
# PacTrans Research Workshop Summary 2024

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# INTRODUCTION & GOALS

## About PacTrans

Pacific Northwest Transportation Consortium (PacTrans) is the Regional University Transportation Center (UTC) for Federal Region 10. PacTrans focuses on developing human-centered and transformative multimodal mobility solutions for an equitable Pacific Northwest. Major goals and objectives of PacTrans include serving as Region 10's research engine, applied technology showcase, workforce development base, education leader, information center, and collaboration platform. PacTrans is a consortium of transportation professionals and educators from six colleges and universities located in the Pacific Northwest: Northwest Indian College (NWIC), Portland State University (PSU), the University of Alaska, Anchorage (UAA), University of Idaho (UI), University of Washington (UW), and Washington State University (WSU). In previous iterations of PacTrans, our consortium also included: Oregon State University, University of Alaska, Fairbanks (UAF), Gonzaga University, and Boise State University.


Figure 1. Illustration of Key Components of Mobility

PacTrans research aims to improve the mobility of people and goods in the Pacific Northwest, with five major research themes:

I. Improved Equity and Accessibility
II. Multimodal System and Connectivity
III. Safety, Reliability, and Resiliency, with Climate Change
IV. Human-System Integration
V. Developing Transformative Solutions

## PacTrans Research Workshop

PacTrans runs a research workshop regularly by inviting representatives from local/state agencies, industry partners, and university researchers and students in the Pacific Northwest. The goal of the workshop is to discuss major mobility challenges in the region and brainstorm potential solutions, which play a central role in guiding future research directions.

**Date & Time**

June 14, 2024 at 9:30 am – 2:00 pm

**Location**

Daybreak Star Indian Cultural Center at Discovery Park in Seattle, Washington

**Attendees**

Nearly 50 people representing local/state agencies, industry partners, non-profits, and university researchers and students, from the Pacific Northwest (Federal Region 10 that includes Alaska, Idaho, Oregon, Washington); see Appendix A for the list of the attendees.

# WORKSHOP FORMAT & ACTIVITIES

## Format

The workshop features two breakout sessions, each 45-min in duration, with 5-6 parallel breakout groups organized around PacTrans major research themes. The first one is on regional mobility challenges and the second is on potential solutions. More details can be found on the workshop agenda in Appendix B. A lead and a co-lead are assigned for each breakout group to lead and facilitate the group discussions. A student/postdoc helper is also assigned to each group to assist the discussion and take notes. Due to the hybrid mode of the workshop, two online breakout groups are organized for each of the two breakout sessions, in addition to the three (first breakout session) or four (second breakout session) in-person breakout groups. After each breakout session, a 30-min group reporting is planned (5-6 min for each group) for the groups to report to all attendees the major findings and the top three recommendations, with Q/A and interactions.

## Activities

The research workshop started at 9:30 am with breakfast. After, PacTrans staff, Jeff Ban and Yinhai Wang, gave a brief presentation to introduce PacTrans, the workshop's goal and format. Then, two breakout sessions then followed, each with a group reporting session. The discussions were active, with many detailed and constructive comments and suggestions. See Appendix C for the detailed notes taken during the discussions. During the breakout discussion, each group was asked to summarize the top three mobility challenges in their topic area (the first breakout session) and recommend the top three most promising solutions to address the challenges (the second breakout session). These were reported and discussed during group reporting. The workshop ended with brief closing remarks from PacTrans Director (Yinhai Wang) and the lunch. Some attendees also participated in group hiking/jogging organized by PacTrans as a social connection activity (from 2-4pm).

# OVERALL FINDINGS & RECOMMENDATIONS

Each breakout group recommended the top three (sometimes top four or five) most pressing challenges and most promising solutions for the topic area they focused on. The detailed recommendations are listed below (in Section 5 of this report). A summary of the recommendations is shown in Table 1, with the most commonly suggested challenges/solutions highlighted in bold text and the other commonly used are highlighted in italic text. Some synergies clearly emerge which cut across all topic areas, as outlined in the following.

For regional mobility challenges,

- Lack of **human-centered design**, which could be lack of representation of different communities, lack of transfer facilities for active transportation users, difficulty to prioritize climate change strategies among different users/groups, or limited information from system (infrastructure) to humans (users).
- Lack of proper supporting **infrastructure**, which could be physical (intermodal transfer facilities, redundant roadway networks to resist disasters, reliable power systems), virtual (information from system to humans), or financial (agency subsidies, funding allocation, cost allocation methods).
- **Climate change**, which can severely impacts equity & accessibility, reliability and resilience of multimodal systems, and infrastructure design adaptive to a rapidly changing climate
- **Equity issues**, which is fundamental to the multimodal system design, climate change impacts, and when applying technology (e.g., digital equity).
- **Other** important issues identified by the groups include: safety (esp. Vision Zero), privacy concerns when applying data and technologies, and lack of education for professionals (workforce), students (next generation engineers/planners), and the public.

For potential solutions

- The **guiding principle** is to understand who we are designing the system for (humans).
- **Technologies** were viewed as one promising solution, which include data analytics/AI methods to analyze users' needs, infrastructure status, and mobility patterns, design technologies to reduce physical barriers & costs, emerging technologies (AVs, EVs, drones, micro-mobility) to transform mobility and provide more sustainable options, as well as alternative power technologies (e.g., solar) than electricity. **Crosscutting concerns** were also raised when using technologies (esp. data/AI), including equity gap, data bias, privacy and security, and how to ensure human-centered design and applications.

- While there are challenges and potential solutions to build **multimodal system and connectivity**, it can also be a solution to address other challenges such as climate change, equity issues, and system reliability/resilience.
- Better design, building, and operation of **infrastructur**e is crucial, which could be physical (to remove barriers, facilitate intermodal transfer, adaptive to climate change, better integrate with power grid), virtual (information/data to better integrate user needs and human-centered design), and financial (cost allocation method).
- **Other** potential solutions include engagement (of different communities, agency partners such as power companies), policy/regulation, best-practices, and education.

Noteworthy is that while PacTrans conducts dedicated education/workforce activities, the recommendations here on challenges and potential solutions related to education clearly indicate that the research and education activities are closely related, and can inform each other to be more relevant and mutually beneficial.

**Table 1. Summary of Major Recommendations0**

| | Equity & Accessibility | Multimodal & Connect. | Safety, Reliability, Resilience | Climate Change | Human-System Integration | Transformative Solutions |
|---|---|---|---|---|---|---|
| **Issues** | Different impacts on different **communities**: 1)Urban: high housing price; 2) RITI: many challenges; 3) Disability: barriers to mobility.<br>Lack of **representatition**, & **agency capacity**.<br>Digital equity; **Climate change** impacts; health impacts (noise, pollution) | Lack/challenge of intermodal transfer **infrastructure** (facilities): esp for active **users** (non-motorized).<br>Financial support, also related to **equity** & accessibility.<br>Resilience of freight system.<br>*Privacy* issues | Lack of **human**-centered design, *safety* culture of Vision Zero.<br>Multi-harzards exacerbated by **climate change** and geomagnetic activities.<br>Lack of redundant **infrastructure**.<br>Challenges related to electrificationof transportation vs. availability & reliability of power **infrastructure** (also related to building codes, etc.) | **Infrastructure** vulnerable to climate change impacts.<br>Difficult to prioritize different climate change adaptation/ mitigation strategies: conflict with each other and with **equity** / *safety* , etc., thus difficult to allocate *fund* .<br>Need to plan for the future while accounting for climate change: how to design/build **infrastructure** for a rapidly changing climate? | Communication: system (**infrastructure**) to **human** and human to human. How do the systems pass/receive information to humans? What humans receive from the system is currently quite limited. *Education* : When, how, and who to educate.<br>Enforcement: how to make people comply (carrots vs. sticks)?<br>*Privacy* : how data is used and whether data is protected | N/A |
| **Solutions** | *Engagement* : low-income, disabled to identify needs, and measure the impacts of EJ policies.<br>**Technology** to reduce costs and physical barriers, enhance safety, address job loss.<br>Interventions: measures of externatilities esp. SOV and freight; best use of subsidies; *Education* on *equity* & accessibility (workforce, communities, higher ed, public) | **Technology**: **data** and data processing (e.g., using **AI**).<br>*Policy* and Legality to help build **multimodal** system & connectivity.<br>Vehicle and **infrastructure** design to facilitate **multimodal** system.<br>Logistics & operational considerations. Improved Cost allocation method | Learn from *best practices* : cultural, professional, technical, esp. non-engineering solutions (*policies* /*education* ).<br>Integrate climate change risks: natural hazards sensing / prediction using **technologies** & **data**; better weather forecasting and community redundancy in longer term.<br>*Engage* utility companies: *Best practices* ; energy harvesting and redundancy using roadway **infrastructure** (vehicle to grid); alternative engergy solutions than electricity; resilience requires multi-source and more distributed energy supplies; backup storage for climate change induced risks (plan for the worst) | Invest in sustainable **multimodal** transportation options.<br>Move from gas tax to utility-based system to incentivize more sustainable travel behavior.<br>Prioritize adaptive, resilient, low-carbon **infrastructure** | Communication: evaluating driving skills, overall knowledge of **technologies**, training needs; *education* materials; user surveys about their perceptions on new technologies.<br>*Education* : need to retrain drivers and other road users; need to update driver license training program and procedure.<br>Enforcement: Automated & digital enforcement (outside&inside of vehicles); **technology** to help workforce gap.<br>*Privacy* : methods to evaluate and address the impacts of using technology on privacy | Guiding principle: what are we designing for? serving humans!<br>**Infrastructure** analysis: using **technology**, **data**, and **AI** methods.<br>Mobility analysis: mobility signal for scalable analysis; e-bike and transit; *human-centered* methods.<br>Leveraging emerging **technology**: AVs, drones, micromobility, EVs (cars, buses, trucks, boats), Solar and alternative power.<br>Re-envisioning transit (e.g., under bold goals such as designing mobility on Mars).<br>Crosscutting **concerns**: *equity* gaps, climate change, data bias, *security & privacy* , balancing priorities |

# BREAKOUT SESSION RECOMMENDATIONS

## Mobility Challenges

I. Equity and Accessibility
   1. Economic
      - Housing price increases (pricing out)
      - Capacity building for agencies
      - Digital equity
      - Challenges faced by rural, isolated, tribal, and indigenous (RITI) communities
      - Need for better representation
   2. Disability
      - Barrier to mobility, impacting freedom of movement
   3. Health & Sustainability
      - Effects of climate change
      - Varied impacts on different communities
      - Issues related to noise and air pollution

II. Multimodal Systems and Connectivity:
   1. Intermodal Transfer Facilities
      - Mobility Challenges (Users)
      - Dependent Users
      - Mentally Challenges
      - Network Connection (Active Transportation Users)
   2. Financial Support for Transportation Systems (esp., Equity and Accessibility)
   3. Resilience of Freight System
   4. Privacy issues were also discussed and considered as a major issue

III. Safety, Reliability, Resilience
   1. Lack of design of human-centered transportation systems and safety culture toward Vision Zero
   2. Multi-hazards (wildfire, seismic activities, flooding, winter storms, wind storms) exacerbated by climate change and geomagnetic activity (e.g., solar flares compromising the power grids and communications infrastructure), e.g., lack of redundant infrastructure

3. Emerging challenges related to the electrification of transportation system vs. availability and reliability of power infrastructure and resources; crosscutting with building codes, transportation (buses/EVs/CAVs)

IV. Climate Change
1. Our communities and transportation infrastructure are vulnerable to climate change impacts (e.g. flooding, wildfires, extreme heat).
2. It is difficult to prioritize different climate/change adaptation/mitigation strategies that can sometimes be in conflict with each other or other transportation system priorities like safety and equity. This makes it challenging to allocate limited funding properly.
3. We need to plan for the future while accounting for climate change impacts – how do we design and build infrastructure for a rapidly changing climate?

V. Human-System Integration
1. Communication: Particularly from system to human and human to humans. How do the systems pass and receive information to humans? What humans receive from the system is limited.
2. Education: When, how, and who should be educated?
3. Enforcement: How to make people comply? What should be incentives or penalties (carrots and sticks)?
4. **Privacy** was also discussed and considered as a major issue, especially users are often wary of how their data is being used and whether it is being protected adequately.

## Potential Solutions

I. Equity and Accessibility
1. Increased Engagement
   - Engage more with low-income and disabled populations to identify their needs
   - Measure the impact of environmental justice (EJ) policies
2. Technology to Reduce Economic Cost and Physical Barrier
   - Improve access and the quality of life
   - Address the economic impacts of job loss
   - Enhance safety
3. Interventions
   - Develop better measures of transportation externalities, especially related to freight and single-occupancy vehicles (SOV)

- Determine the best use of subsidies
- Focus on education development
  a) Workforce development
  b) Capacity building within communities
  c) Higher education initiatives
  d) Public awareness about equity and accessibility issues

II. Multimodal Systems and Connectivity:
1. Technologies
   - Key Data Sources:
     a) Personal Devices
     b) E-commerce
     c) On-board Sensors
     d) User Interaction and Inputs
     e) Education-Tech Transfer
   - Data Processing (Artificial Intelligence)
     a) Data Collection
     b) Data Processing
     c) Information Dissemination
     d) Automatic Control
2. Policy and Legality
3. Vehicle and Infrastructure Design
4. Logistics and Operational Consideration and Cost Allocation Method are also among the top issues.

III. Safety, Reliability, Resilience
1. Learn from best practices (e.g., cultural, professional, and technical exchanges); study the impact of non-engineering solutions (policy/regulations/education/…) or policy changes; study how people perceive the risks and how that affects their decision-making; How do we convince people to get rid of their cars.
2. Incorporate climate change risks, natural hazard sensing and forecasting (with technologies such as LiDAR and UAVs), space weather prediction, crowdsourcing and CAVs, and additional data sets and types into decision-making and inform better design of transport

systems. For the longer term, more rockets for space weather sensing and communication redundancy etc.

3. Engage the utility agencies. Develop failure models and guidelines for best practices. Can we use existing transportation infrastructure for energy harvesting or leverage the transmission lines along roadways to build energy redundancy? Explore alternative energy solutions than electricity (e.g., small modular nuclear reactors; hydropower; wave energy…). Resiliency requires more distributed energy supplies and what are the impact on transportation systems. Vehicle-to-grid (e.g., from buses). Leverage existing energy infrastructure for green energy solutions. How these impact the resilience and reliability and transportation system? How much backup storage capacity do you need to have first responders, food security, waste management, in the scenario climate change induced crisis? (Cascading effects: Plan for the worst).

IV. Climate Change

1. Invest in sustainable multimodal transportation options.
2. Move from a gas tax to a utility-based system that uses pricing mechanisms to incentivize more sustainable travel behavior.
3. Prioritize adaptable, resilient, low-carbon infrastructure.

V. Human-System Integration

1. Communication:
   - Evaluating driving skills and overall knowledge needed for different types of technologies (examples for vehicles: Tesla, Conventional, ..) which also leads to training needs
   - Preparing educational materials for targeted audience of different types of new technologies
   - Conducting user surveys to understand their perception towards these new technologies and whether these technologies are making their travel easier or more confusing.
2. Education:
   - Evaluating the need for retraining drivers and other road users
   - Evaluating the need for updating the drivers license training program and procedure (ex; for safety compliance purposes)
3. Enforcement:
   - Automated enforcement and digital enforcement (not just outside but inside of the vehicle)
   - Technologies to help the enforcement workforce gaps (onboard technologies to help warning the drivers)

4. For Privacy issues, there should be methods to evaluate the privacy impact of using technologies in behavior analysis

VI. Transformative Solutions

1. Infrastructure analysis
   - lidar, low-level flyover imaging to analyze & track the work via computer vision (sidewalk infrastructure, bridges, roadways)
2. Mobility analysis
   - New mobility signals for scalable analysis
   - How e-bikes change urban transit planning
   - Human centered safety and predictive analytics
3. Emerging technologies
   - Autonomous vehicles, Drones
   - Micro mobility
   - Electrified freight, air, boats
   - Solar & alternative power
   - Re-envisioning transit (mobility for a new planet: mars)

**All these should be under the guiding principle: what are we designing for?

4. The group also noted cross-cutting concerns such as, Widening equity gaps, Energy expand & climate change, Data bias, Security & privacy, and Balancing priorities.

# APPENDIX A: WORKSHOP ATTENDEES

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# APPENDIX B: WORKSHOP AGENDA

| | **Friday, June 14, 2024** |
|---|---|
| 9:15 – 9:45 am | Arrival & Breakfast |
| 9:45 – 10:15 am | Introduction:<br>Workshop Goals & Format |
| 10:15 – 11:00 am | Breakout Session I:<br>Mobility Issues & Challenges in the Pacific Northwest |
| 11:00 – 11:30 am | Group Reporting |
| 11:30 – 11:45 am | Coffee Break |
| 11:45 am – 12:30 pm | Breakout Session II:<br>Potential Solutions |
| 12:30 – 1:00 pm | Group Reporting |
| 1:00 – 1:45 pm | Lunch |
| 1:45 – 2:00 pm | Wrap Up |
| 2:00 – 4:00 pm | Social Activities:<br>Hiking or Jogging in Discovery Park |

# APPENDIX C: DETAILED NOTES

These notes were taken by UW/PacTrans graduate students and postdoc researchers: Equity & Accessibility (Yiran Zhang), Multimodal Systems and Connectivity (Chenxi Liu), Safety, Reliability, Resilience (Soheil Keshavarz), Climate Change (Dan McCabe), Human-System Integration (Shakiba Naderian), and Transformative Solutions (Muhammad Karim).

## C.I Equity and Accessibility

Mobility challenges and Issues: Edmund noted that rising housing prices create transportation difficulties, while Haifeng emphasized the poor state of transportation infrastructure in remote and small communities, exacerbated by limited funding. Jon pointed out the lack of staff training and resources, particularly in rural areas, and stressed the need for ADA transition plans and adherence to government standards. Osama discussed the importance of capacity building, and Andy addressed equity issues related to Autonomous Vehicles (AVs) and emerging transit technologies. Anna advocated for micromobility equity within transit systems, and Qing, an urban planner, highlighted the economic and societal costs of serving diverse populations. Discussions also covered the need for micro-transit solutions, which are smaller, often on-demand transit options, and micromobility, which focuses on individual mobility. Andy also emphasized the importance of transportation accessibility for low-income and disabled individuals, including those with sensory impairments. He underscored the need to increase the freedom of movement for disabled individuals. Edmund brought up challenges related to delivery logistics, and Jon discussed the broader impacts of climate change on mobility and the costs associated with supporting freedom to travel. Andy stressed the equitable use of facilities and recovery efforts to mitigate impacts, while Edmund highlighted the broader environmental impacts, including emissions. Yiran addressed digital equity issues, emphasizing the need to overcome both physical and technological barriers. Finally, Qing advocated for better representation and support for wheelchair users in transportation planning.

Potential Solutions: The workshop on potential solutions for equity and accessibility in transportation covered several innovative approaches. Qing proposed using technologies such as Autonomous Vehicles (AVs) and Electric Vehicles (EVs) to reduce economic costs across different communities by decreasing reliance on labor. Andy highlighted the economic impact of job loss due to technological advancements and stressed the importance of identifying and effectively utilizing subsidies for various mobility solutions. Osama emphasized using AI tools to better understand economic and labor needs, enhancing technology to improve accessibility, and engaging with low-income and disabled populations to identify their needs. Qing also pointed out the need for better measures of

transportation's externalities, like air pollution from freight, in the context of climate change. Haifeng discussed the importance of public education and awareness about equity issues, advocating for education development at both public and higher education levels. Osama suggested improved metrics for measuring equity issues to guide interventions, while Edmund emphasized prioritizing transportation equity issues and increasing engagement to measure the impact of environmental justice policies.

## C.II Multimodal Systems and Connectivity

Mobility Challenges and Issues:

- Intermodal Transfer Facilities are critical nodes in the multimodal transportation network, facilitating smooth transitions between different transportation modes such as buses, trains, bicycles, and pedestrian pathways. However, these facilities face numerous challenges that impede connectivity and accessibility. One of the core issues is the lack of seamless integration between modes, resulting in inefficient transfers and increased travel times. Accessibility challenges are significant for users with disabilities and elderly individuals, who may encounter physical barriers and insufficient support services at these transfer points. Dependent users, such as children and those without personal vehicles, face similar difficulties, often compounded by poorly maintained infrastructure and inadequate safety measures. For those with mental challenges, the complexity of navigating intermodal transfer facilities can be overwhelming without well-designed wayfinding systems and clear signage. Furthermore, active transportation users like cyclists and pedestrians often find these facilities disconnected from the broader network, reducing the effectiveness of sustainable travel options. Addressing these challenges is essential to enhance overall connectivity, promote equity, and improve the user experience across the multimodal transportation system.
- Financial Support for Transportation Systems is crucial for developing and maintaining a robust multimodal transportation system that ensures connectivity and accessibility for all users. However, there are significant challenges in securing adequate funding, particularly for projects that enhance equity and accessibility. Urban and rural areas often face disparities in funding allocations, with underserved and low-income communities suffering from inadequate transportation options. These communities may experience poor connectivity due to limited public transit services, poorly maintained infrastructure, and a lack of investment in multimodal integration. Financial constraints also hinder the development of comprehensive networks that connect various transportation modes seamlessly, leading to gaps in service and reduced mobility. The competition for limited funds can result in prioritizing projects that benefit more

affluent areas, further marginalizing vulnerable populations. To overcome these challenges, it is essential to prioritize equitable funding allocations that support the development of an inclusive, well-connected multimodal transportation system. This approach can help create a more just society where mobility is accessible to everyone, regardless of socio-economic status.

- Resilience of Freight System is a key component of a well-connected multimodal transportation network, ensuring the efficient movement of goods across various modes such as rail, road, air, and sea. However, achieving resilience in the freight system faces several challenges that impact connectivity and operational efficiency. Natural disasters, pandemics, and economic crises can disrupt freight operations, highlighting the need for a system that can quickly adapt to changing conditions. Integrating multiple transportation modes to provide flexible options for goods movement is complex and requires significant investment in infrastructure and technology. Real-time tracking, data analytics, and automated systems are essential for enhancing connectivity and response times, yet these technologies are not universally implemented across the freight network. Additionally, physical infrastructure such as bridges, ports, and highways often suffer from underfunding and maintenance backlogs, further straining connectivity and resilience. Addressing these challenges involves coordinated efforts to bolster the infrastructure, integrate advanced technologies, and ensure robust multimodal connections, ultimately supporting a resilient and efficient freight system that can adapt to various disruptions and maintain supply chain continuity.

Potential Solutions:

- Artificial Intelligence based Technologies have the potential to revolutionize multimodal transportation systems by leveraging big data to tackle connectivity challenges and enhance efficiency. These technologies collect extensive data from various sources, including personal devices like smartphones and wearables, which provide real-time information on user movements and preferences. E-commerce platforms add valuable insights into delivery routes, demand patterns, and logistical efficiencies, while on-board vehicle sensors gather critical data on vehicle performance, traffic conditions, and environmental factors. User interactions and feedback through transportation apps further enrich this data pool, highlighting service quality and operational issues. AI processes this diverse data to extract meaningful patterns and insights, optimizing transportation systems by predicting travel demand, adjusting transit schedules dynamically based on real-time traffic data, and efficiently managing vehicle fleets. Additionally, AI enhances user experience by offering real-time updates, personalized travel recommendations, and timely notifications about service changes or disruptions, ensuring seamless transitions between different modes of transport. AI-powered automatic control

systems play a crucial role in managing traffic flow and reducing congestion by making instantaneous adjustments to traffic signals and rerouting vehicles. By integrating AI, cities can create adaptive, efficient, and user-centric transportation networks that address the complexities of modern urban mobility, improving connectivity, reducing travel times, and promoting the use of public and active transportation modes, thus fostering a more sustainable and resilient transportation system.

- Effective policy and legal frameworks are crucial for addressing the challenges of multimodal systems and connectivity by regulating emerging technologies, protecting data privacy, ensuring equitable access, and integrating various transportation modes. Policies mandating standardized infrastructure and interoperability can create cohesive networks where buses, trains, bicycles, and pedestrian pathways are well-connected, ensuring new developments include intermodal transfer facilities with adequate signage, accessibility features, and safety measures. Legal frameworks must also establish clear guidelines on data collection, storage, and usage to protect users' privacy while leveraging data to improve transportation systems, enforcing data protection measures, and requiring explicit user consent. Equitable access can be promoted by allocating funding to develop infrastructure in marginalized areas and prioritizing projects that enhance connectivity for underserved communities. Encouraging public-private partnerships can leverage private sector innovation to improve public transportation services, while legal frameworks facilitate cooperation and data sharing among transportation providers. Policies supporting advanced technologies and infrastructure upgrades can address logistical challenges by incentivizing AI and big data analytics to optimize routes and manage traffic. Robust policy and legal frameworks thus create an efficient, inclusive, and connected transportation network, providing the foundation for sustainable and resilient multimodal systems that meet the diverse needs of all users.
- Developing an equitable cost allocation method is crucial for addressing the challenges of multimodal systems and connectivity. These methods ensure that the financial burden of developing and maintaining transportation infrastructure and services is fairly distributed among all stakeholders, including government agencies, private companies, and users. A well-structured cost allocation method can prioritize funding for critical projects that enhance connectivity between different transportation modes, ensuring that resources are directed to where they are most needed. This approach helps develop and maintain transfer facilities, pedestrian pathways, and bicycle lanes, improving overall user experience. Equitable cost allocation methods can also bridge funding gaps in underserved and low-income communities by incorporating subsidies or grants, promoting social equity through expanded public transit routes and enhanced infrastructure. Implementing strategies like user fees or congestion

pricing can manage demand, reduce congestion, and generate revenue for reinvestment in the transportation system. Public-private partnerships can further share the financial burden, leveraging additional resources for infrastructure development and innovative solutions. In summary, an equitable and strategic cost allocation method enhances the efficiency, accessibility, and integration of transportation networks by ensuring fair cost distribution, prioritizing critical investments, and promoting sustainable travel behaviors.

## C.III Safety, Reliability, Resilience

Mobility Challenges and issues:

- Safety issues can be tackled with emerging technologies
    - Some people mentioned the success of European countries (e.g., Oslo, Norway) in reaching vision zero goals without using sophisticated technology
    - The difference between policy-making in Europe (top-down approach) and the US (bottom-up approach) was discussed
    - SDOT has been implementing a no-turn-on-red policy in the past few months as “no turn on red” signs have been observed in the city recently
        - Some feedbacks claim that this policy has worsened queueing and safety but analysis is needed to evaluate the impact
- The risk and impact of multiple natural hazards such as wildfires, seismic activities, flooding, winter storms, and wind storms are increased and worsened by climate change.
- Geomagnetic activities like solar flares can compromise power grids and communications infrastructure.
- Solar storms stronger than the May 2024 storm are predicted to happen.
- The main concern is the lack of redundant infrastructure, which makes it difficult to maintain resilience and quick recovery during such events.
- The transition to an electrified transportation system, including electric vehicles (EVs), buses, and connected autonomous vehicles (CAVs), presents challenges related to the availability and reliability of power infrastructure.
- Building codes and parking codes are not adjusted to accommodate possible EV-related fires, especially battery explosions
    - Attendees, however, had not heard about such safety issues happening
- Conflicts can occur between multiple stakeholders in case of right of way and curbside regulations.

    - What needs to be done if we put charging stations on a segment of a street and then KCM decides to put a new transit stop there?
- Ensuring a stable and adequate power supply, along with the necessary infrastructure, is crucial for supporting the widespread adoption of electrified transportation systems.

Potential Solutions:

1. Human-centered design and safety culture:
    a) Learn from best practices (e.g., cultural, professional, and technical exchanges)
    b) Impact study on non-engineering solutions (e.g., policy, regulations, education)
    c) Study how people perceive the risks and how that affects their decision-making
    d) Convince people to get rid of their cars
    e) Impact study on reduced lanes and “no turn on red”s
2. Multihazards:
    a) Incorporate climate change risks in design
    b) Natural hazard sensing(with technologies such as LiDAR and UAVs) and space weather forecasting
    c) Employ crowdsourcing, CAVs, and additional data sets and types into decision-making and inform better design of transport systems
    d) For the longer term, more rockets for space weather sensing and communication redundancy.
3. Electrification:
    a) Engage the utility agencies
    b) Develop failure models and guidelines for best practices
    c) Build energy redundancy by using existing transportation infrastructure for energy harvesting or leveraging the transmission lines along roadways.
    d) Leverage existing energy infrastructure for green energy solutions while improving the resilience and reliability of transportation systems.
    e) Explore alternative energy solutions than electricity (e.g., small modular nuclear reactors, hydrogen, hydropower, wave energy).
    f) Explore alternative charging solutions (e.g., wireless on-road charging).
    g) Higher resiliency with distributed energy supplies and vehicle-to-grid (e.g., from buses) technology.
    h) Plan for worst case scenario (e.g. a climate change-induced crisis and subsequent cascading effects) and allocate backup storage capacity (e.g., for first responders and to manage food security and waste management)

## C.IV Climate Change

Mobility Challenges and Issues:

- Key differentiator: mitigation vs. adaptation
    - Adaptation has some overlap with resilience topic
- Doug: from WSDOT perspective, infrastructure vulnerability is huge concern.
    - I-5 bridge (Portland to Vancouver) provides a good example
        - Bridge is dated and vulnerable, but also raises questions around climate change mitigation – how much should we prioritize modes other than cars, e.g.
        - Challenges dealing with multiple jurisdictions
- Land use and transportation interactions
- Variety of different climate threats: heat risk, fire risk, flooding, etc.
    - How to balance these competing risks?
    - Do we have the data that we need to make the right decisions and weigh these risks against each other?
- Within mitigation, a couple of key factors: travel demand and emissions intensity
    - Prioritizing electric/low-emission vehicles vs. managing total demand
- Need to maintain and preserve current infrastructure vs. transformative investments, with limited funding
- Electric vehicle charging infrastructure availability – it seems like EV adoption might be outpacing charger availability
- Funding is a recurring theme – what's the best use of our limited funding?
    - Should we be considering a different approach to funding, outside gas tax? E.g. road user charge
    - Regulations about how funds are spent can be restrictive – e.g., needs to be reinvested in roadway/location where tax was collected
    - Yet another issue where limited data creates challenges
- Equity implications for all of the points above – who is most vulnerable to climate impacts, are funding programs impacting different communities fairly?
- Communication, education, and engagement challenges
- Materials impacts: need to be more proactive in planning for and managing climate change impacts on pavement design – predictions of future climate have important implications for how pavement is designed

Potential Solutions:

- There is a need for more off-the-shelf datasets on climate hazards for agencies to apply in decision-making.
    - Of course this is hard because the research is evolving, but we need to make decisions now.
    - There's a gap between state-of-the-art climate science and practice
    - Ties into broader issues on the intersections of land use and transportation planning.
- Transit-oriented development has potential to help with land use and transportation integration/climate impacts
    - How can research help support this? Do we have enough evidence about TOD's effectiveness?
- Infrastructure issues: do we have more tangible solutions here?
    - Materials: need to study impact of climate change on material selection and understand reliability of models used to make these predictions
    - One practical example: need to elevate infrastructure in flood-prone areas
    - Likewise, we may need a better overall approach to designing resilient infrastructure and accounting for climate-based uncertainty. But there's a tradeoff here, since resilient infrastructure can be more difficult and expensive to build.
    - One common thread… we need funding to make this happen! For sustainable transportation on a holistic level, not just this type of infrastructure.
- Funding as its own issue
    - Comes up for remote rural areas as well – emergency repairs because of erosion
    - Making these sorts of repairs is expensive, often requires bringing in materials from elsewhere for "band-aid" repairs that don't last
    - Can be used to support mitigation efforts as well as funding for adaptation
        - Need to use funds to support urban, suburban, and rural needs
    - It seems to be clear that we need to revamp this system.
    - In simple terms, the solution is to invest more!
    - Challenges of engagement/education for public support
- Role of artificial intelligence

## C.V Human-System Integration

<u>Mobility Challenges and Issues</u>:

One challenge is the **communication:**

- Trust plays a crucial role in how users perceive and interact with technology, influencing acceptance and utilization.
- The presentation of technology by developers and the translation of these innovations into practical applications are crucial. For instance, new autonomous vehicle users, such as those of Tesla, should be fully informed about every guide that leads to higher safety considerations. Many drivers, when switching to automated mode, may leave the car unattended, which can be dangerous. Therefore, it is essential to ensure drivers understand the importance of staying attentive even in automated settings.
- There are limitations in how systems communicate with humans and how humans interpret this information. One example is when pedestrians push the button at a signalized intersection—how would they know that the system received their message?

Another challenge is about **education:**

- Integrating new technologies into driving tests faces the challenge of limited funds.
- Reaching and informing the public, particularly adults, is another significant concern.
- There is uncertainty regarding the optimal timing, methods, and target audience for educational efforts.

There are also challenges regarding **Enforcement:**

- Advancements in cameras and technology can play a crucial role in enforcement issues, but what are the best approaches?
- How can we make sure that these enforcements are effective, and the user will comply?
- What should be the incentives or penalties to make sure that these enforcements work?

And lastly, **Privacy:**

- Users can be worried about the potential misuse of their personal information, leading to a lack of trust in the systems that collect and store their data.
- Lack of insufficient safeguards or filters also will lead to a failure to reassure users that their privacy is being maintained.

Potential Solutions:

**Communication**:

- driving skills and the knowledge needed for different technologies could be evaluated, which will also help identify training needs.
- Creating educational materials for different audiences can ensure users understand these new technologies.

- Conducting user surveys helps understand how people perceive these innovations and whether they find them easier or more confusing.

**Education**:

- Evaluating the need for retraining drivers and other road users is important to ensure they stay updated with the latest safety standards and technologies. Additionally, we need to make sure that these new instructions are logical and reasonable to follow, not just technically sound.
- Using simulations, video games, and social media platforms to educate younger drivers specifically can also enhance their understanding and engagement with these new technologies and safety practices. One example is the “traffic youtuber”.

**Enforcement**:

- Implementing automated and digital enforcement inside the vehicles in addition to outside technologies.
- Utilizing onboard technologies can help address enforcement workforce gaps by for example providing real-time warnings to drivers.
- Piloting the speed limit, for example in Europe, the space mean speed is monitored instead of momentary speed, preventing drivers from merely slowing down near detecting cameras.

**Privacy**:

- Considering what data is collected? how it is used? who has access? how long it is retained? And see what impact would these factors have on privacy concerns?

## C.VI Transformative Solutions

Potential Solutions:

1. Infrastructure analysis
    a. lidar, low-level flyover imaging to analyze & track the work via computer vision (sidewalk infrastructure, bridges, roadways)
2. Mobility analysis
    a. New mobility signals for scalable analysis
    b. How e-bikes change urban transit planning
    c. Human centered safety and predictive analytics
3. Emerging technologies
    a. Autonomous vehicles, Drones
    b. Micro mobility
    c. Electrified freight, air, boats
    d. Solar & alternative power

e. Re-envisioning transit (mobility for a new planet: mars)

*All these should be under the guiding principle: what are we designing for?*

The group also noted cross-cutting concerns such as:

- Widening equity gaps
- Energy expand & climate change
- Data bias
- Security & privacy
- Balancing priorities