Implementing Sustainable Transportation at State DOT’s

By

Joe Zietsman, Ph.D., P.E.
Texas Transportation Institute
Towards a Sustainable Transportation System

- Understanding Sustainable Transportation
- Quantifying Sustainable Transportation
- Applying Sustainable Transportation
Highway 59 On a Good Day
Highway 59 On a Bad Day
Los Angeles, 1956
Los Angeles, Today
Emissions Versus Model Year

Vehicle - kilometers
Accumulated

0 km
16,000 km
32,000 km
48,000 km
64,000 km

Model Year

VOC Emission Rate (g/km)
Los Angeles, Without Pollution Controls
Interaction of Economy on Ecological System

- Solar Energy
- Renewable Resources
- Non Renewable Resources
- Economic subsystem
- Waste
- Recycling
- Damages
- Waste Heat
- Global Ecological System
- Time
Negative Externalities

- Air pollution
- Noise pollution
- Accidents
- Global warming
- Energy use
- Congestion
- Social disruption
- Consumption of land
- Loss of habitat
- Hazardous materials
- Vibration
- Visual intrusion
- Waste disposal
- Water pollution
Evolution of Sustainable Development

- 1700’s - Improvement in standard of living = population surge
- 1960’s – Concern over the human impact on the environment
- 1970’s – Specific concerns identified: global warming, acid rain, population growth, and loss of tropical forests
- 1980 – Sustainable Development used as a term for the first time
- 1987 – Brundland Report
- 1992 – UN Conference in Rio de Janeiro
- 2002 – UN Conference in Johannesburg
Defining Sustainable Transportation

Some Appropriate Measure

Time

Sustainability
Resources
Technology
Needs
Environment
Ecology
Sustainable development is development that ensures *intergenerational equity* by simultaneously addressing the *multi-dimensional* components of economic development, environmental stewardship, and social equity. It is a *dynamic* process, which considers the changing needs of society over space and time. Sustainable development can be viewed as a *continuum*, representing various degrees of sustainability. It must, however, be achieved within resource, environmental, and ecological *constraints*. 
Key Challenges for Sustainable Transportation

- Understand
- Quantify
- Apply
Performance Measures

- Simplify
- Quantify
- Communicate
Categories of Performance Measures

- Input
- Output
- Outcome
Attributes of a Good Performance Measure

- Acceptable
- Affordable
- Measurable
- Relevant

- Sensitive
- Show trends
- Understandable
- Benchmark
Old and New Paradigms

Old Paradigms:
1. Zoning
2. Speed
3. Mobility
4. Supply
5. Output
6. Efficiency
7. Process
8. Activities
9. Aggregate
10. Bottom-up

New Paradigms:
1. Integration
2. Mobility
3. Accessibility
4. Demand
5. Outcome
6. Effectiveness
7. Product
8. Results
9. Disaggregate
10. Top-down
## TxDOT Goals

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social</strong></td>
<td>Reduce Congestion</td>
</tr>
<tr>
<td></td>
<td>Enhance Safety</td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td>Expand Economic Opportunity</td>
</tr>
<tr>
<td></td>
<td>Increase Value of Transportation Assets</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>Improve Air Quality</td>
</tr>
</tbody>
</table>
Goals of Other Areas - Pretoria, South Africa
Goals

Pretoria Corridor
- Improve mobility and accessibility
- Safety and security
- Economic growth
- Protect the environment
- Integrate LU and TRP
- Regulate transit

Houston Corridor
- Improve mobility and accessibility
- Safety and security
- Economic growth
- Protect the environment
- Integrate LU and TRP
- Multi-modal system
- Conserve energy
Texas Showing Nonattainment Areas
Test Corridor
<table>
<thead>
<tr>
<th>Goal</th>
<th>Performance Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce Congestion</td>
<td>Travel rate index</td>
</tr>
<tr>
<td></td>
<td>Buffer index</td>
</tr>
<tr>
<td>Enhance Safety</td>
<td>Annual number of crashes per lane mile</td>
</tr>
<tr>
<td></td>
<td>% lane-miles under TMC surveillance</td>
</tr>
<tr>
<td>Expand Economic Opportunity</td>
<td>% of project funding from alternative sources</td>
</tr>
<tr>
<td></td>
<td>% of land within ½-mile of corridor that is zoned as commercial or industrial</td>
</tr>
<tr>
<td>Increase Value of Transportation Assets</td>
<td>TxDOT’s Pavement Condition Rating (on scale of 1-100)</td>
</tr>
<tr>
<td></td>
<td>% of lane-miles that can be added in median</td>
</tr>
<tr>
<td></td>
<td>Whether toll-eligible project is being tolled</td>
</tr>
<tr>
<td>Improve Air Quality</td>
<td>Daily NOx, CO, and VOC emissions in grams per lane mile</td>
</tr>
</tbody>
</table>

Social, economic, environmental
Formulations

\[ \text{TRI} = \frac{\text{Peak Hour Travel Rate (Minutes per Mile)}}{\text{Off - Peak Travel Rate (Minutes per Mile)}} \]

\[ \text{Buffer Index} = \frac{\text{95th Percentile Travel Time (Minutes)} - \text{Average Travel Time (Minutes)}}{\text{Average Travel Time (Minutes)}} \]
Index Formulation

\[ \text{Index} = \sum_{i=1}^{n} \text{Rating}_i \times \text{Weight}_i \]

\[ \text{Rating}_i = f(\text{Normalizer}_i) \]

- Emissions
- Energy use
- Safety
- Travel cost
- Travel rate
## Quantified Measures

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Calculated values</th>
<th>Scaling values</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Base value</td>
<td>Future value</td>
</tr>
<tr>
<td>Travel rate index</td>
<td>1.60</td>
<td>1.40</td>
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<tr>
<td>Buffer index</td>
<td>0.65</td>
<td>0.58</td>
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<tr>
<td>Annual number of crashes per lane mile</td>
<td>7.94</td>
<td>13.97</td>
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<tr>
<td>Percentage of lane-miles under TMC surveillance</td>
<td>0</td>
<td>100</td>
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<tr>
<td>Percentage of project funding from alternative sources</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>Percentage of land within ½-mile of corridor that is zoned as commercial or industrial</td>
<td>36.08</td>
<td>46.03</td>
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<tr>
<td>Daily NOx, CO, and VOC emissions in grams per lane mile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOC</td>
<td>28,740</td>
<td>21,350</td>
</tr>
<tr>
<td>CO</td>
<td>372,258</td>
<td>292,487</td>
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<tr>
<td>NOx</td>
<td>83,263</td>
<td>22,637</td>
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<tr>
<td>TxDOT’s Pavement Condition Rating (on scale of 1-100)</td>
<td>89.2</td>
<td>95.0</td>
</tr>
<tr>
<td>Percentage of lane-miles that can be added in median</td>
<td>28.8</td>
<td>0.0</td>
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<tr>
<td>Whether toll-eligible project is being tolled</td>
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<td>1</td>
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## Allocation of Weights

<table>
<thead>
<tr>
<th>Goals</th>
<th>Goal weights</th>
<th>Performance measure</th>
<th>Performance measure weight</th>
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<tbody>
<tr>
<td>Reduce congestion</td>
<td>0.25</td>
<td>Travel rate index</td>
<td>0.65</td>
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<tr>
<td></td>
<td></td>
<td>Buffer index</td>
<td>0.35</td>
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<tr>
<td>Enhance safety</td>
<td>0.30</td>
<td>Number of crashes per lane mile</td>
<td>0.90</td>
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<td></td>
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<td>Percentage of lane miles under TMC surveillance</td>
<td>0.10</td>
</tr>
<tr>
<td>Expand Economic Opportunity</td>
<td>0.20</td>
<td>Percentage of project funding from alternative sources</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percentage of land within ½-mile of corridor that is zoned as commercial or industrial</td>
<td>0.60</td>
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<tr>
<td>Improve air quality</td>
<td>0.15</td>
<td>Daily NOx, CO, and VOC emissions in grams per lane mile</td>
<td>0.43 – VOC</td>
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<td></td>
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<td>0.12 – CO</td>
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<td>0.45 – NOx</td>
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<tr>
<td>Increase Value of Transportation Assets</td>
<td>0.10</td>
<td>TxDOT’s Pavement Condition Rating (on scale of 1-100)</td>
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<td>Percentage of lane-miles that can be added in median</td>
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<td>Whether toll-eligible project is being tolled</td>
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## Index Values

<table>
<thead>
<tr>
<th>Goal</th>
<th>Weight</th>
<th>Un-weighted measures</th>
<th>Weighted measures</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Base case</td>
<td>Future case</td>
</tr>
<tr>
<td>Reduce Congestion</td>
<td>0.25</td>
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<td>Expand Economic Opportunity</td>
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<td>Improve Air Quality</td>
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<td>0.31</td>
<td>0.81</td>
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<td>Increase Value Transportation Assets</td>
<td>0.1</td>
<td>0.41</td>
<td>0.49</td>
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<td><strong>Index values</strong></td>
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<td>-</td>
<td>-</td>
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</tbody>
</table>
Link-Based Approach

The graph compares the index values for different links and corridors between the base case and the future case. The x-axis represents the links and corridors, while the y-axis shows the index values ranging from 0.00 to 0.70. The bars indicate the values for each link and corridor under both cases.
Conclusions

- Sustainability needs to be:
  - Understood
  - Quantified
  - Applied

- Integrate into planning process