Development & Application of the Transportation Sustainability Index

Jason Zheng, Graduate Research Assistant
University of Connecticut
Center for Transportation & Urban Planning

6th Annual ITE Symposium
Why Sustainability?

A Holistic Approach to Address Environment, Society, & Economy
Transportation’s Role

Cornerstone of Civilization

More than just Mobility

impacts

Environment, Society, & Economy

Transportation Sustainability
Transportation Sustainability is NOT about Sustaining Transportation
“Paradigm Shift”

Understanding Transportation
Beyond Oil Dependency & Greenhouse Gases

Transportation Systems
Shape our Communities & Social Values

1 Todd Litman, Reinventing Transportation, Exploring the Paradigm Shift Needed...
“Paradigm Shift”

1 Todd Litman, *Reinventing Transportation, Exploring the Paradigm Shift Needed*...
On the other hand...

“drill, baby, drill”
The Need for New Metrics

Scorecard

Progress

Policy & Planning

“What gets measured gets managed”
Movie Ratings
Congestion

Gross Domestic Product
Fuel Price
Comprehensive Metric
assess full impacts, negative and positive

Define Transportation Sustainability
No Universally Accepted Definition
Transportation Sustainability

Our Definition Incorporates:

Canadian Centre for Sustainable Transport

European Commission on Sustainable Development

Numerous Conceptualizations of Sustainability
Equilibrium Model

- Environment
- Sustainability
- Economy
- Society
Nested Model
Green & Brown Agendas

Global

Local
Haughton’s Equity Principles

Intragenerational

Intergenerational

Geographical

Procedural

Interspecies
Composite Index for Transportation Sustainability

CITS Score

3 Domains

12 Elements

19 Indicators

X Variables

The domains organize the elements according to the 3 spheres of sustainability.

The CITS Score is the weighted average of these 12 elements.
<table>
<thead>
<tr>
<th>Domain</th>
<th>Elements</th>
<th>Indicators</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td>4</td>
<td>8</td>
<td>X</td>
</tr>
<tr>
<td>Society</td>
<td>4</td>
<td>7</td>
<td>X</td>
</tr>
<tr>
<td>Economy</td>
<td>4</td>
<td>4</td>
<td>X</td>
</tr>
</tbody>
</table>

*Environment*:
- Transportation and placemaking system is designed to minimize land use efficiency.
- Transportation system meets access needs and is consistent with human health and safety.
- Transportation system is locally self-sufficient and community input.

*Society*:
- Transportation and placemaking system meets needs of individuals and communities.
- Transportation is affordable for minority groups.

*Economy*:
- Transportation system does not contribute to economic vulnerability of society.
- Transportation system is locally self-sufficient and community input.

**X** indicates that variables have not been determined and thus cannot be measured. These indicators are difficult to measure at the state wide level.
<table>
<thead>
<tr>
<th></th>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minimize consumption of renewable &amp; non-renewable resources for transportation</td>
</tr>
<tr>
<td>2</td>
<td>Transportation and placemaking system is designed to maximize land use efficiency</td>
</tr>
<tr>
<td>3</td>
<td>Minimize transportation and place-making system's impact on ecological systems</td>
</tr>
<tr>
<td>4</td>
<td>Limit transportation related wastes &amp; pollution</td>
</tr>
<tr>
<td>Social</td>
<td>5</td>
</tr>
<tr>
<td>--------</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Economic</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>---</td>
</tr>
<tr>
<td>9</td>
<td>Transportation is affordable for individuals</td>
</tr>
<tr>
<td>10</td>
<td>Transportation system provides efficient movement of people &amp; goods for economic growth</td>
</tr>
<tr>
<td>11</td>
<td>Transportation system is financially self-sufficient at the local level</td>
</tr>
<tr>
<td>12</td>
<td>Transportation system does not contribute to economic vulnerability of society</td>
</tr>
</tbody>
</table>
Ranking of the United States

Geographic Flexibility

State Wide Scale

Economic Elements
<table>
<thead>
<tr>
<th>Domain</th>
<th>1</th>
<th>Element</th>
<th>$i_{12}$</th>
<th>1</th>
<th>Indicator</th>
<th>$i_{12;i}$</th>
<th>1</th>
<th>Variable</th>
<th>$X_{12;i}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Minimize consumption of renewable &amp; non-renewable resources for transportation</td>
<td>$I_{1;2}$</td>
<td></td>
<td>Energy Consumption</td>
<td>$I_{1;1;2}$</td>
<td>1</td>
<td>Btu per capita</td>
<td>$X_{1;1;1;2}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Infrastructure Materials Consumption</td>
<td>$I_{1;1;3}$</td>
<td>2</td>
<td>Asphalt consumption (tons) per capita</td>
<td>$X_{1;1;1;2}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Vehicle Materials Consumption</td>
<td>$I_{1;1;3}$</td>
<td>3</td>
<td>Vehicle mass per capita</td>
<td>$X_{1;1;1;3}$</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Transportation and placemaking system is designed to maximize land use efficiency</td>
<td>$I_{2;2}$</td>
<td></td>
<td>Land Use</td>
<td>$I_{2;2;4}$</td>
<td>4</td>
<td>New lane miles per population growth</td>
<td>$X_{2;2;4;5}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$I_{2;2;5}$</td>
<td>5</td>
<td>Land urbanized per population growth</td>
<td>$X_{2;2;4;5}$</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Minimize transportation and place-making system’s impact on ecological systems</td>
<td>$I_{3;2}$</td>
<td></td>
<td>Ecological Systems</td>
<td>$I_{3;2;5}$</td>
<td>6</td>
<td>Loss of wetlands/ agricultural lands (acres) per population growth</td>
<td>$X_{3;2;5;6}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Greenhouse Gas Emissions</td>
<td>$I_{3;2;6}$</td>
<td>7</td>
<td>CO2 emissions per capita</td>
<td>$X_{3;2;5;7}$</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Limit transportation related wastes &amp; pollution</td>
<td>$I_{4;4}$</td>
<td></td>
<td>Pollution</td>
<td>$I_{4;4;7}$</td>
<td>8</td>
<td>Pollution Index</td>
<td>$X_{4;4;7;8}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Waste Production</td>
<td>$I_{4;4;8}$</td>
<td>9</td>
<td>Transportation Solid Waste per capita</td>
<td>$X_{4;4;7;8}$</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Transportation system meets access needs in a way that is consistent with human health &amp; safety</td>
<td>$I_{5;2}$</td>
<td></td>
<td>Health</td>
<td>$I_{5;2;9}$</td>
<td>10</td>
<td>Pedestrian &amp; bicycle mode share</td>
<td>$X_{5;2;9;10}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$I_{5;2;11}$</td>
<td>11</td>
<td>EPA Air Quality Index</td>
<td>$X_{5;2;9;11}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Transportation fatalities per 100,000 people</td>
<td>$I_{5;2;12}$</td>
<td>12</td>
<td>Transportation fatalities per 100,000 people, relative to the # of people that walk &amp; bike</td>
<td>$X_{5;2;9;12}$</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Planning and management of the transportation system incorporates different levels of government</td>
<td>$I_{6;11}$</td>
<td></td>
<td>Government Interoperability</td>
<td>$I_{6;11;11}$</td>
<td>(Variables have not been determined for this factor at the state level)</td>
<td>$X_{6;11;11;11}$</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Transportation is affordable for individuals</td>
<td>$I_{16;11}$</td>
<td>16</td>
<td>Affordability</td>
<td>$I_{16;11;11}$</td>
<td>18</td>
<td>% of household income spent on transportation</td>
<td>$X_{16;11;11;18}$</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Transportation system provides efficient movement of people &amp; goods for economic growth</td>
<td>$I_{17;11}$</td>
<td>17</td>
<td>Mobility</td>
<td>$I_{17;11;11}$</td>
<td>19</td>
<td>Change in GDP growth per VMT growth</td>
<td>$X_{17;11;11;19}$</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Transportation system is financially self-sufficient at the local level</td>
<td>$I_{18;11}$</td>
<td>18</td>
<td>Financial Security</td>
<td>$I_{18;11;11}$</td>
<td>20</td>
<td>Absolute GDP per VMT</td>
<td>$X_{18;11;11;20}$</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Transportation system does not contribute to economic vulnerability of society</td>
<td>$I_{19;11}$</td>
<td>19</td>
<td>Economic Vulnerability</td>
<td>$I_{19;11;11}$</td>
<td>21</td>
<td>% of transportation expenditure from federal funding</td>
<td>$X_{19;11;11;21}$</td>
</tr>
</tbody>
</table>

**Note:** *Indicates that variables have not been determined, and thus cannot be measured. These indicators are difficult to measure at the state wide level.*
Computation

Normalization

Linear Scaling Transformation

Relative

Dimensionless

Equally Weighted
Top 5
District of Columbia
New York
Massachusetts
Oregon
Washington

Bottom 5
South Carolina
Wyoming
Arkansas
Montana
Mississippi
States in Red
More Vulnerable
Surge in Fuel Prices
Changes in Funding Availability
Future Considerations & Next Steps

Weighting System

Urbanity Index

Complete Scores Summer 2010
Final Thoughts

Identify Key Elements

Versatile Framework
Questions?