CONNECTIVITY

Contents

Bicycle and Pedestrian

Bicycle and Pedestrian Network Connectivity

Measure at a Glance

Category: Connectivity
Subcategory: Bicycle/Pedestrian

Indicator Overview

Description

This indicator measures of the extent to which bicycle and pedestrian infrastructure provides access to locations in the region of interest and the directness of routes between nodes in the network. Greater access through more direct routes result in higher scores. Greater network connectivity can encourage greater network utilization. Increase in connectivity increases bicyclists and walkers throughout the area. Increasing bicycle and pedestrian connectivity encourages the use of these modes as an alternative to the private automobile, reduces overall reliance on the private automobile, and travelers' use of this infrastructure has an indirect connection with decreases in automobile and transit emissions.

Human and Environmental Drivers

Human: The connectivity of bicycle and pedestrian infrastructure is a function of extent and design of the network. Construction and maintenance of the bicycle and pedestrian network (sidewalks, bike paths, trails) increases connectivity. Development of bicycle and pedestrian pathways in conjunction with transit service increases overall connectivity.

Application

In the Basin

TRPA currently monitors and reports "Miles of Bicycle and Pedestrian Facilities Improved or Constructed" in the Regional Transportation Plan and as an Environmental Improvement Program performance measure. TRPA has also monitored and reported "Miles of Bicycle and Pedestrian Facilities Constructed" each year since it was identified as one of 14 Regional Plan Performance Measures approved by the TRPA Governing Board in 2013. Bicycle and pedestrian infrastructure provides key links between Tahoe communities and recreation areas and reduces reliance on the automobile. The active transportation network includes all existing infrastructure, including: shared-use paths, bike lanes, bike routes, sidewalks, and enhanced crosswalks. The 2016 Active Transportation Plan reports there are 120 miles of bicycle and pedestrian infrastructure in the Region, and another 120 miles of facilities planned.

External Uses

Carson Area Metropolitan Planning Organization uses the "Miles of Bicycle Lane, Sidewalk, and Shared Use Path Added or Reconstructed" measures to understand which transportation modes are accommodated within the region (Carson Area Metropolitan Planning Organization 2016).

Metro (Portland, OR) uses the "Miles of Bikeways, Sidewalks, and Shared Use Path Added" measures to understand how basic infrastructure influences the built environment of the region (Metro 2014).

Sacramento Area Council of Governments uses "Miles of Bicycle Route and Shared Use Path Added" and "Bike Route Miles per 100,000 Population" to understand the amount of bicycle infrastructure in the region (SACOG 2016a).

The **City/County Association of Governments of San Mateo County** uses "Miles of Bicycle Lane" and "Shared-Use Path Added or Reconstructed" to ensure that bicycle and pedestrian infrastructure is being incorporated into transportation improvement projects (City/County Association of Governments of San Mateo County 2015).

Washoe Regional Transportation Commission uses "Miles of Bicycle Lanes and Sidewalks Added" to understand pedestrian and multimodal safety in the region (Washoe Regional Transportation Commission 2013).

Mid-Ohio Regional Planning Commission uses "Percentage of Parcels within Census Defined Urbanized Areas that have Sidewalks" to understand the accessibility to transportation choices in the region (Mid-Ohio Regional Planning Commission 2011).

San Francisco County Transportation Authority uses use "Bicycle Network Connectivity to understand the performance of non-motorized transportation in the region (San Francisco County Transportation Authority 2013a). The county also uses "Miles of Sidewalk Added or Reconstructed" to understand pedestrian safety in the region (San Francisco County Transportation Authority 2013b)

Literature or Guidance Documents

The **Nevada Department of Transportation's** Planning Executive Group outlines a means for establishing infrastructure to create effective pedestrian and bicycle facilities through projects such as an installation of safe bicycle networks to school. Planning and infrastructure for the projects are largely powered by NDOT's Bicycle and Pedestrian Planning Group with funding partnerships provided through **Nevada's Bicycle and Pedestrian Advisory Board**. (Nevada Department of Transportation n.d.). Connectivity measures are suggested to provide information that is useful for understanding how urban design impacts travel behavior and for designing standards for development that promote network utilization **(Dill 2004)**.

Relationship with Goal

Connectivity: This measure directly relates to the connectivty goal because it provides a direct measure of the network connectivity.

Quality of Life: Improved mobility, access, and transporation options can reduce travel times and are positiively associated with quality of life. Greater connectivity can encourage higher levels of utilization of the active transporation network which which increases levels of physical activity and decreases health problems associated with inactivity (i.e. obesity, heart disease, etc.).

Variations of the Measure / Alternatives to the measures

Miles of Bicycle Lane Added or Reconstructed - Measures the total length of bike lanes added to the system. It directly measures expansion of infrastructure, which is correlated with, but does not include the design elements of connectivity based measures.

Miles of Sidewalk Added or Reconstructed- Measures the total length of sidewalk added to the system. It directly measures expansion of infrastructure, which is correlated with, but does not include the design elements of connectivity based measures.

Miles of Shared Use Path Added or Reconstructed - Measures the total length of paths added to the system, with a focus on multiple use paths. It directly measures expansion of infrastructure, which is correlated with, but does not include the design elements of connectivity based measures.

Bike Route Miles per 100,000 Population - The total length of bike trails, normalized by population within the area of interest. Measure of system state, and system size relative population.

Pedestrian and Bicycle Crossing Opportunities – The number of intersections per unit area.

Bicycle and Pedestrian Network Density – The miles of bicycle and pedestrian paths per unit area.

Safe Bicycle Network to School – The number or percentage of schools that have an identified safe biking route. Percent of Urbanized Areas that have Sidewalks – The proportion centerline feet of roadway within a specified region that have associated sidewalks.

References

(Carson Area Metropolitan Planning Organization 2016)
(Chicago Metropolitan Agency for Planning 2010)
(Chicago Metropolitan Agency for Planning 2013)
(City/County Association of Governments of San Mateo County 2015)
(Dill 2004)
("Environmental Correlates of Walking and Cycling: Findings from the Transportation, Urban Design, and Planning Literatures" 2003)
(Metro 2014)
(Mid-Ohio Regional Planning Commission 2011)
(Mid-Ohio Regional Planning Commission 2012)
(Mid-Ohio Regional Planning Commission 2016)
(Nevada Department of Transportation n.d.)
(Queensland Government Department of Transport and Main Roads 2017)
(SACOG 2016a)
(SACOG 2016b)
(San Francisco County Transportation Authority 2013b)
(San Francisco County Transportation Authority 2013a)
(Southworth 2005)
(Washoe Regional Transportation Commission 2013)

Percent of Roadways with Adjacent Bicycle/Pedestrian Facilities

Measure at a Glance

Category: Connectivity
Subcategory: Bicycle/Pedestrian

Indicator Overview

Description

This indicator measures the proportion of roadway miles that have sidewalks or bike lanes. The measure provides information on the availability of bicycle and pedestrian infrastructure alternatives to travel along a roadway.

Human and Environmental Drivers

The "Percent of Roadways with Adjacent Bicycle/Pedestrian Facilities" is a function of investment in construction and maintenance of bicycle and pedestrian infrastructure (sidewalks, bike paths, trails) relative to construction of additional roadways. Roadway expansion without bicycle or pedestrian lanes will decrease scores, while construction of bicycle or pedestrian lanes along existing roadways will increase the score.

Application

In the Basin

No current in-basin use.

External uses

Florida Department of Transportation uses "Percent of Roadways with Adjacent Bicycle/Pedestrian Facilities" to track active transportation alternatives and quality of life (Florida Department of Transportation n.d.).
Oregon Department of Transportation uses "Percent of Roadways with Adjacent Bicycle/Pedestrian Facilities" to measure progress towards its goal of establishing "safe, walkable and bikeable communities" (Oregon Department of Transportation 2017).
Tennessee Department of Transportation uses "Percent of Roadways with Adjacent Bicycle/Pedestrian Facilities" to understand the mobility, access, and safety of non-motorized traffic (Tennessee Department of Transportation 2016).

Literature or Guidance Documents

Relationship with Goal

Connectivity: The development of bicycle and pedestrian pathways increases overall connectivity and utility. Increasing bicycle and pedestrian connectivity encourages the use of these modes as an alternative to the private automobile. Reducing reliance on the private automobile and private auto trips can improve air quality by reducing emissions.
Safety: Providing adjacent bicycle and pedestrian facilities that are aligned with and separated from roadways increases safety of active transportation travelers. Safety improvements can also increase utilization.

Variations of the Measure / Alternatives to the measures

No variations identified.

References

(City of Davis 2009)
(Florida Department of Transportation n.d.)
(Maryland State Highway Administration 2015)
(Minnesota Department of Transportation 2017)
(National Association of City Transportation Officials 2016)
(Oregon Department of Transportation 2015)
(Oregon Department of Transportation 2017)
(Tennessee Department of Transportation 2016)

Pedestrian Environment Factor

Measure at a Glance	
Category: Connectivity **Subcategory*:*** Bicycle/Pedestrian	

Indicator Overview

Description

This indicator measures the density of streets within a region and is a proxy for pedestrian friendliness or walkability. This measure is computed by as the number of census blocks within a quarter mile area, which means that functionally is a simple measure of street network density (Chicago Metropolitan Agency for Planning 2013).

Human and Environmental Drivers

Shorter block length and greater number of intersections within an area increase the PEF score.

Application

In the Basin

No current in-basin use.

External uses

Chicago Metropolitan Agency for Planning uses "Weighted Pedestrian Environment Factor" to understand neighborhood walkability (Chicago Metropolitan Agency for Planning 2013).

Literature or Guidance Documents

No literature or guidance documents identified.

Relationship with Goal

Connectivity: This measure relates to active transportation connectivity because it provides an indication of the walkability of an area. The measure is intended for quick calculation based on readily available data, and doesn't include a host of factors that are often associated with pedestrian friendliness. These factors include, topography, presence of sidewalks, ease of street crossings, network connectivity, or the presence of amenities.

Variations of the Measure / Alternatives to the measures

Weighted Pedestrian Environment Factor - Aggregates local PEF scores to produce a regional score, by weighting the local scores by population of local area (Chicago Metropolitan Agency for Planning 2013).

A second, unnamed variant, computes the score based only on the subset of streets in the area deemed suitable for walking. (Chicago Metropolitan Agency for Planning 2013).

Pedestrian Environment Factor – A measure by the same name is referenced within the academic literature, based on the presence of six factors associated with walkability; sidewalks, parking lots, building setbacks, block length, intersection type, and census block.

Density (Parks & Schofer 2006).

Pedestrian Friendliness Index (PFI) – Is a subjective weighting of the friendliness of the pedestrian environment developed or the Maryland National Capital Parks and Planning Commission (Parks & Schofer 2006).

References

(Chicago Metropolitan Agency for Planning 2010)
(Chicago Metropolitan Agency for Planning 2013)
(Chicago Metropolitan Agency for Planning 2015)
(Parks & Schofer 2006)

Emerging Technology

Number of Parking Spots with Access to Plug-in Electric Vehicle (PEV) Charging	
Measure at a Glance	
Category: Connectivity **Subcategory*:*** Emerging Technology	
Indicator Overview	
Description	
This indicator is a count of the number of park places that are equiped for charging plug-in electric vehicles. The measure speaks to the ease of use of PEV in an area and adoption of emerging technology.	
Human and Environmental Drivers	
The number of parking places that support PEV charging in the region is a function of public and private investment in construction of PEV charges stations. Policies that encourage installation of PEV charging stations in parking lots encourage consumers to purchase PEVs. Citing PEV charging stations can be a challenge in areas where parking is limited and can create conflict if it involves a reduction in the supply of parking spots for traditional vehicles. Local jurisdictions in the basin have noted that citing PEV sites can be a challenge because of coverage restrictions.	
Application	
In the Basin	
TRPA uses "Number of Parking Spots with Access to PEV Charging" to understand charging station deployment in the Tahoe Region (Tahoe Regional Planning Agency & Truckee Donner Public Utility District 2017).	
External uses	
The San Joaquin Valley Air Pollution Control District includes parking space requirements for the insetting of plug-in electric vehicle charging stations as a part of their Plug-In Electric Vehicle Readiness Plan (California Center for Sustainable Energy & San Joaquin Valley Air Pollution Control District 2014)	
Literature or Guidance Documents	
No literature or guidance documents identified.	
Relationship with Goal	
Connectivity: Greater availablity of charging stations encourages additional use and adoption of PEVs. **Emerging Technology:** This measure direction relates to emerging technology goals because it looks into dispersion and availability of charging stations for plug-in electric vehicles. **Air Quality:** This measure relates to air quality goals because it encourages use of vehicles that produce fewer harmful emissions than traditional private automobiles.	
Variations of the Measure / Alternatives to the measures	
No variations identified.	
References	
(California Center for Sustainable Energy & San Joaquin Valley Air Pollution Control District 2014) (California Center for Sustainable Energy 2013) (Tahoe Regional Planning Agency & Truckee Donner Public Utility District 2017) (United States Department of Energy 2008) (United States Department of Energy 2015)	

Number of Alternative Fueling Stations

Measure at a Glance	
Category: Connectivity **Subcategory**: Emerging Technology	

Indicator Overview

Description

This indicator is a count of the total number of alternative fueling stations within a defined geographic area. The measure is used assess barriers to use or the ease of using alternative fuel vehicles within a region. As the number and connectivity of alternative fueling stations increases, adoption of alternative fuel vehicles is expected to increase.

Human and Environmental Drivers

The "Number of Alternative Fueling Stations" is a function of public and private investment in construction of the fueling stations. Construction can be driven by either consumer demand for alternative fuel fueling stations or by investment in alternative fueling stations designed to create demand for alternative fuel vehicles.

Application

In the Basin

Tahoe Regional Planning Agency uses "Number of Alternative Fuel Stations" and "Total Number of Charging Stations (Level 1, 2, and DC; Residential, Workplace, Destination)" to understand charging station deployment in the Tahoe Region (Tahoe Regional Planning Agency & Truckee Donner Public Utility District 2017).

External uses

Tennessee Department of Transportation uses "Number of Alternative Fuel Stations" to understand the environmental sustainability and protect natural and environmental resources (Tennessee Department of Transportation 2016).
Mid-Ohio Regional Planning Organization uses "Number of Alternative Fuel Stations" to understand the production and use of renewable fuel sources in the region (Mid-Ohio Regional Planning Commission 2011).

Literature or Guidance Documents

No literature or guidance documents identified.

Relationship with Goal

Environmental: Increased availability of alternative fueling stations encourages use of PEVs, which reduces pollutant emissions from mobile sources. Reducing emissions from mobile sources improves air quality.

Connectivity: Availability of alternative fueling stations provides an indication of how ease of use of PEVs within the region or the extent to which there is connectivity that enables use. The measure does not account for the spatial distribution or distance between charging stations, which also influences ease of use.

Variations of the Measure / Alternatives to the measures

Counts of charging stations often differential between the power (or level) of the charging stations and the location of the charging infrastructure. The level of the charging station Level (1, 2, and DC) relates to the length of time required to charge a battery using the station. Higher level charging stations that can charge cars more quickly improve accessibility and ease of use of the infrastructure. The location of infrastructure which is often classified as, residential, workplace, destination, provides an indication of who has access to the charging stations.

References

(Melaina & Bremson 2008)
(Melaina 2003)
(Mid-Ohio Regional Planning Commission 2011)
(Mid-Ohio Regional Planning Commission 2012)
(Mid-Ohio Regional Planning Commission 2016)
(Tahoe Regional Planning Agency & Truckee Donner Public Utility District 2017)
(Tennessee Department of Transportation 2016)
(Toyota 2017)
(United States Department of Energy 2017a)
(United States Department of Energy 2017b)

Plug-in Electric Vehicle (PEV) Charging Equipment with ADA Accessibility

Measure at a Glance	
Category: Connectivity **Subcategory**: Emerging Technology	

Indicator Overview

Description

This indicator measures the accessibility of PEV charging stations, specifically aligning with ADA needs. The measure is reported as a count or a percentatge of charging stations.

Human and Environmental Drivers

Human: Implementation of accesible charging stations for those necessitating ADA accessiblity entails creating a buffer for exiting a parked vehicle, installing new parking spaces with both ADA accessibility and PEV charging, and installation of PEV charging stations at existing parking spaces already marked as ADA accessible.

Environmental: A connected alternative fueling station transportation system encourages use of emerging technology and represents a positive shift toward the alternative fuel use and improved air quality as emissions decrease.

Application

In the Basin

TRPA uses "PEV Charging Equipment with ADA Accessibility" to understand charging station deployment in the Tahoe Region (Tahoe Regional Planning Agency & Truckee Donner Public Utility District 2017).

External uses

No external uses identified.

Literature or Guidance Documents

No literature or guidance documents identified.

Relationship with Goal

Quality of Life - This measure relates to the resident quality of life goal because increases accessibility of amenities to residents and visitors.

Air Quality: Increased availability and accessibility of alternative fueling stations encourages use of PEVs, which reduces pollutant emissions from mobile sources. Reducing emissions from mobile sources improves air quality.

Connectivity: Availability and accessibility of alternative fueling stations provides an indication of how ease of use of PEVs within the region or the extent to which there is connectivity that enables use. The measure does not account for the spatial distribution or distance between charging stations, which also influences ease of use. .

Variations of the Measure / Alternatives to the measures

No variations identified.

References

(California Plug-in Electric Vehicle Collaborative 2012)
(Corelis 2015)
(Tahoe Regional Planning Agency & Truckee Donner Public Utility District 2017 p.)
(United States Department of Energy 2014)

Transit

Transit Connectivity

Measure at a Glance

Category: Connectivity
Subcategory*:* Transit

Indicator Overview

Description

This indicator quantifies the connectivity and spatial coverage of transit service within an area.

Human and Environmental Drivers

Higher density of bus routes and train stations in a given area improves the Transit Connectivity; increasing frequency of service improves the Transit Connectivity; coordination of multiple transit agencies in a given area can increase routes, stations, and service frequency which improves the Transit Connectivity; Universal fare structures/card for regional transit services increases ease of use and network connectivity.

Application

In the Basin

No current in-basin use.

External uses

San Francisco County Transportation Commission uses "Transit Coverage" to understand the pattern of the transit network and the service area covered in the County (San Francisco County Transportation Authority 2013a).
Riverside County Transportation Commission uses "Distribution of Benefits and Costs of Transit" to understand how transit connectivity relates to environmental justice (Riverside County Transportation Commission 2011).
Chicago Metropolitan Agency for Planning uses the "Transit Connectivity Index" to understand system accessibility (Chicago Metropolitan Agency for Planning 2013).

Literature or Guidance Documents

No literature or guidance documents identified.

Relationship with Goal

Connectivity: This measure utilizes the number of routes, route frequency, number of stops, and network coverage to assess the connectivity of the transit service in a given area.

Variations of the Measure / Alternatives to the measures

Transit Connectivity Index (TCI) – Measures the number of bus routes and train stations within walking distance for households in an area. The measure is adjust for the frequency of transit service to the transit stops (CNT 2017).
Transit Coverage – Measures the percent of population with access to transit.
Directness of Transit Routes – Provides a measure of the number of stops and length of the route between two destinations. More stops and longer travel distances related to lower scores.
Distribution of Benefits and Costs of Transit – Quantifies which communities benefit from and bear the costs of transit operations, and used to assess or evaluate concerns related to environmental justice and equity.

References

(CNT 2017)
(Chicago Metropolitan Agency for Planning 2010)
(Chicago Metropolitan Agency for Planning 2013)
(Metropolitan Transportation Commission 2005)
(Metropolitan Transportation Commission 2006)
(Riverside County Transportation Commission 2011)
(San Francisco County Transportation Authority 2013a)

Transit Network Completion

Measure at a Glance	
Category: Connectivity **Subcategory**: Transit	

Indicator Overview

Description

This indicator measures the proportion of the projects identified in a long term plan goal that have been completed. It is a direct measure of implementation progress.

Human and Environmental Drivers

Transit network completion is a function of investment in transit projects included in the plan. Higher levels of investment and greater levels of public and political support will result in faster network completion. Opposition to projects or lower levels of investment to projects within the plan will slow network completion.

Application

In the Basin

Tahoe Transportation District uses "Percent of Long Range Transit Network that is Complete" to understand transit level of service (Tahoe Transportation District 2017).

External uses

No external uses identified.

Literature or Guidance Documents

No literature or guidance documents identified.

Relationship with Goal

Connectivity: This measure relates to the connectivity/transit goal because it measures progress towards completion of a network that would provide regional connectivity.
Operations: This measure relates to the operative completion and facilitation of transit networks.

Variations of the Measure / Alternatives to the measures

Percent of Long Range Transit Network that is Complete.

References

(Knight & Trygg 1977)
(Rodrigue et al. 2013)
(Tahoe Regional Planning Agency 2017)
(Tahoe Transportation District 2017)
(Taylor et al. 2009)

Transit Ridership

Measure at a Glance	
Category: Connectivity **Subcategory*:*** Transit	

Indicator Overview

Description

This indicator measures the number of passengers that use a transit service; could be on an average weekday, weekend, quarterly, etc.. This measure shows transit utilization and is an indirect measure of transit network connectivity.

Human and Environmental Drivers

Total population is positively associated with transit ridership; however, population pattern has a strong influence on ridership. Centralized populations and growth in centralized areas are positively associated with ridership, while sprawl and low-density development is associated with lower levels of ridership. However, ridership has been found to plateau once density reaches about 20-30 people per acre (Armbruster 2010). Lower-income populations generally utilize transit at higher rates than middle-income and high-income populations. Strong network connectivity and high frequency of service are positively associated with ridership. Higher private automobile travel costs tend to have a positive impact on transit ridership. Increases in fuel prices have a minimally positive effect on transit ridership, unless the fuel price is increased significantly, such as the energy crisis in the 1970s. Higher transit fares decreases ridership. Paid parking/parking costs have a positive effect on transit ridership. Other factors that positively influence transit ridership include: parking availability reductions in central business districts/downtown areas, increases in public funding for transit services, lower cost or special discounts to certain demographics (e.g. students, seniors, etc.), use of real-time transit information (Intelligent Transportation Systems (ITS), and improved service information, on-street service, station safety, customer service, safety, cleanliness, and service marketing.

Application

In the Basin

TRPA and Tahoe's transit operators (**Tahoe Transportation District** and **Placer County**) track and report transit ridership to understand usage of the Region's transit system.
https://laketahoeinfo.org/Indicator/Summary/TransitRidership/Overview

External uses

Texas Transportation Institute uses "Ridership per Index of Transit Need Population" and "Transit Ridership" to understand livability in communities and neighborhoods and the demand of transit services (Texas Transportation Institute 2013).
Sacramento Area Council of Governments uses "Weekday Passenger Boardings" to understand transit productivity in the region (SACOG 2016a).
Florida Department of Transportation uses "Transit Ridership" to understand the mobility and accessibility of the state (Florida Department of Transportation n.d.).
Oregon Department of Transportation uses "Transit Ridership" to understand the mobility and economic vitality of the state (Oregon Department of Transportation 2015).
Tennessee Department of Transportation uses "Transit Ridership" to understand the state's transit needs (Tennessee Department of Transportation 2016).
Sacramento Area Council of Governments uses "Transit Ridership" to understand the mobility and accessibility in the region (SACOG 2016b).
Chicago Metropolitan Agency for Planning uses "Transit Ridership" to understand the effectiveness of the region's transit system (Chicago Metropolitan Agency for Planning 2010).
Washoe Regional Transportation Commission uses "Transit Ridership" to understand environmental sustainability and the performance of the region's transportation system (Washoe Regional Transportation Commission 2013).
Santa Barbara County Association of Governments uses "Transit Ridership" to understand journey-to-work mode share in the region (Santa Barbara County Association of Governments 2016).
Denver Regional Council of Governments uses "Transit Ridership" to understand transit system preservation (Denver Regional Council of Governments 2011).
Mid-Ohio Regional Planning Commission uses "Transit Ridership" to understand how to attract and retain a skilled work force (Mid-Ohio Regional Planning Commission 2012).

Literature or Guidance Documents

The **Nevada Department of Transportation** Planning Executive Group analyzes transit ridership alongside maintenance, and established a program to ensure that everything is running according to plan (Nevada Department of Transportation n.d.)

Relationship with Goal

Connectivity: This measure quantifies the number of transit riders per revenue mile. The number of people being served by transit services directly relates to how well the transit service is serving the public and connecting people with the destinations to which they desire to travel.

Congestion: This measure is indirectly related to congestion, as it provides a measure of availability of alternatives to travel in the private automobile.

Variations of the Measure / Alternatives to the measures

There are numerous variations of ridership metric, each of which is designed to provide insight into the effectiveness of the transit service and provides insight into how the frequency, route patterns, or service cost of transit service should be adjusted.

Ridership per Index of Transit Need Population- Adjusts ridership to account for "need" of the population served.

Weekday/Weekend Passenger Boardings – Count of the number of passengers that board transit, segmented by the time of boarding.

Seat Utilization – The proportion of transit seats that are occupied by passengers.

Boardings per Revenue Mile - Count of the number of paying passengers that board transit divided by the number of miles travelled by transit vehicles.

Boardings per Revenue Hour - Count of the number of paying passengers that board transit divided by the number of hours the vehicle is in operation, this includes the time from the bus yard to/from the route .

Annual Growth in Boardings from Base Year – Year over year change in transit riders relative to reference year.

Annual Growth in Boardings per Vehicle Trip from Base Year - Year over year change in transit riders divided by number of transit vehicle trips relative to reference year.

Annual Growth in Boardings per Mile from Base Year - Year over year change in transit riders divided by number of total miles transit vehicles travel relative to reference year.

References

(Armbruster 2010)
(Chicago Metropolitan Agency for Planning 2010)
(Chicago Metropolitan Agency for Planning 2013)
(City/County Association of Governments of San Mateo County 2015)
(Denver Regional Council of Governments 2011)
(Denver Regional Council of Governments 2016)
(Florida Department of Transportation n.d.)
(Metropolitan Transportation Commission n.d.)
(Mid-Ohio Regional Planning Commission 2011)
(Mid-Ohio Regional Planning Commission 2012)
(Mid-Ohio Regional Planning Commission 2016)
(Nevada Department of Transportation n.d.)
(Oregon Department of Transportation 2015)
(Sacramento Area Council of Governments 2016a)
(SACOG 2016b)
(San Francisco County Transportation Authority 2013b)
(Santa Barbara County Association of Governments 2016)
(Taylor & Fink 2003)
(Tennessee Department of Transportation 2016)
(Texas Transportation Institute 2013)
(Transit Cooperative Research Program 1998)
(Washoe Regional Transportation Commission 2013)

Transit Service Hours

Measure at a Glance	
Category: Connectivity **Subcategory***:* Transit	

Indicator Overview

Description

This indicator is the sum of the total number of hours that transit vehicles (e.g. bu*ses*, trains) are in-service. The measure does not include time that vehicles spend travelling to or from storage facilities, it is the hours in service for carrying passengers.

Human and Environmental Drivers

"Transit Service Hours" is a function of the decisions that transit operators make with regard to the number of vehicles in operation at a given time and length of service hours. Decisions with regard to hours of operations are generally balanced with ridership forecasts to minimize unnecessary operating costs. Increasing frequency and timeliness of transit during peak traffic hours can increase ridership and thus revenue.

Application

In the Basin

Tahoe Transportation District uses "Annual Growth in Service Hours from Base Year" and "Growth in Annual Service Hours per Resident from Base Year" to understand transit level of service and inform policy to increase transit service and connections throughout the Region (Tahoe Transportation District 2017).

External uses

Sacramento Area Council of Governments uses "Transit Service Hours", "Weekday Transit Service Hours", and "Increase in Daily Transit Vehicle Service Hours in Environmental Justice (low-income) Areas" to understand transit overall quality and equity (SACOG 2016a, 2016b).

Mid-Ohio Regional Planning Commission uses "Transit Service Hours" to understand how to attract and retain a skilled work force (Mid-Ohio Regional Planning Commission 2012).

Literature or Guidance Documents

No literature or guidance documents identified.

Relationship with Goal

Connectivity: Increases or decreases in "Transit Service Hours" is an indirect measure of transit connectivity. Increasing service hours allows for increased connectivity between transit riders and their destinations.

Operations: "Transit Service Hours" is a direct measure of the decisions transit operators make.

Resident Quality of Life: Increases or decreases in transit service hours impacts residents ability to travel to desired destinations. This measure relates to resident and visitor quality of life when Increasing service hours in low-income neighborhoods increases resident quality of life by providing increased mobility opportunities and decreased reliance on the private automobile where there may be lower vehicle ownership rates.

Environmental: Increased transit service hours decreases the reliance on the private automobile and may reduce emissions. Emissions reductions can improve air quality. may indirectly result from greater accessibility and direct, convenient transit routes to all residents.

Variations of the Measure / Alternatives to the measures

Weekday Transit Service Hours - Total number of service hours on Monday - Friday.

Annual Growth in Service Hours from Base Year- Change in service hours is expressed as year over year change in the number of service hours. Growth can also be calculated relative to the number of service hours in a base year.

Growth in Annual Service Hours per Resident from Base Year - The total number of service hours divided by the residential population of the area. Increase is expressed as year over year change the number of hours per resident.

Increase in Transit Service Hours in Low-income Areas - Number of services hours in neighborhoods identified as low income. Increase is expressed as year over year change in the number of service hours or relative to service in a base year.

References

(Giuliano 2005)

(Guihaire & Hao 2008)

("Los Angeles Public Transit" 2015)

(Mid-Ohio Regional Planning Commission 2011 p.)

(Mid-Ohio Regional Planning Commission 2012)

(Mid-Ohio Regional Planning Commission 2016 p.)

(SACOG 2016a)

(SACOG 2016b)

(Tahoe Transportation District 2017)

(Tennessee Department of Transportation 2016)

REFERENCES

Armbruster B. 2010. Factors Affecting Transit Ridership at the Metropolitan Level 2002-2007. Available from https://repository.library.georgetown.edu/bitstream/handle/10822/553638/armbrusterBrenda n.pdf;sequence=1.

California Center for Sustainable Energy. 2013. San Diego Regional Plug-in Electric Vehicle (PEV) Readiness Plan. Available from http://www.pevcollaborative.org/sites/all/themes/pev/files/docs/SD_PEV_Readiness_Plan_Mai n.pdf.

California Center for Sustainable Energy, San Joaquin Valley Air Pollution Control District. 2014. San Joaquin Valley Plug-in Electric Vehicle Readiness Plan. Available from https://energycenter.org/sites/default/files/docs/nav/programs/pev-planning/san-joaquin/san_joaquin_valley_pev_readiness_plan-web.pdf.

California Plug-in Electric Vehicle Collaborative. 2012. Accessibilty and Signage for Plug-in Electric Vehicle Charging Infrastructure. Available from http://www.pevcollaborative.org/sites/all/themes/pev/files/PEV_Accessibility_120827.pdf.

Carson Area Metropolitan Planning Organization. 2016. 2040 Regional Transportation Plan. Available from http://carson.org/home/showdocument?id=51018.

Chicago Metropolitan Agency for Planning. 2010. Go To 2040. Available from http://www.cmap.illinois.gov/documents/10180/17842/long_plan_FINAL_100610_web.pdf/1e1 ff482-7013-4f5f-90d5-90d395087a53.

Chicago Metropolitan Agency for Planning. 2013. Congestion Management Process Documentation. Available from http://www.cmap.illinois.gov/documents/10180/37082/CMP-Documentation_20121213_draftforRTOC.pdf/ab3dfa55-fdfa-48f4-98c9-f7c15e15d5d5.

Chicago Metropolitan Agency for Planning. 2015. Go To 2040 Update Appendix Indicator Methodology. Available from http://www.cmap.illinois.gov/documents/10180/332742/Update+Indicator+Methodology+FINA L.pdf.

City of Davis. 2009. Bicycle Plan. Available from http://cityofdavis.org/home/showdocument?id=1127.

City/County Association of Governments of San Mateo County. 2015. Final San Mateo County Congestion Management Program 2015. Available from http://ccag.ca.gov/wp-content/uploads/2016/02/2015-CMP_Final_rev.pdf.

CNT. 2017. AllTransit Metrics. Available from http://alltransit.cnt.org/metrics/ (accessed May 24, 2017).

Corelis DJ. 2015. Access California. Available from http://www.pevcollaborative.org/sites/all/themes/pev/files/DSA_EVCS%20Webinar%2009%20S ep%202015.pdf.

Denver Regional Council of Governments. 2011. 2035 Metro Vision Regional Transportation Plan. Available from https://drcog.org/sites/drcog/files/resources/2035%20MVRTP-2010%20Update%20with%20App%202-9_0.pdf.

Denver Regional Council of Governments. 2016. 2015 Annual Report on Traffic Congestion in the Denver Region. Available from https://drcog.org/sites/drcog/files/resources/2015%20Annual%20Traffic%20Congestion%20Rep ort_0.pdf.

Dill J. 2004. Measuring Network Connectivity for Bicycling and Walking. Available from http://reconnectingamerica.org/assets/Uploads/TRB2004-001550.pdf.
Environmental Correlates of Walking and Cycling: Findings From the Transportation, Urban Design, and Planning Literatures. 2003. Annals of Behavioral Medicine **25**:80–91.
Florida Department of Transportation. (n.d.). 2060 Florida Transportation Plan Scorecard. Available from http://www.fdot.gov/planning/performance/Scorecard.pdf.
Giuliano G. 2005. Low Income, Public Transit, and Mobility. Transportation Research Record: Journal of the Transportation Research Board **1927**:63–70.
Guihaire V, Hao J-K. 2008. Transit network design and scheduling: A global review. Transportation Research Part A: Policy and Practice **42**:1251–1273.
Knight R, Trygg L. 1977. Evidence of land use impacts of rapid transit systems. Transportation **6**. Available from http://link.springer.com/10.1007/BF00177453 (accessed May 24, 2017).
Los Angeles Public Transit. 2015. Available from http://www.discoverlosangeles.com/blog/los-angeles-public-transit (accessed May 24, 2017).
Maryland State Highway Administration. 2015. Bicycle Policy & Design Guidelines. Available from http://roads.maryland.gov/ohd2/bike_policy_and_design_guide.pdf.
Melaina M. 2003. Initiating Hydrogen Infrastructures: Preliminary Analysis of a Sufficient Number of Initial Hydrogen Station in the US. International Journal of Hydrogen Energy **28**:743–755.
Melaina M, Bremson J. 2008. Refueling Availability for Alternative Fuel Vehicle Markets: Sufficient Urban Station Coverage. Energy Policy **36**:3233–3241.
Metro. 2014. Regional Transportation Plan. Available from http://www.oregonmetro.gov/sites/default/files/RTP-2014-final.PDF.
Metropolitan Transportation Commission. 2005. Transit Connectivity Report. Available from http://mtc.ca.gov/sites/default/files/Transit_Connectivity_Report.pdf.
Metropolitan Transportation Commission. 2006. Transit Connectivity Plan. Available from http://www.reconnectingamerica.org/assets/Uploads/20060915mtcconnectivityplan.pdf.
Metropolitan Transportation Commission. (n.d.). Vital Signs. Available from http://www.vitalsigns.mtc.ca.gov/.
Mid-Ohio Regional Planning Commission. 2011. 2012 Metropolitan Transportation Plan. Available from http://www.morpc.org/trans/MTP_T-19-11_Att1_Objectives_Eval.pdf.
Mid-Ohio Regional Planning Commission. 2012. 2012 Metropolitan Transportation Plan Project Evaluation - Section lll: Detailed Project Evaluation Measures - Project by Project. Available from http://www.morpc.org/pdf/Section_III_freeway.pdf.
Mid-Ohio Regional Planning Commission. 2016. 2016-2040 Columbus Area Metropolitan Transportation Plan. Available from http://morpc.org/transportation/2016-2040-plan/index.
Minnesota Department of Transportation. 2017. Bicycle Path Design. Available from http://www.dot.state.mn.us/stateaid/bicycle.html.
National Association of City Transportation Officials. 2016. High-Quality Bike Facilities Increase Ridership and Make Biking Safer. Available from https://nacto.org/2016/07/20/high-quality-bike-facilities-increase-ridership-make-biking-safer/.
Nevada Department of Transportation. (n.d.). Planning Executive Group.
Oregon Department of Transportation. 2015. Annual Performance Progress Report (APPR) for Fiscal Year (2014-2015). Available from http://www.oregon.gov/ODOT/CS/PERFORMANCE/docs/ODOT%202015%20Annual%20Performance%20Progress%20Report.pdf.
Oregon Department of Transportation. 2017. Key Performance Measures. Available from http://www.oregon.gov/ODOT/CS/PERFORMANCE/Pages/PerformanceMeasureSummaries.aspx#Safety.

Parks JR, Schofer JL. 2006. Characterizing Neighborhood Pedestrian Environments with Secondary Data. Available from http://www.transportation.northwestern.edu/docs/research/Schofer_CharacterizingNeighborhoodPedestrianEnvironments.pdf.

Queensland Government Department of Transport and Main Roads. 2017, May 9. Cycling Benefits. Available from https://www.tmr.qld.gov.au/Travel-and-transport/Cycling/Benefits.aspx.

Riverside County Transportation Commission. 2011. 2011 Riverside County Congestion Management Program. Available from http://www.rctc.org/uploads/media_items/congestionmanagementprogram.original.pdf.

Rodrigue J-P, Comtois C, Slack B. 2013. The geography of transport systemsThird edition. Routledge, London ; New York.

SACOG. 2016a. Transportation Project-Level Performance Evaluation. Sacramento Area Council of Governments, Sacramento. Available from http://www.sacog.org/sites/main/files/file-attachments/6-mtp_scs_performance_eval_framwork.pdf.

SACOG. 2016b. Metropolitan Transportation Plan/ Sustainable Communities Strategy. Sacramento Area Council of Governments. Available from http://www.sacog.org/sites/main/files/file-attachments/mtpscs_complete.pdf.

San Francisco County Transportation Authority. 2013a. 2013 Congestion Management Plan. Available from http://www.sfcta.org/sites/default/files/content/Planning/CongestionManagementPlan/2013/CMPSF_2013_FINAL.pdf.

San Francisco County Transportation Authority. 2013b. MoveSmartSF San Francisco Transportation Plan 2040. Available from http://www.sfcta.org/documents-and-data/documents.

Santa Barbara County Association of Governments. 2016. Congestion Management Program. Available from http://www.sbcag.org/uploads/2/4/5/4/24540302/2016_congestion_management_program_doc_final.pdf.

Southworth M. 2005. Designing the Walkable City. Jounal of Urban Planning and Development **131**:246–257.

Tahoe Regional Planning Agency. 2017. Transportation Project List. Available from https://eip.laketahoeinfo.org/Project/TransportationList.

Tahoe Regional Planning Agency, Truckee Donner Public Utility District. 2017. Tahoe-Truckee Plug-in Electric Vehicle Readiness Plan. Available from http://tahoealternativefuels.com/wp-content/uploads/2017/05/Tahoe-Truckee_Plug-in_Electric_Vehicle_Readiness_Plan_2017.pdf.

Tahoe Transportation District. 2017. Draft Lake Tahoe Basin Transit Master Plan. Available from http://www.tahoetransportation.org/images/assets/2017-June-6_Final_Tahoe_TMP_reduced.pdf.

Taylor BD, Fink CNY. 2003. The Factors Influencing Transit Ridership: A Review and Analysis of the Ridership Literature. Available from http://www.reconnectingamerica.org/assets/Uploads/ridersipfactors.pdf.

Taylor BD, Miller D, Iseki H, Fink C. 2009. Nature and/or nurture? Analyzing the determinants of transit ridership across US urbanized areas. Transportation Research Part A: Policy and Practice **43**:60–77.

Tennessee Department of Transportation. 2016. 25-Year Transportation Policy Plan. Available from https://www.tn.gov/tdot/section/25-year-transportation-plan.

Texas Transportation Institute. 2013. The Nexus of Livability, Transit, and Performance Measurement. Available from https://tti.tamu.edu/group/transit-mobility/files/2013/05/CALACT-Conf-Jonathan-Brooks-Rural-Transit-Livability-Performance-FINAL-with-notes.pdf.

Toyota. 2017. Mirai Fuel Cell Vehicle. Available from https://ssl.toyota.com/mirai/fcv.html.

Transit Cooperative Research Program. 1998. Funding Strategies for Public Transportation, Volume 1. Available from https://books.google.com/books?id=Tc6_2AtpNXUC&pg=PT32&lpg=PT32&dq=transit+passengers+per+revenue+hour+measure&source=bl&ots=-AODncn2TN&sig=TKF84B1I2wMxkt_fS8Zp7i1yZkw&hl=en&sa=X&ved=0ahUKEwj1oo7Oqv_SAhXnslQKHYnfAnUQ6AEIQjAH#v=onepage&q=transit%20passengers%20per%20revenue%20hour%20measure&f=false.

United States Department of Energy. 2008. Plug-in Hybrid Electric Vehicle Charging Infrastructure Review. Available from https://avt.inl.gov/sites/default/files/pdf/phev/phevInfrastructureReport08.pdf.

United States Department of Energy. 2014. Americans with Disabilities Act Requirements for Workplace Charging Installation. Available from https://energy.gov/sites/prod/files/2015/11/f27/WPCC_complyingwithADArequirements_1114.pdf.

United States Department of Energy. 2015. Plug-in Electric Vehicle Deployment Policy Tools: Zoning, Codes, and Parking Ordinances. Available from https://www.afdc.energy.gov/bulletins/technology-bulletin-2015-08.html.

United States Department of Energy. 2017a. Alternative Fueling Station Locator. Available from https://www.afdc.energy.gov/locator/stations/results?fuel_type=ELEC&location=37.7829829%2C-122.4058287+(863+Mission+St%2C+San+Francisco%2C+San+Francisco+94103).

United States Department of Energy. 2017b. Case Studies. Available from https://www.afdc.energy.gov/case.

Washoe Regional Transportation Commission. 2013. 2035 Regional Transportation Plan. Available from https://www.rtcwashoe.com/mpo-projects/rtp/.