Accessibility Analysis and Connections to Transit

A *Connecting Sacramento* Summary Brief July 2017

Transit systems that offer a network of fast, frequent, and reliable service can still fail to meet ridership expectations. **One common reason for underperforming ridership on a robust transit corridor is that people simply find it hard to access transit stations**. Some stations are adjacent to – or even in the center of – highways, cut off from jobs and households by some other physical barrier, or surrounded by parking, which can be convenient for park-and-ride commuters but a deterrent for riders who may be more likely to use transit for a variety of trip purposes. **People are far more likely to use transit when their trip begins and ends with a short, safe, convenient walk. Improvements to so-called "first- and last-mile connections" can be easy and inexpensive to deliver, and they are essential to maintaining and improving transit's viability in American communities.**

Some missing connections and potential improvements are obvious, but that's not always the case. Moreover, it can be hard to compare different station-accessibility improvement opportunities and know which ones are the most critical and worth prioritizing. **One straightforward approach for identifying problems and evaluating solutions is through accessibility analysis.** This type of analysis can describe how easy it is to reach destinations from any given location, for example the ease of reaching jobs by transit or the ease of reaching a transit station by walking or biking, and provide estimates of potential accessibility improvements' relative impacts.

Accessibility isn't a new concept, but despite mounting evidence documenting its benefits, its practical application as a planning metric has been limited to date. Accessibility calculations require data about the road network, pedestrian network, transit network, and any destinations people might be interested in reaching. They can also require considerable computing power. These data and resources are now readily available to cities and transit agencies—anyone with basic GIS skills can make accessibility calculations using a growing selection of open-source and private software tools and datasets.

With these tools in hand, transit agencies can make the case for targeted walking- and biking-access improvements that build a foundation for successful transit service. City governments can identify access-improvement opportunities that help meet their goals by making it easier to walk, bike, and use transit. MPOs and state DOTs can more effectively prioritize funding allocation and/or provide valuable technical assistance to smaller municipalities and transit agencies seeking to improve transit access in their communities.

This brief describes accessibility metrics and their application in more detail based on the *Connecting Sacramento* study – a transit planning application in Sacramento, California, led by university researchers at the State Smart Transportation Initiative and involving public agencies, new software and data providers, and philanthropic organizations.

Introduction

A critical factor affecting transit ridership and efficacy is people's ability to reach stations: the so-called "first- and last-mile connections." Sometimes a parking lot or drop-off area is the main access point, but people's ability to walk and bike is often much more effective at increasing ridership, particularly when many people live, work, and shop nearby. Quantitative "accessibility" analysis can help identify, evaluate, and prioritize gaps and opportunities for improving walking- and biking-access to transit stations. *Connecting Sacramento* presents a novel approach to evaluating last-mile connections system-wide and quantifying the benefit of various proposed improvements, using widely-available accessibility analysis tools and datasets.

Accessibility analysis

Accessibility metrics indicate the ease of reaching meaningful destinations by different modes, given the available transportation networks and land use configurations. In this study, accessibility is measured in terms of travel time and travel time-based utility. These metrics can represent access to a variety of destination types including stores, restaurants, services, schools, and public spaces. *Connecting Sacramento* measures overall transit accessibility in terms of access to jobs by transit during the morning peak period. This metric includes the time needed to walk to transit stations from any given location, so access to stations by walking is also considered as a key measure of first- and last-mile connections to transit.

For this study, accessibility calculations are made using Sugar Access by Citilabs. Although several open source options exist, Sugar Access is the only known package that includes the necessary data for measuring access by all modes and to all destination types, with built-in network editing, scenario building, and cloud computing capabilities. The pedestrian network is represented using data from Here (formerly Navteq) and the transit network, including travel speeds and headways, is represented using General Transit Feed Specification (GTFS) data. Jobs data come from the Longitudinal Employer-Household Dynamics (LEHD) data, provided by the U.S. Census at the block level.

Other open source tools are free to use, but their data sources (e.g., OpenStreetMap) and capabilities are generally more limited and they require more technical expertise to run. Examples include:

- Conveyal's Transport Analyst, which produces travel sheds using open data (automobile accessibility requires additional speed data).
- UrbanAccess, which measures access to jobs by transit and walking using open data.
- Bike Network Analysis by PeopleForBikes, which measures access to jobs and other destinations by biking using open data.

Travel time decay and utility

Accessibility metrics are sometimes reported as absolute cumulative metrics (e.g., jobs within 30 minutes). These metrics are straightforward to calculate and communicate, but they can be problematic because they assign somewhat arbitrary importance to a particular threshold (e.g., 30 minutes). More meaningful metrics assign different weights (utility) to different destinations depending on their travel time. These weights can be estimated from travel surveys by looking at the distribution of actual trips. Figure 1 shows travel time decay functions derived from the 2009 National Household Travel Survey for home-based trips. The important curves to consider for this study are transit trips to work and walking or biking trips to transit. The curves can be interpreted as follows:

- Nearly 100 percent of transit commuters travel 10 minutes or more, so the utility of a job within 10 minutes is 100 percent.
- Only 50 percent of transit commuters travel 50 minutes or more, so the utility of a job within 50 minutes is 50 percent.
- Nearly 100 percent of people walk or bike two minutes or more to access transit, so the utility of a station two minutes away is 100 percent.
- Only 16 percent of people walk or bike 10 minutes or more to access transit, so the utility of station 10 minutes away is 16 percent.

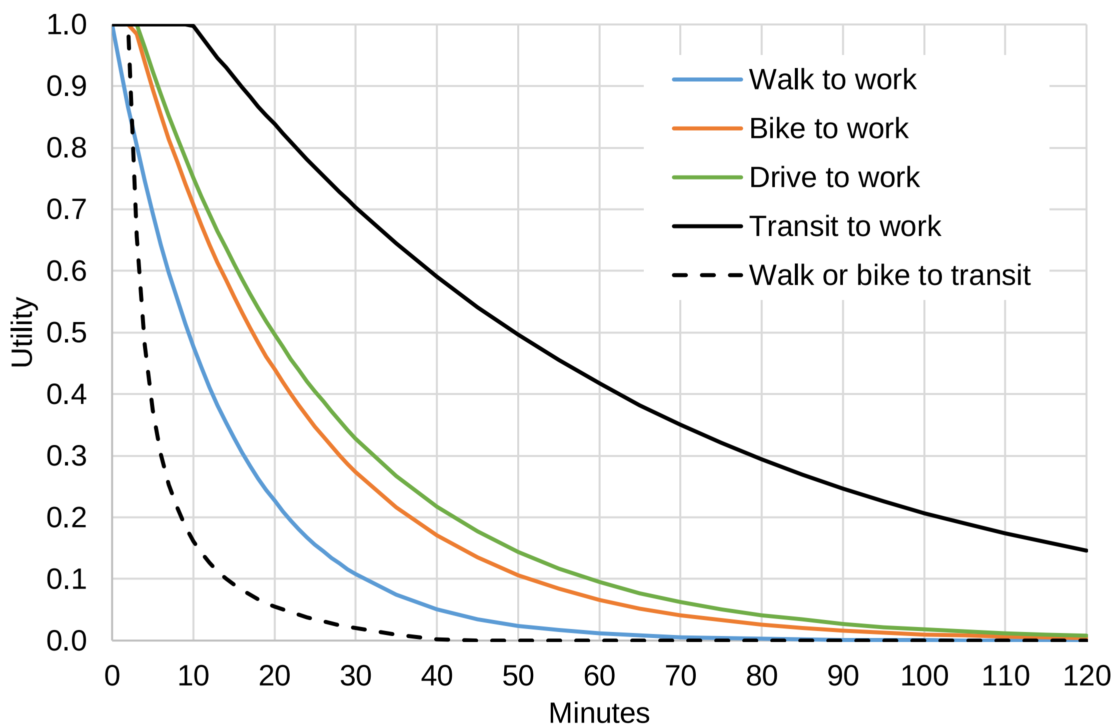

Figure 1. Travel time decay functions for home-based work trips (California) and home-based transit trips (U.S.), derived from the 2009 National Household Travel Survey

Using travel time decay functions, accessibility metrics from any given location are reported as: a) the number of decay-weighted jobs accessible by transit, and b) the utility of a transit station.

Accessibility analysis

The *Connecting Sacramento* study presents methods and metrics for identifying the most critical missing last-mile connections. The result is a prioritized list of Census blocks where accessibility improvements could have the largest impact, affecting the most people. The approach is outlined below:

1. Calculate ***station utility*** based on actual walking distance to the nearest station, an assumed walking speed of 2.8 miles per hour, and the decay function shown in Figure 1.
2. Calculate ***potential utility improvement*** by measuring the straight-line distance to the nearest station, estimating the corresponding station utility (as in step 1), and calculating the difference between the actual utility and straight-line utility. This measure is meant to be used only for scanning and comparing locations generally, since direct connections are not always feasible given the existing network and physical obstacles.
3. Calculate an ***impact score***, which accounts for both the potentially utility improvement and the number of households and jobs that would be affected. This score is calculated as follows:

   $$\textit{Raw impact score} = \textit{Potential utility improvement} \times [\log(\textit{Households}) + \log(\textit{Jobs})]$$

   The logarithmic terms adjust for skewness and differences in scale. Without this step, the large number of jobs in some blocks heavily influence the scores. The final impact score is scaled between 0 and 100.

Case study: Swanston station

The second highest impact score in the Sacramento study area occurs at a block located just east of Swanston station on the Blue Line, north of Downtown (Figure 2).

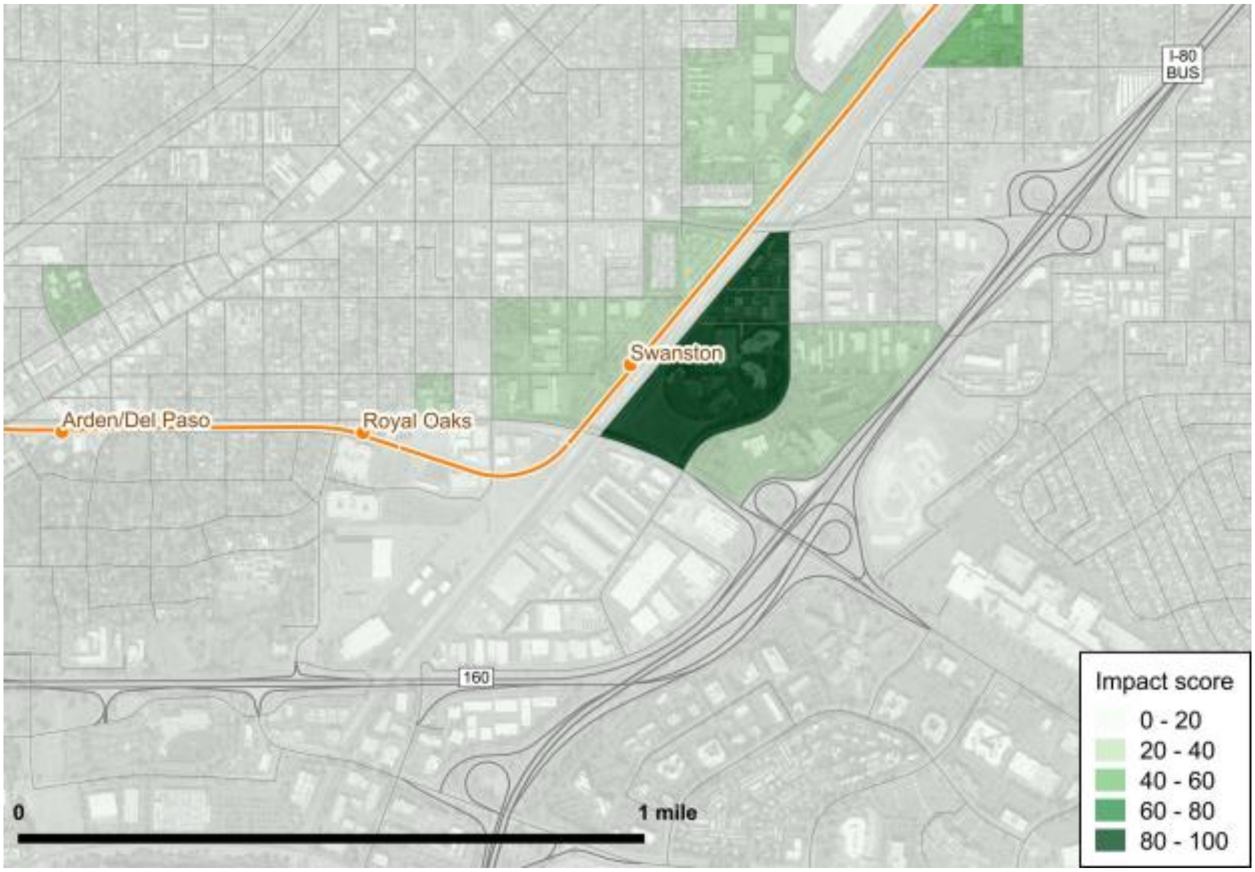

Figure 2. Impact score (0 to 100) around Swanston station

The key reason for this large impact score is the block's high potential utility improvement. The straight-line walking time from that block to Swanston station is 2.4 minutes (83% utility) but the actual walking time is more than 15 minutes (9% utility, as shown in Figure 3), resulting in a potential utility improvement of 74 points. There are few households in the block, but more than 800 employees would be affected.

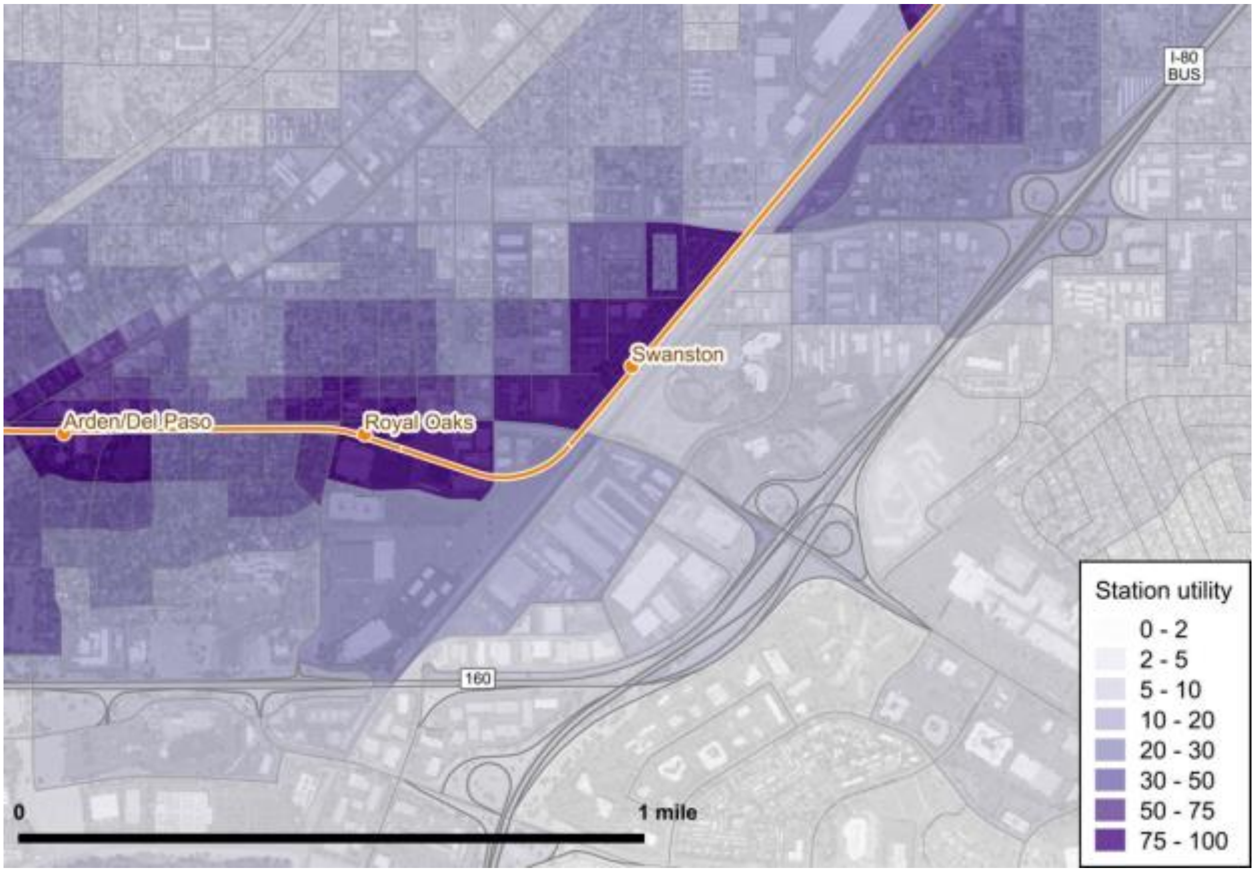

Figure 3. Station utility (0 to 100) around Swanston station

The low utility in this block is due to freight rail lines that separate the station from those neighborhoods, as shown in Figure 4. The nearest crossings are Arden Way to the south and El Camino Ave to the north – both of which are four- to six-lane highways with limited bicycle and pedestrian accommodations, as shown in Figure 5.

Figure 4. Existing conditions around Swanston station

Figure 5. Existing conditions on Arden Way rail crossing

Proposed connection and accessibility impacts

The findings from the above accessibility analysis reinforce the Transit Village Specific Plan, developed by the City of Sacramento in 2007. The plan, developed through a series of public workshops, is meant to enhance the area around the station as a highly-connected transit oriented development and maximize development potential. The plan includes a dense network of bicycle and pedestrian connections west of the station and a bridge across the existing freight line to the east (roughly equivalent to a straight-line connection), as shown in Figure 6.

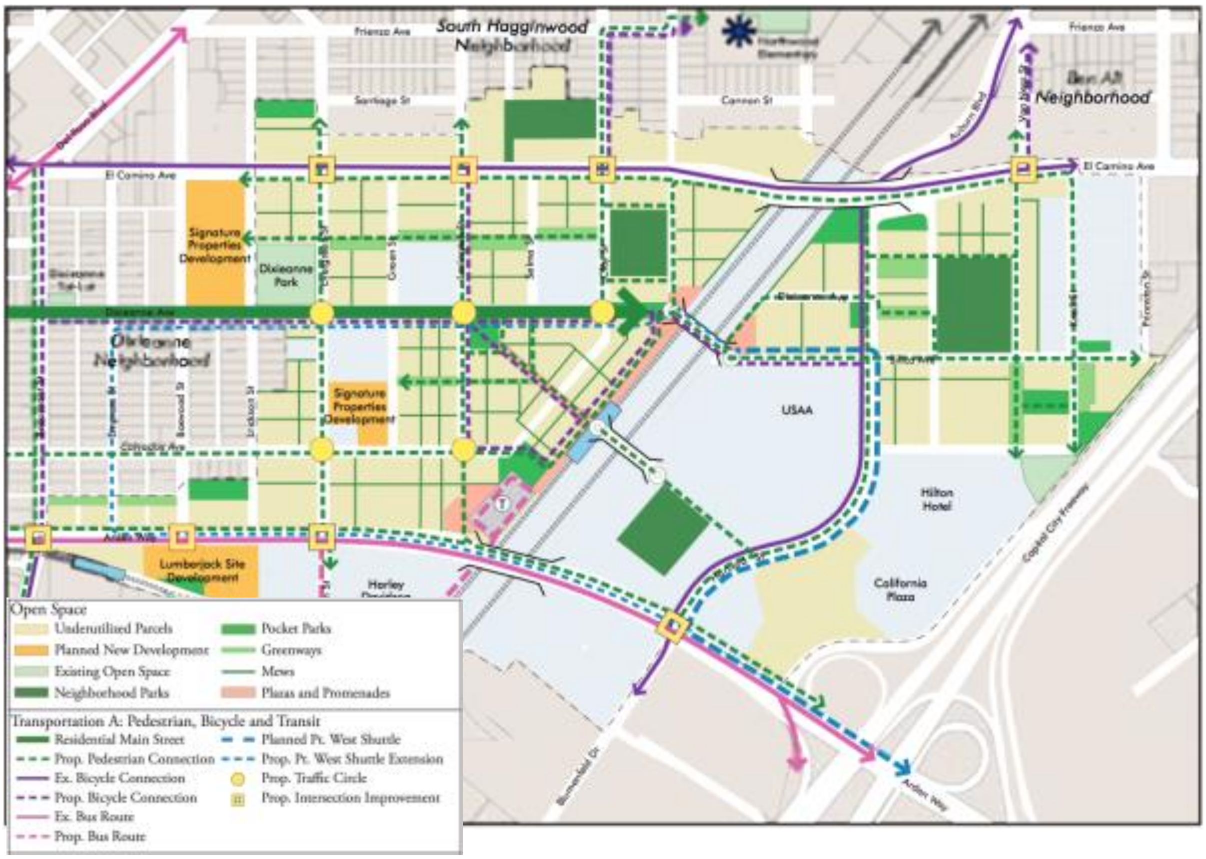

Figure 6. Proposed bicycle and pedestrian connections around Swanston station (source: City of Sacramento)

Accessibility analysis allows for the impacts of the proposed connections to be visualized and quantified. Figure 7 shows the changes, measured as access to jobs by transit, which are highest near the station but spread throughout the system. Those living immediately to the east gain access to an additional 15,000 to 30,000 jobs by transit from the improvements. Within a half-mile of the station, the average increase is 1,600 jobs. Because the connections also improve access to jobs near the station, the impacts spread citywide. In total, roughly 33,000 households gain access to an additional 250 jobs or more.

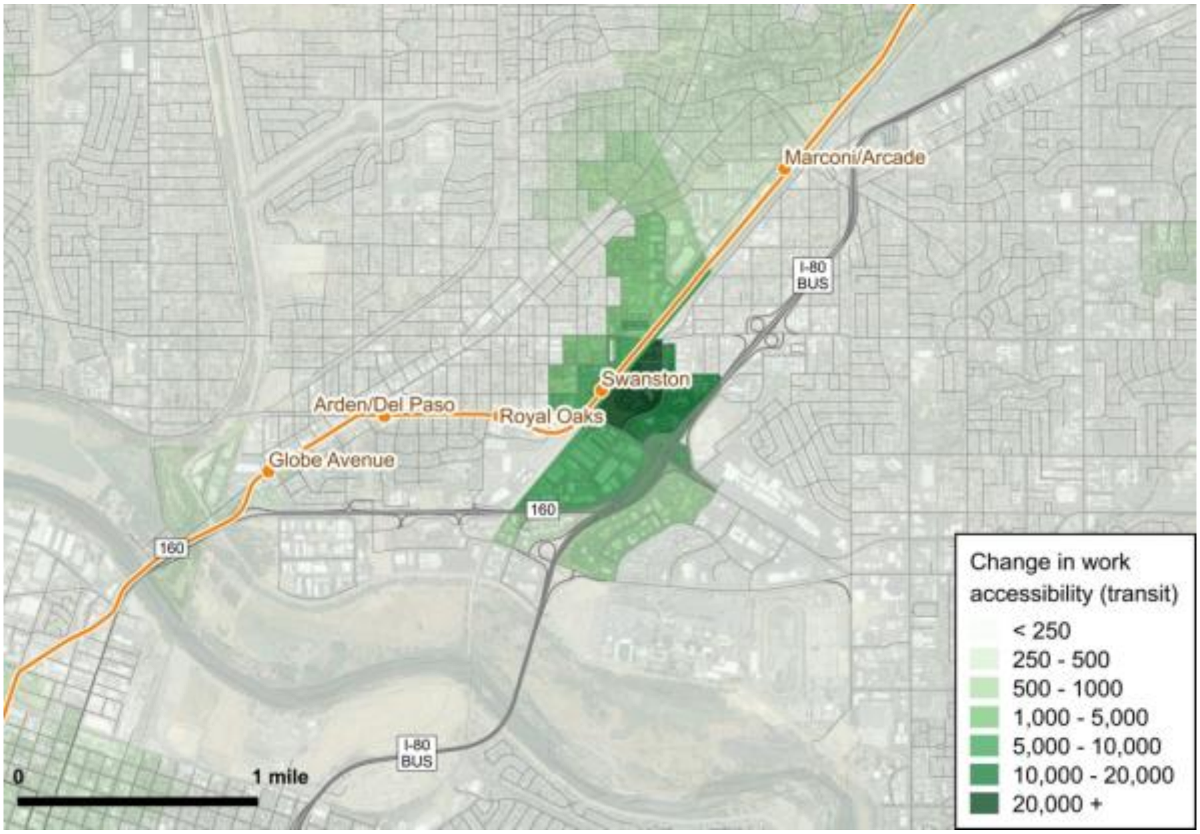

Figure 7. Improvements in access to jobs by transit due to proposed connections to Swanston station

Operationalizing accessibility metrics

Connecting Sacramento demonstrates two key uses of accessibility metrics: prioritizing last-mile connections and quantifying the impacts of accessibility improvements. These metrics, however, can inform decision-making in many ways. Their general uses can be characterized in the following ways:

- Scanning existing conditions
- Identifying and evaluating problems
- Assessing potential solutions
- Setting goals and tracking performance over time
- Engaging and communicating among stakeholders
- Predicting related outcomes – e.g., mode share, household VMT, and land values

To be effective in these applications, however, accessibility metrics – like any performance metrics – must be formally integrated into decision-making processes. Identifying accessibility goals in long-range plans and reporting accessibility metrics in regular benchmarking reports are important steps, but those actions alone probably won't lead to large-scale accessibility improvements. Accessibility metrics should also inform planning decisions, spending prioritization, project design and review, transportation operations and maintenance, land use policies, and related discussions.

Much like the approach described in this brief, the Washington Metropolitan Area Transit Authority (WMATA) conducted accessibility analyses to make the case for strategic investments in pedestrian infrastructure near transit stations, demonstrating the extent to which certain projects could help improve transit ridership. Similarly, the Virginia Department of Transportation has formalized accessibility analysis in its multimodal project prioritization process, called "Smart Scale," and it has made the Sugar Access software available to local governments. Through deliberate use of the tool, cities may use accessibility metrics to create community-oriented transportation plans, bolster transit and achieve mode shift goals, improve transportation equity, and shape private development.

Resources

The following resources offer additional guidance and information on accessibility measurement, strategies for prioritizing first- and last-mile connections to transit, and other applications.

- Accessibility in practice: A guide for transportation and land use decision-making (SSTI, July 2017)
- Operationalizing Accessibility: Tools and Practices (SSTI Webinar, March 2017)
- Accessibility and Smart Scale: Using Access Scores to Prioritize Projects (SSTI Webinar, April 2017)
- Accessibility for all: Open source options for measuring access to destinations (SSTI, June 2017)
- The Why and How of Measuring Access to Opportunity: A Guide to Performance Management (Governor's Institute on Community Design, 2017)
- Metrorail Station Investment Strategy Summary Report (WMATA, August 2016)
- Moving to Access (Brookings)
- Access Across America (Accessibility Observatory)
- Ladders of Opportunity: Connect (U.S. DOT)
- Smart Location Mapping (U.S. EPA)

More information can be found at www.ssti.us.

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