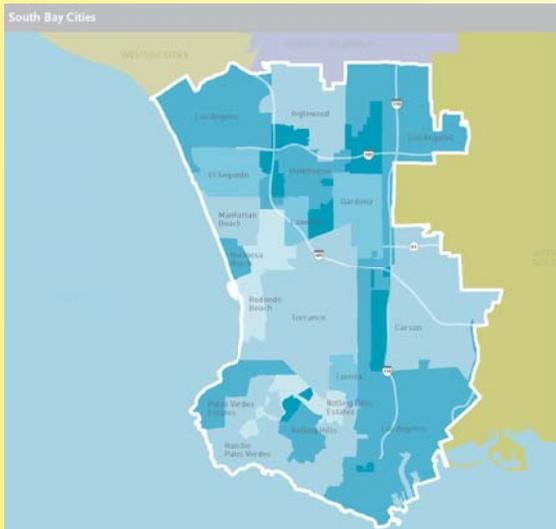


Final Report

Smart Mobility FRAMEWORK

Implementation Pilot Study



Caltrans Division of Transportation Planning



March 2015

EXECUTIVE SUMMARY

Caltrans initiated the “Smart Mobility 2010: A Call to Action for the New Decade” to begin building a conceptual foundation for a new approach to transportation planning and investment. This call to action presents the “Smart Mobility Framework (SMF)”, which articulates the state’s expanded focus on sustainability and lays the groundwork for putting the SMF into practice.

The SMF contains six overarching principles that are linked to seventeen performance measures. The principles are:

- Location Efficiency
- Reliable Mobility
- Health and Safety
- Environmental Stewardship
- Social Equity
- Robust Economy

The key to bringing the SMF to life will be through the way in which it leads to better decision-making and better investments. To make that happen, these principles need to be put into practice, and tied to the processes through which transportation and financing decisions are made. Caltrans conducted two smart mobility implementation pilot studies with the overarching goal to develop, test, evaluate, and document the process, methods, and results of applying the SMF in on-going planning efforts:

- **I-680 corridor within Contra Costa County;** Caltrans District 4 - This pilot study focused on integrating SMF principles and performance measures into existing Caltrans corridor planning processes. The focus was the use of the SMF principles in the development of a second generation Corridor System Management Plan (CSMP) for a 25-mile segment of the I-680 corridor.
- **South Bay Cities Long Range Transportation Plan within Los Angeles County;** Caltrans District 7 – This pilot study focused on using SMF principles and performance measures to more fully integrate transportation and land use planning processes at the sub-regional level. This pilot was done in coordination with Los Angeles County Metropolitan Transportation Authority (Metro), the Southern California Association of Governments (SCAG), and the South Bay Cities Council of Governments (SBCCOG).

These studies have led to the identification of best practices and lessons learned, as well as building the foundation for a replicable process that incorporates smart mobility into comparable efforts throughout Caltrans and partner agencies’ work.

SUMMARY OF RECOMMENDATIONS

A great deal was learned from the two pilots in this implementation study as well as the evolving state of practice in sustainable transportation. Recommended actions to further advance the use of the SMF in Caltrans business practices are:

Context and Scale

1. Conduct pilot efforts outside of major metropolitan areas
2. Conduct pilot studies implementing other project types

Place Types

3. Apply SMF Place Types to incorporate the land use context into transportation decision-making, specifically when identifying and prioritize transportation projects and programs

Performance Measures

4. Develop guidance in selecting SMF performance measures
5. Expand the D4 Complete Streets Guidelines to Statewide Guidelines

Data Sources and Data Collection

6. Incorporate new data sources and data collection technologies.
7. Identify data needed to calculate SMF performance measures and provide adequate resources.
8. Monitor, collect and evaluate post-project data

Analytic Tools and Models

9. Develop and validate post-model tools that interface with travel demand models or sketch models
10. Develop neighborhood travel models to nest within the regional travel demand models
11. Develop a process or simple tool for jurisdictions with limited modeling capabilities or resources
12. Develop better tools that are sensitive to active transportation and innovative transportation
13. Support additional research in development of the Tools for Operations Planning (TOPL) operations analysis tool

Research and Best Practices

14. Continue research and information sharing on best practices
15. Identify and incorporate best practices and latest research on reliability as a performance measure

CONCLUSION

Through the cooperation of state, regional and local planning staffs, creative approaches were found to apply the SMF in each project's context. This showed that the SMF is sufficiently flexible and resilient to fit the needs of different situations, and that it does not require an all-or-nothing approach. Finally, the results of these studies demonstrated that it is possible to incorporate multiple goals into the transportation planning process to achieve sustainable outcomes for our communities and ultimately the state.

INTRODUCTION

The State's demographic, environmental, economic, and quality of life challenges are relevant to virtually every dimension of public policy. The focus here is on the role of mobility in meeting these challenges, as an essential ingredient in meeting people's needs for full participation in society, as contributor to environmental quality, and as a significant factor in supporting economic activity.

- Preface, "Smart Mobility 2010: A Call to Action"

California faces a number of dramatic environmental, social, and economic challenges in the coming decade. Addressing these challenges requires an integrated approach based on an understanding of the interaction and interrelationship of multiple priorities and needs. Nowhere is this more apparent than in planning for the future mobility and multimodal accessibility of the state. Demand for personal mobility continues to grow along with the population, but, at the same time, alternatives for meeting those demands have grown, too. Better integration of local transportation into the social and economic fabric of individuals' communities is in demand.

In consideration of all of these factors, Caltrans initiated the "Smart Mobility 2010: A Call to Action for the New Decade" to begin building a conceptual foundation for a new approach to transportation planning and investment. This call to action presents the "Smart Mobility Framework (SMF)", which articulates the state's expanded focus on sustainability and lays the groundwork for putting the SMF into practice. Caltrans has provided leadership in developing strategies and methodologies for integrating those smart mobility principles, concepts, and performance measures into the planning process with the overarching goal of "moving people and freight while enhancing California's economic, environmental, and human resources by emphasizing convenient and safe multi-modal travel, speed suitability, accessibility, management of the circulation network, and efficient use of land."

The SMF contains six overarching principles that are linked to seventeen performance measures. The principles are:

- Location Efficiency
 - Reliable Mobility
 - Health and Safety
 - Environmental Stewardship
 - Social Equity
 - Robust Economy

Location efficiency is particularly noteworthy since it captures much of the fundamental thinking behind smart mobility. The concept was introduced by Caltrans in the SMF as a way to capture the link between the physical environment and the transportation system, and it is defined by two key

factors: regional accessibility and community design. Together greater location efficiency in both of these factors can contribute to reduced average vehicle trip length, reduced per capita vehicle trips, and greater mode share for trips by walk, bike, and transit.

The key to bringing the SMF to life will be through the way in which it leads to better decision-making and better investments. To make that happen, these principles need to be put into practice, and tied to the processes through which transportation and financing decisions are made. Caltrans has made extensive efforts to implement the SMF, not only leading the research and development of methodologies and processes for applying these principles, but also piloting and refining those approaches in different scenarios to evaluate their effectiveness.

Caltrans conducted two smart mobility implementation pilot studies with the overarching goal to develop, test, evaluate, and document the process, methods, and results of applying the SMF in ongoing planning efforts. These studies have led to the identification of best practices and lessons learned, as well as building the foundation for a replicable process that incorporates smart mobility into comparable efforts throughout Caltrans and partner agencies' work.

The two pilot areas (PA) share some similarities, but also represent different institutional, infrastructure, and policy environments:

- **I-680 corridor within Contra Costa County;** Caltrans District 4 (PA1) - This study focused on integrating SMF principles and performance measures into existing Caltrans corridor planning processes. The focus was the use of the SMF principles in the development of a second generation Corridor System Management Plan (CSMP) for a 25-mile segment of the I-680 corridor within Contra Costa County.
- **South Bay Cities Long Range Transportation Plan within Los Angeles County;** Caltrans District 7 (PA2) – This pilot study focused on using SMF principles and performance measures to more fully integrate transportation and land use planning processes at the sub-regional level. This pilot was done in coordination with Los Angeles County Metropolitan Transportation Authority (Metro), the Southern California Association of Governments (SCAG), and the South Bay Cities Council of Governments (SBCCOG).

This report presents a summary of SMF implementation in the pilot studies, describes a replicable process that incorporates smart mobility into comparable efforts throughout Caltrans and partner agencies' work, and lays out a roadmap for next steps.

APPLYING THE SMART MOBILITY FRAMEWORK

The SMF can be implemented into current transportation planning practices through varied approaches depending upon the type of study, geographical scale, and political environment. Although the smart mobility concept may be new to some, it complements and enhances many existing tools and practices that are used in the planning community. For this reason, it is important to align current policies, plans, and methodologies with the SMF principles and concepts.

Through the two pilot area studies, several lessons were learned in applying smart mobility concepts, particularly in overcoming challenges and barriers. This section discusses the key elements of the SMF and provides examples and lessons learned from the pilot studies. These experiences lead to the actions for incorporating SMF into future implementation efforts described in the recommendations section.

Place Types

The SMF uses place types for classifying areas within towns, cities, and regions as the basis for making transportation investments and directing transportation planning activities. There are seven SMF place types and they are categorized based on two main factors: regional accessibility and community design. The place types are:

- Urban Centers
- Close-in Compact Communities
- Compact Communities
- Suburban Communities
- Rural and Agricultural Lands
- Protected Lands
- Special Use Areas

Each of the place types creates a distinct context for transportation investments and distinct opportunities to gain smart mobility benefits. The SMF place types can be used to identify types of transportation projects and programs that should be considered as possible priorities in order to increase their location efficiency and the potential for other smart mobility benefits. Place types are an important part of the SMF as they help to determine the characteristics of the ideal transportation system and the thresholds that the system's performance should be achieving. While these place types are a good starting point for regions or agencies that have not developed a similar typology, other typologies can be substituted where they already exist.

Applying Place Types in the Pilot Studies:

The South Bay Cities pilot study provided an opportunity to build upon locally available methodologies and data to carry out the basic “place type” concepts. Rather than using the specific Smart Mobility Place Types, the study team used what Metro had defined as “Accessibility Clusters,” which are similarly based on residential density and employment centrality. The team particularly focused on areas with high residential density and high job centrality (e.g., Cluster D), which corresponds most closely with SMF’s “Compact Communities” place type. Maintaining the existing place type definitions helped ensure that the evaluations performed as part of this study maintained their compatibility with the broader Countywide Sustainability Planning policy adopted by Metro in December 2012.

An SMF place type analysis was conducted for the I-680 CSMP corridor, which identified place types within the study area consistent with the Metropolitan Transportation Commission’s (MTC’s) Priority Development Areas. Specifically, most of the I-680 corridor falls within the “suburban community” place type which typically has poor connectivity of the street network, low levels of transit service, and limited integration between housing with jobs, retail, and services. On the other hand, downtown Walnut Creek and downtown Concord, represented by the SMF as “urban center” place type, have high levels of regional accessibility and higher density mixed-use development. This would make them leading candidates for multi-modal strategies, such as improved access via walk, bike, and transit to the Walnut Creek and Concord BART stations. Expected benefits would be increased transit, walk, and bike mode share, reduce emissions, and improve multimodal quality of service. Although the pilot test did not analyze different land use scenarios, the place type analysis provides valuable insights as to where the opportunities exist to achieve smart mobility benefits.

Context and Scale

California is an extremely diverse state. It has some of the largest metropolitan areas in the world, as well as hundreds of small rural towns and cities. Likewise, one would expect that the transportation planning needs of these areas also vary greatly, although many areas share the same six principles that drive the SMF. The challenge is to use the flexibility in the SMF to define the appropriate *context and scale* for each planning effort.

As a planning tool, the SMF serves a different function in highly urbanized areas with constrained, built out transportation systems than it does in smaller communities that face

more basic mobility and access needs. Obviously, transportation investments need to recognize these differences; however, whatever the context, the objective should remain consistent with the SMF goals.

The SMF is a versatile tool applicable to many different scales, political environments, and planning contexts. By its nature, there is no one-size-fits-all implementation strategy for smart mobility principles. The SMF principles are a broad framework that is meant to be applied at all levels, statewide, regionally, and locally, allowing for refinement at the regional and local levels to better reflect the local context. These pilot area studies resulted in some generalized best practices that will ensure that smart mobility principles work within the local context rather than impose a new set of criteria that will be difficult to implement and that might conflict with successful local initiatives already in place. This flexibility of the SMF is demonstrated through the use of local and regional sustainability policies to select performance measures and use of local place types to incorporate the land use context into the transportation decision-making process.

Applying Context and Scale in the Pilot Studies:

Both of the pilot area studies were conducted in highly urbanized areas where well-established MPOs have already made significant investments in a sustainability framework that include a number of smart mobility principles and in some areas, go even further. However, in areas that do not have the resources to advance their own programs to a comparable level, the SMF can serve as a fundamental form of guidance to modernize their own programs.

The SMF was adaptable to the context of the pilots. As an example, in the South Bay Cities pilot, rather than directly applying SMF principles, the study team used Metro's own sustainability principles which are very similar to many of the SMF principles. For the I-680 CSMP, the SMF place types analysis incorporated the Metropolitan Transportation Commission (MTC) Priority Development Areas (PDAs) as well as walk score to define the regional accessibility and community context.

The overarching smart mobility principles can be applied to various project types at any context or scale, and can be refined when defining the purpose and need of specific projects. As the pilot teams found, when there is an existing sustainability framework that is unique to land use, transportation, and demographic conditions of the area, this is an excellent place to start.

Performance Measures

Performance has always been a key element on transportation planning; however, all too often, that focus has primarily been on maximizing the throughput of automobiles on the network or reducing their delays. The SMF recognizes that there are many more social, environmental, and economic factors that need to be considered in these decisions, as well as any evaluation of overall performance. For this reason, the SMF includes seventeen performance measures that relate to the smart mobility principles; Table 1 shows the interrelationship between these as well as lists recommended metrics for each of the performance measures.

These measures reflect a very robust set of factors that can be used in the development of everything from context-sensitive neighborhood solutions to corridor system management plans to long range transportation plans. However, the SMF also made it very clear that every community and every planning study needed to identify which of these 17 measures were most applicable to that particular project. Further, although guidance has been provided in the SMF, a lot of flexibility can still be applied in making the actual choices of what data will be used to measure performance.

Table 1. SMF Principles, Performance Measures and Recommended Metrics

Goal	Performance Measure	Recommended Metrics
Location Efficiency	1. Support for Sustainable Growth	Consistency with regional Sustainable Communities Strategy or Alternative Planning Strategy meeting regional performance standards. Comparison of alternatives based on acres of land consumed, and relative reductions in induced VMT through: compact land use strategies, demand management, and network management.
	2. Transit Mode Share	Percentage of trips within a corridor or region occurring by bus, rail or by other form of high-occupancy-vehicle.
	3. Accessibility and Connectivity	Number of households within 30 minute transit ride of major employment center, within 20 minute auto ride of employment, within walking distance of schools. Weighted regional travel time and cost among trip producers and trip attractors.
Reliable Mobility	4. Multi-Modal Travel Mobility	Travel times and costs by mode between representative origins and destinations, aggregated over corridor or region.
	5. Multi-Modal Travel Reliability	Day-to-day variability of travel times between representative origins and destinations by mode, aggregated over corridor or region.
	6. Multi-Modal Service Quality (Level of Service: LOS)	Mode-specific and blended LOS measures of pedestrian and bicycle accommodation and comfort, transit availability and reliability, and auto travel efficiency. ⁽¹⁾
Health and Safety	7. Multi-Modal Safety	Collision rate and severity by travel mode and facility, compared to statewide averages for each user group and facility type.
	8. Design and Speed Suitability	Conformance with guidance identifying suitable design elements and traffic speed with respect to mix of modes and adjoining land uses and area character. ⁽²⁾
	9. Pedestrian & Bicycle Mode Share	Percentage of trips within a corridor or region occurring by walking or cycling.
Environmental Stewardship	10. Climate and Energy Conservation	VMT per capita by speed range relative to State and regional targets. ⁽³⁾
	11. Emissions Reduction	Quantities of criteria pollutants and GHGs
Social Equity	12. Equitable Distribution of Impacts	Impact of investments on low-income, minority, disabled, youth and elderly populations relative to impacts on population as a whole.
	13. Equitable Distribution of Access and Mobility	Comparative travel times and costs by income groups and by minority and non-minority groups for work/school and other trips.
Robust Economy	14. Congestion effects on Productivity	Time lost to congestion by trips that are economically productive and/or sustaining of essential mobility, measured as vehicle hours of delay (VHD).
	15. Efficient Use of System Resources	Additional VMT that are associated with economic productivity and/or sustaining of essential mobility compared with system expansion cost and impact.
	16. Network Performance Optimization	VHD per capita, per lane mile, per private vehicle mile, per freight vehicle mile, per transit revenue mile, and in total.
	17. Return on Investment	Person miles and revenue per lane mile of road, per transit revenue mile and per dollar invested (from all public and private funding sources). Comparison of alternatives based on benefits per dollar invested relative to: a) system user benefits (time and expense), and b) other Smart Mobility Performance Measures.

⁽¹⁾ Typical resource: Transportation Research Board 2010 Highway Capacity Manual.

⁽²⁾ Typical resources: Caltrans DD64 Complete Streets guidelines; ITE practices on Context Sensitive Solutions.

⁽³⁾ Targets set by California Air Resources Board under SB375. Rates of GHG emissions and fuel consumption both vary by speed range or "bin."

Source: Caltrans. Smart Mobility 2010: A Call to Action for the New Decade, Exhibit 11: Smart Mobility Performance Measures, p. 55.

Applying Performance Measures in the Pilot Studies:

The 17 SMF performance measures provide a great deal of flexibility to adapt to different project contexts, while the SMF is not prescriptive regarding the specific metric used to measure them. For the pilot studies, the team chose from existing performance metrics where there was readily available data and identified new metrics that could be evaluated with minimal data collection to fill in as many of the 17 performance measures as possible.

In the case of the I-680 CSMP, the selection was based on the available data and models as well as the study objectives. The 17 SMF performance measures are related to the six SMF principles, which were similar to the CSMP goals. As shown in Table 2, a total of nine of the 17 SMF performance measures was selected for the CSMP. Specific metrics were identified for each performance measure with multi-modal travel mobility and multi-modal service quality having more than one metric. Of these nine SMF performance measures, all were used for describing the I-680 current conditions (as indicated by “yes” in column 5) and a subset of those were applied during the future scenario testing (as indicated in column 6).

For the South Bay Cities study, a package of performance measures was developed to address as many SMF principles and performance measures as possible using the existing work and data from SCAG and Metro. Additionally, since the SMF did not specifically address Neighborhood Electric Vehicles (NEVs), the definition of multi-modal was broadened to include NEVs and NEV infrastructure when recommending performance measures to evaluate the sustainability outcomes. Ultimately, the recommended performance measures included 16 quantitative and qualitative measures to demonstrate the different outcomes when comparing four land use and transportation scenarios. (See Table 3.) These measures were also sub-divided into those that fit into traditional performance measurement systems and those that were introduced to fulfil SMF objectives.

In both cases, the selection of performance measures was influenced by the existing data sources, the measurement tools that were available, and metrics already being used by the MPOs, county congestion management agencies, or Caltrans. By using the flexibility within the SMF, the teams were able to adapt to these conditions, but still consider the six smart mobility principles when selecting performance measures.

Table 2. I-680 Performance Measures, CSMP Goals, Metrics, and Data Sources

Smart Mobility Framework (SMF) Performance Measure	CSMP Goal Addressed	Metric	Current Conditions	Forecasting	Potential Data sources	
2	Transit Mode Share	Location Efficiency	% of non-SOV trips (includes carpool/vanpools)	Yes	Yes	CCTA model
4	Multi-Modal Travel Mobility	Reliable Mobility	Total user-hours of travel times and travel costs by mode for the corridor	Yes	Yes	PeMS, Tachometer Vehicle Runs, TOPL, CCTA model
			Congestion (Vehicle Hours of Delay) - Time Period - Month - Day of Week - Severity (at 60mph, 35mph) - Hour of Day - Bottleneck Locations & Severity	Yes	For average weekday modeled period	PeMS, TOPL
			Productivity - Lost Lane Miles - by Time of Day	Yes	No	PeMS
5	Multi-Modal Travel Time Reliability	Reliable Mobility	Travel time reliability measures by mode: buffer index, standard deviation; Travel time reliability relative to each mode	Yes	Yes	PeMS for baseline. Evaluating feasibility for forecasting
6	Multi-Modal Service Quality	Multimodal Level of Service	Level of Service (LOS)	Yes	Maybe (if forecast data available)	HCM 2010 MMLoS methodology data sources
		Complete Streets	Complete Streets Evaluation	Yes	No	Satellite imagery, field evaluation
		Sustainable Infrastructure	Pavement Condition - Distressed Lane-Miles - International Roughness Index	Yes	No	Caltrans Pavement Management System
7	Multi-Modal Safety	Health and Safety	Accidents/Accident Rates - by Mode - by Month - by Weekday/Weekend	Yes	No	TASAS, SWITRS, CCTA model, Highway Safety Manual, Caltrans Traffic Safety Index (from HSIP)
9	Pedestrian & Bicycle Mode Share	Health and Safety	Bicycle and pedestrian mode share in corridor	Yes	No	CCTA model, American Community Survey, National Household Travel Survey
10	Climate and Energy Conservation	Environmental Stewardship	VMT by speed range for the corridor	Yes	Yes	CCTA model
11	Emissions Reduction	Environmental Stewardship	Emissions by criteria pollutant	Yes	Yes	CCTA model, EMFAC
17	Return on Investment (ROI)	Robust Economy	Benefit-cost: Net present value of benefits (travel time, reliability) minus net present value of costs (capital, O&M, air pollution, crashes)	n/a	Yes	Results of previous performance measures (2, 4, 5, 7, 9, 10, and 11 above). Cal-B/C

Current Conditions: Indicates whether the metric was applied to existing conditions.

Forecasting: Indicated whether the metric could be measured under future forecasted conditions.

Source: System Metrics Group, 2014.

Table 3. South Bay Cities Performance Measures, Metrics, and Local Principles

		Principles						
		Countywide Sustainability Planning Policy ¹			Sustainable South Bay ²			
SMF Performance Measure	Performance Metric	Connect	Create Community	Conserve	Reduce pollutants	Reduce Congestion	Reduce Gas Consumption	Improve Safety
Accessibility and Connectivity	Average Proximity to Employment (30 min by Transit)	x	x					
	Average Proximity to Employment (20 min Drive)	x	x					
Multimodal Travel Mobility	Average Vehicle Occupancy (AVO)			x	x	x		
	Modal Travel Time and Cost	x						
Multimodal Service Quality	NEV, Bicycle, Walking Facilities	x		x	x	x	x	x
Transit Mode Share	Percentage of Trips by Transit				x	x	x	
Neighborhood Electric Vehicle (NEV) Mode Share	Percentage of Trips by NEV				x	x	x	
Pedestrian and Bicycle Mode Share	Percentage of Trips by Bicycling				x	x	x	
	Percentage of Trips by Walking		x		x	x	x	
Emissions Reduction	Quantities of Criteria Pollutants and GhGs			x	x		x	
Congestion Effects on Productivity	Vehicle Hours of Delay (VHD) or Person Hours of Delay			x	x	x		
Climate and Energy Conservation	Vehicle Miles Traveled (VMT) or Person Miles Traveled			x	x		x	
	Vehicle Hours Traveled (VHT)			x		x	x	x
	VMT per Capita by Speed Range			x	x		x	
Multimodal Safety	Number of Crashes							x
	Number of Vulnerable User Crashes							x

¹ Los Angeles County Metropolitan Transportation Authority. *Metro Countywide Sustainability Planning Policy and Implementation Plan*, Adopted December, 2012.

² South Bay Cities Council of Government. *Sustainable South Bay: An Integrated Land Use and Transportation Strategy*, July 2009.

Source: Kittelson & Associates, Inc., PA2 Final Report, 2014.

Data Sources and Data Collection

At one time or another, we have probably all thought, “I am buried in data, but I can’t find the information I want!” Data collection can be very expensive and time consuming, yet at the same time, the sources of publically and commercially available data has exploded. In implementing the SMF, the challenge is to make the most relevant use of that data, while staying focused on how that will ultimately improve our ability achieve the Smart Mobility goals.

Data Needs in the Pilot Studies:

One concern about implementing the SMF is the amount of data needed to calculate new performance measures. The I-680 CSMP included a Complete Streets Evaluation as well as the 2010 Highway Capacity Manual (HCM) multimodal level of service (MMLOS) analysis as different approaches to incorporating all modes into the corridor study. These efforts were conducted with limited resources for data collection.

For the Complete Streets Evaluation, the approach included cataloguing infrastructure details for crossings and transverse routes as well as parallel routes and alternatives to the freeway corridor. Bicycle and pedestrian improvement opportunities were identified and recommendations were prioritized. (See Appendix E.)

For the MMLOS analysis, specific locations were selected to test the 2010 HCM methodologies since application for the entire I-680 study area was beyond the resources available for data collection. To address the data needs, the approach required balancing the data needs with available resources, yet provided meaningful results for corridor performance. The data inputs included physical characteristics and geometries, traffic and signal data, and transit data for a total of over 30 values. The approach was to apply some default values for specific inputs and focus the analysis on discreet sections along several parallel arterials. (See Appendix F.)

For the South Bay Cities study, the data needs were focused on the development of the Dashboard Calculator tool, but included SCAG Regional Travel Demand Model outputs that fed into the Envision Tomorrow Plus tool. Specifically, the effort required land use data at the block or parcel level to capture the neighborhood scale for existing, traditional, and innovate land use conditions as well as data from research on NEVs and bicycling to calibrate the Dashboard Calculator tool. Additional data would be needed to validate the Dashboard Calculator tool and to incorporate other modes, such as transit, walk, and HOV into the Dashboard (See Figure 1).

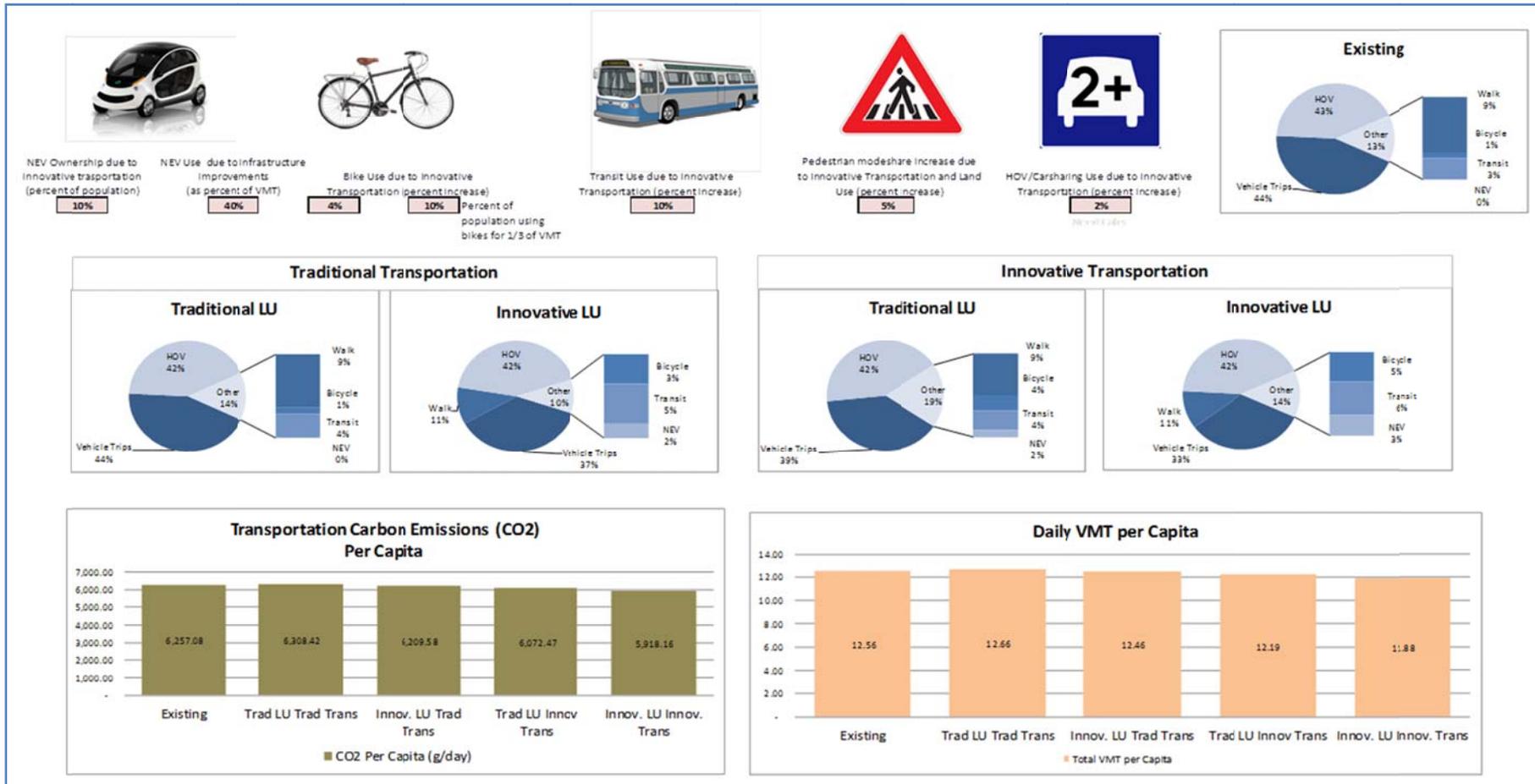


Figure 1. South Bay Cities Dashboard Calculator Tool

Analysis Tools and Models

Choosing the right analysis tool, or package of tools, can be very challenging. There are many tools with different capabilities, customizability, licensing, and transparency. It is important to balance the desire for a tool that is familiar to the local and regional agencies with the need to have a tool that is versatile. It should be able to capture the benefits provided by different patterns of land development and types of transportation projects using smart mobility performance measures. With a growing focus on these and other efforts to expand the breadth of community and transportation planning, there is currently a rapid evolution in these models as existing tools are being expanded and upgraded, and new tools are being developed. The tendency is to “stay with the familiar,” but it is very possible that soon the benefits of these newer tools will outweigh that degree of comfort.

One of the lessons learned in the pilot studies was that “no one shoe fits all.” Basically, it is very unlikely that any single tool will be able to evaluate every smart mobility performance measure adequately for every context. The scale of the study, the type of projects being evaluated, and even the horizon year are all factors that need to be considered in making these choices, choices that will likely be different from application to application.

Smart Mobility 2010 provides a framework that is not intended to be prescriptive allowing for varied approaches to transportation planning as tools become available. Because it is a flexible framework, the SMF is adaptable to changes in transportation and mobility trends.

Applying Analysis Tools in the Pilot Studies:

One of the concerns about implementing the SMF is availability of tools required to analyze these new performance metrics. As such, these were areas of particular focus in the two pilot studies and affected the selection of performance measures, tools, and methodologies for calculating specific performance metrics. Once again, the teams found that working within the framework, there was still a great deal of flexibility to make choices based on the specific conditions and resources available to them.

For the I-680 CSMP, the team considered available travel demand models and concluded that the level of interaction they were looking for between land use and transportation was captured in the traffic forecasts using the countywide travel demand model. The Contra Costa Transportation Authority (CCTA) model seemed most appropriate for the additional network and zonal detail it could provide along the analysis corridor versus the MTC regional model.

To begin the South Bay Cities Study, Envision Tomorrow Plus (ET+), Urban Footprint, and Rapid Fire sketch planning tools were reviewed. The ET+ tool was selected and enhanced with a Dashboard Calculator to provide an easy-to-use process and tool to evaluate some of the recommended smart mobility performance measures. (See Figure 1.) This tool also allowed for a quick comparison between four project scenarios. The study also relied on information derived from the SCAG Regional Travel Demand Model. The Dashboard Calculator tool uses outputs from the ET+ tool and augments the output to capture effects of alternative transportation strategies and programs. As shown by the icons across the top row, the Dashboard Calculator tool includes NEV and bicycling, based on the available on-going research, as well as provides placeholders for transit, walk, and HOV, based on the direction of the Pilot Area 2 Project Team. The ET+ tool was well-suited for scenario development and land use analysis, but requires further development for more detailed transportation project decisions. However, the groundwork was set to include SMF performance measures in future application as new research and tools become available.

HOW TO INCORPORATE SMF

From the lessons learned during the two pilot area studies and the best practices identified through the literature review (Appendix A), this section presents the general steps for incorporating SMF and stakeholder engagement into current planning practices. These steps include the following:

- Consider all six **SMF principles** when developing and defining the purpose and need of the project as well as the objectives of the study.
- Develop project teams that include **stakeholder engagement and collaborative partnerships** throughout the planning process.
- Define land use context, similar to that outlined by the **SMF place types**, when describing the study area, both in existing conditions and in the future.
- Expand performance assessment to include some of the 17 **SMF performance measures** considering the availability of tools and data.

Inherent with implementing the SMF is stakeholder engagement and collaborative partnerships as transportation planning broadens to include local land use and multimodal accessibility. Bringing all stakeholders to the table from the start is key to the success of future planning efforts. Figure 2 presents the general steps of the planning process incorporating the SMF elements and stakeholder engagement. Depending upon the type of study, the specific steps will vary as was the case for the I-680 CSMP and the South Bay Cities Subregional Transportation Plan.

Stakeholder Engagement and Collaborative Partnerships in the Pilot Studies

The I-680 CSMP corridor study was a collaborative effort involving Caltrans Headquarters, District 4, the Metropolitan Transportation Commission (MTC), and the Contra Costa Transportation Authority (CCTA). A Staff Working Group (SWG) was comprised of the I-680 CSMP consultant team, Caltrans, CCTA, and MTC staff, as well as the SMF consultant and TOPL consultant from University of California Berkeley's PATH program. A key points during the study, information was presented to the Technical Advisory Committee (TAC), which expanded to include cities, transit operators, and other agencies, such as Alameda County Transportation Commission and Solano Transportation Authority.

The South Bay Cities study was an effort sponsored by Los Angeles County Metropolitan Transportation Authority (Metro) partnered with South Bay Cities Council of Governments (SBCCOG). Members of the Project Team included representatives from Caltrans District 7, Caltrans Headquarters, and Southern California Association of Governments (SCAG). A presentation was made to the SCAG Sustainability Committee to share the study efforts.

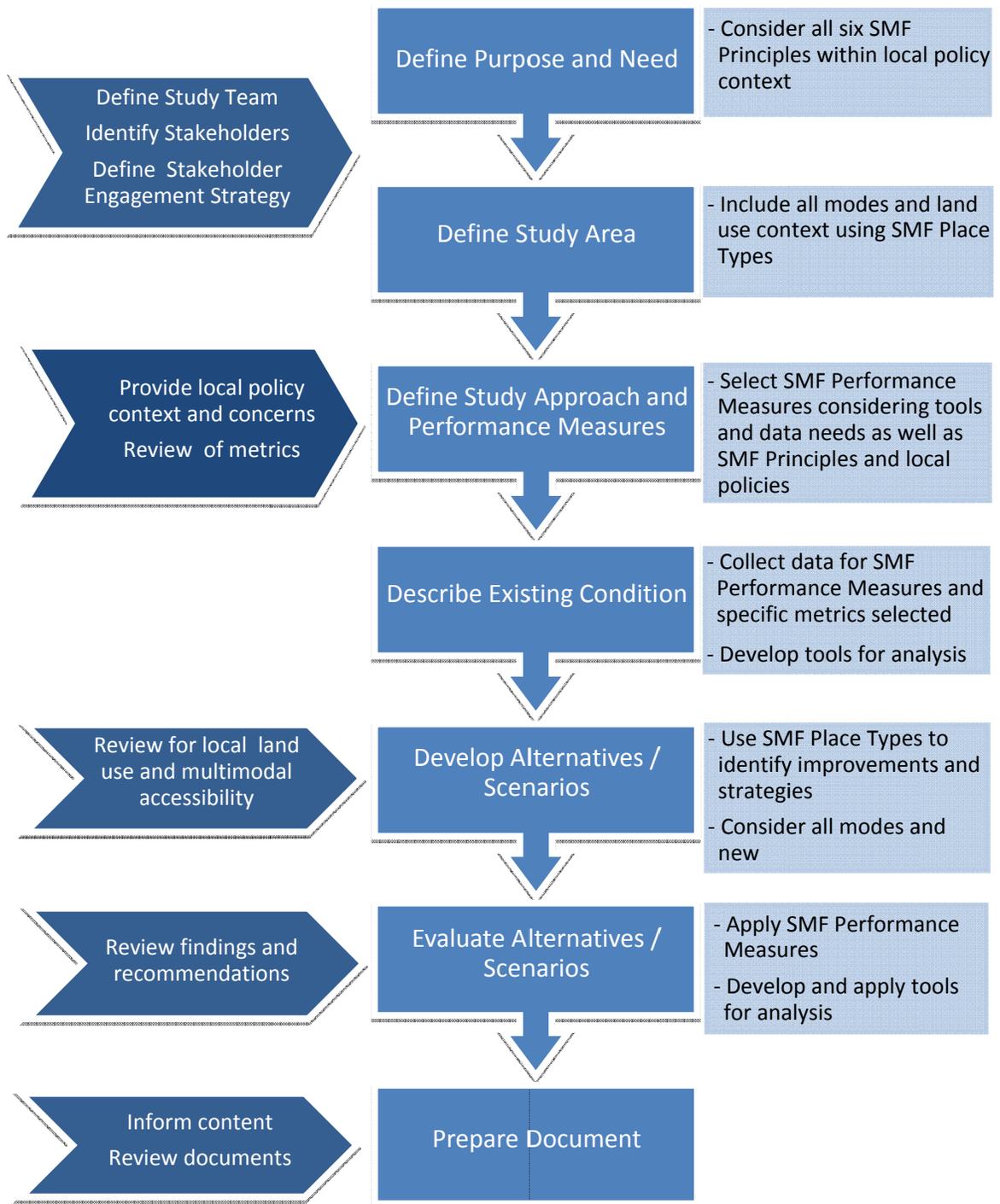


Figure 2. Planning Process with SMF and Stakeholder Engagement

Applying How To in the Pilot Studies: Second Generation CSMP

1. Define Purpose and Need
 - a. Define study goals and objectives
2. Develop Stakeholder Engagement and Outreach Strategy
 - a. Assemble Study Team
 - i. Include all modes (e.g., walk and bicycle groups, transit agencies)
 - ii. Staff Working Group
 - iii. TAC
 - iv. Policy level stakeholders
 - v. Public
 - b. Identify stakeholders
 - c. Define meeting schedule and agendas
 - i. Attendance and outcomes from meetings
3. Define Study Area
 - a. Corridor system should include parallel arterials as well as transit and bicycle facilities
4. Define Approach and Performance Measures
 - a. Expand performance measures to include SMF Performance Measures
 - i. E.g. reliability, benefit-cost
 - ii. Others – Mobility, travel time, delay; safety, productivity
 - iii. Output performance measures – VMT and PMT, VHT and VMT, and PHD
 - b. Determine Corridor Analysis Tools and Methods
 - i. Ensure Adequate Corridor Detection
 - c. Develop Data Collection Plan
 - d. Finalize Performance Measures
5. Describe Existing Conditions / Develop Preliminary Performance Assessment
 - a. Incorporate complete streets assessment
 - i. See D4 Complete Streets Guidelines
 - ii. Define what level of data collection and analysis is appropriate for this corridor study
 - b. Develop Corridor Analysis Model (e.g., TOPL)
6. Develop Alternatives / Scenarios
7. Evaluate Scenarios / Prepare Comprehensive Corridor Performance Assessment
 - a. Utilize tools for corridor performance assessment (e.g., TOPL)
 - b. Identify causality of corridor performance degradation
8. Prepare Document / Develop Corridor System Management Plan

Applying How To in the Pilot Studies: Subregional Long Range Transportation Plan

1. Define Purpose and Need
 - a. Define study goals and objectives
2. Define Stakeholder Engagement and Outreach Strategy
 - a. Assemble Project Team
 - i. Include all modes
 - ii. TAC
 - iii. Policy level stakeholders
 - b. Define meeting schedule and agendas
 - i. Identify attendance and expected outcomes from meetings
3. Define Study Area
 - a. Study Area should consist of analysis zones or accessibility clusters rather than a corridor focus.
4. Determine Approach and Performance Measure
 - a. Expand performance measures to consider SMF principles and performance measures
 - b. Identify measurement tools appropriate for subregional scale
 - c. Identify data needs and develop Data Collection Plan
 - d. Finalize Performance Measures
5. Describe Existing Conditions
 - a. Incorporate results from the Regional Transportation Plan / Sustainable Communities Strategy, and any other local plan that is relevant.
 - b. Make use of the regional travel demand model to cover some of the basic regional mobility measurements.
 - c. Prepare and develop tools for evaluation, e.g., ET+, Dashboard Calculator
6. Define Alternative / Develop Portfolio Scenarios
7. Evaluate Alternatives / Scenarios
 - a. Utilize tools for performance assessment, e.g., SCAG model, ET+, Dashboard Calculator
 - b. Monetize benefits according to performance measure results and conduct a benefit / cost analysis on project packages or scenarios
 - c. Prioritize scenarios according to their benefit / cost results, their fit with the plan and community vision, and unquantified considerations
8. Prepare Document / Prepare the Subregional Long Range Transportation Plan

RECOMMENDATIONS AND NEXT STEPS

A great deal was learned from the two pilot studies, both from the context of the actual planning efforts and for the continued implementation of the SMF. Building upon these two pilot studies are many opportunities to continue to advance to state-of-practice to incorporate smart mobility in all functional units within Caltrans as well as through engagement of outside partners. From the pilot studies, an overall process for implementing SMF was developed can be applied to other studies to demonstrate the breadth and applicability of this framework in all geographic areas of the State. The following are recommended actions to further advance the use of the SMF in Caltrans' and partner agencies' work. These specific actions build upon the on-going efforts at Caltrans and partner agencies to develop strategies and methodologies to integrate smart mobility principles, concepts, and performance measures into the day-to-day practices.

Context and Scale

The SMF principles are a broad framework that is meant to be applied at all levels, statewide, regionally, and locally, but allows for refinement at the regional and local levels to better reflect the unique context. Beyond these two pilot studies, SMF is being incorporated into other transportation planning studies. For example, in Caltrans District 5, San Luis Obispo Council of Governments applied SMF performance measures in the US 101 Mobility Study in San Luis Obispo County as a tool for screening and prioritizing the mobility needs along the corridor. Additional pilot studies would not only increase the body of experience that can be used to explore the best methods to incorporate the SMF more broadly into practice statewide, but also inform how the SMF can be adapted and refined in the future.

1. Conduct pilot efforts outside of major metropolitan areas

The SMF serves a different function in highly urbanized areas with sufficient resources to develop performance measures than it does in smaller communities that have yet to face the full suite of problems that unfettered transportation demand combined with a built-out transportation network can cause. In areas that do not have the resources to advance their own programs to the level of larger, better funded MPOs, the smart mobility principles can serve as a fundamental form of guidance to modernize performance measurement programs for state and federal funding requirements and to meet state law.

- Develop a work plan for each pilot following the general approach described in the How To section to reflect the local scale, political environment, and planning context.
 - The study could include the development of tools to assist those areas with applying the SMF depending upon the resources available.

2. Conduct pilot studies implementing other project types

The two pilot studies covered freeway corridor planning and sub-regional long range planning. However, the SMF can be incorporated into other transportation planning practices as well, such as community plans, circulation elements, and other Caltrans' system planning products. Additional pilot studies could also be broadened to determine how the SMF can be included into areas such as Local Development-Intergovernmental Review process, project initiation documents, and ultimately programming processes.

- Develop a work plan for studies following the general approach described in the How To section to reflect the local scale, political environment, and planning context.
 - Apply the broader SMF principles when developing policies and performance measures.
 - Apply the SMF place types in the study to identify transportation projects and programs that should be considered priorities for investment that will achieve smart mobility benefits.

Place Types

As shown in the two pilot studies, land use context can be incorporated using the SMF place type or similar typologies, in this case, Metro's accessibility clusters. The place type analysis served to be valuable for describing the land use context, but there is more potential with applying the place types to help identify and prioritize transportation project and programs to achieve smart mobility benefits as measured with some of the SMF performance measures. This is particularly true for bicycle and pedestrian improvements that would serve to reduce auto travel, increase mode share, and improve overall multimodal accessibility.

3. Apply SMF Place Types to incorporate land use context in transportation decision-making, specifically when identifying and prioritizing transportation projects and programs

The SMF place types analysis provides a better understanding of the land use context. The SMF place type can then be used as the basis for making investment, planning, and management decisions. SMF place types can be used to identify transportation projects and programs that have the greatest potential to increase the degree of location efficiency, which is based on community design and regional accessibility. For each place type, the SMF provides guidance on key planning activities, transportation projects and programs, and development and conservation projects and programs that are likely priorities to achieve smart mobility outcomes.

Performance Measures

The SMF is not prescriptive in requiring all 17 SMF performance measures to be applied, but rather allows for flexibility in their selection as well as the specific metrics. SMF provides a framework for

each study type to develop a more robust palette of performance measures that can be used by communities and regions to assess their alignment with the SMF.

4. Develop guidance in selecting SMF performance measures

Neither pilot area study was able to implement all 17 SMF performance measures due to limited availability of data. Supplementary measures were also added to meet the unique needs of each study. (See Appendix D for I-680 and Appendix G for South Bay Cities.) The selection of performance measures was influenced by the existing data sources, the measurement tools that were available, and metrics already being used by the MPOs, county congestion management agencies, or Caltrans. As more data sources become readily available, more robust performance measures can be used.

The guidance proposed for selecting SMF performance measures should follow a process similar to that applied for the two pilot studies:

- Review 17 SMF performance measures and their recommended metrics (See Table 1.)
- Consider the following in selecting performance measures:
 - Relevance. Do the performance measures reflect the desired outcomes? Do the performance measure directly relate to the goals and objectives of the study?
 - Comprehensiveness. Do the performance measures inform how well each alternative meets the study objectives?
 - Comprehensibility. Are the performance measures sufficiently well-defined to be clearly understandable to decision-makers and managers?
 - Tools and Data. Are sufficient data available to determine the performance measure now as well as tools to forecast them in the future?
- Document rationale for selected performance measures.

5. Expand the Caltrans District 4 Complete Streets Guidelines to Statewide Guidelines

As part of the I-680 CSMP, the Complete Streets Evaluation (see Appendix E) based on District 4 Complete Streets Guidelines was used as the metric for the SMF performance measure of multi-modal service quality.

- Expand the district level complete streets guidance to a statewide guide to operationalize into Caltrans practices consistently throughout all districts.
- Provide better guidance on the level of data collection and analysis appropriate for different types of planning studies.

Data Sources and Data Collection

One of the concerns with applying SMF performance measures is the amount of data needed as well as the resources and tools available for data collection and analysis. Data collection and analysis can be costly and time consuming.

6. Incorporate new data sources and data collection technologies

- New data sources and data collection technologies continue to be more readily available. Existing processes can be refined and new processes can be initiated. Partnerships can even be formed with other agencies to share and exchange data. Incorporate availability of existing data, such as PeMs, InRIX, BlueMAC, etc, to support new models and methodologies for calculating SMF performance measures.
- Utilize new data sources and initiate data collection technologies for active transportation, such as cell phone data or installation of automated bicycle and pedestrian counters, to collect data on trips and mode share.

7. Identify data needed to calculate SMF performance measures and provide adequate resources

With the availability of new data sources and data collection technologies, resources previously allocated for data collection may be available for other efforts, once the data has been validated and compared to the previous data collected. With some of the SMF performance measures, such as multimodal level of service (MMLOS) and reliability, the amount of data necessary for calculating new metrics has increased. While defaults can be applied in some cases, the data collection plan and the approach to applying these new metrics needs to balance the data needs with available resources.

- Identify data needed to calculate MMLOS and propose an approach that balances data needs with available resources.
- Identify data needed to calculate reliability, such as incident response times and weather.

8. Monitor, collect, and evaluate post-project data

In order to better understand if the desired outcomes are met once the transportation projects are completed, plans should be made to monitor, collect, and evaluate post-project data. Existing data sources can provide the necessary input, but need to be available for the entire study area and need to be collected on a cycle that allows the performance measurement program to be repeated at regular intervals. This data would be particularly valuable in not only assessing outcomes, but for also validating planning tools where the current data is limited.

- Collect and evaluate data to monitor progress at achieving the project goals once transportation projects are constructed and programs are implemented.
- Document data and analysis for use in validating planning tools.
- Include post project data collection as part of grant requirements to allow for funds to collect additional data for monitoring.

Analytic Tools and Models

Choosing an analysis tool, or package of tools, was a challenging exercise in both pilot studies. There are many tools with different capabilities, customizability, licensing, and transparency. Existing tools are being expanded and upgraded, while new tools are being developed. It is unlikely that any single tool will be able to evaluate every smart mobility performance measure adequately for every context. The scale of the study, the type of projects being evaluated, and even the horizon year will impact the effectiveness of many tools. With legislated requirements to measure climate change and traffic impacts traditional approaches and performance measures are necessarily changing, so best practices are being redefined.

Some of the challenges experienced with tools and tool development during the pilot studies include:

- **Scale.** Various performance measures and tools operate at different spatial resolutions to each other. At the sub-regional level for the South Bay Cities study, the tool needed to address both regional travel patterns and local neighborhoods.
- **Transportation Improvements.** For innovative transportation projects, the dashboard tool was developed such that the user could input assumptions about the transportation projects by mode (NEV, Bike, Walk, Transit, and HOV).

9. Develop and validate post-model tools that interface with travel demand models or sketch models

This type of post-model tool was developed in the South Bay Cities pilot study. The outcome is that a tool like this could be used to post-process travel demand model at a local neighborhood scale to measure the benefits of innovative transportation and land use strategies towards achieving more sustainable results.

- For the South Bay Cities, the Strategic Growth Council grant covers conducting further studies and developing the tools and framework. Metro, the SBCCOG, San Diego State University (SDSU) and the Los Angeles Regional Collaborative for Climate Action and Sustainability (LARC), a program of UCLA, have formed a partnership, to develop tools to implement the Sustainable South Bay Strategy.

10. Develop neighborhood travel models to nest within the regional travel demand models

The neighborhood travel model would capture the local trips that occur at the neighborhood scale as well as the transportation interactions with land use and urban design that are not currently captured in the sketch model or the regional travel demand models.

11. Develop a process or simple tool for jurisdictions with limited modeling capabilities or resources

For areas in the state without the tools and resources to develop local travel demand models or sketch planning models, a more qualitative and less data intensive approach is needed. Alternately, the California Statewide Travel Demand Model (CSTDm) may be applied.¹

12. Develop better tools that are sensitive to active transportation and innovative transportation

As shown with the South Bay Cities pilot, active transportation modes, such as walking and bicycling, and innovative transportation, such as the neighborhood electric vehicle program and mobility hubs, have the potential to reduce auto travel, yet tools are still in development to capture the smart mobility benefits.

- Provide flexibility to incorporate alternative transportation modes beyond bicycles and transit, such as electric vehicles, bike share, car share, and information technologies.
- Develop and locally validate thresholds and elasticities for innovative projects and alternative transportation modes that can be used to base future measurements and predictions.

13. Support additional research in development of TOPL tool

The I-680 pilot study was supplementary to and complementary with the ongoing CSMP, which also included a demonstration of the Tools for Operational Planning (TOPL) operations analysis tool developed by UC Berkeley.

- Conduct additional demonstration tests of TOPL to include parallel arterials for a more system-wide analysis.

Research and Best Practices

Conventional approaches and performance measures are changing, so best practices continue to be redefined. It is difficult to develop a performance measurement system that will be consistent year over year with changing priorities, best practices, legislation, and data sources. For that reason, maintaining existing processes where they do not conflict with current policies is important. Changes in legislation should include weighing the costs to implement the change to its benefits.

¹ The California Statewide Travel Demand Model (CSTDm) Version 2.0 is a multimodal, tour-based travel demand model that can forecast all types of travel as well as interregional trips. For more information, see:

http://www.dot.ca.gov/hq/tpp/offices/omsp/statewide_modeling/cstdm.html

14. Continue research and information sharing on best practices

Many state departments of transportation (DOT) are developing and implementing institutional policy changes to incorporate sustainable transportation into agency practice as learned from the Caltrans Preliminary Investigations (PI) and the literature review (see Appendix A).

- Follow up from the literature review with other state DOTs, such as PennDOT and New Jersey DOT, in sharing lessons learned from implementation of the Smart Transportation principles or Washington State DOT's accountability report in its *Gray Notebook*.
- Partner with other state agencies, such as California Natural Resources Agency, to further the SMF principles similar to what North Carolina DOT and that state's Department of Environment and Natural Resources did with the North Carolina Sustainable Communities Task Force.

15. Identify and incorporate best practices and latest research on reliability as a performance measure

Given the interest in the predictability in travel time, future studies should utilize travel time reliability as a performance measure, particularly for corridor management where additional capacity and expansion is not feasible. While the on-going research focuses on travel time reliability for autos, reliability needs to include all modes, particularly, on urban arterials.

- Identify latest research and best practices in reliability
 - Utilize available data sets and identify gaps for additional data collection, such as the Federal Highway Administration's (FHWA) National Performance Management Research Data Set.
 - Review tools available or under development, such as
 - University of Florida/Florida Department of Transportation (FDOT) spreadsheet
 - Transportation Research Board (TRB) Strategic Highway Research Program (SHRP)2-C11 Model
 - Highway Capacity Manual (HCM) 2010 Update

Conclusion

The culmination of many small achievements in these pilot studies resulted in one large lesson learned - that consistently applying the SMF principles, place types, and performance measures into current planning processes can result in incremental policy and program level changes. These changes affect how suites of transportation solutions are identified and are funded. Through the cooperation of state, regional and local planning staffs, creative approaches were found to apply

the SMF in their own local context. This also showed that the SMF is sufficiently flexible and resilient to fit the needs of various situations, and that it does not require a rigid “all or nothing” approach. Finally, the results of these studies demonstrated that incorporating multiple goals and broader performance measures into transportation planning is feasible, and through the collaborative process that engages various stakeholders, can achieve sustainable and livable outcomes for our communities and state. The role of the SMF in the planning process as it becomes standard statewide practice serves to guide Caltrans in achieving the vision and goals established in the Department’s modernized mission to “provide a safe, sustainable, integrated and efficient transportation system to enhance California’s economy and livability.”

TECHNICAL APPENDICES

Appendix A	Literature Review Memo
Appendix B	I-680 CSMP (PA 1) Work Plan
Appendix C	I-680 CSMP (PA 1) CSMP Place Types Analysis
Appendix D	I-680 CSMP (PA 1) I-680 CSMP Performance Measures Memo
Appendix E	I-680 CSMP Complete Streets Evaluation
Appendix F	I-680 CSMP (PA 1) MMLOS Approach, Segment Selection, and Results Memos
Appendix G	I-680 (PA 1) Final Report
Appendix H	South Bay Cities (PA 2) Work Plan
Appendix I	South Bay Cities (PA 2) Approach Memo
Appendix J	South Bay Cities (PA 2) Analysis Results Memo
Appendix K	South Bay Cities (PA 2) Final Report