Introduction

With the Smart Mobility 2010: Call to Action for the New Decade,[1] the California Department of Transportation (Caltrans) launched a new approach to integrating land use and transportation and a new framework for transportation planning and decision-making. 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 includes principles, place types, and performance measures that can be integrated into the planning process. This paper covers the approaches to applying the smart mobility principles, place types, and performance measures as well as the lessons learned from two pilot implementations of the SMF in California focusing upon the multimodal performance measures.

Background

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

To put these SMF concepts into practice, they need to be tied to the current processes and policy contexts 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 to evaluate both freeway operational performance and multi-modal circulation along parallel facilities. 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 assess alternative land use density distribution and innovative transportation strategies and program. 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).

The implementation study 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. [2]

[1] California Department of Transportation (Caltrans). *Smart Mobility 2010: Call to Action for the New Decade*, February 2010.

[2] See http://www.dot.ca.gov/hq/tpp/offices/ocp/Final_Report_24_March_2015.pdf for final report.

An Approach for Integrating SMF

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. A process was identified 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. It is during this step of defining approach and performance measures (as indicated by the orange box) to consider including SMF performance measures.

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 due to congestion. 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 the principles and performance measures.

These measures reflect a very robust set of factors that can be used in the development of variety of transportation plans. However, the SMF also makes it very clear that every community and every planning study needs to identify which of these 17 measures were most applicable to that particular study. 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.

Applying Performance Measures in the Pilot Studies:

For the two 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, while considering the broader policy goals.

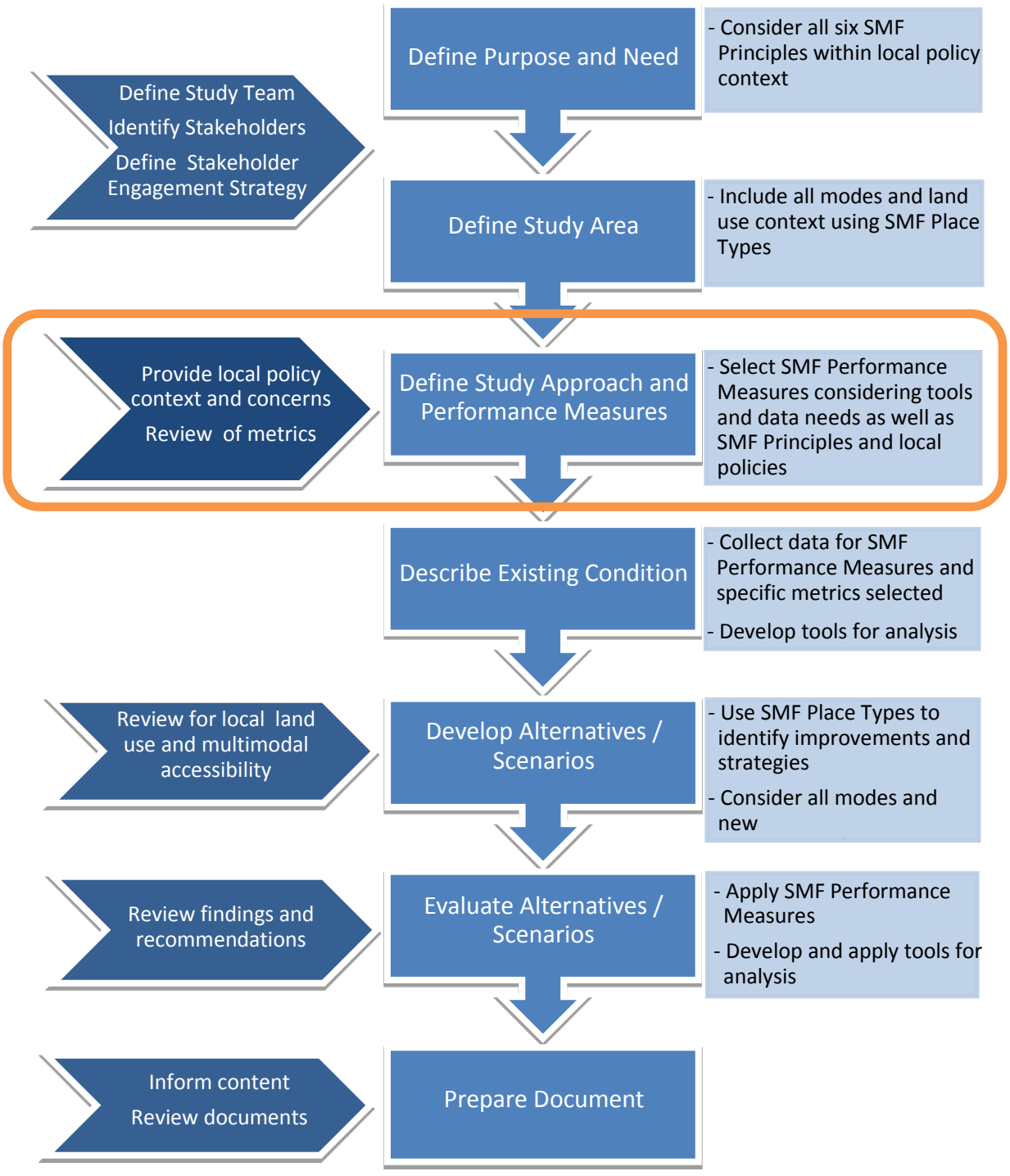

Figure 1 Planning Process with SMF and Stakeholder Engagement

Table 1. SMF Principles and Performance Measures

Principle	Performance Measure*
Location Efficiency	1. Support for Sustainable Growth
	2. Transit Mode Share
	3. Accessibility and Connectivity
Reliable Mobility	4. Multi-Modal Travel Mobility
	5. Multi-Modal Travel Reliability
	6. Multi-Modal Service Quality
Health and Safety	7. Multi-Modal Safety
	8. Design and Speed Suitability
	9. Pedestrian and Bicycle Mode Share
Environmental Stewardship	10. Climate and Energy Conservation
	11. Emissions Reduction
Social Equity	12. Equitable Distribution of Impacts
	13. Equitable Distribution of Access and Mobility
Robust Economy	14. Congestion Effects on Productivity
	15. Efficient Use of System Resources
	16. Network Performance Optimization
	17. Return on Investment

* Most of the performance measures relate to multiple principles. This Exhibit groups each of the performance measures with the principle with which it is most strongly related.

Source: Caltrans. Smart Mobility 2010: A Call to Action for the New Decade, Exhibit 10: Smart Mobility Performance Measures, p. 51.

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. A total of nine of the 17 SMF performance measures was selected for the CSMP. As shown in Table 2, which focuses on the multimodal measures, 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 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 "forecasting" of the future scenario (as indicated in column 6). As indicated, for the multi-modal service quality, both Highway Capacity Manual Multi-modal Level of Service (MMLOS) methodology as well as a Complete Streets evaluation developed for Caltrans District 3 were conducted as part of the preliminary performance assessment. The results of the analysis can be found in Appendices E and F of the SMF Implementation Pilot Study Final Report.[3]

[3] The full SMF Implementation Pilot Study Final Report with Technical Appendices can be found: http://www.dot.ca.gov/hq/tpp/offices/ocp/smf.html#SMFImplem

Table 2. I-680 Performance Measures, CSMP Goals, Multimodal 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

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, I-680 Corridor System Management Plan, 2014.

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, a subset of which focused on multi-modal measures. (See Table 3.) Mode share, which included transit, bicycling, walking, and NEVs, was used to compare the four portfolio scenarios that represented bundles of transportation projects and varying land use distribution at the neighborhood scale. For this pilot study, these performance measures were analyzed using outputs from the SCAG travel model as well as the Envision Tomorrow Plus sketch planning model through a post-model Dashboard tool.

Table 3. South Bay Cities Performance Measures and Metrics

SMF Performance Measure	Performance Metric
Accessibility and Connectivity	Average Proximity to Employment (30 min by Transit)
	Average Proximity to Employment (20 min Drive)
Multimodal Travel Mobility	Average Vehicle Occupancy (AVO)
	Modal Travel Time and Cost
Multimodal Service Quality	NEV, Bicycle, Walking Facilities
Transit Mode Share	Percentage of Trips by Transit
Neighborhood Electric Vehicle	Percentage of Trips by NEV
Pedestrian and Bicycle Mode	Percentage of Trips by Bicycling
	Percentage of Trips by Walking

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

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 smart mobility principles when selecting performance measures.

Conclusion

The lesson learned from the SMF Implementation Study is that consistently application of the SMF principles, place types, and performance measures into current planning processes can result in incremental policy and program level changes that will lead to system-wide, multi-modal transportation solutions being identified and ultimately funded. Through the cooperation of state, regional and local planning staffs, an approach was found to apply the SMF concepts throughout the planning process to lead to more multi-modal transportation solutions. As additional resources are allocated to transportation planning, the challenges related to the limitation of tools and data needs will soon be overcome as additional research, technology, and the availability and broader use of "big data" continue to change how transportation planning is done in California using the SMF.

Acknowledgements

I would like to acknowledge Caltrans SMF staff and other team members (Emily Mraovich, Ann Mahaney, Darwin Moosavi, Alyssa Begley, Erik Alm, Leonard Seitz, Sara Jepson, Wally Siembab, Steve Lantz, Tarek Hatata, Bruce Appleyard, and Darryl dePencier), who contributed to the preparation and review of the SMF Implementation Study Final Report, upon which much of the material in this paper is excerpted.