EVALUATING THE IMPACT OF COMPLETE STREETS INITIATIVES

Center for Inclusive Design and Environmental Access
GOBike Buffalo

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This report was prepared by Molly E. Ranahan, MUP, James A. Lenker, PhD, OTR/L, FAOTA, and Jordana L. Maisel, PhD.

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Project Overview

Introduction

Complete Streets is an emerging urban planning paradigm that strives to balance the needs of pedestrians and bicyclists with those of automobile drivers and transit users. A streetscape designed according to Complete Streets (CS) often includes features such as traffic calming measures, designated bike lanes, and enhanced intersections that facilitate pedestrian crossing. Over 600 municipalities in the United States have adopted Complete Streets policies to date (Seskin, 2014).

The existing literature on Complete Streets has emphasized the strength of CS policy content and used case examples of CS projects to illustrate the state-of-practice in CS implementation (McCann and Rynne, 2010; McCann, 2013). Recent authors have also highlighted the need to accumulate data on CS project implementation and CS project outcomes. In their annual policy report, the National Complete Streets Coalition (NCSC) cited "performance measurement" as one of ten central components by which CS policies are rated. The NCSC web page includes an outline of evaluation strategies and performance indicators for Complete Streets initiatives. McCann (2013) discusses the broader importance of CS project evaluation as an integral component of overall municipal planning processes.

Despite the recognized importance of CS project tracking and outcomes measurement, municipalities struggle to gather such data systematically. We recently interviewed representatives from 13 municipalities with active Complete Streets programs and found that none are comprehensively gathering data that measure the impact of their Complete Streets projects (Lenker, Maisel, and Ranahan, submitted). The shortage of CS impact data is problematic for municipalities needing to justify proposed projects in terms of their cost-benefit trade-offs.

Purpose

In order to accumulate program evaluation data, municipalities need guidance regarding efficient measurement tools that capture the outputs and impacts of their CS projects. This compendium is an attempt to address that need. We sought state-of-practice tools and measurement approaches from the literature on Complete Streets as well as the related fields of sustainability, livability, and health. Rather than provide an exhaustive list of performance measures, our intent is to offer a snapshot of current measurement practices.

This report thus provides a starting point for municipalities seeking to create a "report card" of indicators that demonstrate the impact of their local Complete Streets initiatives. The chapters herein describe measures that assess seven areas of impact: bicycle/pedestrian, citizen feedback, economic, environmental, health, multi-modal level of service, and safety.

Methods

An exhaustive search was performed to identify existing performance indicators and measurement tools. Multiple resources were used, including those described in:

- Agency reports
- Existing Complete Streets policies
- Journal articles and scholarly books identified through electronic database searches, (e.g., Google Scholar, Academic Search Complete, MasterFILE Premier, EBSCOhost, MEDLINE)
- Phone interviews conducted with 13 municipalities with active CS programs

A spreadsheet-based inventory system was created to describe and sort the indicators yielded by the search. Primary and secondary classification categories were created and iteratively refined over the course of the project to form a taxonomy of indicators. Each indicator entry was further described in terms of an associated data collection method, municipality deploying the measure, and reference citation. Members of our local Complete Streets initiative provided constructive critique at an early stage of the project in order to foster compatibility of our classification approach with current practices.

Results

The search yielded 800 indicators that were classified using McCann and Rynne's (2010) framework for evaluating CS projects in terms of outputs and outcomes:

(a) Outputs are the salient features that distinguish CS projects (e.g., miles of on-street bicycle routes, number of crosswalk enhancements, installed curb ramps);

(b) Outcomes are the impacts experienced by citizens, businesses, and the environment (e.g., level of service, crash and injury data, mode share, perceived safety, citizen satisfaction) as a result of CS projects.

For the purposes of this compendium, the spreadsheet inventory was abridged to focus on seven categories of impact: bicycle/pedestrian, citizen input, economic, environmental, health, multi-modal level of service, and safety. Each of the seven categories is described in a section that includes: (a) a definition of the category and its importance; (b) common measurement approaches for that category; (c) novel and innovative measurement tools; and (d) strategies for measurement. The measurement tools were selected based on their potential importance, frequency of use, availability, and cost.

outputs

Definition

Outputs are the salient features of a streetscape (e.g., miles of on-street bicycle routes, number of crosswalk enhancements, installed curb ramps) that distinguish Complete Streets projects from other public works projects. In the context of Complete Streets project evaluation, outputs are the key features of streetscape enhancement that are expected to engender positive impacts on citizens, businesses, and/or the environment.

Significance

At a minimum, tracking new facilities and maintenance improvements (e.g., sidewalk repair, repainting crosswalks) provides a tangible record of activities that emanate from a Complete Streets initiative. An annual summary of outputs can then be used to raise public awareness and foster community support for ongoing CS projects (National Complete Streets Coalition , 2014).

In addition, measurement of project outputs is a vital first step in program evaluation. The fundamental goal of program evaluation is to establish a relationship between “cause” (i.e., the policy, program, or project) and “effect” (i.e., the indicators of a program’s success or failure). Unless one has a clear picture of project outputs, it is impossible to interpret the cause of impacts that are experienced by citizens and businesses.

Common approaches to measuring CS outputs

OUTPUT CATEGORY	RELATED INDICATORS (units)	MEASUREMENT APPROACH
Sidewalk and street improvements	Bicycle lanes (distance, width) Driveways within ROW segment (numeric count) Illumination (square area, # of blocks) Intersection improvements (numeric count or description) Landscape strip (length or square area) Medians (length, width, description of treatment) On-street parking spaces (numeric count) Roadway segment (rating of pavement condition, paint) Roadway speed (mph) Sidewalks (length, width) Traffic calming (# of lanes, lane width, posted speed limit) Transit (schedule changes, added routes) Transit stops (numeric count, density, numeric count of enhanced stops) Vegetation (numeric count of trees/bushes)	Self-Reported Environment Measures • Neighborhood Environment Walkability Scale (NEWS), 2003. • Neighborhood walking survey, 2005 • Perceived physical activity environment, 2005 • Perceptions of Environmental Support Questionnaire, 2003 Observational Measures (Community Audits) • Bicycling Suitability Assessment Form, 2003 • Irvine Minnesota Inventory 2005 • Sidewalk Assessment Tool, 2005 • Systematic Pedestrian and Cycling Environmental Scan (SPACES) Instrument, 2002 • Walking Suitability Assessment Form, 2003 (Brownson et al., 2009)
Stormwater infrastructure	Ratio of pervious to impervious surfaces on urban arterials	Not commonly reported. Consult with municipal water authority, water resource council, or advocacy organization involved with water quality for local measurement options.

Transit-related expenditures	Project dollars spent per mode (pedestrian, bicycle, auto, public transit)	Public works project data
Vegetation	Tree cover, e.g., percentage of block group area with tree canopy cover	Aerial photos GIS database (municipal/county)

Measurement in action

Bridging the Gap is a $365 million tax for transportation maintenance and improvements passed in Seattle in 2006. The program funds streetscape maintenance, which includes paving, tree pruning and planning, and transit enhancements. Each year, the Seattle Department of Transportation publishes summaries of their transportation improvement projects in terms of miles of bike lanes striped, crossing improvements, and urban trees planted. (City of Seattle, 2014)

Measurement strategies

- Identify the CS outputs that you will systematically monitor in your municipality.
- Identify the entity that will be responsible for measuring each type of CS output.
- Measure CS outputs (new streetscape features and maintenance of existing features) as they are implemented (McCann, 2013).
- Coordinate with regional planning organizations to aggregate municipal level output data with regional output data (McCann, 2013).
- Use environmental audits to assess bicycle/pedestrian infrastructure and other streetscape features.
- Audit tools allow systematic assessment of the physical environment, including the presence, condition, and quality of streetscape features.

Select communities measuring CS outputs

Baltimore, MD; Chapel Hill, SC; Denver, CO; Florida DOT; Gainsville, FL; King County, WA; Roanoke, VA; New Hope, MN; Seattle, WA

outcomes

Definition

Outcomes are used to measure the impact of Complete Streets projects on citizens, businesses, and the environment (e.g., level of service, crash and injury data, mode share, perceived safety, and citizen satisfaction).

Significance

In the context of CS project evaluation, outcomes are the expected benefits of streetscape enhancement for citizens, businesses, and the environment.

Common approaches to measuring CS outcomes

OUTCOME CATEGORY	RELATED INDICATORS (units)	MEASUREMENT APPROACH
Bicycle/pedestrian activity	Mode share (# of bike/ped trips per total # of trips) Usage (# of bicyclists/pedestrians per unit time)	Inductance loops Infrared sensors: active/passive Magnetometer Manual observers Pneumatic tubes Pressure sensor/pressure mat Seismic sensor State/municipal DOT Video imaging: automated or manual
Citizen feedback	Perceived safety, satisfaction, comfort, quality of life	Context-sensitive survey that can be administered via phone, mail, or in-person. Neighborhood Environment Walkability Scale (NEWS), 2003, U.S.
Economic impact	Commercial property values ($/ft^2) Foreclosure data (foreclosure risk rating) Residential property values ($/ft^2) Retail sales ($/ft^2; $/yr)	County property tax database **www.foreclosure-response.org** Sales tax receipts Surveys of business owners
Environmental impact	Air Quality Index (# of days with AQI>100) Asthma (prevalence per 1000, ER visits for asthma-related cases) Transportation emissions VMT per capita (miles) VMT per household (miles)	EPA AirNow Air Quality Index report Local air, soil, and water quality agencies State/local departments of health
Health impact	Asthma (incidence, prevalence, acute episodes) Diabetes-type 2 (incidence, prevalence) Chronic disease (incidence, prevalence) Obesity (incidence, prevalence) Physical activity (duration, frequency)	Electromechanical measures of physical activity (accelerometers, GPS) Hospital records Observation of physical activity (corridor and pedestrian counts) Self-report measures of physical activity (surveys, interviews) State/local departments of health
Multi modal LOS	MMLOS	CompleteStreetsLOS Sustainale Transportation Analysis and Rating System (STARS)

Safety	Accident/collision (auto crashes/1000 drivers; bicycle crashes/1000 cyclists; pedestrian collisions/1000 pedestrians) Emergency room visits Injury/fatality (injuries/1000; fatalities/1000) Self-reports of perceived safety	Citizen surveys on perceived safety Hospital records Police department/DOT accident records

Measurement in action

The following sections of this compendium will provide short discussions of strategies, tools, and data sources to guide municipalities seeking to measure these outcome indicators.

bicycle/pedestrian impact

Definition

Measures the impact of Complete Streets projects on usage of bicycle and pedestrian infrastructure.

Significance

The planning and transportation sectors encourage walking and cycling activity through creation of new infrastructure (e.g., bicycle lanes, crosswalk enhancements, improved sidewalks). Measuring the usage of bicycle/pedestrian infrastructure allows municipalities to quantify trends along key corridors. These data can be used to support future investments in infrastructure, amenities (e.g., bicycle parking, benches), and educational programs (Advocacy Advance, 2013; National Complete Streets Coalition , 2014).

Common approaches to measuring bicycle/pedestrian impact

OUTCOME CATEGORY	RELATED INDICATORS (units)	MEASUREMENT APPROACH
Bicycle/pedestrian activity	Mode share (# of bike/ped trips per total # of trips) Usage (# of bicyclists/pedestrians per unit time)	Inductance loops Infrared sensors: active/passive Magnetometer Manual observers Pneumatic tubes Pressure sensor/pressure mat Seismic sensor State/municipal DOT Video imaging: automated or manual

Measurement in action

The Pima Association of Governments (a nonprofit metropolitan planning organization near Tucson, AZ) conducts an annual bicycle and pedestrian count by coordinating staff and volunteers to collect data at 100 locations throughout the region. The goal of the counting effort is to develop a better understanding of the trends and characteristics of pedestrians and cyclists, to assess planning efforts, and to help direct investments. Volunteers are trained prior to data collection. During their shifts, volunteers use tally sheets to record the number, gender, and approximate age of pedestrians and bicyclists using an intersection at 15-minute increments during a two-hour period. In addition, the volunteers record the number of bicyclists riding without a helmet, riding on the sidewalk, and riding the wrong way. Planners use the data to assess bicycle and pedestrian demographics, daily use, seasonal usage patterns, and safety. (Pima Association of Governments, 2014)

Measurement strategies

- Identify needs of activity count data before starting. For example, do you want to…
  - Monitor patterns in walking and biking across seasons of the year?
  - Show the effect of specific projects by comparing counts taken pre- and post-implementation (McCann, 2013)?
  - Use data to develop pedestrian and bicycle volume models?
- Select a measurment method that addresses your counting needs and is within your capital resources.

- Permanent technologies (e.g., inductance loops) require greater capital investment for purchas installation, but are reliable and cost effective over time.
- In contrast, manual counts are labor-intensive, but better for spatial coverage and collecting qualitative data (e.g., gender, age).

- The **FHWA** (2013) describes a range of count methods:
  - Pneumatic tubes are a temporary technology commonly used to count bicyclists only or pedestrians and bicyclists separately at a low-to-moderate cost.
  - Manual observers are commonly used to count bicyclists only, pedestrians only, pedestrians and bicyclists combined, and pedestrians and bicyclists separately at a moderate-to-high labor cost.
  - Inductance loops are a permanent technology, which can be used to count bicyclists only, or pedestrians and bicyclists separately, at a moderate cost.
  - Manual video imaging is a technology commonly used to count pedestrians and bicyclists separately, with the possibility of also counting bicyclists only, pedestrians only, and pedestrians and bicyclists combined, at a low-to-high cost.
  - Seismic sensors and automated video imaging can be used to count bicyclists only, pedestrians only, pedestrians and bicyclists combined, or pedestrians and bicyclists separately at a low-to-moderate cost.
  - Active and passive infrared sensors are semi-permanent technologies, which are commonly used to count pedestrians only, pedestrians and bicyclists combined, or pedestrians and bicyclists separately at a low-to-moderate cost.

Select communities measuring impact of bicycle/pedestrian infrastructure

Baldwin Park, CA; Champaign, IL; Charlotte, NC; Minneapolis, MN; Scottsdale, AZ; Seattle, WA; Vermont DOT

citizen feedback

Definition
Measures the impact of Complete Streets projects on perceived safety, satisfaction, comfort, and quality of life among community residents. Feedback can be sought from multiple stakeholders, including drivers, pedestrians, bicyclists, transit riders, neighborhood residents, and business owners.

Significance
Citizen input gathers insights from salient user groups and is thus a valued component in evaluation of municipal transportation improvement projects. Streetscape features communicate messages to users that affect individual perceptions and influence behavior. Surveys that target special interest groups provide data about people's feelings, choices, and daily experiences after implementing a Complete Streets project.

Common approaches to measuring citizen feedback

OUTCOME CATEGORY	RELATED INDICATORS (units)	MEASUREMENT APPROACH
Citizen feedback	Perceived safety, satisfaction, comfort, quality of life	Context-sensitive survey that can be administered via phone, mail, or in-person. Neighborhood Environment Walkability Scale (NEWS), 2003, U.S.

Measurement in action
In the 2012 **Measuring the Street: New Metrics for 21st Century Streets**, New York City DOT used a cross-section of recent NYC DOT street design projects to detail the metrics it uses to evaluate street projects. The report presented fundamental strategies to enhance street design and discussed how to evaluate safety, equitable service, quality of public space, and traffic flow. Citizen input was collected using pre- and post-construction surveys to depict user satisfaction with public space projects. According to the report, surveys can be used by municipalities to depict changes in perceived safety, satisfaction, comfort, and quality of life that result from a CS project (New York City DOT, 2012).

Measurement strategies
- Identify the stakeholders (e.g., residents, consumers, business owners, cyclists, drivers, pedestrians, and/or transit riders) from whom you desire feedback.
- Identify the outcome indicators that are most important for meeting your project evaluation needs. The questions will typically be context-sensitive and thus very specific to a particular CS project.
  - Where possible, use an existing survey tool or questionnaire that has been tested successfully elsewhere.
  - If existing surveys do not meet your measurement needs, then develop a context-sensitive survey that speaks to the stakeholder groups, environmental conditions, and outcome indicators of greatest local importance.
- Determine how the survey will be administered, e.g., via phone, postal mail, neighborhood canvassing, or in-person at community events.
- Before launching the survey, pilot test the questionnaire with one or two members from each stakeholder group in order to evaluate the clarity of the survey items and the appropriateness of response options.
- Promote the survey through collaboration with public leadership and local advocacy groups.

Select communities measuring citizen feedback
New Hope, MN; New York, NY; Oregon DOT

economic impact

Definition

Measures the fiscal impact of Complete Streets projects.

Significance

There is scant evidence quantifying the economic impact of Complete Streets projects. Existing economic impact studies indicate that pedestrian and bicycle improvement lead to increasing pedestrian and bicycle traffic, increasing sales at area businesses, and rising commercial and residential property values.

Periodic evaluation of fiscal indicators could enable municipalities to demonstrate the impact of Complete Streets projects on the local economy, making these data particularly appealing to policy makers, private developers, and taxpayers.

Common approaches to measuring economic impact

OUTCOME CATEGORY	RELATED INDICATORS (units)	MEASUREMENT APPROACH
Economic impact	Commercial property values ($\$/\text{ft}^2$) Employment data Foreclosure data (risk rating) Residential property values ($\$/\text{ft}^2$) Retail sales ($\$/\text{ft}^2$; $\$/\text{yr}$)	County property tax database **www.foreclosure-response.org** Sales tax receipts Surveys of business owners

Measurement in action

Communities including San Francisco, CA, Toronto, ON, and Boulder, CO have used economic impact studies to measure the influence of bicycle infrastructure on drawing visitors, residents, and businesses to regions, municipalities, and districts. Economic impact was measured by surveying business owners and patrons. **Darren Flusche** (2009) highlights how various communities have used economic data to demonstrate that investments in bicycling infrastructure can boost shopping districts and communities, encourage tourism, and support local businesses.

Measurement strategies

- Identify the economic impact indicators that are most important for evaluating a particular project or corridor.
  - For residential areas, analyze changes in property values using real estate and foreclosure data.
  - For commercial areas, analyze (a) changes in property values using real estate and foreclosure data; (b) changes in employment using census data; and/or (c) changes in local sales using sales tax receipts and business owner surveys.
- Create a survey of business owners to obtain their anecdotal feedback on the benefits they have experienced from changes in pedestrian and bicycle traffic.
  - Before launching the survey, pilot test the questionnaire with 1 or 2 business owners in order to evaluate the clarity of the survey items and the appropriateness of the requested response options.
  - Promote the survey through collaboration with the local chamber of commerce or business association.

Select communities measuring economic impact

Boulder, CO; Gainesville, FL; Hattiesburg, MS; New York, NY; Portland, OR; San Francisco, CA; Toronto, ON; Washington D.C.

environmental impact

Definition

Measures the impact of Complete Streets initiatives on greenhouse gas emissions and stormwater runoff.

Significance

Transportation contributes a significant portion of urban air pollution through vehicle emissions in the forms of carbon monoxide (CO), nitrogen oxides (NOx), particulate matter (PM), hydrocarbons (HC), and others (Bigazzi & Robert, 2008). A significant portion of greenhouse gas emissions related to transportion are estimated to have a 95% contribution to climate change (EPA, 2011). Complete Streets initiatives involving transportation investments and streetscape improvements can reduce air pollution and carbon emissions by improving connections for transit, walking, and biking. Decreasing travel distances, vehicle trips and VMT, which reduces CO_2 emissions, can help a municipality accomplish its air quality, climate change, and congestion reduction goals.

Complete Streets projects that incorporate stormwater features aim to maximize permeable surfaces, tree canopy, and landscaping elements in order to: (a) filter and decrease the amount of contaminated stormwater entering area bodies of water; (b) improve air quality; (c) reduce ambient air temperature; (d) improve watershed viability; and (e) reduce stormwater input to sewer systems (Macdonald et al., 2010). Current metrics related to stormwater are limited to inventoryies of the following outputs: vegetation, street trees, and impermeable surfaces. Future research is needed to develop additional performance measures that address other components (e.g., bioswales, rain gardens) of stormwater management.

Common approaches to measuring environmental impact

OUTCOME CATEGORY	RELATED INDICATORS (units)	MEASUREMENT APPROACH
Air Quality	Air Quality Index (# of days with AQI>100) Asthma (prevalence per 1000; # of ER visits for asthma-related cases)	EPA AirNow Air Quality Index report Local hospital records National Environmental Public Health Tracking Program
Transportation-related pollution	Transportation emissions VMT per capita VMT per household	EPA AirNow Air Quality Index report Travel-based emissions models, MOtor Vehicle Emission Simulator (MOVES Travel demand models
Stormwater run-off	Ratio of pervious to impervious surfaces on urban arterials	Not commonly reported. For local options, consult with municipal water authority, water resource council, or advocacy organization involved with water quality.

Measurement in action

The Community Air Risk Evaluation (CARE) program was established in the San Francisco Bay Area in 2004 to assess and lessen health risks associated with exposures to outdoor toxic air contaminants (TAC). The program examines TAC emissions from point sources, area sources, and on-road and off-road mobile sources co-located with sensitive populations to help focus mitigation strategies. The technical examination is implemented by the program in three phases: 1) an assessment of the sources of toxic air contaminants (TACs) and exposures to fine particulate matter

(PM); 2) modeling and measurement programs to estimate concentrations of TAC and PM; and 3) an assessment of exposures, health risks, and effective mitigations. (Bay Area Air Quality Management District, 2013)

Measurement strategies

- The air quality index (AQI) is calculated using data from the six criteria air pollutants regulated by the **Environmental Protection Agency (EPA)**. An AQI score of 101-150 is deemed unhealthy for sensitive populations, which includes people with lung disease, older adults, and children. An AQI of 151+ is regarded as a health risk for many or all people. County-level data is collected by the EPA and available on their **website**. The EPA calculates the index using air quality measurements from its monitoring stations throughout the US and scaled to county-level scores. (EPA, 2014)

- **Travel-based emissions models** can be used to measure the impact of transportation on air pollution and CO_2. The main influences on vehicle emissions can be divided into six categories: travel, weather, vehicle, roadway, traffic, and driver related factors. Travel-based emissions models can be categorized as: (a) *Average speed models*, which use average speeds as the primary input, and generally deal with regional or city-wide estimates; and (b) *Mode model base emissions*, which use a combination of roadway, driver, and traffic factors as primary inputs and are most useful for predicting emissions effects of operational improvements, as well as improving accuracy of regional estimates (Bigazzi & Robert, 2008).

- **Vehicle miles traveled** can be used to estimate CO_2 emissions for on-road travel. Traditionally, carbon emissions metrics have been applied at a regional scale because it can be difficult to capture these changes at smaller scales of analysis. New tools and the widespread use of VMT per capita have enabled municipalities to begin evaluating their improvements at the neighborhood level VMT per capita is a useful metric because MPOs often use travel demand modes to forecast VMT as part of long range planning processes. The EPA describes a simple formula to estimate CO_2 emissions:

  $$CO_2 = \text{VMT/average fuel economy} * \text{carbon content of fuel}$$

  This formula can be adapted to individual modes and vehicle classes, depending on the detail of the data available (EPA, 2011).

Select communities measuring environmental impact

Pasadena, CA; San Francisco, CA; State of California

health impact

Definition

Measures the impact of Complete Streets projects on physical activity, obesity, and other issues associated with public health.

Significance

Complete Streets projects can potentially impact public health by encouraging active transportation modes. Assessment of physical activity and public health data can demonstrate community-wide benefits associated with investments in public rights-of-way, public transportation, and land use.

Common approaches to measuring health impact

OUTCOME CATEGORY	RELATED INDICATORS (units)	MEASUREMENT APPROACH
Physical activity	Duration (distance, time) of activity Frequency (# trips/week) of activity	Electromechanical measures of physical activity (accelerometers, GPS) Observation of physical activity (corridor and pedestrian counts) Self-report measures of physical activity (surveys, interviews)
Physical health	Asthma (incidence, prevalence, acute episodes) Chronic disease (incidence, prevalence) Diabetes-type 2 (incidence, prevalence) Obesity (incidence, prevalence)	Hospital records State & local departments of health

Measurement in action

A Health Impact Assessment (HIA) helps municipalities improve public health through community planning and urban design. The National Research Council defines HIA as "a systematic process that uses an array of data sources and analytic methods, and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program, or project on the health of a population and the distribution of those effects within the population. HIA provides recommendations on monitoring and managing those effects" (CDC, 2013). HIA is a procedure that helps appraise the potential health impacts of a plan, project, or policy prior to construction or implementation and brings specific health consideration to policies, projects, and plans that fall outside the traditional public health arenas, such as transportation and land use.

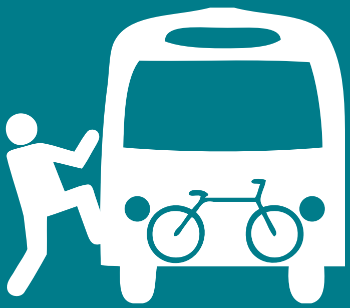
The local government in Davidson, NC initiated **Davidson Design for Life (DD4L)**, a public health initiative funded by a "Health Impact Assessment to Foster Healthy Community Design" grant from the Centers for Disease Control and Prevention (CDC). This grant helped Davidson conduct an HIA to predict the impact of revised street design standards on the health of its residents. The HIA examines how the existing standards have impacted public health and provides recommendations for revisions that can encourage bicycling and walking, reduce travel related accidents and fatalities, and improve air quality. The results of the first HIA also aided the development of the town's Pedestrian and Active Transportation Plan, which identifies ways to enhance health equity across all ages and abilities of residents by promoting physical activity, mobility, and access to services. The plan also provides strategies for assessing the economic benefits of pedestrian-oriented streets. (Town of Davidson, 2014)

Measurement strategies

- Physical activity can be evaluated using:
    - Self-reported methods (e.g., surveys and interviews with residents) that can be used to estimate changes in physical activity after implementing a Complete Streets project.
    - Electromechanical sensors (e.g., accelerometers and GPS) that can be used to track more precisely the amount and type of an individual's physical activity. However, these tools are expensive to use widely, and they are mildly invasive to those who are being measured.
- It is difficult to establish a direct causal link between an individual's increased physical activity level and a specific CS project. Therefore, if physical activity is being measured, it will be important to acknowledge its inherent limitations.
- Partnerships with local health departments and advocacy groups can be explored to seek funding and support.
- Currently, few health-related performance measures exist that are applicable for evaluating individual Complete Streets design features. New health performance measures are needed at the neighborhood level to more fully understand relationships between neighborhood streetscape features and healthy behaviors

Select communities measuring health impact

Arlington, MA; Cincinnati OH; El Paso, TX; Fairhope, AL; Minneapolis–St. Paul; New York, NY; Richland County, SC; San Diego, CA; Seattle, WA



multi-model level of service (MMLOS)

Definition
Measures the impact of Complete Streets projects on the efficiency of transportation infrastructure for drivers, bicyclists, pedestrians, and transit riders.

Significance

Traditionally, transportation projects have prioritized vehicle Level of Service (LOS) in design, implementation, and evaluation of roadway corridors. An "A-F" LOS grading system for roadways is described in the Highway Capacity Manual (Transportation Research Board, 2010). Multi-modal level of service (MMLOS) is increasingly used by those who recognize the value of promoting travel efficiency for users across all transportation modes.

Common approaches to measuring level of service

OUTCOME CATEGORY	RELATED INDICATORS (units)	MEASUREMENT APPROACH
Level of Service	MMLOS	CompleteStreetsLOS Sustainable Transportation Analysis and Rating System (STARS)

Measurement in action

Complete Streets LOS software uses methodologies from the 2010 Highway Capacity Manual to determine the LOS for auto, transit, pedestrian, and bicycle modes along an urban street (Kittelson & Associatiates, Inc., 2014). The multimodal scope of the software makes it relevant for assessing Complete Streets, context sensitive design alternatives, and smart growth from a multi-user perspective. Complete Streets LOS evaluates the MMLOS of one direction of travel for up to eleven intersections.

The North American Sustainable Transportation Council created the **Sustainable Transportation Analysis and Rating System (STARS)** pilot project application manual. STARS is a performance-based system with a multimodal focus to evaluate transportation projects, plans, and programs. The STARS certification process incorporates performance metrics in three areas: access (people), climate and energy (planet), and cost effectiveness (prosperity). The certification is intended to incentivize transportation planners and project managers to address health, safety, and equity into their projects. Municipalities can use STARS to certify that local transportation projects and plans incorporate health and multimodal safety, while increasing efforts to achieve equitable outcomes. To date, municipalities in California, Oregon, Virginia, and Washington have used STARS to:

- update regional transportation plans;
- establish goals, targets, and assessment criteria;
- develop engineering, education, enforcement, and evaluation strategies for bicycle and pedestrian improvements; and
- analyze the economic implications of proposed projects.

(North American Sustainable Transportation Council, 2014)

Measurement strategies

CompleteStreetsLOS software's our-step analysis process uses readily available data, including: (a) physical and geometry (e.g., number of lanes, lane widths and lengths, speed limits, pavement conditions, transit stops); (b) traffic and signal data (parking occupancy, peak hour turning movements, pedestrian volume); and (c) transit data (e.g., frequency, bus-on-time). Thus, the software can facilitate pre- and post-implementation impact of a CS project.

Select communities measuring MMLOS

Des Plaines, IL; Florida DOT; Helena, MT; New Hope, MN; Redmond, WA; Sacramento, CA; Vermont DOT

safety

Definition

Measures the impact of Complete Streets projects on the rates of accidents, collisions, injuries, and fatalities.

Significance

Historically, vehicle safety measures have been a key component of evaluation for transportation projects. However, bicycle and pedestrian safety are typically not measured in a consistent or precise manner. Complete Streets project evaluation provides an opportunity to assess the locations of bicycle and pedestrian safety problems and demonstrate the impact of transportation and ROW investment on safety (National Complete Streets Coalition , 2014). Additionally, safety evaluation enables municipalities to identify locations that could most benefit from future bicycle and pedestrian system improvements.

Common approaches to measuring safety

OUTCOME CATEGORY	RELATED OUTCOME INDICATORS	MEASUREMENT APPROACH
Safety	Accident/collision (auto crashes/1000 drivers; bicycle crashes/1000 cyclists; pedestrian collisions/1000 pedestrians) Emergency room visits Injury/fatality (injuries/1000; fatalities/1000) Self-reports of perceived safety	Citizen surveys to ascertain perceived safety State and local departments of health State and local police departments/DOT

Measurement in action

In 2011, **Annapolis, MD** conducted an evaluation to assess safety of bicyclists, motorists, and pedestrians. The goals of the study included improving safety and mobility for all travelers across all modes, enhancing transportation network efficiency, improving travel choices, increasing non-vehicular trips, and identifying both short-term and long-term solutions. Safety was measured by reviewing (a) crash data, (b) pedestrian, bicycle and motorized vehicle risky behaviors, and (c) evaluating key conflict points and origin-destination patterns. (City of Annapolis et al., 2011)

Measurement strategies

- Contact municipal governments, MPO's, and police departments to identify the type of accident, collision, injury, and fatality data that are already being collected.
  - In particular, it can be helpful if the data set specifies the streetscape location and travel mode (i.e., vehicle. bicycle, or pedestrian) of those involved.
  - Hospitals and local health departments may be a resource for data about emergency room visits.
- Collect accident, collision, injury, and fatality data before and after implementation of a CS project to measure its impact on safety along a particular streetscape.
- Tools such as the Neighborhood Environment Walkability Scale (2003) can be used to collect data from citizens regarding their perceived safety in a neighborhood or along a streetscape.
- Longitudinal comparisons of safety data are best facilitated with data involving accident and injury rates, rather than numeric counts (Complete Streets Coalition, 2014).

Select communities measuring safety

Baldwin Park, CA; Baltimore, MD; Denver, CO; Des Plaines, IL; New Hope, MN; New York, NY; San Antonio, TX

Establishing an Evaluation Plan for Your CS Program

The overarching value of a municipality's CS projects can be demonstrated through program evaluation. Creating a systematic and sustainable evaluation approach requires planning, but it does not have to be onerous. In order to be successful, routine data collection must become a priority.

The following suggestions are intended to help those wishing to create a Complete Streets program evaluation plan, or enhance an existing plan, for their municipality:

1. Consider the values and priorities expressed in one's local CS policy. Was your program initiated to reduce traffic, increase health, reduce accidents, increase business activity, enhance the quality of life for your residents, or some combination thereof?
    - Your program evaluation does not need to be constrained by goals expressed in the original policy; however, one's CS program evaluation plan should address those original priorities.
2. Solicit advice regarding CS evaluation from your municipality's key stakeholder groups, which may include: departments of planning and public works, regional MPO, transit authority, bicycle and pedestrian groups, environmental agencies or coalitions, and representatives from the business community.
    - Find common ground with one or more related agencies. Identify opportunities for shared data collection responsibilities to perfom evaluation jointly.
    - One's plan will have the greatest opportunity for success if the indicators measured appeal to the greatest cross-section of stakeholders.
3. Based on one's local priorities, prepare a master list of potential program evaluation indicators that, for each indicator, describes: (a) the stakeholders who prioritize that indicator; (b) existing sources of data that capture the indicator; (c) estimated equipment and personnel costs required to capture data not already being measured; and (d) the entity that would most logically be responsible for capturing that indicator.
    - Collecting output data can be an easy and impactful first step in CS program evaluation. Output data can include sidewalk and street investments and improvements, transit-related expenditures, stormwater infrastructure, and vegetation. Output data can be used to show change in public works investment over time, and can be incorporated into public education and outreach about existing CS projects.
4. Using this information as a starting point, reconvene representatives from each key stakeholder group to prioritize the indicators that will comprise your program evaluation plan.
    - Select measurement priorities that are within your capital resources and can be sustained over time.
    - For each prioritized indicator, it is critical to obtain buy-in from the entity that will be responsible for gathering that data on an annual basis.
    - As appropriate, plan to collect program evaluation data before and after implementing a CS project in order to demonstrate its impact most clearly.
    - Be pragmatic when establishing the final list of indicators to be captured. It is better to capture a few indicators very well than to capture many indicators poorly or inconsistently.
5. Pilot test your evaluation program by applying it to one CS project.
6. Revise the evaluation plan as needed based on the pilot test experience.

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Center for Inclusive Design & Environmental Access

University at Buffalo School of Architecture and Planning
3435 Main Street, 114 Diefendorf Hall
Buffalo, NY 14214-3087

+1 (716) 829.5902

ap-idea@buffalo.edu

http://www.idea.ap.buffalo.edu

GOBike Buffalo

40 Ellicott Street Suite 447
Buffalo, NY 14203

+1 (716) 218-7161

info@gobikebuffalo.org

http://www.gobikebuffalo.org/