Evaluation of Congestion-Reducing Measures Used in Virginia

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Congestion on U.S. highways, especially in urban areas, is a serious problem that is growing steadily worse. In Virginia, approximately 28 percent of the daily vehicle miles of travel during peak hour traffic in 1989 was congested (volume/service flow ratio > 0.75). Further, the cost of urban area congestion in Virginia is expected to be more than $4 billion in the year 2000. Transportation professionals in Virginia need to implement congestion-reducing measures at every opportunity. Accordingly, this research was conducted to develop a list of congestion-reducing measures and to document the implementation of and experiences with these measures in Virginia. Documentation included a subjective evaluation of each measure's effectiveness, cost, and barriers to implementation. The scope of the research was limited to a literature review and a survey of transportation officials in Virginia.

During the past several years, congestion on U.S. highways, especially in urban areas, has attracted the attention of transportation engineers, planners, and researchers at all levels of government, and several national conferences on congestion have been held. Although Virginia is predominantly rural (78 percent of its road mileage), few Virginians have not experienced congestion. Eleven major urban areas are located entirely or partially in Virginia, as are 33 smaller urban areas. Roadways in these urban areas carry about 54 percent of the travel.

Statistical summaries from the Virginia Department of Transportation (VDOT) 1989 Highway Performance Monitoring System indicated that 28 percent of the daily vehicle miles of travel during peak hour traffic in Virginia was congested (volume/service flow ratio > 0.75).

Day-to-day (recurring) congestion cost Virginia's urban motorists an estimated $172 million in 1986. Adding the costs caused by incidents (nonrecurring congestion) brings the total cost to approximately $430 million. The cost of urban area congestion will amount to more than $4 billion in the year 2000 (*1*). Transportation professionals in Virginia need to implement congestion-reducing measures at every opportunity.

PURPOSE AND SCOPE

The research discussed here had two equally important purposes: (a) to develop a categorical listing of congestion-reducing measures to provide transportation professionals in Virginia with a readily available, comprehensive list of measures they might consider implementing in their area and (b) to document the implementation of and experiences with congestion-reducing measures in Virginia, including a subjective evaluation of each measure's effectiveness, cost, and barriers to implementation.

The research was limited to a synthesis of existing literature and a survey of transportation professionals in Virginia.

METHODS

A comprehensive literature review was conducted to develop a list of congestion-reducing measures currently in use. The primary source of literature was the DIALOG data base. Transportation professionals in the state were sent a questionnaire to determine which congestion-reducing measures had been implemented in recent years.

The questionnaire was mailed to officials in all 41 cities, 29 towns (population greater than 3,500), 13 urban counties, and 21 planning district commissions (PDCs) in Virginia. Metropolitan planning organizations (MPOs) are linked to the PDCs and thus had input to the survey. Within VDOT, the questionnaire was sent to the nine district traffic engineers, the Transportation Planning Division, the Rail and Public Transportation Division, and the planning section in the Northern Virginia District office. The questionnaire consisted of a categorical list of congestion-reducing measures from the literature. Respondents were asked to note whether each measure has been or is being used in their area and then to evaluate the effectiveness, cost, and implementation of the measure. Respondents were also encouraged to list additional measures and provide available supporting documentation. Measures were to be evaluated subjectively relative to congestion-reducing measures in general and according to the following rating scale:

- Effectiveness: 0 = measure has minimal effect on decreasing congestion; 1 = measure has average effect on decreasing congestion; 2 = measure has maximum effect on decreasing congestion.
- Cost: 0 = measure is inexpensive to implement or operate; 1 = measure has an average cost to implement or operate; 2 = measure is costly to implement or operate.
- Implementation: 0 = measure is easy to implement, with few or no physical, legal, or institutional barriers; 1 = measure can be implemented, with some physical, legal, or institutional barriers; and 2 = measure is difficult to implement, with significant physical, legal, or institutional barriers.

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RESULTS

Categorical List of Measures

A total of 53 measures used to reduce congestion was identified in the literature. The primary reference was the Institute of Transportation Engineer's *Toolbox for Alleviating Traffic Congestion* (2). The measures were categorized into supply side and demand side measures.

Supply side measures relate to the highway system or roadway itself and are often referred to in general as transportation system management (TSM) measures. Supply measures are further categorized into those that manage or more efficiently use the capacity of the existing system and those that increase or add to the capacity. The term TSM was first used in the transportation planning process to represent all actions that make better use of existing transportation facilities or services.

Demand side measures relate to the modification of travel behavior or travel demand and are often referred to in general as transportation demand management (TDM) measures. Demand measures are further categorized into those that manage or reduce existing demand and those that avoid or control demand growth.

Figure 1 shows the relationship between supply side and demand side measures, and Table 1 presents the 53 congestion-reducing measures in the four categories just defined. Many of these measures have appeared on lists of measures or strategies to be used for the Traffic Operations Program to Improve Capacity and Safety (TOPICS), to save energy, and most recently, to reduce air pollution (transportation control measures).

Experiences in Virginia

A total of 85 questionnaires was returned. Responses were received from transportation professionals in 23 cities, 8 counties, and 8 MPOs and PDCs located in urbanized areas (population of 50,000 or more) and 23 cities and 7 PDCs located in nonurbanized areas. Responses were also received from 9 transportation planning engineers, 6 district traffic engineers, and 1 public transportation engineer from VDOT.

A summary of the responses is presented in Table 1. The use of and the average rating for the effectiveness, cost, and implementation of the individual measures are included. Table 2 summarizes the same information by each of the four categories of congestion-reducing measures.

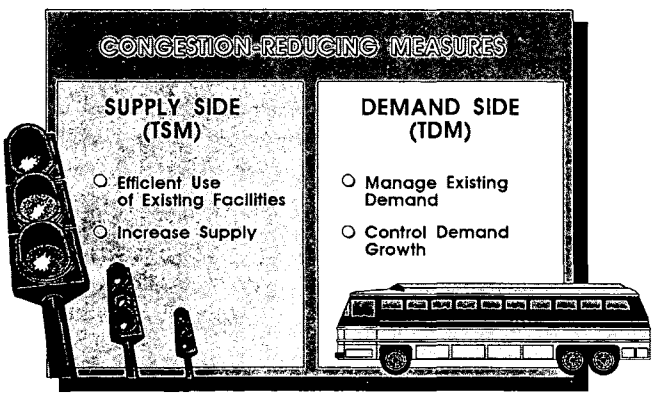

FIGURE 1 Categorization of congestion-reducing measures.

Evaluation of Individual Measures

From the information in Table 1, measures that are the most effective, least expensive, and easiest to implement may be determined. This is accomplished by arbitrarily choosing average ratings of 1.5 or greater, 0.5 or less, and 0.5 or less to represent the most effective, least expensive, and easiest to implement, respectively.

The only measure that was rated on average as being the most effective, least expensive, and easiest to implement was the prohibition of maintenance and repair work during peak traffic conditions.

The following TSM (supply side) measures were rated average or better:

- Incident detection and management systems,
- Motorist information systems,
- Traffic management teams,
- Provision of additional lanes without widening,
- Coordinated signal systems,
- Other signal improvements (e.g., retiming),
- Improvement of other traffic control devices,
- Intersection improvements,
- Turn prohibitions,
- One-way streets,
- Reversible traffic lanes on arterials,
- Prohibition or restriction of on-street parking,
- Traffic management during reconstruction, and
- Prohibition of repair work during peak traffic times.

The following TDM (demand side) measures were rated average or better:

- Flexible daily work hours,
- Commuter matching services (ridesharing),
- Carpool and vanpool preferential parking, and
- Park-and-ride lots.

Evaluation of Measures by Category

- Measures that reduce congestion by managing the existing supply are rated above average in effectiveness and below average in cost and ease of implementation.
- Measures that reduce congestion by adding to the supply are rated the most effective; however, they are also rated the most expensive to implement or operate and the most difficult to implement.
- Measures that reduce congestion by managing the existing demand are rated below average in cost and ease of implementation; however, they are rated below average in effectiveness.
- Measures that reduce congestion by controlling demand growth are rated above average in effectiveness and below average in cost; however, they are rated above average in ease of implementation.

TABLE 1 Congestion-Reducing Measures and Their Use in Virginia

Measure	Used		Average Effectiveness	Average Cost	Average Implementation
	Yes	No			
Category I.A.: Managing Existing Supply/Using Existing Capacity More Efficiently					
Incident detection/management system/program	14	65	1.1	0.8	0.8
Traffic surveillance/control system	12	69	1.6	1.1	1.0
Motorist information system	7	74	1.1	0.9	0.6
Traffic management team	11	70	1.1	0.5	0.5
Integrated freeway and arterial surveillance/control system	3	76	1.4	1.4	1.1
Converting existing facilities to HOV facilities	8	75	1.3	1.0	1.5
Providing additional lanes w/o widening (shoulders, narrower lanes)	34	47	1.4	0.7	0.7
Coordinated signal systems (arterial, grid, closed loop)	66	15	1.6	0.8	0.5
Ramp metering	6	73	0.9	1.1	1.0
Other signal improvements, including hardware, upgrades, retiming, removal	71	16	1.3	0.8	0.3
Improving other traffic control devices	54	25	1.1	0.7	0.4
Intersection improvements, including channelization, turn lanes, signing, bus stop relocation	75	9	1.4	1.0	0.7
Turn prohibitions	59	22	1.0	0.1	0.5
One-way streets	52	32	1.2	0.5	0.9
Reversible traffic lanes on arterials	5	76	1.2	0.8	1.0
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Removing/restricting on-street parking	64	17	1.2	0.2	0.9
Arterial access management	19	61	1.1	0.4	1.1
Goods movement management	8	65	0.7	0.5	1.2
Traffic management during highway reconstruction or other major improvements	60	22	1.0	0.9	0.6
Prohibiting maintenance/repairs on major routes during peak traffic hours	52	28	1.7	0.5	0.4
Category I.B.: Increasing Supply/Adding Capacity					
Constructing new highways	56	26	1.7	1.9	1.4
Reconstructing highway with improved design	64	18	1.6	1.6	1.4
Widening by adding general purpose lanes	51	29	1.5	1.5	1.3
Constructing HOV lanes	9	74	1.7	1.5	1.7
Providing highway grade separations	27	55	1.8	1.9	1.5
Providing railroad grade separations	26	54	1.5	1.9	1.3
Choosing toll-based financing to expedite construction of new facilities	13	70	1.7	1.4	1.6
Category II.A.: Managing/Reducing Existing Demand					
Daily flexible work hours (staggered/flextime)	33	50	1.2	0.2	0.5
Alternative work hours (compressed work week)	23	58	0.9	0.1	0.5
Promoting nonvehicular alternatives to auto usage	26	56	0.7	0.8	0.8
Communication in lieu of travel (teleconferencing)	17	65	0.8	0.4	0.6
Communication in lieu of travel (telecommuting)	11	71	0.8	0.7	0.8
Implementing transportation management associations or organizations	19	63	0.8	0.7	0.7
Promoting/supporting ridesharing as an alternative to auto usage:					
Commuter-matching services	31	51	1.0	0.6	0.5
Reduced tolls	7	72	0.8	0.6	0.7
Providing public information on rideshare/transit	40	42	0.8	0.4	0.2
Guaranteed ride home program	11	72	0.3	0.3	0.3
Tax incentives for vanpools	12	69	0.8	0.7	0.8
Implementing/improving transit fixed-route services	34	49	0.8	1.0	0.6
Implementing express bus services	22	62	1.2	1.2	0.9
Implementing/improving rail transit or commuter rail services	10	74	1.3	1.5	1.3
Implementing/improving paratransit services	32	52	0.6	1.2	0.8
Reducing or not increasing transit fares	13	69	0.8	1.1	0.7
Subsidizing transit usage	28	55	0.9	1.2	0.6
Implementing parking strategies to encourage modal shift:					
Car/vanpool preferential parking	19	65	1.1	0.3	0.5
Park and ride lots	40	44	1.1	0.9	0.9
Differential parking rates	7	76	0.6	0.5	0.5
Governmental control of supply and location	11	70	0.6	0.7	0.8
Category II.B.: Avoiding/Controlling Demand Growth					
Growth management by public policy/ordinance/planning	41	35	1.1	0.7	1.4
Auto-restricted zones	25	52	1.3	1.0	1.3
Designing multiuse sites to minimize traffic (e.g., on-site services)	18	61	0.9	0.8	0.8
Road/congestion pricing (excluding traditional toll construction)	1	77	1.0	1.5	1.0
Requiring congestion-reduction strategies: reduced trip generation, transit for proposed development	11	67	1.2	0.6	1.4

TABLE 2 Evaluation of Congestion-Reducing Measures by Category

Category	Yes Responses		Average Effectiveness	Average Cost	Average Implementation
	Range	Average			
TSM					
Managing existing supply	3-75	34	1.2	0.7	0.8
Adding to supply	9-64	35	1.6	1.7	1.5
TDM					
Managing existing demand	7-40	21	0.9	0.7	0.7
Controlling demand growth	1-41	19	1.1	0.9	1.2

Evaluation of Measures by Use and Performance

- Use. Measures in the two TSM categories received a much higher number of positive responses than the measures in the two TDM categories, both with regard to the upper limits of the range and the average.
- Effectiveness. Measures in the two TSM categories were rated on average higher than the measures in the two TDM categories. Also, measures that add to the supply were rated on average considerably higher than measures in the other three categories.
- Cost. Measures that add to the supply were rated on average as by far the most expensive. Also, measures that address existing conditions, either through efficient use of the existing supply or management of the existing demand, were rated on average as the same—and the rating represents a cost of less than average.
- Implementation. Measures that address existing conditions, either through efficient use of the existing supply or management of the existing demand, were rated on average as about the same—and the rating represents a minimum of problems in implementation. Also, measures in these two categories were rated on average as easier to implement than measures that add to the supply or control the demand growth.

CONCLUSION

In general, measures dealing with supply have been used for years, whereas measures dealing with demand are relatively new. Accordingly, the supply measures are used much more than the demand measures and represent the traditional approaches to reducing congestion. More emphasis on the implementation of demand measures appears to offer potential for reducing congestion.

ACKNOWLEDGMENTS

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REFERENCES

1. E. D. Arnold, Jr. *Congestion on Virginia's Urban Highways.* VTRC Report 88-R24. Virginia Transportation Research Council, Charlottesville, 1988.
2. Institute of Transportation Engineers. *A Toolbox for Alleviating Traffic Congestion.* ITE Publication IR-054A. Washington, D.C., 1989.

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