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Developing Transport Management Improvements for the Tri-State Region: An Overview

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ABSTRACT

A framework for transportation system management (TSM) in the Tri-State Region of New York City is developed. TSM strategies are classified, it is shown how they relate to various parts of the region, their effectiveness is quantified, and guidelines for emphasizing TSM as an early-action program are suggested. Conditions of applicability are defined for principal types of strategies: each type of improvement is allowed to be used in a reasonable way and a means of screening inappropriate activities is provided. These conditions vary by specified action; employment and population density, dependence on public transport, and many action-specific factors are considered. Measures that involve restraining or reducing motor vehicle use are limited mainly to the Manhattan business district. Measures that involve priorities for buses are applicable in radial corridors within New York City, with selective application in outlying business centers. Ridesharing programs, in contrast, apply best in inner and outer suburbs. Traffic engineering improvements are appropriate throughout the study area. The anticipated effectiveness of selected TSM actions provides a useful planning guide. Although many actions have major impacts over a localized area, making it hard to derive areawide impacts from their application, site-specific impacts can be readily quantified. In TSM emphasis should be placed on immediate action improvements in a multimodal context; TSM should be viewed as an action program rather than a planning process. Improvements should be viewed from a far broader perspective than merely the reduction of VMT, especially when the localized nature of many actions and the conjectural aspects associated with anticipating areawide VMT changes are considered.

Modest growth expectations, limited financial and natural resources, and increased environmental concerns have shifted the focus of regional transportation improvements during the last decade. Transportation system management (TSM) emerged as a means of improving the efficiency of the existing transport system. TSM actions are low-capital operational improvements that emphasize management rather than expansion.

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A planning framework for TSM in the Tri-State Region of New York City is developed. Actions are identified and classified and it is shown how they relate to various parts of the region. Definitions of measures of effectiveness are given and the anticipated effectiveness of various actions in achieving goals such as improved accessibility, greater safety, fuel conservation, and cleaner air is quantified. Finally, general guidelines for developing and assessing TSM programs are set forth.

This paper is based on a study of TSM conducted in the New York State part of the Tri-State New York City metropolitan area in 1980 (1). At the time of the study most TSM activities involved making shop-

ping lists of improvements, establishing performance measures, and evaluating traffic reduction techniques. In this paper these activities are brought into clearer focus; many of these suggested directions have reinforced TSM research and practice over the last 5 years (2).

OBJECTIVES AND APPROACH

A framework for TSM planning in Greater New York City is set forth. Its analyses are designed to provide answers to questions such as the following:

- Where are automobile-restraint measures most applicable?
- What are the ranges in impacts and benefits associated with various traffic engineering and transit improvements?
- How much time can be saved by a computerized traffic signal system in selected areas of New York City and along Westchester Avenue in White Plains?
- How many people might a paratransit system in Orange or Suffolk County serve? How many would be automobile drivers?
- What are the ranges in benefits associated with bus priority measures?
- What are the impacts of a traffic restraint program on regional or hub-bound vehicle miles of travel (VMT)?
- What are the patronage impacts of expanding bus service in Nassau County?
- How would VMT be affected by an intensive areawide ridesharing program?

To achieve the objectives expressed by these questions, a thorough review was made of the U.S. and Tri-State experience with TSM improvements and measures of effectiveness. Available measurements of before-and-after conditions were obtained, and results of models and traffic simulation studies were summarized. Effectiveness ranges then were developed for actual conditions in the various geographic sectors within the New York metropolitan area.

The general approach suggested is shown in Figure 1.

1. Candidate actions should be screened as they relate to conditions of applicability drawn from evaluations of past experience and professional judgment;
2. Simple, straightforward measures should be used in evaluating effectiveness of improvements;
3. Cost-effectiveness should be determined by

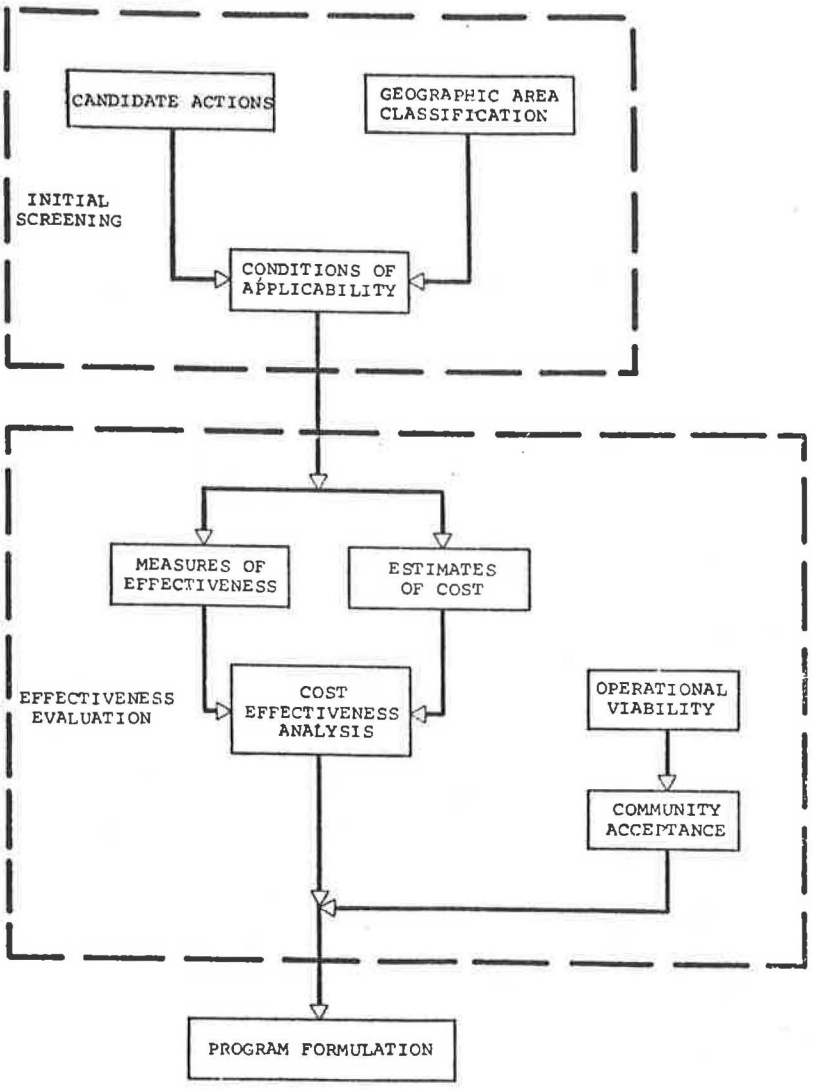

FIGURE 1 TSM approach.

TABLE 1 Comparison of Six TSM Classifications *(3-6)*

RACMs	Federal TSM Regulations	Tri-State TSM Actions	Lockwood and Wagner	JHK/PMM *(6)*	Recommended for Tri-State Region
Inspection and maintenance	Efficient use of road space	Internal transit management efficiency	Mandatory use controls	Traffic operations	Transportation demand
Vapor recovery	Traffic operations improvements	Managing travel demand	User information/assistance	Traffic signalization	Employer actions
Retrofit—heavy duty	Preferential transit and HOVs	Improved transit service	Pricing	Pedestrian and bicycle	Pricing actions
Cold start	Pedestrian and bicycle	Better use of road space	Transit operating modification	Roadway assignment	Regulation
Extended idling	Parking management and control		Supply augmentation	Route diversion	Parking management
Improved public transit	Work schedules, fare structure, and tolls		Demand modification	Parking management	Other
Long-range transit	Reduction of vehicle use			Transit operations	Street system efficiency
Exclusive bus and carpool lanes	Improvement of transit			Transit management	Freeway operations and control
Extended carpool programs	Improved transit management efficiency			Intermodal coordination	Traffic operations and control
On-street parking controls				Commercial vehicles	Preferential treatment for HOVs and transit
Park-and-ride/fringe lots				Work schedule	Pedestrians and bicycle
Pedestrian malls				Pricing	Commercial vehicles
Employer programs				Paratransit	Other
Bicycle lanes and storage					Transit service
Staggered work hours					Passenger service
Road pricing					Terminal improvements
Traffic flow/improvements					System performance
Private car restrictions					New and expanded service
					Vehicles and equipment
					Maintenance
					Internal transit management efficiency
					System maintenance
					Security
					Cost accounting
					Other management improvements
					Vehicle equipment improvements
					Private automobile
					Bus transit
					Commercial vehicles

Note: RACMs = reasonably available control measures to conform with Clean Air Act *(3)*; HOV = high-occupancy vehicle.

comparing the benefits of a given action with the estimated costs to implement, operate, and maintain the improvement; and

4. Operational workability and community acceptance should be considered in formulating programs and establishing priorities.

Classifying Actions

There is no single, generally accepted classification of TSM actions, because each TSM research project generally develops its own taxonomy. In Table 1 several of the more common classifications that have been suggested are compared with the one used for the Tri-State Region. Federal regulations, for example, identify four basic classes: efficient use of road space, reduction of vehicle use, improvement of transit, and improved internal transit management efficiency (4). Lockwood and Wagner proposed a classification consisting of 6 TSM concepts, 24 categories, and numerous action elements (S.C. Lockwood and F.A. Wagner, unpublished data). An FHWA research project has proposed 13 strategies and 59 tactics (6, pp. 5 and 6).

The classification used in the Tri-State study (1) includes five main categories: transportation demand management, street system efficiency, transit service improvements, internal transit management efficiency, and vehicle and equipment improvements. (The vehicle and equipment improvements were included to reflect the many concerns within the Tri-State Region for improving air quality, although they are not normally part of TSM programs.) Parking management actions, such as rate changes, supply constraints, and residential parking permits, form part of demand management, whereas other parking actions relate to improved street system efficiency. However, an alternative classification scheme that treats parking as a separate category has merit and should be used wherever possible.

Defining the Study Area

The 12-county study area contained nearly 12 million people and more than 5 million jobs in 1976 (Table 2). Its counties ranged from densely developed New York (Manhattan) to sparsely settled Dutchess, Orange, and Putnam counties.

Two-thirds of the population and three-fourths of the employment were located within New York City. The greatest concentration of employment was found in Manhattan, where nearly 2.2 million people (40 percent of the area's total) worked. Population density ranged from 62,000 persons/mi^2 in Manhattan to less than 500 persons/mi^2 in Dutchess, Orange, and Putnam counties.

The unusually wide range in population and employment densities coupled with major transportation barriers influenced both travel patterns and the opportunities to effectively manage the transport system. Accordingly, the region was divided into subareas based on employment and population density, topography, rail and road patterns, and political jurisdictions. The following classification scheme, summarized in Table 3, was used to group and apply various TSM actions:

1. Each of the 12 counties formed a basic unit. Counties were further grouped according to employment and population density as follows:
   a. Midtown Manhattan (central business district);

TABLE 2 Population and Employment, New York Region, 1976

Area Counties	Population (000s)	Density (persons/mi^2)	Employment (000s)	Housing (000s)
New York City				
Bronx	1,343	33,061	220	479
Kings (Brooklyn)	2,398	34,403	490	880
New York (Manhattan)	1,417	62,132	2,213	719
Queens	1,968	18,182	483	713
Richmond (Staten Island)	328	5,606	50	108
Subtotal	7,454	24,964	3,456	2,899
Outside New York City				
Dutchess	235	288	94	70
Nassau	1,397	4,856	567	418
Orange	248	290	83	84
Putnam	71	300	14	23
Rockland	254	1,427	81	75
Suffolk	1,279	1,349	363	386
Westchester	878	1,985	357	303
Subtotal	4,362	–	1,559	1,368
Total	11,816	–	5,015	4,267

Source: Tri-State Regional Planning Commission.

TABLE 3 Geographic Classification Scheme for TSM Actions

Geographic Area	TSM Subarea Classification: Major Center	Radial Transportation Corridor	Circumferential Travel Corridor	Areawide
Midtown Manhattan (CBD)	x	–	–	–
Manhattan	x	–	–	x
Brooklyn, Bronx, Queens	x	x	x	x
Richmond	x	x	–	x
Inner suburbs (Nassau, Westchester)	x	x	x	x
Outer suburbs (Suffolk, Putnam, Dutchess, Rockland, Orange)	x	x	x	x
Major water crossings	–	x	x	–
Special activity centers	x	–	–	–

b. Manhattan;
c. New York City, Bronx, and Brooklyn-Queens;
d. New York City and Richmond (Staten Island);
e. Inner suburbs (Nassau and Westchester counties); and
f. Outer suburbs (Suffolk, Putnam, Dutchess, Rockland, and Orange counties).

2. Within each county, special subdivisions include
a. Major centers,
b. Radial transportation corridors,
c. Circumferential travel corridors, and
d. Areawide considerations.

3. Major water crossings and special activity centers (e.g., Shea Stadium, Jones Beach) formed two additional groups.

Applying the Conditions

Some TSM actions can be applied throughout the area. Others are limited to specific areas. Therefore, it is necessary to derive criteria that would encourage meaningful applications of TSM actions.

Accordingly, generalized conditions of applicability or planning guidelines were developed by drawing on past experience, a literature review, and professional judgment. They enable each TSM action to be used in a reasonable and effective way. Some are obvious, such as a high degree of transit dependence and availability as a prerequisite for automobile restraint measures or the need for suitable parallel streets before a pedestrian mall is built. Some may be formulated quantitatively, such as the number of buses per hour that should operate on a street to warrant a bus-only lane. Others must be expressed qualitatively or descriptively, for example, functionally obsolete or poorly located garages or inadequate driver comfort facilities at the end of a bus line. Two basic types of guidelines were established:

1. Land use considerations: type and density of development, such as central area employment, the number of employees required before ridesharing programs can be considered, or the nature of adjacent building frontage or land use; and
2. Transportation considerations: degree of transit use, extent of congestion, number of buses on given routes, or volume-to-capacity ratios.

In combination, these factors produced guidelines for reasonably cost-effective application of various TSM actions. Bus priority lanes on freeways, for example, require certain combinations of freeway design, traffic congestion, traffic flow patterns, and bus use. Actions such as staggered work hours and carpool programs work best when large employers are involved. Automobile restraint measures (or disincentives) require high employment density, high transit use, and extensive street congestion.

Figure 2 (7) shows how various TSM actions relate to population and employment densities within the Tri-State Region. In Table 4, in turn, principal land use and transportation requirements for 20 selected TSM actions are summarized and it is shown where each would best apply within the study area.

These relationships generally are transferable to other U.S. urban areas. In a real sense, they show what works where, enabling inappropriate actions to be quickly screened from the TSM planning process.

1. Some strategies--such as traffic engineering improvements and transit service coordination--apply throughout the study area.
2. Measures that require restraining or reducing the number of automobiles or reducing motor vehicle use (e.g., pricing, automobile-free zones) are mainly limited to the Manhattan business district. The underlying requirements include availability of express transit services, existing high dependence on public transport, high development and employment densities, limited street and parking capacity, inability to expand street capacity, and air-quality problems.

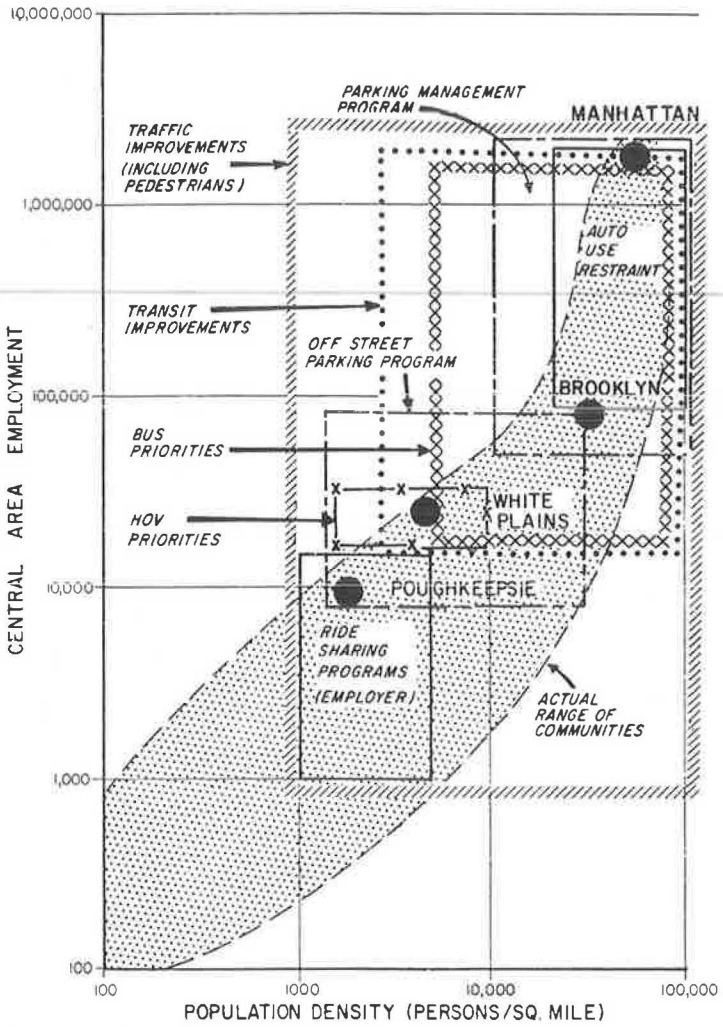

FIGURE 2 Generalized applicability of TSM strategies.

3. Bus priority measures are mainly applicable in New York City where high bus flows are found on arterial streets and express highways. There are also selective applications in inner suburban business districts.

4. Ridesharing or carpool incentives [e.g., high-occupancy-vehicle (HOV) priority lanes and carpool programs] are most applicable in surburban areas where bus volumes and ridership are limited and where cars are the principal mode for the journey to work.

5. The types of parking improvements vary among areas. Parking restraint is applicable in Manhattan, whereas parking expansion is appropriate in suburban centers, such as White Plains and Poughkeepsie. Park-and-ride improvements are most applicable in suburban areas along regional rail lines and express highways.

Building on this framework, potential TSM measures for midtown and lower Manhattan are identified as follows:

- Staggered work hours
- Bridge and tunnel tolls
- Automobile-free zones
- Automobile-use restrictions
- Stabilized or reduced parking supply
- Limited on-street parking
- Enforced parking regulations
- General traffic engineering improvements
- Upgraded traffic signals
- Express streets
- Bus-taxi streets
- Bus lanes
- Pedestrian malls
- Sky-walk system or concourse system
- Goods: curb loading zones
- Truck route systems
- Taxi cruising regulations
- Increased transit service frequency
- Improved access to stations
- Improved subway security

Those for the rest of New York City, the inner suburbs, and the outer suburbs are shown in Tables 5-7. Measures are shown for major centers, radial transportation corridors, crosstown corridors, and areawide applications within each geographic area.

It is significant that New York City has implemented several actions that are consistent with those suggested in Tables 5-7. Since 1980 the city has put into effect an extensive system of bus lanes in midtown and lower Manhattan, established "red zones" along these bus lanes in which there are $100 parking fines, intensified its towing program, and developed the 49th to 50th Street transit-taxiways. An outbound lane has been added to the Queens Midtown Tunnel during the p.m. rush period by preempting one of the two inbound lanes and limiting inbound traffic

TABLE 4 Generalized Applications of Selected TSM Actions, Tri-State Area

Action	Principal Considerations: Land Use and Environment	Transportation	Geographic Area Application
Demand Management			
Staggered work hours	Large employment concentrations	High transit use; overcrowded transit lines	Manhattan CBD
Ridesharing	Large employment concentrations; reduce VMT to improve air quality	Low transit use	Major employment area outside Manhattan CBD
Bridge and tunnel tolls	Existing tolls; major employment concentrations	High peaking congestion; alternative transit service available	Hudson River crossings, also selected crossings of other bodies of water
Area licenses	Large employment concentrations; need to improve air quality	Most trips to area by transit; street congestion; bypass routes available for through traffic	Manhattan CBD
Automobile-free or restricted zones	Major employment and pedestrian concentrations; need to reduce VMT to improve air quality	High transit use	Manhattan CBD
Parking supply constraints	Need to reduce VMT to improve air quality	High transit use; congestion; street capacity constraints	Manhattan CBD
Residential parking permits	Inadequate off-street parking space; high residential density	–	Residential areas in Manhattan, Bronx, Brooklyn, and Queens
Street Use Efficiency			
General traffic improvements	–	Street capacity deficiencies; congestion points	All areas; specific improvements will vary among areas
One-way toll collection	–	Congestion at toll plaza (inadequate reservoir); "escape" routes difficult	Selected East River toll crossings
Freeway ramp controls	–	Freeway congestion; alternative routes available (no entering buses)	Freeways in New York City and inner suburbs
Priority freeway entry for buses	–	Congestion on freeway or ramps; specified number of buses using ramp	Radial freeways, New York City
Park-and-ride lots	Available lane; large employment concentration in CBD; generally, low residential densities	Limited transit in tributary area; radial road capacity constraints; available express transit; minimum competition to established transit system	Principal corridors converging on Manhattan, predominantly in inner suburbs
Priority freeway entry (HOV)	–	Congestion on freeway or ramps; low transit use in corridor	Freeways in inner suburban areas
Bus lanes			
Freeways (bus only or contraflow)	–	Congestion on freeway; specified number of buses; suitable geometry	Radial freeways, New York City
City streets	–	Street congestion; specified number of buses	CBDs in Manhattan, Bronx, Queens, and Brooklyn; major business districts in inner suburbs; arterial streets in New York City
Pedestrian malls (or bus-pedestrian malls)	Pedestrian concentrations; retail frontage	Ability to provide essential services and bypass routes	Central and outlying business districts (no bus malls in outer suburban centers)
Curb loading zones for trucks	Commercial frontage	Curb lanes blocked by parked cars	Business districts; arterial streets in commercial areas of city and some inner suburbs
Transit Service			
Additional express service	Major markets along outlying parts of transit lines	Imbalances between service provided and ridership; track availability; "transportation poor" areas	Bronx subway; Queens, Richmond, Brooklyn, express bus
Service expansion	Areas with growing populations or without transit service	–	Outer Queens and Richmond, inner and outer suburbs
Service coordination	–	Bus-rail services to same or complementary areas	Bronx, Brooklyn, Queens, Richmond, Westchester, Nassau, Suffolk
Paratransit	–	No transit or limited transit in corridor	Inner and outer suburbs

flow. A series of traffic restraint measures on gateways to Manhattan and within the borough is being considered to comply with air-quality standards.

Selecting Measures of Effectiveness

TSM actions should be designed to carry more people in fewer vehicles through an enhanced urban environment and should reinforce developmental goals where possible. Measures of effectiveness provide a means by which various TSM actions can be evaluated within this context. These measures normally reflect the increased efficiency and productivity of the transport system, which, in turn, leads to air-quality and energy impacts. A second type, economic intermeasures, assesses cost-effectiveness, that is, the attainment per dollar or implementation cost (i.e., cost per VMT reduced). A third type includes management-related fiscal measures, such as transit operating costs. Finally, project evaluations should consider qualitative factors, such as general community response or acceptance.

Figure 3 shows how these groups of measures can be used to assess project feasibility, and Figure 4 shows their application in assessing the benefits and impacts of a carpooling program.

Specific measures of effectiveness were derived from a review of available classification schemes. They reflect the specified transportation, economic,

TABLE 5 Potential TSM Actions, New York City: Manhattan, Bronx, Brooklyn, Queens, and Richmond

Major Center[a]	Radial Transportation Corridor	Crosstown Corridor	Areawide
Staggered work hours	Limit on-street parking	Limit on-street parking	Carpooling (outlying special activity centers at LaGuardia and JFK Airports)
Bridge tunnel tolls	Enforce parking regulations	Enforce parking regulations	Residential parking permit program
Automobile-free or restricted areas	General traffic engineering improvements	General traffic engineering improvements	General traffic engineering improvments
Discourage all-day parking	Left-turn lanes and prohibitions	Left-turn lanes and prohibitions	Truck route systems
Limit on-street parking	Upgrade traffic signals	Upgrade traffic signals	Bicycle-lane system
Enforce parking regulations	Meter freeway ramps	Meter freeway ramps	Bus shelters
Expand parking supply	Bus bypass of metered freeway ramps (priority entry)	Bus bypass of metered freeway ramps (priority entry)	Improve subway security
General traffic engineering improvements	Ramp closures	Ramp closures	
Turn controls	Freeway bus lanes (contraflow)	Increase transit service frequency	
Upgrade signals	Bus "queue bypass" of freeway congestion points	Close auxiliary station entrance	
Bus-taxi streets	Arterial bus lanes (normal flow)	Coordinate rail-bus service	
Curb bus lanes	Reversible lanes or streets		
Pedestrian malls	Increase transit service frequency		
Goods: curb loading zones	Improve track productivity		
Increase transit service frequency	Expand express service		
Improve access to stations	Close low-volume stations		
	Close auxiliary station entrance		
	Coordinate rail-bus service		
	Eliminate duplicate transit service		
	Provide park-and-ride lots (rail, subway, express bus)		
	Expand express bus service		

[a]Manhattan CBD excluded.

TABLE 6 Potential TSM Actions, Inner Suburbs and Counties

Major Center	Radial Transportation Corridor	Crosstown Corridor	Areawide
Expand parking supply	Limit on-street parking in developed areas	Limit on-street parking in developed areas	Carpool programs for major employers
Automobile-free or restricted zones	Left-turn lanes and prohibitions	Left-turn lanes and prohibitions	General traffic engineering improvements
Limit on-street parking	Upgrade traffic signals	Upgrade traffic signals	Widen intersection radii along bus routes
Enforce parking regulations	General traffic engineering improvements	General traffic engineering improvements	Bicycle lanes or ways
General traffic engineering improvements	Intersection channelization	Intersection channelization	Bus shelters
One-way streets	Meter freeway ramps	Meter freeway ramps	Subscription bus service
Turn controls	HOV priority entry (HOV bypass-metered freeway ramps)	HOV priority entry (HOV bypass-metered freeway ramps)	Paratransit service
Upgrade signals	Increase transit service frequency	Flyovers at key choke points	Safety improvements
Bus-pedestrian streets	Increase transit coverage		Correct street offsets
Curb bus lanes	Coordinate rail-bus service		Selected street extensions (especially bus routes)
Pedestrian malls	Provide park-and-ride lots (rail, express bus)		
Goods	Flyovers at key choke points		
Curb loading zones			
Off-street loading zones			
Increase transit service frequency			

TABLE 7 Potential TSM Actions, Outer Counties

Major Center	Radial Transportation Corridor	Crosstown Corridor	Areawide
Expand parking supply	Limit on-street parking in developed areas	Limit on-street parking in developed areas	Carpool programs for major employers
Limit on-street parking	General traffic engineering improvements	General traffic engineering improvements	General traffic engineering improvements
Enforce parking regulations	Intersection channelization	Left-turn lanes and prohibitions	Bus shelters
General traffic engineering improvements	Left-turn lanes and prohibitions	Upgrade traffic signals	Subscription bus service
Turn controls	Upgraded traffic signals		Paratransit service
Upgrade signals	Coordinate rail-bus service		Safety improvements
Bus pedestrian streets	Provide park-and-ride lots (rail, express bus)		Correct street offsets
Pedestrian malls	Increase transit coverage		Selected street extensions (especially for bus routes)
Goods			
Curb loading zones			
Off-street loading zones			
Increase transit service frequency			

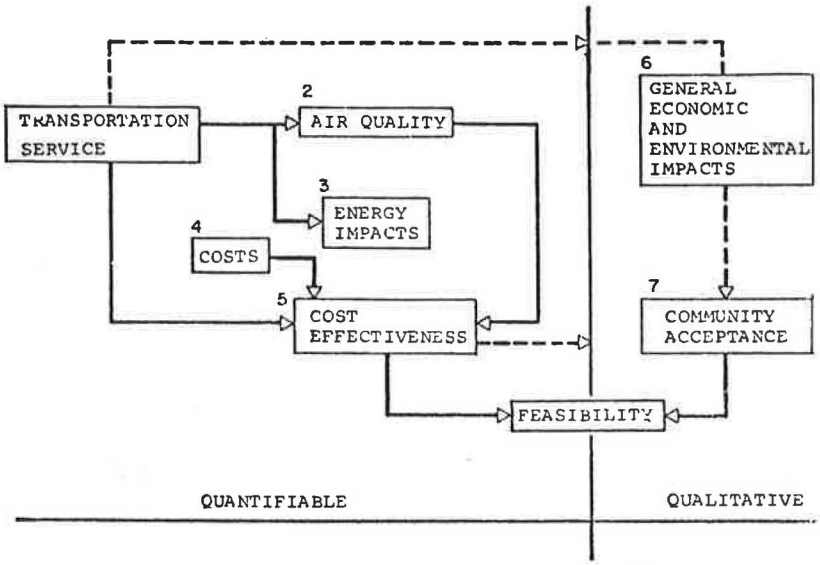

FIGURE 3 Using measures of effectiveness to assess project feasibility.

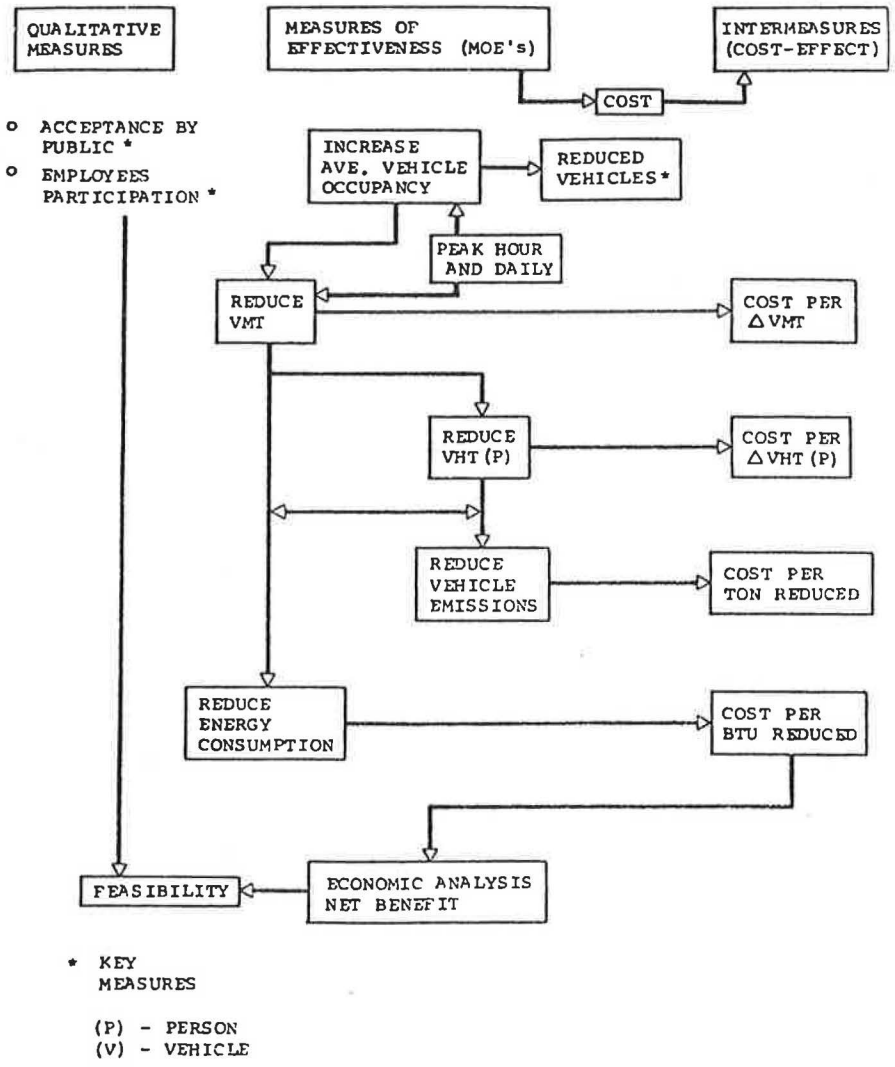

FIGURE 4 Illustrative improvement profile: carpooling programs.

and environmental goals of the region and the capabilities and resources of its planning agencies. Emphasis was placed on selecting a few significant measures that address the salient issues and interrelationships among congestion, mobility, environmental amenity, and costs.

The general measures that are most applicable to TSM strategies include

1. Travel time (minutes per mile, vehicle or person hours of delay or travel time, or average speed),
2. Capacity (persons or vehicles per hour),
3. Safety (number of accidents or accidents per unit of travel),
4. VMT,
5. Average vehicle occupancy (persons per vehicle),
6. Transit ridership,
7. Air quality (tons of carbon monoxide or hydrocarbons emitted), and
8. Energy (BTUs per person or vehicle mile).

The first six measures are basic in that they require data collection or direct estimation. The last two are derived, because they depend on vehicle miles and vehicle hours of travel.

Capital, operating, and maintenance costs also should be considered, both individually and how they relate to changes in system performance, such as annual cost per person-minute saved of VMT reduced. Qualitative factors should complement these parameters in assessing improvement effectiveness.

The preceding measures are easily understood, readily quantified, amenable to statistical analysis, and generally applicable. However, not all are relevant in every case. For example, average vehicle occupancy is not meaningful where traffic signal timing improvements are considered.

Quantifying Improvement Effectiveness

A review of relevant TSM literature found relatively few consistently quantified measures of effectiveness. Some are well documented for selected actions, and others are quantified on the basis of demand or simulation models. Salient observations are as follows:

- Measures dealing with actual performance of the transportation system--capacity, travel time, accidents, vehicle occupancy, and transit ridership--are normally quantified on the basis of actual case studies of before-and-after conditions.
- Changes in VMT are normally inferred or estimated on the basis of changes in transportation measures (car occupancy or transit riders), related factors (carpools formed), or demand models. Few, if any, changes in VMT resulting from TSM actions have been documented in practice. Thus, at the present time assessments of changes in VMT are largely conjectural, and the results have not been verified.
- Air quality and energy consumption are normally calculated from both travel speeds and VMT.

Identifying Complements and Conflicts

Generalized impacts of TSM actions in the Tri-State Region are shown in Table 8. In a broad context, most TSM actions, properly applied, can be complementary. Pricing actions should constrain peak-hour demand, thereby reducing highway congestion and queueing and simultaneously reinforcing transit and reducing emissions. Expanding off-street parking supply should enable on-street parking to be removed, thereby making curb lanes available for buses, commercial vehicles, cars, or property access.

Except where major additions to the road network or off-street parking supply take place, TSM actions generally will not increase VMT. The reasons are ap-

TABLE 8 Generalized Impacts of TSM Actions

Action	Impact				
	Improved Mobility	Reduced Travel Times or Congestion	Increased Transit Use	Reduced VMT	Improved Amenity
Demand management					
Staggered work hours		X			
Ridesharing				X	
Bridge and tunnel tolls				X	
Area licensing				X	
Automobile-restricted zones				Localized	X
Parking management					
Supply constraints			X	X	
Residential parking permits	X				X
Park-and-ride lots	X			X	
Parking programs	X				
Street use efficiency					
Traffic improvements	X	X			
One-way toll collection		X			
Freeway ramp controls		X			
Priority freeway entry					
Buses			X		
HOV		X		?	
Bus lanes, freeway	X	X	X		
HOV lanes, freeway		X		?	
Bus priorities, city streets		X[a]	X		
Pedestrian or transit malls		X[a]			X
Curb loading zone for trucks		X			
Transit service					
Additional express service	X	X	X	X	
Service expansion	X		X	X	
Service coordination		X	X		
Paratransit	X				

[a]Transit.

parent: (a) development densities and topography largely influence choice of travel mode, (b) major changes in modal use require substantial changes in transit performance or automobile restraints (beyond that readily attainable), and (c) TSM actions generally are localized rather than areawide in their impacts.

The principal conflicts between various TSM actions are focused and obvious. They commonly arise between expanding central area parking supply and increasing transit ridership and between ridesharing and public transport in high-density areas. Such conflicts can be minimized by careful design of TSM program packages.

SUMMARY

Impacts

The anticipated effectiveness of selected TSM actions in the Tri-State Region is summarized by the following impacts:

1. Person and vehicle capacity:
   a. On-street parking controls, 50 to 100 percent;
   b. General traffic improvements (typical), 10 to 20 percent; and
   c. Express transit service, 0 to 20 percent.
2. Travel-time savings:
   a. Bus malls, 2 to 5 min/mi;
   b. Bus lanes on city streets, 1 to 5 min/mi;
   c. On-street parking controls, 0.24 to 2.4 min/mi;
   d. Traffic signal improvements, 0.4 to 1.6 min/mi;
   e. Bus lanes on freeways, 1.2 min/mi;
   f. General traffic improvements, 10 to 20 percent gain in speed;
   g. Bus lane around major queue, 3 to 5 min;
   h. One-way toll collection, 2 to 3 min per car;
   i. HOV-ramp bypass, 1 to 3 min per vehicle;
   j. Transit service coordination, 0 to 10 min per trip; and
   k. Express transit service, 2 to 5 min per trip.
3. VMT reductions (estimates):
   a. Automobile-free zone, up to 20 percent across screenline;
   b. Parking rate adjustments ($1.00 rate increase in Manhattan), 5 percent in Manhattan;
   c. Bridge tunnel tolls, 2 to 5 percent at affected crossing or crossings;
   d. Parking supply reduction, 15 to 3 percent in Manhattan;
   e. Gasoline tax (+$0.10), 2 percent areawide; and
   f. Areawide $0.50 license surcharge, 0.7 to 1.3 percent in Manhattan.
4. Cost-effectiveness:
   a. Carpools, $20 to $51 per pool;
   b. Traffic signals, $0.02 per vehicle hour of travel reduced;
   c. Staggered work periods, $0.25 per vehicle hour of travel reduced (suburbs);
   d. Ramp metering, $1.00 per vehicle hour of travel reduced; and
   e. Park-and-ride lots, $0.02 to $0.035 per VMT reduced.

These impacts were drawn from national experience from 1978 through 1980 and provide useful planning guides. Significant findings are as follows:

- Many actions have major impacts over a very localized area. It is hard to derive areawide impacts from the application of these actions, although site-specific impacts can be readily quantified.
- Traffic engineering improvements will increase capacity up to 100 percent, with 10 to 20 percent gains common. Travel-time reductions of 20 percent can translate into energy and air-quality benefits.
- Demand management measures can achieve regulations in VMT up to 5 percent at specific locations on the basis of theoretical studies of travel elasticities and carpool formation. An effective ridesharing program, for example, would reduce VMT an estimated 0.2 percent in the suburbs and 0.1 percent in New York City; costs would average about $0.02/VMT reduced and about $20 to $50 per capita.
- Bus lanes will save bus passengers 1 to 5 min/mi, and bus (or carpool) priority entry treatments will save 1 to 3 min per ramp depending on the amount of congestion.
- Transit improvements will increase ridership, but at a rate less than the amount of additional service provided. A 2 percent gain in bus mileage would result in a 1 percent gain in riders--of which about one-half might be former motorists. Express transit extensions could increase corridor capacity up to 20 percent and save passengers 2 to 5 min per trip.

These values, although calibrated for the Tri-State Region, may also apply to other urban areas; some adjustments may be required. They are generally consistent with cost-effectiveness analysis developed for a typical urban area of 1 million population as part of an UMTA-sponsored study. The study found the following cost-effectiveness ranges: ridesharing, 1 to 2 cents/VMT reduced, and traffic signal timing optimization, 2 cents/vehicle-hr reduced (8). In the metropolitan New York context, ridesharing would be less effective because of the high reliance on transit for Manhattan-bound trips. In the Tri-State Region, public transport will be more effective in improving mobility and reducing VMT than is suggested by the 40 to 43 cents/VMT reduced.

Attitude studies conducted in the Tri-State Region reported good public support for transit improvements as a transportation control strategy. Public support was also found to be great for rush-hour automobile bans in downtown areas and for pollution-free vehicles. In contrast, public support was found to be low for various pricing mechanisms--such as new bridge tunnel tolls or an areawide surcharge. This implies that pricing mechanisms, despite their theoretical attractiveness, must be selectively applied.

Status in 1986

The city of New York, faced with the mandates of the Clean Air Act, is evaluating a menu of alternatives that will reduce congestion in concert with improved transit services. The candidate proposals, which are under study, were designed to (a) allow imitation or implementation within a short time; (b) bring about a substantial reduction in vehicle entries into Manhattan, vehicles in motion, or VMT or vehicle hours of travel; (c) avoid future traffic increases; and (d) minimize adverse social and economic impacts (9).

The options under study include

1. Banning passenger cars from sections of Manhattan's central business district,
2. Congestion pricing,
3. Restricting single-occupant cars from entering Manhattan,
4. Restricting entries by license plate,

5. Increasing tolls,
6. Providing more transitways,
7. Restricting vehicles that stay in motion,
8. Reducing subsidies for parking, and
9. Banning trucks.

Changing the Perspective

The analysis of TSM opportunities and impacts in the Tri-State Region provides insights into TSM programs in other urban areas as well. It suggests pragmatic approaches to identifying and assessing TSM measures in a large metropolitan area--approaches that also apply in other metropolitan areas. It calls for translating concepts and analyses into meaningful productive improvements and for viewing TSM as an action program, not merely as a planning process.

This approach contrasts with the one set forth in the vast body of literature that appeared in the late 1970s and early 1980s; this literature dealt with the philosophy of TSM, its role in the planning and policy process, and elaborate analytical models designed to detect small differences in travel behavior. Fortunately, some redirection of TSM activities to achieve more of an action emphasis is already taking place. NCHRP Report 263 describes planning procedures for early action improvements that call for finding problems and then keying solutions to them; this research is being supplemented by case studies and user-oriented information (2).

Accordingly, the following TSM guidelines are suggested:

1. TSM improvements should be oriented toward early action. They should focus on management and operation rather than on construction, planning, or evaluation. Consequently, line operating agencies such as the transportation (traffic) department and transit agency should play a key role in developing and implementing improvements. Emphasis should be placed on immediate action improvements within a multimodal context.
2. Programs should be developed on an appropriate geographic scale, preferably on an annual basis. They should be responsive to a broad range of mobility and nontransportation objectives and constraints.
3. The workability of TSM improvements should not be studied in the abstract. Their ability to fit the real-world environment is important. Thus, site-specific analysis is essential.
4. Measures of effectiveness should be clear and relevant. Data collection and analysis requirements should be consistent with the resources and capabilities of planning and operating agencies. As few measures as possible should be used. Because TSM is improvement based rather than data based, data collection and analyses should be kept in scale with overall program objectives and agency resources.
5. Emphasis should be placed on more attainable goals than merely reducing VMT. The localized nature of many TSM actions and the conjectural aspects of anticipated VMT reductions raise questions regarding inferences derived regarding areawide VMT change. Consequently, TSM actions should be viewed from a far broader context. They should emphasize measurable benefits of improved mobility, increased safety, reduced congestion, and increased transit ridership, which collectively produce corollary gains in air quality and energy consumption. This suggests a shift away from the emphasis on reducing VMT: small-scale reductions in VMT may be illusory and statistically insignificant in view of the day-to-day variations in urban travel and actual measurement errors.
6. Differing goals and objectives may call for differing improvement types or priorities. This may require selective trade-offs or compromises. Actions to improve air quality or enhance the environment, for example, may not be the same as those designed to improve mobility. In practice, care should be exercised in implementing measures that adversely affect mobility.
7. Improvements should be coordinated with land use patterns and mobility needs. Their applicability should be keyed to (a) perceived problems and needs, (b) basic transportation plan objectives, and (c) specific physical transportation and land use conditions. The goal is to implement measures that reflect basic goals and that are reasonable to users and the community in terms of benefits, impacts, and costs.
8. The coordination aspect among TSM actions should be given greater emphasis. The related actions that improve multimodal mobility should be given precedence over those that merely bring together ongoing proposals in an unrelated sense (for example, improving transit service and road access to new park-and-ride facilities).

In sum, TSM programs should be real and attainable. They should contain a set of coordinated actions in which the whole is greater than the sum of the individual parts. They should be reasonable in the minds of the traveling public and the affected community.

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