Use of Performance Measures that Prioritize Automobiles over Other Modes in Congested Areas

Overall Effect on California Petroleum Use		Affects Petroleum Demand Through Intermediate Indicators:	
Magnitude	High	**Primary**	Improved system operations efficiency with offsetting increase in distance traveled
Certainty	Medium	**Secondary**	Mode Choice
Applicable Level of Government	Local		
Relevant Laws or Cases Affecting Factor	California Government Code §65088.3, §65089, §65460.4 Various local and county planning documents		
Time horizon for implementation and maturity	Shifting to an alternate measure of transportation system performance will have an immediate effect on future decision-making. However, the obdurateness of past transportation infrastructure decisions means that the full effects of such a change would take decades to mature.		
Relevant Topics	level of service, traffic congestion, transit priority, roadway expansion		
Summary	Many commonly-employed performance metrics for transportation system analysis explicitly or implicitly ignore modes other than the automobile. The result is that many projects to expand the transportation network focus on adding automobile capacity at bottlenecks, rather than using alternatives to move additional persons. Because modes other than the automobile are excluded from the scope of analysis, many transportation projects impair the service quality of transit, walking, and biking. The implications are a profound effect on urban travel and motor vehicle fuel use.		

Introduction

Local governments throughout the United States use transportation system performance metrics and set performance goals that guide transportation and land use decision-making. The goal of performance management in transportation is to provide the public with a high-quality transportation network. This is generally interpreted as a mandate to reduce vehicular traffic congestion. In this brief, the authors assess the implications of methodological choices on public decision-making and long-run system impacts.

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The use of current or projected performance levels is a key driver of decisions to expand transportation system capacity at bottlenecks. As explained below, this practice causes traffic congestion, which would ordinarily provide negative feedback to drivers, to become a positive feedback loop on the transportation system. In absence of performance targets, traffic congestion would provide negative feedback to signal the need for alternatives, such as increased vehicle occupancy, alternative routes, or shifting of trips to different times. However, for a local government constrained by automobile-centric performance metrics, the potential for traffic congestion signals a need to expand bottlenecks and reduce densities. Such measures spread traffic outside the scope of a localized analysis and induce additional driving trips and distance traveled. The long-run, cumulative effects of such decisions in a land-constrained environment can be traffic congestion that is dispersed rather than concentrated, reducing planners' ability to address congestion through alternative measures.

In practice, very few state or local governments incorporate level of service methods that consider modes other than the automobile. A myopic focus on automobile travel often precludes alternatives to increase a roadway's effective capacity through use of high-occupancy vehicles. When tied to land use approvals, the analysis of transportation system performance can lead to reductions in density and diversity of land use that increase trip distance and urban design trade-offs that reduce walkability. When modes other than automobile travel are ignored by transportation performance analysis methods, improvements made in support of automobile travel can adversely impact other modes.

Because automobile-centric performance analysis metrics drive continual decisions to reinforce driving at the expense of other modes, their effect on California petroleum use is large.

Level of service

Level of service methodologies attempt to estimate a driver's perception of service quality. Traffic engineers give an intersection or roadway segment a grade—A through F—as a proxy for drivers' perception of service quality.

In general, two types of methods exist: those that apply to signalized intersections and those that apply to open roadways. As it is impractical to directly query drivers' reactions to a roadway segment, traffic engineers substitute input data that is easier to collect. Automobile level of service methods for roadways use one or more of the following inputs: theoretical capacity, observed volumes, observed speeds, number of stops, and presence of roadway amenities and disamenities. Automobile level of service methods for intersections typically use average delay at the intersection or ratio of observed volumes to theoretical capacity.

Recent studies question the ability of existing auto-based methods to accurately estimate drivers' perception of service quality. The current state-of-the-practice method is somewhat lacking in precision and accuracy. When evaluated against recorded video, the method outlined in Highway Capacity Manual 2010 correctly identified automobile level of service grade in 77% of cases (Transportation Research Board, 2010). A study by Pécheux, et al (2000) suggests that drivers perceive a maximum three or four, rather than six, different levels of service quality at signalized intersections. These two studies are just a sampling of those which have questioned the validity of automobile level of service analysis.

Various alternative methods exist to analyze transportation system performance across modes. In 2010, the Transportation Research Board's National Highway Cooperative Research Program published Multimodal Level of Service Analysis for Urban Streets which details methods that can be used to assess user perception of service quality for a variety of modes: transit, bicycling, and walking, in addition to driving (Transportation Research Board, 2010b). Other metrics that can be used to assess system performance include person-delay (Milam, 2009), automobile trips generated, motorized trips generated (Hiatt, 2006), or all trips generated.

Criticisms of automobile-only transportation system analysis

First, many automobile level of service methods consider delay experienced by drivers, with no consideration of passengers, including public transportation passengers. Methods use vehicles rather than people as the key unit of measurement. The shortcomings of an automobile-centric method are especially pronounced when a city or transportation agency seeks to prioritize movement of high-occupancy vehicles and transit as a means to increase the flow of people through a congested area. When a traffic engineer applies any method that employs the vehicle as the primary unit of analysis, a crowded bus shares equal weight with a single-occupant automobile. If the project under consideration includes a transit priority treatment, such as bus-only lanes or signal priority, the traffic engineer would expect reduced delay for transit passengers and increased delay for automobile drivers in parallel traffic (in the case of repurposing a general lane to transit) or cross-traffic (in the case of prioritizing transit vehicles at signalized intersections). However, automobile-centric methods measure costs borne by vehicle drivers but ignore the benefits that accrue to passengers on transit and in high-occupancy vehicles. The additional delay experienced by automobile, bus, and transit drivers would be captured as an adverse impact, but the primary benefit of the project—reduced delay for transit passengers—is excluded from the analysis. The result of the automobile level of service calculations could indicate that the project would degrade level of service—which in many cases must be mitigated by eliminating the HOV or bus-only lane.

The result is similar when a proposed bicycle treatment will reduce automobile capacity, either by removing a mixed-flow vehicle lane or adding amenities for non-motorized modes. Henderson points out that many of the treatments used to make bicycling and walking safer degrade level of service (2011). These include pedestrian amenities such as wider sidewalks, street trees, raised crosswalks, and intersection bulb-outs to reduce crossing distances; and bicycle amenities such as dedicated lanes and physical separation of bicycle paths from vehicle paths. Traffic engineers seeking to optimize a roadway for level of service have removed such multimodal amenities over the years.

Secondly, mitigating adverse impacts, as identified by automobile-centric methods, leads to additional driving at the expense of alternative travel modes. Under the California Environmental Quality Act, a local government must assess the potential environmental impacts of a development project, change in roadway configuration, or other discretionary action. If an initial analysis projects some potential environmental impact, the local government must conduct further study of those impacts. Further study is typically conducted at the developer's expense for private projects and at government's expense for public projects like bus and bicycle lanes. When the local government determines that there will be a traffic impact—specifically that the project will cause delay at intersections to exceed the goals expressed in their general plan—then they must either mitigate this impact or detail the overriding considerations that outweigh the environmental impact. Traffic engineers have a few options to reduce delay at intersections: adding through lanes, adding turn lanes, widening lanes, synchronizing traffic signals, adding left-turn traffic signal phases, and reducing vehicle and pedestrian cross-traffic. Once such options are implemented, the roadway can accommodate additional traffic before delay again exceeds the goals expressed in the community's general plan.

These options often improve the automobile user experience at the expense of the pedestrian user experience. After a local government implements these measures to mitigate impacts to the transportation network, pedestrians must usually travel further to crosswalks to wait longer to cross wider streets. In built-up areas with no space to expand the right-of-way, roadway widening may come at the expense of sidewalk width.

If a local government has exhausted measures to mitigate automobile impacts in a corridor, all future development projects in a congested corridor will have a significant unmitigatable impact. While increasing transit service, which operates more effectively in denser environments, may be one possible measure to increase the number of people who can travel through a corridor—vehicle occupancy is not intrinsic to the automobile level of service model. Thus, a common mitigation measure is to downscale or reject new land use projects in the corridor.

A third common criticism is that level of service is frequently measured based on fifteen minute peak weekday demand, which may not accurately represent the average drivers' experience and could mislead investment decisions. Many methods fail to distinguish between a roadway that is congested for seven hours a day, and roadway that is otherwise uncongested but experiences significant delays for 15 minutes at the end of the school day. At which location should the local government prioritize investment? With many existing methods, the answer lies outside of the standard performance metrics. To better categorize performance and prioritize investment decisions, Caltrans incorporates duration into its level of service metrics. For example, LOSF4 means a highway segment that is severely congested for 4 hours per day (Hiatt, 2006).

Transportation System Performance Analysis in California

Transportation system performance analysis is incorporated into two California planning processes: The California Environmental Quality Act and the Congestion Management Program.

The California Environmental Quality Act requires that lead agencies assess the environmental impacts of their decisions. When it appears that a decision will have a significant environmental impact, the lead agency must prepare an environmental impact report that studies—and proposes mitigation alternatives for—significant environmental impacts. Local governments have the option of mitigating the impacts so that they're no longer significant or claiming that the benefits of the decision outweigh the environmental impacts, known as a statement of overriding considerations.

Municipalities and counties act as lead agencies for land use decisions within their jurisdictions. In general, cities and other lead agencies define thresholds for what constitutes a significant impact in their general plans. However, through statutes and regulations, the State of California also sets many thresholds of significance for certain impacts, such as air quality and water quality. The state affords lead agencies discretion in assessing impact levels and in defining significant impacts.

Many of the environmental factors protected in the California environmental review process pertain to the ability of an area's infrastructure to accommodate a decision, usually a land use decision such as the approval of a new development project. Lead agencies must assess if existing infrastructure (electricity, telecommunications, water delivery, and sewage) and services (public safety) in the area can support the project without exceeding significance standards. Lead agencies must also assess how a project will impact an area's ecological resources, such as species, water, air, and noise.

Transportation and traffic impacts are analyzed as infrastructure impacts rather than ecological impacts - the air quality and noise impacts of vehicles are analyzed separately. Neither the CEQA Statute (Public Resources Code §§21000-21177) nor its Implementation Guidelines (14 CCR, Division 6, Chapter 3, §§15000-15387) require use of a specific method or require the use of a specific methodology. The Guidelines instead require that lead agencies assess whether or not a decision will conflict with an existing plan, ordinance, policy, or congestion management program.

Under CEQA, local governments maintain the ability to choose the specific level of service estimation method employed and which modes should be included in the analysis of transportation network performance. Henderson (2011) notes that San Francisco, like many jurisdictions in California, adopted automobile level of service in the 1970s as a response to the California Office of Planning and Research's CEQA implementation guidelines. In many cases, level of service was adopted by city traffic engineers with no input from the public or city council (Henderson, 2011).

In 1990, the California Legislature established the Congestion Management Program (Government Code §65089). The statute requires Congestion Management Agencies in areas with a population of 50,000 or more to set thresholds and monitor level of service standards for highways and arterials in order to receive gasoline taxes. Thresholds must be no lower than E, unless an intersection or segment experienced level of service F when the bill was passed. If an intersection falls below a threshold, the Congestion Management Agency must develop a deficiency plan to improve level of service. Infill opportunity areas (defined in §65460.4) are exempt from the deficiency plan requirement. Additionally, the program does not apply to counties where local governments representing a majority of the population adopt resolutions seeking exemption (§65088.3).

In contrast with CEQA, the Congestion Management Program statute requires agencies to use automobile level of service, as presented in the Transportation Research Board's Highway Capacity Manual (Transportation Research Board, 2010) or Circular 212 (Transportation Research Board, 1980).

Los Angeles case study

Since local implementations of transportation system performance analysis vary across the state, examining a singular implementation can aid in understanding the potential effects. Los Angeles City and County are the largest in the state, and thus their policies have the largest potential to affect statewide petroleum demand.

The City of Los Angeles has codified "level of service" through ordinance, but has not codified a specific methodology for calculating level of service. The City of Los Angeles Municipal Code (Chapter I, Article 4) requires that public benefit projects do not degrade transportation level of service. The City's adopted General Plan (Transportation Element - Chapter VI - Street Designations and Standards) establishes standards for spot widening streets operating at level of service D or worse in order to gradually widen rights-of-way as abutting properties are redeveloped.

The City of Los Angeles Department of Transportation publishes Traffic Study Policies and Procedures (2012) to provide guidance for independent engineers conducting traffic impact studies/transportation impact assessments. In this document, the Department establishes the required traffic study methodology, Critical Movement Analysis, and defines "significant" impacts. Critical Movement Analysis is a 33-year old methodology for intersection level of service that uses volume to capacity calculations to rate service quality (Transportation

Research Board, 1980). This method differs from the state-of-the practice intersection methodology, which uses observed delay at the peak period (Transportation Research Board, 2010b). The Department acknowledges that this method is inaccurate for corridors where congestion at intersections reduces capacity at upstream intersections or when pedestrian activity in crosswalks reduces intersection capacity. Additionally, the Department acknowledges that the method is not appropriate for evaluating transit, bicycle, and pedestrian enhancements as it is "primarily an automobile-oriented measure" (City of Los Angeles Department of Transportation, 2012). The Department continues to evaluate other options to measure the performance of other transportation modes.

The 2010 Congestion Management Program for Los Angeles County establishes monitoring procedures and performance standards for segments and intersections in the County (Los Angeles County Metropolitan Transportation Authority 2010). These standards apply to both vehicle movements and transit system performance at certain intersections and in certain corridors. The Program allows local governments to use one of two methods for intersections: Intersection Capacity Utilization and Critical Movement Analysis (as used by the Los Angeles Department of Transportation) for intersections. Because several intersections and roadway segments in the county exceed the minimum standard of LOS "E", the county must prepare a deficiency plan to analyze the cause of the deficiency, propose mitigation measures, and prepare an action plan. The Program cross-references other transportation planning documents that include specific mitigation measures, such as freeway widening and system management plans.

Effect on Fuel Use

The net fuel-use effect of automobile-centric performance metrics and targets depends on the net result of three effects. First, if distance traveled is held constant, congestion reduction efforts that smooth traffic flow will lead to increases in system operations efficiency and reductions in fuel use. Second, any increase in distance traveled attributable to the congestion reduction efforts will increase fuel use. Third, congestion mitigation measures often reduce accessibility and the quality of non-auto mobility, shifting individual mode choice decisions toward automobile use.

It may be difficult for traffic engineers to observe smoothed traffic flow, even in the short-run. Scholars agree that traffic congestion affects travel behavior. Most famously, Anthony Downs argues that relieving peak period congestion causes travelers to shift from other modes (such as carpools), from other roads (usually parallel routes), and other times (Downs, 2004). When traffic congestion is mitigated, triple convergence and the expression of previously latent demand occurs almost immediately. This causes the benefits of capacity expansion or system management to accrue not only to those previously using the transportation facility during peak hours, but to those who had previously adjusted their travel in response to congestion. Thus, the congestion reduction effects are somewhat muted when observing the facility during peak demand, but are more observable on other routes and at non-peak times. Thus, the system operations efficiency benefits on fuel use are likely to be *de minimis* or immeasurable.

More important in determining the net fuel-use effect are any increases in distance traveled due to latent and induced demand. Most existing studies address induced demand: trips resulting from changes in land use enabled by vehicle capacity expansion or congestion reduction efforts. The case of suburban freeway expansion enabling additional development is easy for scholars to study.

Few studies have examined latent demand, or trips avoided due to congestion. These are discretionary trips—such as a trip across town for dinner with friends—that a traveler elects to forgo or substitute an inferior trip in response to traffic congestion. Because latent demand is not expressed, it is difficult measure. Even if latent demand is measured in one study, this information is unlikely to apply to other areas with varied, but unmeasured levels of latent demand.

The net effect automobile-centric performance standards have on petroleum use in a corridor depends on the level of latent demand relative to total travel. In a congested urban area with significant latent demand, congestion reduction will be small and the observed changes in petroleum demand are likely to range from a relatively small reduction to a relatively moderate increase. Those who respond to congestion mitigation by shifting from other modes (e.g. transit to single occupant vehicle) and those who express latent demand will produce net increases in distance traveled.

In areas where latent demand is insignificant relative to peak travel volumes, then congestion reduction efforts will produce more observable reductions in congestion. If latent demand is combined with low rates of mode shift to single occupant vehicles, then the short run effects will be a net reduction in congestion and a net reduction in petroleum use. However, it's possible (but not certain) that growth-inducing impacts could generate additional travel demand in the long-run, leading to higher levels of motor vehicle fuel demand versus a counterfactual in which the lack of the transportation facility stimulated additional demand for infill development near existing trip ends. In such cases, use of automobile-centric performance metrics is a contributing factor to sprawl.

Furthermore, anecdotal evidence from Henderson (2011) suggests that use of automobile-oriented level of service methods affect transportation planning in ways other than those included in CEQA studies and Congestion Management Program documents. In San Francisco, traffic engineers have discouraged adding new pedestrian crosswalks in certain instances because additional vehicle delay to allow pedestrian crossings could degrade level of service. The City of San Francisco originally focused on implementing bike lanes that would not significantly impact level of service—meaning that bike lanes were located in areas that had fewer bicycle/vehicle conflicts.

While the use of automobile-centric performance metrics affects system operations efficiency, distance traveled, and mode choice, it's quite difficult to quantify these effects. However, it's possible to estimate the effects of street widening using Highway Statistics data (U.S. Federal Highway Administration, 2010). Because they carry large volumes of surface street traffic, principal arterials are often targets of efforts to reduce congestion through widening. Additionally, principal arterials often appear in congestion management plans and have performance targets. In 1980, the average width of a principal arterial in California was 3.374 lanes. In 2010, the average width was 3.886 lanes. If, in 2010, principal arterials were as wide as in 1980, but carried the same amount of vehicles per lane as they do in 2010, the result would be a 2.1 billion mile (0.65%) decrease in statewide vehicle travel.

Factoring in less observable effects on other aspects of the transportation system for which automobile-centric performance metrics are a contributing factor - the distribution of land uses, and density, and the combined effect of land use and transportation infrastructure on mode choice - the total effect on motor vehicle fuel use is likely greater than 3%, perhaps as high as 15%. Changing performance measurement methods to better support multimodal solutions as mitigation measures in congested areas, rather than roadway expansion and reducing project density and intensity, could be expected to have a similar magnitude reduction in long-run fuel use.

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