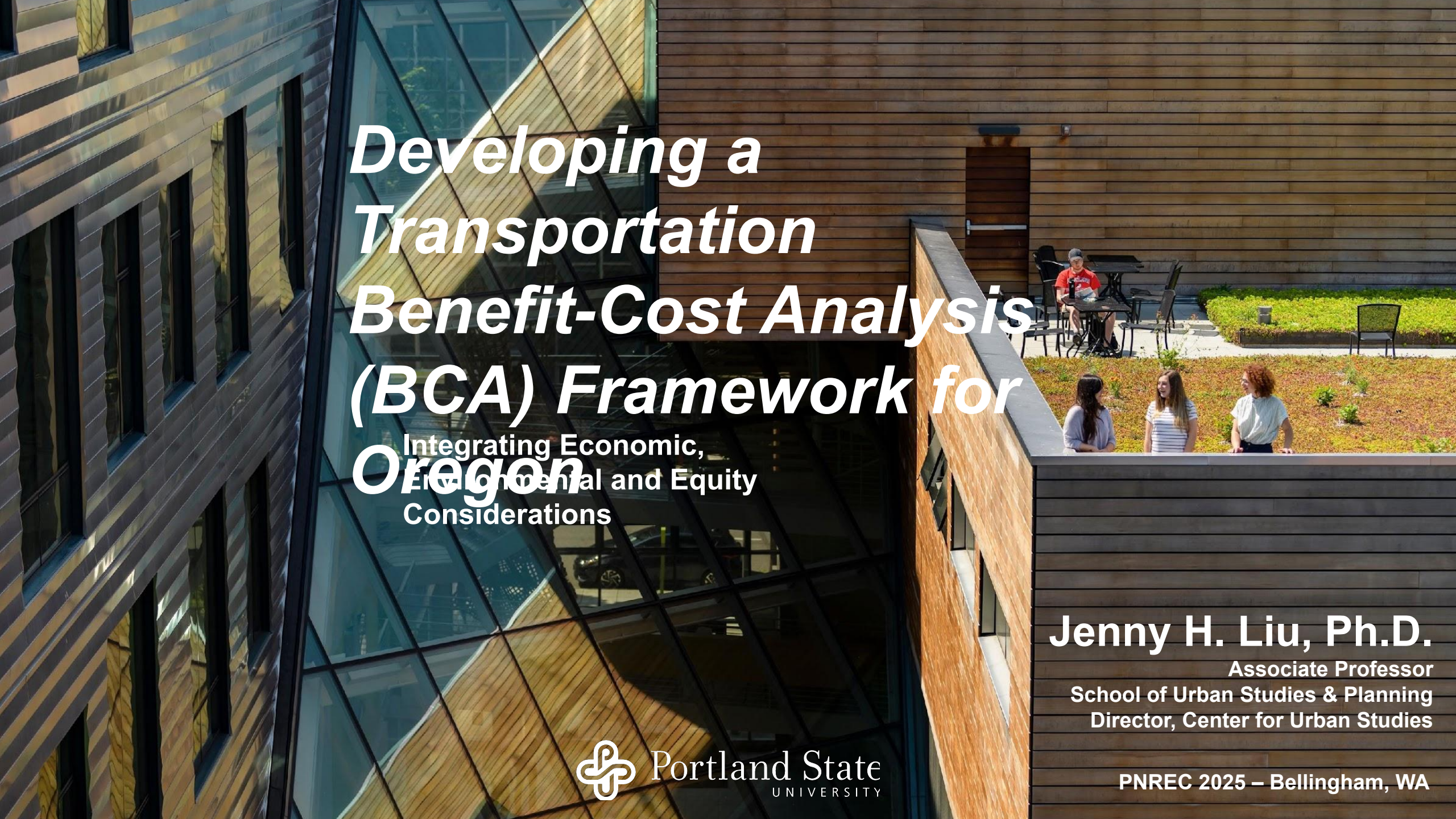


Developing a Transportation Benefit-Cost Analysis (BCA) Framework for Oregon

Integrating Economic, Environmental and Equity Considerations

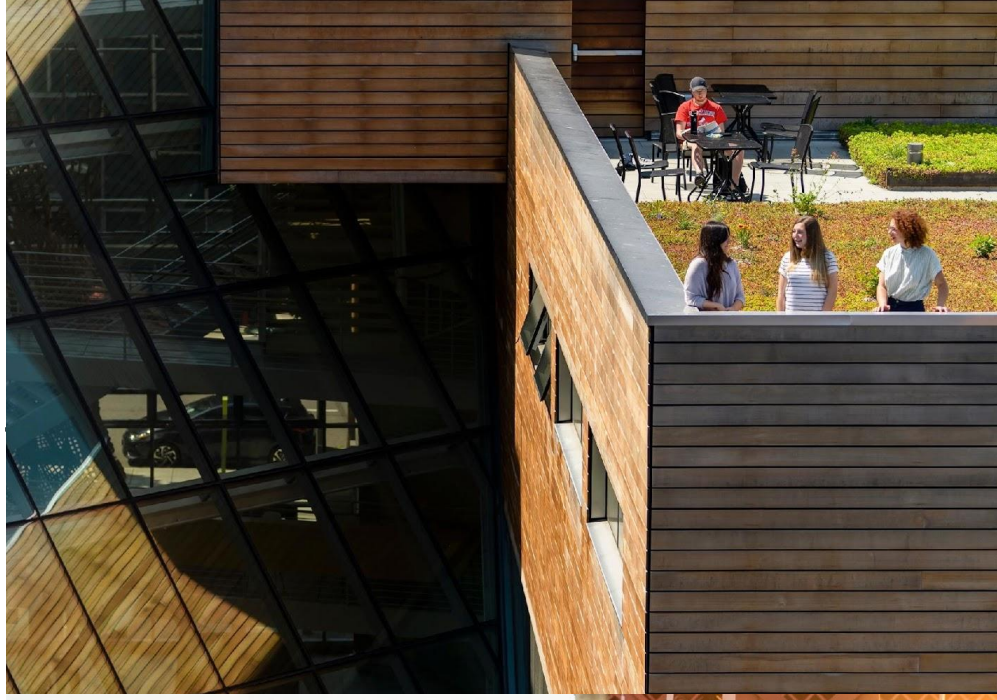
Jenny H. Liu, Ph.D.
Associate Professor
School of Urban Studies & Planning
Director, Center for Urban Studies

Portland State UNIVERSITY

PNREC 2025 – Bellingham, WA

Research Team

Jenny Liu, Ph.D.
Eun Jun Choi, Urban Studies Ph.D. student
Hyeoncheol Kim, Urban Studies Ph.D. studen



Project TAC

Sylvan Hoover, ODOT Climate Office | Chair
Sam Bell, Oregon State Univ
Alex Bettinardi, ODOT TPAU
Anne Brown, Univ of Oregon
Evan Rogers, ODOT Finance & Budget

Funded by Oregon DOT

Problem → Goals → Literature Review → Best Practices Review → Oregon BCA Framework Development → Data Collection → Online BCA Calculator Tool

- Start with literature in workplan; Backward and forward searches
- Web of Science, Google Scholar, TRID (Transportation Research International Documentation), the Federal Highway Administration (FHWA), and the Transportation Research Board (TRB)

- Federal, state, MPOs, international sources
- Two BCA-related workshops in Nov 2024
- Existing Oregon tools – Mosaic, VisionEval

Problem | Goals | Literature Review | Best Practices Review | Oregon BCA Framework Development | Data Collection | Online BCA Calculator Tool

BCA Key Framework Rules

- Discount rates
- Analysis period
- Metrics for analysis
- Sensitivity analysis

Parameters in Literature	Papers
Environment	
Climate Change	Jakob et al. (2006), Kolosz and Grant-Muller (2015), Gossling and Choi (2015), Gossling et al. (2019)
Air Pollution	Jakob et al. (2006), Williges and Mahdavi (2008), Litman (2010), Rabl and de Nazelle (2012), Gerbec et al. (2015), Gossling and Choi (2015), Lawrence et al. (2018), Gossling et al. (2019), Ross et al. (2020)
Noise Pollution	Litman (2010), Gerbec et al. (2015), Gossling and Choi (2015), Gossling et al. (2019)
Soil and Water Quality	Gossling et al. (2019)
Land Use and Infrastructure	Williges and Mahdavi (2008), Sahin et al. (2009), Litman (2010), Lawrence et al. (2018), Gossling et al. (2019)
Traffic Infrastructure Maintenance	Williges and Mahdavi (2008), Litman (2010), Gossling and Choi (2015), Lawrence et al. (2018), Gossling et al. (2019)
Resource Requirements	Lawrence et al. (2018), Gossling et al. (2019)
Travel Time and Vehicle Operation	
Vehicle Operation	Jakob et al. (2006), Williges and Mahdavi (2008), Sahin et al. (2009), Litman (2010), Gerbec et al. (2015), Gossling and Choi (2015), Lawrence et al. (2018), Greer and Ksaibati (2019), Gossling et al. (2019), Ross et al. (2020)
Travel Time	Williges and Mahdavi (2008), Litman (2010), Gossling and Choi (2015), Batarce et al. (2016), Lawrence et al. (2018), Greer and Ksaibati (2019), Gossling et al. (2019)
Congestion	Litman (2010), Gerbec et al. (2015), Gossling and Choi (2015), Greer and Ksaibati (2019), Gossling et al. (2019), Ross et al. (2020)
Health, accidents and perceived comfort	
Health Effects	Wang et al. (2005), Boarnet et al. (2008), Cavill et al. (2008), Litman (2010), Rabl and de Nazelle (2012), Mulley et al. (2013), Gossling and Choi (2015), Gossling et al. (2019), Ross et al. (2020), Van Den Bijgaart et al. (2024)
Safety Effects	Jakob et al. (2006), Williges and Mahdavi (2008), Litman (2010), Gossling and Choi (2015), Kolosz and Grant-Muller (2015), Lawrence et al. (2018), Greer and Ksaibati (2019), Gossling et al. (2019), Ross et al. (2020)
Perceived Safety & Discomfort	Litman (2010), Gossling and Choi (2015), Gossling et al. (2019)
Quality of life, tourism and infrastructure	
Quality of Life, Branding and Tourism	Litman (2010), Gossling and Choi (2015), Gossling et al. (2019), Ross et al. (2020)

Parameters in Practice		Federal (n=3)	State/MPOs (n=31)	International (n=12)
Costs	Capital (construction) cost	100%	77%	100%
	O&M cost	100%	77%	100%
	Replacement cost	67%	19%	25%
	Residual value	100%	39%	25%
Travel time and vehicle operation	Travel time savings	100%	94%	100%
	Vehicle operation cost savings	100%	68%	83%
Health and safety	Safety benefits	100%	94%	100%
	Health benefits	33%	13%	8%
Environment	Emission reduction benefits	100%	77%	100%
	Climate change	100%	45%	92%
	Noise reduction	33%	19%	83%
Other parameters (quantified)	Economic development impacts	0%	10%	58%
	Reliability	33%	13%	50%
	Non-automobile amenity benefits	33%	10%	8%
	Resilience	0%	6%	8%

Lessons from Literature and Best Practices Reviews

- Shared focus on consistency, measurable outcomes and tools
- Adaptation of BCA to local needs and priorities
- Definitions of parameters and measurement methods vary
- Common parameters: capital cost, capital investment, operating and maintenance costs, travel time (avoided travel time costs, travel time savings), safety effects, air pollution
- Movement towards incorporating **multi-modal** and **active transportation** options
- Inclusion of **equity impacts** is a growing

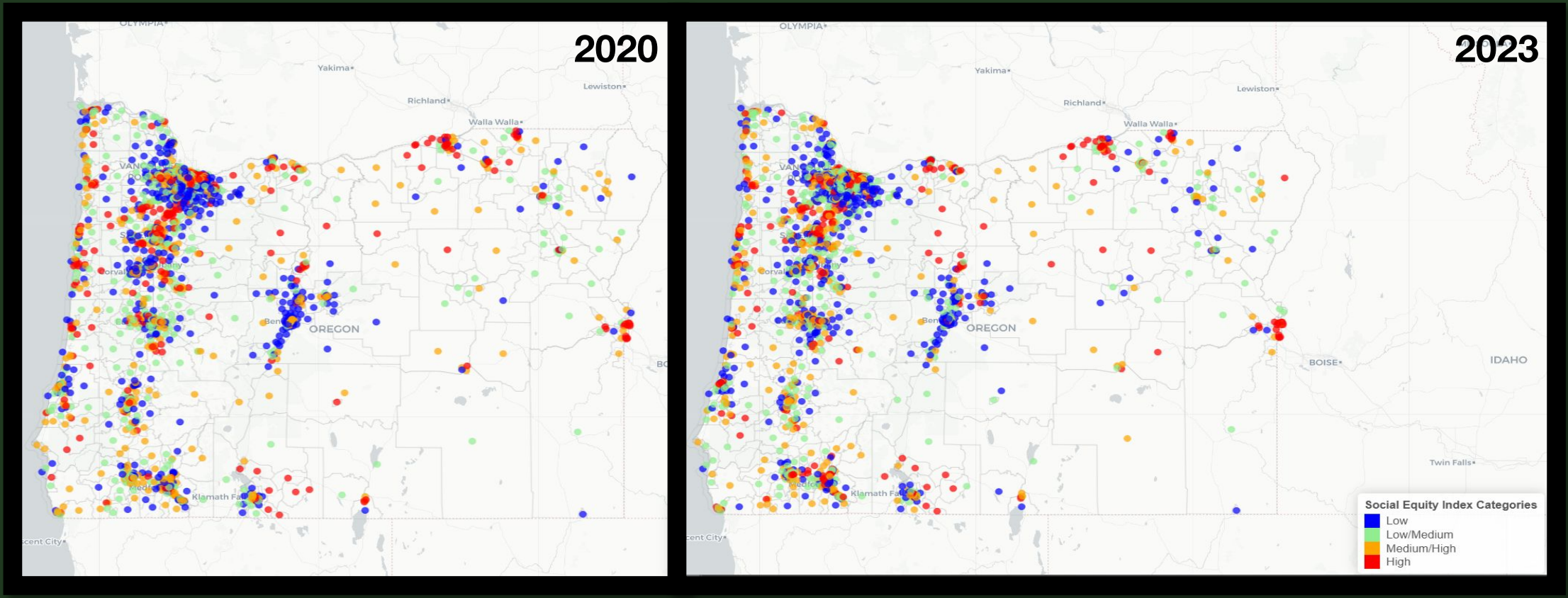
Equity and Distributional Impacts

- Accessibility
- Distributional weights
- Multi-Criteria Decision Analysis (MCDA)
- Geospatial analysis (equity mapping)
- Equity across multiple factors – potential integration with ODOT's Social Equity Index (SEI)

Equity and Distributional Impacts – ODOT SEI

Percent of population living at 200% of poverty or below
Percent of the population that are 64 years or older
Percent of population that are 18 years old or younger
Percent of population age 20-64 that have a disability
Percent of population that speak English ‘not well’ or ‘not at all’
Percent of population that are Persons of Color (POC)
Percent of households that do not own a vehicle

Author: Josh Roll (https://rpubs.com/ODOT_Research/ODOT_SEI_2023)
Maps below created by Eun Jun Choi based on Roll’s methodology



Equity and Distributional Impacts – UK Example

	Distributional impact of income deprivation					Are the impacts distributed evenly?	Key impacts – Qualatitive statements (example below)
	0-20%	20-40%	40-60%	60-80%	80-100%		
User benefits	✓	✓✓	✓✓	✓✓	✓✓✓	No	Although benefits are felt by all income quintiles, the benefits favour those in the least deprived income quintiles. Those in the least deprived income quintile (income quintile 5) experience a considerably higher than expected proportion of benefits, whereas those in the most deprived areas (quintile 1) experience a smaller than expected proportion of benefits.
Noise	×××	✓	✓✓✓	✓✓	✓✓✓	No	Noise impacts favour those in the least deprived income quintiles. Those in the most deprived income quintile experience noise disbenefits, whereas all other income quintiles experience benefits of the intervention.
Air quality	✓✓✓	✓✓	✓	××	✓	No	Air quality impacts favour residents in the most deprived income quintiles. Those in the most deprived income quintile (quintile 1) that may be considered to be the most vulnerable experience a considerably higher proportion of air quality benefits than may be expected from an even distribution. Residents living in income quintile 4 experience air quality disbenefits.
Affordability	××	×	××	✓	✓✓	No	Personal affordability benefits favour those in the least deprived income quintiles. Those in income quintiles 4 and 5 experience benefits in terms of affordability, whereas those in the least deprived income quintiles (who may are the most vulnerable) experience disbenefits as a result of the intervention.
Accessibility	×	×	×	×	×	Yes	Accessibility impacts are appraised as slight adverse for all of the income deprivation quintiles and therefore although the impact is adverse the impact is distributed evenly.

Sartori et al. (2015)

Equity and Distributional Impacts – EU Example

$$W = \left(\frac{\bar{C}}{C_i}\right)^e$$

- Where: $\bar{C}$ is the overall average consumption level, C_i is the per capita consumption in the group, and e is the elasticity of marginal utility of income.

Classes	Consumption	$(\bar{C} / C_i)$	e=0	e=0.3	e=0.7	e=1.2
High income	3,000	0.75	1	0.9173	0.8176	0.7081
Medium income	2,500	0.90	1	0.9689	0.9289	0.8812
Low income	1,250	1.80	1	1.1928	1.5090	2.0245
Average	2,250	1	1	1	1	1

Classes	Net benefits	Elasticity 1.2	Distributional impact
High income	60	0.7081	42.49
Medium income	100	0.8812	88.12
Low income	140	2.0245	283.43
Total	**300**		**414.04**

Department for Transport (2024)

Key differences between Literature and Practice

- Academic literature focuses on definitions and measurement methods
- In practice, the focus tends to be on quantifiable and measurable components
- Costs and benefits not clearly distinguished in academic literature
- BCA in practice is predominantly applied to infrastructure projects
- Distributional analysis and sensitivity analysis is often missing from practical applications
- Emerging modes or technologies not often incorporated in practice due to uncertainties in deployment, lack of standardized data, etc.

Oregon BCA Framework Development [February – December 2025]

- Based on review, establish BCA parameters by mode
- Synthesize methodologies for measurement
- Identify Oregon-specific data sources
- Identify data/measure availability gaps
- Collect, clean and analyze data for framework

Establish procedure for updating BCA parameters

Develop guidance and methodology to incorporate equity and distributional considerations

To be continued… @PNREC 2026

Jenny Liu
jenny.liu@pdx.edu