UCI-ITS-WP-87-1

Testing the Limits of TSM: The 1984 Los Angeles Summer Olympics

UCI-ITS-WP-87-1

Genevieve Giuliano

Institute of Transportation Studies
University of California, Irvine

February 1987

Institute of Transportation Studies
University of California, Irvine
Irvine, CA 92697-3600, U.S.A.
http://www.its.uci.edu

ABSTRACT

This paper analyzes the impact of the transportation system management (TSM) program employed during the 1984 Los Angeles Summer Olympics. Two issues are examined. First, the impact of the various elements of the TSM program on transportation system performance is measured by conducting a series of traffic simulation studies. The results show that TSM was an important contributing factor in the favorable traffic conditions experienced during the Olympics. Second, the potential of employing TSM as a long-term transportation policy strategy is assessed. It is concluded that the travel behavior changes which occurred in response to the TSM program were unique and short-term. Under ordinary circumstances, incentives do not exist to induce changes of the magnitude observed during the Olympics.

INTRODUCTION

Increasing reliance has been placed on transportation system management (TSM) strategies as a way of increasing the capacity of the urban transportation system (Rosenbloom, 1978; Transportation Research Board, 1977; Gakenheimer and Meyer, 1979). Transportation system management focuses on enhancing the effectiveness of the existing system by using non-capital intensive strategies to increase system capacity and by influencing travel demand to reduce peak-period vehicle trips.

Chronic funding shortages, as well as environmental concerns, have caused the construction of new transportation facilities to lag far behind growth in population and economic activities. The result is constantly increasing levels of traffic congestion in major metropolitan areas. In response to current travel forecasts which predict substantial worsening of traffic conditions if major investments in transportation facilities are not made, TSM methods are increasingly being considered to mitigate future transportation problems, both in urban centers (Ferreri, 1982; McConnell-Fay, 1986), as well as in rapidly developing in suburban areas (Cervero, 1986). However, little is known about the feasibility or potential effectiveness of an intensive TSM program, particularly when the selected strategies depend on changes in travel demand.

The 1984 Los Angeles Summer Olympics provide a unique opportunity to empirically evaluate the effectiveness of TSM strategies, and to assess the potential of TSM as a long-term transportation policy strategy. Los Angeles Olympics planners were faced with an unprecedented challenge: how to accommodate the travel demand of an expected 1.2 million visitors, 6 million spectators, and nearly 25,000 athletes, media and related personnel within an already highly constrained transportation network. Planners responded to the challenge with the development and implementation of the most comprehensive TSM program ever undertaken.

The Olympics were an unqualified success from a traffic management perspective. With few exceptions, traffic conditions experienced during the Olympics were better than usual. The apparent success of the Olympics suggests that two issues be explored. First, can the favorable traffic conditions observed during the Olympics be attributed to the TSM program, and if so, can the role of individual strategies be identified? Second, are the Olympics results transferable to long-term transportation policy?

This paper presents the result of an analysis of TSM impacts on transportation system performance during the Los Angeles Olympics aimed at examining these two issues. The remainder of the paper is organized as follows. First, the TSM program implemented during the Olympics is briefly described. Second, the research approach is discussed, and the methodology is presented. Third, the data utilized in the analysis are described. Fourth, results of the analysis are discussed and conclusions on the role of TSM during the Olympics are presented. The paper concludes with a discussion of the transferability issue in the context of transportation planning policy.

THE OLYMPICS TSM PROGRAM

The Olympics TSM Program was formulated during the two years prior to the Olympics by an interagency planning group, the Los Angeles Olympics Transportation Advisory Group. This Group was voluntarily organized by local agency leaders representing state and local transportation departments, state and local police departments, the regional transit district, and local and regional transportation planning agencies.

The TSM program that emerged from this planning process had two important characteristics. First, there was nothing new in the program; it was largely made up of conventional elements. Table 1 summarizes the major program elements. With the exception of the truck diversion program, all of these strategies either have been or are being employed in heavily congested areas around the United States. The second important characteristic was comprehensiveness. While the individual program elements were not unique, their number and intensity were. The TSM program had a dual focus: to facilitate circulation at all of the venues and to maintain a reasonable level of service on the regional transportation system. Every possible method of balancing supply and demand was explored in order to achieve these goals. Because the Los Angeles transportation system was already at capacity,

TABLE 1

OLYMPICS TSM PROGRAM ELEMENTS

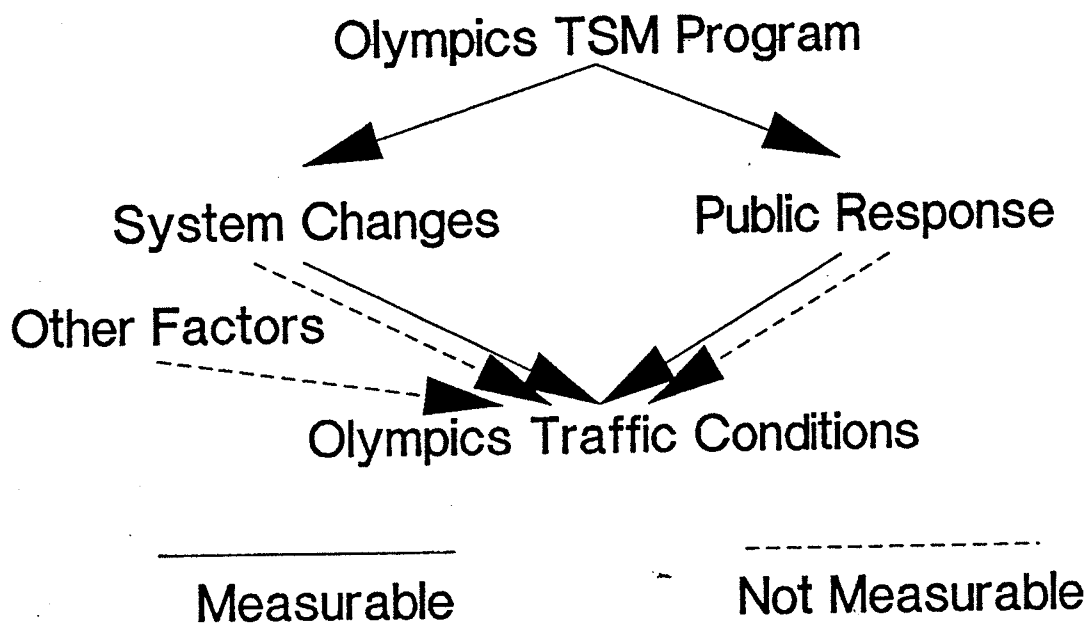
- Marketing of venue access plans and transit services	- Venue access, circulation and parking plans
- Marketing of ridesharing services, transit, alternative work schedules and alternative travel routes	- Olympics transit services
- Truck diversion program	- Freeway ramp metering and use of shoulders
- Media information services on traffic conditions and daily events	- Street and signalization improvements
- System surveillance	- Parking and loading restrictions
- Interagency traffic coordination center	- Ban on construction and maintenance work

Olympics planners were limited to working with marginal improvements. Thus, the strategy became one of accomplishing as many marginal changes as possible.

Major elements of the Olympics TSM program included access, circulation and parking plans for each of the 24 venues; as well as Olympics park-and-ride and shuttle transit services and the designation of bus-only arterial and freeway facilities to support the transit services. A massive campaign marketed travel alternatives for commuters based on anticipated Olympics travel conditions. Daily event schedules and traffic condition reports were circulated through the local media. Signalization and other improvements were implemented on key arterials, and all construction and maintenance activities which could conflict with Olympics traffic were prohibited. A cooperative agreement with the trucking industry led to Operation Breezeway, a program designed to divert truck traffic from heavily congested areas during peak hours. Finally, an intense surveillance system utilizing helicopters, autos, stationary observers, and closed-circuit television monitored major venue areas. This multifaceted program reallocated existing system capacity to more productive uses, and made marginal increases in capacity where possible. It also provided travelers with an unusually high level of information regarding travel alternatives and system conditions.

RESEARCH APPROACH AND METHODOLOGY

In order to address the first research issue of interest, namely the extent to which favorable Olympics travel conditions can be attributed to the TSM program, it is necessary to identify and measure program impacts. The research problem is illustrated in Figure 1. The TSM program generated both system changes and changes in travel behavior. These changes contributed to the traffic conditions observed during the Olympics. Not all of the changes



The Research Problem

Figure 1

are measurable, however. For example, it is not possible to quantify the impact of improved system surveillance, or to quantify all of the changes in travel behavior that may have taken place.[1] Other factors also contributed to traffic conditions during the Olympics. Anecdotal evidence suggests, for example, that business travel was curtailed, and the number of visitors was

---

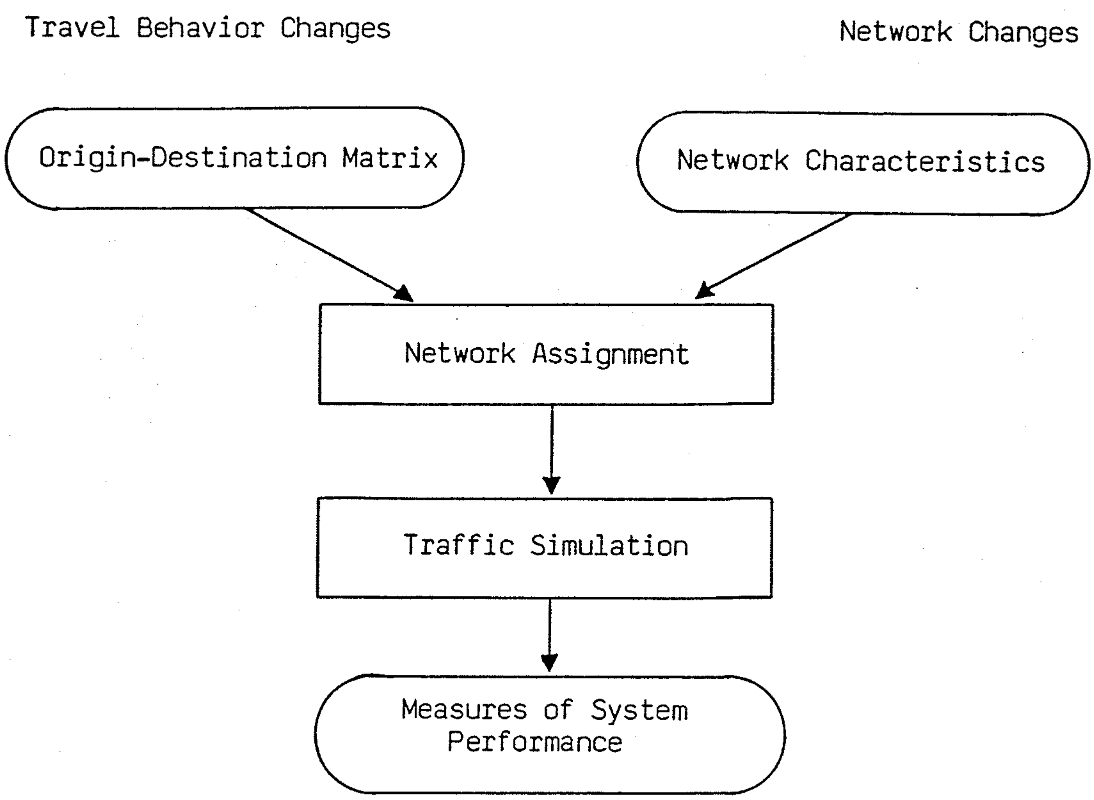
1 Measurement problems here refer primarily to data availability. It is conceptually possible to measure all of these factors; however the data were not available to do so.

not as large as anticipated. These factors are not random; rather, the unmeasurable factors affecting Olympics traffic conditions were predominantly biased toward reducing travel. Failure to control for these factors would result in overstating the role of the TSM program.

A simulation approach was the obvious choice for evaluating the TSM program. Traffic conditions during the Olympics could be simulated, and the impact of individual program elements could be replicated by manipulating supply and demand characteristics. A simulation study eliminates the influence of uncontrolled factors, because all factors are subject to model control.

Simulation models have been widely used to measure the impact of specific TSM improvements on system performance. Most of this research has focused on supply-side strategies. For example, signal timing strategies for arterials and freeway ramp metering effects have been extensively analyzed via simulation studies (May, 1981). Few such studies of demand-oriented TSM strategies have been performed. The most comprehensive effort was an analysis of flexible work hours and freeway performance (Jovanis, 1979). Previous research has been limited by the inability to model complete networks (e.g. interactive freeway and arterial systems), and by the lack of an integrated modeling system to incorporate travel demand changes. The U.S. Federal Highway Administration has recently sponsored the development of a modeling system with these capabilities (KLD & Associates, 1985). This model was adapted for use in this research.

The simulation modeling procedure is illustrated in Figure 2. Travel demand is expressed in the origin-destination matrix, which is a matrix of all trips taking place during the designated period of analysis (e.g., AM peak). In this case, the origin-destination matrix is a synthetic matrix generated



Simulation Modeling Procedure

Figure 2

from observed link volume and turning movement data. System supply characteristics are coded into the network model. The network assignment model assigns paths to the trips based on minimizing total travel time. The assignment is performed as an equilibration procedure between trip demand and capacity supply as expressed by network characteristics. The traffic assignment is then transmitted to the traffic simulation model. The simulation model generates measures of system performance (e.g., freeway and arterial travel speeds) for the simulation period.[2]

---

2 For a more comprehensive discussion of the modeling approach, see Giuliano et al., 1986.

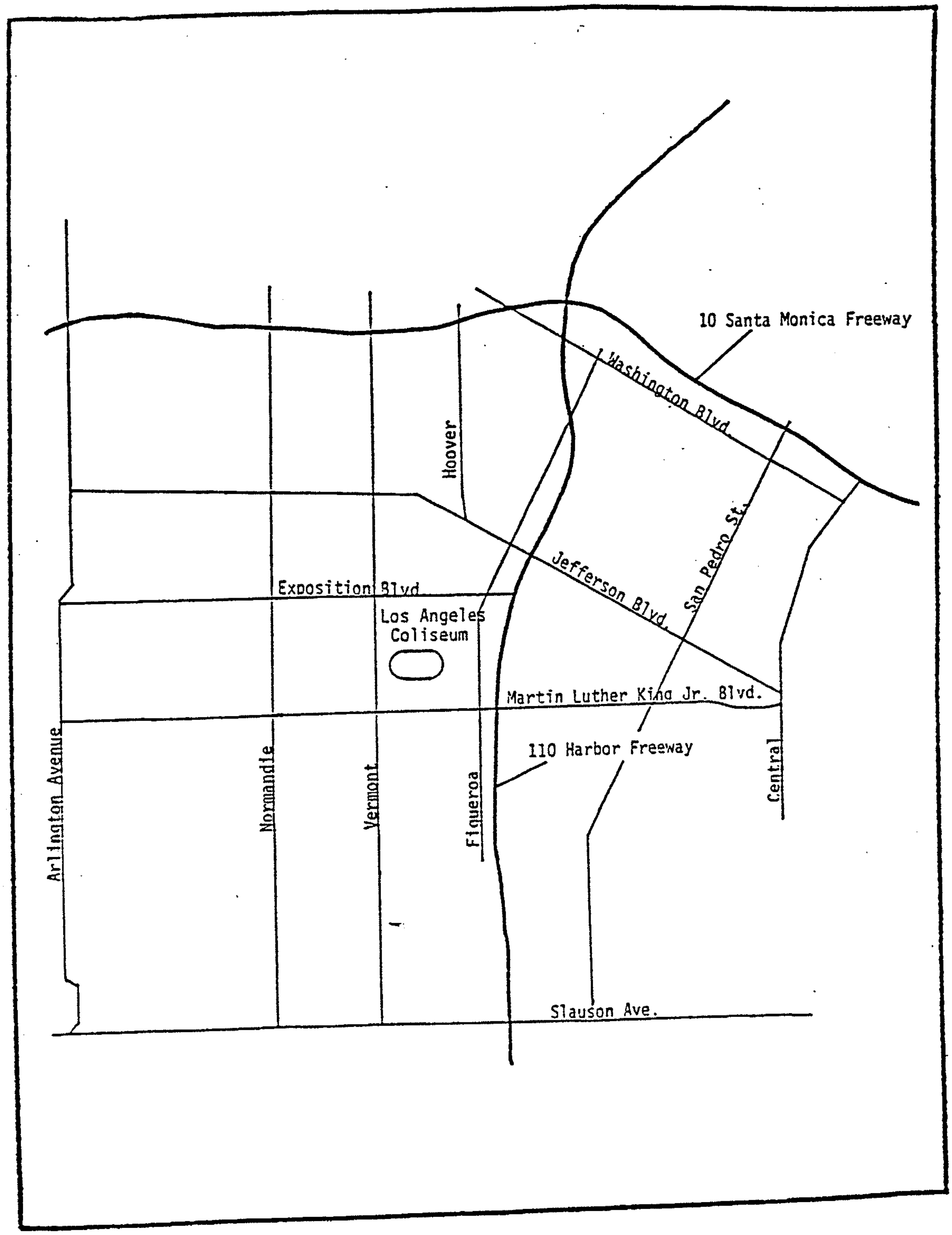
This simulation procedure made it possible to evaluate the impact of specific elements of the TSM program. For example, the impact of changes in work trip scheduling could be quantified by appropriately modifying the origin-destination matrix, conducting the simulation, and by comparing the simulation results to the appropriate baseline. Similarly, the impact of one-way streets could be quantified by appropriately modifying the transportation network, conducting the simulation, and comparing results.

DATA

Because of the computational complexity of the simulation model, there is a trade-off between the desired level of detail of the analysis and the size of the area that can be simulated. In this case, detail was deemed more important, and a small geographic area was selected for analysis.

The primary consideration made in selecting a specific case study area included the extent to which the Olympics were expected to have an impact, and the number of network changes that could be evaluated. The Los Angeles downtown/Coliseum area was selected for the case study. The case study area as coded for the simulation model is illustrated in Figure 3. The Coliseum was the single largest Olympics venue, with up to 122,000 daily spectators. Because of anticipated parking shortages, this venue was the focus of the most intensive high occupancy vehicle (HOV) circulation plan and the greatest variety of transportation system changes. In addition, significant congestion was expected due to overlapping spectator and downtown commute traffic, and thus downtown commuters were a primary focus of commuter TSM marketing efforts.

Olympics TSM program impacts that could be measured included several aspects of spectator and non-spectator travel, as well as the specific changes made in the transportation system. Four general categories of data were



The Case Study Area

Figure 3

required: network characteristics, traffic conditions and characteristics, spectator travel behavior, and non-spectator travel behavior. Network characteristics data were obtained from local agencies and field observations. Traffic conditions data were collected before, during, and after the Olympics in cooperation with local agency personnel. Spectator transit data was provided by the regional transit agency. Other spectator travel data were obtained from the California Department of Transportation. Non-spectator travel data were obtained via a survey of downtown employees.

CASE STUDY RESULTS

The case study consisted of using the simulation modeling system to simulate traffic flow conditions for a set of alternative scenarios. Each scenario corresponds to a specific TSM program element (e.g., work schedule changes, one-way streets). Comparisons across the scenarios give an estimate of their relative effectiveness. The AM peak hour was selected as the period of analysis.

The TSM program elements to be tested were divided into two general categories: supply-side and demand-side elements. These were further subdivided into spectator and non-spectator elements. The list of program elements is presented in Table 2. In all cases, the simulations are based on the actual changes that took place during the Olympics. Thus all demand-side scenarios reflect the extent to which a change in travel behavior took place. It may be noted that a work-trip mode shift is not listed; it was not included because no significant change in work trip mode choice took place. The demand and supply aspects of the Olympics transit service were combined since the HOV system was developed specifically for the transit operation. In addition, a ramp metering scenario was also omitted because the case study area is not a

TABLE 2

TSM PROGRAM ELEMENTS EVALUATED IN THE SIMULATION STUDY

Demand Side		
	Non-Spectator	Work Scheduling Work Absences Non-Work Travel Truck Traffic
	Spectator	Olympics Transit/HOV System
Supply Side		
	Non-Spectator	One-Way Streets Ramp Closures
	Spectator	Olympics Transit/HOV System Event Scheduling
Global		All Strategies

major source of freeway trip origins during the AM peak, and thus freeway ramps operate below capacity and do not need to be metered. A global scenario was also simulated in order to quantify the cumulative impact of all of the TSM strategies. A total of nine different scenarios were simulated.

The case study also required that an appropriate method of measuring the impact of these strategies be established. Two choices were considered. The first was to estimate a worst case scenario, assuming no changes had been made to accommodate the Olympics, then implement each of the strategies and measure the improvement they generate. The other choice was to use the Olympics baseline and remove each of the strategies individually. This allows measurement of the impact of not implementing a strategy. The latter alternative was chosen because the Olympics baseline was a more reliable basis of comparison. To summarize, then, each strategy is evaluated by appropriately adjusting the O-D matrix or the network, performing the traffic simulation, and comparing the results to the baseline simulation. Performance is evaluated by comparing various "measures of effectiveness" (MOEs) between the two scenarios. The MOEs include freeway and arterial speed, freeway and arterial delay, total travel time on the system (global vehicle hours), and global network speed. Freeway delay is measured as the amount of time vehicles are traveling below 40 MPH, and arterial delay measures stop time. Global vehicle hours is the total amount of time vehicles are traveling on the system, and global speed is simply total VMT divided by global vehicle hours.

Non-Spectator Travel

Results for non-spectator travel changes are given in Table 3. Recall that in each case the given strategy was removed from the baseline scenario. The results measure the deterioration in system performance that would have occurred had the strategy not been implemented during the Olympics.

The results show that reductions in work trips and non-work trips had the most favorable impact on system performance. This is reasonable, since these strategies removed a greater number of trips from the peak hour O-D matrix. However, their impact relative to the other two strategies was far greater than the actual difference in the number of trips removed, demonstrating the increasing marginal impact of additional trips on a congested network. Differences between the impact of the reduction in work trips and the reduction in non-work trips are due to variations in average trip length and arterial/freeway distribution of the two types of trips. Reduced truck traffic was the least effective non-spectator TSM element

TABLE 3

CONTRIBUTIONS OF NON-SPECTATOR TRAVEL CHANGES
TO SYSTEM PERFORMANCE

	MOE					
Scenario	Freeway MPH	Freeway Delay (VH)	Arterial MPH	Arterial Delay (VH)	Global MPH	Global VH
Baseline	35.5	316	13.9	1,671	24.1	5,914
Work Schedule Change	33.8	494	12.6	2,202	22.3	6,972
Percent Change From Baseline	-5%	+56%	-9%	+32%	-7%	+18%
Absence from Work	24.5	1,732	12.4	2,349	18.8	8,469
Percent Change	-31%	+448%	-11%	+40%	-22%	+43%
Reduce Non-work Trips	25.4	1,485	12.5	2,369	19.0	8,140
Percent Change	-28%	+370%	-10%	+42%	-21%	+38%
Reduce Truck Traffic	34.4	417.5	13.1	2,024	22.8	6,577
Percent Change	-3%	+21%	-6%	+21%	+5%	+11%

according to the simulation study, because truck traffic makes up a small proportion of peak hour traffic in this area.

Spectator Travel

The data indicated that about 45 percent of the Coliseum spectators used the Olympic transit service. The spectator transit element was modeled by assuming that the bus service did not exist. All of the Olympics transit users were assumed to originate from the same area as the bus they took, to travel at the same time, and to carpool at the observed Olympic vehicle occupancy rate of 2.5 persons per vehicle. Table 4 presents the results.

At the global level, spectator transit use has a somewhat greater impact than work-trip reductions. However, since all of the extra trips are converging on the Coliseum, the impact on the arterial system in absolute value is far greater than in any of the other scenarios. The results indicate

TABLE 4

CONTRIBUTION OF OLYMPIC SPECTATOR TRANSIT USE TO SYSTEM PERFORMANCE

	MOE					
Scenario	Freeway MPH	Freeway Delay	Arterial MPH	Arterial Delay	Global MPH	Global MPH
Baseline	35.5	316	13.9	1,671	24.1	5,914
No Transit	28.4	1,108	8.9	3,497	17.4	8,815
Percent Change From Baseline	-20%	+251%	-36%	+109%	-28%	+49%

that freeway delay would have increased about two and one-half times and arterial delay would have more than doubled had the Olympics transit service not been available and utilized.

Supply Side Changes

Changes in the Coliseum area during the Olympics included one-way streets, ramp closures (including the HOV ramps which were closed to general traffic), and ramp metering. As mentioned previously, the AM peak was not appropriate for testing ramp meter impacts. Thus only one-way streets and ramp closures are discussed.

Results for one-way streets and ramp closures are given in Table 5. These changes were made to better accommodate Olympics traffic and to provide for the Olympics HOV system. The results show that the one-way streets had a slightly positive impact on the arterial system and a slightly negative impact on the freeway system. One-way designation significantly improved performance of the streets involved. However, these streets make up a very small proportion of the total system, and thus the global impacts are slight. Freeway impacts were due to route diversions which caused some additional ramp congestion. Ramp closures had a negative effect on both systems, also due to route diversion which caused extreme congestion in one location. In contrast to the demand-side TSM changes, these network changes had very minor impacts on traffic conditions.

A final supply-side strategy element tested was scheduling of major Olympics event. Coliseum events were scheduled to avoid the heaviest weekday peak periods. The scenario was tested by assuming a peak-hour Coliseum start time, holding actual mode split constant. Results are given in Table 6. The impact on both the freeway system and arterial system is severe: freeway

TABLE 5

CONTRIBUTION OF NETWORK CHANGES TO SYSTEM PERFORMANCE, HOLDING OLYMPICS TRAFFIC CONSTANT

Scenario	Fwy Speed (MPH)	Fwy Delay (Veh-Hrs)	Art Speed (MPH)	Art Delay (Veh-Hrs)	Global Veh-Hrs	Global Speed (MPH)
Baseline	35.5	316	13.9	1,671	5,914	24.1
One-Way Streets	37.2	190.8	13.7	1,712	5,837	24.5
Percent Change From Baseline	+4.8%	-39.6%	-1.4%	+2.4%	-1.3%	+1.6%
Ramp Closures	37.2	186.1	14.4	1,593	5,739	25.1
Percent Change	+4.8%	-41.1%	+3.6%	-4.6%	-2.9%	+4.1%

speed is reduced by half, and arterial speed declines by a similar amount. Delay on both systems increases by orders of magnitude. Comparing these results with those of the other scenarios shows that event scheduling had the single greatest impact--about twice as great as spectator transit use, absences from work, or reductions in non-work trips. These results are biased in the sense that the case study area is the area which would have been most heavily impacted. On the other hand, because spectator trips were much longer (on average) than other trips, they would have had an impact far beyond the

TABLE 6

CONTRIBUTION OF SCHEDULING OLYMPIC EVENTS
OUTSIDE PEAK PERIOD

Scenario	Fwy Speed (MPH)	Fwy Delay (Veh-Hrs)	Art Speed (MPH)	Art Delay (Veh-Hrs)	Global (Veh-Hrs)	Global Speed (MPH)
Baseline	35.5	316	13.9	1,671	5,914	24.1
Peak Start	14.3	4,445	7.3	4,484	12,832	11.0
Percent Change from Baseline	-59.7%	1,306%	-47.5%	+168.3%	+117%	-54%

Coliseum area. It is also worth noting that this scenario has by far the greatest negative effect on the freeway system.

Overall Impact

Another way of evaluating the impact of the TSM program is to estimate what might have happened had none of the TSM strategies been employed. That is, what would have happened if there were no changes in non-spectator travel behavior, no Olympics transit service, no changes in the network, and no effort to avoid scheduling Olympic events during the peak? Two "worst case" scenarios were simulated to show what might have happened, and the results are given in Table 7. "Black Monday" assumes no change in travel behavior and no changes in the network; spectator travel has the baseline non-Olympics

TABLE 7

THE OVERALL IMPACT OF THE OLYMPICS
TSM PROGRAM: WORST CASE RESULTS

	Freeway Speed	Delay	Veh-Trips	VMT
Baseline Olympics	35.5	316	16,921	99,320
Black Monday	2.8	28,180	8,826	85,421
Black Monday + Transit	4.2	18,767	11,010	91,128

	Arterial Speed	Delay	Veh-Trips	VMT
Baseline Olympics	13.9	1,671	24,060	43,373
Black Monday	3.0	11,872	30,592	45,687
Black Monday + Transit	4.3	9,351	33,842	53,270

	Global Speed	Delay	Veh-Trips	VMT
Baseline Olympics	24.1	5,914	40,981	142,693
Black Monday	2.9	40,052	39,418	131,108
Black Monday + Transit	4.2	28,118	44,852	144,398

non-work mode split and vehicle occupancy. "Black Monday with Transit" is the same as Black Monday, except that a 40 percent mode split for spectator travel is assumed.

The system falls into breakdown conditions, and capacity drops significantly, as indicated by the number of trips. This is the result of heavy congestion; some of the trips were never able to enter the network. To illustrate, spillback (vehicle queuing) occurred on four links in the baseline Olympics simulation and on 11 links in the baseline non-Olympics simulation. Spillback occurred on 95 links in Black Monday and on 71 links in Black Monday with Transit. Congestion is so extensive that vehicles literally fill up all of the available roadspace. Had no changes been made to accommodate the Olympics, the threatened gridlock conditions may have indeed occurred.

The case study simulations provided a means for measuring the impact of each of the TSM strategies implemented during the Olympics. Table 8 summarizes the results by rank-ordering the simulated strategies by their global impact. As noted previously, Olympics event scheduling clearly was the most effective of the strategies tested. Had major events conflicted with regular peak-hour traffic, a great deal of congestion would have resulted. Absences from work and reductions in non-work trips were approximately equally effective, and nearly as effective as spectator transit use. Work schedule changes and reductions in truck traffic had a smaller impact than any of the other demand-side strategies.

In contrast, the traffic engineering strategies--ramp metering, ramp closures, and one-way streets--have mixed effects. These results are not unexpected. Only strategies which can significantly improve traffic throughput are effective. Given the level of congestion that exists at peak hour in an area such as central Los Angeles, any reduction in trips generates a greater than proportional reduction in delay, and consequently demand-management strategies have a significant impact. On the other hand, supply-side strategies can only improve the flow of existing trips on the network, and in the absence of significant increases in capacity (e.g., adding a lane), the potential for improvement is limited.

TABLE 8

RELATIVE IMPACTS OF OLYMPIC TSM
PROGRAM STRATEGIES

Scenario	Impact on Global Speed* (Percent)	Impact on Global Veh-Hrs* (Percent)
Event Scheduling	-54%	+117%
Spectator Transit Use	-28%	+49%
Absence from Work	-22%	+43%
Reduce Non-Work Trips	-21%	+38%
Work Schedule Change	-7%	+18%
Reduce Truck Traffic	-5%	+11%
Ramp Metering	0	0
One-Way Streets	+1.6%	-1.3%
Ramp Closures	+4.1%	-2.9%

* Compared to baseline Olympics.

It should be noted that these results are reflective of the case study area selected. Had a larger case study area been used, the impact of the demand-side strategies possibly would have been more pronounced relative to the supply-side strategies because of the limited supply-side options available. For example, higher than normal absences from work occurred throughout Los Angeles, and thus probably had a widespread positive impact on traffic conditions.

Finally, these results must be interpreted in the proper context. These simulations provide a good estimate of the relative effectiveness of the TSM strategies employed during the Olympics, given the level at which they were implemented. They do not provide good absolute estimates because the simulation approach is approximate and subject to error.

CONCLUSIONS

The positive experience of the Olympics leads to an obvious question: can strategies employed during the Olympics be implemented on a permanent basis to address current and future traffic problems? In order to answer this question, the Olympics must be understood as a short-term problem which required short-term solutions. Furthermore, short-term solutions do not necessarily translate into long-term solutions. Two aspects of the Olympic experience illustrate this point: patterns of travel behavior and the Olympics institutional environment.

Patterns of Travel Behavior

The data used in the analysis revealed several key characteristics of non-spectator travel behavior during the Olympics. First, significant changes were highly localized in both time and space. Over the two-week Olympic period, traffic conditions shifted from extremely light during the first few days to normal conditions by the last few days, suggesting that once it became clear that gridlock conditions would not materialize, there was no longer any incentive to make changes in travel behavior. Since traffic congestion is a classic externality problem, this result is not surprising. Without a method for internalizing congestion costs, less congested conditions will not persist.

It is also noteworthy that the greatest changes were concentrated in the downtown/Coliseum area. Travel adjustments were made where they were perceived to be necessary--where traffic conditions were expected to be the worst. These adjustments were made possible by the intensive Olympics public information program which gave area travelers all the data they needed to make informed travel choices. These choices were probably as close to optimal as they could be in a real world situation.

Second, the limited data available suggests that the reduction in non-work travel was focused on everyday activities such as shopping and medical visits. Business-related travel, including sales calls and inter-office meetings, was also curtailed. Taken as a whole, changes in travel behavior during the Olympics were temporary. The choices made, and the extent of those choices, were appropriate as a short-term response, but not necessarily as a long-term response. In fact, travel-demand theory suggests that mode and destination choice would change in response to congestion-generated changes in accessibility, rather than the frequency of travel, as happened during the Olympics.

The Olympics Institutional Environment

Perhaps the most remarkable aspect of the 1984 Olympics was the institutional environment in which the TSM program was developed and implemented. This environment was unique in several ways. First, there was consensus among agency leaders on the problem to be solved. Relatively accurate forecasts of Olympic activities were available. The basic parameters of the problem were quite clear, in contrast to more typical transportation planning issues in which there is often conflict on the nature of the problem itself.

Second, there was consensus on the feasible solutions available to solve the problem. Major capital investments were not feasible. The expected traffic had to be accommodated within the existing system. Moreover, because the Olympics were short term, strategies could be used which might not be feasible under other circumstances.

Third, the institutional leadership was prepared to act. Not only was the problem well-defined, the consequences of non-action were quite clear. The action orientation of local leaders is demonstrated by the group which formulated the TSM program. Unlike most such groups, agency leaders actively participated in the group and took personal responsibility for mobilizing all agency resources necessary for program implementation. Interestingly, program planning responsibility was assigned to the operations departments within the state and city DOTs, not to the planning departments. Decision processes within the participating agencies were also streamlined. Agency leaders had considerable authority and latitude, and were able to take action without the usual hearings, approvals, and other procedural requirements.

Finally, the political importance of a successful Olympics was obvious. Local leaders who had worked to bring the Olympics to Los Angeles had a strong incentive to avoid major traffic problems. Renowned as the home of endless miles of freeways and mammoth traffic jams, Los Angeles has a particular image problem with respect to transportation. Any failure of the system would receive worldwide attention and carry a high political cost. In fact, the gravity of the problem was equated by at least one participant to that of World War II. Everyday conflicts between local agencies were forgotten, and all efforts were directed toward making the Olympics work. This atmosphere of cooperation and leadership made it possible to implement policies that under normal conditions would be unacceptable. Thus, truckers gave up overtime pay, legal holidays were shifted, on-street parking prohibitions were employed, and arterial lanes and freeway ramps were reserved for buses.

With the exception of a synchronized signal system in downtown Los Angeles, however, none of the TSM strategies survived the Olympics, despite the favorable press they received. As one example, a one-way street couplet linking the Coliseum Area with downtown was to remain in place after the Olympics. Intensive opposition by local merchants led to its abandonment shortly after the close of the games, however, despite the circulation benefits it demonstrated. Once the crisis passed, institutional conflicts resurfaced, and traffic problems lost their visibility. The Olympics TSM program proved to be no longer feasible under ordinary circumstances.

Policy Consequences

The results of the analysis presented in this paper show that the TSM program worked. Supply-side strategies were less effective than demand-side strategies. These results are not surprising. Traditional traffic engineering strategies (ramp metering, signal optimization) are easy to implement and politically acceptable. Consequently, these strategies have already been exploited, and there is little potential for their further implementation. Traffic engineering is at its technological limits in areas like Los Angeles. TSM supply-oriented strategies are, by definition, marginal; they seek to improve throughput with no significant capital investment. Because the transportation system in most U.S. metropolitan areas is at or near capacity, marginal changes tend to have little net positive effect. Furthermore, strategies which might have a more favorable impact, such as reserved lanes for high-occupancy vehicles, tend to be politically controversial and thus rarely implemented.

Demand-oriented strategies are effective because they reduce peak-period trips, and any reduction of trips on a congested network will have a significant positive effect. Since demand-oriented strategies must rely largely on voluntary compliance, they have not been extensively implemented. However, when incentives are created which promote behavioral change, as happened during the Olympics, their impact on traffic conditions is quite significant.

The critical issue for policy development is the feasibility of implemention of a given strategy viewed from this perspective, the potential of demand-oriented strategies is more limited. Any effort to reduce work trips, for example, would have impacts on the workplace, and therefore must depend on the actions and policies of employers. Thus, the promotion of work trip reductions must be weighted against possible impacts on employee productivity. As another example, management of truck traffic is even more problematic. During the Olympics, delivery schedules were adjusted, and truckers relinquish overtime pay. Needless to say, truckers have no reason to permanently give up extra pay for the sake of traffic flow. Consideration of any policy to regulate truck traffic would require the analysis of current truck travel patterns, as well as of the economic consequences of changing those patterns.

The Olympics experience demonstrated that transportation system management works. The tools for managing traffic exist, and their effectiveness has been illustrated. The Olympics have limited transferability not because the traffic management solutions were unique, but rather because the decision environment was unique. The Olympics TSM program was successful because there were sufficient incentives for changes in travel behavior to take place. These incentives were short term: a fear of severe traffic problems, and a desire to make the Olympics work. The policy challenge is to identify sufficient long-term incentives for change. So far, acceptable and effective long-term incentives have not been established. Effective incentives--primarily parking and pricing constraints--are controversial and difficult to implement. More acceptable incentives, such as rideshare marketing and transit subsidies, are much less effective. As congestion increases and traffic conditions worsen, however, public perceptions of acceptable management strategies may change. And as public perceptions change, the results of the Olympics may serve as a guideline for the development of an effective long-term TSM program.

Acknowledgment

Support for this research from the California State Department of Transportation, and from the Institute of Transportation Studies, University of California, Irvine is gratefully acknowledged. Opinions and points of view expressed, as well as possible omissions, are those of the author.

REFERENCES

Cervero, R. (1986). Suburban Gridlock, New Brunswick, New Jersey, Center for Urban Policy Research,

Ferreri, M. (1982). Urban Transportation in the year 2000: Is the past prologue?, in H . Levinson and R. Weant, eds., Urban Transportation Perspectives and Prospects, Eno Foundation for Transportation, Westport, Connecticut.

Gakenheimer, R. and M. Meyer (1979). Urban transportation planning in transition: The sources and prospects of TSM. Journal of the American Planning Association, 45 (1), 28-35.

Giuliano, G., K. Haboian, K. Rutherford, J. Prashker and W. Recker (1986). Evaluation of 1984 Los Angeles Summer Olympics Traffic Management, Final Report. Prepared for California Department of Transportation. Institute of Transportation Studies, University of California, Irvine.

Jovanis, P. (1979). Analysis and Prediction of Travel Responses to Flexible Work Hours: A Socioeconomic Workplace and Transportation System Perspective. PhD Dissertation. Berkeley, California: University of California.

KLD & Associates (1985). Traf User Guide, Release 2 (pre-release). Washington, D.C.: Federal Highway Administration.

May, A.D. (1981). Demand-supply modeling for transportation system management. Transportation Research Record, 835, 80-86.

McConnell-Fay, N. (1986). Tackling traffic congestion in the San Francisco Bay Area. Transportation Quarterly, 40 (2), 159-170.

Rosenbloom, S. (1978). Peak-period traffic congestion: A state-of-the-art analysis and evaluation of effective solutions. Transportation 7 (2), 167-191.

Transportation Research Board (1977). Transportation System Management, Special Report 172, Washington, D.C.