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Sustainable Transportation Indicator Data Quality and Availability

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Abstract
This paper investigates the quality and availability of data required for sustainable transportation indicators. This analysis indicates that much of the information required is already collected, but inconsistencies in definitions and collection methods, a lack of disaggregation to appropriate geographic scales, and difficulties accessing data reduce the utility of this information. With relatively little incremental costs, transportation professional organizations could improve the quality of transportation-related statistics to facilitate transportation research, policy analysis and planning.

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Introduction

There is growing interest in the concepts of sustainability, sustainable development and sustainable transportation. Sustainability is generally evaluated using various *indicators*, which are specific variables suitable for quantification (1, 2, 3). Such indicators are useful for establishing baselines, identifying trends, predicting problems, assessing options, setting performance targets, and evaluating a particular jurisdiction or organization.

Sustainability is generally defined to include a variety of economic, social and environmental planning objectives (4), so sustainable transportation indicators must account for a variety of impacts, as summarized in Table 1.

Table 1 **Sustainable Transportation Impacts** (2, 5)

Economic	Social	Environmental
Traffic congestion	Equity / Fairness	Air pollution
Infrastructure costs	Impacts on mobility disadvantaged	Climate change
Consumer costs	Human health impacts	Noise and water pollution
Mobility barriers	Community cohesion	Habitat loss
Accident damages	Community livability	Hydrologic impacts
DNRR	Aesthetics	DNRR

DNRR=Depletion of Non-Renewable Resources

In recent years organizations, such as the *Centre for Sustainable Transportation* (1), the European Commission (6) and various government agencies (2, 7), have worked to identify appropriate sustainable transportation indicators.

Table 1 summarizes sustainable transportation indicators recommended by the Transportation Research Board's *Sustainable Transportation Indicators Subcommittee* (ADD40 [1]). It lists recommended indicator sets grouped into *Most Important* (should usually be used), *Helpful* (should be used if possible) and *Specialized* (should be used to reflect particular needs or objectives).

These data can be presented in various ways to show trends, differences between groups and areas, comparison with peer jurisdictions or agencies, and levels compared with recognized standards. Indicators can be disaggregated by demographic (income, employment, gender, age, physical ability, minority status, etc.) and geographic factors (urban, suburban, rural, etc.), time (peak and off-peak, day and night), and by mode (walking, cycling, transit, etc.) and trip (commercial, commuting, tourism, shopping, etc.).

Table 1 **STI Subcommittee's Recommended Indicators** (8)

	Economic	Social	Environmental
Most Important *(Should usually be used)*	Personal mobility (annual person-kilometers and trips) and vehicle travel (annual vehicle-kilometers), by mode (nonmotorized, automobile and public transport). Freight mobility (annual tonne-kilometers) by mode (truck, rail, ship and air). Land use density (people and jobs per unit of land area). Average commute travel time and reliability. Average freight transport speed and reliability. Per capita congestion costs. Total transport expenditures (vehicles, parking, roads and transit services).	Trip-to-school mode split (nonmotorized travel is desirable) Per capita traffic crash and fatality rates. Quality of transport for disadvantaged people (disabled, low incomes, children, etc.). Affordability (portion of household budgets devoted to transport, or combined transport and housing). Overall transport system satisfaction rating (based on objective user surveys). Universal design (transport system quality for people with disabilities and other special needs).	Per capita energy consumption, by fuel and mode. Energy consumption per freight ton-mile. Climate change emissions. Air pollution emissions (various types), by mode. Air and noise pollution exposure and health impacts. Land paved for transport facilities (roads, parking, ports and airports). Stormwater management practices.
Helpful *(Should be used if possible)*	Quality (availability, speed, reliability, safety and prestige) of non-automobile modes (walking, cycling, ridesharing and public transit). Number of public services within 10-minute walk, and job opportunities within 30-minute commute of residents. Portion of households with internet access.	Portion of residents who walk or bicycle sufficiently for health (15 minutes or more daily). Portion of children walking or cycling to school. Degree cultural resources are considered in transport planning. Housing affordability in accessible locations. Transit affordability.	Community livability ratings. Water pollution emissions. Habitat preservation in transport planning. Use of renewable fuels. Transport facility resource efficiency (such as use of renewable materials and energy efficient lighting). Impacts on special habitats and environmental resources.
Planning Process	Comprehensive (considers all significant impacts, using best current evaluation practices, and all suitable options, including alternative modes and demand management strategies). Inclusive (substantial involvement of affected people, with special efforts to insure that disadvantaged and vulnerable groups are involved). Based on *accessibility* rather than *mobility* (considers land use and other accessibility factors).		
Market Efficiency	Portion of total transportation costs that are efficiently priced. Neutrality (public policies do not arbitrarily favor a particular mode or group) in transport pricing, taxes, planning, investment, etc. Applies *least cost planning*.		

This table identifies various sustainable transport indicators recommended by the Transportation Research Board's Sustainable Transportation Indicators Subcommittee. These are ranked by importance and type.

An important consideration in selecting indicators is the cost and quality of data. Currently, most jurisdictions collect some transportation-related statistics, such as:

- Person travel (by distance, demographic group and travel type)
- Vehicle ownership (by type)
- Vehicle travel (by type, purpose and location)
- Mode split
- Crashes and casualties (by type)
- Travel speeds and congestion delay
- Land use factors (development density and mix)
- Roadway length and condition
- Railroad length and condition
- Airports
- Transport facility expenditures
- Public transit service quality
- Walking & cycling facility length and condition
- Transport system connectivity (transferability between modes)
- Energy consumption
- Pollution emissions
- Traffic and aircraft noise exposure
- Household transport expenditures
- Mobility options for non-drivers

There is currently little consistency or quality control of these statistics (9). To be useful, jurisdictions should collect the same statistics, using consistent definitions, and meet minimum data quality standards, so results can be compared between jurisdictions and over time. Data quality refers to the following features (2):

- *Accuracy.* The methods used to collect statistics must be suitably accurate.
- *Transparency.* The methods used to collect statistics must be accessible for review.
- *Comprehensiveness.* An adequate range of statistics should be collected to allow various types of analysis. This should be disaggregated in various ways, including by geographic area (particularly by urban region), mode and vehicle type and demographic group.
- *Frequency.* Data should be collected regularly, which may be quarterly, annually, or ever several years, depending on type.
- *Consistency.* The range of statistics, their definitions and collection methodologies should be suitably consistent between different jurisdictions, modes and time periods.
- *Availability.* Statistics should be readily available to users. As much as possible, data sets should be available free on the Internet in spreadsheet or database format.

Table 3 indicates key U.S. data sources. This indicates that data are available for most sustainable transportation indicators. Some indicators require special questions in local travel surveys (LTS), data at new geographic scales (such as more local or regional reporting), or special analysis of existing data sets, but only a few indicators require totally new data collection. This indicates that with improved planning and coordination (for example, standardized definitions and survey questions, and finer scale reporting), sustainable transport performance evaluation would require little additional costs. These data quality improvements would provide value for diverse policy and planning analysis, regardless of whether it is called “sustainable” transport planning.

Table 3 **Data Sources**

Indicator	Data Sources
Economic	
Personal mobility (annual person-kilometers and trips) and vehicle travel (annual vehicle-kilometers), by mode (nonmotorized, automobile and public transport).	BTS, FHWA and LTS.
Freight mobility (annual tonne-kilometers) by mode (truck, rail, ship and air).	BTS, FHWA and LTS.
Land use density (people and jobs per unit of land area).	Census
Average commute travel time and reliability.	Census, LTS and TTI
Average freight transport speed and reliability.	BTS, FHWA and LTS ([10]
Per capita congestion costs.	TTI
Total transport expenditures (vehicles, parking, roads and transit services).	BLS (vehicle and transit expenditures), APTA (transit expenditures). Other sources for tolls and parking costs.
Quality (availability, speed, reliability, safety and prestige) of non-automobile modes (walking, cycling, ridesharing and public transit).	LTS and APTA. Other sources needed to improve multi-modal performance indicators, particularly for non-motorized modes (walking and cycling).
Number of services within 10-minute walk, and job opportunities within 30-minute commute of residents.	Walkscore, Census, LTS and regional GIS analysis.
Portion of households with internet access.	Census, NTIA
Social	
Trip-to-school mode split (nonmotorized preferred)	LTS. This may require special survey questions.
Per capita traffic crash and fatality rates.	FHWA, NHTSA, APTA
Quality of transport for disadvantaged people (disabled, low incomes, children, etc.).	LTS. This generally requires special survey questions.
Affordability (portion of household budgets devoted to transport, or combined transport and housing).	BLS, HTAI, LTS
Overall transport system satisfaction rating (based on objective user surveys).	LTS. This generally requires special survey questions.
Universal design (transport system quality for people with disabilities and other special needs).	LTS. This generally requires special survey questions.
Portion of residents who walk or bicycle sufficiently for health (15 minutes or more daily).	LTS. This generally requires special survey questions.
Portion of children walking or cycling to school.	LTS. This generally requires special survey questions.
Degree cultural resources are considered in planning.	Requires special analysis of planning process.
Housing affordability in accessible locations.	HTAI, Local GIS analysis
Transit affordability.	APTA, LTS.
Environmental	
Per capita energy consumption, by fuel and mode.	FHWA, LTS. Requires special analysis of fares.
Energy consumption per freight ton-mile.	ORNL, FHWA
Climate change emissions.	ORNL, LTS, local, regional or state energy data.
Air pollution emissions (various types), by mode.	LTS, with local, regional or state emission data.
Air and noise pollution exposure and health impacts.	Local, regional or state air quality data.
Land paved for transport facilities (roads, parking, etc).	Special GIS Analysis ([11])
Stormwater management practices.	Requires special analysis.
Community livability ratings.	Requires special analysis.
Water pollution emissions.	Local, regional or state water quality data.
Habitat preservation in transport planning.	Requires special analysis of planning process.
Use of renewable fuels.	ORNL, LTS, local, regional or state fuel data.
Transport facility resource efficiency (such as use of renewable materials and energy efficient lighting).	Requires special analysis.
Impacts on special habitats and environmental resources.	Requires special analysis.

This table indicates potential sources of sustainable transportation indicators data in the U.S.

Key to Table 3 data sources:

APTA = American Public Transportation Association *Transit Statistics* (www.apta.com/research/stats)

BLS = Bureau of Labor Statistics, *Consumer Expenditure Survey* (www.bls.gov)

BTS = Bureau of Labor Statistics, *Transportation Statistics Annual Report* (www.bts.gov)

Census = U.S. Census Bureau (www.census.gov)

FHWA = *Highway Statistics* (www.fhwa.dot.gov/ohim)

HTAI = Housing and Transportation Affordabilty Index (http://htaindex.cnt.org)

LTS = Local Travel Surveys (www.surveyarchive.org)

NHTSA = National Highway Traffic Safety Administration (www.nhtsa-tsis.net)

NTIA = National Telecommunications and Information Administration (www.ntia.doc.gov)

ORNL = Oak Ridge National Laboratories, *Transportation Energy Book* (www-cta.ornl.gov/data)

TTI = Texas Transportation Institute's *Urban Mobility Report* (http://mobility.tamu.edu/ums)

Walkscore (www.walkscore.com).

Outside the U.S., transportation-related statistics are generally more limited and less standardized (12, 13). Other data sets exist, some of which are listed below, but none of these are as comprehensive, consistent, frequent or available as the U.S. data sets (14).

International Road Federation (www.irfnet.org)
Millennium Cities and Mobility In Cities Database (www.uitp.org/publications/MCD2-order)
National Transit Database (www.ntdprogram.gov)
OECD Transport Statistics (www.oecd.org)
International Transport Forum (www.internationaltransportforum.org)

Some organizations, such as the European Union (http://ec.europa.eu/energy/publications/statistics/statistics_en.htm) and the *OECD* (www.sourceoecd.org/factbook) provide international transportation-related data, and some countries, such as the United Kingdom (www.dft.gov.uk/transtat) and Australia (www.btre.gov.au) collected and make available transportation-related statistics, but they are generally unsuited to comparisons between different jurisdictions and countries.

The problem researchers face is not an absolute lack of data collection, but a lack of consistency, transparency, and availability of the data that are collected by various organizations and jurisdictions. This suggests that efforts to improve international data quality could provide large benefits, for research, policy analysis and planning purposes.

Conclusions

Indicators are things we measure to evaluate progress toward goals and objectives (15). Such indicators have many uses: they can help identify trends, predict problems, assess options, set performance targets, and evaluate a particular jurisdiction or organization. Indicators are equivalent to senses (sight, hearing, touch, smell, taste) – they determine how things are perceived and what receives attention. Which indicators are used can significantly affect planning decisions. An activity or option may seem good and desirable when evaluated using one set of indicators, but harmful when evaluated using another. It is therefore important for good planning to have appropriate and high quality performance indicators.

Although there are many possible definitions of sustainability, sustainable development and sustainable transportation, experts increasingly agree that these should refer to a balance of economic, social and environmental health. Comprehensive and sustainable transport planning therefore requires a balanced set of indicators reflecting appropriate economic, social and environmental objectives.

There are currently no standardized indicator sets for comprehensive and sustainable transport planning. Each jurisdiction or organization must develop its own set based on needs and abilities. Although most of the needed data are collected by U.S. government agencies, definitions, survey questions and analysis methods are not consistent. Outside of the U.S., data consistency and available are even worse, creating a significant problem for sustainable transportation planning.

It would be useful for major planning and professional organizations to establish recommended sustainable transportation indicator sets, data collection standards, and evaluation best practices in order to improve sustainability planning and facilitate comparisons between jurisdictions, organizations and time periods.

Specifically, this analysis indicates that there would be significant benefits to a major international research program implemented by international organizations such as the Transportation Research Board, the World Congress for Transportation Research, the Institute of Transportation Engineers, or the OECD with the following tasks:

1. Perform a comprehensive review of existing transportation-related data sets and data collection activities.
2. Consult with data collection experts and users to identify best current practices with regard to factors such as collection methods, comprehensiveness and availability.
3. Provide general recommendations for improving the quality of transportation-related statistics.
4. Develop specific proposals for the development of universal data quality guidelines and standards that could be adopted by jurisdictions, agencies and professional organizations that collect, manage and use such statistics.

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