Transportation Service Standards—As If People Matter

REID EWING

The land use–transportation system is just that—a system—but it is seldom planned or managed as such. Instead, roads are viewed in isolation, and system performance is measured by levels of service on individual roadways. Operating speed becomes the essential element in transportation planning. The emphasis on speed encourages excess travel and contributes to urban sprawl, undermining society's environmental, energy, and growth management goals. In Florida and Washington State, the search is on for better ways to measure transportation system performance. Adding impetus is the neotraditional planning movement, which has rejected speed as the ultimate measure of performance but only hinted at what might replace it. A paradigm shift in performance measurement—from speed to personal mobility, accessibility, livability, and sustainability—is argued. Alternative performance measures used around the United States are identified and assessed preliminarily. Growth management systems of the future will almost certainly rely on multiple measures, not discarding speed but giving weight to other considerations as well.

> Now, traditionally, traffic experts have operated with one objective: to move people into and around cities as rapidly and efficiently as possible. . . . Speed becomes uppermost, and the fact that it is never obtained, no matter what contrivances the engineers make, never seems to deter them in their pursuit of it. . . . Cities should be an end, not a means. Rationally one wants to have traffic *stop* there, not go *through*, one wants movement within them to be *slow*, not *fast*. (*1*,pp. 255–256)

Such sentiments have long been expressed by those outside the transportation field (*2*,pp.21–24; *3*,pp.1–2; *4*,p.167). They are beginning to be echoed by transportation professionals. Frequent references are seen to the need for a "paradigm shift" in land-use–transportation planning (*5–7*). If a shift is required in planning, it is equally so in the way transportation system performance is measured. In brief, less emphasis should be placed on how fast vehicles move and more on how well people are accommodated.

THE OLD PARADIGM

The 1985 *Highway Capacity Manual* speaks of levels of service in sweeping terms (*8*,p.1-3), yet when it comes time to operationalize the concept, the manual makes operating speed the essential element in transportation planning.

For urban and suburban arterials, levels of service are measured explicitly in terms of operating speed (*8*, Table 11-1).

Joint Center for Environmental and Urban Problems, Florida Atlantic University/Florida International University, 220 Southeast 2nd Avenue, Fort Lauderdale, Fla. 33301.

For other types of facilities, the relationship to operating speed is less direct but no less important. Once a facility's design speed is set, levels of service become a simple function of operating speed (*8*, Tables 3-1, 7-1, and 8-1).

Growth Management

Roadway levels of service have long been used in facility design, traffic operations, and traffic control. When architects of growth management began looking for ways to measure the adequacy of public facilities and services, roadway levels of service were both handy and legally defensible (*9*).

In designing a facility (intersection, roadway section, etc.), the level of service in the design year is the prime concern. After all, the purpose of the facility is to move traffic efficiently.

Growth management is a different ball game. How to best utilize existing facilities is as important as what to build anew. Public purposes such as downtown preservation and energy conservation vie for priority with efficient movement of traffic.

Speed at What Cost?

One negative consequence of higher speeds is more vehicle miles traveled (VMT). Able to drive faster, motorists drive farther (*10–12*). They also drive more frequently, as discretionary trip making increases (*13*,*14*).

Although motorists may benefit from more travel, society as a whole does not because the costs of automobile travel are only partially borne by the traveler. When such factors as delay, air pollution, and parking costs are added, automobile use is extraordinarily expensive—an estimated 75 cents/mi. [This estimate represents the sum of midrange cost estimates discussed previously (*15–21*)]. If these costs were fully reflected at the gas pump, a gallon of gas would cost $4.50 or more (*22*).

Urban Sprawl and Automobile Dependence

The emphasis on vehicle speed has other unfortunate consequences. It tends to encourage urban sprawl, with all the attendant costs of sprawl. Under roadway level-of-service standards, infill development is precluded in areas in which roads are already congested. Meanwhile, outlying areas with excess roadway capacity remain developable until they too become congested (*23*).

Even after excess capacity is used up, level-of-service standards may encourage sprawl. Speed can be maintained either by expanding roadway capacity to match the growth of traffic or by moderating the growth of traffic to remain in line with available capacity. The near-universal response to congestion has been to build roads as fast as resources permit. That, in turn, has kept long-distance travel feasible (*24*).

Sprawl leads to automobile dependence, which leads to more sprawl and more automobile dependence. Unfortunately, the ability of some to travel far and fast does not translate into mobility for all. The young, old, poor, and handicapped are worse off now than they were before the automobile. In an automobile-centric society, they suffer from "deprivation of access" (*25*). The negative effects are well documented (*26–30*).

APPLICATIONS IN SEARCH OF STANDARDS

The need for new transportation service standards is immediate and pressing. Localities in at least two states are wrestling with issues of transportation performance measurement as part of second-generation growth management systems. The neotraditional planning movement has rejected speed as the ultimate performance measure but only hinted at what might replace it.

Florida's Change in Direction

Florida is a leader in growth management. New Jersey, Maine, Vermont, Rhode Island, Georgia, Washington State, and Maryland have borrowed concepts or even legal language from Florida's 1985 growth management law.

Yet, after several years of experience, it has become clear that the state needs a paradigm shift of its own. Land use and transportation planning have never been fully integrated, and transit planning has remained incidental to growth management. Roadway levels of service have come to drive the transportation planning process. Urban sprawl and automobile dependence have actually worsened under growth management.

Realizing this, state government has changed the rules of growth management. Cities and counties now have the following options:

- They may designate so-called transportation concurrency management areas (TCMAs) in their comprehensive plans. TCMAs are regions such as downtowns that are geographically compact; have a mix of residential, retail, recreational, and other uses; and offer travelers alternatives to the automobile.
- They may replace separate elements of their comprehensive plans with a unified mobility element. Mobility elements must incorporate policies to reduce VMT and make more efficient use of roadway capacity.

If they choose the first option, cities and counties may, within TCMAs, set their own level-of-service standards for most state highways, without regard to standards of the Florida Department of Transportation. At the same time, localities must adopt policies to guarantee that adequate "levels of mobility" are maintained within TCMAs, even as traffic increases.

How to measure levels of mobility is left up in the air. The rule says only that localities shall establish "numerical indicators against which the achievement of the mobility goals of the community can be judged, such as modal split, annual transit trips per capita, automobile occupancy rates. . .".

Washington's Venture into the Unknown

Washington State modeled its growth management law after Florida's, but unlike Florida, Washington has neither statewide minimum roadway level-of-service standards to which cities and counties must adhere nor methodological guidelines that must be followed in estimating roadway levels of service. Thus, localities are free to innovate.

There is near-universal agreement in the Seattle region that the 1985 *Highway Capacity Manual* is too limiting. King County is developing a four- or five-part transportation adequacy measure. Pierce County is trying to choose between congestion indexes, congestion rates, accessibility indexes, and link level-of-service measures. The city of Bellevue plans to average levels of service across intersections within mobility management areas.

This may be an exception to Mae West's wise observation, "Too much of a good thing is wonderful." All the innovation in transportation performance measurement has left local officials wondering if they can meet the state requirement that level-of-service standards be regionally coordinated. They also wonder if they could defend their chosen measures against a legal challenge.

Neotraditional Planning Movement

The most significant development in the planning field since Radburn and the Greenbelt Town movement is the advent of neotraditionalism—a return to pre-automobile town planning principles. The importance of the movement is illustrated by the dozens of articles on the subject and the dozens of new developments planned according to traditional principles [for a partial bibliography and list of developments, see article by Lerner-Lam et al. (*31*)].

An ITE Committee (5P-8) is charged with developing street design standards for neotraditional neighborhoods (*32*). Design standards are important, but they are not enough. New design standards must be accompanied by new performance standards. Otherwise, neotraditional designs will not make it through the development approval process.

NEW PARADIGMS

If the old "speed" paradigm is ill suited to people's needs, what is to replace it? There are at least four possibilities: mobility, accessibility, livability, and sustainability. The four are distinct but not mutually exclusive. Whereas levels of service relate to facilities, "mobility" generally pertains to populations, "accessibility" to land uses, "livability" to environments, and "sustainability" to communities. These terms have been used interchangeably on occasion, so it is important to be clear about the meaning of each.

Mobility and Accessibility

Mobility refers to the ease with which individuals can move about (*33–35*). Using Reno's seminal work as a guide, a mobile population is one that travels freely because the time and cost of travel are moderate and the travel options are numerous; mobility is reflected in automobile ownership, transit usage, daily person trips, and miles of travel (*36*).

Accessibility refers to the closeness of urban activities to one another (*37–41*). Accessibility can be measured in over-the-road distance, travel time, or travel cost. Thus, accessibility is a function both of land use patterns and the transportation system that serves them. A pithy restatement of the concept is provided by Karlqvist (*42*,p.71): "maximum contact with minimum effort."

Lest there be any inkling that mobility and accessibility are the same, the reader is referred to the literature of the 1970s, when accessibility was a hot topic (*43–45*). Writing in 1979, Dalvi reported that British transport planning had shifted its focus from vehicular mobility to personal mobility. Although he approved of the shift, Dalvi presumed that transport planning would ultimately turn its attention to "accessibility provision":

> It is not enough to focus simply on the characteristics of the transport system. It is equally necessary to consider the spatial distribution of opportunities, so that transport policies might be evaluated not only in terms of moving the people to the opportunities but also *moving the opportunities to the people*. This means that land uses and location planning are as vital to the efficiency of resource use in transport as the management of transport services and the determination of modal split. (*46*,p.640) (emphasis added)

High levels of mobility bring with them high social costs (at least in automobile-dependent America). High levels of accessibility have the opposite effect. Newman and Kenworthy (*47*) have shown traffic to be more fuel efficient in low- than in high-density areas; this is a result of higher running speeds. However, the resulting fuel savings are more than offset by longer trips and more motorized travel. In the tradeoff between fuel-efficient traffic (high mobility) and fuel-efficient land use (high accessibility), the latter wins.

Livability and Sustainability

Livability and sustainability are broad concepts. Focusing on transportation, a livable environment is one that "puts the automobile in its rightful place as one among many options for travel" (*48*,p.5). There are two sides to this. First, automobile traffic must be calmed, that is, reduced in volume and speed. Second, other modes must be enhanced, primarily through changes in land use and facility design. Pedestrians and bicyclists must be given as much priority as automobiles within the street environment (*49,50*).

In the book *Livable Streets* (*51*), the qualities that make a street livable are factors such as safety from traffic, peace and quiet, attractive appearance, and street life; ease of movement by car is only one of many qualities valued by residents and not the most important. A livable street environment is better not only for residents but for pedestrians, bicyclists, transit users, and perhaps even motorists, since it makes for a more pleasant driving experience.

The concept of sustainability had its origins in the environmental movement. Sustainable development "meets the needs of the present without compromising the ability of future generations to meet their own needs" (*52*,p.8). It does so by conserving natural resources and protecting the natural environment (*53,54*).

In the transportation sector, the principal threats to sustainable development are excessive fossil fuel consumption and the air pollution that results. Both depend on VMT. Both also depend on vehicle trip rates and congestion levels because "cold starts," "hot soaks," and low operating speeds add to air pollution and fuel consumption (*55*).

Among modes, walking and biking rank highest on the sustainability scale, being nonpolluting and non-fossil-fuel consuming. The single-occupant automobile ranks lowest. Transit and ridesharing may rank high or low depending on how these modes are accessed.

> A reduction in commute VMT may not result in a proportional reduction in mobile source emissions. If carpoolers drive to carpool staging areas in single occupant vehicles or if transit riders drive to park-and-ride lots to take transit, auto trips and therefore cold start emissions are not reduced. (*56*,p.160)

MENU OF TRANSPORTATION PERFORMANCE MEASURES

It is easy to call for a paradigm shift in transportation performance measurement, but to move beyond speed, a new set of performance measures will be needed.

Happily, a myriad of measures have been formulated for one purpose or another. Thus, it is mainly a matter of reviewing the alternatives and choosing those that stack up well against appropriate criteria. This paper provides a menu of possibilities and a preliminary assessment of the choices.

Areawide Level-of-Service Measures

In the 1985 *Highway Capacity Manual*, roadway levels of service are defined for individual facilities, not for groups of facilities. By focusing on the condition of individual road facilities at a particular hour, levels of service oversimplify the experience of travelers. Travel is experienced in complete trips. Over the course of a day, a person may travel on scores of roadway segments and dozens of different roads. Even a single peak-hour trip may involve travel on many facilities. Presumably, a traveler's perception of roadway conditions is based on an entire trip or possibly an entire day's worth of travel, not on the delay at one intersection or the congestion on one roadway segment.

Also, travelers have choices. Where a well-developed road network exists, many routes are available for a given trip. For many trips, increasingly even for work trips, a traveler may have discretion in the time of travel. And with the growing number of rail systems and exclusive high-occupancy-vehicle (HOV) lanes on freeways, the traveler may have a real choice of mode.

Must adequate levels of service be maintained for every route, mode, and hour of travel that might be chosen by travelers? That has been the modus operandi of growth management programs. Or is it sufficient that government provide trip makers with acceptable travel options? Only by considering trips in their entirety and looking at alternatives available to travelers can the performance of the transportation system be fairly assessed.

Areawide level-of-service measures have been allowed on an exception basis in Florida's local comprehensive plans (*57*). Areawide measures have been constructed by (a) summing volumes and capacities in overall volume-to-capacity measures, (b) averaging levels of service weighted by lane miles or VMT, or (c) adopting performance summaries that specify the percentage of lane miles or VMT above a given level of service. Areawide measures are used outside Florida by some of the nation's leaders in growth management [Montgomery County, Maryland; San Jose, California; and soon Bellevue, Washington (Figure 1)].

It is a small step conceptually and methodologically from averaging travel speeds for segments that make up arterials (accepted practice since the *Highway Capacity Manual* was updated in 1985) to averaging travel speeds for arterials that make up networks (not accepted as yet but reasonable in the context of growth management). With areawide averaging, local governments will have ample incentive to fix localized traffic problems because travel speeds fall precipitously as capacities are approached and exceeded on individual facilities. Less incentive is provided by other methods of areawide measurement.

IMPACTED by DEVELOPMENT	CAPACITY	VOLUME
River Oaks & Zanker	759	347
No First & Orchard	1842	1212
No First & Plumeria	1928	1402
No First & Bonaventure	1865	1184
No First & Trimble	3436	3302
No First & Component	2497	2125
No First & Charcot	2573	2321
No First & Karina	2653	2244
No First & Brokaw	3015	2738
TOTALS	20,568	16,875

WEIGHTED AVERAGE V/C = 16,875 / 20,568

= 0.820

= LOS "D"

FIGURE 1 Weighted average intersection level of service (San Jose, California).

Areawide Congestion Indexes

Although new to growth management, congestion indexes have long been used to compare roadway conditions from year to year and place to place. They are sure to play a role in congestion management systems under the federal Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) (*58,59*).

Best known is the roadway congestion index, defined as the number of VMT locally per lane mile of freeways or principal arterials (*60*). The index has been estimated annually since the early 1980s for selected metropolitan areas (Figure 2). Other areawide congestion indexes include the congestion severity index and the lane-mile duration index (*61,62*).

The various indexes are compared by Turner (*63*). Conceptually, all have the same strength or weakness (depending on one's point of view): all measure the degree of roadway congestion for more than just the peak hour. If it is concluded that many travelers have flexibility in their travel hours and that their perceptions of roadway congestion are based on a day's worth of travel, then congestion indexes may be better measures of transportation service than are levels of service. However, like levels of service, congestion indexes measure only one thing—vehicular mobility—with all of its implied limitations.

Ridesharing–Trip Reduction Measures

With the growth of travel demand management (TDM) has come the use of ridesharing–trip reduction measures (*64,65*). Such measures are found in dozens of trip reduction ordinances around the United States and more are to come in states mandating local trip reduction programs (California, New Jersey, and Washington). Trip reduction ordinances set performance standards for large employers, who must then induce enough employees to share rides or switch work hours to meet the standards.

Probably the best known example is the Los Angeles region's Regulation XV, which measures performance in terms of average vehicle occupancies of commuters during the morning peak period. Other measures commonly used include the mode split for non-single-occupant modes and the percent vehicle trip reduction during peak hours (Figure 3).

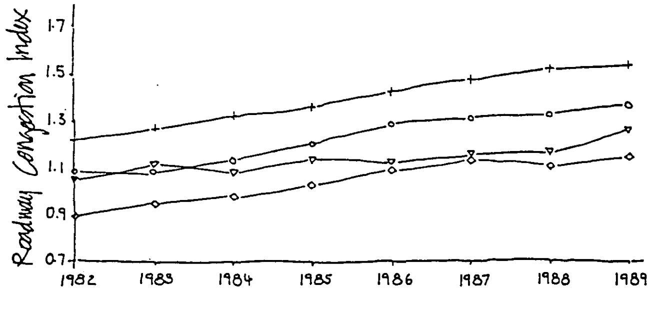


FIGURE 2 Congestion trends in major areas (*60*,p.16).

JURISDICTION	% RIDESHARING/ BIKING/ WALKING	DAILY VEHICLE TRIP REDUCTION	PEAK HOUR VEHICLE TRIP REDUCTION	AVG. VEHICLE OCCUPANCY
Pleasanton, CA			■	
Sacramento, CA	■	■		
Montgomery County, MD	■			■
North Brunswick, NJ			■	
Alexandria, VA			■	
Maricopa County, AZ	■			

FIGURE 3 Measures in trip reduction ordinances.

Such measures are well suited to employer-based TDM programs. Employers have some influence over employees' modes and times of travel through their parking policies, scheduled work hours, and ridesharing programs. But it must be recalled that these measures disregard home-to-work trip lengths (over which employers have no influence). Given that ridesharing is practical only on long commutes, a community that performs well by these measures probably has high VMT to begin with (*66*). Further, given the circuitry of carpool and vanpool trips, an increase in ridesharing may not translate into a significant drop in VMT (*67*).

Multimodal Mobility Measures

Most attempts to measure mobility in multimodal terms have been outside growth management. Examples include Eck's passenger transport index, Polus and Tomecki's level of service of the transportation system, Lomax's speed of person volume, and Courage's personal mobility index (*68–71*).

Within the field of growth management, examples of multimodal mobility measures come from opposite corners of the United States. The city of Miami measures levels of service for automobiles and transit together in transportation corridors. The "practical capacity" of corridors is computed as the sum of automobile and transit capacities (assuming theoretical occupancy and load factors). Person-trip volumes are divided by practical capacities to arrive at volume-to-capacity ratios. Levels of service are then determined with reference to volume-to-capacity standards (Figure 4).

King County, Washington, is developing a transportation adequacy measure for use by its localities. The measure is made up of automobile, transit, nonmotorized, and transportation system management (TSM)/TDM indexes, weighted to reflect local priorities. In urban centers, the transit and nonmotorized indexes may be weighted most heavily; in suburban communities, the automobile and TSM/TDM indexes may be given greatest weight. Facilities will be rated, weights will be applied to the ratings, and an overall transportation adequacy measure will be computed for subareas of the county.

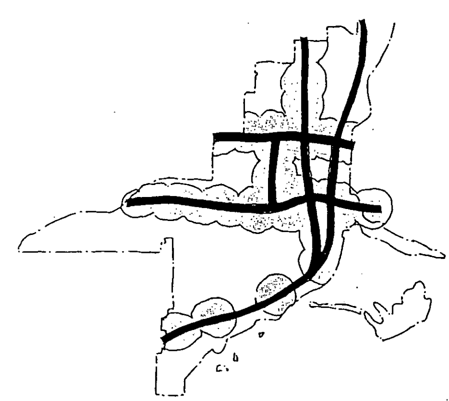
Why measure mobility in multimodal terms when the single-occupant automobile is so dominant? Travelers in some exceptional places such as older central cities still rely on transit and walking for basic mobility. Those without automobiles, regardless of where they live, depend on alternative modes for their mobility. And the rest may become candidates for alternative modes when the full force of federal clean air and congestion management requirements is felt.

Still, there is a certain sense of "adding apples and oranges" with these measures. Modes are not interchangeable for all trips, nor equally valued by all travelers. Service quality is not even measured the same way for different modes (see the 1985 *Highway Capacity Manual*). Any measure that treats modes as interchangeable could have perverse consequences. Buses and sidewalks could be empty and roads gridlocked; yet transportation facilities would be judged adequate and additional development permitted on the basis of excess bus and sidewalk capacity.

Accessibility Measures

The concept of accessibility has been operationalized in measures of varying sophistication and functional form [see previous literature reviews (72–75)]. Accessibility measures may be as simple as average trip length or as complex as "gravity" measures that reflect the regional distribution of jobs, shopping, or other activities.

Simple accessibility standards developed by the American Public Health Association were used by planners in the 1950s



PERSON-TRIP VOLUME/ PERSON-TRIP CAPACITY	LEVEL OF SERVICE
.01 .60	A
.61 .70	B
.71 .80	C
.81 .90	D
.91 1.00	E
1.01+	F

FIGURE 4 LOS standards for Miami's transportation corridors.

and 1960s (*76*). More sophisticated measures were advanced in the 1970s and early 1980s and applied to such diverse areas as travel modeling, siting of public facilities, and analysis of minority employment opportunities [see previous reviews (*77,78*)].

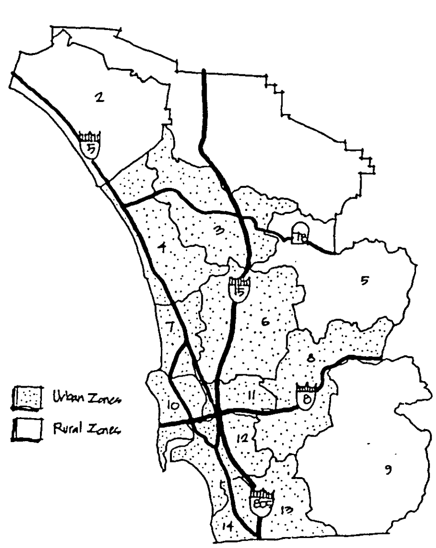
More recently, academic interest in accessibility has waned. Gravity-type models continue to be the workhorse of land use–transportation planning, both in travel modeling and land use allocation (via Lowry-type models). But given the power of accessibility measures, one might have guessed they would amount to more.

Perhaps they will in this new era of growth management, as the emphasis shifts from moving vehicles to moving people to moving opportunities to people. Accessibility standards have been developed for the San Diego metropolitan area and are being considered now by localities in the Seattle region (Figure 5).

VMT and VHT

A class of performance measures includes vehicle trip rates, VMT, and VMT on a per person or per household basis. VMT was chosen in the federal Clean Air Act Amendments of 1990 as the principal performance measure for air quality planning in areas of serious ozone and carbon monoxide pollution (*79*).

VMT has a simple elegance for growth management as well. If development is compact, land uses are mixed, the road network provides direct connections, and transit and ridesharing are well utilized, VMT will be low.



AUTOMOBILE	TRAVEL TIME Minutes	
TRIP PURPOSE	Urban	Rural
Employment	30.	44
shopping	12	21
services	16	25

FIGURE 5 Regional access standards (San Diego Association of Governments).

One approach to VMT standards is suggested by the California Clean Air Act (*80*). Areas with serious pollution problems must bring the growth of VMT, which has been three times the growth of population, in line with population growth. This means that VMT per capita cannot increase as new development is approved (Figure 6).

One thing VMT does not measure is congestion, which, along with VMT, is a major determinant of vehicle emissions, fuel consumption, and time wasted in traffic. It has been suggested that vehicle hours traveled (VHT) might be a better measure of travel demand than is VMT, at least for air quality planning purposes, because vehicle emissions per mile decline with increasing speed (up to about 45 mph), whereas vehicle emissions per hour are essentially independent of speed. Transportation control strategies that reduce VMT may or may not improve air quality, depending on their effect on travel speeds. Strategies that reduce VHT can be counted on to improve air quality.

SELECTING PERFORMANCE MEASURES

How to choose among the many transportation performance measures? Transportation planners are not the first to wrestle with this issue. There is an extensive literature on the measurement of government performance. Even with respect to transportation performance measurement, others have passed this way before (*81–83*).

Performance measures should be easily understood, readily measured, and not too numerous. Whether deserved or not, public agencies have a reputation for fostering needless complexity.

Equally important, performance measures should follow from established goals and objectives. Florida's State Comprehensive Plan calls for energy-efficient transportation systems; easy access to services, jobs, markets, and attractions; and increased ridesharing by public and private employees. Local comprehensive plans establish even more specific goals, objectives, and policies, which may suggest performance measures.

The land use–transportation system is universally acknowledged to be a system (even if it is seldom planned or managed as such). This has implications for the choice of transportation performance measures. Ideally, measures will reflect the efficiency of both land use patterns and transportation network configurations, they will acknowledge the multimodal nature

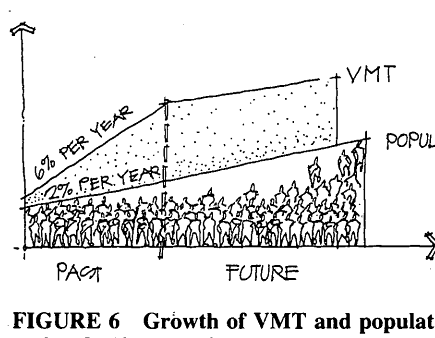


FIGURE 6 Growth of VMT and population under California's Clean Air Act.

of the system, and they will treat the links and nodes as part of a system.

At a minimum, two dimensions of performance must be captured. One is traffic congestion, which may be represented by levels of service or congestion indexes. The other dimension is travel volume, which may be represented by ride-sharing–trip reduction measures, accessibility measures, or VMT.

These two dimensions of performance are distinct from one another. To illustrate, one study compared alternative development patterns and found that some patterns generate low VMT and low average speeds, others high VMT and high average speeds, and still others low VMT and high average speeds (*84*). Another study compared transportation control measures and found that some reduce VMT and improve average speed, whereas others affect only VMT or speed, but not both (*55*). By limiting the measures to levels of service, we give away half the farm.

Ideally, a third dimension of transportation system performance would be captured as well: travel opportunity for the transportation disadvantaged. A congestion-free system with moderate travel volumes may still leave those without the automobiles at home without transit, walking, or biking opportunities. This dimension may be represented by multi-modal mobility measures, accessibility measures, or simple mode-split measures.

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Publication of this paper sponsored by Committee on Transportation Programming, Planning, and Systems Evaluation.