Performance measures for bicycle and pedestrian investments

Presented by Robbie Webber, State Smart Transportation Initiative
Pro Walk/Pro Bike/Pro Place
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Research question

In May 2013, SSTI convened a Community of Practice meeting in Minneapolis focusing on the topic of, "Making the Most of the Transportation Alternatives Program Under MAP-21." Representatives of state DOTs and MPOs discussed their ideas and concerns with the new program under recently passed federal transportation legislation. Among the questions that emerged from the meeting was a desire for some guidance on performance measures for biking and walking investments. This paper is a result of that discussion and follow-up interviews with state DOT, MPO, and city transportation staff along with advocates for biking and walking, researchers, and consultants also concerned with this question.

Introduction

Responding to pressure to document the benefits of highway and transit investments, cities, states, and the federal government have set a number of goals and performance metrics for their transportation systems. The goals largely focus on progress towards widely accepted goals: reducing congestion, reducing emissions, lowering transportation costs, and promoting personal mobility.

Like highway and transit investments, measuring performance and evaluating how policies and investments are contributing to bicycle and pedestrian modal goals is critical to ensuring progress towards them. However, determining how to measure the performance of bicycle and pedestrian policies and investments is an emerging skill and has proven particularly challenging. Because the focus on bike and pedestrian transportation is a relatively recent phenomenon, there is little agreement about what the goals and performance metrics for these types of policies and investments should be, much less on how progress towards these goals should be measured.

Agencies promoting nonmtorized transportation often focus on more than simply traffic counts, but take a broader view, seeking to quantify quality of life, livability. sustainability, livability, universal access to the transportation system, and economic development, among other goals. However, progress in these areas is either difficult to measure or to tie to specific policies or investments in bicycle and pedestrian infrastructure. System wide goals that are easily measured for other transportation modes – congestion relief, air quality improvements, or reduction in commute times – are more challenging to measure for non-motorized transportation.

During our interviews with stakeholders about their opinions and practices with regard to performance measures, their answers often were colored by their normal sphere of influence or

area of interest. Engineers focused on how infrastructure works for non-motorized users, but not always the outcomes of infrastructure changes. Planners focused on the environment for walking and biking, whether the transportation system was easy to use, and the overall "friendliness" or feel of the transportation environment. Few interview subjects had ideas about how standard transportation metrics could be applied to biking and walking investments. This indicated that there was not a good consensus of best practices in measuring success of non-motorized transportation projects.

Although MAP-21 does not require performance measures for projects funded via the Transportation Alternatives Program, FHWA is very interested in developing metrics for bicycle and pedestrians projects. The National Association of City Transportation Officials includes performance measures for bike and pedestrian projects as part of their *Urban Street Design Guide*, and cities, MPOs, and states have set goals for funding projects. However, few have developed metrics for evaluating projects after they have been completed.

The metrics listed below fall into two broad categories according to whether they are based on outputs—e.g. total number of bike lane miles—or outcomes—e.g. reductions in pedestrian fatalities. Some of these are currently being used by jurisdictions, while many others are under consideration.

Output-based Metrics

Metrics based on outputs allow governments to measure their efforts to achieve their goals by quantifying the projects or policies that have been implemented. Output-based metrics rest on the assumption that the output being measured, such as total miles of bike lanes in a community, is associated with goals that are being pursued, such as improved bicyclist safety or a more sustainable community. It is often difficult to gauge how well these output-based metrics track with the relevant outcomes. However, one primary benefit of output-based metrics is that they are usually relatively easy to measure, making them a useful first step for agencies developing a performance management program.

Quantity of Infrastructure. Many municipalities measure their bicycle and pedestrian transportation performance by measuring the number of miles of new bike paths, bike lanes, sidewalks, or other bike and pedestrian infrastructure. This metric is predicated on the assumption that people will walk and bike more if there is more bicycle and pedestrian infrastructure. This assumption is not without merit; indeed, most cities that have improved the quality and extent of their infrastructure have seen increases in walking and biking. However, infrastructure projects that fail to advance the community towards its bicycle and pedestrian transportation goals are not good investments.

Infrastructure Ratings. Over the years, a number of systems have been developed to rate facilities based on how well they meet the needs of bicyclists. Pedestrian facility rating systems are less researched, partly because the importance of sidewalk coverage looms so large above other pedestrian considerations.

If one or more of these metrics were used consistently to rate existing infrastructure, bicycle and pedestrian infrastructure investments could then be measured by how much they improve the rating.

Each of the following infrastructure rating systems can help communities measure the improvement of their bicycle and pedestrian transportation systems. However, all have significant limitations and may require information that is not readily available for many routes favored by bicyclists, such as local residential streets.

In addition, the first two rating systems do not assess connectivity and overall accessibility of the network, as they only rate roadways or even roadway segments, not routes to destinations.

Bicycle Level of Service (BLOS). Developed in 2007 and being used by several states and cities, BLOS provides useful ratings for arterial and collector routes. However, this rating system has several significant shortcomings. It requires multiple data sources that may not be readily available, and it measures only on-street mid-block conditions and does not provide ratings for bike paths, cycletracks, or other separated facilities. In addition, the BLOS does not rate such important bicycle network components as a grid of low-volume streets and bicycle boulevards.

Bicycle Compatibility Index. This metric, developed by FHWA in 1998, relies on visual preference surveys of bicyclists as they view films of various street segments. The Bicycle Compatibility Index does not involve actual testing of bicyclists riding the segments and, like the BLOS, it was developed to rate on-street mid-block cycling conditions and cannot be used to rate bike paths, cycletracks, or bicycle boulevards.

Neither of the above two measures assess intersections, as they only rate the midblock conditions. This is a serious flaw, since navigating an intersection, especially one with heavy traffic, dedicated turn lanes, and many turning vehicles, is often one of the most difficult and intimidating aspects of bicycling.

Bicycle Level of Stress. This methodology, published in 2012, measures the connectivity of the bicycle network via facilities comfortable for the average person–the 66 percent classified as "interested but concerned" by Roger Geller—would feel comfortable using. It provides a more holistic measure of bicycling conditions than BLOS and the Bicycle Compatibility Index because it is based on stress levels of intersections as well as the midblock sections of roadways and bikeways. Although it was not developed as a performance measure, it could be used to measure the contribution of an infrastructure project to the overall bikeability of a city.

The level of stress measure also facilitates the identification of bike accessibility gaps, barriers, and islands – i.e. isolated areas of the city. This information would allow decision makers to more accurately determine the degree to which a facility would reduce the isolation of a particular area of the city. This measure could be an especially important one for evaluating areas containing schools, dense residential developments, shopping districts, or employment centers.

Because Bicycle Level of Stress also rates intersections as well as street segments, it has been used to rate the overall bicycle network and whether an average bicyclist can access areas of the city without undue detour. The drawback of the Bicycle Level of Stress is that it is very data-intensive, even more so than the BLOS, and the data may not be easily available in many cities.

Pedestrian Environmental Quality Index serves a similar function for pedestrians. It does not assess the city-wide pedestrian network, but does allow planners to identify problem areas and locations within neighborhoods. Following the completion of a project, a re-assessment could be used to assess its impacts on an area, neighborhood, or intersection. Since walking distances tend to be short, a neighborhood-based metric may be adequate when enough areas of the city are assessed.

Accessibility. Walk Score—which scores cities, neighborhoods, and specific addresses based on access to destinations by foot, transit, and bike—is considered the standard accessibility tool for walking and biking. It rates how far one would have to travel from a given location for trips to schools, shops, restaurants, parks, grocery stores, and other destinations and develops a scroe based on destinations by mode. Walk Score does not factor in the presence of sidewalks or the safety of the trip—perceived or real—although the overall density of the neighborhood, block length, and general connectivity of the neighborhood is included in the score. Walk Score's bicycle access rating system, Bike Score, is based on the same factors that Walk Score uses for pedestrian access along with the availability of bicycle paths and lanes and the prevalence of hills.

Changes in these ratings could be used as a metric for non-motorized accessibility and a proxy for the ability to walk or bike to most daily needs. However, because the score is based exclusively on the physical proximity of destinations, Walk Score sometimes inappropriately rates bike- and pedestrian-unfriendly locations—such as suburban big box clusters and malls—higher than most people would normally consider appropriate due to the density of destinations within a small area.

Outcome-based Metrics

Communities are motivated to make investments in walking and biking to improve economic development, quality of life, public health, aesthetics, or social justice. Measuring these impacts—the outcomes of bicycle and pedestrian policies and investments—directly, rather than measuring outputs assumed to be associated with them, yields data that is more clearly linked to bike/pedestrian program goals. However, gathering data on outcome-based measures is often much more difficult than gathering it on output-based measures. If a city is trying to promote a modal shift from cars to bicycles, it is not enough to measure the number of bicycles per day in a corridor. They need to know what mode bikers *would have been using* if they were not on bicycles—a much more difficult task. Further complicating the issue is the need to connect changes, such as increased bicycle mode share, to specific policies and infrastructure improvements. New York City, a leader in the use of outcome-based measures, measures performance, such as retail sales growth, in places with new infrastructure against similar

unimproved comparison sites and against borough averages in order to isolate the effects of their projects.

While collecting the data for outcome-based performance measurement is often more difficult than for output-based measurement, measuring performance based on outcomes is generally superior because it provides a clearer link between new policies or investments and community goals.

Economic development. A number of communities have done studies of corridors before and after making investments in biking and walking infrastructure. Some of these were done to allay fears that removing parking or restricting motor vehicle lanes would have an adverse effect on property values, business revenues, or customer access. In other cases, investments in biking and walking were part of a larger strategy to improve a neighborhood, and studies were done to document the results. Economic development indicators include changes in property values, sale tax receipts, and other measures associated with economic activity. The relationship between infrastructure improvements and economic effects can be determined either by measuring changes at unimproved comparison sites or by identifying the contributions of bicyclists and pedestrians to total sales revenue. For example, in communities with a Bicycle Benefits program, where participating businesses offer discounts to customers arriving by bike, businesses tracking about their sales to customers arriving by bike would allow more targeted measurement of bicycle-related economic activity. Observational surveys of a corridor can also capture pedestrians and bicyclists entering businesses.

Public health. Many communities have goals to increase physical activity, lower chronic disease rates, or improve other metrics of the general population. Surveys of public health before and after a program or infrastructure investment can show correlation between biking and walking investments and public health indicators, such as minutes of daily physical activity or rates of obesity, diabetes, or asthma among residents. A number of communities are using this approach to assess their investments.

Quality of life. Quality of life encompasses a wide range factors, such as public perceptions about the community, aesthetics, crime, and others. Although some of these factors seem unrelated to transportation policy and infrastructure, pedestrian and bicycle investments—particularly streetscaping— can play a part in overall quality of life. Along with community surveys, usage rates for public infrastructure, such as benches and parks, can give planners insight into the livability impacts of pedestrian and bicycle investments.

Mode shift. Shifting trips from single-occupancy vehicles to alternate modes is a goal of many communities and states. Modal shift can reduce congestion during peak periods, improve air quality, and lessen the need for costly roadway maintenance and new highway capacity. Since many trips are within easy walking and biking distances, investments in infrastructure and programs for non-motorized transportation can pay big dividends in terms of reduced automobile infrastructure costs. Acquiring accurate information about mode split of all trips is key, especially when assessing the impact of specific projects on corridors..

Many communities lack accurate information about walking and biking trips and rely instead on American Community Survey mode split data. However, the ACS only measures the trip to work and does not allow respondents to report the use of multiple modes for a single trip. In addition, ACS data does not provide data at the corridor or neighborhood level that could be used to assess the impacts of a particular investment.

While ACS data is the easiest source for information about traveler mode choice, there are other ways to collect more nuanced information at a finer level of detail. Two existing options are to use traveler surveys or to simply count the number of persons traveling by each mode at a given location.

The near universal adoption of cellular phones, which makes it possible to track the movement of people throughout the day using anonymous cellular phone signal information, provides a third option for documenting travel behavior. This is an emerging field and the companies that provide this data have thus far focused on driving patterns and trips. However, by creating new algorithms to separate drivers from bikers, walkers, and transit passengers, the share of travelers using each mode in a certain corridor could be determined. This would allow communities to see changes in travel mode share over time and to more quickly and accurately assess the impacts of new policies and infrastructure. SSTI is pursuing research on the topic of using cell phone data to more accurately interpret transportation choices within a corridor.

Even with reliable information about the number of travelers using each mode in a corridor, the accurate assessment of a policy or project's impact on traveler mode choice is difficult. For example, there is evidence from bike share systems that many of the new bicycle trips occurring after system installation were shifted not from car trips, but from transit. Therefore, an increase in the number of new bicycle trips is not necessarily an indication of a reduction in car trips in the same corridor. However, improved bicycle and pedestrian infrastructure can also facilitate transit usage that previously had been an unattractive option because of distance or dangerous access.

Congestion and air quality. Motor vehicle congestion is fairly easy to measure and is often measured in real time. Air quality is also monitored in most urban areas, and improvements in these metrics, particularly in air quality nonattainment areas, are usually a top priority.

While increased levels of bicycling and walking does not always translate into discernibly lower levels of congestion, since drivers who switch to an alternate mode will normally be replaced by drivers that would have traveled by a different route or at a different time. However, a number of cities and states are undertaking efforts to model how changes in biking and walking patterns might forestall actual declines in these metrics. This is the basis of the claim in Portland, OR that if all the bicyclists that cross the Hawthorne Bridge were driving, another bridge would be needed.

The Nonmotorized Transportation Pilot Project demonstrated that modes shifts toward biking and walking can indeed have a measurable reduction in vehicle miles traveled. Congestion reductions can also be measured at specific locations, such as around schools, laces of employment, and activity centers.

Safety. Although reducing crashes is a goal in most communities, the total number of crashes involving bicyclists and pedestrians is so small that it is usually impossible to find a statistically significant change in crashes in any one location. In addition, bicycle crashes are often underreported, making the overall numbers unreliable. Despite these limitations, crash rates can serve as a useful safety metric, but only over the long time periods that allow for comparison between rolling averages.

It is critical that the number of crashes or injuries be tied to overall nonmotorized VMT and/or the number of nonmotorized trips in order to develop a meaningful crash rate statistic, but accurate data on total number of biking and walking trips and total biking and miles traveled is hard to obtain. Notable exceptions are reports from the four Nonmotorized Transportation Pilot Program projects and a recent research effort by Washington State DOT.

Performance measurement for bicycle and pedestrian safety has recently received renewed attention. While the number of traffic fatalities for drivers has been declining steadily for decades, there has been an alarming jump in bicyclist and pedestrian fatalities. This has led to a bipartisan bill to direct U.S. DOT to set safety goals based on non-motorized vehicle miles traveled. As noted by the bill's sponsors, bicycling has become increasingly popular over the last decade, so the rise in crashes could simply be a result of more exposure. However, while pedestrians and bicyclist constitute 16 percent of fatalities nationwide, only one percent or federal safety funds are spent on these modes.

The rate of speeding among drivers is one safety measure that is easy to obtain and crucial for bicycle and pedestrian safety. Reducing average speeds, especially near schools and parks, can reduce the frequency and severity of crashes while also increasing the perception of safety on the street for nonmotorized users. Measuring the Street, put out by New York City DOT provides examples of how New York has used these metrics to evaluate their pedestrian-bicycle improvements.

Educational programs can increase safety as well, but measuring the impact of these programs is often harder than

Considerations when developing performance measures

Trip to work vs. other trips

Although commuting to and from work is estimated to only account for 20 percent of trips, the mode chosen for work trips often sets the stage for non-work trips. Because workers often trip chain on the way to and from work, if the commute trip is made by one mode, all those additional trips before and after work are likely to be made via that mode as well. In addition, if an employment area and commute trip is not transit, pedestrian, or bicycle friendly, any lunch trips, mid-day errands, or trips for meetings are difficult to make via these mode as well.

The importance of major destinations

Although commuting trips are a minority of all trips, some bicycle/pedestrian metric—Walk/Bike Score, Bicycle Stress Level or Level of Service, walkability, etc.—should be assigned to major employment areas because of the number of people that need to access them regularly. In addition, other destinations that regularly attract large numbers of people such as schools, shopping districts, parks, and sports arenas should receive special attention when metrics are being considered. It is especially important to consider connections to destinations that are likely to attract children, the elderly, people with disabilities, low-income populations, and other groups unable or less likely to drive.

Individual locations vs. systematic measures

It may be easier to measure performance and outcomes at an individual locations, intersections, or segments than overall systematic changes. For instance, a problem intersection can be changed and safety improved by adding paint, traffic signals, signage, or other measures. If a high-crash location is identified, infrastructure changes leading to improved safety can easily be documented.

Spot improvements may indeed have an effect on the overall system. If an intersection is considered very dangerous for pedestrians and bicyclists, a spot improvement may allow more people to access whole sections of the city or network, thus changing travel patterns or mode share. However, in most cases these smaller changes are not going to show overall system changes.

Examples of performance metrics

Below are examples of efforts to measure the impacts of investments in biking and walking. Each document demonstrates a set of tools being used and suggests additional metrics that can be used. They also disscuss the challenges to measuring progress towards accurately portraying changes in these modes. However, they serve as demonstrations of how local and state agencies and organizations can begin to develop valid performance measures.

Nonmotorized Transportation Pilot Projects

Perhaps the longest-running and most comprehensive efforts to shift mode split toward biking and walking have been the four pilot projects funded under SAFETEA-LU. The entire premise of the program was to see if a large infusion of federal funding focused solely on increased biking and walking could have a significant impact on mode split over five years. The four projects—Sheboygan County, WI; Minneapolis, MN; Marin County, CA; and Columbia, MO—each submitted interim and final reports over the course of the project. Because many of the programs and infrastructure were implemented only close to the end of funding, full results are just now being seen and continued progress reports were submitted. The evaluations of the projects give an excellent example of performance measures for each community

Illinois Bike Plan

Included in the new Illinois Bike Plan are performance measures for the state. In addition to measuring their infrastructure improvements, Illinois is also concerned with tracking funding levels, educational programs, encouragement, and overall policies that will improve biking in the state. Each metric falls under one of the following categories:

- Planning and policies
- Design and maintenance
- Funding
- Education and promotion

They have also identified goals in the following categories and developed a matrix of action items to support the goals:

- Safety
- Access and connectivity
- Choices/transportation options
- Collaboration
- Equity/environmental justice
- Public health and wellbeing
- Economic competitiveness
- Environment
- Communication

The list of action items is considerably longer than the metrics by which progress will be measured. However, this illustrates the key point that goals and checklists of actions are not the same as performance measures.

Methods for Estimating Bicycling and Walking in Washington State

As mentioned above, a number of performance measures rely on knowing how many miles are traveled by bicycle. It is difficult to estimate this number because bicycles and shoes do not have odometers and traffic flow on major corridors is often not continuously tracked.

Washington State DOT has developed a methodology to estimate the amount of bicycling and walking being done in the state. This allows them to assess the impacts of their investments by having miles-traveled information use with raw crash or corridor use data.

Alliance for Biking and Walking Benchmarking Report 2014

The Alliance is a network of biking and walking advocacy groups across North America, and they have published several reports rating the efforts of cities and states to improve conditions for pedestrians and bicyclists. The 2014 report, *Bicycling and Walking in the United States: 2014 Benchmarking Report*, covers many metrics including commute mode share, miles of paths and marked routes, walking and bike-friendly policies, health indicators, connections to transit, and many more.

Conclusion

Just as with any transportation investment, states and communities must chose the performance measures for their nonmotorized transportation program based on the priorities of the entire system. Access to jobs, schools, and daily needs for all sectors of the population; increased safety; economic development; livability; and improved public health are common goals. The performance measures selected can reflect any or all of these; however it is important to set the performance measures based on public input and community values.

Data collection is difficult for many of the performance measures in this report. We are just beginning to gather the information and research the connections between investments in biking and walking improvements and many larger community goals. New methods of gathering information and new models for predicting and then testing outcomes are being developed.

We welcome your feedback on this draft report, and we are interested in hearing what metrics your agency or community is using.

See the attached matrix for an overview of the pros and cons of the metrics discussed in the report.

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