OREGON METRO'S BENEFIT-COST ANALYSIS CALCULATOR TOOLKIT

SUPPORTING TRANSPORTATION PLANNING ALTERNATIVES ANALYSIS

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EXECUTIVE SUMMARY

Oregon Metro developed a cost benefit calculator termed the Multi-Criteria Evaluation (MCE) calculator to support transportation planning alternatives analyses. Key features include:

- **Estimating "triple-bottom-line" (economic, environmental, and social/equity) transportation investments**
- **More comprehensive set of criteria, more comparability between criteria, and more explicit equity analysis**
- **Builds upon previous efforts for FHWA, SANDAG, MTC, PSRC, and others**
- **Is open source and available online (1)**

1 BENEFITS

Table 1 presents the comprehensive set of benefits estimated by the MCE tool. These benefits include traditional BCA network benefits (2), as well as triple-bottom-line measures that are relatively new to travel forecasting, and have only been implemented by select agencies (3, 4, 5). What is common to these agencies is:

- Stakeholders asking new, more comprehensive set of planning and policy questions
- Maintaining a travel model with the appropriate resolution for the question at hand.

TABLE 1. Oregon Metro MCE Benefit Measures

BENEFIT	TYPE	QUANTITY	EQUITY ANALYSIS
Travel time and cost	O-D	Minutes of travel time saved by mode, including trucks	Yes
Travel time reliability	O-D	Decrease in travel time variability (standard deviation of travel time)	Yes
Physical activity	O-D	Quality-adjusted life years (QALYs) saved via ITHIM (7)	Yes
Vehicle ownership cost	Zone	Number of household vehicles	Yes
Travel options (6)	Zone	Destination, mode accessibility logsum	Yes
Safety	Link	Fatal, Injury, Property-Damage Only Crashes	No
Emissions	Link	Tons of CO2e, PM2.5, PM10, NOx, VOC via MOVES (8)	No
Surface water	Link	VMT-based cost of impacts	No
Noise	Link	VMT-based cost of impacts	No
Vehicle operating costs	Link	Gallons of fuel consumed, VMT-based non-fuel costs	No

2 INTEGRATION WITH THE TRAVEL MODEL

The benefits calculator is a platform independent program implemented in Python, in the ActivitySim framework (9). The steps to run the calculator are:

- Run travel model data export scripts (in R and EMME) to produce the inputs for the calculator, i.e. zone, matrix, and link data files
- The calculator then:
  - Reads the open data format travel model output files for a base and build scenario
  - Evaluates user-defined Python expressions for zone, O-D pair, and link (and household, person, and trip in the case of a disaggregate model) level data processors
  - Expressions are segmented by equity group when applicable, and include subtracting the base from the build quantity, monetization, annualization, etc.

The different processors provide sufficient flexibility to specify all the benefits. Figure 1 shows example zone processor expressions.

FIGURE 1. Custom Expressions in the Benefits Calculator

Description	Target	Expression
#zone-based inputs		
hbo productions in base scenario	base_prod_hbo	zones.base_hboprl + zones.base_hboprm + zones.base_hboprh
hbo productions in build scenario	build_prod_hbo	zones.build_hboprl + zones.build_hboprm + zones.build_hboprh
hbo logsum in base scenario	base_ls_hbo	zones.base_hbodcls
hbo logsum in build scenario	build_ls_hbo	zones.build_hbodcls
#calculate travel options benefit by zone		
access benefit hbo	access_benefit_hbo	(0.5 * (base_prod_hbo + build_prod_hbo) * (build_ls_hbo - base_ls_hbo) / UPM_HBO) * (VOT_HBO / 60) * DISCOUNT_RATE * ANNUALIZATION_FACTOR
travel options benefit	travel_options_benefit	access_benefit_hbo + access_benefit_hbr + access_benefit_hbs + access_benefit_hbw + access_benefit_nhbnw + access_benefit_nhbw

3 TESTING THE CALCULATOR

The MCE calculator was rigorously tested for a synthesized major capital investment in the year 2040.

- The base scenario includes 2040 land use and network improvement projects that are included in Metro's Financially Constrained forecast (i.e. programmed and budgeted).
- The build scenario adds approximately 13 miles of an additional lane to Interstate 205 in the Southeast of the region.

Figure 2 shows increases in link volume (red bands) and decreases (green) as a result of the project. Figure 3 shows a reasonable increase in the logsum-based travel options (i.e. accessibility) benefit for LEP communities resulting from the project.

FIGURE 2. Difference in Auto Volumes

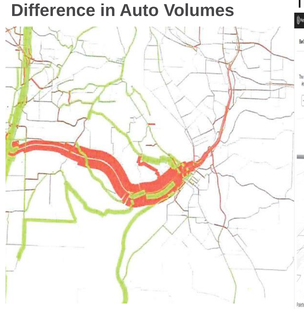
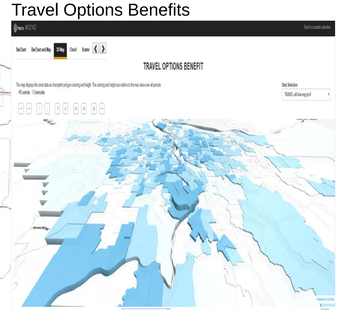


FIGURE 3. Travel Options Benefits



4 EQUITY ANALYSIS

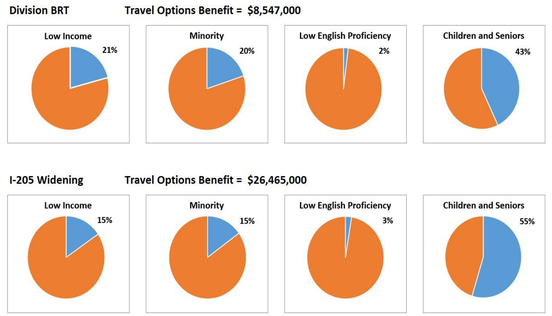
Central to the adoption of the MCE toolkit at Metro is its ability to report benefits by equity group, or in Metro's case, Historically Marginalized Communities. Metro's includes 4 equity groups based upon US Census classifications (12) (13):

- Age (under 18 or over 65)
- Low English Proficiency
- Low Income (<$25k)
- Race/Ethnic minorities

Figure 4 shows benefits per household by Historically Marginalized Community and benefit by two build scenarios:

- Division Street Bus Rapid Transit
- Interstate 205 capacity expansion

FIGURE 4. Benefit Share by Equity Group



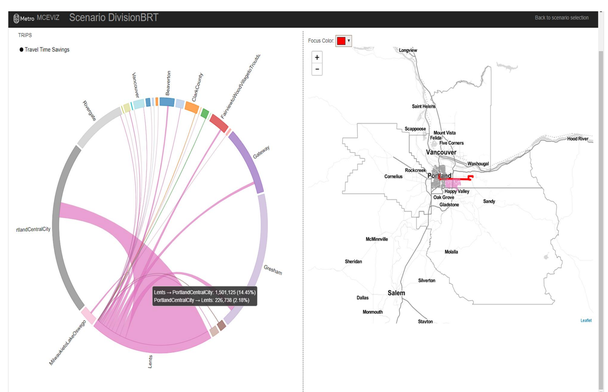
5 VISUALIZATION DASHBOARD

In addition to developing the calculator and the benefit measures, Metro also developed an interactive MCE visualization dashboard (10). The online and open source tool includes:

- Bar charts to visualize benefits by type and equity group
- 3D maps to illustrative benefits across the region
- Chord charts for comparing travel time benefits by alternative

Figure 5 illustrates travel time saving benefits using a BRT line from Lents to Portland CBD (purple chord)

FIGURE 5. Online MCE Visualization Dashboard



6 CONCLUSIONS

- Quantifying a comprehensive set of benefits is essential to Metro's mandate
- Reporting benefits by Census based groupings is key to toolkit adoption as equitable outcomes are a priority.
- The tool is useful for auditing results from the travel model
  - The benefits calculator provides a tremendous amount of information that is converted into easily understandable units such as minutes and dollars
  - It helps to illuminate model system components and their sensitivities that are not often analyzed (such as logsums)
- We believe this tool should be standard practice in our industry
  - This would help ensure forecasts are correct and reasonable, much like FTA's New Starts and Users Benefits program (11)
- User-defined expressions, as opposed to hard coded benefit calculations, allowed for easier revisions and debugging
- Questions remain about how best to "roll-up" (i.e. weight / prioritize) the benefits when compared to costs as part of the overall MCE toolkit

7 FURTHER READING

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10. Model visualization dashboard, https://metromodelingservices.github.io/MCEVIZ
11. Travel Forecasts for the Capital Investment Program. FTA. https://www.transit.dot.gov/funding/grant-programs/capital-investments/travel-forecasts
12. US Census 2010: AGE18, AGE65, POC
13. ACS 2011-2015: POV, LEP