STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

TECHNICAL REPORT DOCUMENTATION PAGE

TR0003 (REV 10/98)

ADA Notice

For individuals with sensory disabilities, this document is available in alternate formats. For alternate format information, contact the Forms Management Unit at (916) 445-1233, TTY 711, or write to Records and Forms Management, 1120 N Street, MS-89, Sacramento, CA 95814.

1. REPORT NUMBER	2. GOVERNMENT ASSOCIATION NUMBER	3. RECIPIENT'S CATALOG NUMBER
CA16-2630		

4. TITLE AND SUBTITLE	5. REPORT DATE
Transit Performance Measures in California	April 2016
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR	8. PERFORMING ORGANIZATION REPORT NO.
Caroline Rodier, Ph.D. and Emily Issac	MTI Report 12-57
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. WORK UNIT NUMBER
Mineta Transportation Institute College of Business San José State University San José, CA 95192-0219	11. CONTRACT OR GRANT NUMBER DTRT12-G-UTC21
12. SPONSORING AGENCY AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
California Department of Transportation Division of Research, Innovation and Systems Information PO Box 94287, MS-83 Sacramento, CA 94273-0001	Final Report 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This research is the result of a California Department of Transportation (Caltrans) request to assess the most commonly available transit performance measures in California. Caltrans wanted to understand performance measures and data used by Metropolitan Planning Organizations (MPOs) and transit agencies to help it develop statewide measures. This report serves as a summary reference guide to help Caltrans understand the numerous and diverse performance measures used by MPOs and transit agencies in California. First, investigators review the available literature to identify a complete transit performance framework for the purposes of organizing agency measures, metrics, and data sources. Next, they review the latest transit performance measures documented in planning reports for the four largest MPOs in California (San Francisco Bay Area, Los Angeles, San Diego, and Sacramento). Researchers pay special attention to the transit performance measures used by these MPOs, because these measures are available for the majority of California's population. Finally, investigators summarize 231 performance measures used by a total 26 local transit agencies in the State of California, based on transit planning documents available on the internet.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
Transit performance measures; Transit data; Metropolitan Planning Organizations; Caltrans; Transit planning	No restrictions. This document is available to the public through The National Technical Information Service, Springfield, VA 22161.

19. SECURITY CLASSIFICATION *(of this report)*	20. NUMBER OF PAGES	21. COST OF REPORT CHARGED
Unclassified	57	

Reproduction of completed page authorized.

DISCLAIMER STATEMENT

This document is disseminated in the interest of information exchange. The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California or the Federal Highway Administration. This publication does not constitute a standard, specification or regulation. This report does not constitute an endorsement by the Department of any product described herein.

For individuals with sensory disabilities, this document is available in alternate formats. For information, call (916) 654-8899, TTY 711, or write to California Department of Transportation, Division of Research, Innovation and System Information, MS-83, P.O. Box 942873, Sacramento, CA 94273-0001.

MINETA TRANSPORTATION INSTITUTE

Transit Performance Measures in California

MTI Report 12-58

MINETA TRANSPORTATION INSTITUTE

MTI

MINETA TRANSPORTATION INSTITUTE

The Mineta Transportation Institute (MTI) was established by Congress in 1991 as part of the Intermodal Surface Transportation Equity Act (ISTEA) and was reauthorized under the Transportation Equity Act for the 21st century (TEA-21). MTI then successfully competed to be named a Tier 1 Center in 2002 and 2006 in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). Most recently, MTI successfully competed in the Surface Transportation Extension Act of 2011 to be named a Tier 1 Transit-Focused University Transportation Center. The Institute is funded by Congress through the United States Department of Transportation's Office of the Assistant Secretary for Research and Technology (OST-R), University Transportation Centers Program, the California Department of Transportation (Caltrans), and by private grants and donations.

The Institute receives oversight from an internationally respected Board of Trustees whose members represent all major surface transportation modes. MTI's focus on policy and management resulted from a Board assessment of the industry's unmet needs and led directly to the choice of the San José State University College of Business as the Institute's home. The Board provides policy direction, assists with needs assessment, and connects the Institute and its programs with the international transportation community.

MTI's transportation policy work is centered on three primary responsibilities:

Research

MTI works to provide policy-oriented research for all levels of government and the private sector to foster the development of optimum surface transportation systems. Research areas include: transportation security; planning and policy development; interrelationships among transportation, land use, and the environment; transportation finance; and collaborative labor-management relations. Certified Research Associates conduct the research. Certification requires an advanced degree, generally a Ph.D., a record of academic publications, and professional references. Research projects culminate in a peer-reviewed publication, available both in hardcopy and on TransWeb, the MTI website (http://transweb.sjsu.edu).

Education

The educational goal of the Institute is to provide graduate-level education to students seeking a career in the development and operation of surface transportation programs. MTI, through San José State University, offers an AACSB-accredited Master of Science in Transportation Management and a graduate Certificate in Transportation Management that serve to prepare the nation's transportation managers for the 21st century. The master's degree is the highest conferred by the California State University system. With the active assistance of the California Department of Transportation, MTI delivers its classes over a state-of-the-art videoconference network throughout the state of California and via webcasting beyond, allowing working transportation professionals to pursue an advanced degree regardless of their location. To meet the needs of employers seeking a diverse workforce, MTI's education program promotes enrollment to under-represented groups.

Information and Technology Transfer

MTI promotes the availability of completed research to professional organizations and journals and works to integrate the research findings into the graduate education program. In addition to publishing the studies, the Institute also sponsors symposia to disseminate research results to transportation professionals and encourages Research Associates to present their findings at conferences. The World in Motion, MTI's quarterly newsletter, covers innovation in the Institute's research and education programs. MTI's extensive collection of transportation-related publications is integrated into San José State University's world-class Martin Luther King, Jr. Library.

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the information presented herein. This document is disseminated under the sponsorship of the U.S. Department of Transportation, University Transportation Centers Program and the California Department of Transportation, in the interest of information exchange. This report does not necessarily reflect the official views or policies of the U.S. government, State of California, or the Mineta Transportation Institute, who assume no liability for the contents or use thereof. This report does not constitute a standard specification, design standard, or regulation.

REPORT 12-58

TRANSIT PERFORMANCE MEASURES IN CALIFORNIA

Caroline Rodier, Ph.D.
Emily Issac

April 2016

A publication of
Mineta Transportation Institute
Created by Congress in 1991

College of Business
San José State University
San José, CA 95192-0219

Copyright © 2016
by **Mineta Transportation Institute**
All rights reserved

Library of Congress Catalog Card Number:
2016939417

To order this publication, please contact:

Mineta Transportation Institute
College of Business
San José State University
San José, CA 95192-0219

Tel: (408) 924-7560
Fax: (408) 924-7565
Email: mineta-institute@sjsu.edu

transweb.sjsu.edu

042516

ACKNOWLEDGMENTS

The authors thank the Mineta Transportation Institute and the California Department of Transportation for funding this work. Thanks also for Dr. Richard Lee for his support of this research report. All errors are those of the authors.

The authors thank MTI staff, including Executive Director Karen Philbrick, Ph.D.; Publication Support Coordinator Joseph Mercado; Executive Administrative Assistant Jill Carter; and Editor and Webmaster Frances Cherman.

TABLE OF CONTENTS

Executive Summary **1**

I. Introduction **4**

II. Literature Review **5**

Data Sources 5

Performance Measures 9

III. California Metropolitan Planning Organizations **20**

General Findings 20

Southern California Association of Governments (SCAG) 22

San Diego Association of Governments (SANDAG) 24

Sacramento Area Council of Governments (SACOG) 25

Metropolitan Transportation Commission (MTC) 26

IV. California Transit Agencies **27**

V. Conclusion **30**

Appendix A: Description of Key National Transit Database (Performance Measure Data) **33**

Abbreviations and Acronyms **36**

Endnotes **37**

Bibliography **41**

About the Authors **44**

Peer Review **45**

LIST OF FIGURES

1. Transit Agencies: Frequency of Measures by Performance Categories 28

LIST OF TABLES

1. Service Availability 10
2. Service Delivery 11
3. Safety and Security 13
4. Community Impact 14
5. Maintenance 16
6. Financial Performance 18
7. Agency Administration 19
8. Consolidated MPO Measures and Metrics by MPO 21
9. SCAG Regional-Level Performance Analysis 22
10. SCAG Agency-Level Transit Measures 23
11. SCAG Regional Transportation Plan Transit Measures 23
12. SANDAG Transit Performance 25
13. SACOG Transit Performance 25
14. MTC Transit Performance 26
15. Frequency of Performance Measures by Category for Transit Agencies 29

EXECUTIVE SUMMARY

This research is the result of a California Department of Transportation request to assess the most commonly available transit performance measures in California. Caltrans wanted to understand the transit performance measures currently used by Metropolitan Planning Organizations (MPOs) and transit agencies to help develop its own. In sum, this report serves as a summary reference guide to help Caltrans understand the numerous and diverse performance measures used by MPOs and transit agencies in California.

The first phase of this research involved a review of the available transit performance measure guidance publications. The goal was to identify a complete framework (categories, example metrics, and data) within which to organize this review of California agency measures. The investigators found the Transportation Research Board's TCRP Report 88, *A Guidebook for Developing a Transit Performance-Measurement System* (TCRP, 2003)[1] to be consistent with and more comprehensive than other more recent and older published guidance documents. Researchers identified the following key transit performance measures for use in this report:

- Service Availability: Ease of transit access based on where (service coverage and/or stop accessibility), how often (frequency), and how long (hours of service) service is provided.

- Service Delivery: Quality of passengers' day-to-day experiences using transit, such as service reliability, quality of customer service, and passenger comfort.

- Safety and Security: Likelihood that an accident will occur involving passengers or that a passenger will become the victim of a crime while using transit. Examples include the rate of accidents per specified distance, the injury accidents per passenger-miles, and quantity of safety devices and personnel.

- Community Impact: Quality-of-life impacts on the communities served by transit such as mobility, job access, economic growth and productivity, personal finances, pollution reductions, and equitability of transit service.

- Financial Performance: How efficiently agencies use resources to meet travel demand within their budget constraints.

- Agency Administration: Administrative efficiency, including employee productivity, employee relations, workdays lost due to injury, and efficiency of service delivery (i.e., vehicle miles per employee or cost of administrative staff to operations staff).

Major sources of data for these performance measures include the following:

- In-house: Data that transit agencies normally have on hand through good record-keeping – for example, schedule data, system maps, service design standards, dispatch logs, maintenance records, operations logs, accident and incident records, financial data, fleet data, employee records, and complaint records.

- National Transit Database (NTD): Primary source for data, information, and statistics on the U.S. transit systems. Reporting required by those receiving Urbanized Area Formula Program (Section 5307) or Rural Area Formula Program (Section 5311) grants. Data examples include service area, agency information, fleet information, capital and operating funds, costs and expenses, maintenance, safety, service provided and consumed, and energy consumption.

- Other local, state, and federal agencies: Information on external factors that help evaluate the quality and location of transit service: demographic data, traffic data, GIS data, and transportation planning models.

  Automated systems: Technology that improves data accuracy and completeness, timeliness of reporting, and data collection costs: automatic vehicle location (AVL), train control systems, automatic passenger counters (APC), and electronic fareboxes.

Next, investigators examined the use of performance measures in recent reports and publications by the four major California metropolitan planning organizations (MPOs). The MPOs include:

- Southern California Association of Governments (SCAG);

- San Diego Association of Governments (SANDAG);

- Sacramento Area Council of Governments (SACOG);

- San Francisco Bay Area Metropolitan Transportation Commission (MTC).

The measures provided by these MPOs provide the most comprehensive and consistent source of transit performance measure data in California. In other words, these measures are available for a majority of the population of California and, as a result, Caltrans may be particularly interested in these measures as they consider the availability of data and the development of measures for the State of California.

The MPOs studied in this report together evaluate 40 different measures. Nearly half of the performance measures collected by the MPOs measure financial performance.

- Service Availability: All MPOs measured service availability – coverage by SANDAG, SCAG, and SACOG, frequency by SCAG and SANDAG, hours of service by SANDAG and SCAG, and stop accessibility by SANDAG stop accessibility.

- Service Delivery: SANDAG used several measures of service delivery, including missed trips, on-time performance, and passenger load, as well as a measure of passenger environment. SCAG used relative measures of auto and transit travel time.

- Community Impact: All MPOs measured community impacts. SANDAG used demographic data to evaluate service to low-income, elderly, and disabled populations; SCAG, SANDAG, and SACOG examined travel times and/or distance between

origin and destination locations; and SACOG included service equitability.

- Maintenance: SCAG examined the average age of the transit fleet.
- Financial Performance: All MPOs conducted numerous measures of financial performance – including ridership, productivity, cost-effectiveness, and cost-efficiency.
- Agency Administration: MTC included an administrative performance measure.

The last step of this project was to evaluate the most recent transit agency planning documents in California, based on an internet search. Investigators reviewed documents from 26 transit agencies, which, in total, included 231 performance measures. Researchers found that the most frequently measured category was financial and, within that category, that the top three measures were farebox recovery, passenger trips per vehicle revenue or service hours, and cost per vehicle revenue or service hour. Delivery was the next most frequent performance measure category, and its top measures were on-time performance, responsiveness to calls, number of complaints, and missed trips. Safety measures, such as accidents, crime, and injuries, were also evaluated by some agencies. Less frequently evaluated measures include availability, maintenance, and administrative measures.

Not surprisingly, it appears that when agencies have data they use that data to measure transit performance. The data mandated for National Transit Data, especially financial data, are commonly used to evaluate transit performance by both MPOs and transit agencies. Performance measures also seem to align with agency goals. Transit agency measures tend to focus more on issues related to customer service, whereas MPOs measures focus more on overall scope, location, quality, and equitability of transit service.

I. INTRODUCTION

This research is the result of a California Department of Transportations' (Caltrans) request to assess the most commonly available transit performance measures in California. Caltrans wanted to understand performance measures and data used by Metropolitan Planning Organizations (MPOs) and transit agencies to help them develop statewide transit performance measures. In sum, this report serves as a summary reference guide to help Caltrans understand the numerous and diverse performance measures used by MPOs and transit agencies in California. The report consists of three key elements:

1. A review of the available literature to identify a complete framework of the types of transit performance measures available for the purpose of organizing transit performance measures produced by California agencies and the sources of data available to calculate these measures.

2. A discussion of the latest transit performance measures for the four largest MPOs in California (San Francisco Bay Area, Los Angeles, San Diego, and Sacramento). Investigators paid special attention to the transit performance measures used by these MPOs, because these measures are available for the majority of California's population.

3. A summary of transit measures from 26 local transit agencies in the State of California based on a search of the internet for transit-planning documents.

II. LITERATURE REVIEW

Investigators reviewed the literature to develop a framework for organizing the numerous and diverse transit performance measures produced by California agencies. To this end, researchers searched the internet for sources that provided comprehensive transit performance frameworks. Research on new specific performance measures is outside of the scope of this project. Investigators found that the Transportation Research Board's TCRP Report 88, *A Guidebook for Developing a Transit Performance-Measurement System*[2] (hereafter TCRP Report 88) was consistent with frameworks in other publications and the most comprehensive work on the topic. As a result, that report is a major source for this literature review. The review included guidance from the Florida Department of Transportation,[3] *Best Practices in Evaluating Transit Performance* from the Colorado Department of Transportation,[4] a TRB conference report on the use of performance measures,[5] and a report on digital software tools for analyzing the National Transit Database.[6]

TCRP Report 88 identifies and provides a detailed summary of over 400 transit performance measures. The report narrows down its index of the 400 transit performance measures by providing recommended core performance measures and categories specific to fixed-route and demand-response services. As presented in section 2.2, these core performance measures and their categories have been adapted for the purposes of this report to provide a framework with which to organize the performance measures used by California agencies.

Based on the reviewed literature, the following sections provide guidance to agencies on the major data sources from which transit agencies can calculate performance metrics (section 2.1) and the major categories under which recommended performance measures and metrics fall (section 2.2). Note that these sections are drawn from TCRP 88 unless otherwise specified.

DATA SOURCES

TCRP Report 88 describes the major data sources from which transit agencies can access the data required to calculate various performance measures. These sources include:

- In-house data;
- National Transit Database;
- Other local, state, and federal agencies;
- Automated systems;
- Manual data collection;
- Surveys; and
- Safety reviews.

In-house data refer to the data that transit agencies normally have on hand through good record-keeping, such as operation logs and fleet data. Measures calculated using in-house data are attractive to many transit agencies because they require little investment of staff time or resources. Examples of in-house data include:

- Schedule data;
- System maps;
- Service design standards;
- Demand-responsive service dispatch logs;
- Maintenance records;
- Operations logs;
- Accident and incident records;
- Financial data;
- Fleet data;
- Employee records; and
- Complaint records.

The National Transit Database (NTD) is the primary source for data, information, and statistics on U.S. transit systems. Appendix A includes a description of the specific data contained in the NTD database. Congress uses the NTD to determine the annual allocation of federal transit funds. Any transit agency, state, or MPO that receives the Urbanized Area Formula Program (Section 5307) or Rural Area Formula Program (Section 5311) grants must report annual data to the NTD.[7] NTD includes "in-house" data on financial and service information from public transportation agencies. Financial data must be reported annually using accrual accounting and the Uniform System of Accounts. Under accrual accounting, agencies (1) record revenues when they earn them, regardless of whether they actually receive the revenue in the same fiscal year and (2) record expenses as soon as they owe an entity, whether or not they actually pay the funds for that expense within the same fiscal year (p. 31).[8] Financial data includes revenue ("the total amount of money earned during a transit agency's fiscal year," p. 28) and expenses ("the costs an agency incurs to provide transit services," p. 28).[9] Service data provides insight into the effectiveness and productivity of a transit agency (for example, all miles and hours vehicles travel). It is mandated that almost all service data collected is completely accurate and cannot be estimated.

The NTD is open to the public and available to transit agencies to measure the internal efficiency and effectiveness (i.e., passengers per revenue hour, passengers per vehicle mile, farebox recovery ratio, and cost per passenger).[10] Due to its uniformity, data from the

NTD is useful for comparing performance across different transit agencies. Examples of the kind of data available from the NTD include:

- Service area characteristics (e.g., area and population);
- Agency type;
- Number of vehicles operated in annual maximum service;
- Sources of, and uses for, capital funds;
- Sources of, and uses for, operating funds;
- Labor hours and cost data;
- Overall agency income and expenses;
- Fleet information;
- Rail and maintenance infrastructure data;
- Directional route miles by bus facility type;
- Safety and security incidents;
- Amount of service provided (e.g., vehicle miles, vehicle hours, and service days);
- Amount of service consumed (e.g., unlinked trips and passenger miles [PM]); and
- Energy consumption.

The Lehman Center for Transportation Research at Florida International University developed software for the Florida DOT to assist in analyzing NTD data and to help select and compare peer agencies.[11]

Other local, state, and federal agencies can supply information on external factors that help evaluate the quality and location of transit service. This data include:

- *Demographic data* that typically include employment, population, and housing. Analysts use this data to calculate performance measures related to the number of people by attributes (e.g., income and ethnicity) by type of location (e.g., medical, employment, and education). The U.S. Census Bureau, MPOs, and/or city planning departments typically produce this data. Data from the census and transportation demand models can have relatively small units of analysis. Analysts will typically aggregate this data to different geographic scales, which include and exclude areas with and without transit service. One example is the number of people by attribute of interest (e.g., low-income or environmental justice) located within a quarter mile of a bus stop.

- *Traffic data*, often available from local public works departments and state Department of Transportations (DOTs), include daily traffic volumes, traffic speeds, sidewalk inventories, traffic signal timing information, and the number of lanes provided on the streets. Local planning, community development, and public works departments may also have information on sidewalk inventory and peak-period traffic volumes. These data are useful for measures that include mobility, travel time, pedestrian and bicycle access to transit stops, and vehicle and person capacity of transit operations.

- *GIS Data* are often available from planning organizations that already use GIS software in their operations. These data are useful for spatially analyzing data for measures of service coverage, route coverage, and service density. Analysts use GIS data, for example, to calculate actual walking paths to transit stops.

- *Transportation planning models* (or travel demand models) typically use demographic and transportation data to forecast future travel patterns and demand. These models estimate the relative quantity and quality (i.e., travel time and cost) of transit and auto travel between specific areas of interest, and region-wide. This is another approach to evaluating the quality of transit service in a region. Such transit performance measures would use model data for a current calibrated base year. Similar measures are used to evaluate the future expected performance of regional transportation plans.

Automated systems help improve data accuracy and completeness, timeliness of reporting, and data collection costs.

- *Automatic Vehicle Location* (AVL) equipment tracks the real-time locations of AVL-equipped buses for dispatching. AVL collects and stores data about bus arrival and departure times at specified locations. Comparisons between scheduled and actual arrival and departure times can provide data for on-time performance measures.

- *Train Control Systems* maintain safe separations between trains, and provide data similar to that obtained from bus AVL systems. For instance, automatic train control systems that govern when doors open and close are coordinated with fixed- and moving-block signal systems to provide detailed dwell-time information.

- *Automatic Passenger Counters* (APC) automate the collection of passenger boarding and alighting data so that the number of people getting on and off at individual stops can be recorded. Useful data gathered through APC systems include:

  - Stop, route, and system-level ridership;

  - Maximum passenger loads and their locations;

  - How long standing loads occur during a trip; and

  - How often loads exceed a pre-determined level.

- *Electronic Fareboxes* can provide information on ridership and trip patterns by recording passenger boardings and linked trips (trips involving one or more transfers). If integrated with an AVL system, magnetic fare cards or "smart cards" generate data on individuals' transit travel. Electronic fareboxes that require an operator to press a button on the farebox as each passenger boards can result in errors if, for example, the operator fails to register a boarding, or presses the wrong button.

Manual Data Collection typically includes information on ridership and schedule reliability. Information collected may be less expensive to collect compared to that from automated systems, and is often sufficient for a small transit agency's purposes. While manual data collection is typically accurate, a limited number of collected samples can cause sampling errors wherein data collected on one day is not representative of conditions in general. The TCRP 88 report identifies three main types of manual data collectors:

- *Bus operators* record the number of people getting on and off at a particular location. This is typical for demand-responsive systems and for smaller fixed-route systems.

- *Traffic checkers* are staff that either ride transit vehicles or stand at a location and record data such as arrival times, passenger boarding and alighting volumes, passenger loads, and dwell times. Medium and large fixed-route systems may use traffic checkers.

- *Field supervisors* record the arrival time of transit vehicles to calculate on-time performance and headway regularity.

Customer Satisfaction Surveys help transit agencies identify customer needs and preferences. They are also used to evaluate how well the transit service meets these needs and preferences, and where improvements can be made.

Safety Reviews of vehicle maintenance are important to identify safety problems before they result in an incident.

Passenger Environment Surveys track the cleanliness and ride comfort of transit.

PERFORMANCE MEASURES

The performance measures listed in the tables below are from the TCRP Report 88's set of recommended core performance measures for fixed-route services (Chapter Five, p. 110).[12] This set represents recommended measures that all transit agencies, at a minimum, would ideally measure to cover all perspectives on their performance. The TCRP Report 88 divides these recommended measures into seven categories. The categories are as follows:

1. Service Availability

2. Service Delivery

3. Safety and Security

4. Community Impact

5. Maintenance

6. Financial Performance

7. Agency Administration

Information on each measure's metrics and data requirements are from the individual performance measure descriptions offered in Chapter 6 of the Guidebook. The page number next to each measure in the table indicates the page of the Guidebook on which a detailed description of the measure can be found. The letter superscripts indicate which of the four California MPOs examined in this report use the same measures in their own performance monitoring programs. The four MPOs examined are the Southern California Association of Governments (SCAG); the San Diego Association of Governments (SANDAG); the Sacramento Area Council of Governments (SACOG); and the San Francisco Bay Area Metropolitan Transportation Commission (MTC). The last column of the chart indicates the data source for the measure, based on the major types of data sources identified by the TCRP Report 88 on pages 130-140.[13]

Service availability measures assess the ease with which passengers can use transit services based on where (service coverage and/or stop accessibility), how often (frequency), and how long (hours of service) service is provided. Service availability is a very important measure because transit is only an option if it is easily available to passengers. Service availability measures typically require in-house data, such a trip schedule, hours of operation, and transit stop locations, along with GIS software for information on walking paths to transit stops and information on the number of streets and intersections within an area.

Table 1. Service Availability

Measure	Metrics	Data Requirements	Data Source
Service Coverage (p. 180)	% area served by transit [abc]	Transit stop locations Walking paths to transit stops	In-house GIS software
Frequency (p. 186)	Transit vehicles per hour [ac] Time intervals between transit vehicles (headway) [ac]	Scheduled Headways	In-house
Hours of Service (p. 187)	How long service is provided during a day, measured by LOS threshold (for example, A=19-24 hours/day, B=17-18 hours/day, C=14-16 hours/day, D=12-13 hours/day, E=4-11 hours/day, F=0-3 hours/day) [c]	Hours of operation	In-house

Table 1, continued

Measure	Metrics	Data Requirements	Data Source
Stop Accessibility (p. 184) (how easily pedestrians/ bicyclists can access a transit stop from locations in the stop's vicinity)	Pedestrian level of service Bicycle level of service Street crossing difficulty [c] % stops/stations ADA accessible [c] % of park-and-ride-lot spaces filled Network Connectivity Index: number of links (i.e., street segments between intersections), divided by number of nodes (i.e., intersections) in a roadway system	Traffic volumes Pedestrian/bicycle facility type/ width and distance between the facility and general traffic Detailed evaluation of conditions at/near a given stop (e.g., grades, lateral clearances, surface hardness, etc.) Number of parking spaces and counts in transit lots Information on the number of streets and intersections within an area	Local roadway agency or windshield survey; Outsourced evaluation; In-house information; Local roadway agency

SANDAG=a, SACOG=b, SCAG=c, MTC=d; Source: TCRP Report 88.

Service delivery measures evaluate the quality of passengers' day-to-day experiences using transit, such as service reliability, the quality of customer service from agency staff, and passenger comfort. Simple service delivery measures (number of missed trips, complaint rate, and customer response time) require only good record-keeping on the part of the transit agency, such as regularly updated incident and compliance logs. However, most measures tend to require large amounts of data, such as extensive manual or automated data collections and customer satisfaction or passenger environment surveys. For instance, to evaluate the rate at which transit vehicles depart or arrive at a location on time requires either field surveys by traffic checkers or automatic vehicle location data.

Table 2. Service Delivery

Measure	Metric	Data Requirements	Data Source
Missed Trips (p. 211)	Number of trips removed from the daily schedule [a]	Schedule Incidents/dispatch logs	In-house
Complaint rate (p. 218)	The number of passenger complaints or compliments per unit of time, passengers, or trips	Service hours Boardings, passengers Documented complaints and compliments	In-house
Route directness (p. 265)	Ratio of route length to the shortest-path length Additional travel time/ distance compared to an auto making the same trip Number of deviations	Transit travel time Auto travel time Number of deviations Productivity Distance between route and deviation target Population and employment	GIS software, In-house, Traffic Data

Table 2, continued

Measure	Metric	Data Requirements	Data Source
On-time performance (p. 206)	% transit vehicles departing or arriving at a location on time [a]	Field surveys or AVL data	Manual Data Collection, AVL Data
Customer response time (p. 221)	How quickly, customer inquiries are addressed	Date and time of inquiry and response	In-house Data
Passenger load (p. 230)	Passengers per seat [a] Number of passengers at the maximum load point %/number of trips with standees Maximum number of standees PMT (passenger miles traveled) per seat miles	Passenger counts Number of seats provided	Manual Data Collection or APC data, In-house Data
	Area per passenger	Passenger counts Vehicle dimensions	Manual Data Collection or APC data, In-house Data
	Standing time duration	Passenger counts Time information	Manual Data Collection or APC data, In-house Data
Reliability factor (p. 264)	% trips or travel time is no more than X% higher than average	Travel time/speed surveys or AVL data.	Manual Data Collection or AVL data
Transit/auto travel Time (p. 263)	Transit travel times vs. auto travel times [c]	Transit travel times (schedule data, AVL data, or field checks), auto travel times	In-house or AVL or Manual Data collection, Transportation Planning Models
Number of fare media sales outlets (p. 201)	% of daily trips made via fare card (e.g. MetroCard) purchased out-of-system	Records of sales outlets for transit fare media Information that tracks fare card serial numbers and use	In-house
Customer satisfaction (p. 227)	An overall rating of customer satisfaction with a transit agency's service (i.e., % customers "very satisfied")	Market research based on statistically appropriate sampling plans, questionnaires, and analysis designs	Customer Satisfaction Surveys
Headway regularity (p. 209)	Service regularity: % of headways deviate no more than a specified amount of the scheduled.	Field surveys (e.g., by traffic checkers) or AVL data.	Manual Data Collection or AVL data
Passenger environment (p. 225)	An overall rating of potential passenger satisfaction while riding transit, based on evaluations of cleanliness, customer information, equipment, and operators	Trained checkers sent to collect data; customer surveys on their perceptions of the various categories and indicators.	Manual Data Collection Customer Satisfaction Passenger Environment Survey
Customer loyalty (p. 229)	% "secure" or "vulnerable" transit customers, based on a customer loyalty score	Customer ratings of overall satisfaction, likelihood to continue use and to recommend	Customer Satisfaction Surveys

SANDAG=a, SACOG=b, SCAG=c, MTC=d; Source: TCRP Report 88.

Safety and security measures rate the likelihood that an accident will occur involving passengers or that a passenger will become the victim of a crime while using transit. Some examples of safety and security measures include the rate of accidents per specified distance and the injury accidents per passenger-miles. These measures only require in-house data, such as accident records and driver logs, and data recorded to the NTD, such as fatalities, injuries, and property damage. Transit agencies should note that comparisons of safety and security measures across different agencies might be difficult due to differences in reporting methods. Investigators found that safety and security measures were not represented in MPO data reviewed for this report, but that they are collected relatively frequently by transit agencies within MPO regions.

Table 3. Safety and Security

Measure	Metric	Data Requirement	Data Source
Accident rate (p. 276)	Number of accidents per specified distance or time	Accident records Odometers Driver logs	In-house Data
Incidents of vandalism (p. 287)	Total number of cited criminal activity directed against transit property	Police reports Repair records	In-house Data
Crime rate (p. 284)	Number of crimes against passengers, agency staff, or transit property per year	Crime reports	In-house Data
Number of vehicles with specified safety devices (p. 286)	Absolute number or % of vehicles equipped with specified safety devices such as security cameras, intercom systems, emergency alarms, and/or AVL equipment	Number of vehicles with specified devices Total number of vehicles in fleet	In-house Data
Passenger safety (p. 277)	Fatal accidents per PMT/VMT (vehicle miles traveled) Injury accidents per passenger-miles/ VMT Property-damage-only accidents per PMT/VMT	Recorded data on fatalities, injuries, and property damage	NTD
	Response time Incident/accident durations	Incident/accident reports from law enforcement and the state department of motor vehicles	Other local and state agencies
Police officers per transit vehicle (p. 285)	On-board police officers or security staff per transit vehicle	Number of transit police officers, number of transit vehicles	In-house Data

Source: TCRP Report 88.

Community impact measures deal with quality-of-life impacts on the communities served by transit – such as mobility, job access, economic growth and productivity, personal finances (i.e., savings that individuals derive from choosing to use transit instead of driving), and pollution reductions. Community impact measures also evaluate how equitably transit services are distributed to communities throughout the region. Many community impact measures require access to data from MPOs or city planning departments, such as demographic data on car ownership or per-mile cost of operating an automobile. These

measures likely require the use of GIS software and/or data from a regional transportation-planning model. The TCRP 88 strongly advises transit agencies to work in coordination with the local MPOs when developing community impact measures, and evaluating community impact measures annually or in association with a particular major transit project.

Table 4. Community Impact

Measure	Metric	Data Requirement	Data Source
Personal economic impact (p. 249)	% of household income used for transit Difference in transit and automobile out-of-pocket costs Average fare Average system user cost per trip	Average incomes Average trips by mode Average parking costs by area Transit fare Roadway toll Cost of operating a car	Census data, travel demand models
Demographics (p. 240)	% households without cars % population too young to drive % population with incomes under $X [a] % elderly/disabled [a]	Demographic information for certain areas Information on the areas served by transit agency	Census data
Communications (p. 251) (How well transit agencies communicate)	Number of residents with positive transit perceptions and with knowledge of transit service Information provision for persons with disabilities and non-English speakers	Community transit perceptions/knowledge Number of brochures in alternative formats/ languages Employee skills including languages	Surveys, In-house data

Table 4, continued

Measure	Metric	Data Requirement	Data Source
Mobility (p. 236) (The degree of ease of travel between origins and destinations)	Origin-destination travel times Average speed [a c] or travel time VMT [b] by congestion level Relative delay rate Roadway LOS or v/c ratios Corridor mobility/travel index Reliability	Travel time, speed, and VMT data by origin and destination	Surveys (O-D, home interview, roadside), In-house data, Traffic data
	Congestion burden index	% of workforce driving to work Travel time/speed studies Free-flow/acceptable-flow rates VMT or PMT for freeways/ arterials	Census Data, Traffic data from local roadway agency
	Transportation choice ratio	Hourly miles of transit service Number of lane-miles of highways/ arterials	NTD, Federal Highway Administration
Service equity (p. 244)	Examining those who benefit from the project or service and those who are worse off (at the micro-level) [b]	Households with no autos Population with physical disabilities, low-income single parents, people too young or old to drive, unemployed adults, and recent immigrants	GIS software, Labor statistics, Census, National Transportation Surveys, Focus groups, Interviews
Community economic impact (p. 247)	% state/regional gross product by transit Expenditures by mode, tax revenues from transit Cost of vehicle accidents Highway capacity Parking spaces in the absence of transit	Number of direct jobs in the transit industry in the area Estimated roadway onstruction project costs Tax revenue that is dedicated to transit	In-house data, MPOs, State and local taxing authorities

Table 4, continued

Measure	Metric	Data Requirement	Data Source
Environmental Impact (p. 256)	Transit-related air/water pollution per VMT/1,000 boardings/capita Air quality at transit stops/ stations/terminals vs. air quality in other areas Air/water pollution reduced with transit Surface area covered by transit facilities % population exposed to X% pollution	Emissions for transit vehicles Emission rates for current model year compared with the fleet average Air quality at transit stops, stations, and terminals Residents and workers near transit	Transit vehicle manufacturer Other agencies, i.e., MPOs or planning; GIS
Visual impact (p. 258)	"Legibility:" the ease with which a landscape's parts can be recognized and organized into a coherent pattern	Residents' perceptions and preferences Visual simulation Photo-realism	Surveys, case studies, sketches, GIS, virtual models

SANDAG=a, SACOG=b, SCAG=c, MTC=d; Source: TCRP Report 88.

Maintenance measures assess the quality and maintenance of an agency's vehicles, and how that quality and maintenance impacts passenger satisfaction with transit services. Maintenance measures help maintenance staff to run the maintenance department as efficiently as possible. These measures typically only require in-house data, such as maintenance records, fleet information, vehicle model information, and financial and operating data.

Table 5. Maintenance

Measure	Metric	Data Requirements	Data Source
Road calls (p. 289)	The number of unplanned revenue service road calls per specified distance or time	Maintenance records, vehicle miles	In-house
Average spare ratio vs. scheduled spare ratio (p. 294)	The % of the spare fleet actually available to substitute for other vehicles	Number of vehicles in maximum service, total fleet size; Number of vehicles available service/day	NTD; In-house
Fleet cleaning (p. 292)	% of fleet cleaned daily	Records of the number of vehicles cleaned each day or after trip, fleet size	In-house
Maintenance work orders (p. 291)	Total work orders per bus model/ to model buses; total orders/ total buses.	Maintenance records for each bus	In-house

Table 5, continued

Measure	Metric	Data Requirements	Data Source
Fleet Age (p. 216, 295, 296)	Average life of vehicle Average age of vehicle Average age of the transit fleet [c]	Average lifespan of vehicle components by vehicle model Date of component installation by vehicle Age of each vehicle in the fleet	In-house
Maintenance effectiveness (p. 321)	Mechanics per 1,000 revenue miles, open maintenance work orders, repeat repairs/breakdown per month, total labor hours spent on preventive maintenance vs. total labor hours	Financial and operating data	In-house
Fleet maintenance performance (p. 320)	VMT per gallon; maintenance labor cost/ VMT, material cost/ VMT, consumables cost/VMT, cost/VMT per bus model vs. fleet, and labor costs vs. material costs; average consumables cost/ bus model vs. fleet; value of parts/month vs. inventory	Financial and operating data; fleet data; energy consumption data	In-house; NTB

SANDAG=a, SACOG=b, SCAG=c, MTC=d; Source: TCRP Report 88.

Financial performance measures evaluate how efficiently agencies use resources to meet travel demand within their budget constraints. Financial performance measures are the most widely used measures of transit agencies, due in part to NTD reporting requirements – which require transit agencies to annually report data on measures such as ridership, farebox recovery ratio, and cost per revenue mile. However, many of the recommended financial performance measures require more complex data than that reported to the NTD, such as measures of ridership, which require automatic passenger counters or manual data collection on passenger boardings. While each transit agency must evaluate its financial performance, the TCRP 88 encourages agencies to quantify how much transit service benefits the community.

Table 6. Financial Performance

Measure	Metric	Data Requirements	Data Source
Ridership (p. 301)	Monthly system-wide boardings Daily linked trips [b c]	APC/AVL data Scheduling dispatch reports Driver logs	APC/AVL Data, Manual Data Collection
Productivity (p. 314)	Total passengers divided by total revenue or service hours [a b c d]	Driver logs AVL equipment Scheduling software	AVL, Manual Data Collection
Cost-effectiveness (p. 312)	Farebox recovery ratio [a b c d] Operating ratio Cost per passenger/PM [c d] Subsidy per passenger/PM Revenue per passenger/ PM Cost per capita	Financial and operating data	NTD
Cost-efficiency (p. 307)	Cost per vehicle hour [c d] Cost per vehicle mile Cost per vehicle trip [c]	Financial and operating statistics	NTD
Energy consumption (p. 306)	Gallons of fuel per vehicle revenue mile Electricity consumed per vehicle revenue mile	Financial and operating data Energy Consumption	NTD
Risk management (p. 325)	Vehicle liability losses General liability losses Property losses Workers compensation payments	Financial and insurance records	In-house data

SANDAG=a, SACOG=b, SCAG=c, MTC=d; Source: TCRP Report 88.

Agency administration measures indicate levels of administrative efficiency by evaluating employee productivity, employee relations, workdays lost due to injury, and efficiency of service delivery (i.e., vehicle miles per employee or cost of administrative staff to operations staff). Analysts calculate these measures with in-house data, such as financial, operating, and administrative records. While agency administration measures do not measure the system's ability to meet the needs of its customers, these measures succeed in determining how well an agency utilizes its resources to provide transit service.

Table 7. Agency Administration

Measure	Metric	Data Requirements	Data Source
% Positive Drug/Alcohol Tests (p. 278)	% positive drug/alcohol tests from agency staff in positions that can directly impact the safety of passengers and other employees	The number of people tested and the number of positive tests	Random drug testing
Employee productivity (p. 323)	Staff tardiness rate Staff absenteeism rate Pay-to-platform hours Total regular and overtime hours per month Overtime per person per week % overtime labor hours paid due to absences and backlogged work orders	Employee timecard information	In-house data
Employee relations (p. 324)	Staff turnover rate Number of employee suggestions/implemented Number/% employees trained Employee satisfaction	Employment records Suggestion program records Employee skills database	In-house data, Survey
Administrative performance (p. 319)	VMT/hours per employee [d] Cost/number of administrative staff to operations staff Labor hours per vehicle hour Passenger trips per employee	Access to a transit system's financial, operating and administrative records	In-house Data

SANDAG=a, SACOG=b, SCAG=c, MTC=d; Source: TCRP Report 88.

III. CALIFORNIA METROPOLITAN PLANNING ORGANIZATIONS

Researchers examined the use of performance measures by the four major California metropolitan planning organizations (MPOs) as part of this project, based on information from recent reports and publications found on MPO websites, which are made available to the public. The investigators reviewed system performance reports, regional and metropolitan transportation plans, and coordinated plans. This section presents findings from four major MPOs in California currently using performance measures as part of their transportation planning process. These MPOs include:

- Southern California Association of Governments (SCAG);
- San Diego Association of Governments (SANDAG);
- Sacramento Area Council of Governments (SACOG);
- San Francisco Bay Area Metropolitan Transportation Commission (MTC).

The measures provided by these MPOs provide the most comprehensive and consistent source of transit performance measure data in California. In other words, these measures are available for a majority of the population of California and, as a result, Caltrans may be particularly interested in these measures as it considers the availability of data and the development of measures for the State of California.

GENERAL FINDINGS

The MPOs studied in this report together evaluate 40 different measures as tabulated in Table 8. Nearly half of the performance measures collected by the MPOs measure financial performance. Financial performance is the only category of performance for which MPOs can collect uniform data on the transit agencies within their regions. Federal and state law requires that transit agencies report financial and operating information in order to apportion funding. Therefore, not only is financial and operating information easily accessible due to this reporting requirement, it is also uniform across the thousands of transit agencies in the country.

Table 8. Consolidated MPO Measures and Metrics by MPO

Category	Measure	Metrics	MPOs
Service Availability	Service Coverage	% transit-supportive area served by transit	SANDAG, SCAG, SACOG
		% jobs/housing/population with transit access	
		% new jobs near high-frequency transit	SACOG
		% new homes near high-frequency transit	
	Frequency	Time intervals between transit vehicles (headway)	SCAG
		% stops that have transit service within a specified timeframe(s)	SANDAG
		Minimum headways at or below an established threshold	
	Hours of Service	How long service is provided during a day, measured by LOS threshold (for example, A=19-24 hours/day, B=17-18 hours/day, C=14-16 hours/day, D=12-13 hours/day, E=4-11 hours/day, F=0-3 hours/day) [a c]	SANDAG, SCAG
	Stop Accessibility	Walking distance to bus stop	SANDAG
		% stops/stations ADA accessible	
Service Delivery	Missed Trips	Number of trips removed from the daily schedule	SANDAG
		% trips completed	
	On-Time Performance	% transit vehicles departing or arriving at a location on time	SANDAG
		% ADA trips with pickup in schedule window	
	Passenger Load	Average % seats occupied	SANDAG
	Transit-Auto Travel Time	Transit travel times vs. auto travel times	SCAG
		Overall transit travel times vs. overall travel time by auto	
	Passenger Environment	Occupancy on board vehicles by distance, speed, fare, and type of service	SANDAG
Community Impact	Demographics	Number of return trips provided per week to destinations from rural villages	SANDAG
		% bus stops and transit stations fully accessible to disabled populations in the region	
	Mobility	Average speed	SCAG, SANDAG
	Service Equitability	% minority and low-income census tracts with transit service vs. average level of service and amenities provided in nonminority census tracts	SANDAG
		Total homes in environmental justice areas near high-frequency transit	SACOG
Maintenance	Vehicle Age	The average age of the transit fleet	SCAG

Table 8, continued

Category	Measure	Metrics	MPOs
Financial Performance	Ridership	Total transit person trips	SCAG, SACOG
		Total daily trips	
		Per capita trips	
		% of weekday commute travel by transit	SACOG
	Productivity	Total passengers/boardings per total revenue/service hours	SCAG, SANDAG, SACOG, MTC
		Passengers per Vehicle Revenue Mile	SCAG, MTC
	Cost-effectiveness	Farebox recovery ratio	SCAG, SANDAG, SACOG, MTC
		Cost per passenger/PM	SCAG, MTC
	Cost-efficiency	Cost per vehicle hour	SCAG, MTC
		Cost per vehicle mile	SCAG
		Cost per vehicle trip	SCAG
Administration	Administrative performance	Revenue-vehicle hours per employee equivalent	MTC

SANDAG=a, SACOG=b, SCAG=c, MTC=d

SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS (SCAG)

SCAG encompasses six counties (Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura) and 191 cities in an area of more than 38,000 square miles. It divides its performance measurement into two levels of analysis – the regional level, and the agency level. Stakeholders in the Regional Transit Technical Advisory Committee identified regional-level measures, and the High-Speed Rail and Transit Subcommittee reviewed these measures;[14] see Table 9. The California Transportation Commission's 2010 *Regional Transportation Plan Guidelines* and the *TCRP Report 88: A Guidebook for Developing a Transit Performance Measurement System*[15] were used as sources to identify agency-level performance measures.

Table 9. SCAG Regional-Level Performance Analysis

Performance Measure	Metric
Ridership	Total Trips
	Per Capita Trips*
Service	Route Miles
	Vehicle Revenue Hours
	Vehicle Revenue Miles
Productivity	Passengers per Vehicle Revenue Hour
	Passengers per Vehicle Revenue Mile

Table 9, continued

Performance Measure	Metric
Costs	Cost per Vehicle Revenue Hour
	Cost per Passenger Trip
	Cost per PM

**Per Capita Trips are a key transit performance measure at SCAG because it indicates changes in transit demand that account for population growth. Source:* SCAG, *Transit System Performance Report – Fiscal Year 2011-12 (2015).*

SCAG analyzes regional metrics, which use data from the NTD, by constructing a 20-year time series dating back to 1992. This time series allows SCAG to understand trends and the changing nature of transit service provision and consumption over time in the region. All of the agency-level performance measures used by SCAG for FY 2011-2012 used data obtained from the NTD. See Tables 10 and 11.

Table 10. SCAG Agency-Level Transit Measures

Measure	Metrics
Cost Efficiency	Operating Cost per Vehicle Revenue Hour
Cost Effectiveness	Farebox Recovery
	Operating Cost per Passenger Trip
	Operating Cost per PM
Productivity	Passengers per Vehicle Revenue Hour
	Passengers per Vehicle Revenue Mile
Maintenance	Fleet Average Vehicle Age
Mobility/Travel Time	Average Vehicle Speed

Source: SCAG, *2012-2035 RTP Transit Appendixes* (2012, p. 10).

Table 11. SCAG Regional Transportation Plan Transit Measures

Performance Measure	Metric
Ridership	Per Capita Transit Trips
Availability	Frequency
	Span-of-Service
	Location of stops and stations
	Productivity (boardings per service hour)
Speed	Average speed by modal transit vs. average auto speed
	Overall transit travel times vs. overall travel time by auto (accounting for travel time to and from metro stations/bus stops on each end of the trip)
Costs and Revenues	Farebox recovery
	Costs per PM traveled
Accessibility	% of jobs, housing and population with available transit

Source: SCAG, *2012-2035 RTP Transit Appendixes (2012).*

SCAG also executed performance benchmarking to peer regions (New York-Newark-Bridgeport; Chicago-Naperville-Michigan City; Washington-Baltimore-Northern Virginia; Boston-Worcester-Manchester; San Jose-San Francisco-Oakland; Philadelphia-Camden-

Vineland; Houston-Baytown-Huntsville; Atlanta-Sandy Springs-Gainesville; Miami-Fort Lauderdale-Pompano Beach; and Detroit-Warren-Flint) to establish a frame of reference for the cost-effectiveness of current operations and to identify areas where other regions provide service at a lower cost. Performance benchmarking through peer comparison has become a new and popular method for evaluating performance due to the online availability of NTD data to gather information on individual transit agencies. SCAG looked at the following three measures in the peer comparison benchmarking analysis:

- Cost per Person Mile (PM) Traveled;
- Cost per Service Hour;
- System Productivity (passengers per hour by transit type).

SAN DIEGO ASSOCIATION OF GOVERNMENTS (SANDAG)

SANDAG represents 18 cities in the San Diego region. This region uses NTD data submitted to FTA for Transit Title VI on Low-Income and Minority Census Tracts, census data, regional travel demand model, and automatic data collection through the Regional Transit Management System, including automatic vehicle location and automatic passenger counters.[16] Table 12 includes a list of their performance measures. These objectives relate to the goals of the Regional Comprehensive Plan (RCP) or the Regional Transportation Plan (RTP), or they are tracked through the annual Transportation Development Act program.

SANDAG relies on the Regional Transit Management System (RTMS), which is an advanced management tool for providing real-time performance monitoring and reporting.[17] The RTMS uses data from AVL technology for real-time dispatch control and for real-time vehicle location to monitor on-time performance goals. Additionally, SANDAG utilizes the Passenger Counting Program (PCP), which provides stop-by-stop boarding and alighting information for weekday trips and a sampling of weekend trips. The PCP relies on manually collected data, but will soon use data from Automated Passenger Counters (APC). Currently, 48% of SANDAG vehicles are equipped with AVL, and 75% with APC. SANDAG has plans to advance its real-time transit data by integrating arterial (A-PeMS) and transit (T-PeMS) modules from the Caltrans Performance Measurement System (PeMS). A-PeMS collects and stores arterial data from roadway sensors. T-PeMS is a transit extension that uses APC and AVL, described above, to compute performance measures.

Table 12. SANDAG Transit Performance

Measure	Metric
Financial	Farebox Recovery
Productivity	Passengers per revenue-hour
	Average % of seats occupied
Access	Walking distance to bus stop (using GIS software)
	% "existing/planned" smart growth areas served by the minimum transit
	Number of return trips provided per week to destinations from rural villages
	% bus stops and transit stations fully accessible to disabled populations
Convenience	% stops that have transit service within a specified timeframe(s)
	Minimum headways (in minutes) that are at or below an established threshold
Reliability and Speed	% trips on time at departures, arrivals, and in-route timing points
	% trips completed
	% ADA trips with pickup within schedule window
	Average transit operating speed
Environmental Justice	% minority/low-income census tracts with transit vs. mean LOS non-minority*
Comfort	On-board occupancy suit distance, speed, fare, and type of service

** Level of Service (LOS); Non-minority is the population that does not include minorities, who include Black or African-Americans, Hispanics, Asian American or Pacific Islander, and American Indian or Alaskan Native. Source:* SANDAG, Coordinated Plan 2014-2018 (2014).

SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG)

The Sacramento Area Council of Governments covers 22 cities in the counties of El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba. The 2016-2036 Metropolitan Transportation Plan/Sustainable Communities Strategy[18] includes information on SACOG's performance measures. SACOG uses data provided by operators, State Controller Reports, and the NTD to evaluate their performance on the following performance measures presented in Table 13.[19]

Table 13. SACOG Transit Performance

Measures	Metrics
Ridership	Total transit person trips
	Transit person trips per capita
	% weekday commute travel by transit
Productivity	Passenger boardings per service hour
	Frequency of service
	Total daily trips
Financial	Transit costs recovered by ticket sales (%)
Service Coverage	Share of new jobs near high-frequency transit (% of new jobs)
	Share of new homes near high-frequency transit (% of new homes)
Community Economic Impact	Total homes in environmental justice areas near high-frequency transit (% of homes)

Source: SACOG, 2016-2036 Metropolitan Transportation Plan/Sustainable Communities Strategy (2015).

METROPOLITAN TRANSPORTATION COMMISSION (MTC)

MTC is the transportation planning, coordinating, and financing agency for the nine counties in the San Francisco Bay Area. As described in the MTC *Statistical Summary 2014*,[20] the MTC collects the performance measures listed in Table 14. The data used to evaluate transit performance with these measures includes transit operators' annual Transportation Development Act claim for funds, the NTD, State Controllers' reports, and other "in-house" data from individual transit agencies as requested by MTC.

Table 14. MTC Transit Performance

Measure	Metric
Cost efficiency	Operating cost per revenue-vehicle hour
Cost effectiveness	Operating cost per passenger
Service effectiveness	Passengers per revenue-vehicle hour
	Passengers per revenue-vehicle mile
Labor efficiency	Revenue-vehicle hours per employee equivalent
Final	Ratio of fares received to total operating cost

Source: MTC, Statistical Summary (2015).

IV. CALIFORNIA TRANSIT AGENCIES

Investigators identified transit agency planning documents developed from 2010 to 2015 from internet searches. The list of transit agencies in California found in the NTD was a helpful reference for identifying reports with transit performance measures. The scope of the research project did not include the analysis of performance measures from all California transit agencies. Agencies that had developed performance measures but did not evaluate transit performance were not included in this report. Researchers compiled a list of performance measures from the following agencies, using their most recent reports (see date):

- Antelope Valley Transit Authority[21]
- Caltrain[22]
- City of Davis[23]
- City of Lodi[24]
- Fairfield and Suisun Transit[25]
- Foothill Transit[26]
- Fresno Council of Governments[27]
- Golden Gate[28]
- San Joaquin Regional Transit District[29]
- Livermore Amador Valley Transit Authority[30]
- Los Angeles County Metropolitan Transportation Authority[31]
- Marin Transit[32]
- Mendocino Transit Authority[33]
- Modoc County Transportation Commission[34]
- Napa County Transportation and Planning Agency[35]
- Petaluma Transit[36]
- Placer County Transportation Planning Agency[37]
- Riverside Transit Agency[38]
- Sacramento Regional Transit[39]

- San Mateo County Transit District[40]
- San Francisco Municipal Transportation Agency[41]
- Solano Transportation Authority[42]
- Transit Joint Powers Authority for Merced County[43]
- Union City Transit[44]
- Visalia Transit[45]
- Western Placer Consolidated Transportation Services Agency[46] (2011)

Figure 1 shows the frequency of performance measures used by transit agencies by performance measure category. The most frequent measures are in the financial category, followed by the delivery category – and then maintenance, availability, and administration.

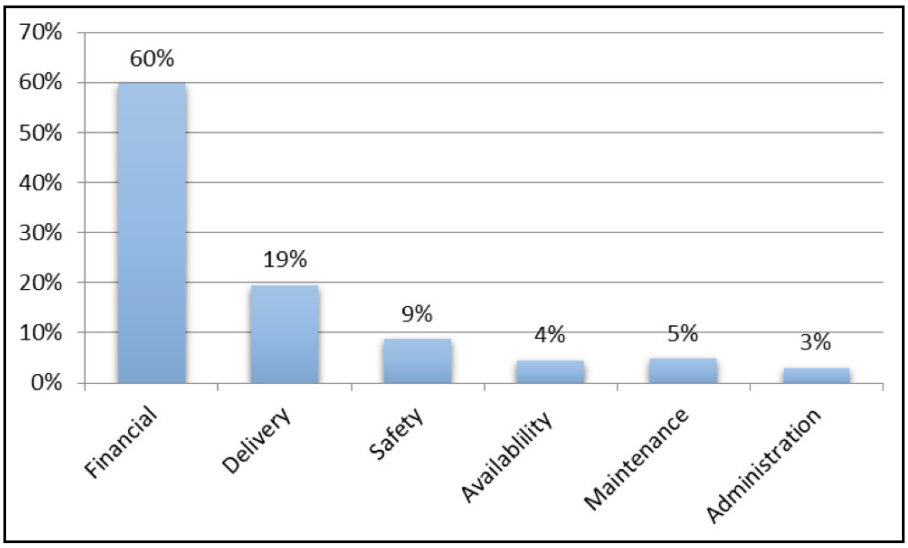

Figure 1. Transit Agencies: Frequency of Measures by Performance Categories (N=231)

Table 15 documents the specific measures within each category, as well as the frequency of use. Investigators saw a wide range of measures within the financial category, which largely uses NTD data. The most common measures in the financial category are farebox recovery, passenger trips per vehicle revenue or service hours, and cost per vehicle revenue or service hours. The most common measures for delivery are on-time performance, responsiveness to calls, and number of complaints. For safety, number of accidents, crimes, and injuries are the most typical measures. The measures used for availability include proximity to bus stops and frequency of service.

Table 15. Frequency of Performance Measures by Category for Transit Agencies (N=231)

Measures	Metrics	Frequency	Percent
Financial (N=138)	Farebox Recovery	32	23%
	Passenger Trips/Vehicle Revenue or Service Hours	24	17%
	Cost/Vehicle Revenue or Service Hours	21	15%
	Passenger Trips/Vehicle Revenue or Service Miles	13	9%
	Cost/Passenger Trips	13	9%
	Subsidy	10	7%
	Mean Fare	8	6%
	Passenger Trips/Week or Month	4	3%
	Cost/Vehicle Revenue or Service Miles	7	5%
	Vehicle Revenue Mile/Vehicle Revenue Hour	2	1%
	Passenger Miles/Vehicle Revenue or Service Miles	1	1%
	Cost/Passenger Miles	1	1%
	Energy/Vehicle Revenue or Service Miles	2	1%
Delivery (N=45)	On-Time Performance	10	22%
	Responsiveness to Calls	8	18%
	Complaints	9	20%
	Service Calls	5	11%
	Missed Trips	5	11%
	Load Factor	4	9%
	Timed Transfers	2	4%
	Transit Travel Times	2	4%
Safety (N=20)	Accidents	14	70%
	Crime	3	15%
	Injuries/Passenger Trips	2	10%
	Training	1	5%
Availability (N=10)	Proximity to Bus Stops	7	70%
	Frequency	3	30%
Maintenance (N=11)	Maintenance	9	82%
	VMT/Service Interruption	2	18%
Administrative (N=7)	Performance	4	57%
	Hours of Training	1	14%
	Employee Productivity	1	14%
	Employee Relations	1	14%

V. CONCLUSION

The first phase of this research involved a review of the available transit performance measure guidance publications. The goal was to identify a complete framework (categories, example metrics, and data) within which to organize this review of California agency measures. Investigators found the Transportation Research Board's TCRP Report 88, *A Guidebook for Developing a Transit Performance-Measurement System* (TCRP, 2003) to be consistent with and more comprehensive than other published guidance documents. Researchers identified the following key transit performance measures for use in this report:

- Service Availability: Ease of transit access based on where (service coverage and/or stop accessibility), how often (frequency), and how long (hours of service) service is provided.

- Service Delivery: Quality of passengers' day-to-day experiences using transit, as manifested in such categories as service reliability, quality of customer service, and passenger comfort.

- Safety and Security: Likelihood that an accident will occur involving passengers, or that a passenger will become the victim of a crime while using transit. Examples include the rate of accidents per specified distance, the injury accidents per passenger-miles, and quantity of safety devices and personnel.

- Community Impact: Quality-of-life impacts on the communities served by transit, such as mobility, job access, economic growth and productivity, personal finances (i.e., savings that individuals derive from choosing to use transit instead of driving), pollution reductions, and equitability of transit service.

- Financial Performance: How efficiently agencies use resources to meet travel demand within their budget constraints.

- Agency Administration: Efficiency, including employee productivity, employee relations, workdays lost due to injury, and efficiency of service delivery (i.e. vehicle miles per employee, or cost of administrative staff to operations staff).

Major sources of data for these performance measures include the following:

- In-House: Data that transit agencies normally have on hand through good record-keeping– for example, schedule data, system maps, service design standards, dispatch logs, maintenance records, operations logs, accident and incident records, financial data, fleet data, employee records, and complaint records.

- National Transit Database (NTD): Primary source for data, information, and statistics on the U.S. transit systems. Reporting required by those receiving Urbanized Area Formula Program (Section 5307) or Rural Area Formula Program (Section 5311) grants. Data examples include service area, agency information, fleet information, capital and operating funds, costs and expenses, maintenance, safety, service provided and consumed, and energy consumption.

- Other local, state, and federal agencies: Information on external factors that help evaluate the quality and location of transit service – demographic data, traffic data, GIS data, and transportation-planning models.

- Automated systems: Technology that improves data accuracy and completeness, timeliness of reporting, and data collection costs – automatic vehicle location (AVL), train control systems, automatic passenger counters (APC), and electronic fareboxes.

Next, researchers examined the use of performance measures in recent reports and publications by the four major California metropolitan planning organizations (MPOs). These MPOs include:

- Southern California Association of Governments (SCAG);

- San Diego Association of Governments (SANDAG);

- Sacramento Area Council of Governments (SACOG); and

- San Francisco Bay Area Metropolitan Transportation Commission (MTC).

The measures provided by these MPOs provide the most comprehensive and consistent source of transit performance measure data in California. In other words, these measures are available for a majority of the population of California and, as a result, Caltrans may be particularly interested in these measures as they consider the availability of data and the development of measures for the State of California.

The MPOs studied in this report together evaluate 40 different measures. Nearly half of the performance measures collected by the MPOs measure financial performance.

- Service Availability: All MPOs measured service availability – coverage by SANDAG, SCAG, and SACOG, frequency by SCAG and SANDAG, hours of service by SANDAG and SCAG, and stop accessibility by SANDAG.

- Service Delivery: SANDAG used several measures of service delivery, including missed trips, on-time performance, and passenger load, as well as a measure of passenger environment. SCAG used relative measures of auto and transit travel time.

- Community Impact: All MPOs measured community impacts – SANDAG used demographic data to evaluate service to low-income, elderly, and disabled populations; SCAG, SANDAG, and SACOG examined travel times and/or distance between origin and destination locations; and SACOG included service equitability.

- Maintenance: SCAG examined the average age of the transit fleet.

- Financial Performance: All MPOs conducted numerous measures of financial performance – including ridership, productivity, cost-effectiveness, and cost-efficiency.

- Agency Administration: MTC included an administrative performance measure.

The last step in this research was to evaluate the most recent transit agency planning documents in California based on an internet search. Investigators reviewed documents from 26 transit agencies – which included 231 performance measures. Researchers discovered that the most frequently measured category was financial and, within that category, the top three measures were farebox recovery, passenger trips per vehicle revenue or service hours, and cost per vehicle revenue or service hour. Delivery was the next most frequent performance measure category, and its top measures were on-time performance, responsiveness to calls, number of complaints, and missed trips. Safety measures, such as accidents, crime, and injuries, were also evaluated by some agencies. Less frequently evaluated measures included availability, maintenance, and administrative measures.

Not surprisingly, it appears that when agencies have data they use that data to measure transit performance. The data mandated for National Transit Data, especially financial data, are commonly used to evaluate transit performance by both MPOs and transit agencies. Performance measures also seem to align with agency goals. Transit agency measures tend to focus more on issues related to customer service, whereas MPO measures focus more on overall scope, location, quality, and equitability of transit service.

APPENDIX A: DESCRIPTION OF KEY NATIONAL TRANSIT DATABASE (PERFORMANCE MEASURE DATA)

Appendix A describes the data available from the 2014 National Transit Database (2015) Office of Budget and Policy, Federal Transit Administration, U.S. Department of Transportation.

Category	Data Labels
Transit Agency Information	State
	Organization Type
	Transit Agency Name
	Urbanized Area
	Urbanized Area Population
	Service Area Square Miles
	Month Fiscal Year Ends
	Transit Mode
	Service Type
	Vehicles Operated in Annual Maximum Service (VOMs)
Fleet Size	Vehicles Operated in Maximum Services: Directly Operated & Purchased Transportation
Operating Funds	State Funds: General Revenue & Dedicated and Other
	Local Funds: General Revenue & Dedicated and Other
	Federal Funds: FTA Urbanized Area Formula Funding & Other
	Directly Generated Funds: Directly Operated Fare Revenues, Purchased Transportation Fare Revenues, Other Revenues, & Dedicated and Other
Federal Government Sources for Transit Operating Funds Applied	Urbanized Area Formula Program Funds: Eligible Operating Assistance & Capital Assistance Spent on Operations
	Capital Program Funds
	Transportation Bill (e.g., MAP21) Funds
	Other FTA Funds: Eligible Operating Assistance & Capital Assistance Spent on Operations
	Funds Received from Other USDOT Grant Programs
	Other Federal Funds
Transit Capital Funds Applied – Summary and Federal Sources	Directly Generated Funds: Dedicated Taxes, Tolls, and Others & Other Directly Generated Funds
	State Funds: Funds Allocated out of General Revenue, Dedicated Taxes, Tolls, and Others, & Total State Funds
	Local Funds: Funds Allocated out of General Revenue & Dedicated Taxes, Tolls and Others
	Federal Funds: Capital Program, Urbanized Area Formula, MAP-21, Other FTA, Other USDOT, & Other Federal
Capital Funds Applied by Type of Expenditure	Guide Way
	Stations
	Administrative Buildings
	Facilities
	Rolling Stock
	Other Vehicles
	Fare Revenue Collection Equipment
	Systems
	Other

Table continued

Category	Data Labels
Transit Operating Expenses by Mode, Type of Service and Function	Vehicle Operations Vehicle Maintenance Non-Vehicle Maintenance General Administration
Transit Operating Expenses by Mode, Type of Service and Object Class	Operators Wages Other Salaries & Wages Fringe Benefits Services Materials and Supplies: Fuel and Lube & Tires and Other Utilities Casualty and Liability
Revenue Vehicle Maintenance Performance	Revenue Service Interruptions: Major Mechanical Failure, Other Mechanical Failure & Total Revenue System Mechanical
Energy Consumption	Diesel Gasoline Liquefied Petroleum Gas Liquefied Natural Gas Methanol Ethanol Bunker Fuel Compressed Natural Gas Kerosene Hydrogen Biodiesel Other Fuel Electric Propulsion Electric Battery
Employee Work Hours and Employee Counts	Employee Work Hours: Vehicle Operations, Maintenance (Vehicle and Non-Vehicle), General Administration, Capital Actual Employee Count: Vehicle Operations, Maintenance (Vehicle and Non-Vehicle), General Administration, Capital
Transit Operating Statistics: Service Supplied	Annual Scheduled Vehicle Revenue Miles Annual Vehicle Miles Annual Vehicle Revenue Miles Annual Vehicle Hours Annual Vehicle Revenue Hours
Transit Operating Statistics: Service Consumed	Unlinked Passenger Trips Passenger Miles
Transit Operating Statistics: Service Supplied and Consumed – Train Statistics – Rail Modes	Number of Trains in Operation (Average Week Day) Annual Train Miles Annual Train Revenue Miles Annual Train Hours Annual Train Revenue Hours
Maintenance Facilities	General Purpose Vehicles General Purpose Facilities Heavy Maintenance Facilities

Table continued

Category	Data Labels
Transit Way Mileage – Rail Modes	Track Miles by Type
	Number of Crossings
	Directional Route Miles
Transit Way Mileage – Non-Rail Modes	Lane Miles by Type
	Directional Route Miles by Type
Age Distribution of Active Vehicle Inventory	Active Vehicles By Age Grouping (in Years)
	Total Active Fleet
	Average Age of Fleet (in Years)
Fare per Passenger and Recovery Ratio	Fare Revenues Earned
	Total Operating Expenses
	Unlinked Passenger Trips
	Fare Revenues per Unlinked Passenger Trip
	Fare Revenues per Total Operating Expense (Recovery Ratio)
Service Supplied and Consumed Ratios: Operating Expenses	per Vehicles Operated in Maximum Service
	per Vehicle Hour
	per Unlinked Passenger Trip
	per Passenger Mile
	per Employee Work Hour
Funds Earned from State Taxes Dedicated at their Source to Transit	Income Taxes
	Sales Taxes
	Property Taxes
	Gasoline Taxes
	Other Taxes
Funds Earned from Local Taxes Dedicated at their Source to Transit	Income Taxes
	Sales Taxes
	Property Taxes
	Gasoline Taxes
	Other Taxes
Statement of Finances	Cash and Receivable
	Investments
	Special Funds
	Other Assets
	Long-Term Debt
	Term Pension Liabilities
	Other Estimated Liabilities
	Other Liabilities

ABBREVIATIONS AND ACRONYMS

ADA	Americans with Disabilities
APC	Automatic Passenger Counters
A-PeMS	Arterial Performance Measurement System
AVL	Automatic Vehicle Location
Caltrans	California Department of Transportation
GIS	Geographic Information System
LOS	Level of Service
MPO	Metropolitan Transportation Agency
MTC	San Francisco Bay Area Metropolitan Transportation Commission
NTD	National Transit Database
PCP	Passenger Counting Program
PeMS	Performance Measurement System
PM	Passenger Miles
PMT	Passenger Miles Traveled
RTP	Regional Transportation Plan
RCP	Regional Comprehensive Plan
RTMS	Regional Transit Management System
SACOG	Sacramento Area Council of Governments
SANDAG	San Diego Association of Governments
SCAG	Southern California Association of Governments
T-PeMS	Transit Performance Measurement System
TCRP	Transit Cooperative Research Program
VMT	Vehicle Miles Traveled
V/C	Volume to Capacity

ENDNOTES

1. Ryus, Paul. *A Guidebook for Developing a Transit Performance-Measurement System*. Report no. 88. TCRP g-06. Washington, D.C.: Transportation Research Board of the National Academies, 2003. Accessed November 28, 2015. http://www.trb.org/Publications/Blurbs/152127.aspx.

2. Ibid.

3. Florida Department of Transportation. *Best Practices in Evaluating Transit Performance*. N.p.: Florida Department of Transportation, 2014. Accessed December 3, 2015. http://www.dot.state.fl.us/transit/Pages/BestPracticesinEvaluatingTransitPerformanceFinalReport.pdf.

4. Colorado Department of Transportation. *Establishing a Framework for Transit and Rail Performance Measures*. Division of Transit and Rail, Colorado Department of Transportation. December 2012. https://www.codot.gov/programs/transitandrail/resource-materials-new/fhu-s-performance-measures-report.

5. Pickrell, Steven, and Lance Neumann. "Use of Performance Measures in Transportation Decision Making." In *Implementing Performance Measurement in Transportation Agencies*, compiled by H. Kassoff, 17–33. Transportation Research Board Conference Proceedings 26. 2001. Accessed December 6, 2015. http://onlinepubs.trb.org/onlinepubs/conf/reports/cp_26.pdf.

6. Gan, Albert, Feng Gui, and Li Tang. "System for Transit Performance Analysis Using the National Transit Database." *Journal of Public Transportation* 14, no. 3 (November 2011): 87–107. Accessed December 3, 2015. http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1131&context=jpt.

7. Florida Department of Transportation. *Best Practices in Evaluating Transit Performance*. N.p.: Florida Department of Transportation, 2014. Accessed December 3, 2015. http://www.dot.state.fl.us/transit/Pages/BestPracticesinEvaluatingTransitPerformanceFinalReport.pdf.

8. Ryus, Paul. *A Guidebook for Developing a Transit Performance-Measurement System*. Report no. 88. TCRP g-06. Washington, D.C.: Transportation Research Board of the National Academies, 2003. Accessed November 28, 2015. http://www.trb.org/Publications/Blurbs/152127.aspx.

9. Ibid.

10. Gan, Albert, Feng Gui, and Li Tang. "System for Transit Performance Analysis Using the National Transit Database." *Journal of Public Transportation* 14, no. 3 (November 2011): 87–107. Accessed December 3, 2015. http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1131&context=jpt.

11. Ibid.

12. Ryus, Paul. *A Guidebook for Developing a Transit Performance-Measurement System*. Report no. 88. TCRP g-06. Washington, D.C.: Transportation Research Board of the National Academies, 2003. Accessed November 28, 2015. http://www.trb.org/Publications/Blurbs/152127.aspx.

13. Ibid.

14. Southern California Association of Governments. *Transit Appendix: 2012–2035 Regional Transportation Plan/Sustainable Communities Strategy*. N.p.: Southern California Association of Governments, 2012. Accessed November 28, 2015. http://rtpscs.scag.ca.gov/Documents/2012/final/SR/2012fRTP_Transit.pdf.

15. ———. *Transit System Performance Report FY2011–2012*. Transit System Performance Report. Los Angeles, CA: Southern California Association of Governments, 2015. Accessed December 2, 2015. http://scag.ca.gov/Documents/FY2011_2012_System_Performance_Report.pdf.

16. San Diego Association of Governments. *Coordinated Plan 2014–2018*. San Diego, CA: San Diego Association of Governments, 2014. Accessed November 29, 2015. http://www.sandag.org/uploads/publicationid/publicationid_1868_17892.pdf.

17. Ibid.

18. Sacramento Area Council of Governments. *2016 Metropolitan Transportation Plan/Sustainable Communities Strategy*. Sacramento, CA: Sacramento Area Council of Governments, 2015. Accessed November 28, 2015. http://sacog.org/mtpscs/2016-draft-mtpscs/.

19. Ibid.

20. Metropolitan Transportation Commission. *Statistical Summary of Bay Area Transit Operators: Fiscal Years 2009-10 through 2013-14*. Oakland, CA: Metropolitan Transportation Commission, 2015. Accessed November 28, 2015. http://files.mtc.ca.gov/pdf/StatSumm_2014.pdf.

21. Antelope Valley Transit Authority. *Business Plan and Short Range Transit Plan FY 2014*. 2013. PDF.

22. Caltrain. *Short Range Transit Plan 2015–2024*. 2015. PDF.

23. City of Davis. *Short Range Transit Plan 2015–2021*. 2014. PDF.

24. City of Lodi Transit Division, and MV Transportation, Inc. *Short Range Transit Plan 2005-2009*. 2005. PDF.

25. Fairfield and Suisun Transit. *Short Range Transit Plan 2012/13–2022/23*. 2013. PDF.

26. Foothill Transit. *Business Plan and Budget 2014–2015 Proposed*. 2014. PDF.

27. City of Fresno. *Short Range Transit Plan 2016–2020*. 2015. PDF.

28. Golden Gate, Highway, and Transportation District. *Short Range Transit Plan 2014–2024*. 2015. PDF.

29. San Joaquin Regional Transit District. *Short Range Transit Plan 2014–2018*. 2013. PDF.

30. Livermore Amador Valley Transit Authority. *Final Mini-Short Range Transit Plan 2010 to 2019*. 2010. PDF.

31. Los Angeles County Metropolitan Transportation Authority. *2012 Metro Transit Service Policy*. N.p.: Los Angeles County Metropolitan Transportation Authority, 2012. Accessed November 28, 2015. http://media.metro.net/images/service_changes_transit_service_policy.pdf.

32. Marin Transit. *Short Range Transit Plan 2011/12–2020/21*. 2012. PDF.

33. Mendocino Transit Authority. *2012–16 Short Range Transit Development Plan*. 2012. PDF.

34. Modoc County Transportation Commission. *Short Range Transit Development Plan 2013/14 to 2017/18*. 2013. PDF.

35. Napa County Transportation and Planning Agency. *Napa County Short Range Transit Plan FY 2013–2022*. 2013. PDF.

36. Petaluma Transit. *Short Range Transit Plan 2012/13–2021/22*. 2012. PDF.

37. Placer County Transportation Planning Agency. *Short Range Transit Plan for Western Placer Consolidated Transportation Services Agency*. 2011. PDF.

38. Riverside Transit Agency. *Short Range Transit Plan 2014–16*. 2014. PDF.

39. Sacramento Regional Transit District. *Short Range Transit Plan FY 2012–2022*. Sacramento, CA: Sacramento Regional Transit District, 2014. Accessed November 28, 2015. http://www.sacrt.com/documents/Planning/SRTP2014.pdf.

40. San Mateo County Transit District. *Short Range Transit Plan 2014–2023*. 2014. PDF.

41. San Francisco Municipal Transportation Agency. *SFMTA Strategic Plan 2013–2018*. San Francisco, CA: San Francisco Municipal Transportation Agency, 2012. Accessed November 28, 2015. https://www.sfmta.com/sites/default/files/pdfs/FY%202013%20-%20FY%202018%20SFMTA%20Strategic%20Plan.pdf.

42. Solano Transportation Authority. *Coordinated Short Range Transit Plan*. 2013. PDF.

43. Transit Joint Powers Authority for Merced County. *Short Range Transit Plan 2012–2017*. 2012. PDF.

44. Union City Transit. *Short Range Plan 2013–2022*. 2013. PDF.

45. Visalia Transit. *Five Year Short Range Transit Plan 2010/11–2015/16*. 2013. PDF.

46. Ibid.

BIBLIOGRAPHY

AECOM, and AMMA Transit Planning. *Short Range Transit Plan FY 2010–11*. N.p.: Imperial County Transportation Commission, 2012.

Antelope Valley Transit Authority. *Business Plan and Short Range Transit Plan FY 2014*. 2013. PDF.

Caltrain. *Short Range Transit Plan 2015–2024*. 2015. PDF.

City of Davis. *Short Range Transit Plan 2015–2021*. 2014. PDF.

City of Fresno. *Short Range Transit Plan 2016–2020*. 2015. PDF.

City of Lodi Transit Division, and MV Transportation, Inc. *Short Range Transit Plan 2005-2009*. 2005. PDF.

City of San Francisco Office of the Controller. *City Services Benchmarking: Public Transportation*. By Peg Stevenson. San Francisco, CA: San Francisco Municipal Transportation Agency, 2014. Accessed November 28, 2015. https://www.sfmta.com/sites/default/files/agendaitems/7-10-2014%20City%20Services%20Benchmarking%20Report.pdf.

Colorado Department of Transportation. *Establishing a Framework for Transit and Rail Performance Measures*. Division of Transit and Rail, Colorado Department of Transportation. December 2012. https://www.codot.gov/programs/transitandrail/resource-materials-new/fhu-s-performance-measures-report.

El Dorado County Transit Authority. *Triennial Performance Report FY 2010–2012*. N.p.: El Dorado Transit County Authority, 2013. Accessed November 28, 2015. http://3nmak51dheck3t8vkw20jvcz.wpengine.netdna-cdn.com/wp-content/uploads/2015/06/Triennial-Performance-Audit-201012-May.pdf.

Fairfield and Suisun Transit. *Short Range Transit Plan 2012/13 - 2022/23*. 2013. PDF.

Florida Department of Transportation. *Best Practices in Evaluating Transit Performance*. N.p.: Florida Department of Transportation, 2014. Accessed December 3, 2015. http://www.dot.state.fl.us/transit/Pages/BestPracticesinEvaluatingTransitPerformanceFinalReport.pdf.

Foothill Transit. *Business Plan and Budget 2014-2015 Proposed*. 2014. PDF.

Gan, Albert, Feng Gui, and Li Tang. “System for Transit Performance Analysis Using the National Transit Database.” *Journal of Public Transportation* 14, no. 3 (November 2011): 87–107. Accessed December 3, 2015. http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1131&context=jpt.

Golden Empire Transit District. *Short Range Transit Plan 15/16–19/20*. 2015. PDF.

Golden Gate, Highway, and Transportation District. *Short Range Transit Plan 2014–2024*. 2015. PDF.

Kiss-off, H. *Implementing Performance Measurement in Transportation Agencies*. Transportation Research Board Conference Proceedings 26. 2001. Accessed December 6, 2015. http://onlinepubs.trb.org/onlinepubs/conf/reports/cp_26.pdf.

Livermore Amador Valley Transit Authority. *Final Mini-Short Range Transit Plan 2010 to 2019*. 2010. PDF.

Los Angeles County Metropolitan Transportation Authority. *2012 Metro Transit Service Policy*. N.p.: Los Angeles County Metropolitan Transportation Authority, 2012. Accessed November 28, 2015. http://media.metro.net/images/service_changes_transit_service_policy.pdf.

LSC Transportation Consultants, Inc. *Western El Dorado County Short- and Long-Range Transit Plan*. N.p.: El Dorado Transit, 2014. Accessed November 28, 2015. http://www.edctc.org/C/SLRTP/FINAL%20S-LRTP%20V2%20for%20viewing.pdf.

Marin Transit. *Short Range Transit Plan 2011/12–2020/21*. 2012. PDF.

Mendocino Transit Authority. *2012–16 Short Range Transit Development Plan*. 2012. PDF.

Metropolitan Transportation Commission. *Statistical Summary of Bay Area Transit Operators: Fiscal Years 2009–10 through 2013–14*. Oakland, CA: Metropolitan Transportation Commission, 2015. Accessed November 28, 2015. http://files.mtc.ca.gov/pdf/StatSumm_2014.pdf.

Modoc County Transportation Commission. *Short Range Transit Development Plan 2013/14 to 2017/18*. 2013. PDF.

Napa County Transportation and Planning Agency. *Napa County Short Range Transit Plan FY 2013–2022*. 2013. PDF.

Petaluma Transit. *Short Range Transit Plan 2012/13–2021/22*. 2012. PDF.

Placer County Transportation Planning Agency. *Short Range Transit Plan for Western Placer Consolidated Transportation Services Agency*. 2011. PDF.

Riverside Transit Agency. *Short Range Transit Plan 2014–16*. 2014. PDF.

Ryus, Paul. *A Guidebook for Developing a Transit Performance-Measurement System*. Report no. 88. TCRP g-06. Washington, DC: Transportation Research Board of the National Academies, 2003. Accessed November 28, 2015. http://www.trb.org/Publications/Blurbs/152127.aspx.

Sacramento Area Council of Governments. *2016 Metropolitan Transportation Plan/ Sustainable Communities Strategy*. Sacramento, CA: Sacramento Area Council of Governments, 2015. Accessed November 28, 2015. http://sacog.org/mtpscs/2016-draft-mtpscs/.

Sacramento Regional Transit District. *Short Range Transit Plan FY 2012–2022*. Sacramento, CA: Sacramento Regional Transit District, 2014. Accessed November 28, 2015. http://www.sacrt.com/documents/Planning/SRTP2014.pdf.

San Diego Association of Governments. *Coordinated Plan 2014–2018*. San Diego, CA: San Diego Association of Governments, 2014. Accessed November 29, 2015. http://www.sandag.org/uploads/publicationid/publicationid_1868_17892.pdf.

San Francisco Municipal Transportation Agency. *SFMTA Strategic Plan 2013–2018*. San Francisco, CA: San Francisco Municipal Transportation Agency, 2012. Accessed November 28, 2015. https://www.sfmta.com/sites/default/files/pdfs/FY%20 2013%20-%20FY%202018%20SFMTA%20Strategic%20Plan.pdf.

San Joaquin Regional Transit District. *Short Range Transit Plan 2014–2018*. 2013. PDF.

San Mateo County Transit District. *Short Range Transit Plan 2014–2023*. 2014. PDF.

Santa Clara Valley Transportation Authority. *Short Range Transit Plan 2014–2023*. 2014. PDF.

Solano Transportation Authority. *Coordinated Short Range Transit Plan*. 2013. PDF.

Southern California Association of Governments. *Transit Appendix: 2012–2035 Regional Transportation Plan/Sustainable Communities Strategy*. N.p.: Southern California Association of Governments, 2012. Accessed November 28, 2015. http://rtpscs.scag.ca.gov/Documents/2012/final/SR/2012fRTP_Transit.pdf.

———. *Transit System Performance Report FY2011–2012*. Transit System Performance Report. Los Angeles, CA: Southern California Association of Governments, 2015. Accessed December 2, 2015. http://scag.ca.gov/Documents/FY2011_2012_System_Performance_Report.pdf.

Transit Joint Powers Authority for Merced County. *Short Range Transit Plan 2012–2017*. 2012. PDF.

Union City Transit. *Short Range Plan 2013–2022*. 2013. PDF.

Visalia Transit. *Five Year Short Range Transit Plan 2010/11–2015/16*. 2013. PDF.

ABOUT THE AUTHORS

CAROLINE RODIER, PH.D.

Caroline Rodier, Ph.D. is a Research Associate at the Mineta Transportation Institute and the Associate Director of the Urban Land Use and Transportation Center—and a Research Scientist—at the Institute of Transportation Studies, University of California, Davis. Dr. Rodier's major areas of research include transport, land use, and environmental planning and policy analysis; she has extensive experience applying land use and transport models to inform public investment, planning, and policy decisions. She has managed the development of activity-based microsimulation travel models for the State of California and the San Joaquin Valley, as well as California's PECAS land-use model. Dr. Rodier has expertise in the design and implementation of research projects that routinely make use of expert and stakeholder interviews, focus groups, and travel behavior surveys. Her research includes parking information and pricing technology pilot projects (most recently SFpark); shared-use modes to facilitate first- and last-mile access to transit; travel needs and mobility solutions for diverse populations in California (e.g., the elderly and immigrants); traffic safety impacts of Variable Message Signs; and the scoping plan for California's landmark climate change legislation, Assembly Bill 32. Dr. Rodier has also conducted reviews of legal and institutional challenges in the areas of automated speed enforcement, low speeds modes (e.g., Segways and neighborhood electric vehicles), and the provision of public parking for carsharing services. Most recently, Dr. Rodier led the development of the content for scenario activities used in the workshop on Automated Vehicles within the Built Environment: 2020, 2035, and 2050 at the Automated Vehicle Symposium 2014 and 2015. She currently serves as the Chair of the Transportation Research Board's Emerging and Innovative Public Transport and Technologies Committee. She holds a B.A. in U.S. History from Barnard College at Columbia University, and an M.S. in Community Development and a Ph.D. in Ecology from the University of California, Davis.

EMILY ISAAC

Emily Isaac is a Research Assistant at the Institute of Transportation Studies at the University of California, Davis. Since 2014, she has focused her research on transportation network companies and the market for on-demand transportation services. In 2015, she graduated from the University of California, Davis with a bachelor's degree in Community and Regional Development.

PEER REVIEW

San José State University, of the California State University system, and the MTI Board of Trustees have agreed upon a peer review process required for all research published by MTI. The purpose of the review process is to ensure that the results presented are based upon a professionally acceptable research protocol.

Research projects begin with the approval of a scope of work by the sponsoring entities, with in-process reviews by the MTI Research Director and the Research Associated Policy Oversight Committee (RAPOC). Review of the draft research product is conducted by the Research Committee of the Board of Trustees and may include invited critiques from other professionals in the subject field. The review is based on the professional propriety of the research methodology.

MTI FOUNDER

Hon. Norman Y. Mineta

MTI BOARD OF TRUSTEES

Founder, Honorable Norman Mineta (Ex-Officio)
Secretary (ret.), US Department of Transportation
Vice Chair
Hill & Knowlton, Inc.

Honorary Chair, Honorable Bill Shuster (Ex-Officio)
Chair
House Transportation and Infrastructure Committee
United States House of Representatives

Honorary Co-Chair, Honorable Peter DeFazio (Ex-Officio)
Vice Chair
House Transportation and Infrastructure Committee
United States House of Representatives

Chair, Nuria Fernandez (TE 2017)
General Manager and CEO
Valley Transportation Authority

Vice Chair, Grace Crunican (TE 2016)
General Manager
Bay Area Rapid Transit District

Executive Director, Karen Philbrick, Ph.D.
Mineta Transportation Institute
San José State University

Joseph Boardman (Ex-Officio)
Chief Executive Officer
Amtrak

Anne Canby (TE 2017)
Director
OneRail Coalition

Donna DeMartino (TE 2018)
General Manager and CEO
San Joaquin Regional Transit District

William Dorey (TE 2017)
Board of Directors
Granite Construction, Inc.

Malcolm Dougherty (Ex-Officio)
Director
California Department of Transportation

Mortimer Downey* (TE 2018)
President
Mort Downey Consulting, LLC

Rose Guilbault (TE 2017)
Board Member
Peninsula Corridor Joint Powers Board (Caltrain)

Ed Hamberger (Ex-Officio)
President/CEO
Association of American Railroads

Steve Heminger* (TE 2018)
Executive Director
Metropolitan Transportation Commission

Diane Woodend Jones (TE 2016)
Principal and Chair of Board
Lea+Elliot, Inc.

Will Kempton (TE 2016)
Executive Director
Transportation California

Art Leahy (TE 2018)
CEO
Metrolink

Jean-Pierre Loubinoux (Ex-Officio)
Director General
International Union of Railways (UIC)

Michael Melaniphy (Ex-Officio)
President and CEO
American Public Transportation Association (APTA)

Abbas Mohaddes (TE 2018)
CEO
The Mohaddes Group

Jeff Morales (TE 2016)
CEO
California High-Speed Rail Authority

David Steele, Ph.D. (Ex-Officio)
Dean, College of Business
San José State University

Beverley Swaim-Staley (TE 2016)
President
Union Station Redevelopment Corporation

Michael Townes* (TE 2017)
Senior Vice President
Transit Sector, HNTB

Bud Wright (Ex-Officio)
Executive Director
American Association of State Highway and Transportation Officials (AASHTO)

Edward Wytkind (Ex-Officio)
President
Transportation Trades Dept., AFL-CIO

(TE) = Term Expiration or Ex-Officio
* = Past Chair, Board of Trustee

Directors

Karen Philbrick, Ph.D.
Executive Director

Hon. Rod Diridon, Sr.
Emeritus Executive Director

Peter Haas, Ph.D.
Education Director

Donna Maurillo
Communications Director

Brian Michael Jenkins
National Transportation Safety and Security Center

Asha Weinstein Agrawal, Ph.D.
National Transportation Finance Center

Research Associates Policy Oversight Committee

Asha Weinstein Agrawal, Ph.D.
Urban and Regional Planning
San José State University

Jan Botha, Ph.D.
Civil & Environmental Engineering
San José State University

Katherine Kao Cushing, Ph.D.
Enviromental Science
San José State University

Dave Czerwinski, Ph.D.
Marketing and Decision Science
San José State University

Frances Edwards, Ph.D.
Political Science
San José State University

Taeho Park, Ph.D.
Organization and Management
San José State University

Diana Wu
Martin Luther King, Jr. Library
San José State University

MINETA
TRANSPORTATION INSTITUTE
MTI

SAN JOSÉ STATE
UNIVERSITY

Funded by U.S. Department of Transportation and California Department of Transportation