/h and 100 km/h on study sites. 12 fixed camera poles distanced between 1.5km and 7km.	80 km/h posted speed limit -8% number of speeding vehicles 100 km/h posted speed limit -5% number of speeding vehicles
(Hess, 2004)	Cambridge, Great Britain	Progressive introduction of speed cameras from 1991 consisting of 49 overt fixed camera sites with warning signs within 1 km of camera site.	Within 250m **-46%** weighted injury crashes Within 2,000m **-21%** weighted injury crashes
(LNCS, 1997)	West London, Great Britain	A-class roads in London. Controls were comparable roads in other areas of London with no cameras over the same period. 21 fixed speed camera sites at start of project in 1992 (plus 12 red light camera sites) along 10 routes.	-12.4% all crashes **-55.7%** fatal crashes
(Hung-Leung, 2000)	Hong Kong	The experimental group was one 20 km section of highway in Hong Kong divided into 2km sections. The control group was other highway sections in Hong Kong where no speed camera enforcement took place. 10 fixed speed enforcement systems with two cameras operating continuously on a rotational basis.	**-65%** number of speeding vehicles (15 km/h or more over the speed limit) **-23%** injury crashes (compared to a 32% increase for control group) **-66%** fatal crashes (experimental group only)

Study	Location	Treatment and Comparison	Key Reported Outcomes
(Oei, 1996)	Netherlands	Four experimental and four control roads for phase 1 and phase 2 study. Phase 3 conducted in September 1994, with two 'new' control roads for crash data comparisons. Four two-lane rural road stretches in four Dutch provinces, 10-17km in length. For phase 3, one road of main study, the N266 in the province of Noord-Brabant used. Unattended fixed overt speed cameras and radar operating randomly along each of the four experimental roads from early morning until midnight.	Phase 1 **-3 km/h** (1.86 mph) reduction in average speed **-3 km/h** reduction in 85th per. speed Phase 2 **-5 km/h** (3.11 mph) reduction in average speed **-8 km/h** (4.97 mph) reduction in 85th per. speed -10% proportion of drivers exceeding speed limit **-35%** crashes as compared to control roads
(Keall et al., 2002)	New Zealand	Experimental roads were in the Midland Police Region of New Zealand, consisting of all 100km/h open roads in existing speed camera areas, 100km/h open roads generally, and 100km/h open roads with existing speed cameras plus new covert speed cameras. The comparison areas were 100km/h open roads in existing speed camera areas and in the rest of New Zealand.	**-1.3 km/h** (0.81 mph) average speed **-4.3 km/h** (2.49 mph) 85th per. speed Covert Enforcement -11% all crashes -19% injury crashes Overt Enforcement -17% all crashes **-31%** injury crashes
(Shin et al., 2009)	Arizona, USA	All motorized vehicles on a limited access freeway segment of Arizona State Route 101, running through Scottsdale, Arizona. Six fixed speed cameras at 6 stations in the enforcement zone.	**-44%** to **-55%** all crashes **-46%** to **-55%** injury crashes
(Retting, Kyrychenko, et al., 2008)	Arizona, USA	8-mile corridor of the Scottsdale Loop 101 urban freeway, by comparison to the 6.5 mile corridor which was the subject of the Arizona 2009 study.	**-5 mph** average speeds (70 mph to 65 mph) -14% proportion of drivers exceeding speed limit

Table D-11 Wilson et al. Meta-Analysis Studies – Mobile SSC Results

Study	Location	Treatment and Comparison	Key Reported Outcomes
(Agustsson, 2001)	Copenhagen, Odenseand, Svendburg; Denmark	Twenty experimental sites compared with ten control sites. Mobile speed cameras in operation two hours a day on average at varied sites.	**-2.4 km/h** (1.49 mph) average speed **-10.4%** proportion of drivers exceeding speed limit **-4.5%** proportion of drivers exceeding speed limit by 10 km/h or more **-22%** injury crashes first year **-20%** injury crashes second year
(Cairney et al., 1993)	Unley, South Australia	Ten experimental sites and two control sites. Overt mobile speed camera, random deployment to enforce a new 40 km speed limit to local residential streets.	**-5 km/h** (3.11 mph) average speed after program launch, remained the same after intensified enforcement Control sites showed no change or increases in speed
(Diamantopoulou, 2002)	Victoria, Australia	Interventions were overt patrol cars using mobile radar, covert patrol cars using mobile radar, and mixed overt/covert cars using mobile radar. Most operations were overt.	**-71.3%** injury crashes on the same day or for up to four days after enforcement was present The effect was strongest when a mix of overt/covert enforcement was in use.
(Pérez et al., 2007)	Barcelona, Spain	A 24.1 km experimental urban beltway with 3 lanes in each direction, with posted speeds of mainly 80 km/h. 8 overt cameras operated from 22 different sites. The cameras were moved randomly from site to site during the study period.	**-27%** reduction crashes and number of people injured
(Jones et al., 2008)	Norfolk, Great Britain	29 experimental mobile, overt sites consisting of a 72 km total road length, most with posted speeds of 60 mph or above. 20 experimental sites were compared with be-tween 12 and 44 control sites.	**-18%** all crashes **-44%** fatal + serious injury crashes
(Vaa, 1997)	Oslo, Norway	One experimental road divided into six sites, one control road divided into six sites. One	**-0.9 km/h** to **-4.8 km/h** (0.56 to 2.98 mph) average speed

Study	Location	Treatment and Comparison	Key Reported Outcomes
		35km long stretch of semi rural undivided two-lane road in Norway with mainly 80km/h speed limits. Five police patrols using stationary speed enforcement with observation units (mainly in unmarked hidden cars).	**-10%** reduction proportion of speeding drivers
(Retting & Farmer, 2003)	Maryland, USA	Combination of residential streets, school and work zones, and arterial roads in seven districts in Baltimore. Five speed cameras in unmarked police cars deployed twice per week at each zone between 6.00am and 10.00pm, Monday to Saturday.	-14% average speeds (compared to control) **-82%** proportion of drivers exceeding speed limit by 10 mph or more
(Retting, Farmer, et al., 2008)	Maryland, USA	Residential streets with speed limits of 35mph or less and school zones in Montgomery County were targeted for enforcement. 6 mobile cameras and 2 fixed cameras. 10 sites from 20 locations in Virginia were used as controls.	**-10%** average speed Warning signs + enforcement **-70%** proportion of speeding drivers 10 mph or more Warning signs only **-39%** reduction No warning signs or enforcement **-16%**

CMF Clearinghouse

A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The Crash Modification Factor (CMF) Clearinghouse, run by FHWA, provides a database of crash modification factors for a range of countermeasures (FHWA, 2024a). A CMF reflects the safety effect of a countermeasure, whether it is a decrease in crashes (CMF below 1.0), increase in crashes (CMF over 1.0), or no change in crashes (CMF of 1.0).

The CMF Clearinghouse lists several CMFs related to speed safety camera. Key findings are summarized in Table D-12. As evinced, SSC systems have CMFs of 0.60 to 0.95 along segments for all crashes, but do have higher CMFs for rear-end crashes when placed at intersections (FHWA, 2024a). Note that these studies were described in more detail in previous chapters.

Table D-12 CMF Clearinghouse: SSC

Countermeasure	CMF	Crash Type	Crash Severity	Area Type
Implement speed safety cameras (H. Li et al., 2020)	0.905	All	Fatal, Serious Injury, Minor Injury, Possible Injury	All
Implement mobile speed safety camera system (H. Li et al., 2020)	0.855	All	All	Urban
Install automated section speed enforcement system (Montella et al., 2015)	0.60	All	All	Urban
Install speed safety camera at signalized intersection (Izadpanah et al., 2015)	1.09	Rear End	All	Urban and Suburban
Installation of fixed combined speed and red-light cameras (De Pauw et al., 2014b)	1.57	Rear End	All	All
Installation of fixed speed cameras (Høye, 2015)	0.95	All	Fatal, Serious Injury, Minor Injury, Possible Injury	Rural

Key Takeaways

The meta-analyses show that there is a strong body of evidence that suggests that, after controlling for the quality of the studies, both SSC mobile and fixed, leads to reduce speeds and crashes at the camera site. Studies have been conducted in a variety of countries and urban classifications, as well as different types of roadways and times of the year. Most crash reduction analyses are in the vicinity of 15% to 25%, while speed reductions vary from 5% to 10%. More recent studies seem to confirm these trends.

APPENDIX E

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Background

The below review of safety effects of traditional law enforcement represented an extra task not originally scoped for this project and thus was completed by ODOT Research Staff at the direction of the research coordinator with review by the Technical Advisory Committee (TAC).

Acknowledgements

The author appreciates ODOT research colleague Josh Roll convening this work as part of SPR 873 and guiding the content to supplement the larger project. In addition to Josh, TAC members Nicole Charlson and Jiguang Jiao provided critical feedback to make this review clearer and more comprehensive. The structure and format of this review attempts to follow the strong example in this project from Sophia Semensky, Miguel Figliozzi, and team.

10.1 REVIEW OF TRADITIONAL SPEED ENFORCEMENT ON SAFETY

Speed control by uniformed officers using vehicle and motorcycle to enforce posted speed limits is a traditional approach used to improve safety that can be compared with newer, automated approaches. This brief review of the efficacy of traditional law enforcement approaches relies on topical searches of Google Scholar to identify candidate studies, and includes studies cited within those studies. Studies chosen for inclusion in this review prioritized a clear real-world enforcement intervention, and quantifiable results in either speed or crash outcomes. Studies that relied on subjective perceptions or contexts that may not be applicable to Oregon were excluded.

Studies employ a variety of methods, geographies, and time periods, which explains some of the variation in results. Figure 1 illustrates a general logic model of the most common, measurable components in traffic enforcement and safety outcomes.

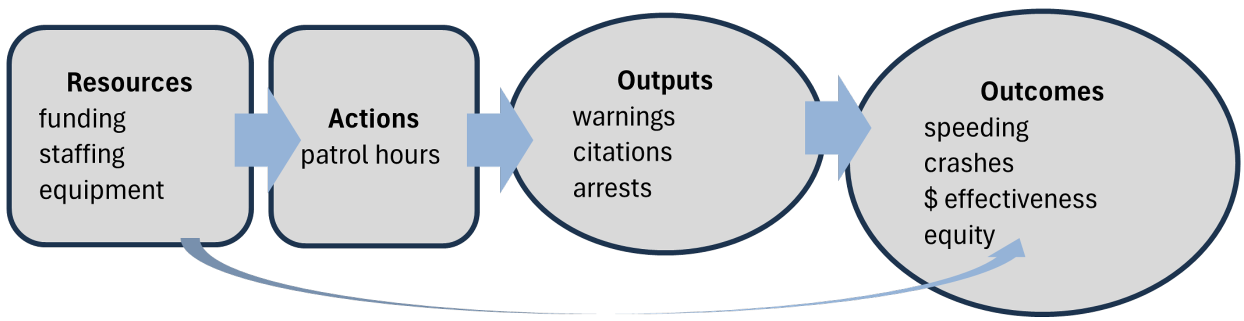

Figure E.1: Generalized logic model of the impact of speed enforcement on safety. Some studies directly link enforcement outputs to safety outcomes, while others rely on another causal chain.

Overall, research to date shows that traditional law enforcement can be an effective intervention to control speeding and can mitigate crash risk, yet studies do not comprehensively show how to maximize law enforcement effectiveness.

This review begins with a focus on speeding rates, then overall crash outcomes, cost effectiveness, and finally spatial and equity impacts of traditional speed enforcement.

10.1.1 Speed Outcomes of Traditional Speed Enforcement

Increases in traditional speed enforcement are associated with between a 1% and 12% decrease in speeding behaviors but are limited in time and space of the enforcement. Drivers appear to respond to increased enforcement in contexts where they perceive a greater risk of being ticketed, but that behavior rarely extends past the times and places where they expect traditional law enforcement to be present.

Speed feedback signs can provide individualized guidance on driver speed, and can be located in problem areas to supplement traditional enforcement. Speeding observations in a 1976 study in North Carolina showed that a series of interventions, including a speed check zone, a parked patrol car, and a simulated speed enforcement scene all reduced speeding significantly, but speeds returned within 1,000 feet to 2 miles downstream, described as a distance halo effect (Dart and Hunter, 1976). [14] The research team found no significant impact when deploying a visual speed indicator such as speed reader board that detected speeding and displayed the words SLOW DOWN. However, more recent research with new, dynamic speed feedback signs are showing impact. Dynamic speed feedback signs positioned at five sites transitioning from a high-speed context to low-speed resulted in different impacts depending on the initial driver speed (Shakir Mahmud et al., 2023). At these signs, faster drivers slowed down by 1.2 to 3.0 mph more than average drivers. Though not necessarily a traditional traffic enforcement technique, dynamic signs may be an effective support to reduce driver speeding behaviors.

A comparison of increased traffic enforcement in a semirural, agricultural area outside of Oslo, Norway found a 10-11% decrease in speeding during night-time, but only a 4% decrease during the day (Vaa, 1997). Some speed reductions persisted as long as eight weeks, though a two-week time halo effect was found in most interventions. This study showed a reduction in speeds in both 60 and 80 km/h speed zones across all time periods except morning rush hours of 6-9 am suggesting morning Oslo commuters may be the most resistant to traditional speed enforcement methods. Though this isolated experiment in Norway showed traditional traffic enforcement reduced speeding except during the morning commute, impacts in Oregon may be better understood with local evidence.

An Oregon-specific natural experiment measured the impacts of state budget cuts from House Bill 5100 in 2003, which reduced Oregon State Police troopers by 35% (DeAngelo & Hansen, 2014). This study isolated the causal effect using difference-in-difference ordinary least squares and Poisson regression with counterfactual analysis, in addition to comparison with three control groups: national without Oregon, Washington and Idaho, and a synthetic group. The layoff caused a 26% decrease in traffic citations and a 1% increase in average freeway speeds from automatic recorders. The authors suggest the actual speed change may be higher, since the speed recorders were located near urban areas. The average speed of citations following layoffs increased from 19.5 to 20 mph over the speed limit (2.6%). This Oregon study shows that traditional enforcement methods can reduce overall freeway traffic speeds.

Monitoring speed violators over time suggests the type of court judgement may have a role in subsequent speeding citations and crashes. A study in Maryland (J. Li et al., 2011) showed that drivers placed on probation had a significantly lower risk of subsequent speeding ticket with an adjusted proportional hazard ratio (AHR) of 0.83, compared with drivers issued fines and points which resulted in an AHR of 0.93. A hazard ratio of less than one indicates the risk of an event is lower in a treatment group than the control group (in this case, a not-guilty verdict). In this study, AHR compared drivers appearing in court for speeding but found not guilty with those receiving other verdicts, while controlling for demographic and driving history covariates. This

[14] The “halo effect” in traffic enforcement refers to the duration or distance of effect after police are no longer present. The term has a slightly different meaning in psychology, which is a cognitive bias that transfers a positive impression of something to a different person or product (Neugaard, 2024). The origin of the halo effect is attributed to a circa 1920 study by Edward L. Thorndike, who found that when commanding officers highly ranked servicemen in intelligence and service without speaking to them, there was a high correlation among taller and more attractive servicemembers. This halo effect is when people generalize an outstanding trait about a person to other, unobserved characteristics.

finding suggests that a probation judgement may result in a 17% decrease in speeding behaviors, as compared with a not guilty judgement. Also, the study showed that drivers younger than 21 were at least twice as likely to have a repeated speeding violation or crash, compared with those 50 and older. Overall, this study showed that probation before judgment "was associated with significantly fewer repeat speeding tickets and a non-significant decrease in crashes," showing that judicial process—not just enforcement—is an important process in deterring dangerous driving.

The National Highway Traffic Safety Administration (NHTSA) finds that high-visibility enforcement can be highly effective in managing speed in high-crash or high-violation areas (NHTSA, n.d.). The evidence used to demonstrate the impact is limited, however. NHTSA uses the example of Vision Zero SF resulting in 1,800 speeding violations issued on target corridors in San Francisco, California reducing speed by about 5% during enforcement, with speeds climbing back only one week after concluding the intervention.

Traditional traffic enforcement can effectively reduce speeding on the targeted corridors, but is subject to fading effects over time and space. Drivers speed back up after leaving areas they deem as a higher risk for receiving a speeding ticket. These studies show little benefit of signage interventions or related messaging campaigns. Probation judgements for speeding violations may be more effective at reducing repeated speeding than fines, suggesting traffic law enforcement may improve safety outcomes when planned in concert with judicial processes. The notion behind effectiveness of probation judgements is that offending drivers must remember to self-control their driving in order to avoid a larger penalty. Though this approach requires an up-front funding commitment from an agency that may not be recovered through fines, probation judgements may be more effective in reducing speed and crashes than simple citations and fines.

10.1.2 Crash Outcomes of Traditional Speed Enforcement

Similar to speeding, increases in traditional enforcement is associated with a decrease in crash rates overall at sub-state geographic levels, but there is no evidence of impact statewide. In a meta-analysis of 13 previous studies that included a mix of all crashes and injury crashes, Elvik (2012) estimated a crash modification function curve showing that doubling enforcement efforts in an area may reduce crashes by 20%, as compared with baseline levels. The relative impact of increased enforcement decreases based on those results, estimating a 40% reduction with a fourfold increase in enforcement, and as much as 50% fewer crashes with six times the regular enforcement levels. The individual studies in this meta-analysis showed inconsistent effects, but a dose-response pattern emerged when results of all 13 studies were pooled. Most of the studies included in Elvik's meta-analysis were from Europe and Australia, and those from the U.S. were quite old (1968 and 1973). Also, none of them focused on fatal crashes as the dependent variable. Hence, more recent work from the U.S. could be more representative for this context.

A 2021 study found that "traffic stops do not prevent traffic deaths" (Sarode et al., 2021). This panel analysis of 33 state patrols in the United States showed no significant relationship between the number of police traffic stops and motor vehicle traffic deaths at the state level, looking at the years 2004 through 2016. The authors claim that their state-level analysis could possibly correct for variation in local police reporting. Sarode and colleagues also performed sub-analyses of the data by race, and looked at police warnings, citations, and arrests, also finding no significant association with traffic fatalities. Though not mentioned by Sarode and colleagues, the temporal pooling of data by year could remove a halo effect of traffic enforcement. Taken together, these aggregate studies suggest enforcement can support traffic safety, but impacts vary over time and space.

The natural experiment of Oregon's mass layoff of troopers from budget cuts caused a significant increase in crashes (DeAngelo & Hansen, 2014). Compared to other studies that associate general relationships, this study makes causal claims due to their difference-in-difference approach of comparing the changes in Oregon with the pre-layoff period, with comparison geographies and counterfactual factors. Laying off 35% of state troopers increased crashes and resulting fatalities (19%), incapacitating injuries (14%), and visible injuries (12%). The authors conclude that in situations where states reduce traffic enforcement budgets, increased injuries and fatalities can be expected, though increased punishments may offset the reduction.

Fayetteville, North Carolina developed an increased traffic stop intervention that also emphasized avoiding over-representation of Black residents in stops (Fliss et al., 2020). This study compared eight similar North Carolina agencies to Fayetteville's results, providing a municipal analysis suitable for mid-sized cities in similar contexts. Analysis of pre-and-post intervention traffic enforcement data showed a 121% increase in traffic stops leading to a 28% reduction in traffic fatalities and a 23% injury reduction (Fliss et al., 2020). A 7% reduction in traffic stops of Black residents constituted a 21% reduction in Black vs. white stop rate ratio. Further, the study showed de-prioritizing investigatory stops was not associated with an increase in non-traffic crime. Therefore, the Fayetteville intervention of re-prioritizing traffic stop types to a safety orientation improved crash injury consequences and racial disparity of enforcement, with little to no impact on non-traffic crime.

One study from Massachusetts did find a direct, positive link between citations and crash data (Makowsky & Stratmann, 2011). By looking at municipalities experiencing budget crunches, they surmised that cash-strapped towns that increased citations per municipality by 100, resulted in a reduction of crashes between 4 and 16.2 during the same time periods, depending on modeling approach. This finding adds knowledge from the Oregon study of reducing a police force in response to budgeting, that holding enforcement constant while increasing citations can have a positive safety effect. Similar to other studies, this study in Massachusetts may not be directly transferrable to other contexts, and did not include large cities (mean population 18,000). The methodological implication for other studies pointed out by Makowsy and Stratmann is that by failing to include citations or other unobserved variables, previous studies suffer from endogeneity bias.

A meta-analysis of 35 previous studies showed that the most effective crash reduction outcome from traffic violations is license suspension and revocation (17% reduction), followed by other interventions such as individual (8% reduction) and group meetings (5% reduction), and warning letters (Masten & Peck, 2004). Most of these programs were administered by drivers license agencies, but some are initiated by courts. Quasi-experimental evaluations of California's traffic violator school (TVS) in the early 1990's found that "any positive effects of TVS programs are cancelled out by the detrimental effects of the traffic violation dismissal policy, leading to a net increase in crashes" (Masten & Peck, 2004, p. 414). The authors noted limits to how clearly their findings should be translated to policy, but did recommend using warning letters “at a very early point count,” and “license suspension should be triggered as soon as is legally feasible” since they are by far the most effective countermeasure(2004, p. 415) . Notably, educational material such as brochures had no significant impact on crash rates.

Evidence from Ontario, Canada shows that traffic violations can reduce the risk of being involved in a fatal crash, but only for a short time. Case-crossover analysis showed that drivers who received violations did reduce their risk of a fatal crash in the month following the conviction by more than a third, but the impact was insignificant after only 3-4 months (Redelmeier et al., 2003). Another Canadian study (Blais & Gagné, 2010) showed that reducing citations by 61% during a 21-month period was associated with a 3% increase in injury crashes within Quebec City, and just over 1% across the Quebec province.

Traditional traffic enforcement has an important role in reducing vehicle crashes, but those impacts are also limited to the time and location of the police involvement. This challenge leaves cost effectiveness an important issue, to optimize the location, time, and intensity of enforcement to reduce speeding and crashes.

10.1.3 Cost Effectiveness of Traditional vs. Automated Speed Enforcement

Law enforcement comes with substantial costs to public agency budgets though NHTSA provides some grant funds specifically for this purpose. Several studies, particularly in larger US cities, have addressed how effective traffic law enforcement is, while taking account of the costs.

Donald Shoup provided one of the earliest studies of law enforcement effectiveness in Los Angeles (Shoup, 1973). Eight different experimental patrols were tested, resulting in the warnings-only patrol having greatest impact on safety with the least cost. After normalizing costs of increasing patrols, benefits of reductions in crashes and crime, increases in concentrated traffic enforcement in a small area were not financially justified. However, Shoup noted a lack of calculated benefit in reduced travel time related to enforcement could not be calculated, and so the overall picture may be incomplete. In the half-century since this study’s publication, it has been cited only 18 times, with no direct follow-up or update of the methods.

A case study in New York City of 140 automated speed cameras suggests this intervention can save substantial money and lives (S. Li et al., 2019). Compared with no speed cameras, the authors find quality-adjusted life years (QALYs) increase by 0.00044 units and reduce costs by $70 over the life of an average resident. If the number of cameras were more than doubled to 300, the study shows a doubling of their life-saving impacts and cost reduction, saving “7000 QALYs and US$1.2 billion over the lifetime of the current cohort of New Yorkers.”

Vision Zero SF reported funding of the intervention came through a grant from the California Active Transportation Program (cost unreported), and noted the lack of lasting effect as a reason for “regular, sustained enforcement to achieve lower vehicle speeds” (Vision Zero SF, 2019). The brief speed reductions despite an on-site and generalized marketing campaign and 1,800 traffic citations issued to drivers suggests that this combination of high-visibility enforcement was not sustainably effective.

Studies outside the US may have limited usefulness in a modern American context. Nonetheless, a Norwegian study found that existing enforcement levels of 12.26 citations per million kilometers driven in the early 2000s were sufficient to deter drinking and driving and non-use of seat belts, but that increased enforcement is needed and likely cost-effective to deter speeding in the country (Elvik et al., 2012). In Uganda, deploying four squads of new traffic patrols cost around $72,000 per year, while increased citations exceeded the cost by four times, in addition to resulting in a 17% reduction in traffic fatalities (Bishai et al., 2008). Social norms and enforcement laws vary in Norway and Uganda, limiting generalizability in the US.

The limited breadth of studies on cost effectiveness suggests that communities adjust enforcement levels based on a variety of policing roles, which can include traffic enforcement, but that enforcement's effectiveness is dependent on duration and space of police action. Initial findings from New York City's automated speed enforcement show positive benefits and scalability with reasonable costs. Effectiveness of in-person traffic enforcement fades as resources are moved within a jurisdiction, while an always-on automated system does not have the same impacts of a time halo that reduces impact after police leave.

10.1.4 Spatial and Equity Impacts of Traditional Speed Enforcement

Traffic enforcement impacts communities beyond the time and place of intervention. A time halo effect refers to the duration of enforcement's influence on driver behavior after the enforcement activity is concluded. The distance, or spatial halo effect concerns the impact of enforcement on driver behavior outside of the immediate traffic enforcement area.

An early study of the spatial halo effect showed that while enforcement greatly decreased speeding in the immediate area of intervention, the halo effect only reached a 1,000 feet beyond the enforcement treatment and was complexly absent 2 miles further (Dart & Hunter, 1976).

Recent research on racial discrimination of traditional versus automated traffic enforcement in Chicago (IL) shows that automated systems can be less discriminatory than police stops (Xu et al., 2024). This finding supports previous research, including other studies showing that despite white drivers being more likely to be found carrying contraband (Pierson et al., 2020), Hispanic and Black people are more frequently stopped and frisked (Gelman et al., 2007), and nationwide analysis shows the criteria for searching Hispanic and Black drivers was lower than white drivers (Pierson et al., 2020).

The Fayetteville enforcement intervention (Fliss et al., 2020) showed that traffic enforcement priorities impact racial equity, which may not be related to overall crash risks. New policing approaches that incorporate an anti-racist approach to enforcement can succeed in reducing crash risks without disparate impacts on residents by race.

Considering spatial halo effects and equity implications together suggests challenges in achieving long-term traffic safety impacts while promoting equity. Rotating the locations of traffic enforcement may help maintain a deterrent to speeding, but the practice could also result in over-policing some communities more than others without careful monitoring and evaluation.

10.1.5 Significant Findings and Remaining Gaps on Traffic Enforcement Efficacy

While this review is not comprehensive, several findings persist across the questions around the speed and safety impacts of traffic enforcement. First, traditional traffic enforcement alone, even when combined with messaging efforts, creates only temporary reductions in speed and crashes. Police forces must continually rotate and re-target their efforts on high-incident locations to achieve benefits, while other areas can become new hot spots for speeding and crashes.

High visibility campaigns show little to no results by themselves as traffic interventions, though dynamic speed feedback signs show promising results in some contexts (Shakir Mahmud et al., 2023). The only studies in this brief review that showed benefits from campaigns with messaging components did so when combined with aggressive traffic enforcement. Many of the studies observe impacts only in the time and place of the intervention, but more research is needed on how long benefits persist.

Scientific studies focus on a certain place and time and cannot be generalized to all contexts. Halo effects of time and space for traffic enforcement are persistent. Throughout decades and across continents, drivers change their behavior only near active traffic enforcement, and only for a few days or weeks afterwards. Sensitivity analyses are needed for the spatial and temporal impact of traffic enforcement on safety outcomes. Research methods also need to be sensitive to spatial effects, such as the modifiable area unit problem (where geographic record boundaries mismatch the phenomena), and spatial autocorrelation (where nearby measurements influence one another through proximity rather than change in the variable of interest). A related challenge is the *streetlight effect*, defined as: "where knowledge of past discoveries leads agents to narrow search for reasons of data availability rather than adopt a wider search aperture based on reasons of market size or policy importance" (Hoelzemann et al., 2024, p. 2). Referring to Figure 1, few studies include variables on patrol hours or citations as predictors of safety outcomes, perhaps because of the lack of readily available data. More studies of traffic enforcement in a variety of geographies, time periods, and using causal data and methods are needed to support critical policy decisions in a breadth of contexts.

Cost effectiveness of programs remains a significant gap in our knowledge, despite the first significant study on the topic in 1973. Despite the intuitive value of cost effectiveness, the difficulty of linking budgets to patrol volume and outcomes may hamper updated knowledge on the value and impacts of traffic enforcement.

Studies on advanced driver assistance systems (ADAS), such as adaptive cruise control, intelligent speed assistance, and connected vehicle technology are needed to determine whether these technologies can reduce speeding and crash frequency and severity in different contexts, including their impacts on roadway users outside the vehicles. This topic is emerging and largely unstudied in real-world contexts, since ten out of fourteen ADAS features exist in over half of new vehicles released in 2023 (MITRE, 2024). Similarly, evolving technologies like vehicle telematics could influence drivers through insurance rates and other price signals to improve safety outcomes. Autonomous driving features may eventually lead to reduced speeding, once mature, but some theorize at SAE levels 3 and 4 may lead to increased driver distraction and crash risk. All these advancements will result in uneven impacts on communities, with high costs of new features delaying on-vehicle safety improvements in poorer communities. Additional research on these topics could improve safety and equity outcomes and resulting policies.

Table 2-1. Speed and Crash Outcomes Summary: Traditional Speed Enforcement

Study	Site	Characteristics	Method	Speed Results	Crash Results
(Blais & Gagné, 2010)	Quebec	61% reduction of traffic citations in a 21-month period	Describe statistics and time-series analyses	n/a	Collisions with injuries increased **3.73%** in Quebec City, and by **1.56%** throughout the Quebec province.
(Dart & Hunter, 1976)	North Carolina highway 55	Two-lane rural roadway	Analysis of variance between control, a visual speed indicator sign, a speed enforcement scene, a parked patrol car, and a speed check zone	Approximately **10-12%** reduction in speeds from all enforcement treatments, returning between 1,000 feet and 2 miles downstream. Visual speed indicator had no significant effect.	n/a
(Elvik, 2012)	Varied	Varied	Meta-analysis of 13 studies to estimate accident modification functions	n/a	**20%** reduction in crashes plausible with a doubling of enforcement from the baseline. **50%** reduction in crashes may be possible with a 6X increase in enforcement.
(DeAngelo & Hansen, 2014)	Oregon	Mass layoff reduces Oregon State Police troopers by 35% in 2003, and a 26% decrease in traffic citations	Natural quasi-experiment using difference in differences	**1%** in average highway speeds after layoff	**14%** increase in incapacitating injuries, **12%** increase in visible injuries, and **19%** increase in fatalities after layoff

Study	Site	Characteristics	Method	Speed Results	Crash Results
(Fliss et al., 2020)	Fayetteville, North Carolina	Increased traffic safety stops near high-crash intersections, while halting searches over-representing Black residents	Multivariate examination of intervention effects	n/a	**28%** reduction in fatalities, **23%** reduction of injuries
(J. Li et al., 2011)	Maryland	Non-commercial drivers settling a speed citation	Longitudinal analysis of the effect of different court rulings on subsequent speeding and crashes	suspension of prosecution/no prosecution judgements or probation before judgment led to reduced repeat speeding tickets	Suspension of prosecution/no prosecution judgements led to a decrease in subsequent crashes
(Makowsky & Stratmann, 2011)	Massachusetts	Municipalities experiencing budget shortfalls that increased traffic citations	Panel data incorporating city budgets, traffic citations, and crashes	n/a	Municipalities that increase citations by 100 implies between 4 and 12.7 fewer injury crashes, but effect on fatalities is inconclusive.
(Masten & Peck, 2004)	Varied	Varied	Meta-analysis of 35 studies	n/a	License suspension was most effective at reducing crashes (dw = 0.11)
(Redelmeier et al., 2003)	Ontario, Canada	licensed drivers involved in fatal crashes over previous 11 years	Case-crossover	n/a	**35%** reduction in a fatal crash the month after a traffic conviction, lessened in two months, and not significant by 3-4 months

Study	Site	Characteristics	Method	Speed Results	Crash Results
(Sarode et al., 2021)	United States	33 state patrols; traffic stops and motor vehicle fatality data	Univariate panel analysis	n/a	No significant association between police traffic stops and motorized vehicle crash deaths at the state level, nor disaggregated by race.
(Shoup, 1973)	Los Angeles, California	Urban drivers	Comparison of 8 experimental traffic enforcement patrols	n/a	Up to 19% reduction in injury accidents in beats with 4 officers added.
(Vaa, 1997)	Semi-rural Norway	6-week enforcement intervention in 60-80 kph speed zones	Comparison of increased enforcement vs. control roadway	10-11% reduction in speeding drivers during night-time, but only 4% reduction during day	n/a
(Vision Zero SF, 2019)	San Francisco, California	Increased speeding enforcement with variable-message signs, targeted media and local education initiatives	Descriptive statistics from interventions	4.6% reduction in mean speed the day of the event 3.8% reduction in mean speed one week after the event, but none later	n/a

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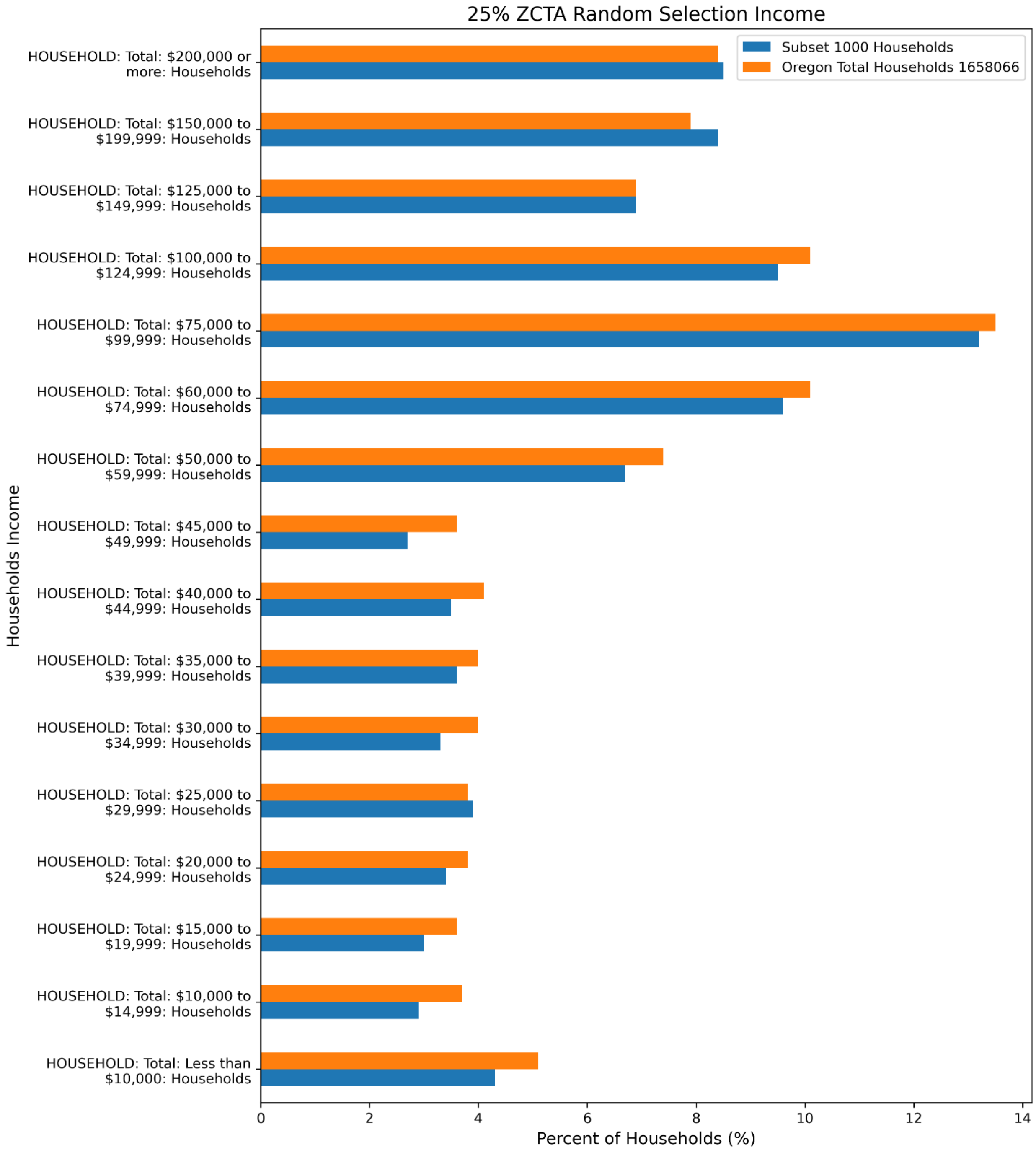

Figure E.2: Random Population Selection Subset vs. Oregon Total Population Income

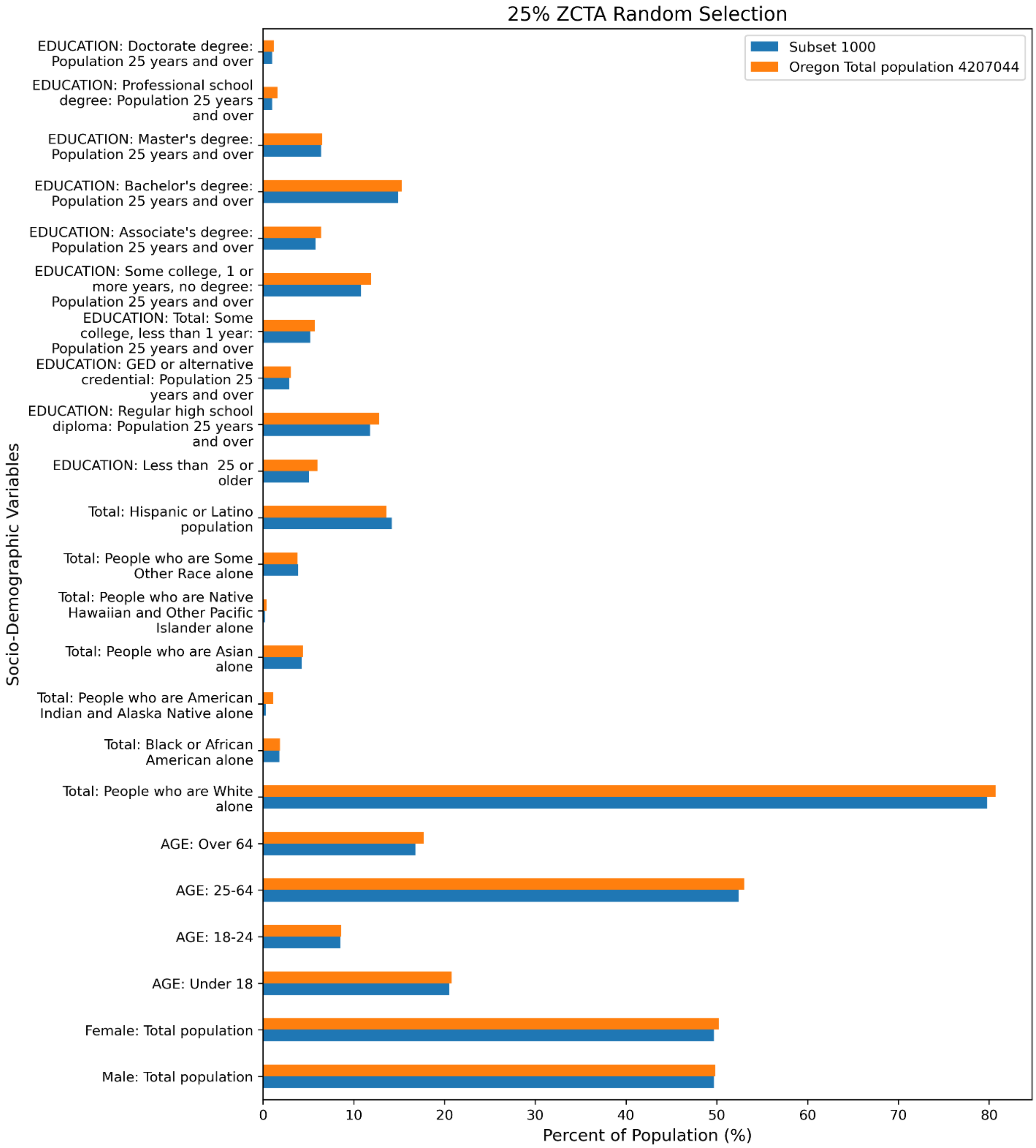

Figure E.3: Random Population Selection Subset vs. Oregon Total Population Socio-Demographics

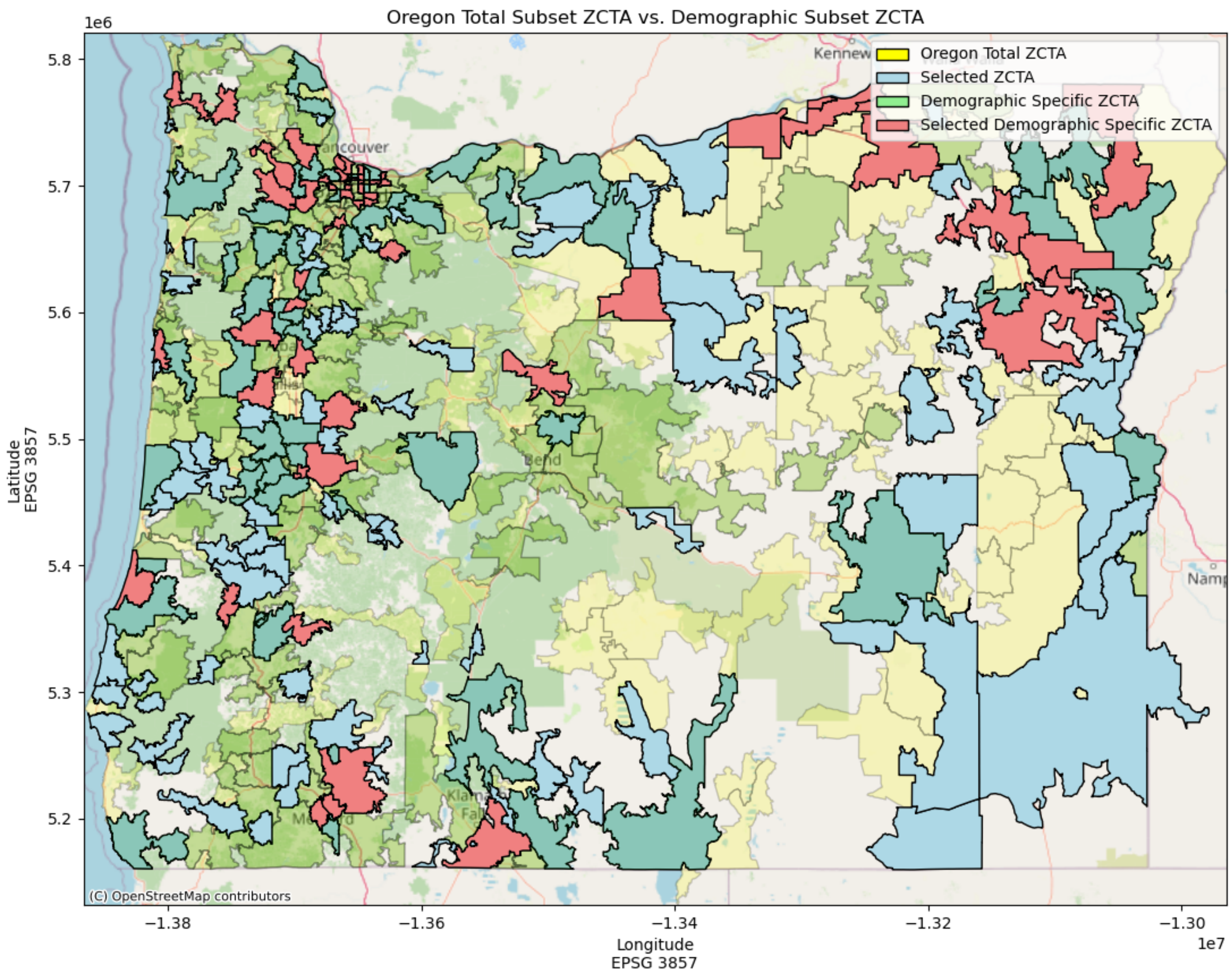

Figure E.4: Combined Oregon Total ZCTA vs. Demographics Subset ZCTA