OREGON VULNERABLE ROAD USERS SAFETY ASSESSMENT

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Oregon Department of Transportation

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TABLE OF CONTENTS

TABLE OF CONTENTS iii
LIST OF FIGURES v
LIST OF TABLES v
LIST OF ACRONYMS vii
1. INTRODUCTION AND BACKGROUND 1
1.1 WHAT DOES VULNERABLE ROAD USER SAFETY MEAN? 1
1.2 VULNERABLE ROAD USERS IN THE UNITED STATES AND IN OREGON 2
1.3 EQUITY AND VULNERABLE ROAD USER SAFETY 5
1.4 SAFE SYSTEM APPROACH CONSIDERATIONS 5
1.5 SAFETY AS A PUBLIC HEALTH ISSUE 8
1.6 COORDINATION WITH OTHER OREGON TRANSPORTATION EFFORTS 9
2. VULNERABLE ROAD USER SAFETY PERFORMANCE 13
2.1 VULNERABLE USER HISTORICAL CRASH TRENDS 13
2.2 CRASH TRENDS - SAFER PEOPLE 14
2.2.A CONTRIBUTING FACTORS BASED ON CRASH REPORTS 14
2.2.B OVERREPRESENTATION BY THE SOCIAL EQUITY INDEX 17
2.2.C OVERREPRESENTATION BY RACE AND ETHNICITY 19
2.3 CRASH TRENDS - SAFER ROADS 20
2.3.A INTERSECTIONS AND SEGMENTS 20
2.3.B LIGHTING CONDITIONS 20
2.4 CRASH TRENDS - SAFER SPEEDS 21
2.5 CRASH TRENDS – SAFER VEHICLES 24
2.6 CRASH TRENDS - POST CRASH CARE 25
3. SELECTING HIGH-RISK AREAS 26
3.1 DEFINITIONS 26
3.2 IDENTIFYING OVERREPRESENTED RISK FACTORS 26
3.3 CONSIDERATIONS DURING METHODOLOGY DEVELOPMENT 29
3.4 HIGH-RISK AREA SCORING 30
3.5 VULNERABLE ROAD USER HIGH-RISK AREAS 32
4. SUMMARY OF CONSULTATION 35

4.1 SAFETY CONFERENCE EVENT, MARCH 2023 36
4.2 PARTNERS WORKSHOP, JUNE 2023 36
4.3 TRIBAL ENGAGEMENT, AUGUST 2023 38
4.4 OREGON BICYCLE AND PEDESTRIAN ADVISORY COMMITTEE CONSULTATION 39
5. PROGRAM OF STRATEGIES 40
5.1 SAFER PEOPLE 41
5.2 SAFER ROADS 42
5.3 SAFER SPEEDS 44
5.4 SAFER VEHICLES 45
5.5 POST-CRASH CARE 46
6. CHALLENGES AND NEXT STEPS 47
6.1 VRU ASSESSMENT DATA CHALLENGES AND NEXT STEPS 47
6.2 OUTREACH AND COLLABORATION CHALLENGES AND NEXT STEPS 48
6.3 IMPLEMENTATION, MONITORING, AND EVALUATION 48
7. CONCLUSION 49

LIST OF FIGURES

Figure 1: OREGON VULNERABLE ROAD USER FATALITIES, 2012-2021 3

Figure 2: OREGON VULNERABLE ROAD USER FATALITIES AND SERIOUS INJURIES BY ROADWAY TYPE, 2017-2021 3

Figure 3: SAFE SYSTEM APPROACH WHEEL (USDOT) 6

Figure 4: TRANSPORTATION SAFETY PYRAMID 9

Figure 5: INTEGRATED TRANSPORTATION PLANNING 10

Figure 6: PEDESTRIAN AND BICYCLIST FATALITIES AND SERIOUS INJURIES, OREGON, 2017-2021 13

Figure 7: VRU EQUITY OVERREPRESENTATION 17

Figure 8: PEDESTRIAN OVERREPRESENTATION ANALYSIS BY SOCIAL EQUITY INDEX 18

Figure 9: BICYCLE OVERREPRESENTATION ANALYSIS BY SOCIAL EQUITY INDEX 18

Figure 10: RISK OF PEDESTRIAN-VEHICLE FATALITY BY VEHICLE OPERATING SPEED AND PEDESTRIAN AGE 21

Figure 11: RISK OF SEVERE INJURY OR DEATH BY VEHICLE TYPE 22

Figure 12: PROPORTION OF VULNERABLE ROAD USER CRASHES BY INJURY SEVERITY AND POSTED SPEED LIMIT, OREGON, 2017-2021 23

Figure 13: VEHICLE SALES BY BODY TYPE, 1990-2022 24

Figure 14. MEDIAN RESPONSE TIME BY ODOT REGION 25

Figure 15. MEDIAN TRANSPORT TIME BY ODOT REGION 25

Figure 16: OREGON VRU RISK SCORE, PEDESTRIANS, STATE HIGHWAYS, STATEWIDE 32

Figure 17: OREGON VRU RISK SCORE, BICYCLISTS, NON-STATE HIGHWAYS, ODOT REGION 2 33

LIST OF TABLES

Table 1: PRIMARY CONTRIBUTING FACTORS IN VULNERABLE USER FATALIES & SERIOUS INJURIES 15

Table 2: PROPORTION OF FATAL AND SERIOUS INJURY CRASHES THAT INVOLVE A VULNERABLE ROAD USER AND REPORT DISTRACTION 16

Table 3: PROPORTION OF FATAL AND SERIOUS INJURY CRASHES THAT INVOLVE A VULNERABLE ROAD USER AND REPORT IMPAIRMENT 16

Table 4: VULNERABLE ROAD USER FATALITIES BY RACE AND ETHNICITY 19

Table 5: VULNERABLE USER FATALITIES AND SERIOUS INJURIES BY LOCATION TYPE 20

Table 6: OREGON VULNERABLE USER FATALITIES AND SERIOUS INJURIES BY LIGHTING CONDITION 20

Table 7: VULNERABLE ROAD USERS RISK FACTORS 28

Table 8: JURISDICTIONS WITH GREATEST MILEAGE OF HIGH-RISK AREAS FOR PEDESTRIANS, STATE HIGHWAYS 34

Table 9: JURISDICTIONS WITH GREATEST MILEAGE OF HIGH-RISK AREAS FOR PEDESTRIANS, NON-STATE HIGHWAYS 34

Table 10: JURISDICTIONS WITH GREATEST MILEAGE OF HIGH-RISK AREAS FOR BICYCLISTS, STATE HIGHWAYS 34

Table 11: JURISDICTIONS WITH GREATEST MILEAGE OF HIGH-RISK AREAS FOR BICYCLISTS, STATE HIGHWAYS 35

LIST OF ACRONYMS

AADT	Annual Average Daily Traffic
ACS	American Community Survey
ADA	Americans with Disabilities Act
ADAS	Advanced Driver Assistance System
ARTS	All Roads Transportation Safety Program
BIPOC	Black, Indigenous, and People of Color
BPRR	Bicycle-Pedestrian Risk Rating
CEI	Cost Effectiveness Index
CRF	Crash Reduction Factor
DMV	Driver and Motor Vehicle Services
DOT	Department of Transportation
EMS	Emergency Medical Services
F	Fatal
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
GHG	Greenhouse Gases
HSIP	Highway Safety Improvement Program
NACTO	National Association of City Transportation Officials
NCAP	New Car Assessment Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NRSS	National Roadway Safety Strategy
OBPAC	Oregon Bicycle and Pedestrian Advisory Committee
OBPP	Oregon Bicycle and Pedestrian Plan
OBPSIP	Oregon Bicycle and Pedestrian Safety Implementation Plan
ODOT	Oregon Department of Transportation
OHA	Oregon Health Authority
OHP	Oregon Highway Plan
OPTP	Oregon Public Transportation Plan
OR-NEMSIS	Oregon Emergency Medical Services Information System
OTOP	Oregon Transportation Options Plan
OTP	Oregon Transportation Plan
SAP	Strategic Action Plan
SEI	Social Equity Index
SHSP	Strategic Highway Safety Plan
SI	Serious Injury
SSA	Safe System Approach
STS	Oregon Statewide Transportation Strategy
TSAP	Transportation Safety Action Plan
USDOT	US Department of Transportation
VMT	Vehicle Miles Traveled
VRU	Vulnerable Road User
VRU SA	Vulnerable Road User Safety Assessment

1. INTRODUCTION AND BACKGROUND

All States are required to develop a Vulnerable Road Users Safety Assessment (VRU SA) as part of their Highway Safety Improvement Program (HSIP) in accordance with 23 U.S.C. 148(l). The initial VRU SA must be included in its Strategic Highway Safety Plan (SHSP) or provided as a separate document (addendum) from the existing SHSP. Oregon's Transportation Safety Action Plan (TSAP) serves as the state's SHSP, and the 2023 VRU SA is considered an addendum to the 2021 TSAP.

The VRU SA is an assessment of the safety performance with respect to vulnerable road users and outlines the state's current and upcoming efforts to improve the safety of vulnerable road users in accordance with federal law. It must be data-driven, incorporate the Safe System Approach (SSA), and comply with guidance issued by the Federal Highway Administration (FHWA). FHWA expects State and local governments to use the VRU Safety Assessment findings and recommendations to adjust project selection criteria and make other changes to guide investments to improve the safety of vulnerable road users. The VRU SA updates and builds upon the vulnerable user actions identified in the 2021 Oregon TSAP and safety goal and objectives of the 2023 Oregon Transportation Plan (OTP). The VRU SA will continue to be revised with each update of the TSAP.

Oregon's VRU SA describes the current state of safety for people walking and bicycling in the state and assesses the safety in high-risk areas by considering crash history and risk factors associated with an increase in crashes. It encourages safety partners and the public to implement a program of projects or strategies – based on the Safe System Approach – to reduce the frequency and severity of crashes involving vulnerable road users.

1.1 WHAT DOES VULNERABLE ROAD USER SAFETY MEAN?

The term "vulnerable road user" (VRU) is used to describe a person who is unprotected by an outside shield like a car or truck when they are traveling. They are considered "vulnerable" because they have a greater risk of injury in any crash with a vehicle and therefore need protection against such crashes through safer system designs. Vulnerable road users can include (but are not limited to): a pedestrian; a roadway worker[1]; a person operating a wheelchair or other personal mobility device, whether motorized or not; a person operating an electric scooter or similar; and a person operating a bicycle or other nonmotorized means of transportation.[2]

[1] https://www.oregon.gov/odot/safety/pages/work-zone.aspx

[2] Position/Policy Statement: Vulnerable Road Users, National Safety Council, 2018. https://www.nsc.org/getattachment/d5babee6-582d-4e66-804f-8d06f9b021a4/t-vulnerable-road-users-147

For this safety assessment, a vulnerable road user is defined by the Federal Highway Administration as "a nonmotorist such as a pedestrian, bicyclist, other cyclist, person on personal conveyance or an injured person who is, or is equivalent to, a pedestrian or pedalcyclist."

For the remainder of this assessment the term "people walking" will be used to refer to pedestrians including people using a wheelchair or other medical personal mobility device as well as people walking unassisted. The term "people biking" refers to pedalcyclists, including people riding unassisted and electric-assisted bicycles and tricycles. The term "person on personal conveyance" is used to describe a person using any other non-motorized means of transportation such as skateboards, scooters, and e-scooters. Furthermore, the VRU SA must include a quantitative analysis of vulnerable road user fatalities and serious injuries which have specific definitions as outlined in the Model Minimum Uniform Crash Criteria (MMUCC) guidelines[3].

VULNERABLE ROAD USER

"A NONMOTORIST SUCH AS A PEDESTRIAN, BICYCLIST, OTHER CYCLIST, PERSON ON PERSONAL CONVEYANCE OR AN INJURED PERSON WHO IS, OR IS EQUIVALENT TO, A PEDESTRIAN OR PEDALCYCLIST."

FEDERAL HIGHWAY ADMINISTRATION

1.2 VULNERABLE ROAD USERS IN THE UNITED STATES AND IN OREGON

National Vulnerable Road User Safety. Vulnerable road users have accounted for a growing share of all United States roadway fatalities in recent years. In 2020, 6,516 people walking and 938 people biking were killed in traffic crashes nationally. [4] Nationally, the total projected number of people killed in traffic crashes while walking increased by another 13 percent from 2020 to 2021 and the number of people killed in traffic crashes while bicycling increased by another 5 percent from 2020 to 2021.[5]

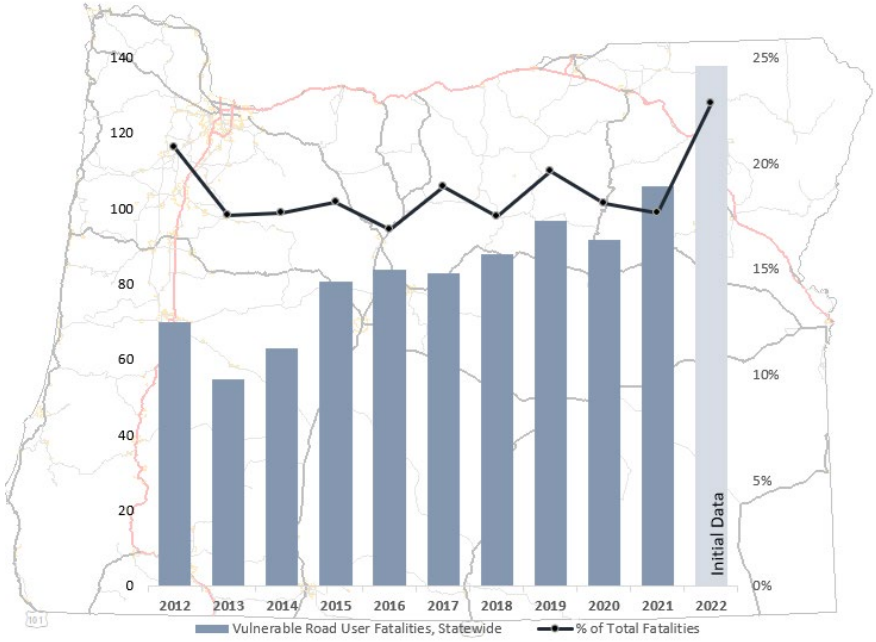
Oregon Vulnerable Road User Safety. In Oregon, from 2017 to 2021, vulnerable users constituted 18.3% of fatalities in Oregon. As shown in Figure 1, 106 vulnerable road users died in traffic crashes in 2021 in Oregon, marking a historic high. And initial data shows that number increased by 30% to another historic high of 138 fatalities in 2022.

[3] MMUCC Guideline (transportation.gov) 4th edition

[4] https://www-fars.nhtsa.dot.gov/Main/index.aspx

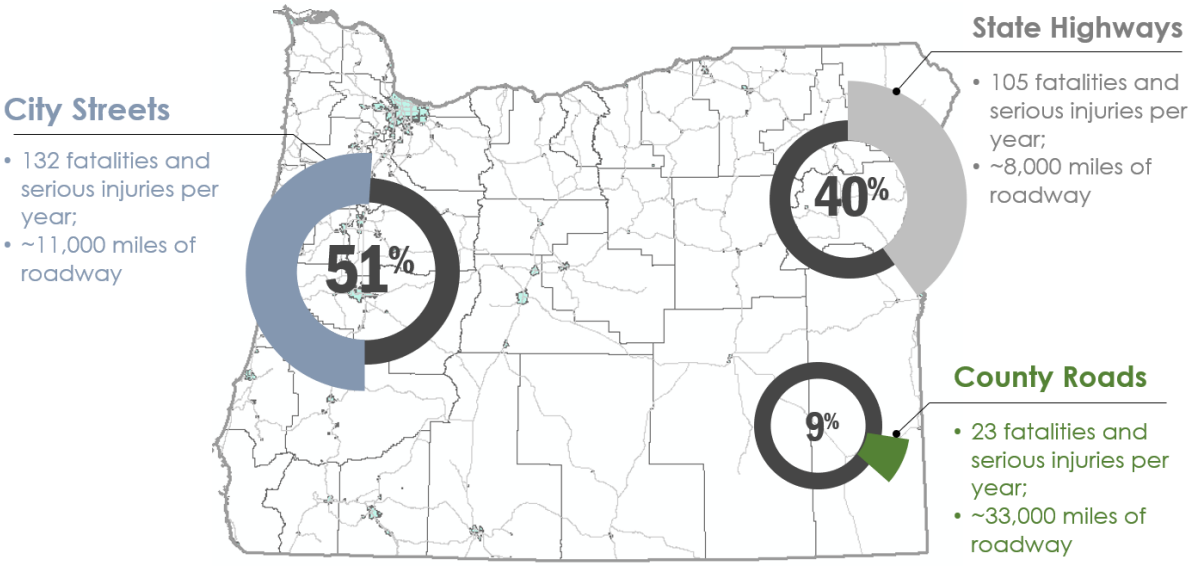
[5] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813515

Figure 1: OREGON VULNERABLE ROAD USER FATALITIES, 2012-2021



As illustrated in Figure 2, vulnerable road user fatalities and serious injuries occur on all types of public facilities: State highways, city streets, and county roads. Between 2017 and 2021, approximately 60% of all vulnerable road user fatalities and serious injuries occurred on non-state roadways (city streets, county roads and tribal roads).

Figure 2: OREGON VULNERABLE ROAD USER FATALITIES AND SERIOUS INJURIES BY ROADWAY TYPE, 2017-2021



2017 – 2021 Fatalities and Serious Injuries, participant level data

Vulnerable User Safety Compared to Overall Roadway Safety Performance. Total traffic deaths in Oregon have increased during the 5-year study period (2017-2021), while total serious injuries remained somewhat stable between 2017 and 2020 before increasing in 2021. Vulnerable user fatalities and serious injuries are aligned with the increasing trend among all road user fatalities in Oregon. However, preliminary data for 2022 shows a potential increase in the proportion of vulnerable road user fatalities to the total: from 18.3% (2017-2021) to an estimated 23.3% in 2022.

Progress Toward Meeting Safety Performance Targets. Safety Performance Management is part of FHWA's Transportation Performance Management program, which FHWA defines as a strategic approach that uses system information to make investment and policy decisions to achieve national performance goals. FHWA has established safety performance measure requirements for the purpose of carrying out the HSIP and assessing fatalities and serious injuries on all public roads. As noted in the Final Rule on the safety performance measures "State DOTs and MPOs will be expected to use the information and data generated as a result of the new regulations to inform their transportation planning and programming decision-making and directly link investments to desired performance outcomes. In particular, FHWA expects that the new performance measures outlined in this rule will help State DOTs and MPOs make investment decisions that will result in the greatest possible reduction in fatalities and serious injuries."[6]One of the five performance measures state DOTs are required to report to FHWA annually is focused specifically on vulnerable road users: Number of Non-motorized Fatalities and Non-motorized Serious Injuries.[7]

USDOT's Safety Performance Management Final Rule establishes the process for ODOT to select and report their safety targets, and the process that FHWA will use to assess whether ODOT has met or made significant progress toward meeting safety targets. According to the FHWA State Highway Safety Report for Oregon, the state did not meet or make significant progress toward its targets in any of the five performance areas, including non-motorized fatalities and serious injuries. This has been the case for the past four years (2018 through 2021).[8]

Federal law places requirements on states that have not met or made significant progress toward meeting safety targets. The Safety Performance Management Final Rule requires that Oregon spend a minimum amount of funds on safety projects in future years and submit an HSIP Implementation Plan to FHWA describing actions the state will take to improve performance.

Beginning in 2021, the VRU Safety Special Rule also requires that in states where vulnerable road users make up 15% or more of annual traffic fatalities, that state must spend at least 15% of their highway safety funds on projects that address the safety of vulnerable users. In 2021, Oregon experienced 106 vulnerable user fatalities, which is 17.7% of the 599 fatalities recorded that year.[9]

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[6] Federal Register : National Performance Management Measures: Highway Safety Improvement Program

[7] State Safety Performance Targets, USDOT. https://safety.fhwa.dot.gov/hsip/spm/state_safety_targets/

[8] State Highway Safety Report (2021) - Oregon. https://www.fhwa.dot.gov/tpm/reporting/state/safety.cfm?state=Oregonr

[9] 2021 Oregon Traffic Crash Summary, Oregon DOT, June 2023. https://www.oregon.gov/odot/Data/Documents/Crash_Summary_2021.pdf

1.3 EQUITY AND VULNERABLE ROAD USER SAFETY

Equity in transportation is the effort to achieve fairness in outcomes and to provide safety to protect all road users by acknowledging that not all people, or all communities, are starting from the same place. Economically and socially vulnerable populations, including low-income individuals, marginalized communities, and those facing social disadvantages, are overrepresented in vulnerable road user crashes. These groups face a heightened risk due to a combination of factors, including limited access to safe transportation options, awareness about road safety, and a higher likelihood of living in areas with inadequate infrastructure for pedestrians and cyclists. As a result, they often bear a disproportionate burden which underscores the need for targeted interventions and policies to address this disparity and improve road safety for all.

As highlighted in the Transportation Safety Action Plan (TSAP), in Oregon, areas with the highest number of low income and Black, Indigenous, and People of Color (BIPOC) residents experience pedestrian injury rates nearly three times higher than areas with the lowest number of low income and BIPOC residents. The Social Equity Index (SEI) [10] was incorporated into the analysis to further address transportation-related disparities, focusing on fatal and serious injury crash rate (per 100k population) as described in Section 2.3. It's important to note that this crash-based analysis is distinct from the subsequent risk-based analysis discussed later in the document.

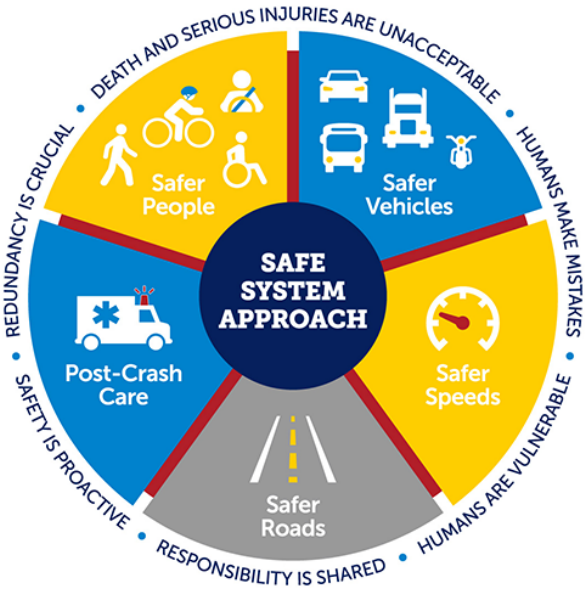
Identifying a range of complex factors and historical systems that influence the safety of vulnerable road users is crucial. The analysis and strategies within this Safety Assessment elevate the need for safety improvements that support economically and socially vulnerable populations in Oregon.

1.4 SAFE SYSTEM APPROACH CONSIDERATIONS

The 2023 OTP calls for a safe system approach to safety, with the goal to "enable safe travel for all people, regardless of their age, ability, race, income, or mode of transportation." The Safe System Approach starts with the belief that it is unacceptable to allow deaths and serious injuries to occur on the surface transportation system. It also acknowledges that road users are human beings who sometimes make mistakes, and those mistakes may lead to crashes. Therefore, safety must be addressed proactively through systems that create conditions and redundancies reducing the likelihood of a mistake or crash resulting in death or serious injury.

[10] Social Equity Website, Oregon DOT. https://www.oregon.gov/odot/equity/pages/default.aspx

Figure 3: SAFE SYSTEM APPROACH WHEEL (USDOT)



The Safe System Approach considers five elements of a safe transportation system—safer people, safer roads, safer speeds, safer vehicles, and post-crash care—in an integrated and holistic manner. Achieving zero traffic deaths and serious injuries requires strengthening all five elements.[11]

Safer People. In the context of the Safe System Approach, prioritizing "Safer People" is at the heart of comprehensive road safety strategies and user safety must be equitably addressed, including those who walk, bike, roll, and ride transit. It underscores a shared responsibility and signifies a commitment to safeguarding the lives and well-being of all road users, irrespective of their chosen mode of transportation. Additionally, it places a significant obligation on decision makers to proactively shape road environments that are conducive to the safety of every road user. These efforts encompass not only improving infrastructure and road design but also implementing policies, education, and enforcement mechanisms that collectively work toward the common goal of ensuring that every everyone arrives at their destination safely.

Safer Roads. Designing transportation infrastructure to accommodate human errors and injury tolerance can significantly reduce the severity of crashes that do occur while also minimizing conflicts between road users. The road environment plays a crucial role in shaping the overall safety experience for road users. This can be achieved by physically separating individuals with varying travel speeds, scheduling dedicated times for different user groups to navigate the space, and ensuring that users are alerted to the presence of other road users.

Safer Speeds. Recognizing the exponential relationship between speed and kinetic energy is crucial; even a slight uptick in speed results in a substantial increase in kinetic energy. Those increases play a pivotal role in increasing the severity of injuries which highlights the fragility of the

[11] All content related to the Safe System Approach is quoted or adopted from the FHWA Safe System Approach website and related sources. https://highways.dot.gov/safety/zero-deaths

human body. Research consistently reveals that high-speed crashes significantly diminish the likelihood of survival for individuals involved. This is especially true for vulnerable road users who are not protected by a motor vehicle's size, weight, and safety devices. The Safe System Approach promotes safer speeds in all roadway environments through a combination of thoughtful, equitable, context-appropriate roadway design, appropriate speed-limit setting, targeted education, outreach campaigns, and enforcement.

Safer Vehicles. Vehicles should be designed and regulated to minimize the severity of crashes – primarily focused on the vehicle's occupants – using safety measures that incorporate the latest technology. At the same time, vulnerable road users must navigate a transportation system of ever-increasing motor vehicles (by size and weight) that increase the risk of a pedestrian- or bicycle-involved crash resulting in death or serious injury. The Safe System Approach promotes expanding the availability of vehicle systems and features that help prevent crashes and minimize the impact of crashes on both occupants and non-occupants.

Post-Crash Care. People who are injured in traffic crashes rely on emergency first responders to quickly locate and stabilize their injuries and transport them to medical facilities. Post-crash care also includes traffic incident management to reduce the opportunity for a secondary crash to occur. The Safe System Approach promotes increasing the survivability of crashes through expedient access to emergency medical care, while creating a safe working environment for vital first responders and forensics teams investigating the scene. This also includes preventing secondary crashes through robust traffic incident management practices.

The Safe System Approach and the traditional approach differ in their underlying philosophies and strategies. Overall, the Safe System Approach is more holistic and protective of vulnerable road users. It recognizes that the traditional approach of solely focusing on behavior modification is inadequate and that creating safe, forgiving road environments is crucial to safeguarding the well-being of those who are more susceptible to injury. Figure 4 summarizes the differences.

Behavior vs. System Emphasis:

- Traditional Approach: The traditional approach primarily focuses on modifying human behavior and reducing human error. It places the onus on road users to follow rules and regulations and make fewer mistakes to enhance safety.
- Safe System Approach: In contrast, the Safe System Approach recognizes that humans are fallible and will make errors. It shifts the emphasis from solely addressing human behavior to viewing transportation design and operation as a holistic system. This system is designed to accommodate human mistakes and protect road users, acknowledging that errors will occur.

Crash Prevention vs. Severity Reduction:

- Traditional Approach: Traditional road safety aims to prevent all crashes (regardless of severity) through measures such as traffic engineering, traffic law enforcement, driver education, awareness campaigns and emergency response. The primary goal is to minimize the number of crashes.
- Safe System Approach: The Safe System Approach acknowledges that, despite best efforts, crashes will still occur. Instead of solely focusing on prevention, it also aims to reduce the

severity of crashes when they do happen. This is achieved by emphasizing improved road system designs and operations that lessen the impact forces and, therefore, minimize injuries and fatalities.

Blame vs. Shared Responsibility:

- Traditional Approach: The traditional approach often assigns blame to individuals involved in crashes, focusing on culpability and fault. This can lead to a blame-centric culture and, as many crashes have complex or multi-causes, misdirected efforts at assigned causation and fault.
- Safe System Approach: The Safe System Approach promotes a shared responsibility for road safety. It recognizes that both road users and road authorities play a role in ensuring safety and that the road environment should be forgiving of human errors.

Design-Centric vs. Human-Centric:

- Traditional Approach: The traditional approach tends to focus on infrastructure that may not always consider the needs and safety of vulnerable road users.
- Safe System Approach: The Safe System Approach is human-centric, encouraging design and operation of the transportation systems with the understanding that humans make mistakes and are of varying abilities. It focuses on creating safer road environments for everyone, including vulnerable road users, through design and infrastructure changes.

1.5 SAFETY AS A PUBLIC HEALTH ISSUE

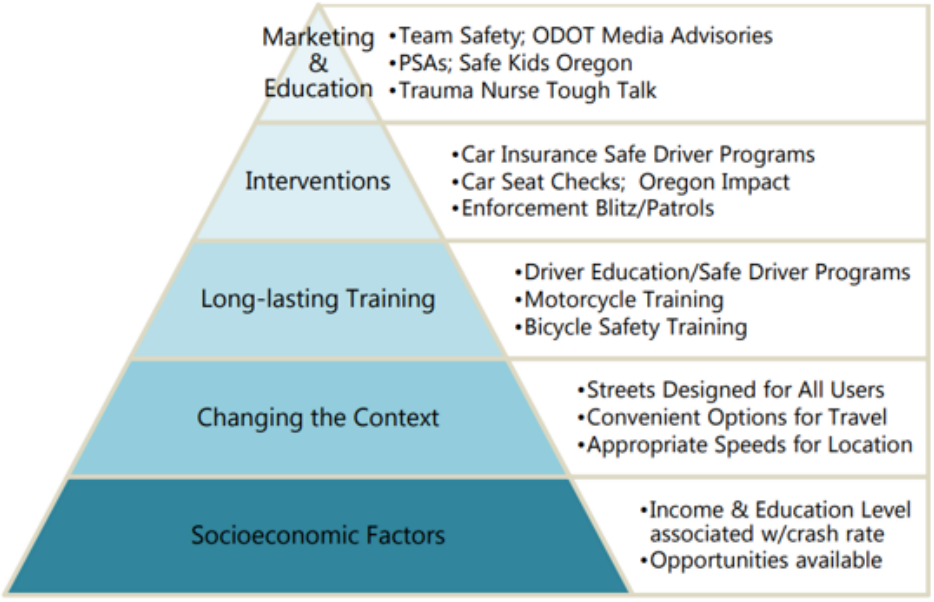
Socioeconomic and health disparities can play a role in crashes involving vulnerable road users. Vulnerable populations may have a higher prevalence of health issues, including chronic conditions that could affect their mobility, cognition, or reaction times making them more susceptible to crashes. In addition to increased susceptibility, they are more exposed to the dangers of traffic compared to occupants of motor vehicles. This places them at a higher risk of injury and fatalities in the event of a crash which directly impacts public health.

The public health field has adopted a health impact pyramid to understand what types of interventions, countermeasures, and strategies make the greatest impact on community change. This type of model can also be applied to changes in transportation safety culture. [12]

The pyramid shown in Figure 4 below, from the Lane County Transportation Safety Action Plan, applies the health impact model to the types of interventions, strategies, and countermeasures that are implemented to prevent fatal and severe traffic crashes. The base of the pyramid consists of broader societal changes, such as income and educational attainment and street design. Moving up the pyramid, the interventions become more targeted toward groups or individuals. This includes things such as enforcement, education, and marketing. These have been shown to be effective but can require more effort because the intervention is at an individual rather than community-wide level. All levels of the pyramid are important points of change and express the need to have a multi-layered approach to creating safety strategies.

[12] The Safe System Pyramid: A new framework for traffic safety, Transportation Research Interdisciplinary Perspectives, 2023. https://www.sciencedirect.com/science/article/pii/S2590198223001525

Figure 4: TRANSPORTATION SAFETY PYRAMID[13]



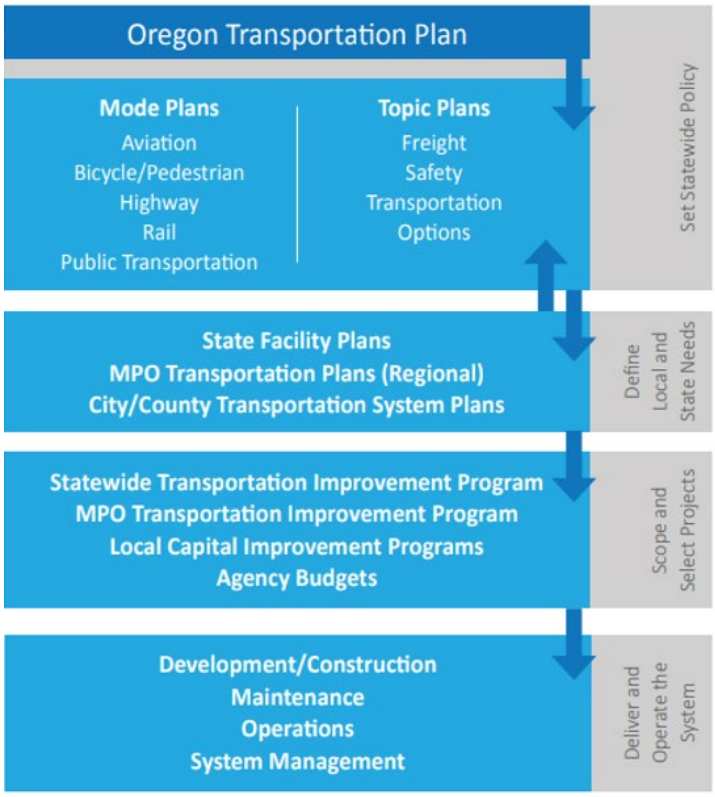
1.6 COORDINATION WITH OTHER OREGON TRANSPORTATION EFFORTS

Addressing the safety of vulnerable road users through a multifaceted, collaborative, and comprehensive approach is essential to provide safe transportation options for everyone. The United States Department of Transportation's (USDOT) National Roadway Safety Strategy (NRSS) commits the USDOT to respond to the current crisis in traffic fatalities by "taking substantial, comprehensive action to significantly reduce serious and fatal injuries on the Nation's roadways." The strategies outlined in the Vulnerable Road Users Safety Assessment align with and support relevant nationwide actions of the USDOT as well as Oregon's policy and modal plans.

In Oregon, the following statewide modal and topical plans include declarations, strategies, and implementing actions related to vulnerable road user safety. These plans (and others in Oregon) are integrated as illustrated in Figure 5.

[13] Transportation Safety Pyramid, Lane County Transportation Safety Action Plan (p.18), 2017.

Figure 5: INTEGRATED TRANSPORTATION PLANNING[14]



Oregon Transportation Plan (OTP). The 2023 Oregon Transportation Plan commits to "enable safe travel for all people, regardless of their age, ability, race, income, or mode of transportation" with an objective to "Implement a holistic, proactive approach to system safety that eliminates the occurrence of people being killed or seriously injured on the transportation system by anticipating human mistakes and recognizing the vulnerability of people on the road." Implementing actions related to vulnerable road users are many, including the following:

- Plan, design, construct, operate, and maintain the transportation system to reduce speed differentials on roadways; provide context-appropriate physical and temporal separation between different modes of travel.
- Reduce the potential severity of crashes in the event of user error by applying proven countermeasures, including lighting, physical separation, staggered signal phasing, and context-specific speed management techniques.
- Adopt safety messaging across all agencies to reflect human fragility and the principles of a Safe System approach so that transportation safety is integrated into everyday decision-making for the public (individual drivers, passengers, and people walking, rolling, and biking).

Transportation Safety Action Plan (TSAP). The 2021 Oregon Transportation Safety Plan, which serves as Oregon's Strategic Highway Safety Plan (SHSP), states that "Oregon envisions no deaths or life-changing injuries on Oregon's transportation system by 2035." The TSAP included a

[14] Oregon Transportation Plan. https://www.oregon.gov/odot/planning/pages/plans.aspx

comprehensive analysis of then-current safety data, people walking and rolling are primary emphasis areas in the TSAP, which includes dozens of implementing actions. The following are a few representative actions from the plan:

- Evaluate locations with a high frequency of crashes involving people walking or biking and risk factors through analysis of existing data and development of new data sources.
- Continue to identify effective pedestrian safety and bicyclist safety countermeasures by testing new treatments, conducting before and after evaluations, and supporting research to refine crash modification factors. Replicate the most effective treatments at additional locations.
- Implement best practices to eliminate work zone-related fatalities and serious injuries.
- Provide education and other countermeasures to improve work zone safety for workers and the traveling public.

Strategic Action Plan (SAP). The 2021-2023 Strategic Action Plan, which is in the process of being updated to reflect 2024-2028, is focused on "accelerating the development of a transportation system that is modern, reliable, and serves all Oregonians in an efficient, environmentally responsible, and safe manner." Improving safety is a core focus within this plan.

Oregon Bicycle and Pedestrian Plan (OBPP). The 2016 Oregon Bicycle and Pedestrian Plan provides a decision-making framework for walking and biking efforts in the State within the context of the overall transportation system. It includes a declaration to "…an evaluation and revision of Oregon's approach to safe walking and biking facilities to eliminate deaths and serious injuries." It includes dozens of implementing actions including the following:

- Provide education and outreach to school children about walking and biking options and how to safely use those modes and develop safe walking and biking connections to schools.
- Build and maintain partnerships with local jurisdictions, schools and education districts, the Oregon Department of Education, the Oregon Health Authority, and local transportation options providers through collaborative efforts to endorse, promote and implement Safe Routes to School Programs.
- Improve pedestrians' and bicycle users' perceived safety by supporting personal security.
- Promote training curricula for traffic engineers, planners, developers, and other transportation officials to conceptualize, design, and achieve a system that safely accommodates a multitude of transportation uses and users and provides viable transportation options.

Oregon Transportation Options Plan (OTOP). The 2015 Oregon Transportation Options Plan "envisions a safe, affordable, and efficient transportation system for Oregon residents, employees, and visitors." It casts a vision of "Oregon communities [that] are prosperous, enjoyable, and healthy places to live; places where people of all ages and abilities benefit from active, shared transportation options." Actions include the following:

- Raise awareness of the availability of transportation options through the integration of road safety education for all modes into classroom and through lifelong learning, including traffic diversion programs and community programs such as Safe Routes to Schools, Drivers Education, licensing renewals, and community cycling workshops.
- Promote training curricula for traffic engineers, planners, developers, and other transportation officials to conceptualize, design, and achieve a system that safely

accommodates a multitude of transportation uses and users and provides viable transportation options.
- During project development look for opportunities that encourage efficient multimodal travel and maximize system safety.

Oregon Public Transportation Plan (OPTP). The upcoming Oregon Public Transportation Plan update will provide a long-range vision and policy framework to help shape the public transportation system over the next 25 years considering emerging statewide trends, opportunities, and challenges. Actions include the following:

- Plan for, design, and locate transit stops and stations to support safe and user-friendly facilities, including providing safe street crossings.
- Design and locate public transportation facilities so that a wide range of users, including pedestrians, cyclists, and people with disabilities can safely access them.
- Provide passenger and operator security on public transportation vehicles and at stops and stations through investments in facility design, amenities, appropriate security systems and personnel, and coordination with law enforcement staff.

Oregon Statewide Transportation Strategy (STS). The 2013 Oregon Transportation Statewide Strategy is a state-level scenario planning effort that examines all aspects of the transportation system, including the movement of people and goods, and identifies a combination of strategies to reduce greenhouse gas emissions. The STS identifies a variety of effective GHG emissions reduction strategies in transportation systems, vehicle and fuel technologies, and urban land use patterns to address the impacts of climate change. Implementing actions relevant to vulnerable road users include the following:

- Constructing appropriate bicycle and pedestrian facilities including safe and convenient crossings.
- Using educational materials and special signing to change driving practices.
- Developing incident response and motorist assistance programs.

Oregon Highway Plan (OHP). The Oregon Highway Plan, most recently amended in 2023, and scheduled for a major update in 2024, defines policies and investment strategies for Oregon's state highway system for the next 20 years. It further refines the goals and policies of the OTP and is part of Oregon's Statewide Transportation Plan. Related actions include the following:

- Address pedestrian and bicycle access issues and design concerns when designing grade-separated crossings.
- Continually improve safety for all users of the highway system using solutions involving engineering, education, enforcement, and emergency medical services.
- Whenever safety improvement is the stated objective of the project, include goals and a process to evaluate the outcome and further refine the project selection and solution process.

2. VULNERABLE ROAD USER SAFETY PERFORMANCE

The VRU SA includes an assessment of safety performance with respect to vulnerable road users. The Oregon Department of Transportation (ODOT) performed quantitative analyses of vulnerable road user fatalities and serious injuries that included relevant crash event data and considered demographics at the locations of those crash events.

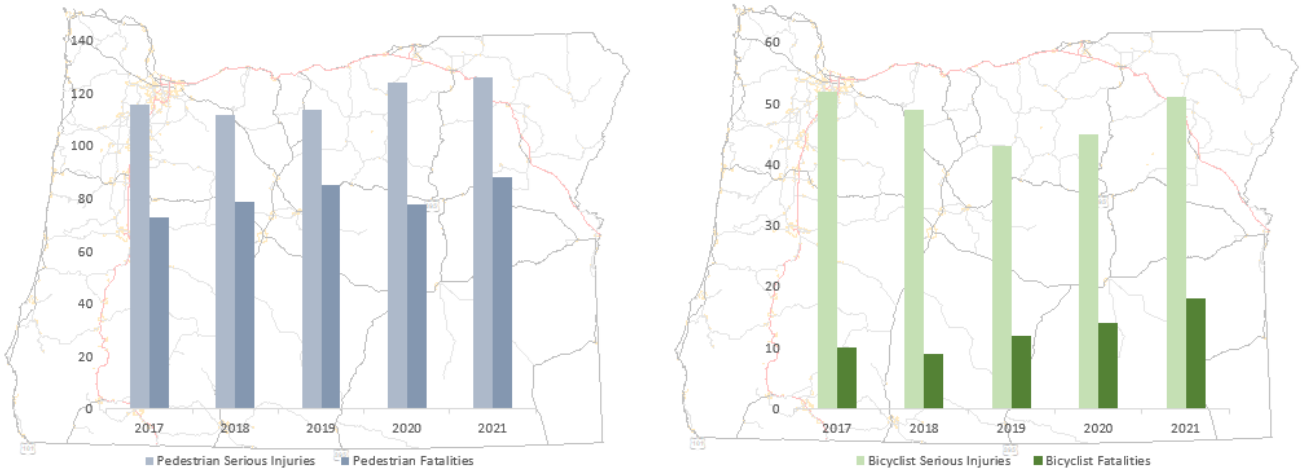
ODOT analyzed human behavior and contributing factors, social equity disparity, factors such as lighting condition and posted speed limit, and a series of other risk factors as described below. Further details regarding the analysis methodology are available in the technical memos developed in support of this assessment.

2.1 VULNERABLE USER HISTORICAL CRASH TRENDS

After a gradual 30 year decline, traffic fatalities involving people walking are at a 40 year high nationally. Oregon mirrors these national trends. In the 5-year period between 2005 and 2009, an average of 47 people walking were killed in traffic crashes each year in Oregon. In comparison, between 2017 and 2021 an average of 80 people walking were killed in traffic crashes each year, a 70% increase.

In the five-year period between 2017 and 2021, a total of 403 people walking and 63 people bicycling were killed in vehicle crashes on Oregon roadways. Another 592 people walking and 240 people bicycling sustained serious injuries during that period. This section describes some examples of the most notable VRU safety trends.

Figure 6: PEDESTRIAN AND BICYCLIST FATALITIES AND SERIOUS INJURIES, OREGON, 2017-2021



2.2 CRASH TRENDS - SAFER PEOPLE

The Safe System Approach encourages safe, responsible behavior by all road users and road owners to create conditions that elevate everyone's ability to reach their destination unharmed. To evaluate human behavior trends related to vulnerable user safety and social determinants of health safety outcomes, ODOT evaluated contributing factor and participant error data associated with crashes.

2.2.A CONTRIBUTING FACTORS BASED ON CRASH REPORTS

Drivers, pedestrians, and bicyclists are safer when they comply with traffic laws and correctly use roadway facilities. The Safe System Approach to roadway safety emphasizes the fact that humans make mistakes and the need to proactively build systems that reduce the likelihood of these mistakes resulting in fatal or serious injury crashes. Contributing factors are often identified during crash investigations and can help inform the selection of appropriate safety treatments. They include a wide range of conditions, actions, or events that, when combined, increase the likelihood of a crash occurring.

Contributing factors can be both human and non-human related. Human-related contributing factors may include driver behaviors like speeding, distracted driving, impaired driving, or failure to obey traffic laws. Non-human-related factors could involve things like road conditions, weather, time of day, and design or mechanical issues with a vehicle. For example,

- Inadequate separation: Bicyclists and pedestrians are safer when they are separated from motor vehicles. When facilities are inadequate, there is dense traffic, or visibility is limited, pedestrians might walk in the roadway or cyclists may opt to ride on sidewalks or against the direction of traffic.
- Crossing locations: The likelihood of a crash increases when crossing locations are limited and/or when pedestrians and bicyclists cross at locations not intended for crossing.

Errors are a subset of contributing factors and refer to mistakes or incorrect actions made by a person involved in the crash. In general, they represent deviations from safe and appropriate road user actions that directly contributed to the crash. Common errors include running a red light, failing to yield the right of way, making an improper lane change, or following too closely. Errors coded in the crash data are based on law enforcement crash records; this information helps inform strategies to support safer behaviors. It's important to note that more than one participant in a crash may commit more than one error in a crash.

Crashes involving vulnerable road users can result from a variety of contributing factors and errors, both by the road users themselves and by other participants. Common contributing factors and error codes in these crashes may include:

- Failure to Yield Right of Way (Failure to Stop or Yield): This error can occur when one road user does not give the appropriate right of way to another road user when required by traffic laws.
- Distracted Driving: Drivers using mobile phones, adjusting in-car systems, or engaging in any form of distracted driving can collide with vulnerable road users.

- Speeding: Motorists exceeding the speed limit or traveling too fast for road conditions may have reduced reaction time and stopping distance, increasing the risk of striking vulnerable road users.
- Impairment: Impairment refers to a state when a person's physical or mental abilities are diminished or restricted rendering them less capable of performing certain tasks or functions in a safe manner, this most often includes alcohol and/or drugs.

Table 1 below shows the primary contributing factors reported in Oregon crashes between 2017 and 2021 involving a vulnerable road user fatality or serious injury. The percentages show the proportion of all assigned contributing factors for fatal or serious injury vulnerable user crashes. These factors come from cause, error, and/or event codes derived from police reports which include accounts from the person driving and any witnesses. It is important to note that these reports may not include the account of the vulnerable user who was seriously injured or killed.

Contributing Factors. Contributing factors could come from the cause, error, or event tables in the Oregon Crash Database. As shown in the table below using contributing factors, road users failing to yield contributes to approximately 35% of fatal and serious injury crashes involving people bicycling and to approximately 24% of fatal and serious injury crashes involving people walking. Other common contributing factors include non-motorists illegally in the roadway[15] (28% of fatal and serious injury crashes involving people walking and 11% of fatal and serious injury crashes involving people bicycling) and non-motorists identified by the reporting officer/witness as not visible or wearing non-reflective clothing[16] (20% of fatal and serious injury crashes involving people walking and 10% of fatal and serious injury crashes involving people bicycling).

Table 1: PRIMARY CONTRIBUTING FACTORS IN VULNERABLE USER FATALIES & SERIOUS INJURIES

CONTRIBUTING FACTOR	% OF PEDESTRIAN F&SI	% OF BICYCLIST F&SI
DID NOT YIELD RIGHT-OF-WAY	24%	35%
NON-MOTORIST ILLEGALLY IN ROADWAY	28%	11%
NON-MOTORIST NOT VISIBLE; NON-REFLECTIVE CLOTHING	20%	10%
DISREGARDED TRAFFIC SIGNAL	5%	7%

Although there are additional factors involved, none of these were identified as contributing to more than 7% of fatal and serious injury crashes involving vulnerable road users in Oregon. It's important to note that the low occurrence of speeding, inattention, or other behaviors being cited

[15] Non-motorists illegally in roadway include VRUs who violated Oregon State laws. Some examples include crossing a freeway (except from a disabled vehicle), suddenly stepping into the roadway causing a hazard, etc.

[17] Although there is no legal requirement for people walking or biking to wear high-visibility or reflective clothing, this has been included as an option on police crash reporting forms in Oregon because it is helpful for law enforcement to determine whether a driver had a reasonable amount of time (based on speed, lighting, geometrics, etc.) to identify a person in the roadway and avoid a crash.

as contributing factors to crashes may be because people involved in a crash are unlikely to self-report such behavior. Underreporting can make it challenging to gather accurate data and statistics on the prevalence of these factors which are needed to diagnose and implement effective safety treatments.

Road User Distraction. Distraction includes driving, walking, or biking while doing another activity that takes the road user's attention away from safely navigating the transportation system. The proliferation of cell phones and other mobile electronic devices has resulted in increasing distractions. Available data and anecdotal evidence point to distraction as a significant traffic safety concern. For example, a survey conducted by Southern Oregon University found that three out of four drivers surveyed engage in distracted driving. Distraction can be a difficult element to include in the crash report, because it relies on a witness testimony or a road user's self-reporting. Table 2 below shows the average yearly proportion of fatal and serious injury crashes that involve a vulnerable user and report distraction between years 2017 and 2021.

Table 2: PROPORTION OF FATAL AND SERIOUS INJURY CRASHES THAT INVOLVE A VULNERABLE ROAD USER AND REPORT DISTRACTION

FATAL AND SERIOUS INJURY CRASHES	AT LEAST ONE DISTRACTED ROAD USER
INVOLVING A PERSON WALKING	15.0%
INVOLVING A PERSON BIKING	15.0%

Road User Impairment. Fatal and serious injury crashes involving people walking or biking are affected by impairment, both for motor vehicle drivers and people walking or biking.

As shown in Table 3, crash reports indicate more than 36% of fatal and serious injury crashes that involve a person walking also include at least one road user impaired by alcohol or other drugs; for fatal and serious injury crashes involving a person biking, 17% included impairment.

Table 3: PROPORTION OF FATAL AND SERIOUS INJURY CRASHES THAT INVOLVE A VULNERABLE ROAD USER AND REPORT IMPAIRMENT

FATAL AND SERIOUS INJURY CRASHES	AT LEAST ONE IMPAIRED ROAD USER (ALCOHOL AND/OR OTHER DRUGS)
INVOLVING A PERSON WALKING	36.3%
INVOLVING A PERSON BIKING	17.4%

2.2.B OVERREPRESENTATION BY THE SOCIAL EQUITY INDEX

The Social Equity Index (SEI) is a measure of disparity focusing on economically and socially vulnerable populations in Oregon. It serves as a decision support tool, assisting agency staff in identifying communities of concern, thereby aiding in the allocation of transportation resources to reduce social disparities. The SEI is informed by socio-demographic data from the U.S. Census Bureau's American Community Survey (ACS). More information about the SEI can be accessed through the ODOT website.[17]

SEI Values are categorized as:

- Low Disparity
- Low/Medium Disparity
- Medium/High Disparity
- High Disparity

Figure 7 shows that about 33% of the motor vehicle miles traveled (VMT) occurred on roadways passing through high disparity regions, but about 58% of all vulnerable user crashes occurred on those roadways. Based on the analysis, roadways within high disparity regions are overrepresented in the crash data and considered to be a risk factor in crashes involving vulnerable users.

Figure 7: VRU EQUITY OVERREPRESENTATION

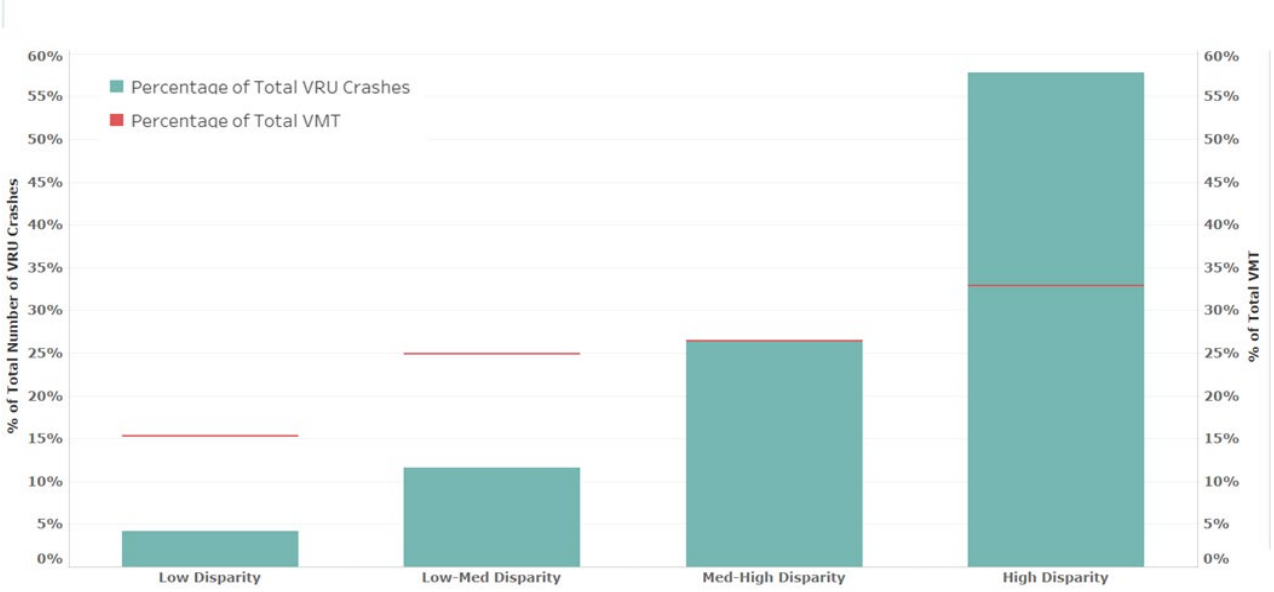


Figure 8 and 9 show the pedestrian and bicyclist fatalities and severe injuries per 100k population for each SEI disparity level. Based on the analysis, medium/high and high disparity areas have a higher number of fatalities and severe injuries per population compared to low and low/medium disparity areas.

[17] Social Equity, Oregon Department of Transportation. https://www.oregon.gov/odot/equity/pages/about.aspx

Figure 8: PEDESTRIAN OVERREPRESENTATION ANALYSIS BY SOCIAL EQUITY INDEX

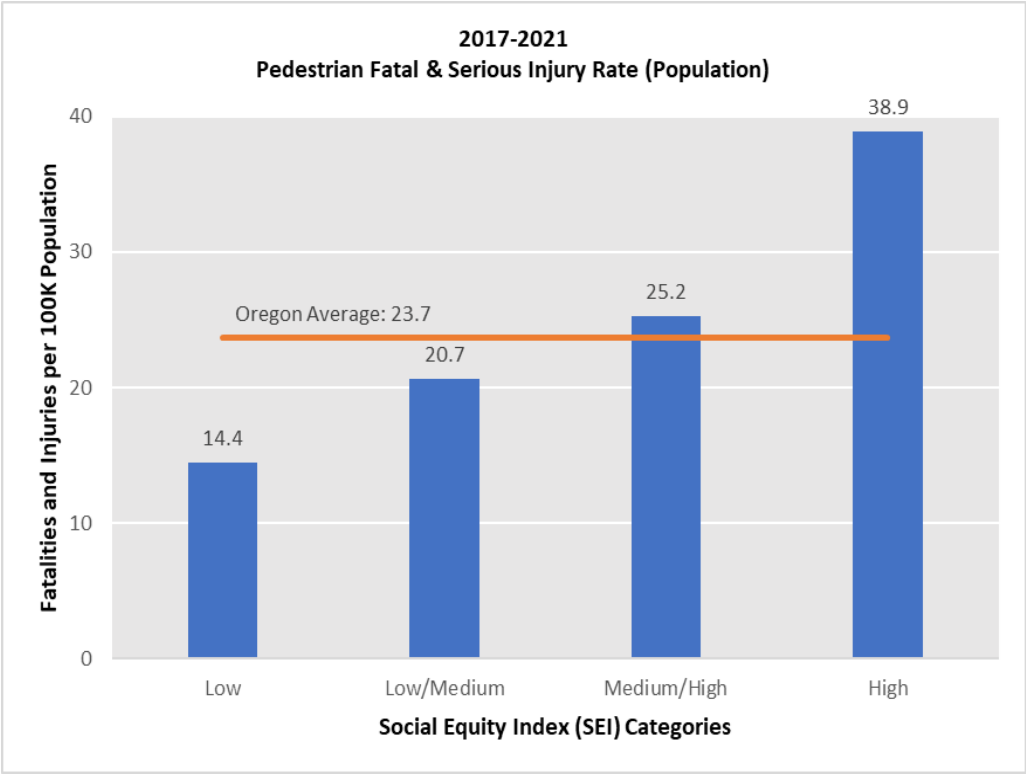
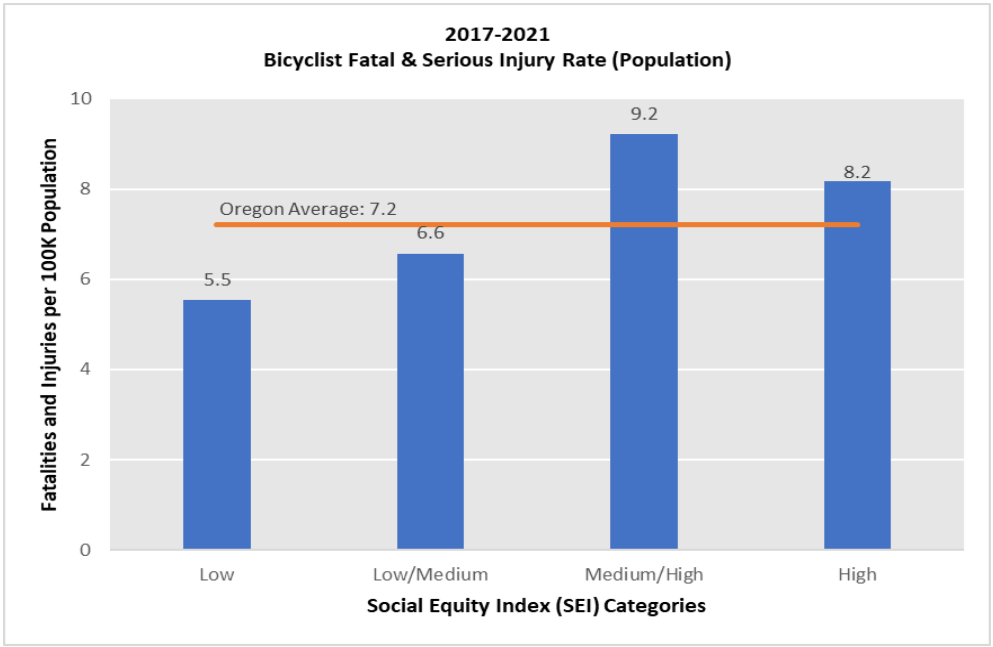


Figure 9: BICYCLE OVERREPRESENTATION ANALYSIS BY SOCIAL EQUITY INDEX



2.2.C OVERREPRESENTATION BY RACE AND ETHNICITY

Table 4 shows the number of fatalities by race and ethnicity group during the five-year period from 2017 to 2021 using data from the National Highway Traffic Safety Administration (NHTSA)'s Fatality Analysis Reporting System (FARS). Population data is based on the 2021 U.S. Census Bureau dataset.[18] Of the total 466 fatalities, Black or African Americans and American Indians or Alaska Natives have the highest over-representation compared to the total population. [19]

Table 4: VULNERABLE ROAD USER FATALITIES BY RACE AND ETHNICITY

RACE / ETHNICITY	NUMBER OF VRU FATALITIES	VRU FATALITIES PROPORTION	POPULATION (ESTIMATE)[20]	PROPORTION
WHITE (NON-HISPANIC)	341	73%	3,138,802	74%
WHITE (HISPANIC)	47	10%	512,544	12%
TWO OR MORE RACES	1	0%	177,908	4%
ASIAN, ASIAN AMERICAN, OR OTHER PACIFIC ISLANDER ALONE	22	5%	232,975	6%
BLACK OR AFRICAN AMERICAN ALONE	18	4%	97,426	2%
AMERICAN INDIAN OR ALASKA NATIVE ALONE	24	5%	80,482	2%
OTHER RACE OR UNKNOWN	13	3%	0	0%
TOTAL	466	100%	4,240,137	100%

[18] https://www.census.gov/quickfacts/OR?
[19] Understanding Pedestrian Crash Injury and Social Equity Disparities in Oregon, Project SP 841, Phase I Analysis. Oregon DOT. https://www.oregon.gov/odot/Programs/ResearchDocuments/SPR%20841Injuries-Equity.pdf
[20] Population is estimated using the race percentage and the total population of all races using parameters from this website: https://www.census.gov/quickfacts/OR?

2.3 CRASH TRENDS - SAFER ROADS

The Safe System Approach encourages transportation infrastructure design that increases safety for the traveling public and accommodates human mistakes and injury tolerances to reduce the severity of crashes that do occur. To evaluate environmental and roadway design elements related to vulnerable user safety, ODOT evaluated reported roadway condition data associated with vulnerable user crashes.

2.3.A INTERSECTIONS AND SEGMENTS

Location on the road has a different potential impact for people killed or seriously injured while walking or bicycling along roadway corridors. Roadway segments tend to be the primary location for crashes involving people walking. Roadway segments account for 61% of fatalities and serious injuries to people walking, while intersections account for 39%. Conversely, when it comes to people bicycling, intersections pose a higher risk. Intersections account for 56% of fatalities and serious injuries to people bicycling, while roadway segments account for 44%.

Table 5: VULNERABLE USER FATALITIES AND SERIOUS INJURIES BY LOCATION TYPE

ROAD USER	% OF F&SI AT INTERSECTIONS	% OF F&SI ON SEGMENTS	TOTAL
PEDESTRIAN	39%	**61%**	100%
BICYCLIST	**56%**	44%	100%

2.3.B LIGHTING CONDITIONS

Navigating the transportation system can be more challenging at night for all road users, including people walking and rolling. As shown in Table 6 below, 66 percent of fatal and serious injury crashes involving people walking occur in dark, dawn, or dusk conditions. Crashes involving people biking exhibit different characteristics. Understanding these differences is challenging without considering factors like exposure (e.g., the number of cyclists and miles traveled in both daylight and dark conditions), making it complex to establish a cause-and-effect relationship.

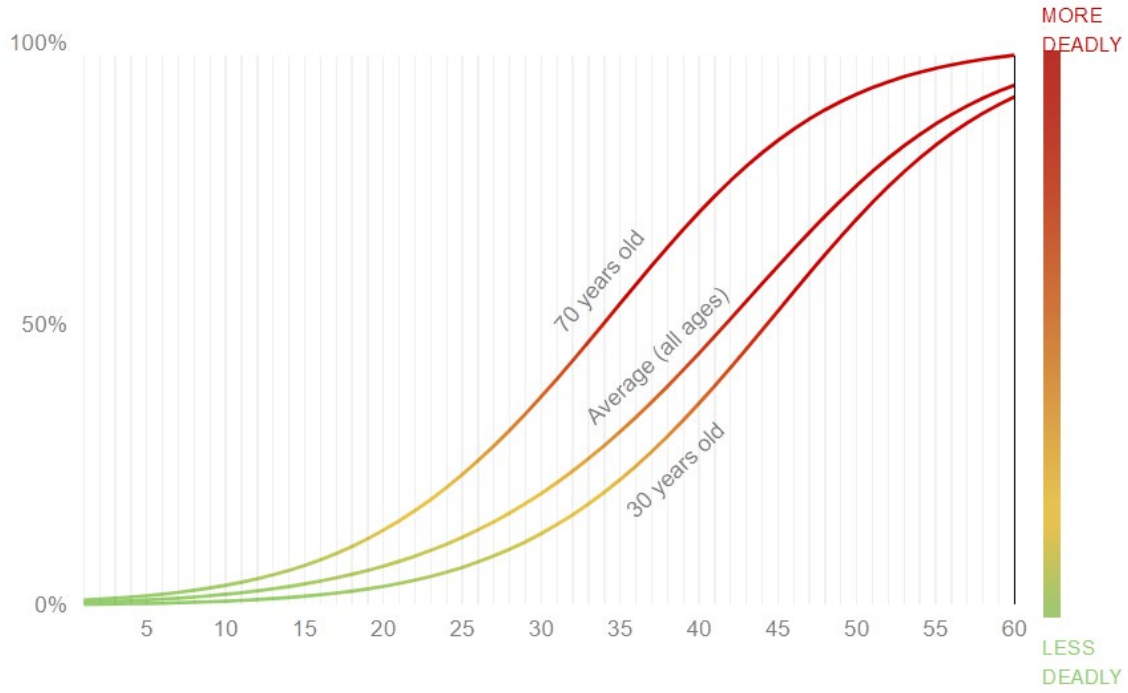
Table 6: OREGON VULNERABLE USER FATALITIES AND SERIOUS INJURIES BY LIGHTING CONDITION

ROAD USER	DARK	DARK (WITH LIGHTS)	DAWN/DUSK	DAY
WALKING	23%	**36%**	7%	34%
BICYCLING	8%	16%	5%	**72%**

2.4 CRASH TRENDS - SAFER SPEEDS

The probability of a vulnerable user being seriously injured or killed in a crash increases as vehicle speed increases. Survivability at different speeds is further influenced by socio-environmental factors such as a person's age or health. For example, as illustrated in Figure 10, a 30-year-old has only a 50% chance of being killed in a crash with a car traveling 45 mph, while a 70-year-old has a 50% chance of being killed in a crash with a car traveling 35 mph.

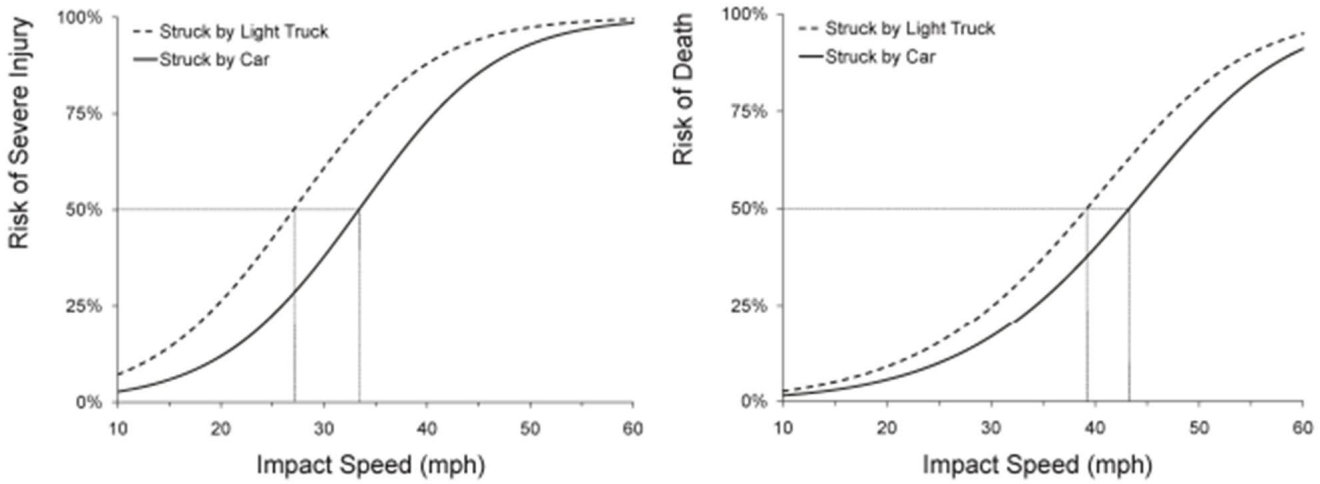
Figure 10: RISK OF PEDESTRIAN-VEHICLE FATALITY BY VEHICLE OPERATING SPEED AND PEDESTRIAN AGE[21]



The size, type, and design of the vehicle involved in a crash further influences the impact of speed on vulnerable user crash outcomes. As illustrated in Figure 11, the probability of a vulnerable user being seriously injured or killed in a crash increases even more rapidly as the speed and size of vehicles increases.

[21] Tefft, B.C. (2011). Impact Speed and a Pedestrian's Risk of Severe Injury or Death (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety.

Figure 11: RISK OF SEVERE INJURY OR DEATH BY VEHICLE TYPE[22]

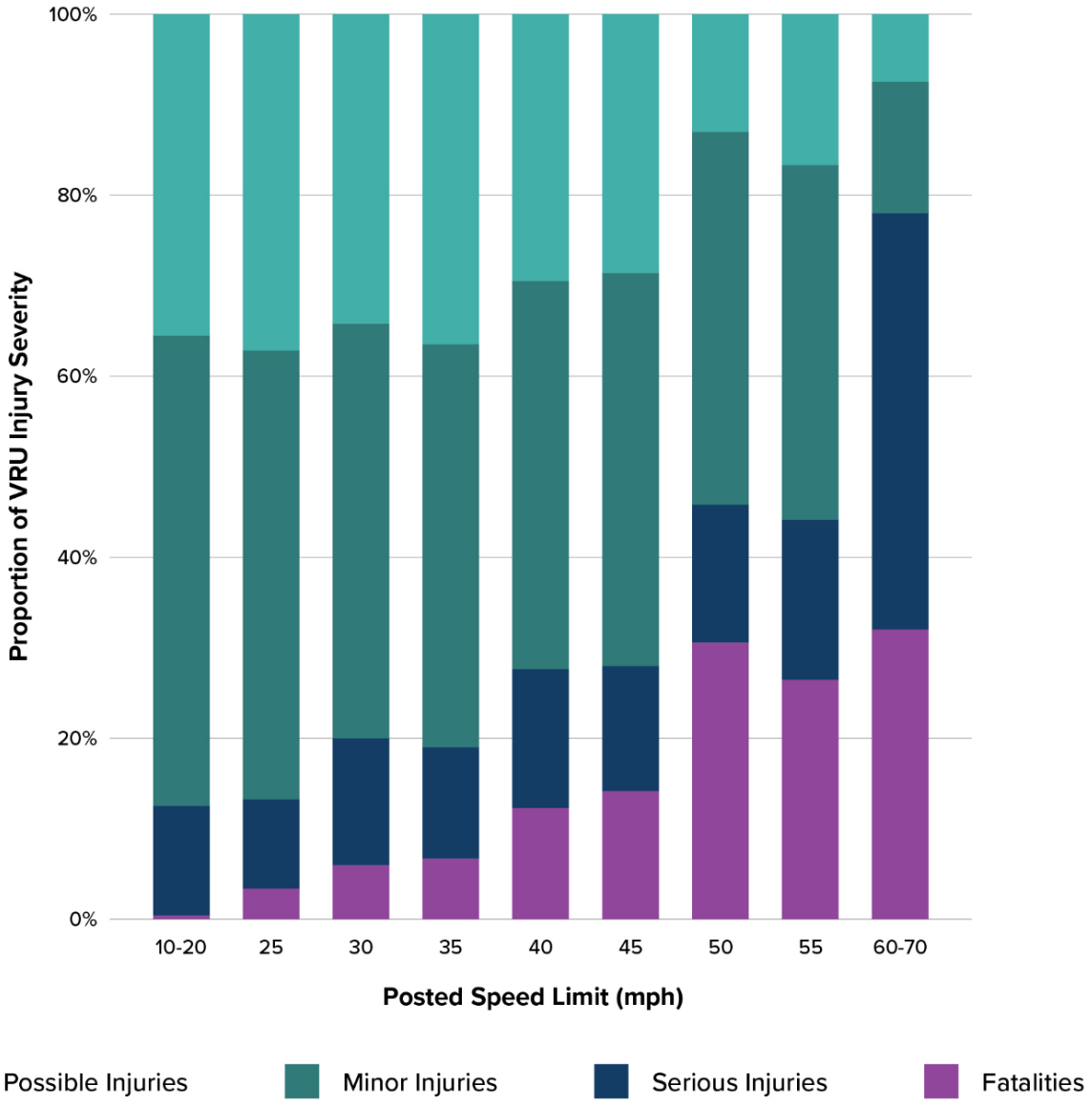


To evaluate trends related to speed and vulnerable user safety in Oregon, ODOT evaluated posted speeds and vulnerable user crash data.

Vulnerable User Crash Severity by Posted Speed Limit. Figure 12 below shows the number of vulnerable user fatalities and injuries on roadways by posted speed limit,[23] which serves as a rough estimate for relative motor vehicle operating speed.

[22] Impact Speed and a Pedestrian's Risk of Severe Injury or Death, AAA Foundation for Traffic Safety, 2011. https://nacto.org/wp-content/uploads/2017/11/2011PedestrianRiskVsSpeed.pdf
[23] Speed limit data collected from the law enforcement crash reports for each reported crash.

Figure 12: PROPORTION OF VULNERABLE ROAD USER CRASHES BY INJURY SEVERITY AND POSTED SPEED LIMIT, OREGON, 2017-2021



The figure demonstrates two points:

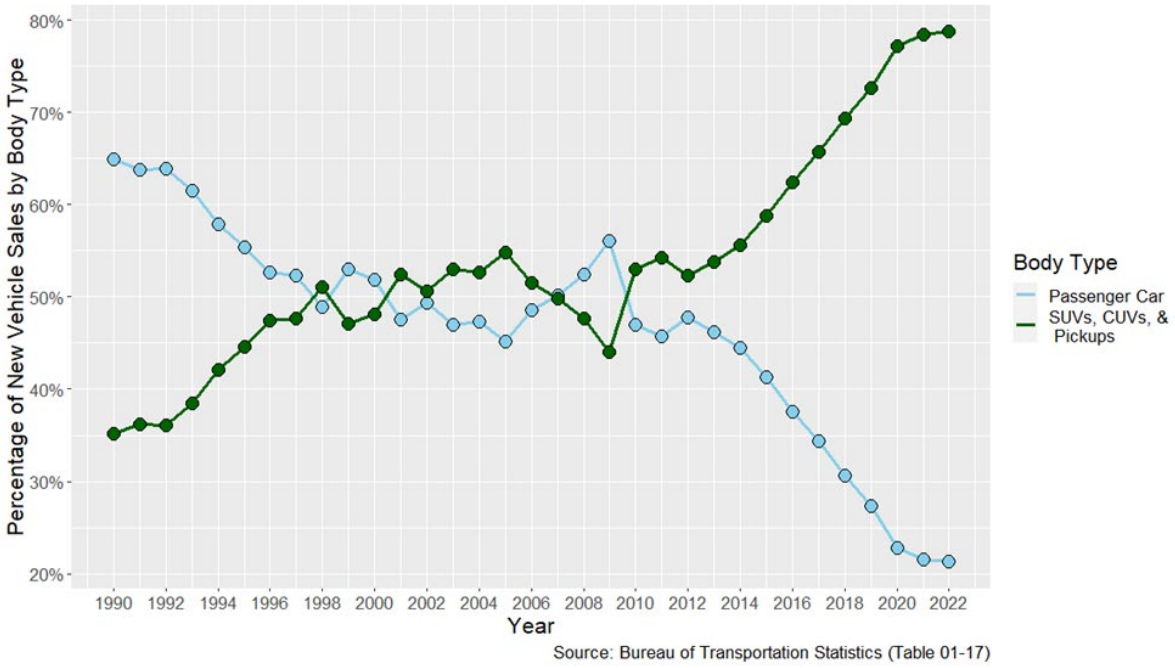
1. Higher posted speed limits are correlated with greater severity. For example, at posted speed limits of 45 mph and higher, very few possible injuries or minor injuries were reported.
2. Overall, most VRU-involved crashes occur on streets with posted speed limits between 25 and 35. In Oregon this includes urban and suburban arterials that serve multiple road user modes and travel purposes.

2.5 CRASH TRENDS – SAFER VEHICLES

Vehicles are designed and regulated to minimize the severity of crashes – primarily focused on the vehicle's occupants. Unfortunately, some changes to vehicle design may increase safety risk for vulnerable road users outside of vehicles. As vehicles increase in weight and size, often reflecting consumer preferences and accommodating features such as expanded protective zones for occupant safety and space for electric batteries, the likelihood of a pedestrian or bicycle crash leading to fatal or serious injuries also rises. Larger, heavier vehicle designs also often require structures that can obstruct a driver's view of vulnerable users when making turns or backing up, increasing the likelihood of a crash.

The average weight of passenger vehicles has grown, with the average vehicle up 6% in total weight with pickups up 30% compared to pickups of the 1970s. Since 2010, the percentage of new vehicle sales in the US that are light trucks (Sport Utility Vehicles, Crossover utility vehicles, and pickups) has increased from approximately 53% to nearly 80% of all sales.

Figure 13: VEHICLE SALES BY BODY TYPE, 1990-2022[24]



At an aggregate level, SUVs and pickup trucks are being linked to an increase in overall traffic injury for vehicle occupants and vulnerable road users alike. Without significant efforts directed towards safer vehicles, this trend is likely to continue.

[24] Bureau of Transportation Statistics

2.6 CRASH TRENDS - POST CRASH CARE

The Safe System Approach promotes increasing the survivability of crashes through expedient access to emergency medical care, while creating a safe working environment for vital first responders and forensics teams investigating the scene.

Humans have a limited tolerance for crash forces, which necessitates swift action when a crash occurs. This is particularly important for vulnerable users because the initial impact with a motor vehicle is likely to cause personal injury. The "Golden Hour" in the context of post-crash care refers to the critical period following a traumatic injury, such as a roadway crash, when the likelihood of a positive outcome is highest if the injured person receives prompt and effective medical treatment within the first 60 minutes after the injury occurs.

On a state level, Oregon's state trauma system ensures that high quality community resources are available to respond to individuals who are traumatically injured by assuring an integrated statewide system of resources, including establishment of trauma regions and designation of trauma care hospitals.[25]

Within the Oregon Health Authority (OHA), the Emergency Medical Services and Trauma Systems Section administers Oregon's emergency medical services (EMS) data.[26] The Oregon Emergency Medical Services Information System (OR-NEMSIS) is Oregon's prehospital emergency medical services data system. OR-NEMSIS includes EMS agency and personnel licensing, EMS agency prehospital patient care reporting, and hospital trauma registry reporting. All licensed transporting EMS agencies submit patient care reports electronically to this central repository.

Figure 14. MEDIAN RESPONSE TIME BY ODOT REGION

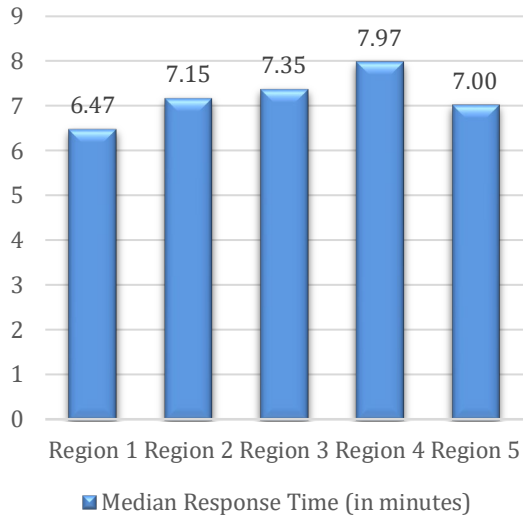
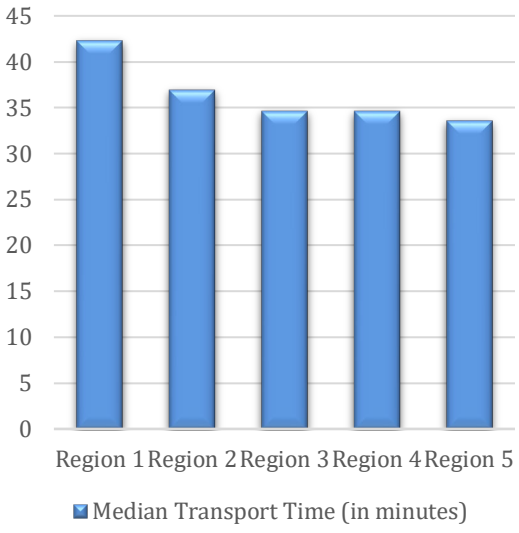


Figure 15. MEDIAN TRANSPORT TIME BY ODOT REGION



The efficiency of EMS plays a critical role in ensuring the well-being of those involved in roadway crashes. Median response and transport time varies by region. Varying terrains and population densities contribute to unique challenges for emergency response teams. In densely populated urban areas, factors such as traffic congestion and the complex layout of streets can affect how quickly emergency services can reach the scene. On the other hand, in rural or remote regions, where distances are often greater and road conditions may be less predictable, response times face a different set of challenges.

[25] Oregon Health Authority : The Oregon Trauma and Tertiary Care Program : Trauma Systems : State of Oregon
[26] Oregon EMS Data Strategic Plan, 2022-2024

3. SELECTING HIGH-RISK AREAS

The HSIP requires States to identify hazardous locations, sections, and elements that constitute a danger to all users including vulnerable road users. In addition, as part of the quantitative analysis of vulnerable road user fatalities and serious injuries, States must identify areas as high-risk to vulnerable road users.

3.1 DEFINITIONS

The following definitions are assumed for purposes of the Oregon VRU SA. The terms can be combined to describe various outputs of the data-driven methodology (e.g., the "High-Injury Network" includes the specific roadway segments, intersections, or corridors that have a high number of VRU fatalities and serious injuries).

- **Risk Factor**: Elements identified as contributors to future VRU-involved crash risk, including the potential for future crash events and the potential for severe outcomes.
- **High-Risk**: Locations or facility types exhibiting the greatest number of VRU risk factors.
- **Network**: Specific roadway segments, intersections, or corridors
- **High-Injury**: Locations or facility types exhibiting the greatest frequency of VRU fatalities and serious injuries.
- **Area**: A geographic region (e.g., a county, city, or sub-area of a city).
- **Facility Type**: A roadway segment or intersection with a roadway characteristic or combination of characteristics (e.g., suburban 5-lane arterial with a posted speed greater than 30 mph).

3.2 IDENTIFYING OVERREPRESENTED RISK FACTORS

Any safety analysis focused on crash history is limited by the completeness and accuracy of the underlying data set. There is an inherent incompleteness of the crash data set in that it represents only those crashes reported by law enforcement or participants, and then included in the official database. Similar to motorized modes, crash data for non-motorized modes are primarily collected using police crash records. However, pedestrian and bicycle crashes, especially if there are minor injuries, may go underreported; for example, some sources estimate that up to 20% of crashes involving pedestrians and 10% of crashes involving bicyclists are underreported.[27] Underreporting can obscure trends and patterns in pedestrian and bicycle crashes. This can make it challenging to identify recurring issues and address them proactively.

This assessment mitigates the limitations of analysis conducted only on crash history by studying additional potential risk factors to help identify a broader set of data to better predict the location and type of future vulnerable road user crashes. Steps include identifying risk factors associated with higher vulnerable user crash frequencies (overrepresentation) on all public roads and incorporating demographics to determine overrepresented populations and geographies.

ODOT conducted an overrepresentation analysis of the Oregon-specific datasets to identify potential crash risk factors for vulnerable users. This overrepresentation analysis evaluates the

[27] https://nap.nationalacademies.org/read/27294

crash frequency (using 7-year crash data from 2015 to 2021 including all severity levels) associated with certain roadway characteristics compared to the overall presence of those characteristics on the roadway system.

While the VRU Safety Assessment itself is focused on reducing fatalities and serious injuries for people walking and bicycling, this overrepresentation analysis uses all reported vulnerable user crashes (regardless of severity) to analyze of risk factors for people walking and bicycling. In cases where the underlying dataset of specific roadway characteristics was only available for a portion of the state (e.g., an inventory of street lighting was only available in ODOT Region 1), the overrepresentation analysis was scaled to only consider the geographic area for which that dataset was available.

ODOT analyzed several roadway- and equity-related risk factors to determine potential overrepresentation in vulnerable user crashes.

The following table presents the final list of risk factors carried forward in the VRU Safety Assessment, as shown in the Risk Factor column. The table also indicates if the risk factor was identified in this overrepresentation analysis or through other plans referenced in this work. Additionally, some risk factors such as high-access density, no sidewalks, and no bicycle lanes, were still carried forward in this assessment, even though they were not associated with overrepresentation, because of their association in other assessment methods and the strong perceived association related to behavior and presence or absence of facilities for vulnerable users:

- **Overrepresentation Analysis (’23 VRU SA OVERREP).** This analysis identified risk factors linked to a higher likelihood of vulnerable user crashes. This analysis involved comparing the total number of VRU crashes to the total Vehicle Miles Traveled (VMT) in various categories. For example, the analysis revealed that VRU crashes occurred more frequently in high SEI disparity areas than low disparity areas, making high SEI disparity a recognized risk factor.
- **2021 Oregon Bicycle & Pedestrian Safety Implementation Plan (‘21 OBPSIP).** This plan took a data-driven approach to identifying risk factors for pedestrian and bicycle involved crashes, high-risk locations, and countermeasures to address these risks following the process outlined in NCHRP Research Report 893: Systemic Pedestrian Safety Analysis.
- **2023 All Roads Transportation Safety (ARTS) Program Bicycle-Pedestrian Risk Rating (‘23 ARTS BPRR) Tool**. To improve the current ARTS program that distributes Highway Safety Improvement Program funding to Oregon DOT Districts and local agencies, ODOT revised the previously-used Cost Effectiveness Index (CEI) tool by incorporating the list of risk factors shows in the table and developing a new tool for use in ARTS applications.

Table 7: VULNERABLE ROAD USERS RISK FACTORS

RISK FACTOR	'23 VRU SA OVERREP	'21 OBPSIP	'23 ARTS BPRR
MEDIUM HIGH OR HIGH SOCIAL EQUITY INDEX DISPARITY LEVEL	x		x
ARTERIAL OR MAJOR COLLECTOR FUNCTIONAL CLASSIFICATION	x	x	x
NUMBER OF LANES (>= 2 LANES PER DIRECTION)	x	x	x
TRAFFIC VOLUME	x	x	
HIGH-ACCESS DENSITY (>= 40 ACCESS POINTS PER MILE)		x	x
NO SIDEWALKS (OR ONLY ONE SIDE), (URBAN ONLY)		x	x
POSTED SPEED (>= 35 MPH)	x	x	x
PROXIMITY TO SCHOOLS (<1 MILE)	x	x	x
PROXIMITY TO TRANSIT STOPS (<0.1 MILE)	x	x	x
SHOULDER WIDTH (<= 6 FEET, RURAL ONLY)	x		x
NO BICYCLE LANE (URBAN ONLY)		x	x
NO STREET LIGHTING	x	x	x
SIGNALIZED INTERSECTION SPACING (<=0.5 MILE)	x		x

3.3 CONSIDERATIONS DURING METHODOLOGY DEVELOPMENT

Identifying areas, facilities, and networks that pose the highest risk to VRUs can be accomplished through various combinations of datasets, analysis methodologies, and metrics. The final methodology and metrics were developed and refined based on the following considerations.

- **Segmentation**: Every analysis that develops a need-based network must address how to segment that system for scoring and prioritization. Limitations in this study will stem from the scope of the system (all public roads in Oregon), limited data on state and particularly on non-state roads, and the computer software and project schedule requirements.
- **Urban versus Rural**: The risks to, and needs of, VRUs can be quite different in urban and rural contexts. Additionally, because VRU volumes are significantly higher in urban areas, a statewide analysis, focused on facilities and volumes, would likely flag predominantly urban areas, facilities, and networks and thus ignoring potential risks outside of urban areas. As such, the methodology evaluates urban and rural areas differently based on their different risk factors.
- **Multiple outputs and metrics**: A single analysis output or metric is unlikely to accurately capture the highest priorities for VRU safety across the state. For example, looking only at High Injury locations may not reveal locations that pose such a high risk that VRUs avoid traveling there. For this reason, the methodology incorporates multiple screening methods and outputs that capture both risks and high-injury locations.
- **Data limitations**: From a statistical perspective, the data set of VRU-involved crashes is a relatively small sample. Further, this study relies on limited infrastructure and traffic volume data on the local system, and little-to-no exposure (via volumes) data for the VRUs themselves. As a result, ODOT focused primarily on risk factors that are available on all roadways and that have been identified in multiple VRU evaluations.
    - **Counterintuitive results**: One effect of the data limitations is the potential for erroneous conclusions. For example, if more people walking are seriously injured and killed at locations near transit stops, a naïve conclusion from incomplete data could be to assume transit stops are themselves unsafe. This does not consider the increased volume of people walking and bicycling in these areas.
    - **Lack of vulnerable users does not indicate a lack of risk**: People walking and bicycling may avoid some roadway segments due to a lack of corridor facilities and crossing opportunities. A lack of vulnerable road users (with a correlative lack of crashes involving this user type) does not make those roadways safe.
- **Coordination with Recent Methods**: ODOT's 2021 Bicycle and Pedestrian Safety Implementation Plan and 2023 All Roads Transportation Safety (ARTS) Program Cost-Effectiveness Index (CEI) analysis were used, and built upon, to determine the High-Risk Areas for this assessment.

Oregon has developed a multi-factor definition for High-Risk Areas based on the analysis described above and to align with TSAP implementation that includes hotspot, systemic, and comprehensive projects and strategies to reduce the frequency and severity of crashes.

3.4 HIGH-RISK AREA SCORING

To identify high-risk areas, ODOT analyzed all public roadways in Oregon for the presence of risk factors and the frequency of crashes involving people walking or biking during the five-year period from 2017 to 2021. The following sections highlight how the risk score and crash score were calculated to identify high-risk areas.

Risk Score. The risk score was calculated using thirteen risk factors as shown below:

1. **Equity,** Medium-High or High (all segments)
2. **Functional Classification**, Minor Arterial or Major Collector (all segments)
3. **Annual Average Daily Traffic (AADT),** Between 10,000 and 40,000 (all segments)
4. **Schools,** Within 1 mile (all segments)
5. **Transit Stops,** Within 0.1 mile (all segments)
6. **Posted Speed Limit,** Greater than or equal to 35 mph (State highways only)
7. **Number of Lanes,** Greater than or equal to 2 lanes per direction (State highways only)
8. **Traffic Signals,** Within 0.5 mile (State highways only)
9. **Access Density,** Greater than or equal to 40 access points per mile (State highways only)
10. **Bike Lane,** No bike lane (urban State highways only)
11. **Sidewalk,** No sidewalk (urban State highways only)
12. **Shoulder Width,** Less than or equal to 6 ft (rural State highways only)
13. **Street Lighting,** No street lighting (ODOT Region 1 State highways only)

For this assessment, each roadway segment received 1 point for each present risk factor. Due to the limited availability of data (e.g., State highways versus non-State highways), and differing applicability of some of the risk factors (e.g., rural versus urban areas), some risk factors were only applicable to certain types of segments.

In summary, the total number of applicable risk factors was as follows:

1. Urban State highways in ODOT Region 1: 12
2. Urban State highways in all other ODOT regions: 11
3. Rural State highways in Region 1: 11
4. Rural State highways all other regions: 10
5. Non-State highways: 5

To provide a fair comparison among the five roadway categories, a normalized risk score was calculated for each segment by dividing the total number of risk factors present by the total number of applicable risk factors. For example, a non-State highway was evaluated for five risk factors and the total number of present risk factors was then divided by five. The value was then multiplied by 100 to represent a percentage of the total evaluated risk.

Crashes Per Mile Score. The crash score was calculated using the historical 5-year crash data from 2017 to 2021. VRU Crashes Per Mile were calculated, and the segments were distributed into several bins representing quantiles.

- Segments with 0 crashes received 0%
- 1st quantile received 25%

- 2nd quantile received 50%
- 3rd quantile received 75%
- 4th quantile received 100%

Total Score. The total score was calculated using a combination of Crashes Per Mile Score and Risk Score. There was not a straightforward way to weigh either of the two scores, combining risk factors and crash data provides a comprehensive evaluation of safety. The risk score focuses on addressing root causes and risk reduction, while the crashes per mile score offers insight into the current safety performance. Historically, traditional safety analyses have relied solely on crash history, which is not the best way to identify high-risk areas, especially for VRU crashes given the small sample size of crash data. Therefore, ODOT created multiple combinations of weighting the risk score and crash score, and upon assessing each approach, decided on the following weighting: **80% Risk Score + 20% Crashes Per Mile Score.**[28]

Risk factors can capture trends and patterns not evident in crash history, especially when analyzing crashes involving vulnerable road users. ODOT decided on using an 80% weighting on the risk score because it places a stronger emphasis on proactively addressing risk factors, which can lead to long-term safety improvements for vulnerable road users.

The risk weighting factors utilized in the analysis were initially established using high-level statewide data that was accessible at the time. These factors serve as a foundational framework for prioritizing safety risk and treatments and provide an important starting point in our commitment to enhancing road safety for vulnerable users. It's important to acknowledge that vulnerable road user safety is a complex matter influenced by various factors that may not be fully captured in this comprehensive dataset. In addition, there may be unique challenges and characteristics that influence the nature of road safety risks for vulnerable road users not captured in current datasets. For example, in rural regions and in Tribal areas, vulnerable road users may need to travel longer distances to access essential services like schools, healthcare facilities, and stores, increasing their exposure to road risks.

To ensure the applicability and relevance of our safety strategies, continuous and in-depth analyses into the risk factors and associated weighting is necessary. Ongoing updates will allow us to refine the weighting factors, ensuring that they align with the specific requirements of safety analysis. Incorporating new and updated research findings as they become available will enable us to keep our safety initiatives optimally effective and responsive to evolving road safety challenges. In addition, collaborative engagement with local stakeholders, including community members, safety experts, and transportation decision makers, can provide the necessary data and inputs to fine tune the risk factor analysis. This approach ensures that safety assessments are not only data-driven but also focused on the specific needs and concerns of facilities and areas, ultimately leading to more effective and targeted safety strategies. Incorporating other datasets that consider factors not accounted for in crash data help create a more robust means to identify potential locations that could benefit from safety treatments.

[28] ODOT analyzed several different weights for crash history and risk factors, including 50% of each. This 80%/20% decision will be re-evaluated in the future based on its effectiveness to identify safety needs.

3.5 VULNERABLE ROAD USER HIGH-RISK AREAS

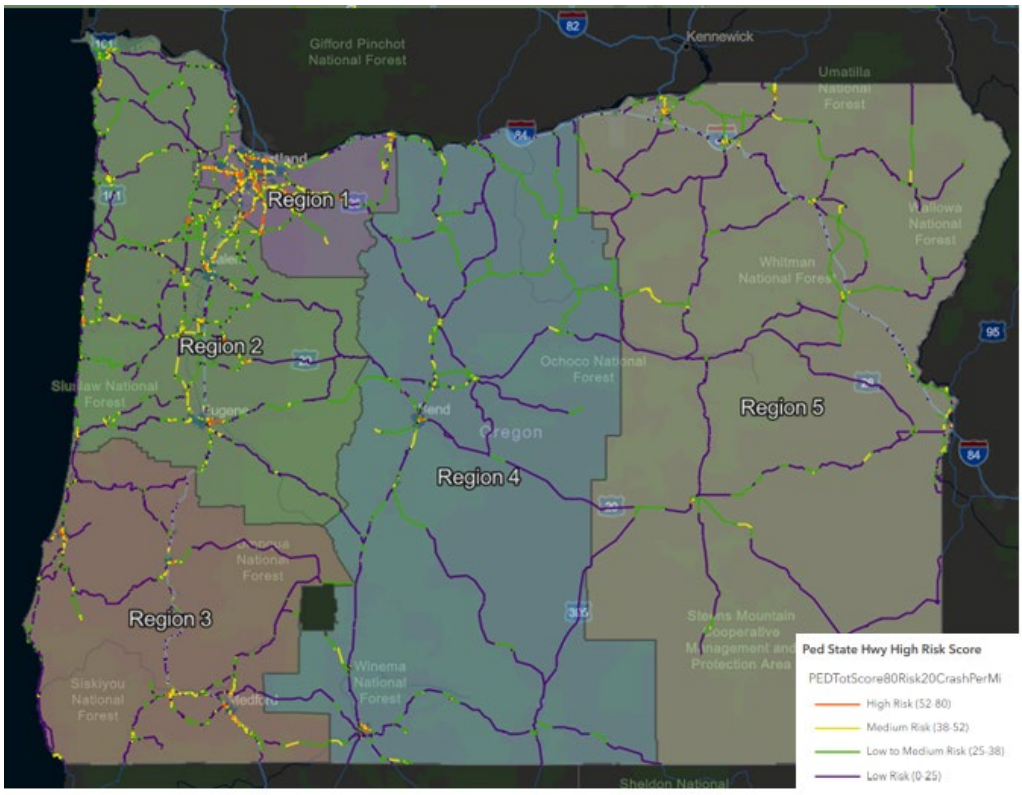
To identify high-risk areas, ODOT applied the methodology detailed in **Section 3.3 High-Risk Area Scoring** on all public roadways in Oregon. In this process, four interactive layers were created, which allowed for the identification of high-risk areas within an ArcGIS webmap[29] as follows:

- State Highways, People Walking
- State Highways, People Biking
- Non-State Highways, People Walking
- Non-State Highways, People Biking

The interactive webmap tool's primary purpose is to assist in identifying high-risk areas for any target facilities within a given jurisdiction or geographic region. Users have the capability to apply filters based on area type (rural/urban), functional classification, county, city, any risk factor, and crash history.

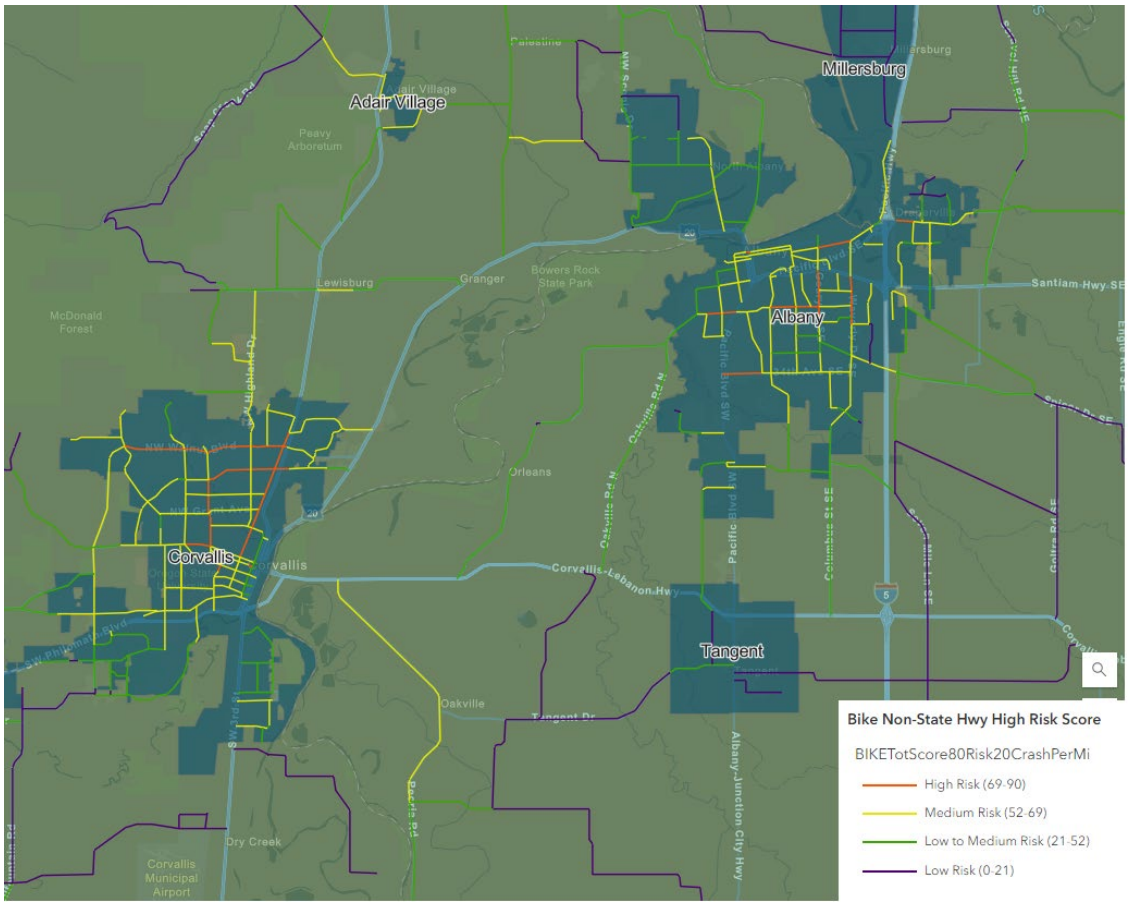
Figure 14 illustrates the risk of pedestrian crashes on all state highway roadways in Oregon. Figure 15 provides an example of a specific area within ODOT Region 2, highlighting the risk of bicycle crashes on rural, non-State highways.

Figure 16: OREGON VRU RISK SCORE, PEDESTRIANS, STATE HIGHWAYS, STATEWIDE



29 2023_ODOT_VulnerableRoadUser_Interactive Map (arcgis.com)

Figure 17: OREGON VRU RISK SCORE, BICYCLISTS, NON-STATE HIGHWAYS, ODOT REGION 2



Upon review of statewide data in the four primary categories mapped, ODOT identified those jurisdictions with the highest number of roadway miles considered High-Risk per this methodology. Also included is the proportion of that city's system that scored High-Risk.

State highways within cities play a pivotal role in the transportation infrastructure, connecting urban and suburban areas while serving as vital arteries for both local and long-distance travel. They facilitate the movement of people, goods, and services, often serving as the backbone of a city's transportation network. While providing connectivity and convenience, state highways within cities are often higher speed facilities which present unique challenges for ensuring safety for all road users. Tables 8 through 11 summarizes jurisdictions with the greatest state highway mileage of high-risk areas for state highways and non-state roads:

Table 8: JURISDICTIONS WITH GREATEST MILEAGE OF HIGH-RISK AREAS FOR PEDESTRIANS, STATE HIGHWAYS

	High-Risk Mileage (mi)	Total State Mileage (mi)	Proportion High-Risk
Total	*195*	*6,891*	*2.8%*
City			
Portland	24.7	66.0	37.4%
Springfield	9.3	12.9	72.0%
Grants Pass	6.7	17.1	39.1%
Beaverton	5.6	13.3	45.3%
Hillsboro	5.4	11.0	49.0%

Table 9: JURISDICTIONS WITH GREATEST MILEAGE OF HIGH-RISK AREAS FOR PEDESTRIANS, NON-STATE HIGHWAYS

	High-Risk Mileage (mi)	Total City Mileage (mi)	Proportion High-Risk
Total	*368*	*19,277*	*1.9%*
City			
Portland	125.5	478.5	26.2%
Salem	31.9	188.4	31.9%
Beaverton	26.4	87.3	30.2%
Eugene	22.5	175.0	12.9%
Medford	15.3	99.3	15.5%

Table 10: JURISDICTIONS WITH GREATEST MILEAGE OF HIGH-RISK AREAS FOR BICYCLISTS, STATE HIGHWAYS

	High-Risk Mileage (mi)	Total State Mileage (mi)	Proportion High-Risk
Total	*202*	*6,891*	*2.9%*
City			
Portland	25.6	66.0	38.8%
Springfield	9.5	12.9	73.5%
Beaverton	6.1	13.3	45.6%
Grants Pass	5.9	17.1	34.7%
Albany	5.8	16.1	35.8%

Table 11: JURISDICTIONS WITH GREATEST MILEAGE OF HIGH-RISK AREAS FOR BICYCLISTS, STATE HIGHWAYS

	High-Risk Mileage (mi)	Total City Mileage (mi)	Proportion High-Risk
Total	*371*	*19,277*	*1.9%*
City			
Portland	126.7	478.5	26.2%
Salem	33.7	188.4	17.9%
Beaverton	26.3	87.3	30.2%
Eugene	22.5	175.0	12.9%
Medford	15.1	99.3	15.5%

These four separate studies and associated maps led to a subset of cities with the most high-risk mileage. There are several rural and Tribal areas that are considered high-risk, as well as other cities that exhibited high-risk safety needs. Rural communities present unique challenges and characteristics that influence the nature of road safety risks for vulnerable road users. In rural regions and in Tribal areas, vulnerable road users may need to travel longer distances to access essential services like schools, healthcare facilities, and stores, increasing their exposure to road risks. While some strategies may be applicable in both urban and rural contexts. ODOT will continue to collaborate with local partners to identify and address vulnerable road user safety needs in those areas, too.

4. SUMMARY OF CONSULTATION

At the outset of this study, ODOT sought to incorporate input from our local partners as an integral component of this assessment. The consultation was driven by our commitment to enhancing the safety of vulnerable road users statewide through the application of the Safe System Approach. The collaboration involved engaging local partners and Tribal governments, from areas with geographical and/or roadway-specific characteristics that contribute to a higher frequency of crashes involving vulnerable road users. Our shared objectives included identifying safety priorities, assessing risk factors, and exploring potential solutions to enhance road safety for vulnerable road users.

In addition, ODOT initiated a comprehensive review of relevant pre-existing documentation and actions. This step was essential to ensure the alignment of our Partners Consultation Plan with FHWA guidelines, the fulfillment of OTC's Public Involvement Policy requirements, the promotion of adherence to the State Agency Coordination Program, and the dedication to consult with Tribal governments as part of our broader commitment to statewide planning. The dialogue around data, the Safe System Approach, safety priorities encompassing both crash-related and risk-driven factors, and the exploration of potential solutions have all been central to this effort.

Primary engagement activities included a presentation and workshop at the Oregon Transportation Safety Conference, a virtual Partners Workshop aimed at informing relevant partners of the VRU

Safety Assessment and seeking their input on its development, Tribal consultation, and regular project updates with the Oregon Bicyclist and Pedestrian Advisory Committee.

ODOT staff held several consultation events to inform partners about and gather their feedback on the VRU Safety Assessment process. The following sections summarize these events and their outcomes.

4.1 SAFETY CONFERENCE EVENT, MARCH 2023

In March 2023, ODOT staff facilitated a workshop on the VRU Safety Assessment as part of the 2023 Annual Transportation Safety Conference in Grand Ronde, Oregon. Approximately 50 attendees participated in the workshop that featured an overview presentation about the VRU Assessment, including a summary of the FHWA requirements and the five objectives of the Safe System approach (Safer People, Safer Roads, Safer Speeds, Safer Vehicles, and Post-Crash Care). The workshop also included small-group discussions centered on each of the Safe System Approach principles to gather insights from the audience on their priorities, challenges, and experiences working to improve bicycle and pedestrian safety in their communities.

OUTCOMES. The safety conference provided a unique venue for a trial run of the consultation questions and to gather preliminary input on vulnerable road user safety challenges and opportunities in Oregon. Partners from a variety of agencies and safety organizations provided valuable feedback that allowed the project team to refine the materials for the Partners Workshop while also influencing the analysis, risk factors, and emphasis of the VRU Safety Assessment.

4.2 PARTNERS WORKSHOP, JUNE 2023

On June 30, 2023, ODOT facilitated a virtual roundtable discussion with identified partners. The 31 attendees included representatives of the following entities:

- National Highway Traffic Safety Administration (NHTSA)
- Federal Highway Administration (FHWA)
- Oregon Transportation Safety Committee
- Oregon Emergency Medical Services and Trauma Systems
- Metro (Portland region’s metropolitan planning organization)
- TriMet (Portland area’s transit agency)
- City of Eugene
- Portland Bureau of Transportation
- City of Newport
- Hood River County Transportation District/Columbia Area Transit
- The Street Trust
- Oregon Impact
- Oregon Walks

The workshop objectives focused on the consultation requirements within the FHWA Office of Safety Memorandum, including:

- Gain local knowledge and perspective on the factors contributing to the safety concerns in high-risk areas and identify potential projects or strategies to improve the safety of VRUs.
- Seek insights on policies, rules, and procedures that could be revised to ensure the consistent consideration of the safety needs of vulnerable road users across all project types.
- Consult institutional, advocacy, and community groups, particularly those that represent populations that may be underrepresented.

The workshop discussion included the following items:

Vulnerable Road User Safety Assessment Components. Attendees noted the importance of speed in vulnerable user-involved crashes and using the Safe System Approach.

Analysis Methodology. ODOT summarized the VRU Assessment's methodology for data analysis and its relationship to previous safety planning efforts, including the 2023 All Roads Transportation Safety (ARTS) pedestrian and bicycle analysis and the 2021 Pedestrian and Bicycle Safety Implementation Plan. ODOT also discussed the VRU Safety Assessment's analysis of demographic and equity data. Feedback from attendees included an interest in addressing vehicle size/weight in VRU crashes and concerns about exposure data and travel data availability.

Program of Strategies. ODOT summarized FHWA requirements for this element of the Assessment, including addressing greenhouse gas emissions and equity.

Partner Consultation and Engagement. This section included a summary of consultation and engagement efforts with various entities (previous and upcoming), such as the Oregon Bicycle and Pedestrian Advisory Committee (OBPAC) and Tribal consultation.

Safe System Approach. Attendees highlighted the importance of culturally-specific approaches to traffic safety projects and outreach. They also discussed the benefits of alcohol detection devices and concerns about increasing vehicle weight and size affecting VRU fatalities and serious injuries. Other topics included the potential for common traffic engineering performance measures, such as volume-to-capacity ratios, to impede safety improvements.

- **Safer Speeds.** Safer Speeds was a major point of discussion in the Partners Workshop held in June of 2023. Attendees noted the importance of speed in the severity of VRU crashes and the need for better speed enforcement. Several participants noted that common traffic engineering standards, such as volume-to-capacity ratios and restrictions on raised crossings can hinder efforts to reduce speeds.
- **Safer Vehicles.** Participants in the June 2023 Partners Workshop emphasized the need for safer vehicles. This concern centered on the recent increases in vehicle size and weight, which have correlated with increased VRU fatalities and serious injuries. While ODOT does not have direct jurisdiction over vehicle size and weight, attendees noted the potential for the state to index vehicle registration fees to weight. This topic highlighted a need for further study and potential policy changes at the State and Federal levels to address this trend.
- **Post-Crash Care.** Attendees of the Partners Workshop noted that California has a post-crash team that analyzes every fatal crash in the state. They also noted that the Portland

Police Bureau has expressed interest in establishing a similar program in the city. In consideration of those comments, some cities have begun including hospital discharge data in their safety data analysis and planning activities, which Oregon could learn from and incorporate over time.

OUTCOMES. The Partners Workshop provided a valuable opportunity to inform partners about the VRU Assessment's progress and gather input on their priorities and experiences. Attendees emphasized the importance of using the Safe System Approach (i.e., addressing increasing vehicle weight/size), considering equity, and using a data-driven approach to safety.

- Input on the analysis methodology was incorporated into the crash history and risk-based analysis, and in the identification of High-risk Areas.
- Interest in vehicle-related topics led to further investigation into Oregon DOT's ongoing research and efforts at the federal level.
- The discussion of data limitations, including challenges with travel data for people walking and bicycling, informed the team's analysis and recommended next steps beyond this assessment.

4.3 TRIBAL ENGAGEMENT, AUGUST 2023

On August 30, 2023, ODOT staff held a Tribal Partners Workshop with representatives from the Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians, the Confederated Tribes of the Umatilla Indian Reservation, the Klamath Tribes, the Confederated Tribes of Siletz Indians, and the Burns-Paiute Tribe. ODOT staff gave an overview of the VRU Assessment process, including the Safe System Approach and a summary of the analysis methodology employed up to that point.

Tribal representatives expressed the following concerns and opinions:

- Car ownership tends to be lower in Tribal communities.
- Some Tribal members are hesitant to see new bus shelters near their homes because of the perception that pedestrians and transit riders are more likely to commit crimes.
- Highways often have no or narrow shoulders.
- Quantitative data analysis for individual projects is difficult due to a lack of high-quality data.
- Drug and alcohol dependency (leading to more crashes) is a major issue in Tribal communities.
- Crashes in Tribal areas often go unreported.
- Tribal areas often lack infrastructure to support VRUs (e.g., bike lanes and sidewalks).

Tribal representatives also discussed potential avenues for community engagement and education, including open houses, cultural events such as rodeos, and walk-to-school days. However, attendees expressed the concern that some areas have no existing safe routes to school and were unsure if it would be wise to encourage walking in such circumstances. Finally, attendees noted that Tribes are working to partner with other jurisdictions and ODOT, but that coordinating project specifics is difficult and that funding for VRU projects is lacking.

Safe People. The Tribal Engagement workshop included a discussion of the role of alcohol and drug misuse in relation to vulnerable road user crashes. At the Partners Workshop, representatives

for the Portland Bureau of Transportation described how their agency engages in cultural-specific approaches to traffic safety outreach and projects.

OUTCOMES. The Tribal Partners workshop provided a valuable opportunity for ODOT to inform representatives about the VRU SA process and gather their feedback on this effort and VRU safety concerns in general.

- The workshop highlighted the need for increased coordination with Tribal governments at the planning and project levels.
- Additional effort was taken to identify the rural needs of pedestrians and bicyclists, and in particular those traveling from a Tribal community to a nearby city for goods and services.

4.4 OREGON BICYCLE AND PEDESTRIAN ADVISORY COMMITTEE CONSULTATION

The Oregon Bicycle and Pedestrian Advisory Committee (OBPAC) is a Governor-appointed committee created in statute to advise ODOT on establishment of walkways and bikeways and regulation of pedestrian and bicycle traffic. ODOT staff gave overviews of the VRU Assessment process, including the Safe System Approach and a summary of the analysis methodology and results to date at OBPAC meetings on July 25 and September 26, 2023. OBPAC also convened a working group to review and provide written comment on a final draft of the VRU assessment in late October 2023.

At the July and September meetings, OBPAC members shared support for the additional focus on vulnerable road user safety and hope that the assessment would result in additional actions from ODOT and partners to address negative trends. Members emphasized the need to focus on addressing crash risk factors. For instance, some intersections and roads are so dangerous that people walking and biking avoid them, thus crashes are not occurring there. "Near misses" and incidents that people do not report because they are in shock after a crash while walking or biking are also important missing safety data. Members also discussed the impact of safety and convenience on people's travel choices and behaviors, emphasizing the need for ODOT to improve the actual and perceived safety and convenience of walking and biking to achieve policy goals addressing safe routes to school, climate change, congestion, mode split, and equity.

In addition, OBPAC provided the following comments and topics for further discussion during check-in meetings and as part of their review of the draft safety assessment document.

OUTCOMES

Safer People

- What do we know about the drivers who strike vulnerable users? Example items include their driving record (previous citations), licensure status, and impairment.
- Remove "non-motorist not visible; non-reflective clothing" cause from the crash attributes. This is victim blaming.
- Distracted driving is unlikely to be captured in crash reports.
- Recognize the change in the use of smart phones over the past 10+ years as it relates to road user behavior.
- Include number of citations and traffic enforcement officers per capita

Safer Vehicles

- Is there information about vehicle maintenance or condition included in these studies?
- Consider graduated vehicle fees based on vehicle size and safety rating of the vehicle. More rigorous testing and experience may be required to drive a higher-risk, heavier vehicle.
- Recognize the increased sales of larger vehicles (SUVs, CUVs, and pickups).

Safer Roads

- Utilize road safety audits and proven safety countermeasures more
- Narrow and slow down roadways
- Add pedestrian infrastructure
- Investigate increasing rates of pedestrian deaths on highways and freeways (tied to homelessness). Consider strategies to provide housing in safer locations,

Safer Speeds

- Lower design speeds in urban areas to focus on speeds that don't kill and severely injure vulnerable road users

Data Analysis

- Improve data collection.
- Build statewide ped/bike count program to be able to include exposure data (currently not accounting for rate of usage of transportation system).
- In the Safety Assessment, include rates per mile of roadway (State/City/County).
- In the Safety Assessment, add specific streets for total mileage in Tables 8-11.

VRU Safety Assessment and its Implementation

- Commit to creating and implementing concrete actions
- Tie to funding programs (who gets funds/what they can use funds for)
- Meet with cities on top 5 lists and discuss what to do together about locations

5. PROGRAM OF STRATEGIES

The Oregon Vulnerable Road Users Safety Assessment includes strategies to reduce safety risks to vulnerable road users in areas identified as high-risk and systemically statewide. Oregon DOT took into consideration the input from safety data analysis, the consultation described above, the Safe System Approach, and the Complete Streets Design Model[30].

Although not directly factored into the risk assessment, the strategies were also guided by the principles of the Americans with Disabilities Act (ADA), as well as considerations related to Transportation System Access, Temporary Traffic Control, and Access to Transit. All of which contributes to creating a safer and more accessible environment for all road users, particularly those who may be at higher risk due to mobility challenges or other factors. In addition, it reflects a commitment to safety, equity, and inclusivity in transportation systems.

[30] Complete Streets | FHWA (dot.gov) Complete streets are planned and designed to accommodate all users including pedestrians, cyclists, transit users, and motorists

Sources for these vulnerable road users safety strategies include existing Oregon plans and manuals focused on pedestrian and bicyclist safety, other state and local agency's innovative treatments, and programs, and national and international sources. These include the following:

- NCHRP 20-44(13): Oregon Bicycle and Pedestrian Safety Implementation Plan
- FHWA Proven Safety Countermeasures
- NHTSA Countermeasures That Work
- NHTSA New Car Assessment Program (NCAP)
- National Association of City Transportation Officials (NACTO) Urban Street Design Guide
- Oregon Transportation Plan (OTP)
- Oregon Transportation Safety Action Plan (TSAP)
- Oregon Strategic Action Plan (SAP)
- Oregon Bicycle and Pedestrian Plan (OBPP)
- Oregon Transportation Options Plan (OTOP)
- Oregon Public Transportation Plan (OPTP)
- Oregon Statewide Transportation Strategy (STS)
- Oregon Highway Plan (OHP)

The strategies and references below are organized by the Safe System Approach elements: Safer People, Safer Roads, Safer Speeds, Safer Vehicles, and Post-Crash Care.

5.1 SAFER PEOPLE

The Safe System Approach addresses the safety of all road users, including those who walk, bike, drive, ride transit, and travel by other modes. An important principle of the Safe System approach is that responsibility is shared. All transportation partners and road users must ensure that crashes do not lead to fatal or serious injuries. While preceding this VRU Assessment, Oregon's TSAP already includes several strategies and actions related to improving vulnerable road users safety, including the following.

- Improve awareness and understanding of transportation laws, roles, and responsibilities through programs such as Safe Routes to School.
- Implement a Safe Routes to School Program.
- Implement and promote increased funding for the bicycle safety training in the Safe Routes to School program.
- Work with school districts, state, regional, Tribal, county, and city governments and local education interest groups to evaluate and implement best practices for safety in school zones.
- Expand Driver's Education content to embrace "Road User Education" that includes all modes. Content should include driving safely around bicyclists and pedestrians (e.g., bike lanes, bike boxes, pedestrian hybrid beacons).
- Identify unsafe walking, biking, or driving behaviors that could be addressed through legislation. Identify and pursue legislation to modify these behaviors.
- Coordinate efforts to provide safe crossings and access to public transportation facilities for pedestrians and bicyclists, including people with disabilities.
- Identify and implement appropriate facility design, lighting, and other changes to improve personal security and safety for pedestrians, bicyclists, and transit riders.

- Elevate safety improvements in school zones, work zones, transit stops, and economically and socially vulnerable populations.
- Increase lifelong safety education for all roadway users, transportation facility designers and operators, first responders, and enforcement officers; with particular focus on the transportation safety needs of youth and aging populations.
- Emphasize the safety of people walking, bicycling, and rolling through outreach and education to all system users.
- Expand use of yard signs promoting driver awareness of people walking and bicycling.

This VRU Safety Assessment emphasizes the importance of maintaining and, where possible, expanding these strategies. With ongoing updates to the assessment, it is crucial to consistently reassess and enhance the strategies based on the latest data and using more comprehensive analysis. This will allow for potential refinements to the TSAP implementation plan, enabling a progression towards more promising VRU safety strategies.

5.2 SAFER ROADS

Designing to accommodate human mistakes and injury tolerances can reduce frequency and severity of crashes involving vulnerable users. It is important to use proactive tools to identify and mitigate risks in the transportation system, rather than waiting for crashes to occur and reacting afterwards. This includes the potential to evaluate and apply surrogate safety measures or leading indicators, such as near miss events that allow for the comparison of safety-related events by acting as proxies for likely crash outcomes.

Oregon's primary source of infrastructure safety solutions is the All Roads Transportation System (ARTS) program's Crash Reduction Factors (CRF) Manual.[31] The Safety Countermeasures List in the ODOT CRF Manual is developed to provide safety practitioners, intending to use Highway Safety Improvement Program (HSIP) funding, with a list of effective countermeasures that are appropriate improvements to many common safety issues. The countermeasures presented in this manual are aimed at reducing crash frequency or severity on all public roads. These countermeasures represent infrastructure improvements at intersections and along roadways such as the addition of signs, signals, or markings, or a change in roadway design. The safety treatments in this list are those that have been in place for an extended period and/or have proven effective. As new safety research data becomes available, the list will be evaluated to update, add, or remove some safety improvement countermeasures.

The CRF Manual includes a section called "Bike/Ped Systemic" focused on 31 approved infrastructure treatments for improving vulnerable user safety. It also includes other treatments that, while not primarily intended to reduce crashes involving people walking and bicycling, can provide this benefit to vulnerable users. Oregon DOT and safety partners also refer to the FHWA Proven Safety Countermeasures, FHWA's Pedestrian Safety Guide and Countermeasure Selection System, and toolboxes from other state transportation agencies.[32]

[31] Crash Reduction Factor Manual, Oregon DOT, 2023. https://www.oregon.gov/odot/Engineering/ARTS/CRF-Manual.pdf
[32] For example, Caltrans' Pedestrian Safety Countermeasures Toolbox. https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/ped-bike/caltrans-ped-safety-countermeasures-toolbox-a11y.pdf

A subset of those strategies along with other strategies includes the following.

- Focus on reducing fatal and serious injury crashes statewide.
- Emphasize proven safety countermeasures that minimize conflicts between modes that result in serious injury or death.
- Implement pedestrian signals with countdown timers to provide clear guidance to pedestrians and drivers.
- Use leading pedestrian intervals to give pedestrians a head start when crossing, enhancing their visibility.
- Consider pedestrian-only signal phases to allow exclusive crossing time for pedestrians.
- Enhance lighting at intersections, focusing on pedestrian-scale lighting to improve visibility for vulnerable road users, especially at night. Ensure that lighting fixtures are properly maintained to avoid dark spots.
- Design and construct protected intersections with dedicated spaces for pedestrians and cyclists, separated from vehicular traffic.
- Install protected bike lanes and pedestrian refuge islands to improve safety at intersections.
- Add dedicated right-turn signal phases to separate turning vehicles from pedestrian crossings.
- Implement bicycle-specific signals at intersections to improve cyclist safety.
- Install buffered and separated bike lanes to provide dedicated spaces for cyclists.
- Create shared-use paths to accommodate both pedestrians and cyclists, ensuring safe coexistence.
- Mark crosswalks at appropriate locations to indicate pedestrian crossing areas.
- Use warning signs, refuge islands, and flashing beacons to enhance the safety of marked crosswalks.
- Install pedestrian hybrid beacons at high-risk crossings to facilitate safe pedestrian crossings.
- Widen paved shoulders on rural roads to provide safer space for cyclists and pedestrians.
- Use clear markings to designate paved shoulders as shared-use paths in areas with high pedestrian activity.
- Construct new sidewalks in areas with pedestrian demand and high-risk road user interactions.
- Maintain and repair existing sidewalks to ensure they are safe and accessible for pedestrians.
- Elevate maintenance practices that address potential hazards for vulnerable users, including signalized intersections and sidewalks. Regularly inspect and maintain facilities to ensure their safety and functionality.
- Target safety initiatives and engineering solutions to reduce fatal and serious injury crashes, with a specific focus on vulnerable road users.
- Monitor and evaluate the effectiveness of safety measures to achieve this goal.
- Integrate the Safe System Approach into all transportation projects, emphasizing proven safety countermeasures and physical/temporal separation between modes.
- Elevate the safety of vulnerable road users in project design and implementation.
- Implement urban design strategies that promote safety through visibility and natural surveillance.

- Develop comprehensive databases for vulnerable road user safety data to identify high-risk areas and research new or improved countermeasures.
- Improve security and perceived safety for vulnerable road users through illumination and other improvements, especially at transit stops.
- Advocate for the proactive incorporation of vulnerable road user safety needs in emerging technologies.
- Elevate the safety of vulnerable road users in project design and implementation.

In addition to the ARTS program, ODOT recently updated the Intersection Safety Implementation Plan. The update is based on a data-driven framework for conducting systemic intersection safety analyses that is in line with the Safe System Approach (SSA). The main goals of this update include:

- Reducing Conflict Points: the potential for intersection crashes is substantially reduced where conflict points are minimized, especially for vulnerable road users. The best way to achieve this is by separating different modes of transportation whenever possible. Constructing dedicated lanes or pathways for pedestrians, cyclists, and motorized vehicles which greatly reduces the likelihood of conflicts.
- Improving and Reducing Conflict Angles: reducing conflict angles at intersections, not only reduces the likelihood of crashes but also the injury severity if a crash occurs.
- Reducing Approach Speeds: A critical aspect of enhancing intersection safety is the reduction of approach speeds for all modes of transportation. Slower speeds provide more reaction time and reduce the severity of potential crashes, aligning with the Safe System Approach's emphasis on reducing injury severity.
- Improving Visibility: To mitigate the potential for blind spots and improve visibility, the plan focuses on ensuring that all road users have a clear line of sight at intersections.

This VRU Safety Assessment emphasizes the importance of maintaining these strategies and safety treatments. With ongoing updates to the assessment, it is crucial to consistently reassess and enhance the strategies and safety treatments based on the latest research, data, and updated analysis methods. This will allow for potential refinements enabling a progression towards more promising VRU safety strategies treatments.

5.3 SAFER SPEEDS

People have limits for tolerating crash forces before death and serious injury occurs; therefore, it is critical to design and operate a transportation system that is human-centric and accommodates human vulnerabilities. This is especially true for people walking and bicycling who are not protected by the physical structure and safety devices of motor vehicles. Reducing motor vehicle speeds can accommodate human injury tolerances in three ways: improving visibility, providing additional time for drivers to react when necessary, and reducing impact forces when a crash occurs.

Safer Speeds overlaps with several of the traditional "Es of Safety." Engineers design roadways and calculate appropriate posted speed limits, and they can add countermeasures on roadways that exhibit higher-than-desired operating speeds. Enforcement partners support regulatory speed limits with presence and (when necessary) corrective actions like warnings and citations. And Education partners help the public understand the importance of safer speeds to reduce the number and severity of crashes.

The following are several strategies to address motor vehicle operating speed:

- Set appropriate posted speed limits by applying the latest ODOT-approved methods (e.g., basing posted speed limit in urban areas on the 50th percentile speed).[33]
- Support the expanded use of automated enforcement ensuring it is done in a way that has safety as the priority and addresses equity concerns.
- Consider speed humps or tables, where appropriate, in residential areas, school zones, and high-risk pedestrian locations to reduce vehicle speeds. Pair with clear signage and road markings to enhance visibility
- Design roundabouts with pedestrian and cyclist-friendly features, including clearly marked crosswalks, refuge islands, and dedicated bike lanes and implement traffic-calming elements at the approach to roundabouts to reduce vehicle speeds and improve safety.
- Install speed feedback signs in areas with a history of speeding or high-risk road user interactions.
- Use road diets as an opportunity to add bike lanes or shared-use paths, creating a safer environment for all road users. Utilize lane narrowing to slow down vehicle speeds, provide safer crossing opportunities for pedestrians and to add bike lanes or shared-use paths, creating a safer environment for all road users. Ensure that lane narrowing is implemented in areas with high pedestrian and cyclist activity.
- Implement left-turn wedges and hardened centerlines at intersections to reduce the risk of conflicts between left-turning vehicles and vulnerable road users
- Consider opportunities to create a buffer between pedestrians and moving traffic such as street trees
- Actively manage speeds and reduce speed differentials between roadway users
- Promote public awareness and education about the presence of enforcement technology to deter speeding.

This assessment presented an opportunity for a more involved discussion of the Safe Speeds component of the Safe System approach and has emphasized the need to integrate safety and risk assessments that consider more directly integrating speed and kinetic energy assessment and management into future safety identification methods.

5.4 SAFER VEHICLES

Vehicles should be designed and regulated to minimize the frequency and severity of crashes, which includes incorporating technological solutions. The vast difference in mass and speed between motor vehicles and vulnerable road users requires additional attention be paid to design and regulations' effects on the safety of road users outside the vehicle.

Oregon DOT is currently conducting research regarding factors associated with pedestrian injury severity, with a focus on vehicle design and speed.[34] It assesses the role of vehicle type, weight, and size as well as roadway and road user characteristics in fatal and serious injury crashes involving pedestrians.

[33] Updated ODOT Speed Zone setting methodology effective 5/1/20
[34] Roll, Josh. Vehicle Design and Speed: Factors Associated with Pedestrian Injury Severity in the Pacific Northwest. Submitted to the Transportation Research Board 8/1/23 (Pending Review).

The National Association of City Transportation Officials (NACTO) joined local governments and national organizations from across the United States to call on the U.S Department of Transportation (USDOT) to stop giving 5-star safety ratings to vehicles that are more likely to be involved in crashes where vulnerable road users die.[35] NACTO's letter to NHTSA recommends the following features be included in the vehicle rating system to support the safety of people walking and bicycling.

1. Advanced Driver Assistance System (ADAS) features to sense and protect people outside vehicles
2. Intelligent speed assistance systems to limit unsafe speeds
3. Pedestrian protection and crashworthiness/survivability for people outside the vehicle
4. Direct visibility from the driver's seat, which is related to vehicle size and hood height

While ODOT lacks influence over vehicle design, this assessment with the analysis of the contributing factors can assist in identifying potential safety measures and treatments that can be implemented to enhance the overall safety of the road environment for vulnerable road users. Additionally, identification of vehicle size and weight issues can help influence on-going pedestrian severity injury research.

5.5 POST-CRASH CARE

Humans have a limited tolerance for crash forces, prompting swift reactions when a crash occurs. This is particularly important for vulnerable users because the initial impact with a motor vehicle is likely to cause personal injury. The "Golden Hour" in the context of post-crash care refers to the critical period following a traumatic injury, such as a crash, when the likelihood of a positive outcome is highest if the injured person receives prompt and effective medical treatment within the first 60 minutes after the injury occurs.

During this initial hour, medical intervention can be especially effective in stabilizing the injured individual, preventing further complications, and improving the chances of survival and recovery. It's important for emergency medical responders and healthcare providers to reach the injured person and begin treatment as quickly as possible during the Golden Hour to maximize the chances of a successful outcome.

While the term "Golden Hour" is a widely recognized concept in emergency medicine, it's important to note that the time frame isn't always precisely 60 minutes, and the importance of immediate medical attention can extend beyond that period, depending on the nature and severity of the injuries. Nonetheless, the concept underscores the critical importance of rapid response and medical care for trauma victims. When a person is injured in a crash, they rely on emergency first responders to quickly locate them, stabilize their injury, and transport them to medical facilities for further care. Potential post-crash care strategies include the following.

- Installing directional signs and mile point markers, especially for vulnerable road users on highways and rural roads, can be critical in guiding responders to a precise crash location.
- Supporting a robust communication network, including cell phone coverage on rural roads and highways, ensures that crashes can be quickly reported to emergency services.

[35] Cities and Organizations Across the Country Call on USDOT to Stop Giving 5-Star Safety Ratings to Dangerous Vehicles, NACTO, August 2, 2023. https://nacto.org/2023/08/02/stop-giving-5-star-safety-ratings-to-dangerous-vehicles/

- Improved lighting, especially on urban and suburban roads and highways, can help guide responders to a precise location and provide care quicker.
- Integrate hospital, EMS, and crash data to improve analysis of crashes involving people walking and bicycling that may not be included in the crash database. A comprehensive data integration effort allows for a better understanding of differences in crash severity reported at the scene and by medical professionals.
- Support Incident Management which plays a key role in improving safety for on scene responders and victims.
- Identify opportunities for collaboration with crash reconstruction and forensics to better understand contributing factors and how those factors relate to injury severity.

This VRU Safety Assessment has identified underreporting and injury categorization as important considerations in developing future safety crash data and risk assessment methods. While ODOT is already engaged with the Oregon Health Authority (OHA) on tracking trauma system outcomes associated with traffic crashes, this Assessment underscores the need to work more closely to consider trauma system data for vulnerable road user crashes, including response times, crash severity (as reported by hospital data), and underreporting.

6. CHALLENGES AND NEXT STEPS

This initial Vulnerable Road Users Safety Assessment identified several barriers that, when overcome, will help Oregon DOT and its safety partners continue to make improvements to this assessment and resulting projects and strategies in the future.

6.1 VRU ASSESSMENT DATA CHALLENGES AND NEXT STEPS

This assessment identified several data-related limitations to analyzing vulnerable road users' safety needs and identifying strategies to reduce the frequency and severity of crashes involving people walking and bicycling. The following is a summary of those issues and potential next steps to address them in the future.

- Lack of comprehensive data on VRU exposure (e.g., pedestrian and bicyclist volumes) limited the analysis capabilities to identify and evaluate potential risk factors.
    - ***Potential Next Step:*** Continue investigating readily available data such as crowd-source estimates and other tools that collect pedestrian and bicyclist volumes. As more counters are installed and software developed and improved in the future, a scalable dataset can be used to estimate VRU exposure.
- Because of time limitations for this effort, land use data was not available for this first analysis.
    - ***Potential Next Step:*** Incorporate land use and zoning data in future activities relating to VRU safety assessment.
- The underreporting of non-fatal incidents involving people walking and bicycling skews the available crash data, potentially leading to biased analyses.
    - ***Potential Next Step:*** Analyze the extent of underreporting and consider other data sources to mitigate this limitation (e.g., hospital discharge data, crowd-sourced incident reporting).

- This study is limited to the available risk factor datasets, and these data were not available at the same level for all types of roadways.
    - ***Potential Next Step:*** Complete collection of roadway inventory data for all public roads (State highways and non-State highways), including shared use path presence, cycling facilities presence, and presence of lighting.

These data limitations highlight the need for improved data collection strategies and standardized reporting protocols to enhance the understanding, evaluation, and mitigation of risks faced by vulnerable road users.

6.2 OUTREACH AND COLLABORATION CHALLENGES AND NEXT STEPS

The short duration of the project limited the team's ability to conduct multiple engagement and outreach activities to partners and the public. In addition, the timing and effort required for the safety data analysis and determination of high-risk areas did not allow for extensive engagement with those agencies identified in advance of this publication.

Next Steps:

- Continued and enhanced consultation with the previously-contacted partners, along with an assessment of who did not participate in the 2023 VRU Safety Assessment but should be included in implementation and future revisions.
- Expand community engagement and partnerships across agencies, jurisdictions, and organizations to better understand and address safety issues.
- Provide training and outreach to disseminate the Safe System approach more broadly.
- The VRU Safety Assessment identified the extent of the VRU fatality and serious injury problem off the state system. The crash and risk assessment methodology can be applied to local jurisdictions and Tribal governments to allow a focused VRU safety assessment. Consultation and outreach efforts will be made to make local jurisdictions and Tribal governments aware of this assessment and the ability to employ to their particular network and area.
- Develop a partnership engagement plan for implementing the findings from this assessment that focuses on economically and socially vulnerable populations.
- Set up recurring meetings with local and non-traditional partners, such as tribal partners and public health programs, to implement the partnership engagement plan and to leverage opportunities that support effective changes outlined in this assessment.
- Increase safety funding to address the items listed above.

6.3 IMPLEMENTATION, MONITORING, AND EVALUATION

While much work was accomplished in this first Vulnerable Road Users Safety Assessment, ODOT will continue to build upon and grow partnerships to help improve capabilities in analysis, problem identification, and project and strategy prioritization to improve safety for vulnerable road users.

While this assessment does not include specific projects (because of limited time, presence of other plans which serve as project identification and implementation, and concerns over data limitations), there are strategies developed and included that can be pursued and aligned with

existing and future plans such as the Transportation Safety Action Plan (which serves at the Oregon Strategic Highway Safety Plan as follows:

- Performance Metrics and Indicators Reflecting Safe System Objectives
- Monitoring Progress with Safe System Metrics
- Evaluation of Safety treatments within the Safe System Context
- Assessment of existing strategies and implementation efforts focusing on VRUs in the TSAP

In addition, support for these strategies will continue to be pursued through existing safety programs such as the All Roads Transportation Safety (ARTS) program that administers Highway Safety Improvement Program (HSIP) funding, implementation of the TSAP, and coordination with agencies responsible for the implementation of other related transportation plans.

Monitoring and evaluation of safety output (e.g., infrastructure projects aimed at providing safer options for people walking and biking) and safety outcomes (e.g., the number and severity of crashes involving vulnerable users) will continue through TSAP implementation.

7. CONCLUSION

The Oregon Vulnerable Road Users Safety Assessment is an assessment of the safety performance with respect to people walking and bicycling in Oregon. It outlines the state's plan to improve the safety of vulnerable road users in accordance with federal law. More than 400 people walking and bicycling in Oregon have been killed in traffic crashes in the past 5 years, and another 832 suffered serious injuries during that same period.

Oregon DOT and its safety partners identified primary contributing factors to vulnerable road user-involved crashes as well as other factors (related to roadway inventory features and social equity) that correlate with increased probability of future risk of fatal and serious injury crashes. These include posted speed limit, lighting conditions, road users not yielding right-of-way, health equity disparity, and roadway functional classification, among other factors. This assessment then identified High-Risk Areas based on a combination of crash history and risk factors to identify geographies and roadway types that are most at-risk for future crashes involving people walking and bicycling.

The Safe System Approach provides a framework for identifying and categorizing a program of strategies to reduce the number and severity of vulnerable road user-involved crashes. Implementation of these strategies will improve safety in the High-Risk Areas and statewide. This implementation must include progress monitoring, evaluation of effectiveness, and regular updates to continue incorporating new data, new research, and new methods to improve safety for people walking and bicycling in Oregon.