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Track Time and Monetary Costs of Transportation as a Comprehensive Performance Measure: Development and Application of Transportation Cost Index

Liming Wang
Portland State University

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Tracking time and monetary costs of transportation as an accessibility measure: Development and application of Transportation Cost Index

Liming Wang, Portland State University

In Collaboration with
Jenny Liu, Huajie Yang, Wei Shi (PSU)
Bud Reiff (Metro), Brian Gregor (Oregon System Analytics)
Outline

● Why we need yet another performance measure (YAPM)?
● Transportation Cost Index: the idea and implementations
● Applications and Demonstration
● Conclusions
Performance Measures: Mobility vs Accessibility
Need for Accessibility Measures

- As a supplement/replacement of traffic-centric measures: LOS, travel delays/congestion
- MAP-21 emphasizes use of performance measures in transportation planning & operation
- State legislations: Oregon Job and Transportation Act (OJTA)
Existing Accessibility Measures

- Handy and Niemeier, 1997
- Geurs and van Wee, 2004
- NCHRP Report 446, 618, 694, 708 ...
Market Potential Measures

Employment accessible within 30 minutes by public transit during a.m. peak
- Easy to interpret/understand
- Opportunities, mode, time-of-day and time budget specific

Source: University of Minnesota, Accessibility Observatory
Utility-based Measures

Logsum as an accessibility measure

- An Elegant, composite measure for all modes; possible to derive net user benefit between scenarios
- Hard to interpret by itself; unable to compare across regions/times (benchmarking)

\[ E(CS) = \ln \left( \sum_{m'} \exp \left( U_{m'kj} \right) \right) + C \]
Generalized Costs Indicator

Per distance generalized costs for motorized trips

- Easy to interpret/understand; able to monitor trends and compare scenarios
- Ignores land use system; mode, time-of-day specific


<table>
<thead>
<tr>
<th>Table 4</th>
<th>Generalised costs indicator, for private car, 2007 (2000=100) by type of trip.</th>
</tr>
</thead>
</table>
| Location: | Randstad 107  
Outside Randstad 105 |
| Time of day | Rush hour 109  
Outside rush hour 105 |
| Trip purpose | Business 102  
Commuter 110  
Other 106 |
| Distance (km) | Up to 15 105  
15 to 30 110  
30 to 50 108  
More than 50 104 |
H+T® Affordability Index

- Tracks out-of-pocket monetary costs of transportation and adds them to housing costs as a location efficiency measure;
- Ignores time costs; not track the performance of transportation system except for Auto/Transit mode split and VMT.

Source: Center for Neighborhood Technology (CNT)
Wish List for YAPM

- A comprehensive measure able to present an overall picture of transportation and land use;
- Fill gaps in policy areas not adequately covered by existing performance measures, such as the equity and compatibility aspects (Reiff and Gregor, 2005);
- Easy to interpret/understand;
- Applicable to use cases ranging from prioritization, scenario evaluation/comparison, to benchmarking and standard;
# Applicability of Performance Measures

**Selection Criteria:**
- Easy to apply
- Objective quantitative measure
- Good data availability
- Easy to understand

![Applicability of Performance Measures](image)

<table>
<thead>
<tr>
<th>Application</th>
<th>Prioritization</th>
<th>Comparison</th>
<th>Long-term Benchmark</th>
<th>Near-team Standard or Threshold</th>
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<tbody>
<tr>
<td>Transportation System Planning / Subarea Plans / Multi-jurisdictional Corridor Planning</td>
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<td>TCI</td>
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<tr>
<td>Project / Corridor Planning</td>
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<td>Plan Amendments / Zone changes subject to TPR</td>
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<td>Development Review</td>
<td></td>
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</tbody>
</table>
TCI: the idea and implementations
Consumer Price Index (CPI)
From CPI to Transportation Cost Index (TCI)

Measures changes in the “price level” of a market basket of trips/destinations meeting households’ daily needs:

1. Identify a basket of trips/destinations based on pre-defined groups (e.g. trip purpose categories);
2. Track the time and monetary costs of accessing trips/destinations in the basket.
Transportation Cost Index (TCI)

- Comprehensive measure of transportation and land use;
- Able to serve as a performance measure for policy areas including equity, transportation and land use compatibility and balance;
- Easy to interpret/understand;
- Based on widely available data sources, possible for all types of applications, esp. benchmarking and scenario evaluation/comparison.
Implementation A: Travel Survey-based Method

Relies primarily on input from household activity survey, e.g. Oregon Travel & Activity Survey (OTAS)

1. Construct travel baskets based on activity diaries or a sample of trips/tours that are representative of regional travel pattern, potentially by trip purpose, household size, income group and geography;

2. Track the time and monetary costs of making these trips/tours.

Suitable for prioritization and benchmarking applications.
Implementation B: TDM-based Method

Relies on inputs from travel demand model
- Data readily available for regions w/ TDM;
- Theoretically can calculate the transportation cost for every income group and for every TAZ;
Suitable for scenario evaluation/comparison.
Implementation B: TDM-based Method
Calculate Travel Costs: Cost Estimate by Mode

\[ C = C_0 + k \cdot TD + w \cdot TT \]

- \( C_0 \) - Constant
- \( k \cdot TD \) - Monetary costs (Fuel and tire costs, Ownership costs, insurance, etc) of travel
- \( w \cdot TT \) - Time costs of travel
Applications and Demonstration
Generalized Costs by Household Income Level (Portland)

1994

2011
Generalized Costs by Presence of Children (Portland)

1994

2011
Per Person Generalized Costs by Household Income (Portland)

1994

2011
Generalized Costs by Purpose and Income Level (Portland)

1994

2011
Transportation Costs by MSA (All households)

Data source: 2009 NHTS
Transportation Costs by MSA (Low Income)

Data source: 2009 NHTS
Generalized Costs by Income Level (Corvallis)

2010        2030 Preferred        2030 Preferred Scen1
Generalized Costs by Trip Purpose and Income Level (Corvallis)

2010                2030 Preferred      2030 Preferred Scen1
Generalized Costs by Income Level (Corvallis)

Low Inc | Mid Inc | High Inc | All Households

2010

2030 Preferred
Ongoing and Future Work

- Adopted by the Accessibility Indicator Development Team (IDT) as one of indicators for the Oregon Mosaic project mandated by OJTA
- Test TCI usage in public engagement and policy making process
- Reconcile TCIs from the two methods;
- Verify patterns of transportation costs with information from alternative data sources, such as CES.
Code and Working Papers

● Code (under active development/testing) available at [http://github.com/cities-lab/tci](http://github.com/cities-lab/tci)

● Working Papers:


Acknowledgements

National Institute for Transportation and Communities

Oregon DOT
Extra Slides
Income Levels

To be consistent with the classification used in Metro’s TDM, household income levels are classified with this scale (1994 dollars):

- < $25K: Low Income
- $25-50K: Mid Income
- > $50K: High Income
Identify Activity Centers (Travel Market Basket)

Origin Employment Density

Legend:
- 0 – 25
- 25 – 150
- 150 – 500
- 500 – 1000
- 1000 – 5000
- 5000 – 10000
- 10000 – 50000
- 50000 – 1e+05
- 1e+05 – 2e+05
- 2e+05 – 350000
Steps (Giulinao, 1991)

1. Calculate employment/size term density;
2. Identify TAZs with densities greater than density cutoff D and group contiguous TAZs identified into preliminary centers;
3. Calculate total employment or size terms for each center identified in step 2 and eliminate centers with total employment or size terms below total cutoff E from centers identified in step 2. The remaining are activity centers.
Determine Cutoffs

• Giulinao (1991) provides no guidance in selecting density cutoff (D) or total cutoff (E). They relied on expert knowledge
• Sensitivity Tests to determine cutoffs
Sensitivity Tests: HBW
Sensitivity Tests: HBS
Sensitivity Tests: HBS
Sensitivity Tests: HBO
Travel Costs Calculation: Cost Estimate by Mode

• Auto

\[ C_{auto} = C_{auto0} + k_{auto} \cdot TD_{auto} + w_{auto} \cdot TT_{auto} \]

- \( C_{m0} \) - Constant
- \( k_{auto} \cdot TD_{auto} \) - Monetary costs (Fuel and tire costs, Ownership costs, insurance, etc) of driving
- \( w_{auto} \cdot TT_{auto} \) - Time costs of driving
Travel Costs Calculation: Cost Estimate by Mode

• Public Transit:
  \[ C_{\text{public}} = \text{fare} + w_{\text{public}} \cdot TT_{\text{public}} \]
  – Fare: Transit fares
  – \( w_m \cdot TT_{\text{public}} \): Time costs of riding transit

• Non-motorized modes (bicycling and walking)
  \[ C_{\text{bicycle}} = C_{\text{bicycle}_0} + w_{\text{bicycle}} \cdot TT_{\text{bicycle}} \]
  \[ C_{\text{walk}} = w_{\text{walk}} \cdot TT_{\text{walk}} \]
  – Time costs of Bicycling and Walking
Parameters

VOT (ratio to hourly wage):
walk=0.5    bike=0.5
auto / van/ truck driver=0.5
auto / van / truck passenger=0.35
bus=0.35    rail=0.35
dial-a-ride/paratransit=0.35
taxi=0.35    school bus=0.35
carpool / vanpool=0.35
other (specify)=0.5
driveAlone=0.5
drivePass=0.5
pass=0.35    busWalk=0.35
parkAndRideBus=0.35

Monetary costs per mile:
walk=0       bike=0
auto / van/ truck driver=$0.592
auto / van / truck passenger=$0.592
bus=$1.01    rail=$1.38
dial-a-ride/paratransit=0
taxi=$2.6     school bus=0
carpool / vanpool=0
other (specify)=$0.296
driveAlone=$0.592
drivePass=$0.592
pass=$0.592   busWalk=$1.01
parkAndRideBus=$1.01