necessarily significantly) for algorithms 7 and 10. This lane drop causes the most severe shock waves on the facility for most of the afternoon rush period.

The long duration of false alarms in this section is a major cause of the high percentage of messages of long duration in the cumulative distribution of incident-message duration (Figures 9 and 10).

When shockwaves are less severe, as in the case of the sun effect on traffic on the outbound freeway near Des Plaines Avenue, the individualized thresholds (related to the 50 percent detection level) seemed to improve the false-alarm situation considerably for all algorithms. Another problem section inducing false alarms and rendering the individualized set of thresholds there ineffective was the bridge near Addison Creek between 25th Avenue and Mannheim Road, where only algorithm 8 showed improved operation. The effect of other problem sections inducing nonincident shock waves resulting in false alarms can be determined from the above figure.

FINDINGS, OBSERVATIONS, AND RECOMMENDATIONS

Based on the analyses conducted in the course of this research the following are the major findings and observations.

1. No statistically significant differences at the 5 percent level of significance in DR, FAR, and MTTD were found among algorithms 7, 8, and 10 for the 80, 90, and 90-50 percent detection levels, when they were operated on the Eisenhower Expressway.
2. The introduction of individualized thresholds at problem sections did not affect algorithm 8 but improved DR and FAR of algorithm 7 and improved DR and MTTD for algorithm 10.
3. As far as the MTTD was concerned, no apparent differences between the on-line and off-line evaluations were observed.
4. The efficiency of algorithms 7 and 8 remained statistically the same for the 90 and 90-50 percent detection levels.
5. When compared with the locally developed algorithms (16-14 and Bayesian) at the 90-50 percent detection level, algorithm 7 showed overall superiority.
6. Nearly half of all incident and false-alarm messages lasted longer than 30 min.
7. The introduction of individualized thresholds at problem sections could reduce the number of false alarms generated in these sections.
8. DR obtained by algorithms in the off-line evaluation are considerably higher than those obtained in the on-line evaluation.
9. The shockwave-suppressor mechanism of algorithm 8 seemed to be quite effective; required less effort to prepare thresholds for this than for any other algorithm.
10. FARs are quite high, and reducing them poses the biggest challenge in refining present algorithms or developing new ones.
11. The distribution of false alarms over time seemed to be uniform for the 90 and 90-50 percent detection levels, which indicates that no changes in thresholds at any particular section with time during rush hour were necessary.
12. Algorithms 7 and 8 seem to operate quite similarly, but algorithm 7 was apparently better.

The recommendations for further action are

1. To investigate the behavior of traffic features at bottlenecks during incidents in order to be able to distinguish between incident- and non-incident-related shockwaves,
2. To develop an effective and inexpensive supportive incident-verification system to minimize FAR, and
3. To develop an improved nonincident shockwave-suppressor mechanism and to incorporate it into the efficient pattern-recognition algorithms.

ACKNOWLEDGMENT

The research reported in this paper, like that in the preceding paper, was conducted within the framework of IDOT and with the cooperation of FHWA. We wish to acknowledge the support of the staffs of the Bureau of Air Operations and the Traffic Systems Center in the data-collection and programming phases of this study. The contents of this report reflect our views, and we alone are responsible for the facts and the accuracy of the data presented here. The contents do not necessarily reflect the official views or policies of IDOT or FHWA. This report does not constitute a standard, specification, or regulation.

Publication of this paper sponsored by Committee on Freeway Operations.

Development of a Transport System Management Planning Process in the Delaware Valley Region

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The joint Federal Highway Administration and Urban Mass Transportation Administration (FHWA-UMTA) guidelines require cities to develop a transportation system management (TSM) element, a short-range element of the transportation plan. The metropolitan planning organizations (MPOs) initially responded to these requirements by preparing a plan report that includes a composite list of projects from the highway and transit capital programs (reverse process). Then, the MPOs began to improve on their initial submissions and to create a process for developing the TSM elements of the plans. This paper presents the Delaware Valley's experience, the outcome of the first

two stages of TSM element development, and the process currently being followed in developing future TSM plans.

Growing government emphasis on short-range transportation system management (TSM) planning has prompted individual urban areas to reformulate the transportation planning process. Experiences around the country have varied, and much can be learned from examining them.

This paper presents the response of the Delaware Valley Region (DVR) to the requirement of TSM planning by providing a regional perspective on the transportation system. The experiences and outcome of the first two stages of TSM development and the process currently being followed in developing future TSM plans are also presented.

REGIONAL PERSPECTIVE

A full appreciation of DVR's response to the TSM planning requirement can only be gained through an understanding of the region's transportation network.

Public Transportation System

Unlike most urban areas in the United States, the DVR Planning Commission (DVRPC) region possesses an extensive system of various types of fixed-guideway rail transit [1333 track km (828 miles) in 1976, of which 269 km (167 miles) was streetcar, 894 km (555 miles) was 13 commuter railroads, and 171 km (106 miles) was rapid transit]. Most of these rail systems have been in place for 50 or more years, and the development of the region closely followed these lines for many years.

A total of 10 895 parking spaces are available at 153 suburban and exurban railroad stations. Bike racks are also provided at 45 stations, 37 of which are in the suburbs.

The two highest-density corridors served by line-haul transit in the region are the Broad Street corridor and the 69th Street-Center City-Frankford corridor. The density along these Southeastern Pennsylvania Transportation Authority (SEPTA) rapid-transit lines results in a high percentage of passengers boarding rapid transit by foot or from surface transit.

The rapid transit system is supplemented by 73 bus routes, 5 trackless lines, and 12 light rail routes, all operated by SEPTA's City Transit Division (CTD). Five of the light-rail routes avoid congestion by operating underground for 4 km (2.5 miles) on the way to the center of the central business district (CBD). Two light rail routes, the Media and Sharon Hill lines, feed the 69th Street terminal from Delaware County; one suburban rapid transit line, the Norristown Line, also feeds into this terminal.

The Delaware River Port Authority's (DRPA) high-speed Philadelphia-Lindenwold line from New Jersey also serves the CBD with four stations and brings people from the New Jersey suburbs into the Philadelphia CBD.

Highway System

The road network within the nine-county DVRPC region is composed of more than 11 000 km (6900 miles) of streets and highways. Of this, approximately 6 percent is limited-access facilities (turnpikes, freeways, and parkways), 5 percent is divided highways, and the vast majority (89 percent) is undivided arterial streets and roads.

More than 85 000 000 km (53 000 000 miles) were traveled on this highway system on an average day in 1972, of which 64 percent was carried by the network in the five Pennsylvania counties and 36 percent by the network in the four New Jersey counties.

While the great majority (78 percent) of the regional system operated at acceptable levels of service with free or stable flow, traffic exceeded capacity on 15 percent of the route kilometers. This is the equivalent of level of service F, or very poor.

An additional 7 percent of the system distance operated between levels of service D and E, which indicates unstable traffic flow with extensive to critical delays, particularly during peak periods of travel.

INITIAL RESPONSE TO TSM PLANNING REQUIREMENT

The initial TSM document (1) for the DVR was produced under a very strict time limitation: only six months from the September guideline to the March submission date. The metropolitan planning organization (MPO), in this case DVRPC, used funds previously allocated to the transit development program to create the TSM plan. As a result of the foregoing, several decisions made by the MPO largely influenced the content and style of the original TSM plan.

1. More emphasis on TSM came from the Urban Mass Transportation Administration than from the Federal Highway Administration. That emphasis was reflected in more transit staff involvement at the MPO level and in the transit emphasis in the issued document.
2. Staff of the various agencies involved in the preparation of the TSM viewed it lightly as just another federal requirement. The tight schedule that caused the railroading of the plan was resented because primary emphasis was on meeting the deadline.
3. The plan was both mode and project oriented. Multimodal proposals were few. TSM was largely a reflection of the transportation improvement program, while regulatory strategies for the most part were ignored.

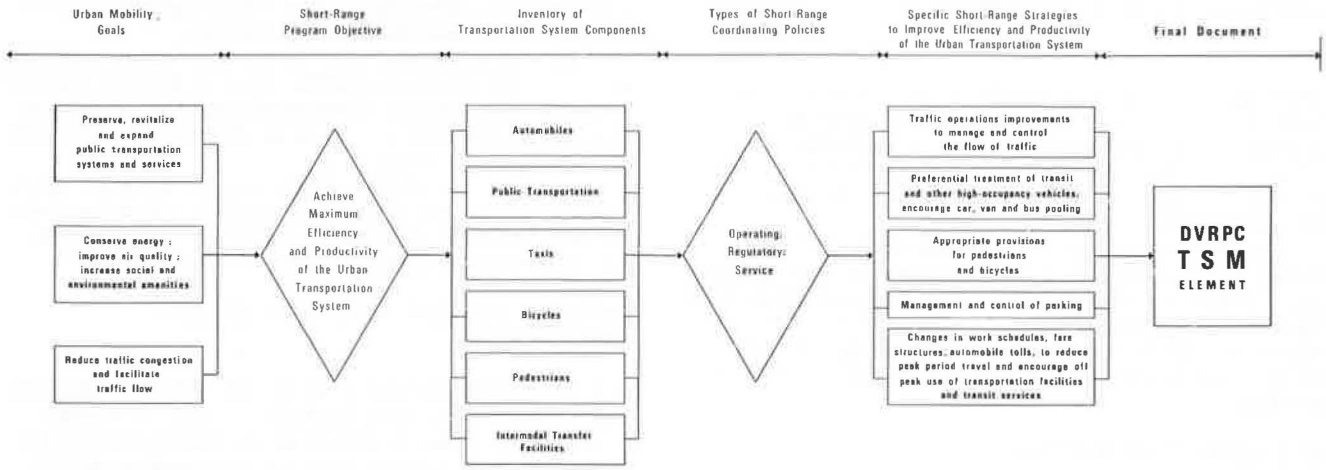
The first TSM effort for the DVRPC region could best be described as a catalog approach. Although this approach was successful in achieving what the MPO staff felt were the primary concerns (be completed on time and address fully each element of the federal guideline), experience has shown the TSM process to differ entirely from the production of the TSM document. Figure 1 shows the logic used in the development of the original TSM plan.

SECOND PHASE OF TSM PLANNING

A second phase of TSM planning began at DVRPC after March 1976. This phase was research oriented and focused on discrete elements of the transportation system. Unlike the previous planning, adequate time was available to collect appropriate data, to propose various possible strategies or actions, to solicit local input and participation, to analyze the impacts of various strategies or actions, and to make recommendations. Several studies of this nature were under way concurrently at the MPO; the results of one even received national attention. These studies included

1. Demand modification strategies program (2),
2. Evaluation of Trenton Commons and Chestnut Street Transitway study (3),
3. Parking analyses for the short range (4),
4. Short-range program development, and
5. Impact on mobility, energy, and emissions.

Figure 1. Planning process for developing original DVRPC TSM plan.



These studies were undertaken by the MPO staff, assisted occasionally by other agencies, particularly in the area of data collection. Four of these studies closely followed a case-study approach to detailed analyses of discrete elements of the regional transportation system. The fifth study was an attempt to measure the total regional impact if the entire original TSM plan were implemented. An unencouraging note was the conclusion of the fifth study, which showed the TSM plan as having only a small impact on total regional mobility, energy consumption, and fuel emissions. This finding will undoubtedly affect the next TSM plan.

During this second phase of TSM planning, transportation professionals' appreciation of their TSM concept heightened greatly. Criticism of the concept ended completely, and efforts to integrate local, county, city, and transit-operator improvements into the TSM framework became evident.

One member government, the city of Philadelphia, and its major transit operator, SEPTA, began TSM planning projects of their own. It should be noted, however, that the city of Philadelphia, Port Authority Transit Corporation, SEPTA, Mercer Metro, and the Pennsylvania and New Jersey Departments of Transportation have had ongoing project-oriented technical studies that supply numerous TSM improvement projects.

Twenty-two months after the publication of the original TSM plan in March 1976, DVRPC published a TSM summary of activities that reported on all TSM developments and research efforts in the region. This document represented a second benchmark in the TSM planning process for two reasons. First, it reported the results of numerous independently conducted and implemented efforts to fulfill the spirit of the TSM planning requirement. Second, it marked the demise of the view of TSM as a fragmented effort in which each agency advanced efforts in its own best interests but with scant joint planning or coordination.

During this period, a comprehensive roles and responsibilities statement had been prepared by the MPO staff. However, the board of the MPO failed to endorse the document because they felt it to be doubtful that the MPO board could impose such an agreement on other constituted boards such as transit authorities, toll roads, and bridge commissions or authorities; these other agencies are not represented on the MPO board.

THIRD PHASE OF TSM PLANNING

The need for improved interagency cooperation was recognized in January 1978, when the region formed a special TSM task force to assist DVRPC staff in preparing the short-range transportation plan for the region. Performing an advisory role, the task force was to monitor, comment on, and solicit input as DVRPC staff prepared a new short-range transportation plan for the region. The eight-step process is to be followed in this order:

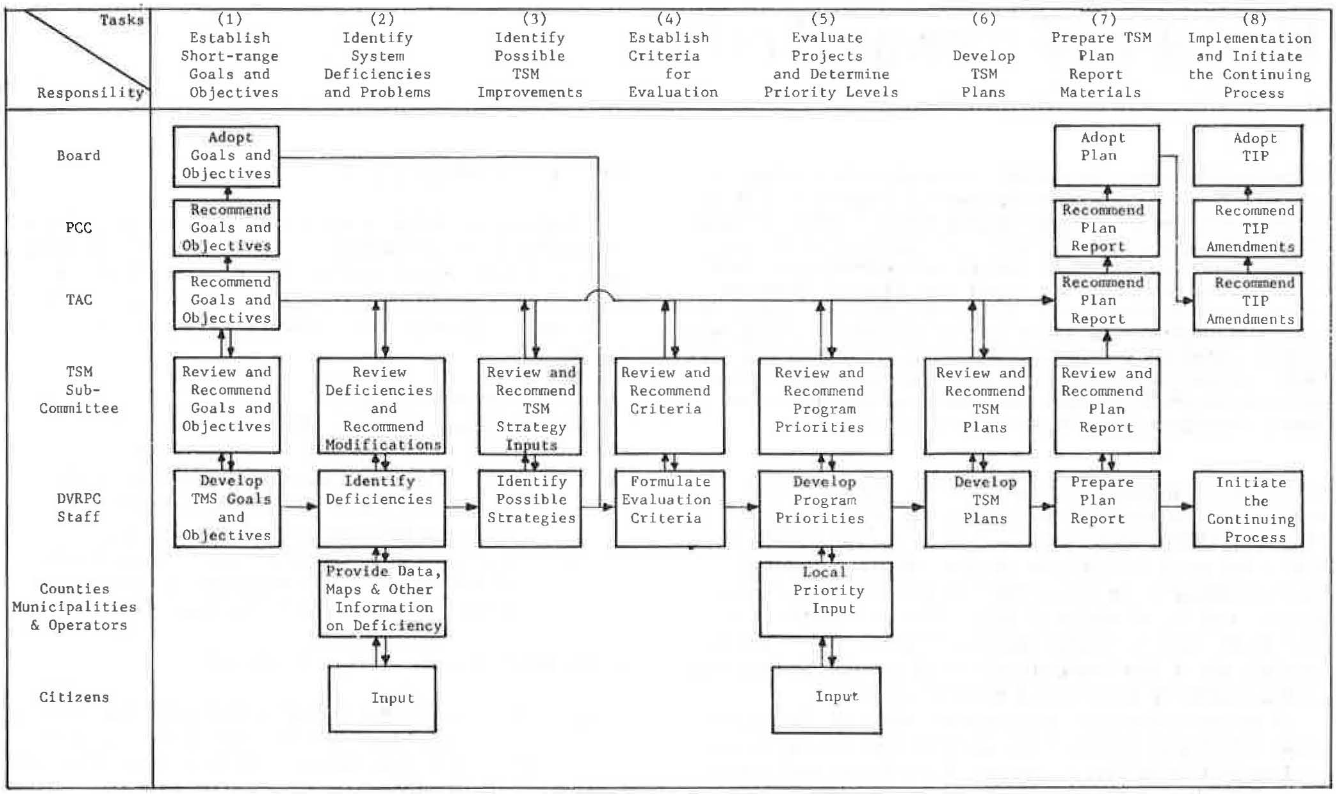
1. Establish short-range goals and objectives;
2. Identify transportation system deficiencies and problems;
3. Identify possible TSM improvements, including current plans and programs;
4. Establish criteria for project and plan evaluation;
5. Determine project and plan study priorities;
6. Develop a plan from the above activities;
7. Prepare TSM report materials; and
8. Initiate needed follow-up activities and planning studies.

In cooperation with the task force, DVRPC staff have prepared TSM planning guidelines for the region. Input from all agencies involved in surface transportation will be used to develop the short-range transportation plan. An important step was taken when the DVRPC board, the MPO governing body, adopted short-range goals and objectives for transportation planning. These goals and objectives were developed by DVRPC staff with the assistance of the TSM task force:

1. Goals
   a. Improve efficiency, mobility, safety and productivity of the transportation system;
   b. Conserve resources such as energy and money;
   c. Improve environmental quality;
2. Objectives
   a. Reduce congestion;
   b. Reduce energy consumption;
   c. Improve transit use;
   d. Improve air quality;
   e. Reduce noise level;
   f. Reduce accidents;
   g. Increase automobile occupancy;
   h. Improve accessibility of transportation services to all potential users; and
   i. Reduce cost.

Figure 2 illustrates the process for developing the new TSM plan for the region. Important innovations

Figure 2. Planning process for developing revised DVRPC TSM plan.



over the previous process are

1. Full participation of counties, transit operators, cities, MPO, and state departments of transportation on the TSM task force (thus all participants will be involved in the process);
2. Clear linkage with the technical advisory committee on highways and transit plans and the planning coordinating committee and board of DVRPC;
3. Systematic study of transportation deficiencies and problems and possible remedies;
4. Priorities assigned to projects recommended in the TSM plan;
5. Goals and objectives developed specifically for TSM planning in the DVRPC region (these goals and objectives will be used when the plan is evaluated); and
6. Provision for timely citizen input during development of the TSM plan.

The process outlined in Figure 2 has not advanced far enough to state definitely the strengths and weaknesses of the process. One apparent strength is broad-based interest in TSM planning. One apparent weakness is the pace at which the task force can assimilate, review, and comment on what is prepared by the MPO staff. The process calls for task force recommendations at each step in the process, so a slow pace will ensure a two- or three-year effort to produce the new plan.

It should be kept in mind that DVR covers portions of two states, four cities, nine counties, three transit-operating authorities, four toll-road authorities, and three interstate bridge agencies. Obtaining agreement from all these jurisdictions and coordinating it is time-consuming and requires substantial diplomacy. Nevertheless, the conditions of DVRPC are not totally unique, and other large regions may benefit from its experience.

ACKNOWLEDGMENT

This paper was financed in part by the Federal Highway and Urban Mass Transportation Administrations of the United States Department of Transportation and the Pennsylvania Department of Transportation. The contents reflect our views and do not necessarily reflect the official views or policies of the funding agencies.

REFERENCES

1. Transportation System Management Element of the Transportation Plan for the Delaware Valley Region: Volume 1. Delaware Valley Regional Planning Commission (DVRPC), Philadelphia, March 1976.
2. Transportation System Management Element—Demand Modification Strategies Program. DVRPC, Philadelphia, final rept., June 1978.
3. Transportation System Management Element—An Evaluation of Trenton Commons and Chestnut Street Transitway. DVRPC, Philadelphia, Aug. 1977.
4. Transportation System Management Element—Parking Analysis at Terminal and Fringe Areas. DVRPC, Philadelphia, final rept., June 1978.
5. Transportation System Management Element, 1977 Summary of Activities. DVRPC, Philadelphia, Jan. 1978.
6. Responsibilities and Authorities of the Various Transportation Agencies in the Delaware Valley Region. DVRPC, Philadelphia, Sept. 1977.
7. Transportation System Management Element Regional/Systemwide Approach—TSM Planning Guidelines. DVRPC, Philadelphia, rev., July 1978.

Publication of this paper sponsored by Committee on Urban System Operations.