

**EVALUATING EFFECTS OF TRAVEL DEMAND MANAGEMENT  
IN A MEDIUM-SIZED URBAN AREA**

**Final Report  
Submitted to  
The Urban Transit Institute**

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**August 27, 2001**

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### Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle EVALUATING EFFECTS OF TRAVEL DEMAND MANAGEMENT IN A MEDIUM-SIZED URBAN AREA: THE STUDY OF I-40 GREENSBORO- WINSTON-SALEM CORRIDOR		5. Report Date August 2001	
		6. Performing Organization Code	
7. Author/s RYOICHI SAKANO, Ph.D. AND JULIAN BENJAMIN, Ph.D.		8. Performing Organization Report No.	
9. Performing Organization Name and Address Urban Transit Institute The Transportation Institute North Carolina A&T State University Greensboro, NC 27411		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. DTRS98-G-0033	
12. Sponsoring Organization Name and Address U.S. Department of Transportation Research and Special Programs Administration 400 7 <sup>th</sup> Street, SW Washington, DC 20590-0001		13. Type of Report and Period Covered Final August 2001	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
<p>16. Abstract</p> <p>Travel demand management (TDM) is a set of procedures that have been shown to alleviate unlimited use of automobiles. Demand is managed by limiting highway capacity to meet demand to travel by car and providing incentives or disincentives to increase average vehicle occupancy, to change the time and routes of travel, and to shift travel from the auto to transit. The objectives of this project are to</p> <ol style="list-style-type: none"> <li>1. Identify potential TDM elements that would effectively reduce auto travel in the mid-sized urban area with a corridor connecting two urban centers,</li> <li>2. Evaluate the acceptability of measures by the public, policy makers, and public officials,</li> <li>3. Develop and illustrate a method to evaluate the effectiveness of TDM to reduce auto travel for specific areas and projects.</li> </ol> <p>The research approach will be divided into two phases. In the first phase, there will be a review of a comprehensive list of successful TDM measures. From this list a questionnaire will be prepared that will determine which TDM measures are suitable for Greensboro/Winston-Salem/High Point Metropolitan area and other mid-sized urban areas. The survey instrument will be tailored separately for three different groups: local policy makers, local residents, and transportation engineers and planners. The questionnaire will list and concisely define each TDM measure and will ask each subject to evaluate each measure according to the perceived suitability in her/his community. In the second phase, a specific package of TDM measures will be combined with a proposed highway improvement. The impact on travel demand of the highway improvement will then be evaluated with and without the TDM package.</p>			
17. Key Words Transportation Demand Management, Metropolitan Planning Organization, TDM, MPO		18. Distribution Statement	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. Of Pages 88	22. Price N/A

## **Executive Summary**

Transportation demand management (TDM) is a set of procedures that make efficient use of current highway network and capacity. It helps make more efficient use of the highway network by alleviating the unlimited use of the automobile, increasing the average vehicle occupancy, shifting travel from peak hours, diverting traffic from congested areas, and encouraging the use of public transportation. Although TDM has been around for thirty years, its implementation has been limited mostly in large metropolitan areas and a few medium-sized metropolitan areas that have integrated a comprehensive TDM strategy into its transportation plan.

This study is intended to identify the current implementation of the TDM measures, to evaluate the effectiveness of each TDM measure and to compare with cost of implementing these TDM measures in medium-size metropolitan areas. A web-based questionnaire was developed to assess the effectiveness and cost of TDM measures. The Metropolitan Planning Organizations (MPOs), which set and implement area transportation plans and collect various local information on traffic condition and travelers' behavior, throughout the nation were invited to participate the survey. All sizes of metropolitan areas are surveyed for comparison purpose. Among 354 MPOs invited to participate in this study, 72 Metropolitan Planning Organizations responded.

Survey results reveal that many MPOs have implemented some types of TDM. Public transportation is the most common TDM measures applied in the metropolitan areas, followed by park and ride facilities and area-wide carpool and vanpool programs. High Occupancy Vehicle lanes and toll roads have been implemented in few areas. Many MPO planners seem to be

concerned that there is an adverse equity effect of HOV lanes and toll roads, indicate various barriers to implement them, and assess their effectiveness not significant to reduce congestion or air pollution in their areas. Furthermore, these two measures are considered the very costly in terms of their initial implementation cost, operating cost, and non-monetary cost.

Most MPO planners consider employer-based TDM measures (flexible work hours, compressed work week, and tele-commuting), which are intended to change working schedules of commuters, hence, their travel patterns, very effective to reduce traffic congestion and air pollution. These TDM measures mainly affect medium income commuters and are considered relatively inexpensive to implement with quite low non-monetary cost incurred in their areas. Although these measures are supported by employees, many MPOs find that many employers do not have any interest or support of these work arrangements.

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# **I. Overview of Study**

## **I.1. Introduction**

For the past forty years immigration of population from rural areas to urban areas throughout the country resulted in concentration of population in metropolitan areas and urbanization of surrounding areas. To coordinate the urban development, the local governments implemented the urban development plan. Many metropolitan areas experienced steadily increasing traffics around the areas, mainly due to commuting from the suburbs to the central business district. As an important component of the urban development plan, the metropolitan area governments set up MPOs to develop and implement the transportation plan to solve the problem of traffic congestion and resulting negative impact on the locals such as traffic accidents and pollution. Initially, the MPOs responded to these problems by developing plans to increase the network and capacity of highways across urban areas. In the 1970s, facing an oil embargo and sudden increase in energy prices the U.S. Department of Transportation initiated a study to increase the use of public transportation. This was a watershed of transportation planning in the U.S. This policy called for discouraging people driving to work, and was the first Transportation demand management (TDM) in the U.S.

TDM, also called transport demand management, travel demand management or congestion management, is a set of procedures that make efficient use of current highway network and capacity. It is intended to reduce traffic during peak hours through alleviating the unlimited use of the automobile, increasing the average vehicle occupancy, shifting travel from peak hours, diverting traffic from congested areas, and encouraging the use of public transportation. Until recently, TDM has been implemented mainly in large urban centers such as Los Angeles, New York, Washington, D.C., and Atlanta. However, shifting businesses and

population from large urban centers to medium-size metropolitan areas, such as Charlotte, Raleigh-Durham-Chapel Hill (Research Triangle), and Greensboro-Winston-Salem-High Point (Piedmont Triad) in North Carolina, lead these areas more traffic congestion than ever. Until now, these medium-size metropolitan areas mainly responded by constructing new highways and resulted in a limited use of TDM.

Most medium-size metropolitan areas, as compared with larger metropolitan areas, do not have extensive highway network or public transportation throughout the areas. Their populations rapidly increase, so their suburban areas extend out from the center of the area. Although the business and industrial development is carefully planned, residential areas are developed and clustered throughout the areas, and commercial development comes along major highways and streets. Often, these medium-sized metropolitan areas have more than one central business districts, such as the Research Triangle and the Piedmont Triad. Many of new comers are dual-career families, in which a husband and a wife may commute to different locations. As a result, there are high traffic flows between two or more central districts within the metropolitan area. In addition, most of these medium-sized metropolitan areas are along major Interstate Highways between two larger metropolitan areas, i.e. Piedmont Triad and Charlotte are located between Washington, D.C. and Atlanta, so there are a high level of through-traffic, both commercial and private. These unique characteristics of medium-size metropolitan areas call for different sets of TDM measures. Those measures often used in larger metropolitan areas may not be feasible, effective, or acceptable by the public in the medium-size metropolitan areas.

## **I.2. Objective of Study**

The objective of this study is threefold; to identify the current implementation of the

TDM measures, to evaluate an effectiveness of each TDM measure, and to compare with the cost of implementing these TDM measures in the medium-size metropolitan areas.

Although the TDM has been around for thirty years, its implementation has been limited mostly in large metropolitan areas and a few medium-size metropolitan areas that have integrated a comprehensive TDM strategy into its transportation plan. However, some local governments in medium-size metropolitan areas, which respond to traffic problems mainly by expanding the network and capacity of highways, began considering alternative strategies to solve ever-increasing traffic problems on highways. For example, both the Research Triangle and Charlotte in North Carolina recently started TDM feasibility studies. With renewed attention mainly from medium-sized metropolitan areas, first it is important to understand current implementation of TDM not only in large-sized metropolitan areas, but also in medium-sized metropolitan areas. A nationwide survey can reveal what kind of traffic problems each metropolitan area faces and how they implement the TDM to solve those problems.

Second, this study evaluates the effectiveness of those implemented TDM measures. The effectiveness of a TDM measure can be measured in various dimensions, i.e. specific changes in travel behavior of commuters such as shift of peak-hour travel to off-peak hour and shifting away from congested areas, a reduction in overall congestion, and a reduction in air pollution. Of course, the effectiveness of each TDM measure depends on the current level of implementation of each TDM measure and other factors such as current traffic conditions and networks of highways in the area. Thus, the effectiveness of TDM measures in each area is evaluated in conjunction with these factors.

Third, this study evaluates costs associated with implementing TDM measures. Costs of implementing TDM measure include the initial capital expenditure, annual operating costs, and

non-monetary costs to local residents near the congested areas targeted by a particular TDM measure. Although the TDM is a cost-saving alternative to expanding highways to solve the traffic problem, its monetary cost may vary from one TDM measure to another. Non-monetary costs are often borne by residents nearby the highway where the TDM measure is implemented, including increased accident and traffic problem on local streets and noise/air pollution.

It is important to note that the effectiveness and cost of TDM measures can be evaluated only with the understanding of current level of implementation of the TDM measures. Also, with a standardized survey, a nationwide study permits us to draw an overall picture of the TDM implementation in the nation and to compare directly one area with another.

Previous studies in the transportation demand management mainly focused in the transportation demand management (TDM) implemented in large metropolitan areas. Some studies looked at a particular metropolitan area and evaluated the effectiveness of each TDM measures. Others reviewed various area-specific studies and tried to identify a general pattern of results. Because each area-specific study was done differently, the later studies were more qualitative assessment of the TDM measures and did not take into account specific characteristics of each metropolitan area. Quite a few medium-size metropolitan areas and no small-size metropolitan areas were studied.

### **I.3. Study Method**

A web-based questionnaire was developed to assess the effectiveness and cost of TDM measures. Because this study focuses on various TDM measures implemented in many different metropolitan areas, a traveler survey is not feasible. Instead, MPOs, which set and implement area transportation plans and collect various local informations on traffic condition and travelers

behavior, are expected to have much of this information. Because of their expertise, their responses are expected to be more standardized and more objective. Thus, the MPOs throughout the nation were invited to participate the survey. All sizes of metropolitan areas are surveyed for comparison purpose.

#### **I.4. Expected Contribution of Study**

The estimated model can not only identify effective TDM measures in medium-size metropolitan areas, but is also used to predict the effect of TDM measures in areas that have not implemented some or any TDM measures at all. Because factors affecting effectiveness and cost of TDM measures are modeled, the model can predict the effectiveness and cost of TDM measures at a particular metropolitan area, given the characteristics of the metropolitan area.

By measuring the effectiveness and cost of each TDM measures in conjunction with the current level of implementation, the study can provide a rough cost-benefit analysis of TDM measures. In addition, the study can predict an equity effect of TDM measures, which may be more important in some metropolitan areas such as those in South.

## **II. Literature Review**

### **II.1. Introduction**

TDM is used extensively in Europe where there is wider agreement that the use of the automobile must be restrained to preserve the urban environment. Saleh and Bell (1997) present a comprehensive summary of TDM projects in Europe. They classify TDM into Main Measures and Complementary Measures. The authors conclude that packages of TDM elementary measures be constructed out of one or more main measures and one or more complementary measures for maximum impact (e.g. V1008 Consortium, 1989; Jones, 1991; Oda, 1990; DOT, 1994 and Saint-Laurent et al, 1994). Saleh and Bell also suggest criteria for evaluation of TDM measures that include demand impacts, network impacts and environmental impacts.

TDM is also used in the United States to a lesser extent and many of them are in large metropolitan areas such as Los Angeles, Washington, D.C., and Seattle. Although there are some small examples of its use in the Piedmont Triad and North Carolina in general, there is no effort to use a comprehensive TDM program in the mid-size metropolitan areas in the southeast. Some recent applications of TDM in the United States include parking restrictions (Bradley, 1996), employer based programs (Higgins, 1996), HOV lanes (Paiewonsky, 1997, Best, 1997 and Fedrick, 1997) and traffic light preemption for public transit (Khasnabis and Rudraraju, 1997).

### **II.2. Types of Transportation Demand Management**

An extensive effort that summarizes the use of TDM in metropolitan areas is presented by Saleh and Bell (1997). They consider a wide range of options both one at a time and all together. For this report travel demand management and transportation demand management are considered to be the same concept. They point out that the TDM strategies depend on the goals

to be achieved. These goals may be to:

- a. reduce congestion
- b. reduce pollution
- c. reduce energy consumption and
- d. improve safety.

There are also several strategies to achieve these goals which include:

- a. reduce vehicle miles,
- b. reduce temporal peaks of car demand and
- c. reduce spatial concentration of car demand.

There are several types of transportation demand management which are applied as different tools to achieve the various goals.

#### *a. Innovative Supply Measures*

The first type of measures is innovative supply. These include the following:

1. Park and ride lots for public transportation
2. Car-pool or vanpool programs that can reduce the number of vehicle miles by increasing the number of passengers per vehicle. These programs usually use computer match programs that find people who are leaving similar origins for similar destinations. Dial-a-ride can enable pick up and delivery of passengers and is especially used for elderly and disabled passengers.

3. Traveler information service which is used to give commuters the best route to work.
  - i. Variable message signs give information en route
  - ii. In-vehicle message units give shortest routes to individual commuters
  - iii. Home message units give on-line information before trips are started.

#### *b. Pricing Measures*

The second type of TDM measure is pricing measures. These include the following:

1. Paying a toll to use the highway or other surface transportation facility (e.g. a bridge or tunnel) during rush hour for all users. This form of congestion pricing will apply to everyone.
2. Decarlo-Souza (2000) points out that tolls may be combined with HOV lanes to form high occupancy toll (HOT) lanes. In these lanes extra passengers are not required if a toll is paid. This toll may change during the day depending on traffic volume so that it acts as a congestion price.
3. Decarlo-Souza (2000) also discusses parking pricing.
4. Parking discounts to car poolers or others who travel to work in a prescribed manner.

#### *c. Regulation Measures*

The third type is various TDM regulation measures including

1. High occupancy vehicle lanes (HOV) are priority lanes on the highway for cars with extra passengers.
2. Priority reserved parking spaces at the destination (e.g. work) for people who take 2 or more passengers or who pay a toll.

3. Employers can provide free transit passes to their employees. There is provision in current federal legislation to give employers incentives to provide this type of program.
4. Programs to encourage tele-commuting to work or (possibly) other activities. Working at home some days each week can also reduce the cost of travel.
5. Flexible work hours (flextime) reduces congestion during the rush hour by having people travel at different times.
6. Compressed workweek (work four days or less each week) reduces the number of commute trips.
7. Auto restricted zones at certain times of the day.

*d. Complementary measures to TDM*

Complementary measures consist of measures that are combined in packages to make main measures more effective. These include the following:

1. Traffic light measures coordinated to improve traffic flow and to enhance the travel time of public transit. An example is computer coordinated traffic signals in Greensboro, NC.
2. Variable message signs can be used to provide drivers with up to the minute information about traffic conditions. These have also been installed in key locations in the Piedmont Triad of North Carolina (e.g. Finch et al, 1994).
3. Ramp metering is used to space vehicles to smooth the flow of traffic and is used in large urban areas in the United States (e.g. Salem and Papageogiou, 1995).

*e. Combinations of TDM strategies*

Combinations of TDM measures will enhance their impacts. Packages of main and complementary strategies are particularly effective. For example, carpooling can be encouraged by a good computer match system along with HOV lanes on key highways and priority parking for reduced rates at places of employment. Bus priority traffic lights can be combined with HOV lanes, turn restrictions, dedicated bus lanes and vehicle information systems to make bus competitive in both cost and time and to promote the use of transit (e.g. Jones, 1991, SAVE, 1996 and ELGAR, 1996).

In their handbook on TDM, The U.S. Center for Transportation Research (1996), TDM is divided into eight groups which is summarized in Table 1.

**Table 1**  
**Types of TDM Strategies**

Influence Travel by	Strategies
Mode	Carpools, vanpools, transit, bike, walk
Time	Flextime, staggered work hours, compressed work weeks, HOV lanes
Frequency	Linked trips, trial use of alternative modes
Trip Length	HOV lanes, land use design, telecommuting
Convenience	Preferential parking for carpools, vanpools
Regulation	Employee commute options, trip reduction ordinances, regional developments
Route	Congestion pricing, intelligent transportation systems
Cost	Parking pricing, congestion pricing, transit subsidies

Source: The Center for Transportation Research (1996)

### **II.3. Empirical Study of TDM**

Papers which focus on U. S. applications of TDM include the following: Ferguson (2,000) divides TDM into voluntarism which include the voluntary provision of transportation,

markets which consist of value pricing mechanisms, and regulations which consist of travel restrictions. He also examines a set of papers that analyze the impacts of TDM.

There are many articles that organize TDM similarly. They include Paul Ricotta (2000), U. S. Department of Transportation (2000), Litman (1999), Victoria Transport Policy Institute (2001), and the OECD Expert Group (1994).

There are several aspects of transportation that are influenced by TDM. Traditionally, evaluations are made of the immediate objectives of each TDM measure. Saleh and Bell (1997) list the following impacts that are measured:

- a. mode switch
- b. route switch
- c. destination switch
- d. activity time switch
- e. changing trip frequency
- f. changing vehicle occupancy
- g. changing tour patterns.

However, there are several attempts at evaluating specific TDM. Levinson, Golenberg, and Zolgrapos (1999) describe some direct impacts that relate to the immediate objectives of TDM such as reduction in delays, reductions in accidents and increases in vehicle occupancy although these are difficult to measure. Wellander and Leotta (2001) examine the effectiveness of HOV lanes by comparing them to general use lanes and using existing traffic count data.

While there is a plethora of articles classifying and organizing TDM, there are few studies that investigate its impacts. The studies that do use of empirical data focus on a single measure in one urban region. Furthermore, TDM has been implemented generally in large metropolitan

areas, and most TDM studies are reported for those large metropolitan areas. Although TDM was introduced in the 1970's, its potential has not yet been untried in most of medium and small urban areas, and no comprehensive review studies of TDM and its effectiveness in the medium and small urban areas have been reported.

## **III. Survey Design**

### **III.1. Introduction**

The objective of this study is to identify current implementation of the Transportation Demand Management (TDM) across the U.S. It requires surveying as many areas as possible to understand the current status of the TDM throughout the U.S. It is infeasible to apply a common type of travel survey among commuters throughout the U.S., who may or may not notice the TDM measures in their areas. Instead, the information about the current TDM measures should be readily available at the Metropolitan Planning Organizations (MPOs), which set and implement the local transportation plan. In addition, these organizations are responsible to collect information about local traffic condition and travel patterns. Thus, this study developed a survey instrument to the MPOs.

### **III.2. Survey Instruments**

Most MPOs have Internet access. To shorten the turn-around time of survey implementation and to automate data input, a web-based questionnaire was developed. The questionnaire used in this study is presented in Appendix A.

The questionnaire is divided into five sections, (1) MPO information, (2) Current traffic condition, (3) Current implementation of TDM measures, (4) Effectiveness of TDM measures, and (5) Costs of TDM measures. Because a web-based questionnaire requires each participant to be logged-on to the Internet, it is not desirable to ask questions that require each participant to look for such information during the survey. Most socio-economic information on MPO areas and a quantitative information of traffic conditions and some TDM implementation such as public transportation are available in various federal government reports, so more qualitative

information was collected on the survey.

There are so many different types of TDM measures and their variations, only some commonly applied representative TDM measures are included in the survey. They include (1) Converting existing lanes to HOV (High Occupancy Vehicle) lanes, (2) Toll Roads, (3) Public transportation, (4) Park and ride facilities, (5) Area-wide carpool/vanpool program, (6) Free or discount transit pass programs, (7) Priority reserved parking programs, (8) Parking discount programs, (9) Flexible work hours, (10) Compressed work week, and (11) Tele-commuting. On each TDM measures, a set of four standard questions are asked, (a) Current and future implementation of the TDM measure, (b) Public acceptance of TDM measure, (c) Equity effect of TDM measure, and (d) Barriers for implementing the TDM measure. In addition, several TDM measure specific information are collected.

The effectiveness of these TDM strategies can be measured in various ways, depending on the objectives of each MPOs. Six representative criteria are used to measure the effectiveness of TDM measures. The six criteria are the most-commonly-used objectives of many MPOs. They are (1) Reducing the need to make trips, (2) Shifting peak hour travel to off-peak hours, (3) Shifting trips away from congested locations to other areas, (4) Reducing congestion in currently congested areas, (5) Reducing travel time of all travelers, and (6) Reducing air pollution in the entire MPO area.

Finally, costs of TDM measures are measured in terms of three aspects, an initial capital expenditure, annual operating costs, and non-monetary costs. Non-monetary cost includes an increased accident and traffic problem on local streets near the highway where the TDM measure is implemented and noise/air pollution in surrounding residential areas.

Throughout the survey the participants are asked to provide their objective qualitative

assessment of TDM measures. Ratings are used for public acceptance, barriers to implementation, effectiveness, and costs of TDM measures. Because the basis of ratings is arbitrarily set by each survey participant, the overall ratings are not intended to interpret an absolute value, but are used for relative comparison among TDM measures.

### **III.3. Survey Implementation**

The Association of Metropolitan Planning Organizations publishes the profiles of both member and non-member Metropolitan Planning Organizations (MPOs) each year. The year 2000 Profiles contains name and contact information of three-hundred-fifty-four MPOs throughout the nation. The Profiles also provide population and geographic area information in most MPOs, which are used to classify MPOs into three groups; large-size MPOs with population of more than one million, medium-size MPOs with population of more than one-hundred-thousands and up to one-million, and small-size MPOs with population of one-hundred-thousands or less. This population classification scheme is made arbitrary in this study.

The Profiles provides E-mail addresses of most MPOs. An initial invitation E-mail for participating in the survey was sent to more than three hundred MPOs. A regular invitation mail was sent to all other MPOs without E-mail address and those MPOs whose E-mail was not delivered. Also, the participation invitation was posted on the TransTDM listserv hosted at the Center for Urban Transportation Research of the University of South Florida. Two weeks later a follow-up E-mail was sent to those MPOs that had not responded yet. The Microsoft Word version of the questionnaire was attached to the follow-up E-mail in case that the MPO planner might not be able to access the web or not have enough time to finish the web-based questionnaire.

## **IV. Survey Results**

This section presents the summary of descriptive analysis results of the survey questionnaires and some inference from mean, frequency and correlation analysis. Detailed results of each question on the survey questionnaire are presented in Appendix C.

### **IV.1. Survey Response**

Among 354 MPOs invited to participate in this study, 72 MPOs responded. Appendix B lists these seventy-two MPOs. A list of seventy-two MPOs responded to the survey is presented in Appendix B. Due to a limited number of responses and because the majority of respondents are medium-size MPOs, the survey results presented in the following sections are based on all seventy-two MPOs. As more MPOs respond after this report, the similar descriptive analysis will be done for each of three size categories in terms of population; large-size MPOs (more than one million population), medium-size MPOs (more than one hundred thousands up to one million population), and small-size MPOs (one hundred thousands population or less).

### **IV.2. Survey Data**

The survey results are divided into four categories, (1) Current traffic condition in MPO areas, (2) Implementation of TDM measures, (3) Effectiveness of TDM measures, and (4) Cost of TDM measures. The following sections present summaries of descriptive statistics of survey results of seventy-two MPOs, which responded to the survey. Not every MPO has implemented all eleven TDM measures asked on the questionnaire, or not all seventy-two MPOs answered every question. Of seventy-two MPOs, sixty-six MPOs completed the survey. Thus, the sample

size varies among results and is indicated in each statistics. For reference, a full descriptive statistic result of the survey questions is presented in Appendix C.

### **IV.3. Current Traffic Congestion Problems**

The survey questionnaire starts with evaluating current traffic congestion problems experienced in MPO areas. Three basic questions are asked about current traffic congestion problems on the questionnaire, (1) Locations of traffic congestion, (2) Daily and weekly congestion patterns, and (3) Causes of traffic congestion. All seventy-two MPOs answered the three questions and a summary result of these responses is shown in Table 2.

First, 83% of MPOs indicated that they experienced traffic congestion on arterial streets, 67% on limited access highway and 64% at suburban business/commercial areas. Little more than half of MPOs (54%) experienced traffic congestion in the central business district as well.

Most MPOs experience traffic congestion during peak hours, 85% during morning peak hours and 92% during evening peak hours. On the other hand, only 25% of MPO areas experienced traffic congestion between 9 AM and 4 PM, and only 11% at weekday nights.

Reasons for this traffic congestion are commuting which is the most important factor (86%), followed by shopping (64%), special events (53%), through-traffic (50%), and commercial and industrial freight deliveries (44%).

**Table 2**

**Current Traffic Congestion Problems**

**a. Congestion Areas**

Limited access highways	67%
Arterial streets	83%
Bridges/Tunnels	38%
Central business district	54%
Suburban business/commercial areas	64%
Other	18%
None of the above/No noticeable congestion	1%
Number of Answers	72

**b. Congestion Time**

Weekday mornings between 6 AM and 9 AM	85%
Weekdays between 9 AM and 4 PM	25%
Weekday afternoons between 4 PM and 6 PM	92%
Weekday nights	11%
Weekends	40%
No particular time	3%
Number of Answers	72

**c. Congestion Reasons**

Commuting	86%
Shopping	64%
Special events (sports, music concerts, etc.)	53%
Commercial and industrial (freight deliveries)	44%
Through traffic	50%
Other	13%
No particular types of trip contribute to the congestion	3%
Number of Answers	72

Furthermore, a correlation analysis reveals that commuting is a reason for congestion that is highly correlated with weekday morning and afternoon peak hour congestion (0.61 and 0.61). On the other hand, shopping seems to contribute to congestion during weekday off-peak hours (0.37 during daytime and 0.27 during nights) and weekend (0.50). Freight deliveries and through-traffic further contribute to congestion during weekday daytime off-peak hours (0.32 and 0.32) and weekday nights (0.22 and 0.27). Congestion on limited access highways occurs during the weekday morning peak hours (0.44) and due to commuters (0.31) and through-traffic (0.35). Congestion in arterial streets occurs during weekday morning and afternoon peak hours (0.22 and 0.27) due to freight delivery (0.40). Congestion at central business district and suburban business/commercial areas tend to occur during the weekday morning peak hours (0.31 and 0.32) due to commuting (0.28 and 0.20). Shopping and special events are another contributing factors for congestion at suburban business/commercial areas (0.22 and 0.22).

These correlation analysis results suggest that a typical MPO area experience traffic congestion due to commuters during peak hours along arterial streets and limited access highways. While through-traffic adds to the congestion during off-peak hours on limited access highways, shopping and freight deliveries contribute in congestion during off-peak hours at suburban business/commercial areas and central business district. Special events such as sports and music concerts worsen the congestion problem during the evening peak hours and weekday nights and during the weekends.

#### **IV.4. Current Implementation of TDM Measures**

Next, an extensive set of questions was asked about MPO experiences, perceptions, and expectations about each type of nine TDM measures. Original eleven TDM measures are

grouped into nine distinct measures in this section; (1) Converting to HOV (High Occupancy Vehicle) lanes, (2) Toll Roads, (3) Public transportation, (4) Park and ride facilities, (5) Area-wide carpool/vanpool program, (6) Free or discount transit pass program, (7) Priority reserved parking and parking discount programs, (8) Flexible work hours and compressed work week, and (9) Tele-commuting. On each of nine TDM measures, MPO planners were asked about (a) Current and future implementation of the TDM measure, (b) Public acceptance of TDM measure, (c) Equity effect of TDM measure, and (d) Barriers for implementing the TDM measure. In the following sections, a summary result on these four questions will be presented. In addition, various TDM measure-specific questions are asked, and their results are presented in Appendix C.

*a. Current Implementation of TDM Measures*

Nine TDM measures are divided into two groups in terms of who implements it, (i) Local government or (ii) employers. The first group, the local government initiated TDM measures include (1) Converting to HOV lanes, (2) Toll roads, (3) Public transportation, (4) Park and ride facilities, and (5) Area-wide carpool/vanpool programs. Table 3-a shows a summary of statistic of level of current and future implementation of these measures. Numbers in the table indicate what percentages of MPO areas offer currently a particular TDM measure, or plan to offer it in near future, or not offer or plan to offer it. Among the 71 MPOs that answered, the most common local government initiated TDM measure is a public transportation service, currently 94% of MPO areas offer this service in their areas and another 1% plans to implement it in near future. Of 67 MPO areas currently or in the near future offer public transportation, 63% also provide park and ride facilities and another 13% plan to implement it in the near future. These

park and ride facilities are implemented strategically to encourage usage of the public transportation. 56% of MPO areas organize area-wide carpool and/or vanpool programs and another 7% plan to implement it in the near future. These three TDM measures offer alternative modes of travel and seem directly to aim to reduce the number of single-occupancy vehicles (SOVs) on highway and arterial streets. On the other hand, the uses of HOV lanes and toll roads are not common among MPO areas. Only 8% of MPO areas currently implement HOV lanes with additional 13% of MPO areas planning near in the near future, while only one out of three MPO areas either currently implement or plan near future toll roads in their areas. These two measures, of course, are intended to discourage SOVs, but are not quite acceptable to the general public as other TDM measures in the U.S.

The second group of TDM measures are employer-based TDM measures, which include (1) Free or discount transit pass program, (2) Priority reserved parking, (3) Parking discount programs, (4) Flexible work hours, (5) Compressed work week, and (6) Tele-commuting. Although these TDM measures are offered by some employers in majority of MPO areas except for the parking discount programs, less than one out of five employers offer these TDM measures in most of those MPO areas. Those TDM measures based on arrangement of work schedule are most common TDM measures in this group, including flexible work hours, compressed work weeks, and tele-commuting. Other three TDM measures implemented less among MPO areas are free/discount transit pass program and priority reserved parking and parking discount programs, and are intended to encourage usage of the public transportation and carpool/vanpool. This result contrasts to the earlier finding of common implementation of public transportation and area-wide carpool/vanpool programs as TDM measures initiated by local governments.

**Table 3**

**Current Implementation of TDM Measures**

**a. Local Government Initiated TDM Measures**

TDM Measures	Currently Implemented	Not Implemented, but Planned	Not Implemented, and Not Planned	Obs
Converting to HOV lanes	8%	13 %	79%	71
Toll Roads	28%	4%	68%	71
Public Transportation	94%	1%	4%	71
Park and Ride Facilities	63%	13%	24%	67
Area-wide Carpool/Vanpool	56%	7%	37%	71

**b. Employer-Based TDM Measures**

TDM Measures	Offered by Employers			Not offered by Employers	Obs
	100%-51%	50%-20%	20%-1%		
Free/Discount Transit Pass	0%	3%	58%	39%	67
Priority Reserved Parking	3%	1%	53%	43%	68
Parking Discount	2%	6%	38%	54%	63
Flexible Work Hours	6%	18%	69%	7%	67
Compressed Work Week	2%	2%	91%	6%	66
Tele-commuting	0%	2%	80%	18%	66

*b. Public Acceptance of TDM Measures*

The current level of implementation of TDM measures among MPO areas may reflect the acceptance of these TDM measures by the public. Table 4 shows what proportion of MPO planners perceive the level of acceptance by the public on a particular TDM measure, from very favorable to neutral to very unfavorable. As a summary measure, a simple average of acceptance level is computed for comparison purpose and shown on the Ave. column. Among nine TDM measures, toll roads are least accepted measures, followed by HOV lanes. On the other hand other seven measures are equally favorably accepted by the public. This result is

expected given the fact that the first two TDM measures penalize SOV travelers in terms of money and time, while the other seven TDM measures offer benefit to users of those TDM measures. It is important to note that these results are based on MPO planner’s perception about the public acceptance rather than actual survey among commuters.

**Table 4**

**Public Acceptance of TDM Measures**

	Very Favorable		Neutral	Very Unfavorable		Ave	Obs
	5	4	3	2	1		
Converting to HOV lanes	0%	37%	57%	21%	5%	3.1	19
Toll Roads	4%	11%	33%	37%	15%	2.5	27
Public Transportation	24%	55%	13%	6%	1%	3.9	67
Park and Ride Facilities	19%	40%	40%	2%	0%	3.8	53
Area-wide Carpool/Vanpool	14%	62%	24%	0%	0%	3.9	42
Free/Discount Transit Pass	20%	61%	15%	5%	0%	4.0	41
Priority Reserved Parking or Parking Discount	18%	39%	37%	5%	0%	3.7	38
Flexible Work Hours or Compressed Work Week	27%	50%	23%	0%	0%	4.0	52
Tele-commuting	27%	50%	23%	0%	0%	4.0	52

*c. Equity Effect of TDM Measures*

TDM measures may affect the commuters with different income levels differently. Table 5 presents an equity effect of nine TDM measures. Numbers in Table 5 indicate what percentage of MPO planners perceive how a particular income group uses a particular TDM measure. Because more than one income group may use a particular TDM measure, the sum of percentage points among all three income groups can be more than 100%. Commuters with less than \$20,000 total annual income before taxes are most likely to use the public transportation services

(84%) and free or discount transit pass programs (61%), while commuters with more than \$50,000 total annual income before taxes are more likely to use toll roads (69%). Most commuters with total annual income before taxes between \$20,000 and \$50,000 use all TDM measures except for the public transportation. Thus, for public transportation, the most common TDM measures initiated by the local government, mainly affect the lower income commuters' travel pattern. However, the park and ride facilities are more likely used by middle income commuters, thus encouraging this group to use public transportation. Another common local government initiated TDM measure, the area-wide carpool and vanpool programs are also used mainly by middle income commuters (88%). Higher usage level of carpool and vanpool programs by middle income commuters also result in higher usage level of priority reserved parking or parking discount programs by this group (92%). Thus, in general, any TDM measures that affect the carpooling and vanpooling tend to affect most medium income commuters. It is clear that a varying accessibility of automobiles as travel mode between lower income commuters and middle and high-income commuters seem to reflect on this difference. Interestingly, free or discount transit pass programs are used equally by lower income commuters and middle income commuters (61% and 65%). Finally, because only limited types of jobs can offer flexible work hours, compressed workweek, and tele-commuting, these TDM measures tend to affect mainly middle and high income commuters. Again, it is important to note that these results are based on MPO planner's perception about the public usage among different income levels rather than actual survey of commuters.

**Table 5**

**Equity Effect of TDM Measures**

	Total Annual Income Before Taxes			Obs
	Less than \$20,000	\$20,000 - \$50,000	More than \$50,000	
Converting to HOV lanes	43%	86%	43%	7
Toll Roads	31%	62%	69%	13
Public Transportation	84%	35%	5%	55
Park and Ride Facilities	20%	83%	26%	35
Area-wide Carpool/Vanpool	22%	88%	41%	32
Free/Discount Transit Pass	61%	65%	13%	31
Priority Reserved Parking or Parking Discount	16%	92%	44%	25
Flexible Work Hours or Compressed Work Week	20%	87%	51%	45
Tele-commuting	5%	69%	67%	39

*d. Barriers to Implement TDM Measures*

The level of implementation varies among TDM measure because of varying barriers to implement these TDM measures. The level of barrier to implement TDM measures is rated from *most significant* (5) to *not significant at all* (0). Table 6 presents a summary result of level of barriers caused by various groups and reasons as simple average of ratings over all responses. Higher numbers indicate a greater barrier to implement a particular TDM measure by a particular group or reason. For more detail, a rating frequency that is used to compute these summary measures is presented on Appendix C.

Three TDM measures face significant lack of support or interest or opposition by commuters; HOV lane (3.0), toll roads (3.5), and area-wide carpool and vanpool programs (3.0). On the other hand, two employer-based TDM measures, flexible work hours and compressed work week (1.6) and tele-commuting (1.9), have the least barriers from employees. However,

these two as well as other three employer-based TDM measures face significant lack of support or interest or opposition by employers. Elected officials' support reflects the support by commuters, where they tend to show no interest or even oppose toll roads (3.7) and HOV lane (3.2). Costs of implementation and operation are another important factors for toll roads (2.9), HOV lanes (2.7), park and ride facilities (2.8), and free or discount transit pass program (2.6). Many MPO planners consider both HOV lanes (2.9) and toll roads (3.1) not effective to achieve their objectives such as reducing congestion and air pollution. These two TDM measures are often neither applicable (3.3 for HOV lanes and 3.5 for toll roads) nor considered (2.0 for HOV lanes and 2.5 for toll roads) in many MPO areas. On the other hand, three employer-based TDM measures, flexible work hours, compressed work week, and tele-commuting, are considered effective to achieve MPO objectives, applicable to the area, and have been considered for implementation.

**Table 6**

**Barriers to Implement TDM Measures**

	<div style="display: flex; justify-content: space-between;"> <div style="width: 15%;"><i>Lack of Support/Interest or Opposition by Commuters/Employees</i></div> <div style="width: 15%;"><i>Lack of Support/Interest or Opposition by Employers</i></div> <div style="width: 15%;"><i>Lack of Support/Interest or Opposition by Elected Officials</i></div> <div style="width: 15%;"><i>Cost of Implementation/Operation</i></div> <div style="width: 15%;"><i>Not Effective for Achieving MPO objectives</i></div> <div style="width: 15%;"><i>Not Applicable to the Area</i></div> <div style="width: 15%;"><i>Never Considered</i></div> </div>						
Converting to HOV lanes	3.0 (50)		3.2 (50)	2.7 (49)	2.9 (51)	3.3 (48)	2.0 (39)
Toll Roads	3.5 (46)		3.7 (46)	2.9 (44)	3.1 (48)	3.5 (39)	2.5 (33)
Park and Ride Facilities	2.1 (57)		2.1 (57)	2.8 (56)	2.4 (58)	1.9 (45)	1.2 (39)
Area-wide Carpool/Vanpool	3.0 (59)	3.2 (59)	2.4 (58)	2.2 (57)	1.5 (54)	1.6 (43)	1.1 (40)
Free/Discount Transit Pass	2.4 (57)	3.6 (57)	2.3 (57)	2.6 (54)	1.9 (55)	1.5 (38)	1.2 (33)
Priority Reserved Parking or Parking Discount	2.4 (56)	3.6 (56)			2.1 (55)	1.9 (41)	1.7 (39)
Flexible Work Hours or Compressed Work Week	1.6 (63)	3.5 (63)			1.4 (61)	1.2 (61)	1.5 (43)
Tele-commuting	1.9 (60)	3.7 (60)			1.6 (57)	1.5 (42)	1.3 (42)

#### IV.5. Effectiveness of TDM Measures

The third section of the questionnaire asks each MPO planner to rate each of ten TDM measures in terms of effectiveness and/or impact on six criteria, (1) Reducing the need to make trips, (2) Shifting peak hour travel to off-peak hours, (3) Shifting trips away from congested locations to other areas, (4) Reducing congestion in currently congested areas, (5) Reducing travel time of all travelers, and (6) Reducing air pollution in the entire MPO area.

The effectiveness of TDM measures is rated from *very effective* (9) to *not effective at all* (0). (Note: On Questions 1 and 2, *very effective* is 5. On Question 3, *very effective* is 7.) If a TDM measure is considered to affect adversely, then it should be selected as *adversely affect* (-1). If a particular TDM measure does not apply to the criteria at a Metropolitan area, it should be selected as *not applicable* (N/A). Table 7 presents a summary of result of effectiveness rating of ten TDM measures on six criteria, that is a simple average of ratings over all responses except those answered *not applicable*. Not every TDM measure has an effect on each of six criteria, so the survey asks MPO planners to evaluate only those TDM measures which are commonly expected to have an effect on a particular criterion. Because the rating range varies from one criterion to another, these summary measures are only used to compare among TDM measures on each criterion. For more detail, a rating frequency that is used to compute these summary measures is presented on Appendix C.

The first three criteria specifically ask how TDM measures affect a travel pattern, while the next three criteria ask the overall effects of TDM measures in an area. On the first criteria of *Reducing the need to make trips*, with maximum rating of five for both compressed work week and tele-commuting show a promising effect (2.3 and 2.3), followed by flexible work hours (1.8). Toll roads seem to have little effect on this criterion, maybe because they do not affect

commuting needs but only affect travel for shopping and entertainment. On the second criteria of *Shifting peak hour travel to off-peak hours*, with a maximum rating of five for both flexible work and compressed work week which show high impact (2.8 and 2.7) because these TDM measures tend to change commuting time of participants, followed by tele-commuting (2.4). Neither HOV lanes nor toll roads seem to affect commuters travel pattern here. On the third criteria of *shifting trips away from congested locations to other areas*, none of six TDM measures seem to have significant effect, compare with a maximum rating of seven. In a relative sense, three TDM measures, park and ride facilities, area-wide carpool/vanpool programs, and tele-commuting, may have more effect than HOV lanes or toll roads. It is clear from these three questions that commuters, who are identified as the most significant source of congestion earlier on this survey, and their travel pattern are less likely to be affected by either HOV lanes or toll roads. On the other hand, employer-based TDM that directly affect work hours of employees have more impact.

The next three criteria evaluate the overall effect of TDM measures on three aspects; (a) Reducing congestion in currently congested areas, (b) Reducing travel time of all travelers, and (c) Reducing air pollution in the entire MPO area. These three are results of changes in travel pattern evaluated in the first three criteria, and often used as objectives of many MPOs. On the criteria of *Reducing congestion in currently congested areas*, three employer-based TDM measures stand out; flexible work hours (4.1), compressed work week (4.1), and tele-commuting (3.8), all of which are considered to have significant effect on each of earlier three criteria, i.e., *reducing the need to make trip*, *shifting peak hour travel to off-peak hours*, and *shifting trips away from congested locations to other areas*. Then, alternative modes of travel and other TDM measures to encourage usage of alternative mode of travel come next, area-wide carpool and

vanpool programs (3.7), free or discount transit pass (3.6), park and ride facilities (3.4), and public transportation (3.4). On the other hand, HOV lanes (3.1) and toll roads (2.2) seem to be less effective to reduce congestion. On the second overall criteria of *Reducing travel time of all travelers*, the result is similar to *Reducing congestion*, except for alternative mode of travel and other TDM measures to encourage usage of alternative mode of travel being considered less effective on this criterion. By reducing congestion, the travel time of all travelers tends to decrease. However, those using an alternative mode of travel may increase their travel time, so that overall travel time may not increase so much as the reduction in congestion. On the other hand, with HOV lanes, those SOV drivers still experience congestion and may spend as much travel time as before, but those HOV drivers can significantly reduce their travel time, so that overall travel time may reduce more than its reduction in congestion. Finally, on the last criteria of *Reducing air pollution in the entire MPO area*, tele-commuting gets the highest rating of effectiveness (4.1), followed by other employee-based TDMs and alternative modes. Both public transportation (3.5) and area-wide carpool and vanpool programs (3.7) reduce a number of SOV vehicles directly, and are considered as effective as employer-based TDM measures, flexible work (3.3) and compressed work week (3.4). Two TDM measures to encourage usage of public transportation come next, park and ride facilities (3.3) and free or discount transit pass program (3.1). Then, those TDM measures which encourage an increase in occupancy of each vehicle, HOV lanes (2.8) and priority reserved parking and parking discount programs (2.3).

On six criteria, three employer-based TDM consistently indicate their effectiveness, while toll roads are considered least effective or not effective at all. Providing alternative modes of travel seem relatively effective in general, and at slightly lesser magnitude those TDM measures to encourage alternative modes of travel and high occupancy of vehicles.

**Table 7****Perceived Effectiveness of TDM Measures**

	Reducing the need to make trips	Shifting peak hour travel to off-peak hours	Shifting trips away from congested locations to other areas	Reducing congestion in currently congested areas	Shifting peak hour travel to off-peak hours	Shifting trips away from congested locations to other areas
Converting to HOV lanes		1.1	1.8	3.1	3.2	2.8
Toll Roads	1.1	1.3	1.4	2.2	1.9	1.2
Public Transportation			2.2	3.4	2.6	3.5
Park and Ride Facilities			2.6	3.4	2.6	3.3
Free/Discount Transit Pass				3.6	2.6	3.1
Area-wide Carpool/Vanpool			2.6	3.7	2.9	3.7
Priority Reserved Parking and Parking Discount				3.0	2.7	2.3
Flexible Work Hours	1.8	2.8		4.1	4.1	3.3
Compressed Work Week	2.3	2.7		4.1	4.0	3.4
Tele-commuting	2.3	2.4	2.6	3.8	3.9	4.1
Maximum Rating	5	5	7	9	9	9

#### IV.6. Cost of TDM Measures

Each TDM measure was evaluated in terms of its implementation cost, which is divided into three categories; an initial capital expenditure, annual operating costs, and non-monetary costs to local residents near the congested areas targeted by a particular TDM measure. These monetary costs are assumed to include all monetary costs incurred by all levels of governments (local, state, and federal), commuters (both those who use a TDM measure and those who do not), and local businesses. Non-monetary cost includes an increased accident and traffic problem on local streets near the highway where the TDM measure is implemented and noise/air pollution in surrounding residential areas. The cost of each TDM measure was rated from *very costly* (9) to *not costly at all* (0).

Table 8 summarizes the evaluation of implementation cost ratings of nine TDM measures. Numbers in table are simple average of cost ratings over all responses except those answered *not applicable*. Because a rating range varies from one type of cost to another, these summary measures are only used to compare among TDM measures on each cost type. For more detail, a rating frequency that is used to compute these summary measures is presented on Appendix C.

On the implementation cost, three TDM measures are considered as very costly by most MPO planners, converting existing lanes to HOV lanes (7.6), toll roads (6.6), and public transportation (6.6). Although these measures are considered much cheaper than expanding lanes or highway networks, they still require a capital investment at an initial implementation such as toll facilities and vehicles. On the other hand, employer-based TDM measures are considered as least expensive at the implementation, flexible work hours or compressed work week (1.8) and tele-commuting (2.2). The result is similar for operating cost, where the public

transportation (6.9) seems the most costly TDM measure among nine TDM measures. On non-monetary cost, the result is again similar to other types of cost, but a difference between those with the highest cost and those with the lowest cost narrows. Toll roads (4.3) and HOV lanes (3.9) are two highest non-monetary cost TDM measures, maybe because they tend to divert some traffic from highways to other streets.

**Table 8**  
**Costs of TDM Measures**

	Implementation Cost	Operating Cost	Non-monetary Cost
Converting to HOV lanes	7.6	5.5	3.9
Toll Roads	6.6	5.7	4.3
Public Transportation	6.6	6.9	2.6
Park and Ride Facilities	4.7	3.4	1.9
Area-wide Carpool/Vanpool	3.4	3.3	1.7
Free/Discount Transit Pass	3.2	3.6	1.6
Priority Reserved Parking or Parking Discount	2.3	2.4	1.6
Flexible Work Hours or Compressed Work Week	1.8	1.8	1.4
Tele-commuting	2.2	2.1	1.4
Maximum Rating	9	9	9

#### **IV.7 The Cost-Effectiveness of TDM Measures**

These various ratings of effectiveness and costs are combined into a single index. The perceived effectiveness ratings are averaged over six criteria, while the perceived cost ratings are averaged over three cost categories and divided by nine. Table 9 summarizes these total effectiveness index and total cost index of ten TDM strategies. The highest cost measures that included HOV lanes and tolls were found to have little effectiveness. Conversely, the lowest cost

measures (employer based measures) were found to have the most effectiveness. Other TDM measures to encourage usage of public transportation or vanpooling/carpooling are found to have modest effectiveness and moderate cost. This result will not change in general even if different weights are assigned among six effectiveness measures and three cost measures by reflecting each MPO's objective priority.

**Table 9**

**Perceived Costs and Effectiveness of TDM Measures**

	Total Cost Index	Total Effectiveness Index
Converting to HOV lanes	0.63	0.23
Toll Roads	0.61	0.20
Public Transportation	0.60	0.31
Park and Ride Facilities	0.37	0.36
Area-wide Carpool/Vanpool	0.31	0.40
Free/Discount Transit Pass	0.31	0.33
Priority Reserved Parking and Parking Discount	0.23	0.41
Flexible Work Hours and Compressed Work Week	0.19	0.42
Tele-commuting	0.21	0.37
Maximum Rating	1.00	1.00

## **V. Conclusion**

This study attempts to identify the current implementation of the TDM measures, to evaluate the effectiveness of each TDM measure, and to compare with cost of implementing these TDM measures in the medium-size metropolitan areas. A web-based questionnaire was developed and used to collect objective assessment of Metropolitan Planning Organizations (MPOs) throughout the U.S. Seventy-two MPOs responded to the survey, of which the majority is medium-size metropolitan areas.

The survey result confirms that most metropolitan areas experience traffic congestion during morning and evening peak hours on limited access highways and arterial streets due to commuting. In addition, in many metropolitan areas through-traffic contributes further congestion on limited access highways, and shopping and freight deliveries are the main sources of congestion during weekday day-time off-peak hours and nights

Many MPOs have implemented some types of Transportation Demand Management (TDM). Public transportation is the most commonly applied TDM measures among the seventy-two MPO areas, followed by park and ride facilities and area-wide carpool and vanpool programs. HOV lanes and toll roads have been implemented in few areas. Many MPO planners seem to be concerned about the adverse equity effect of HOV lanes and toll roads, indicate various barriers to implement them, and assess their effectiveness not significant to reduce congestion or air pollution in their areas. Furthermore, these two TDM measures are considered very costly in terms of their initial implementation cost, operating cost, and non-monetary cost.

The public transportation and area-wide vanpool and carpool programs are more widely accepted, have more positive impact on low and middle income commuters, and are considered

more acceptable among the public. Even though these are moderately effective to reduce congestion and air pollution, many MPO areas face lack of support or interest of commuters for these measures and they are relatively costly for local governments to implement. Three TDM measures (park and ride facilities, free or discount transit pass programs, and priority reserved parking and parking discount programs), which are intended to encourage public transportation and vanpooling and carpooling program participation, are considered to have some effect on reducing traffic congestion and air pollution by reducing single occupancy vehicles on streets. Although their costs are relatively low, there is a lack of support or interest of commuters and employers. Finally, most MPO planners consider employer-based TDM measures (flexible work hours, compressed work week, and tele-commuting), which are intended to change working schedules of commuters, hence, their travel patterns, very effective to reduce traffic congestion and air pollution. These TDM measures mainly affect medium income commuters and are considered relatively inexpensive to implement with quite low non-monetary cost incurred in their areas. Although these measures are supported by employees, many MPOs consider employers not having any interest or support on these work arrangements.

These results indicate that many MPOs are considering employer-based TDM measures more potential to achieve their objectives rather than more traditional local-government initiated TDM measures. It seems important to further investigate potential of these employer-based TDM measures in medium-size metropolitan areas. In particular, a change in the nature of many white-color jobs and recent technological advance will make tele-commuting a great potential TDM measure in the near future. On the other hand, toll roads and HOV lanes (including HOT lanes) often used in Europe and other countries are less popular in the U.S. More creative and publicly acceptable forms of value-pricing measures need to be developed in the U.S. to become

an effective tool of congestion management and air pollution control.

Although only the descriptive analysis results are presented on this report, the data collected on this survey can be used to analyze further to reveal some causal-relationship between current level of congestion and implementation on one hand and effectiveness and cost of TDM measures on the other hand. Regression analysis can be used to examine a relationship between characteristics of metropolitan area (census data) and choice/effectiveness of TDM strategies. This analysis is used to identify which TDM strategies should be inquired in the second phase study at a particular metropolitan area. It may use a nested logit model or Tobit model for TDM strategy choice (non-mutually exclusive choice). Structural equation analysis can be used to identify factors contributing to effective TDM strategies. This analysis is a complement to the regression analysis. These are potential and useful future extension of this study.

Based on the result of this study, potential TDM measures will be identified for Piedmont Triad region of North Carolina by applying the factor and structural analysis. Effectiveness criteria developed in this study will be used to evaluate each TDM measure in Piedmont Triad region. Taking into consideration public acceptance and cost of implementation, the most cost-effective TDM combinations can be recommended in conjunction with current I-40 expansion project in the region.

Further emphasis must be placed on prescribing cost effective TDM especially for small and medium sized cities. Given guidelines of what to expect will help small and medium sized urban areas to have their TDM potential reached.

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## Appendix

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# **Appendix A**

## **Survey Questionnaire**







## C.2. Toll Roads

a. Does your MPO area currently have **toll roads**? (Please select one)

Yes, have now.	<input type="checkbox"/>
Not have now, but plan in the future.	<input type="checkbox"/>
Not have now and not plan in the future.	<input type="checkbox"/> ⇒ skip to C.2.f
Have now, but plan to drop tolls in the future.	<input type="checkbox"/>

b. Which of the following types of locations/streets do you impose or plan to impose **tolls**? (Please select as many as apply)

Limited access highways	<input type="checkbox"/>
Arterial streets	<input type="checkbox"/>
Bridges/tunnels	<input type="checkbox"/>
Central Business district	<input type="checkbox"/>
Other (please specify) [ _____ ]	<input type="checkbox"/>

c. Which of the following types of the congestion pricing (using general types of **tolls**) do you implement or plan to implement? (Please select as many as apply)

Route-use (a flexible charge on highway, bridge, etc.)	<input type="checkbox"/>
Distance-based (toll based on the distance traveled, e.g., with a ticket system)	<input type="checkbox"/>
Cordon-based (a fixed charge at the boundary of a specified area)	<input type="checkbox"/>
Time-based (time varying - time of day (e.g. 6AM to 9AM) or days of week (e.g. Monday to Friday))	<input type="checkbox"/>
Congestion-based (toll based on the real time measurement of level of congestion)	<input type="checkbox"/>
Other (please specify) [ _____ ]	<input type="checkbox"/>

d. Is public opinion favorable to implementing **tolls on roads** (public acceptance)? (Please select one)

Very favorable	<input type="checkbox"/>
Favorable	<input type="checkbox"/>
Neutral	<input type="checkbox"/>
Unfavorable	<input type="checkbox"/>
Very unfavorable	<input type="checkbox"/>

e. **Toll roads** are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)

less than \$20,000	<input type="checkbox"/>
between \$20,000 and \$50,000	<input type="checkbox"/>
more than \$50,000	<input type="checkbox"/>

f. Please rate the following barriers to implement (or not implement) the **Toll roads** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers:	Most Significant			Least Significant		Not a Barrier
	5	4	3	2	1	0
Lack of support/interest or opposition by commuters						
Lack of support/interest or opposition by elected officials						
Cost on implementation/operation						
Not effective for reducing congestion or achieving the objectives of the MPO						
Not applicable to the area						
Never considered						
Other (please specify) [ _____ ]						

**C.3. Public transportation (including bus, rail, and ferry)**

a. Does your MPO area currently provide **Public Transportation**? (Please select one)

Provided	
Not provided, but planned in the future	
Not provided and not planned in the future	⇒ skip to C.6 (Area-wide vanpool programs)

b. Please evaluate the following objectives of providing **Public Transportation** in your MPO areas. (Please select one for each objective)

	Very important	Important	Not important
Reducing traffic			
Providing transportation to those without means of transportation			
Providing transportation to elderly and handicapped			
Other 1 (please specify) [ _____ ]			
Other 2 (please specify) [ _____ ]			

c. If **Public Transportation** is provided to reduce traffic, which of the following locations is it intended to reduce traffic? (Please select as many as apply)

Limited access highways	
Arterial streets	
Bridges/tunnels	
Central Business district	
Suburban business/commercial areas	
Other (please specify) [ _____ ]	

d. Is public opinion favorable to implementing **Public Transportation** (public acceptance)? (Please select one)

Very favorable	
Favorable	
Neutral	
Unfavorable	
Very unfavorable	

e. If Flexible-route **Public Transportation** (Dial-A-Ride/On-demand) is provided to the general population in your MPO area, what proportion of the general population can access the Flexible-route **Public Transportation**? (Please select one)

0%	
1% -25%	
26% - 50%	
51% - 75%	
76% - 100%	

f. **Public Transportation** is used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)

less than \$20,000	
between \$20,000 and \$50,000	
more than \$50,000	

**C. 4. Park-and-Ride Facilities** (parking space is supplied near public transit stops or stations)

a. Does your MPO area currently provide **Park-and-Ride Facilities**? (Please select one)

Provided	
Not provided, but planned in the future	
Not provided and not planned in the future	⇒ skip to C.4.e





e. Please rate the following barriers to implement (or not implement) the **Free or discount public transit pass programs** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers	Most Significant			Least Significant		Not a Barrier
	5	4	3	2	1	0
Lack of support/interest or opposition by employees/commuters						
Lack of support/interest or opposition by employers						
Lack of support/interest or opposition by elected officials						
Cost on implementation/operation						
Not effective for reducing congestion or achieving the objectives of the MPO						
Not applicable to the area						
Never considered						
Other (please specify) [ _____ ]						

**6. Area-wide Carpool and/or Vanpool Programs (where vans are provided)**

a. Does your MPO area currently implement **Area-wide Carpool/Vanpool Programs**? (Please select one)

Implemented	
Not implemented, but planned in the future	
Not implemented and not planned in the future	⇒ skip to C.6.e

b. Please rate the usage of the following origin-destination pairs from "Used by many carpoolers/vanpoolers" (5) to "Used by few carpoolers/vanpoolers" (1) under **Area-wide Carpool/Vanpool Programs**. If no one uses a particular origin-destination pair, please select "None" (0). (Please select one for each origin-destination pair)

	Used by Many			Used by Few		None
	5	4	3	2	1	0
Suburb to Center-city						
Suburb to Suburb						
Center-city to Suburb						
Within center-city						
From MPO area to Outside MPO areas						
From outside MPO areas to MPO area						

c. Is public opinion favorable to implementing **Area-wide Carpool/Vanpool Programs** (public acceptance)? (Please select one)

Very favorable	
Favorable	
Neutral	
Unfavorable	
Very unfavorable	

d. **Area-wide Carpool/Vanpool Programs** are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)

less than \$20,000	
between \$20,000 and \$50,000	
more than \$50,000	

e. Please rate the following barriers to implement (or not implement) the **Area-wide Carpool/Vanpool Programs** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers	Most Significant			Least Significant		Not a Barrier
	5	4	3	2	1	
Lack of support/interest or opposition by employees/commuters						
Lack of support/interest or opposition by employers						
Lack of support/interest or opposition by elected officials						
Cost on implementation/operation						
Not effective for reducing congestion or achieving the objectives of the MPO						
Not applicable to the area						
Never considered						
Other (please specify) [ ]						

**C.7. Priority reserved parking spaces and/or Parking discounts for employees who take 2 or more passengers**

a. Do public and private employers in your MPO area currently offer **priority reserved parking spaces**? (Please select one)

Offered by most work places (more than 50%)	
Offered by many work places (between 50% and 20%)	
Offered by few work places (less than 20%)	
Not offered any work places	



f. Please rate the following barriers to implement (or not implement) the **Priority reserve parking spaces and/or parking discounts** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers	Most Significant			Least Significant		Not a Barrier
	5	4	3	2	1	
Lack of support/interest or opposition by employees/commuters						
Lack of support/interest or opposition by employers						
Not effective for reducing congestion or achieving the objectives of the MPO						
Not applicable to the area						
Never considered						
Other (please specify) [ _____ ]						

**C. 8. Flexible work hours and/or Compressed work week (For example: four days a week, ten hours a day)**

a. Do public and private employers in your MPO area currently offer **flexible work hours**? (Please select one)

Offered by most employers (more than 50%)	
Offered by many employers (between 50% and 20%)	
Offered by few employers (less than 20%)	
Not offered by any employers	

b. Do public and private employers in your MPO area currently offer **compressed work week**? (Please select one)

Offered by most employers (more than 50%)	
Offered by many employers (between 50% and 20%)	
Offered by few employers (less than 20%)	
Not offered by any employers	⇒ If your answer on C.8.a above is "Not offered any work places," then skip to C.8.f

c. Where are most of the employers who offer **flexible work hours and/or compressed work week** located in your MPO area? (Please select as many as apply)

Central business district	
Suburban business/commercial areas	
Rural areas	
Other (please specify) [ _____ ]	

d. Are employees favorable to offering **flexible work hours and/or compressed work week** (employees' acceptance)? (Please select one)

Very favorable	
Favorable	
Neutral	
Unfavorable	
Very unfavorable	

e. **Flexible work hours and/or compressed work week** are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)

less than \$20,000	
between \$20,000 and \$50,000	
more than \$50,000	

f. Please rate the following barriers to implement (or not implement) the **Flexible work hours and/or compressed work week** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers:	Most Significant			Least Significant		Not a Barrier
	5	4	3	2	1	0
Lack of support/interest or opposition by employees/commuters						
Lack of support/interest or opposition by employers						
Not effective for reducing congestion or achieving the objectives of the MPO						
Not applicable to the area						
Never considered						
Other (please specify) [ _____ ]						

**C. 9. Tele-commuting programs at home or near home (satellite office)**

a. Do public and private employers in your MPO area currently offer **tele-commuting programs**? (Please select one)

Offered by most employers (more than 50%)	
Offered by many employers (between 50% and 20%)	
Offered by few employers (less than 20%)	
Not offered by any employers	⇒ skip to C.9.e

b. Where are most of the employers who offer **tele-commuting programs** located in your MPO area? (Please select as many as apply)

Central business district	
Suburban business/commercial areas	
Rural areas	
Other (please specify) [ _____ ]	

c. Are employees favorable to offering **tele-commuting programs** (employees' acceptance)? (Please select one)

Very favorable	
Favorable	
Neutral	
Unfavorable	
Very unfavorable	

d. **Tele-commuting programs** are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)

less than \$20,000	
between \$20,000 and \$50,000	
more than \$50,000	

e. Please rate the following barriers to implement (or not implement) the **Tele-commuting programs** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers:	Most Significant			Least Significant		Not a Barrier
	5	4	3	2	1	
Lack of support/interest or opposition by employees/commuters						
Lack of support/interest or opposition by employers						
Not effective for reducing congestion or achieving the objectives of the MPO						
Not applicable to the area						
Never considered						
Other (please specify) [ _____ ]						

10. Please describe any other measures beside ten TDM measures listed above to achieve your MPO objectives.

**D. Please evaluate the impact of your current TDM measures in your MPO areas.**

Please rate each of ten TDM measure in terms of effectiveness/impact on the following six criteria. Its effectiveness should be rated from "very effective" (9) to "not effective at all" (0). (Note: On Questions 1 and 2, "very effective" is 5. On Question 3, "very effective" is 7.) If a TDM measure is considered to affect adversely, then please select "adversely affect" (-1). If a particular TDM measure does not apply to the criteria, please select "not applicable" (N/A).

The effectiveness/impact of each TDM measure should be evaluated on the overall effect to all travelers rather than an individual traveler using a particular TDM measure.

**1. Reducing the need to make trips. (Changing a transportation mode from a single occupancy vehicle to other modes such as carpooling is NOT considered as reducing the need to make a trip, because the trip is still made.)**

	Very effective			Not effective			Adversely effective	N/A
	5	4	3	2	1	0		
Tolls								
Flexible work hours								
Compressed work week								
Tele-commuting programs								

**2. Shifting peak hour travel to off-peak hours.**

	Very effective			Not effective			Adversely effective	N/A
	5	4	3	2	1	0		
Converting lanes to HOV lanes								
Tolls								
Flexible work hours								
Compressed work week								
Tele-commuting programs								

**3. Shifting trips away from congested locations to other areas.**

	Very effective			Not effective			Adversely effective	N/A	
	7	6	5	4	3	2			1
Converting lanes to HOV lanes									
Tolls									
Public transportation									
Park and ride facilities									
Carpool/vanpool programs									
Tele-commuting programs									

**4. Reducing congestion in currently congested areas (by reducing the need to make trips, by shifting trips from the peak hour, by shifting trips to other areas, and by promoting carpooling/vanpooling/public transportation.)**

	Very effective										Not effective		Adversely effective	
	9	8	7	6	5	4	3	2	1	0	-1	N/A		
Converting lanes to HOV lanes														
Tolls														
Public transportation														
Park and ride facilities														
Public transit pass programs														
Carpool/vanpool programs														
Priority reserve parking & Parking discount														
Flexible work hours														
Compressed work week														
Tele-commuting programs														

**5. Reducing travel time of all travelers. (For example, a vanpool program may increase the travel time of those participating in the program, but it reduces the overall congestion and may reduce the travel time of all other commuters. Overall, the total travel time of all travelers may decrease. If this is the case, then it is considered an effective TDM measure to reduce travel time.)**

	Very effective										Not effective		Adversely effective	
	9	8	7	6	5	4	3	2	1	0	-1	N/A		
Converting lanes to HOV lanes														
Tolls														
Public transportation														
Park and ride facilities														
Public transit pass programs														
Carpool/vanpool programs														
Priority reserve parking & Parking discount														
Flexible work hours														
Compressed work week														
Tele-commuting programs														

**6. Reducing air pollution in the entire MPO area.**

	Very effective									Not effective		Adversely effective	N/A
	9	8	7	6	5	4	3	2	1	0	-1		
Converting lanes to HOV lanes													
Tolls													
Public transportation													
Park and ride facilities													
Public transit pass programs													
Carpool/vanpool programs													
Priority reserve parking & Parking discount													
Flexible work hours													
Compressed work week													
Tele-commuting programs													

**E. Please evaluate monetary costs of implementing the TDM measures, including costs incurred by the government, the private firms and the general public.**

Each TDM measure used by the MPO requires resources; the local government (and ultimately taxpayers), commuters (both those who use a TDM measure and those who do not), and local businesses. It may require an initial capital expenditure such as with Park and Ride facilities, and annual operating costs such as with public transportation. It may also impose some non-monetary costs to local residents near the congested areas targeted by a particular TDM measure. For example, tolls on highway may divert some traffic to local streets near the highway and may lead to increased accidents and noise/air pollution in surrounding residential areas.

Please rate a cost of each of nine TDM measures from "very costly" (9) to "not costly at all" (0). If a particular TDM measure does not apply, please select "not applicable" (N/A). Monetary costs must include all monetary costs incurred by the governments, commuters, and businesses.

**1. Initial Implementation Cost**

	Very costly									Not costly			N/A
	9	8	7	6	5	4	3	2	1	0			
Converting lanes to HOV lanes													
Tolls													
Public transportation													
Park and ride facilities													
Public transit pass programs													
Carpool/vanpool programs													
Priority reserve parking & Parking discount													
Flexible work hours & Compressed work week													
Tele-commuting programs													

**2. Annual Operating Cost**

	Very costly									Not costly			N/A
	9	8	7	6	5	4	3	2	1	0			
Converting lanes to HOV lanes													
Tolls													
Public transportation													
Park and ride facilities													
Public transit pass programs													
Carpool/vanpool programs													
Priority reserve parking & Parking discount													
Flexible work hours & Compressed work week													
Tele-commuting programs													

**3. Non-Monetary Costs such as accidents and noise & air pollution.**

	Very costly									Not costly			N/A
	9	8	7	6	5	4	3	2	1	0			
Converting lanes to HOV lanes													
Tolls													
Public transportation													
Park and ride facilities													
Public transit pass programs													
Carpool/vanpool programs													
Priority reserve parking & Parking discount													
Flexible work hours & Compressed work week													
Tele-commuting programs													

**F. If you have any comments on this survey, please write your comments below.**

This is the end of questionnaire. Please verify your answers, then send your answers to the following address by a regular U.S. postal mail:

Dr. Sakano Department of Economics and Transportation/Logistics North Carolina A&T State University Greensboro, NC 27411
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Thank you very much for your participation on this survey.

If you would like to know more about this survey, the Transportation Institute at the North Carolina A&T State University, or regional MPOs which support this survey, please visit our web site at [www.ncat.edu/~sakanor/research/UTI2000/UTI2000.htm](http://www.ncat.edu/~sakanor/research/UTI2000/UTI2000.htm).

## **Appendix B**

### **List of Metropolitan Planning Organizations (MPOs) Participated in Study**

## List of Metropolitan Planning Organizations Participated in Survey

Casper MPO
Southwest Washington Regional Transportation Council
Central Midlands Council of Governments
Hampton Roads Virginia
Regional Public Transportation Authority
Victoria Metropolitan Planning Organization
Atlanta Regional Commission
La Crosse Area Planning Committee
TMACOG
Tallahassee-Leon County - Tallahassee Florida
Texarkana MPO
Richmond Regional Planning District Commission
Wilmington Area Planning Council
Wichita-Sedgwick County Metropolitan Area Planning Dept.
Fargo-Moorhead Metropolitan Council of Governments
Indianapolis MPO
Bangor Area Comprehensive Transportation System (BACTS)
Southeastern Regional Planning & Economic Development District
Area Plan Commission of Tippecanoe County
SEMCOG
Lee County MPO
Missoula Office of Planning and Grants
Baltimore Regional Transportation Board
Capital District Transportation Committee (CDTC)
Burlington - Graham
San Diego Association of Governments
North Front Range Transportation and Air Quality Planning Council
Metropolitan Council
St. Joseph Area Transportation Study Organization
Tyler Urban Transportation Study
Abilene MPO
East Central Wisconsin Regional Planning Commission
INCOG
Mid-America Regional Council
Greensboro Urban Area MPO
Johnson City Tennessee
Akron Metropolitan Area Transportation Study (AMATS)
Topeka-Shawnee County Metro Planning Commission
Northern Middlesex Council of Governments
Santa Barbara County Association of Governments
Lawrence Douglas County Metropolitan Planning Commission
Rocky Mount

Lima-Allen County Regional Planning Commission
Wichita Falls Metropolitan Planning Organization
Forsyth County/Winston-Salem Urban Area
Augusta Regional Transportation Study
Deleware Valley Regional Plan
Greenville Area Transportation Study
Central Virginia Metropolitan Planning Organization
Metropolitan Transportation Commission
Charlotte County-Punta Gorda MPO
West Michigan Shoreline Regional Development Commission
South East Texas Regional Planning Commission
Mountainland Association of Governments
Black Hawk Metropolitan Area Transportation Policy Board
Nashua Regional Planning Commission
Las Cruces MPO
Southeastern Connecticut Council of Governments
Jackson-Tennessee Urban Area MPO
Grand Junction/Mesa County RTPO
Chicago Area Transportation Study
Middle Rio Grande Council of Governments
San Joaquin Council of governments
Denver Regional Council of Governments
Washoe County
Grand Strand Area Transportation Study
Durham-Chapel Hill-Carrboro MPO
Cumberland MD-WV
Rochester-Olmstead Council of Governments
SLOCOG - San Luis Obispo Council of Governments
Cape Cod
East-West Gateway Coordinating Council

## **Appendix C**

### **Summary Statistics of Questionnaire Response**

**B. Please tell us about current traffic conditions in your MPO region.**

**1. Does your MPO area experience congestion in any of the following locations? (Please select as many as apply)**

**Table 1.a: Congestion Areas**

Limited access highways	67%
Arterial streets	83%
Bridges/Tunnels	38%
Central business district	54%
Suburban business/commercial areas	64%
Other	18%
None of the above/No noticeable congestion	1%
Number of Answers	72

**2. Does your MPO area experience congestion during any of the following periods? (Please select as many as apply)**

**Table 1.b: Congestion Time**

Weekday mornings between 6 AM and 9 AM	85%
Weekdays between 9 AM and 4 PM	25%
Weekday afternoons between 4 PM and 6 PM	92%
Weekday nights	11%
Weekends	40%
No particular time	3%
Number of Answers	72

**3. Which types of trips contribute to the congestion in your MPO area? (Please select as many as apply)**

**Table 1.c: Congestion Reasons**

Commuting	86%
Shopping	64%
Special events (sports, music concerts, etc.)	53%
Commercial and industrial (freight deliveries)	44%
Through traffic	50%
Other	13%
No particular types of trip contribute to the congestion	3%
Number of Answers	72

**C. Please tell us about the following Transportation Demand Management (TDM) measures in your MPO region.**

**1. Converting existing general traffic lanes to High Occupancy Vehicle (HOV) lanes**  
**[Do not expand traffic lanes]**

**a. Does your MPO area currently implement HOV lanes? (Please select one)**

Implemented	8%
Not implemented, but planned in the future	13%
Not implemented and not planned in the future	79%
Number of Answers	71

**b. What proportion of HOV lanes is HOT lanes (High Occupancy and Toll lanes available to single occupancy vehicles for a toll)? (Please select one)**

0%	89%
1% - 25%	11%
26% - 50%	0%
51% - 75%	0%
76% - 100%	0%
Number of Answers	19

**c. Where do you implement or plan to implement HOV lanes? (Please select as many as apply)**

Limited access highways	81%
Arterial streets	6%
Other	13%
Number of Answers	16

**d. Is the public favorable to implementing HOV lanes (public acceptance)? (Please select one)**

Very favorable	(5)	0%
Favorable	(4)	37%
Neutral	(3)	57%
Unfavorable	(2)	21%
Very unfavorable	(1)	5%
Average		3.1
Number of Answers		19

**e. HOV lanes are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)**

less than \$20,000	43%
between \$20,000 and \$50,000	86%
more than \$50,000	43%
Number of Answers	7

f. Please rate the following barriers to implement (or not implement) the **HOV lanes** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers:	Most Significant			Least Significant		Not a Barrier	Ave	Obs
	5	4	3	2	1			
Lack of support/interest or opposition by commuters	18%	28%	22%	16%	2%	14%	3.0	50
Lack of support/interest or opposition by elected officials	24%	24%	26%	8%	8%	10%	3.2	50
Cost on implementation/operation	12%	20%	27%	16%	10%	14%	2.7	49
Not effective for reducing congestion or achieving the objectives of the MPO	27%	16%	20%	12%	6%	20%	2.9	51
Not applicable to the area	54%	8%	8%	0%	2%	27%	3.3	48
Never considered	23%	13%	5%	3%	10%	46%	2.0	39
Other	86%	0%	14%	0%	0%	0%	4.7	7

## 2. Toll Roads

a. Does your MPO area currently have **toll roads**? (Please select one)

Yes, have now.	28%
Not have now, but plan in the future.	4%
Not have now and not plan in the future.	68%
Have now, but plan to drop tolls in the future.	0%
Number of Answers	71

b. Which of the following types of locations/streets do you impose or plan to impose **tolls**? (Please select as many as apply)

Limited access highways	74%
Arterial streets	0%
Bridges/tunnels	30%
Central Business district	0%
Other	22%
Number of Answers	23

c. Which of the following types of the congestion pricing (using general types of **tolls**) do you implement or plan to implement? (Please select as many as apply)

Route-use (a flexible charge on highway, bridge, etc.)	6%
Distance-based (toll based on the distance traveled, e.g., with a ticket system)	44%
Cordon-based (a fixed charge at the boundary of a specified area)	19%
Time-based (time varying - time of day (e.g. 6AM to 9AM) or days of week (e.g. Monday to Friday))	13%
Congestion-based (toll based on the real time measurement of level of congestion)	13%
Other	31%
Number of Answers	16

**d. Is public opinion favorable to implementing tolls on roads (public acceptance)? (Please select one)**

Very favorable	(5)	4%
Favorable	(4)	11%
Neutral	(3)	33%
Unfavorable	(2)	37%
Very unfavorable	(1)	15%
Average		2.5
Number of Answers		27

**e. Toll roads are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)**

less than \$20,000	31%
between \$20,000 and \$50,000	62%
more than \$50,000	69%
Number of Answers	13

**f. Please rate the following barriers to implement (or not implement) the Toll roads from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)**

Barriers:	Most Significant		Least Significant			Not a Barrier	Ave	Obs
	5	4	3	2	1			
Lack of support/interest or opposition by commuters	39%	26%	13%	7%	0%	15%	3.5	46
Lack of support/interest or opposition by elected officials	50%	17%	13%	7%	2%	11%	3.7	46
Cost on implementation/operation	18%	30%	18%	11%	5%	18%	2.9	44
Not effective for reducing congestion or achieving the objectives of the MPO	38%	10%	17%	10%	13%	13%	3.1	48
Not applicable to the area	54%	8%	10%	3%	10%	15%	3.5	39
Never considered	36%	6%	6%	9%	6%	36%	2.5	33
Other	100%	0%	0%	0%	0%	0%	5.0	2

**3. Public transportation (including bus, rail, and ferry)**

**a. Does your MPO area currently provide Public Transportation? (Please select one)**

Provided	94%
Not provided, but planned in the future	1%
Not provided and not planned in the future	4%
Number of Answers	71

b. Please evaluate the following objectives of providing **Public Transportation** in your MPO areas. (Please select one for each objective)

	Very important	Important	Not important	Ave	Obs
	3	2	1		
Reducing traffic	25%	40%	35%	1.9	65
Providing transportation to those without means of transportation	90%	10%	0%	2.9	67
Providing transportation to elderly and handicapped	84%	16%	0%	2.8	67
Other	50%	50%	0%	2.5	8

c. If **Public Transportation** is provided to reduce traffic, which of the following locations is it intended to reduce traffic? (Please select as many as apply)

Limited access highways	46%
Arterial streets	74%
Bridges/tunnels	13%
Central Business district	74%
Suburban business/commercial areas	46%
Other	11%
Number of Answers	46

d. Is public opinion favorable to implementing **Public Transportation** (public acceptance)? (Please select one)

Very favorable	(5)	24%
Favorable	(4)	55%
Neutral	(3)	13%
Unfavorable	(2)	6%
Very unfavorable	(1)	1%
Average		3.9
Number of Answers		67

e. f Flexible-route **Public Transportation** (Dial-A-Ride/On-demand) is provided to the general population in your MPO area, what proportion of the general population can access the Flexible-route Public Transportation? (Please select one)

0%	13%
1% -25%	54%
26% - 50%	4%
51% - 75%	11%
76% - 100%	17%
Number of Answers	46

f. **Public Transportation** is used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)

less than \$20,000	84%
between \$20,000 and \$50,000	35%
more than \$50,000	5%
Number of Answers	55

4. **Park-and-Ride Facilities** (parking space is supplied near public transit stops or stations)

a. Does your MPO area currently provide **Park-and-Ride Facilities**? (Please select one)

Provided	63%
Not provided, but planned in the future	13%
Not provided and not planned in the future	24%
Number of Answers	67

b. For which of the following types of the public transportation does your MPO area provide **Park-and-Ride Facilities** or plan to provide them? (Please select as many as apply)

	Currently provided	Not provided now, but planned in the future	Not provided now and not planned in the future	Obs
Local bus	74%	16%	9%	43
Express bus	71%	16%	13%	45
Light rail	28%	24%	48%	29
Subway	19%	4%	78%	27
Commuter rail	26%	29%	45%	31
Ferry	11%	15%	74%	27
Other	69%	23%	8%	13

c. Is public opinion favorable to implementing **Park-and-Ride Facilities** (public acceptance)? (Please select one)

Very favorable	(5)	19%
Favorable	(4)	40%
Neutral	(3)	40%
Unfavorable	(2)	2%
Very unfavorable	(1)	0%
Average		3.8
Number of Answers		53

d. **Park-and-Ride Facilities** are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)

less than \$20,000	20%
between \$20,000 and \$50,000	83%
more than \$50,000	26%
Number of Answers	35

e. Please rate the following barriers to implement (or not implement) the **Park-and-Ride Facilities** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers:	Most Significant			Least Significant		Not a Barrier	Ave	Obs
	5	4	3	2	1			
Lack of support/interest or opposition by commuters	16%	9%	19%	11%	14%	32%	2.1	57
Lack of support/interest or opposition by elected officials	14%	12%	18%	14%	11%	32%	2.1	57
Cost on implementation/operation	16%	29%	14%	20%	4%	18%	2.8	56
Not effective for reducing congestion or achieving the objectives of the MPO	21%	12%	12%	22%	9%	24%	2.4	58
Not applicable to the area	20%	9%	9%	4%	16%	42%	1.9	45
Never considered	15%	3%	3%	3%	15%	62%	1.2	39
Other	67%	0%	0%	0%	0%	33%	3.3	3

5. **Free or discount public transit pass programs** (For example: employer subsidy for transit)

a. Do public and private employers in your MPO area currently offer **free or discount public transit pass programs**? (Please select one)

Offered by most employers (more than 50%)	0%
Offered by many employers (between 50% and 20%)	3%
Offered by few employers (less than 20%)	58%
Not offered by any employers	39%
Number of Answers	67

b. Where are most of the employers who offer **free or discount public transit pass programs** located in your MPO area? (Please select as many as apply)

Central business district	67%
Suburban business/commercial areas	52%
Rural areas	7%
Other	7%
Number of Answers	42

c. Are employees favorable to implementing **free or discount public transit pass programs** (employees' acceptance)? (Please select one)

Very favorable	(5)	20%
Favorable	(4)	61%
Neutral	(3)	15%
Unfavorable	(2)	5%
Very unfavorable	(1)	0%
Average		4.0
Number of Answers		41

d. **Free or discount public transit pass programs** are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)

less than \$20,000	61%
between \$20,000 and \$50,000	65%
more than \$50,000	13%
Number of Answers	31

e. Please rate the following barriers to implement (or not implement) the **Free or discount public transit pass programs** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers:	Most Significant			Least Significant		Not a Barrier 0	Ave	Obs
	5	4	3	2	1			
Lack of support/interest or opposition by employees/commuters	16%	16%	16%	21%	12%	19%	2.4	57
Lack of support/interest or opposition by employers	32%	35%	16%	7%	2%	9%	3.6	57
Lack of support/interest or opposition by elected officials	9%	21%	23%	11%	14%	23%	2.3	57
Cost on implementation/operation	17%	17%	24%	13%	15%	15%	2.6	54
Not effective for reducing congestion or achieving the objectives of the MPO	15%	11%	11%	15%	13%	36%	1.9	55
Not applicable to the area	11%	11%	13%	8%	0%	58%	1.5	38
Never considered	12%	3%	9%	6%	9%	61%	1.2	33
Other	20%	60%	0%	0%	0%	20%	3.4	5

6. **Area-wide Carpool and/or Vanpool Programs** (where vans are provided)

a. Does your MPO area currently implement **Area-wide Carpool/Vanpool Programs**? (Please select one)

Implemented	56%
Not implemented, but planned in the future	7%
Not implemented and not planned in the future	37%
Number of Answers	71

b. Please rate the usage of the following origin-destination pairs from "Used by many carpoolers/vanpoolers" (5) to "Used by few carpoolers/vanpoolers" (1) under **Area-wide Carpool/Vanpool Programs**. If no one uses a particular origin-destination pair, please select "None" (0). (Please select one for each origin-destination pair)

	Used by Many			Used by Few		None 0	Ave	Obs
	5	4	3	2	1			
Suburb to Center-city	22%	29%	10%	20%	20%	0%	3.1	41
Suburb to Suburb	13%	13%	25%	20%	25%	5%	2.5	40
Center-city to Suburb	3%	8%	5%	35%	43%	8%	1.7	40
Within center-city	0%	0%	6%	14%	50%	31%	0.9	36
From MPO area to Outside MPO areas	26%	8%	8%	13%	34%	11%	2.5	38
From outside MPO areas to MPO area	19%	14%	14%	14%	33%	6%	2.6	36

c. Is public opinion favorable to implementing **Area-wide Carpool/Vanpool Programs** (public acceptance)? (Please select one)

Very favorable	(5)	14%
Favorable	(4)	62%
Neutral	(3)	24%
Unfavorable	(2)	0%
Very unfavorable	(1)	0%
Average		3.9
Number of Answers		42

d. **Area-wide Carpool/Vanpool Programs** are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)

less than \$20,000	22%
between \$20,000 and \$50,000	88%
more than \$50,000	41%
Number of Answers	32

e. Please rate the following barriers to implement (or not implement) the **Area-wide Carpool/Vanpool Programs** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers:	Most Significant			Least Significant		Not a Barrier 0	Ave	Obs
	5	4	3	2	1			
Lack of support/interest or opposition by employees/commuters	19%	31%	19%	7%	17%	8%	3.0	59
Lack of support/interest or opposition by employers	17%	34%	22%	14%	8%	5%	3.2	59
Lack of support/interest or opposition by elected officials	5%	21%	26%	21%	12%	16%	2.4	58
Cost on implementation/operation	12%	11%	25%	5%	28%	19%	2.2	57
Not effective for reducing congestion or achieving the objectives of the MPO	11%	13%	4%	9%	15%	48%	1.5	54
Not applicable to the area	16%	5%	12%	7%	14%	47%	1.6	43
Never considered	10%	8%	5%	3%	8%	68%	1.1	40
Other	33%	33%	0%	0%	0%	33%	3.0	3

7. **Priority reserved parking spaces** and/or **Parking discounts** for employees who take 2 or more passengers

a. Do public and private employers in your MPO area currently offer **priority reserved parking spaces**? (Please select one)

Offered by most work places (more than 50%)	3%
Offered by many work places (between 50% and 20%)	1%
Offered by few work places (less than 20%)	53%
Not offered any work places	43%
Number of Answers	68

**b. Do public and private employers in your MPO area currently offer parking discounts? (Please select one)**

Offered by most work places (more than 50%)	2%
Offered by many work places (between 50% and 20%)	6%
Offered by few work places (less than 20%)	38%
Not offered any work places	54%
Number of Answers	63

**c. Where are most of the employers who provide priority reserved parking spaces and/or parking discounts located in your MPO area? (Please select as many as apply)**

Central business district	68%
Suburban business/commercial areas	42%
Rural areas	0%
Other	8%
Number of Answers	38

**d. Are employees favorable to offering priority reserve parking spaces and/or parking discounts (employees' acceptance)? (Please select one)**

Very favorable	(5)	18%
Favorable	(4)	39%
Neutral	(3)	37%
Unfavorable	(2)	5%
Very unfavorable	(1)	0%
Average		3.7
Number of Answers		38

**e. Priority reserve parking spaces and/or parking discounts are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)**

less than \$20,000	16%
between \$20,000 and \$50,000	92%
more than \$50,000	44%
Number of Answers	25

f. Please rate the following barriers to implement (or not implement) the **Priority reserve parking spaces and/or parking discounts** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers:	Most Significant			Least Significant		Not a Barrier	Ave	Obs
	5	4	3	2	1			
Lack of support/interest or opposition by employees/commuters	14%	14%	16%	21%	21%	13%	2.4	56
Lack of support/interest or opposition by employers	38%	25%	16%	7%	5%	9%	3.6	56
Not effective for reducing congestion or achieving the objectives of the MPO	15%	11%	15%	16%	16%	27%	2.1	55
Not applicable to the area	17%	10%	10%	10%	12%	41%	1.9	41
Never considered	26%	8%	0%	3%	10%	53%	1.7	39
Other	33%	0%	0%	0%	0%	67%	1.7	3

8. **Flexible work hours and/or Compressed work week** (For example: four days a week, ten hours a day)

a. Do public and private employers in your MPO area currently offer **flexible work hours**? (Please select one)

Offered by most employers (more than 50%)	6%
Offered by many employers (between 50% and 20%)	18%
Offered by few employers (less than 20%)	69%
Not offered by any employers	7%
Number of Answers	67

b. Do public and private employers in your MPO area currently offer **compressed work week**? (Please select one)

Offered by most employers (more than 50%)	2%
Offered by many employers (between 50% and 20%)	2%
Offered by few employers (less than 20%)	91%
Not offered by any employers	6%
Number of Answers	66

c. Where are most of the employers who offer **flexible work hours and/or compressed work week** located in your MPO area? (Please select as many as apply)

Central business district	59%
Suburban business/commercial areas	76%
Rural areas	10%
Other	16%
Number of Answers	63

d. Are employees favorable to offering flexible work hours and/or compressed work week (employees' acceptance)?  
(Please select one)

Very favorable	(5)	39%
Favorable	(4)	46%
Neutral	(3)	15%
Unfavorable	(2)	0%
Very unfavorable	(1)	0%
Average		4.2
Number of Answers		61

e. Flexible work hours and/or compressed work week are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)

less than \$20,000	20%
between \$20,000 and \$50,000	87%
more than \$50,000	51%
Number of Answers	45

f. Please rate the following barriers to implement (or not implement) the Flexible work hours and/or compressed work week from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers:	Most Significant			Least Significant		Not a Barrier	Ave	Obs
	5	4	3	2	1			
Lack of support/interest or opposition by employees/commuters	3%	6%	17%	22%	25%	25%	1.6	63
Lack of support/interest or opposition by employers	29%	32%	17%	11%	5%	6%	3.5	63
Not effective for reducing congestion or achieving the objectives of the MPO	5%	8%	11%	15%	16%	44%	1.4	61
Not applicable to the area	7%	11%	2%	11%	13%	57%	1.2	46
Never considered	16%	12%	2%	5%	9%	56%	1.5	43
Other	25%	0%	0%	0%	0%	75%	1.3	4

9. Tele-commuting programs at home or near home (satellite office)

a. Do public and private employers in your MPO area currently offer tele-commuting programs? (Please select one)

Offered by most employers (more than 50%)	0%
Offered by many employers (between 50% and 20%)	2%
Offered by few employers (less than 20%)	80%
Not offered by any employers	18%
Number of Answers	66

b. Where are most of the employers who offer **tele-commuting programs** located in your MPO area? (Please select as many as apply)

Central business district	60%
Suburban business/commercial areas	81%
Rural areas	17%
Other	12%
Number of Answers	52

c. Are employees favorable to offering **tele-commuting programs** (employees' acceptance)? (Please select one)

Very favorable	(5)	27%
Favorable	(4)	50%
Neutral	(3)	23%
Unfavorable	(2)	0%
Very unfavorable	(1)	0%
Average		4.0
Number of Answers		52

d. **Tele-commuting programs** are used mostly by commuters with total annual household incomes before taxes of (Please select as many as apply)

less than \$20,000	5%
between \$20,000 and \$50,000	69%
more than \$50,000	67%
Number of Answers	39

e. Please rate the following barriers to implement (or not implement) the **Tele-commuting programs** from the "most significant barrier" (5) to the "least significant barrier" (1). If the item is not a barrier to implement, choose "Not a barrier" (0). (Please select one for each barrier)

Barriers:	Most Significant			Least Significant		Not a Barrier	Ave	Obs
	5	4	3	2	1			
Lack of support/interest or opposition by employees/commuters	7%	7%	20%	20%	27%	20%	1.9	60
Lack of support/interest or opposition by employers	37%	30%	18%	7%	2%	7%	3.7	60
Not effective for reducing congestion or achieving the objectives of the MPO	9%	9%	14%	12%	18%	39%	1.6	57
Not applicable to the area	12%	12%	5%	7%	14%	50%	1.5	42
Never considered	10%	12%	5%	5%	12%	57%	1.3	42
Other	40%	0%	0%	0%	0%	60%	2.0	5

**D. Please evaluate the impact of your current TDM measures in your MPO areas.**

**1. Reducing the need to make trips. (Changing a transportation mode from a single occupancy vehicle to other modes such as carpooling is NOT considered as reducing the need to make a trip, because the trip is still made.)**

	Very effective			Not effective			Adv. Effect	N/A	Ave	Obs
	5	4	3	2	1	0				
Tolls	0%	2%	6%	5%	11%	19%	0%	56%	1.1	62
Flexible work hours	3%	9%	18%	14%	20%	22%	2%	12%	1.8	65
Compressed work week	8%	17%	18%	14%	22%	9%	2%	11%	2.3	65
Tele-commuting programs	8%	11%	20%	18%	22%	5%	2%	15%	2.3	65

**2. Shifting peak hour travel to off-peak hours.**

	Very effective			Not effective			Adv. Effect	N/A	Ave	Obs
	5	4	3	2	1	0				
Converting lanes to HOV lanes	0%	3%	2%	12%	3%	14%	3%	63%	1.1	65
Tolls	2%	3%	3%	12%	5%	20%	0%	55%	1.3	65
Flexible work hours	11%	18%	29%	12%	11%	5%	2%	12%	2.8	65
Compressed work week	9%	17%	26%	18%	12%	3%	2%	14%	2.7	66
Tele-commuting programs	11%	11%	17%	20%	18%	8%	0%	17%	2.4	66

**3. Shifting trips away from congested locations to other areas.**

	Very effective			Not effective					Adv. Effect	N/A	Ave	Obs
	7	6	5	4	3	2	1	0				
Converting lanes to HOV lanes	0%	0%	6%	5%	2%	9%	6%	12%	3%	58%	1.8	66
Tolls	0%	2%	5%	2%	3%	5%	12%	20%	2%	51%	1.4	65
Public transportation	2%	6%	5%	11%	15%	17%	20%	17%	3%	5%	2.2	65
Park and ride facilities	5%	6%	8%	5%	20%	11%	18%	14%	2%	14%	2.6	66
Carpool/vanpool programs	6%	3%	6%	11%	17%	8%	17%	14%	2%	18%	2.6	66
Tele-commuting programs	6%	3%	6%	9%	17%	15%	12%	15%	2%	15%	2.6	66

**4. Reducing congestion in currently congested areas (by reducing the need to make trips, by shifting trips from the peak hour, by shifting trips to other areas, and by promoting carpooling/vanpooling/public transportation.)**

	Very effective										Not effective					Adv. Effect	N/A	Ave	Obs
	9	8	7	6	5	4	3	2	1	0									
Converting lanes to HOV lanes	0%	5%	3%	2%	3%	5%	3%	6%	3%	8%	3%	60%	3.1	65					
Tolls	2%	2%	0%	2%	3%	5%	6%	6%	6%	16%	2%	52%	2.2	64					
Public transportation	0%	5%	6%	11%	14%	12%	12%	12%	11%	11%	3%	3%	3.4	65					
Park and ride facilities	2%	2%	8%	9%	8%	12%	11%	9%	18%	8%	0%	14%	3.4	65					
Public transit pass programs	0%	3%	3%	14%	9%	14%	8%	13%	11%	5%	2%	19%	3.6	64					
Carpool/vanpool programs	2%	9%	5%	9%	6%	11%	8%	12%	14%	8%	0%	17%	3.7	65					
Priority reserve parking & Parking discount	0%	0%	3%	6%	9%	11%	9%	16%	8%	9%	0%	28%	3.0	64					
Flexible work hours	2%	5%	3%	8%	23%	17%	9%	11%	8%	3%	0%	12%	4.1	65					
Compressed work week	3%	6%	5%	5%	22%	17%	6%	8%	11%	5%	0%	14%	4.1	65					
Tele-commuting programs	6%	5%	5%	2%	12%	17%	8%	11%	9%	9%	0%	17%	3.8	65					

**5. Reducing travel time of all travelers. (For example, a vanpool program may increase the travel time of those participating in the program, but it reduces the overall congestion and may reduce the travel time of all other commuters. Overall, the total travel time of all travelers may decrease. If this is the case, then it is considered an effective TDM measure to reduce travel time.)**

	Very effective										Not effective					Adv. Effect	N/A	Ave	Obs
	9	8	7	6	5	4	3	2	1	0									
Converting lanes to HOV lanes	0%	0%	6%	3%	3%	5%	5%	2%	5%	5%	3%	63%	3.2	63					
Tolls	2%	0%	2%	2%	2%	3%	6%	2%	11%	10%	6%	56%	1.9	63					
Public transportation	0%	5%	6%	3%	11%	10%	11%	10%	19%	11%	11%	3%	2.6	63					
Park and ride facilities	0%	3%	3%	2%	10%	11%	10%	8%	25%	8%	3%	16%	2.6	61					
Public transit pass programs	0%	0%	3%	3%	13%	10%	6%	11%	17%	11%	3%	22%	2.6	63					
Carpool/vanpool programs	2%	2%	3%	10%	8%	6%	11%	6%	18%	11%	3%	19%	2.9	62					
Priority reserve parking & Parking discount	0%	0%	0%	5%	13%	7%	13%	11%	8%	15%	0%	28%	2.7	61					
Flexible work hours	3%	5%	6%	11%	8%	16%	10%	13%	10%	3%	0%	15%	4.1	62					
Compressed work week	3%	8%	5%	6%	11%	15%	6%	13%	11%	5%	0%	16%	4.0	62					
Tele-commuting programs	8%	3%	6%	5%	10%	11%	10%	6%	10%	13%	0%	18%	3.9	62					

**6. Reducing air pollution in the entire MPO area**

	Very effective					Not effective					Adv. Effect	N/A	Ave	Obs
	9	8	7	6	5	4	3	2	1	0				
Converting lanes to HOV lanes	0%	0%	3%	5%	2%	5%	5%	5%	5%	5%	3%	63%	2.8	62
Tolls	0%	0%	0%	0%	2%	2%	6%	5%	13%	10%	5%	58%	1.2	62
Public transportation	10%	3%	2%	8%	16%	8%	6%	16%	10%	11%	6%	5%	3.5	63
Park and ride facilities	5%	3%	3%	6%	11%	8%	13%	8%	16%	11%	2%	13%	3.3	62
Public transit pass programs	0%	3%	2%	10%	14%	8%	8%	14%	8%	11%	3%	19%	3.1	63
Carpool/vanpool programs	8%	3%	2%	6%	16%	6%	10%	11%	13%	8%	2%	16%	3.7	63
Priority reserve parking & Parking discount	0%	0%	2%	0%	13%	3%	15%	8%	15%	15%	0%	28%	2.3	60
Flexible work hours	3%	6%	2%	3%	10%	8%	18%	18%	15%	6%	0%	11%	3.3	62
Compressed work week	3%	3%	3%	8%	13%	3%	16%	16%	10%	11%	0%	13%	3.4	62
Tele-commuting programs	10%	8%	2%	5%	14%	5%	10%	13%	11%	8%	0%	16%	4.1	63

**E. Please evaluate monetary costs of implementing the TDM measures, including costs incurred by the government, the private firms and the general public.**

**1. Initial Implementation Cost**

	Very costly					Not costly					N/A	Ave	Obs
	9	8	7	6	5	4	3	2	1	0			
Converting lanes to HOV lanes	18%	5%	10%	3%	2%	2%	2%	2%	0%	0%	60%	7.6	62
Tolls	11%	8%	8%	3%	6%	6%	2%	0%	2%	0%	53%	6.6	62
Public transportation	19%	15%	24%	16%	13%	5%	6%	0%	0%	2%	0%	6.6	62
Park and ride facilities	3%	3%	10%	14%	16%	17%	10%	5%	6%	2%	14%	4.7	63
Public transit pass programs	0%	0%	3%	6%	10%	16%	15%	15%	10%	6%	19%	3.2	62
Carpool/vanpool programs	3%	0%	5%	5%	11%	8%	13%	18%	13%	3%	21%	3.4	62
Priority reserve parking & Parking discount	0%	2%	2%	2%	3%	3%	21%	16%	16%	10%	26%	2.3	62
Flexible work hours & Compressed work week	2%	2%	0%	0%	3%	5%	10%	16%	31%	20%	11%	1.8	61
Tele-commuting programs	2%	0%	2%	3%	3%	7%	13%	13%	25%	15%	18%	2.2	61

**2. Annual Operating Cost**

	Very costly					Not costly					N/A	Ave	Obs
	9	8	7	6	5	4	3	2	1	0			
Converting lanes to HOV lanes	3%	5%	5%	6%	6%	3%	5%	0%	3%	0%	63%	5.5	62
Tolls	5%	13%	3%	2%	8%	6%	3%	3%	3%	0%	53%	5.7	62
Public transportation	21%	21%	25%	13%	8%	5%	7%	0%	0%	0%	0%	6.9	61
Park and ride facilities	0%	0%	2%	5%	21%	19%	15%	6%	19%	0%	13%	3.4	62
Public transit pass programs	0%	2%	2%	5%	15%	25%	10%	11%	7%	3%	21%	3.6	61
Carpool/vanpool programs	0%	0%	2%	13%	15%	3%	13%	19%	11%	3%	21%	3.3	62
Priority reserve parking & Parking discount	0%	0%	3%	3%	5%	6%	10%	16%	21%	8%	27%	2.4	62
Flexible work hours & Compressed work week	0%	0%	3%	0%	5%	2%	10%	20%	31%	15%	15%	1.8	61
Tele-commuting programs	0%	0%	3%	3%	8%	3%	7%	5%	2%	2%	67%	2.1	61

**3. Non-Monetary Cost**

	Very costly					Not costly					N/A	Ave	Obs
	9	8	7	6	5	4	3	2	1	0			
Converting lanes to HOV lanes	0%	0%	3%	3%	8%	3%	7%	5%	2%	2%	67%	3.9	60
Tolls	2%	3%	3%	2%	8%	7%	5%	3%	5%	2%	60%	4.3	60
Public transportation	0%	0%	2%	5%	15%	10%	10%	22%	22%	12%	3%	2.6	60
Park and ride facilities	0%	0%	2%	0%	2%	12%	12%	18%	22%	18%	15%	1.9	60
Public transit pass programs	0%	0%	2%	0%	3%	5%	7%	22%	12%	27%	23%	1.6	60
Carpool/vanpool programs	0%	0%	2%	0%	0%	12%	10%	12%	23%	20%	22%	1.7	60
Priority reserve parking & Parking discount	0%	0%	2%	0%	3%	5%	7%	10%	20%	22%	32%	1.6	60
Flexible work hours & Compressed work week	0%	0%	3%	0%	0%	8%	5%	8%	27%	31%	17%	1.4	59
Tele-commuting programs	0%	2%	2%	0%	0%	9%	3%	7%	28%	29%	21%	1.4	58

## **Appendix D**

### **Web Pages**

1. Home Page of MPO Survey
2. MPO Survey Instruction Page
3. Request Form Page

# Home Page of MPO Survey

<http://www.ncat.edu/~sakanor/research/UTI2000/UTI2000.htm>

**Project Information Page - Microsoft Internet Explorer**

File Edit View Favorites Tools Help

← Back → Search Favorites History

Address <http://www.ncat.edu/~sakanor/research/UTI2000/UTI2000.htm> Go

## Evaluating Effects of Travel Demand Management in Medium-Sized Urban Area: The Study of I-40 Greensboro-Winston-Salem Corridor

Dr. Ryoichi Sakano, Dr. Julian Benjamin, and Dr. Moshe BenAkiva

### The Proposal

[The MPO Questionnaire](#): Web-based MPO questionnaire.

### The Result

### Web Links

[Transportation Institute, North Carolina A&T State University, Greensboro, North Carolina](#)

### Regional MPOs

[Piedmont Authority for Regional Transportation \(PART\)](#)

[Burlington - Graham MPO, Burlington, North Carolina](#)

[Winston-Salem/Forsyth County Urban Area MPO, Winston-Salem, North Carolina](#)

### Regional DOTs

[DOT, City of Greensboro, North Carolina](#)

[DOT, City of Winston-Salem, North Carolina](#)

[Department of Economics & Transportation/Logistics at North Carolina A&T State University](#)

## MPO Survey Instruction page

<http://www.ncat.edu/~sakanor/research/UTI2000/MPOstartpage.htm>

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**Questionnaire for Metropolitan Planning Organization**

**Transportation Institute**

**North Carolina A&T State University**

Thank you for your willingness to participate in the transportation survey. This survey is conducted by the Transportation Institute at North Carolina A&T State university, in cooperation with the Massachusetts Institute of Technology, sponsored by the U.S. Department of Transportation, and supported by the Piedmont Authority for Regional Transportation (PART), North Carolina.

This survey should take about 30 minutes to complete. Your participation is completely voluntary, and all replies will be anonymous. Please answer all questions. By providing your frank answer, you are giving the institute the ability to better meet the public needs in transportation.

The objective of the survey is to evaluate the current transportation demand management (TDM) implementation at each Metropolitan area throughout the U.S. and to develop a procedure to determine which TDM measures will have potential effects on particular objectives of the Metropolitan Planning Organization in a specific area.

If you are ready to start the questionnaire, please **CLICK** on [**Start Questionnaire**] button. If you have any question, please send us e-mail by clicking [E-mail] button. If you prefer to receive a questionnaire by mail, please **CLICK** on [**Request Questionnaire**] button.

## Request Form Page

<http://www.ncat.edu/~sakanor/research/UTI2000/Requestform.htm>

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The screenshot shows a Microsoft Internet Explorer browser window. The title bar reads "Request Questionnaire Form by Mail - Microsoft Internet Ex...". The address bar contains the URL "http://www.ncat.edu/~sakanor/research/UTI2000/Requestform.htm". The main content area has a light orange background and is titled "Request Questionnaire Form by Mail" in blue text. Below the title, a message states: "Please fill the following mailing information. The questionnaire form will be mailed to the address promptly." The form includes the following fields:

- Your name: A dropdown menu labeled "Title" followed by a text input field.
- Your MPO name: A text input field.
- Street address 1: A text input field.
- Street address 2: A text input field.
- Street address 3: A text input field.
- City: A text input field.
- State: A text input field.
- Zip code: A text input field.

At the bottom of the form are two buttons: "Submit" and "Reset". The browser's status bar at the bottom shows "Done" on the left and "Internet" on the right.

# **Appendix E**

## **E-mails**

1. Invitation e-mail to Participate the Survey
2. Follow-up e-mail

## Invitation e-mail to Participate the Survey

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Dear Sir/Madam,

We are conducting a study of transportation demand management (TDM) measures that are used by various metropolitan planning organizations. This survey is prepared by the Transportation Institute at North Carolina A&T State University, in cooperation with the Massachusetts Institute of Technology, sponsored by the U.S. Department of Transportation, and supported by the Piedmont Authority for Regional Transportation (PART), North Carolina.

TDM includes actions and facilities that help to move traffic in an urban area such as high occupancy vehicle lanes which are available to carpoolers and vanpoolers. Other examples include tolls that vary during peak periods, an area-wide carpool/vanpool program, public transportation and employer-based TDM measures such as flexible work hour and telecommuting. We would like to know more about how you use TDM in your urban area.

We have prepared a questionnaire which we would like you (or an MPO planner in your organization) to complete. It can be accessed on the web at <http://www.ncat.edu/~sakanor/research/UTI2000/MPOstartpage.htm>. It is best viewed by Microsoft Internet Explorer, though you can use Netscape Navigator/Communicator to answer the questionnaire. You may also obtain a copy from us in Microsoft Word or by express mail by requesting at this web site or by replying to this e-mail.

All responses on this survey will be strictly confidential and will be used for research purposes only. We will send you a summary of our survey results if you request it in the questionnaire.

We greatly appreciate if you (or an MPO planner in your organization) can answer the questionnaire by March 20th.

If you have any questions or comments, please let us know by replying to this e-mail or at the address listed below.

Thank you for your assistance with this survey.

Sincerely,

Dr. Ryoichi Sakano  
Associate Professor  
and  
Dr. Julian Benjamin  
Professor

Department of Economics and Transportation/Logistics  
North Carolina A&T State University  
Greensboro, NC 27411  
Tel. (336) 334-7744 x 2019  
Fax. (336) 334-7093  
e-mail: [sakanor@ncat.edu](mailto:sakanor@ncat.edu)

## Follow-up e-mail

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Dear Sir/Madam,

We are conducting a study of transportation demand management (TDM) measures that are used by various metropolitan planning organizations. We have sent you an invitation by e-mail to participate in the survey on March 6th and requested a reply the questionnaire by March 20th. However, we have not heard from your organization yet.

We have prepared a questionnaire which we would like you (or an MPO planner in your organization) to complete. It can be accessed on the web at <http://www.ncat.edu/~sakanor/research/UTI2000/MPOstartpage.htm>. It is best viewed by Microsoft Internet Explorer, though you can use Netscape Navigator/Communicator to answer the questionnaire.

We also have attached the questionnaire in Microsoft Word format to this e-mail. If you prefer, you may answer the questionnaire by directly filling the Word document, save it and send it to the following e-mail address: [sakanor@ncat.edu](mailto:sakanor@ncat.edu).

All responses on this survey will be strictly confidential and will be used for research purposes only. We will send you a summary of our survey results if you request it in the questionnaire.

Please answer the questionnaire as soon as possible. If you have already replied to the questionnaire, please discard this e-mail.

If you have any questions or comments, please let us know by replying to this e-mail or at the address listed below.

Thank you for your assistance with this survey.

Sincerely,

Dr. Ryoichi Sakano  
Associate Professor  
and  
Dr. Julian Benjamin  
Professor

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