Incorporating Assumptions for TDM Impacts in a Regional Travel Demand Model

WA-RD 746.1

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March 2010

Washington State
Department of Transportation
Office of Research & Library Services

WSDOT Research Report

RESEARCH REPORT

WA-RD 746.1
GCA5703

INCORPORATING ASSUMPTIONS FOR TDM IMPACTS IN A REGIONAL TRAVEL DEMAND MODEL

FINAL REPORT

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March 2010

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TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. WA-RD 746.1 CUTR project 21171260	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Incorporating Assumptions for TDM Impacts in a Regional Travel Demand Model		5. Report Date March 2010 6. Performing Organization Code
7. Author(s) Philip L. Winters, Edward L. Hillsman, Chanyoung Lee, and Nevine Labib Georggi Email: (winters, hillsman, lee, georggi)@cutr.usf.edu		8. Performing Organization Report No.
9. Performing Organization Name and Address Center for Urban Transportation Research University of South Florida 4202 E. Fowler Av., CUT 100 Tampa Fl 33620 Tel: 813-974-3120		10. Work Unit No. (TRAIS) 11. Contract or Grant No. WSDOT Contract GCA5703
12. Sponsoring Agency Name and Address Washington State Department of Transportation Transportation Building, MS: 7372 Olympia, Washington 98504-7372 Project Manager: Brian Lagerberg ; Research Manager, Kathy Lindquist		13. Type of Report and Period Covered FINAL 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Faced with substantial funding shortfalls in meeting transportation needs, one of Washington State Department of Transportation's key strategies for preserving mobility is improving the efficient operation of the existing transportation facilities by increasing the use of transportation demand management (TDM) strategies to decrease drive alone rates. This requires an ability to forecast the magnitude and geographic distribution of changes in travel patterns likely to result from more aggressive TDM programs. It also requires an ability to estimate the effect these changes will have on delay, speed, and travel time throughout affected corridors. This project developed a Transportation Demand Management Assessment Procedure (TDMAP), as a sketch planning modeling approach to incorporate TDM into WSDOT's travel demand model. TDMAP does so by (1) extracting mode split tables from the model; (2) processing them to be compatible with TRIMMS© 2.0, an existing tool that estimates changes in travel behavior as a result of implementing different TDM strategies; (3) running the tables through TRIMMS© 2.0; and then (4) processing them back into the four-step model for distribution over the transportation network. The study did develop a low cost method to help WSDOT plan TDM strategies as part of its overall transportation planning process. Ideally, the next generation would also help WSDOT identify and choose the most cost-effective mix of program elements for improving traffic and air quality conditions in a corridor, and for the desired level of change in vehicle traffic, and see how the cost and mix varies with the desired level of change. Building such a tool requires additional research, and improved data on the cost and effectiveness of TDM program elements under different conditions. Recommendations for research and data development to help bring this goal to fruition were made.

17. Key Word TDM, TDMAP, transportation demand management		18. Distribution Statement	
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price

Form DOT F 1700.7 (8-72)

ACKNOWLEDGEMENTS

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The research team is grateful for the support of the following individuals who provided valuable input to enhance this research:

Robert Ancar, Office of Policy and Performance, New York State DOT

Colin Black (Contemporary Transport Ltd, Tonbridge, U.K.)

Lori Diggins, LDA Consulting, Washington DC

Matt Hansen, Supervisor of Market Development, King County Metro, WA

Bill Loudon (DKS & Associates, Oakland, CA)

Wendy Morgan (Center for Transportation and Environment, Atlanta, GA)

Bill Roach, Market Development for King County Metro - retired

Eric Schreffler, Transportation Consultant ESTC, San Diego, CA

Grant Zammit, Traffic Management and System Operations, FHWA – Atlanta, GA

The research team thanks Mr. Craig Helmann, WSDOT, for providing data and information needed to work with the Puget Sound Regional Travel Demand Model.

The efforts of Ms. Kathy Lindquist, Research Manager, WSDOT Office of Research and Library Services, are acknowledged and appreciated.

DISCLAIMER

EXECUTIVE SUMMARY

According to the 2006 Washington Transportation Plan, the Washington State Department of Transportation (WSDOT) identified an estimated $38 billion funding shortfall in meeting the identified $67 billion need (2005 dollars). One of WSDOT's key strategies in preserving mobility in light of this shortfall is improving the efficient operation of the existing transportation facilities by increasing the use of transportation demand management (TDM) strategies to decrease drive alone rates. With a large gap in unfunded needs and growing environmental concerns such as climate change, WSDOT is increasingly interested in managing demand for vehicle trips to improve overall performance of the highway system, mitigate congestion during construction, and reduce greenhouse gases. This requires an ability to forecast the magnitude and geographic distribution of changes in travel patterns likely to result from more aggressive TDM programs. It also requires an ability to estimate the effect these changes will have on delay, speed, and travel time throughout affected corridors. Although Regional Travel Demand Modeling procedures can perform a limited assessment of TDM impacts such as parking, pricing, and tolling, it is difficult for these procedures to estimate the impacts of other TDM specific measures such as rideshare matching services, emergency/guaranteed ride home and employee transportation coordinators.

This project developed a sketch planning modeling approach to feed WSDOT's travel model. The Transportation Demand Management Assessment Procedure (TDMAP) incorporates TDM into the transportation planning process by modifying mode split tables to reflect the impact of implementing a particular TDM strategy or mix of strategies in specific corridors over time. After reviewing existing models, the team developed TDMAP that consists of a set of subroutines that integrate with TRIMMS© 2.0 (Trip Reduction Impacts for Mobility Management Strategies), a visual basic application (VBA) spreadsheet model. TRIMMS© 2.0 uses constant elasticity trip demand functions to estimate impacts from TDM strategies that change the cost of travel. These strategies include: transit subsidies, changes in parking costs, vehicles miles traveled (VMT) charges, and other incentives or disincentives. The outputs are estimated changes in mode splits, vehicle trips, and VMT. TRIMMS© 2.0 also evaluates the impact of strategies' changes in access time and travel times to predict those outputs. TDMAP uses the analytical power of TRIMMS© 2.0 to produce estimates of changes in travel behavior at the traffic assignment zone (TAZ) using the WDOT origin-destination (O/D) level travel data.

The project resulted in a low cost method to help WSDOT plan TDM strategies as part of its overall transportation planning process. Two operational issues remain to be resolved.

First, additional work is needed to assess the usability and usefulness of the TDMAP module within a "production" environment, where the regional model is used frequently for a wide variety of analyses, some involving the use of TDMAP and others that do not. This kind of production experience is beyond the scope of a research study. However, the project staff is interested in learning about experience in using TDMAP and what changes might make it easier to use.

Second, both PSRC's present regional transportation model and TDMAP can model the effects of changing the costs of parking, or the costs of using different travel modes. Where these are the only TDM elements to be analyzed, and when they are to be applied and analyzed for the whole region, they could be modeled as at present, or left to TDMAP. Additional experience and sensitivity analysis are needed to determine which would be preferable. Where these are the only elements to be analyzed, and are to be examined for small areas or groups of employers, TDMAP may be preferable. Where an analysis involves other TDM elements, whether for the whole region or not, and whether linked to policies that influence trip costs or not, then the TDMAP module would be preferable.

Ideally, the next generation of methods would also help identify and assess the most cost-effective mix of program elements for conditions in a corridor, and for the desired level of change in vehicle traffic, and see how the cost and mix varies with the desired level of change. Development of such methods requires additional research, and improved data, on the cost and effectiveness of TDM program elements under different conditions. This report makes recommendations for research and data development to help accomplish this goal. These recommendations include collecting additional data and improving quality control of what is already collected. Ideally, such improvements could lead to the development of a complementary tool to help estimate the costs to the public and private sector for implementing the demand management programs. This would be useful for states or cities that provide funding for voluntary TDM programs but do not mandate employer participation.

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CHAPTER 1 - INTRODUCTION

STUDY BACKGROUND AND PROBLEM STATEMENT

According to the 2006 Washington Transportation Plan, WSDOT identified an estimated $38 billion funding shortfall in meeting the identified $67 billion need (2005 dollars). One of WSDOT's key strategies in preserving mobility in light of this shortfall is improving the efficient operation of the existing transportation facilities by increasing the use of transportation demand management (TDM) to decrease drive alone rates. With a large gap in unfunded needs and growing environmental concerns such as global warming, WSDOT is increasingly interested in managing demand for vehicle trips to improve overall performance of the highway system, mitigate congestion during construction, and reduce greenhouse gases. This requires an ability to forecast the magnitude and geographic distribution of changes in travel patterns likely to result from more aggressive TDM programs. It also requires an ability to estimate the effect these changes will have on delay, speed, and travel time throughout affected corridors.

Some traffic projections are possible through the modeling process, but behavioral changes developed in reaction to TDM has been done retrospectively (what happened) rather that predicatively (what if). Although multimodal, operational, and construction mitigation processes have tools that assist in comparing and planning various options to improve transportation system performance, TDM planning methods may not have been as developed or have yet to mature in proving as beneficial as others.

At the same time, TDM efforts in Washington are proving they make a difference. The Washington State Legislature passed the Commute Trip Reduction (CTR) Law in 1991 as part of the Washington State Clean Air Act. The goals of the program are to reduce traffic congestion, air pollution, and petroleum consumption through employer-based programs that decrease the number of drive-alone commute trips, (1). Washington State Department of Transportation (WSDOT) reports that since 1993, the drive-alone rate at work sites in the CTR Program decreased more than the state average. Approximately 570,000 employees commute to CTR worksites on a daily basis. The percentage of people who drove alone to work to CTR worksites declined from 70.9 percent in 1993 to 65.5 percent in 2007 (a decrease of 7.6 %), (2). CTR commuters reduced emissions of nearly 4,000 tons of air pollution in 2007 through the choices they made. They also reduced petroleum consumption by about 7.9 million gallons, saving them over $23 million in fuel costs.

This project was conducted in parallel with a separate but complementary project for the Florida Department of Transportation (FDOT) titled "Developing a Technique that Predicts the Impacts of Transportation Demand Management (TDM) on a Transportation System," (FDOT Contract BDK85 WO 977-06). The same researchers worked on both projects simultaneously to pool resources, particularly the expertise of the assembled peer review panel that was required for the WSDOT project. Two web meetings were conducted in January and September 2009. The expert members of the review panel were updated on the progress of both research studies and were consulted on issues when the research team members solicited input and guidance on both projects.

This study developed a procedure that estimates the impacts of TDM measures along specific corridors.

STUDY OBJECTIVE

The objective of this research study was to develop a supplementary tool to WSDOT's EMME/2 that incorporates TDM into the transportation planning process by modifying trip and/or mode split tables to reflect the impact of implementing a particular TDM strategy or mix of strategies in specific corridors over time. This tool will assist WSDOT with planning and programming TDM strategies as part of a traffic mitigation effort to be used in developing future near- or long-term planning.

STUDY APPROACH

The development process focused on adding an off-model TDM Assessment Procedure (TDMAP) to the traditional trip-based travel demand modeling process: trip generation, trip distribution, mode choice, and trip assignment. The off-model is a plug-in that imports the origin/destination (O/D) person trip tables from the mode split step, applies the impacts of TDM strategies on mode split, updates the O-D tables, then exports them back to model before the trip assignment step, as illustrated in Figure 1.

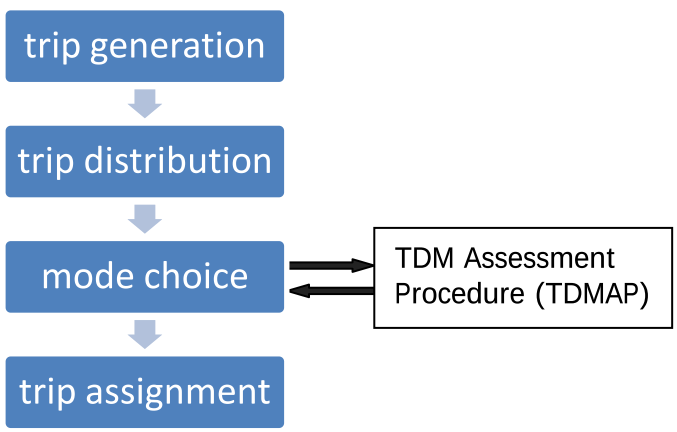


Figure 1 – A Travel Demand Model and the TDM Assessment Procedure

The FDOT research hypothesis assumed increases in employers' expenditures for subsidies and incentives, in support of employees commute options program, will decrease the drive-alone rate. If a strong relationship between expenditures and changes in mode split were established, TDM programs can be incorporated more confidently as a congestion management option. The research centered on the relationship between TDM effectiveness at the worksite level and employer-based TDM program costs. Data collection efforts focused on the examination of thousands of employer trip reduction plans submitted over many years and cost survey results of those employers with the goal of integrating the information with the new TDMAP. Despite using the most comprehensive data set from the CTR program, a strong relationship between changes in expenditures for subsidies and incentives, and changes in the drive-alone rate could not be established. The FDOT project concluded with developing a practical guide for collecting TDM cost data at the worksite level and providing an example of the TDMAP.

STUDY APPLICATIONS

TDMAP should allow WSDOT, other state DOTs or any regional agency to input various programs, incentives, disincentives, and worksite characteristics and obtain predictions about TDM impacts on the system to address short-term, corridor-specific situations such as construction mitigation and/or longer-term, system-wide implications such as climate change. For example, in their Transportation 2040 report, the PSRC discussed integrating their forecasting tools in a modeling system that would allow conducting analysis of alternatives in the region (3). The tools include their travel demand model, air quality analysis tool, land use forecasting tool, and others. The effectiveness of the integrated framework will allow PSRC to expand their capabilities to develop and analyze various alternatives, improve accuracy in the forecasts, and provide efficiencies in the analytical process. Figure 2 shows the integrated modeling framework (as developed by PSRC), with TDMAP suggested as a plug-in for the travel forecasts process to examine different employer-based TDM strategies or set of strategies that if applied, can change the forecasted traffic of the region. PSRC would then have the option of predicting the impacts of TDM within the model that forecasts traffic.

REPORT ORGANIZATION

Chapter 2 reviews the literature on available models that assess the effectiveness of TDM programs as well as recent CUTR projects that used CTR data to develop a methodology for estimating the impacts of employer-based TDM projects on a corridor, and another study that developed a model for TDM benefit/cost analysis. Chapter 3 discusses the methodology used to develop the TDMAP and Chapter 4 demonstrates the methodology by using data from a travel demand model. Chapter 5 discusses the results of the study and provides recommendations for future research.

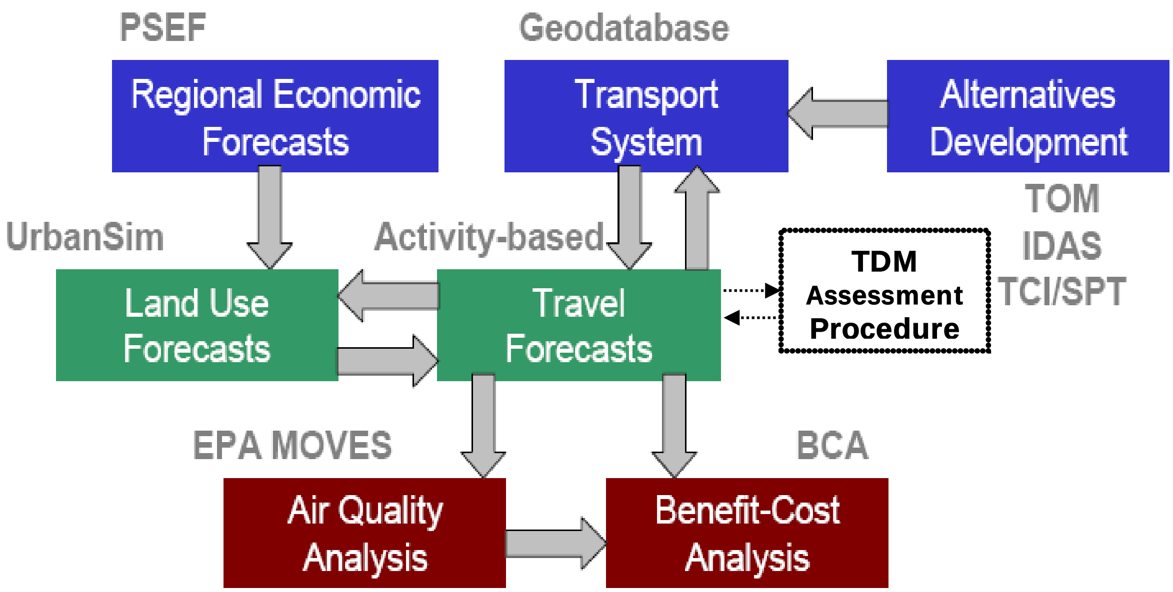


Figure 2 – PSRC Integrated Modeling Framework with the Addition of TDMAP

CHAPTER 2 – LITERATURE REVIEW

The project team reviewed several TDM models as well as recent relevant research. A summary of this review is provided in this chapter.

OVERVIEW OF TDM MODELS

The **Air Resources Board (California) Cost-Effective Model** is an automated Microsoft Access database developed to assess the cost-effectiveness of TDM strategies implemented to reduce employee trips (4). The methodology used to calculate the trip reduction is relatively simple. Users are asked to perform a weeklong commute travel survey to collect the mode split and travel distance information. The following equation is used to calculate the current weekly vehicle trips per commute employee. These values are then compared with the national average or other user specified data to calculate the yearly trip reduction.

Vehicle trips per year reduced =
Current weekly vehicle trips per commute employee –
[(National average vehicle trips/employee/wk) x (weeks) x (employees)]

One of the main limitations in using the method for forecasting is that this model does not estimate travel behavior changes directly, and therefore is not a forecasting method per se. Instead, it relies on surveys or other estimates of program participation as inputs. The user must also supply appropriate emission factors.

Federal Highway Administration's **Travel Demand Management Evaluation Model (FHWA TDM Model)** is a software program developed in the 1990's as a DOS-based program that analyzes the vehicle-trip reduction effects of a wide range of travel demand management strategies (5). The TDM Model has been widely applied throughout the U.S. for the purpose of analyzing Transportation Control Measures or other TDM programs.

Strategies addressed by the model include improved transit, HOV lanes, carpooling and vanpooling promotion, telecommute and work hour strategies, and pricing and subsidies. The "pivot-point" mode choice model was used to estimate strategies that affect the time and/or cost of travel. Empirical evidence documented in the model's look-up tables were the basis of evaluating other strategies, such as employer-based support programs and work hour shifts.

The TDM Model's data requirements include baseline travel data, zone-to-zone person and vehicle trip tables for the analysis area (these may be derived from the regional travel model or constructed from employee commute survey data), or total person and vehicle trips for an individual site/area. Other data requirements include impacts of strategies on travel time and cost by mode and descriptions of other (non-time/cost-based) TDM programs. The user has the option to change default parameters affecting strategy effectiveness. The outputs of the model are changes in modal share, vehicle-trips, VMT, average vehicle occupancy, and ridership. The TDM Model does not estimate emissions benefits directly. The user must apply VMT and/or trip-based emission factors. The default coefficients and data on strategy effectiveness in the TDM model date from around 1990 or earlier.

The methodology and procedure of the Environmental Protection Agency (EPA) **COMMUTER Model** are based on the FHWA TDM model (6). The COMMUTER Model's spreadsheet-based simplicity and aggregation of results are its major strengths. This spreadsheet program is intuitive to use and requires no prior modeling experience with traditional four-step planning models. The COMMUTER model also differentiates based on urban type, metropolitan size, and scope of analysis. The aggregation of results is justified by assuming that TDM programs generate modest modal changes providing an acceptable trade-off between accuracy and ease of use.

The pivot logit equation approach used by the COMMUTER model simplifies the estimation process and drastically reduces data requirements, making the model available to a broad audience, including users with even modest technical orientation. Coefficients derived from regional or area-specific travel demand models are used as inputs and applied to the pivot logit equation to estimate changes in baseline mode shares spurred from specific TDM strategies. Similar to the FHWA TDM Model, the coefficients used by the COMMUTER Model are assumed to be derived using sound statistical methods to guarantee statistical robustness. Among the constraints of the COMMUTER model are:

- Coefficients are affected by factors such as the number and type of variables included in the model (and the interactions between the variables), calibration procedures, and the quality of the underlying data;
- Coefficients may have been derived from another urban area;
- There is no guarantee that the pivot logit equation will predict actual mode shift (predicted mode shift will lie on the logit curve);
- Changes in vehicle trips and vehicle miles of travel (VMT) are strongly dependent on the starting modal shares;
- The logit equation is based on discrete, mutually exclusive choices (auto vs. transit, without considering concurrent choices (e.g., transit and biking);
- The model estimates change using a "with" and "without" strategy approach without respect to the elapsed time – there is no distinction between short run vs. long run effects.

The trade-off of using pivot-point modeling versus more intensive four-step travel demand forecasting model, is justified by assuming that for modest change in mode shares, such as those generated by TDM strategies, the incremental extrapolation is fairly accurate. Like many of the models discussed in this section, the COMMUTER model has had only limited validation testing with actual, in-the-field results; thus, the level of reliability is not well documented. The use of the pivot-point logit equation precludes the distinction between short run and long run effects. The parameters that influence modal shares are the byproduct of cross-sectional analyses (unless specified otherwise) which do not take into account the long-run adjustments those users inevitably face.

The **CUTR Worksite Trip Reduction Model** was developed using worksite trip reduction data from three urban areas in the United States Los Angeles, Tucson, and Washington State that have had trip reduction requirements on employers for many years (7). Two approaches were used for the model building process: a linear statistical regression model and an artificial neural network model. The linear statistical regression models were used as a benchmark for the validity and accuracy of the neural network models. Several phases were followed to build the models. Models were built for each of the three datasets using a variety of approaches for handling the data, including variable selection, grouping of incentives, and the treatment of outliers. Models were also built after combining the data from the three urban areas into a single dataset. The only model to get better results simultaneously on all three cities' validation sets was a neural network model built with no variable selection on equally sampled combined data.

A comparison of the COMMUTER Model and the WTRM model using over 450 records from Washington State CTR Program found differences between each model's estimate and the actual change as measured by the reported difference between consecutive plan years (8). As shown by the first row of the Table 1, the WTRM slightly under predicts the vehicle trip rate (VTR) change while the COMMUTER mode over predicts the VTR reduction. The actual mean value of VTR change for all worksites is minus 1.99, compared to the WTRM result of minus 1.67. But the WTRM result is closer to the survey result than that predicted by COMMUTER model (-2.98).

Table 1 – The Statistics of VTR Changes Derived from Survey Data as Predicted by WTRM and COMMUTER Models

		Num of Work-sites		**Survey VTR First Year**	**Survey VTR Last Year**	**Survey VTR Change**	**WTRM VTR Change**	**COMMUTER VTR Change**
First year/Last year Gap	**All (2-10)**	457	**Mean**	82.27	80.28	**-1.99**	-1.67	-2.98
			StDev	15.60	16.16	**7.99**	3.24	3.80
	2	90	**Mean**	81.01	81.63	**0.63**	-0.43	-1.14
	4	86	**Mean**	82.37	81.44	**-0.92**	-1.87	-3.01
	6	63	**Mean**	79.19	77.32	**-1.87**	-1.35	-2.53
	8	76	**Mean**	83.96	82.54	**-2.42**	-2.08	-3.29
	10	142	**Mean**	83.47	78.83	**-4.64**	-2.27	-4.17

Source: Evaluation of COMMUTER Model and Worksite Trip Reduction Model Based on Washington State CTR Data, (8), page 10.

The Washington State **TDM Effectiveness Estimation Methodology (TEEM)** model was developed as an analytical tool to quantify the effectiveness of TDM and land use strategies in the Central Puget Sound Region (9). The model was created based on local data sources and can estimate the effectiveness of 20 TDM and land use strategies at a corridor or sub area level. Each strategy is evaluated separately using different methodologies. The combined impacts can be evaluated based on the assumption of the interaction of different strategies. When more than one strategy is being tested, TEEM is designed to apply sensitivity factors to base mode shares incrementally. By readjusting the base mode shares, the methodology can accurately represent two types of interactions: a directly additive one and a multiplicatively additive one. If the strategies do not interact or affect the same markets and are directly additive, then no adjustment of the predicted changes is necessary. If the strategies are multiplicatively additive, the readjustment of the base mode share provides an accurate assessment of the combined affect, but the individual effects cannot be identified. Users of this model need to be aware of when such interaction may be occurring as special adjustments need to be made.

The most recent development in TDM model is represented by TRIMMS© (Trip Reduction Impacts for Mobility Management Strategies) a visual basic application (VBA) spreadsheet model developed by CUTR under the National Center for Transit Research. TRIMMS© estimates the transportation and environment effects of TDM strategies. TRIMMS© also provides program cost effectiveness measures, such as benefit to cost ratio benchmarking. The following paragraphs highlight the types of TDM programs that can be evaluated and the approach used but we refer the reader to the final report for TRIMMS©," Quantifying the Net Social Benefits of Vehicle Trip Reductions: Guidance for Customizing the TRIMMS Model, for a complete description of the cost/benefit analysis portion of TRIMMS©."

TRIMMS© uses constant elasticity trip demand functions to estimate impacts from TDM strategies that change the cost of travel. These strategies include transit subsidies, changes in parking costs, VMT charges and other incentives or disincentives. The outputs are estimated changes in mode splits, vehicle trips, and VMT. TRIMMS© also evaluates the impact of strategies generated by changes in access time and travel times to predict those outputs.

Unlike the previous models, TRIMMS© trip demand functions make use of direct elasticities and cross elasticities. Direct elasticities refer to the percentage change in the demand for trips of any given mode resulting from a change in its own price. For example, a direct elasticity of -0.5 for single occupancy vehicle trips with respect to fuel costs means that each 1 percent increase in the price of fuel results in a 0.5 percent reduction in the demand for vehicle trips. Cross elasticities refer to the percentage change in the demand for trips of any given mode caused by a change in price of other modes. For example, an increase in parking prices causes a direct negative percent change in the demand for auto trips and causes a positive change in the demand for public transit services. The use of cross elasticities acknowledges a certain degree of substitution between modes. The extent of substitution depends on circumstances and measured by the cross elasticities.

Elasticities can be short run or long run; short run to be 1 or 2 years, and the long run to be about 12 to 15 years. TRIMMS default values use short run estimates as they tend to average lower than the long run. This means that users are less responsive to price changes in the near term. The default parameters were drawn from empirical literature on the demand for transportation and the role of elasticities. In the event locations have their own values, TRIMMS was designed so the user can change all elasticity parameters.

A unique aspect of TRIMMS© relative to most of the other models is the direct inclusion of employer support strategies as part of the analysis. These support strategies include, but are not limited to, employee transportation coordinator, emergency ride home program, preferential parking for pools and discounts for walking/bicycling gear. Although these support programs do not directly affect the cost of using a mode, they tend to impact travel behavior by complementing other strategies. For example, emergency ride home (ERH) programs may not cause a person to switch to transit or a carpool but research has found that the level of interest in those modes raises makes carpooling more attractive 20 percent or more when ERH is available.

For these employer support strategies, TRIMMS© relies on an econometric analysis of the relationship between these support strategies and the strategies that affect directly costs or time. The analysis used data from 1995 to 2005 from the CTR database. The database includes information on mode split, worksite characteristics, and employer support programs. Ultimately, the impact of employer support programs is based on regression equation coefficients that weight the relative strength of pricing strategies and employer support programs. The highest predictive employer-support model was incorporated into TRIMMS© and allows for interaction between these employer-support variables.

We refer the reader to Appendix A of the TRIMMS final report the final report at http://www.nctr.usf.edu/pdf/77704.pdf for details on the modeling technique and the use of these demand functions. The final report also provides guidance to help TDM professionals to use the model by selecting the appropriate cost parameters, providing referenced sources where such parameters can be obtained, and by offering general guidance on how to incorporate data already at their disposal (11).

FORECASTING TDM EFFECTIVENESS

Predicting what is possible for TDM and forecasting future impacts begins with understanding what TDM programs have achieved in the past. Most *post hoc* TDM evaluations have focused on measuring a mix of outputs and outcomes, but have not measured impacts on the transportation system performance. The term “output” means an activity and/or associated product or service related to progress toward the TDM agency’s goals and objectives. Outputs included number of commuters requesting assistance, number of employers assisted and number of vans in service. Outcomes are the results or consequences that will occur from carrying out a TDM activity. Typically, TDM outcomes focus on cumulative measures such as changes in single occupant vehicle share, vehicle miles of travel eliminated, vehicle trips reduced and emissions reduced. The impact on a particular road network is not reflected in these evaluations. Most TDM evaluations are not able to directly measure the changes in travel speed, delay, temporal and spatial extent of congestion. In short, the need remains to establish a direct quantitative relationship between TDM strategies and the performance of the transportation system.

To address this need, in 2007, CUTR used State of Washington's Commute Trip Reduction (CTR) data to take a retrospective approach to estimating the impact of TDM on operations (i.e., changes in travel speed and delay) (10). The study objectives were to develop a methodology for measuring the impacts of employer-based TDM programs on the performance of a traffic network using measures universal to traffic operations staff, transportation planners, and decision-makers. The study used CORSIM, a micro-simulation traffic model, to simulate the effects of CTR programs implemented by 189 employers in an 8.6-mile segment of I-5 in the Seattle downtown area.

The current performance of the selected network with the actual volumes provided by the WSDOT (Scenario With TDM) was compared to that of a scenario with vehicle trips actually reduced by CTR programs at the worksites added onto the network (Scenario Without TDM). Performance measures analyzed included the spatial and temporal extent of congestion, recurring delay, speed, and travel time. On the segment of I-5 in the study area, savings in A.M. peak delay due to CTR programs were over 152,000 vehicle minutes and about 17,300 vehicle miles of travel were reduced. Savings in PM peak delay were nearly 170,000 vehicle minutes and 14,500 vehicle miles were reduced. Finally, the amount of fuel saved in the morning and evening peak periods were about 3,500 and 4,300 gallons, respectively. The study demonstrated that TDM programs have a significant impact on the operation of the transportation network.

A sensitivity analysis was conducted assuming a more conservative estimate of 4 percent decrease in average vehicle trip rate (VTR). Even though this reduction was less than one-third of the 14 percent vehicle trip rate decrease observed due to current CTR programs), the impacts were not proportional. Relative to the observed 14 percent VTR, the model found a the 4-percent VTR reduction yielded a 29 percent reduction in delay as compared to 32 percent from the 14 percent VTR reduction. Other system performance measures such as decrease in delay in vehicle-minutes, emissions, energy consumption, and spatial extent of congestion (i.e., decrease in lane-miles that takes 30 percent or longer than uncongested travel time) was 70 percent of the more intensive commute trip reduction program on larger employers.

The project clearly demonstrated TDM could serve as a tipping point; providing small changes in the location or time of trips that could substantially alter transportation system performance. However, the study also found that while TDM spatially and temporally made impacts on the system, the results were not uniform. This recognizes that TDM, like every other transportation solution, is not the "silver bullet" for every congested road segment or time period. That retrospective study approach explored the types of TDM impacts that could be demonstrated on a corridor segment but it was not designed as a predictive model over a network.

Other projects sought to produce estimates of changes in travel behavior for forecasting TDM impacts at the worksite and activity center level.

Through CUTR's *Economics of Travel Demand Management: Comparative Cost Effectiveness and Public Investment* project, members of the research team documented the above constraints of the various TDM models and the need for improved tools (11). Guidance issued in 2008 for the Congestion Mitigation and Air Quality Improvement (CMAQ), indicates that

"The [CMAQ project] selection process should also clearly identify the basis for rating projects, including emissions benefits, cost effectiveness, and any other ancillary selection factors such as congestion relief, greenhouse gas reductions, safety, system preservation, access to opportunity, sustainable development and freight, reduced SOV reliance, multi-modal benefits, and others (12)"

Thereby, confirming the need for a more robust model to estimate the impacts of CMAQ projects (a common source of funding for TDM programs). Specifically, the guidance calls for a quantification of benefits and costs to inform the CMAQ project selection process and project evaluations.

This project developed a method which resulted in TRIMMS© (Trip Reduction Impacts for Mobility Management Strategies). The purpose of this spreadsheet based model was to assess changes in travel behavior due to changes and trade-offs based on time, cost, and access to demand management programs.

TRIMMS© was targeted for use as a practitioner-oriented sketch planning tool at the worksite level. The spreadsheet model was designed to provide instant feedback to users as to the impacts of various mix or mixes of incentives, disincentives, and TDM programs. The outputs included changes in mode split, vehicle trips, vehicle miles of travel, and emissions. Unlike other TDM models, TRIMMS© also uses a wide range of costs and benefits to conduct a cost benefit analysis to help decision-makers to make informed decisions on where to spend limited resources. The model allows for the customization of default values and the flexibility to exclude elements not relevant to their analysis.

After conducting in-depth research, weighing the options, and in the interest of efficiency with available resources (not reinvent the wheel), this project research team decided to use the best available model, TRIMMS© Version 2.0 as the tool to estimate impacts of TDM strategies.

During the course of this WSDOT project, members of the project team were also developing the second generation of the TRIMMS© Version 2.0, including allowing the user to apply the analysis to an area broader than a worksite (13). However, TRIMMS© Version 2.0 did not accommodate processing in a batch (e.g., hundreds of sites) or accommodating different strategies to be tested in only certain areas (e.g., testing incentives in a corridor) without manually running the program multiple times. It should be noted that this Florida DOT-funded project made other significant improvements including providing default values for 85 urban areas and including a Monte Carlo simulation of the costs/benefits. These additional improvements are not relevant to this WSDOT project at this time and thus not part of TDMAP.

Like the COMMUTER Model, TRIMMS© is a spreadsheet application that estimates the impacts of a range of TDM initiatives and outputs results such as changes in mode split, VMT and vehicle trips. TRIMMS© evaluates strategies directly affecting the cost of travel, like transit or vanpool subsidies, parking pricing, and VMT pricing. TRIMMS© also evaluates the impact of strategies affecting access time and travel time and adjusts results accounting for a host of employer-based program support strategies, such as emergency ride home programs and level of effort by the Employee Transportation Coordinator.

TRIMMS© 2.0 provides more regional customization of default benefit and cost parameters. This flexibility improves the ability of analyst to identify and put in place TDM programs that can produce the highest estimated net social benefits. To simplify its use, the model provides default parameters for 85 metropolitan statistical areas in the U.S., including three areas in the State of Washington.

While TRIMMS 2.0 was a significant improvement over previous models, it was designed to be applied on a case-by-case basis such as a single worksite or a group of worksites. To take advantage of four-step transportation planning models' ability to assess improvements to the transportation system, additional work would be necessary. This fact was recognized by TRIMMS developers who recommended future research examine (13):

" . . . integrating TRIMMS© 2.0 as an off-model to be used with the four-step regional transportation planning models could assist transportation planners in estimating the impacts on traffic flows and traffic congestion in particular corridors due to TDM."

The Transportation Demand Management Assessment Procedure (TDMAP) developed under this research effort accomplishes this objective. TDMAP consists of a set of subroutines that integrate with TRIMMS©2.0 to produce estimates of changes in travel behavior at the traffic assignment zone (TAZ) using the WDOT origin-destination (O/D) level travel data.

Subsequent sections of this report will summarize each component of TDMAP. Figure 3 provides the schema for TRIMMS© and Figure 4 below provides an overview of the complete TDMAP.

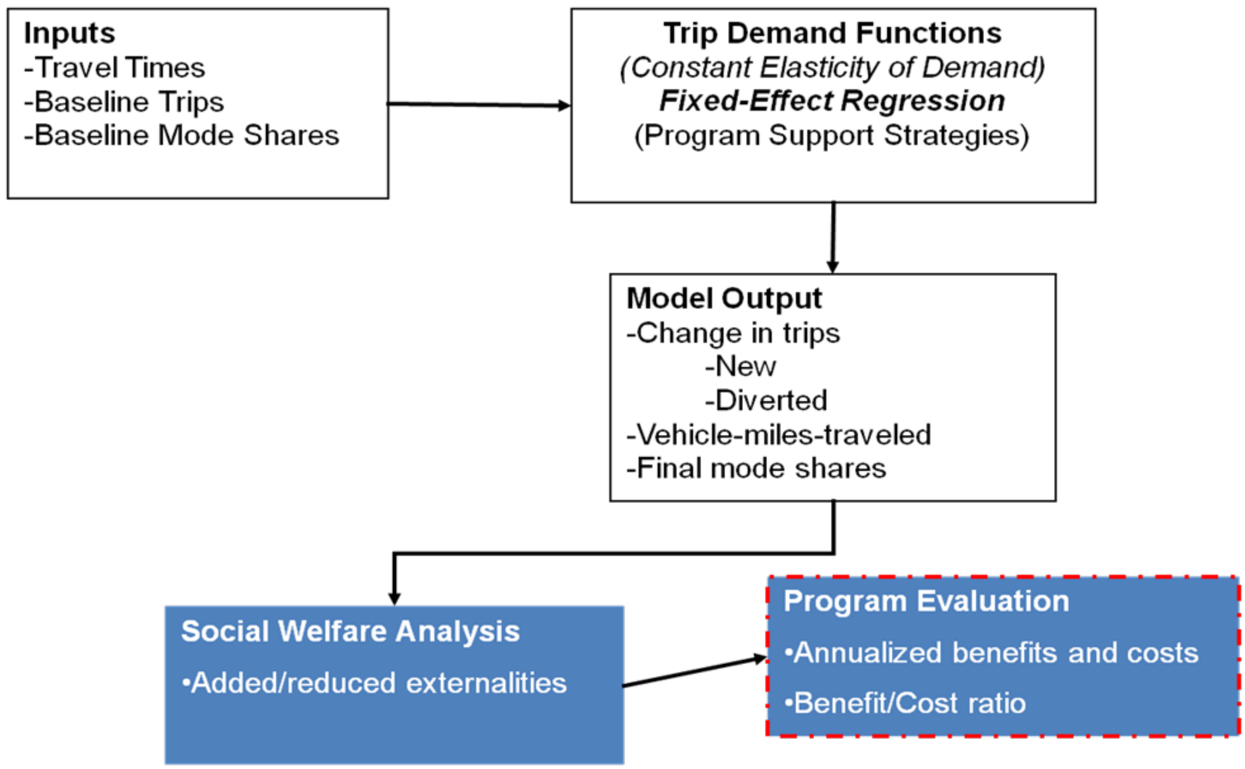


Figure 3 – TRIMMS Schema

Source: Sisinnio Concas, "TRIMMS - Trip Reduction Impact of Mobility Management Strategies," 2009 Institute of Transportation Engineers Annual Meeting and Exhibit Presentations (14).

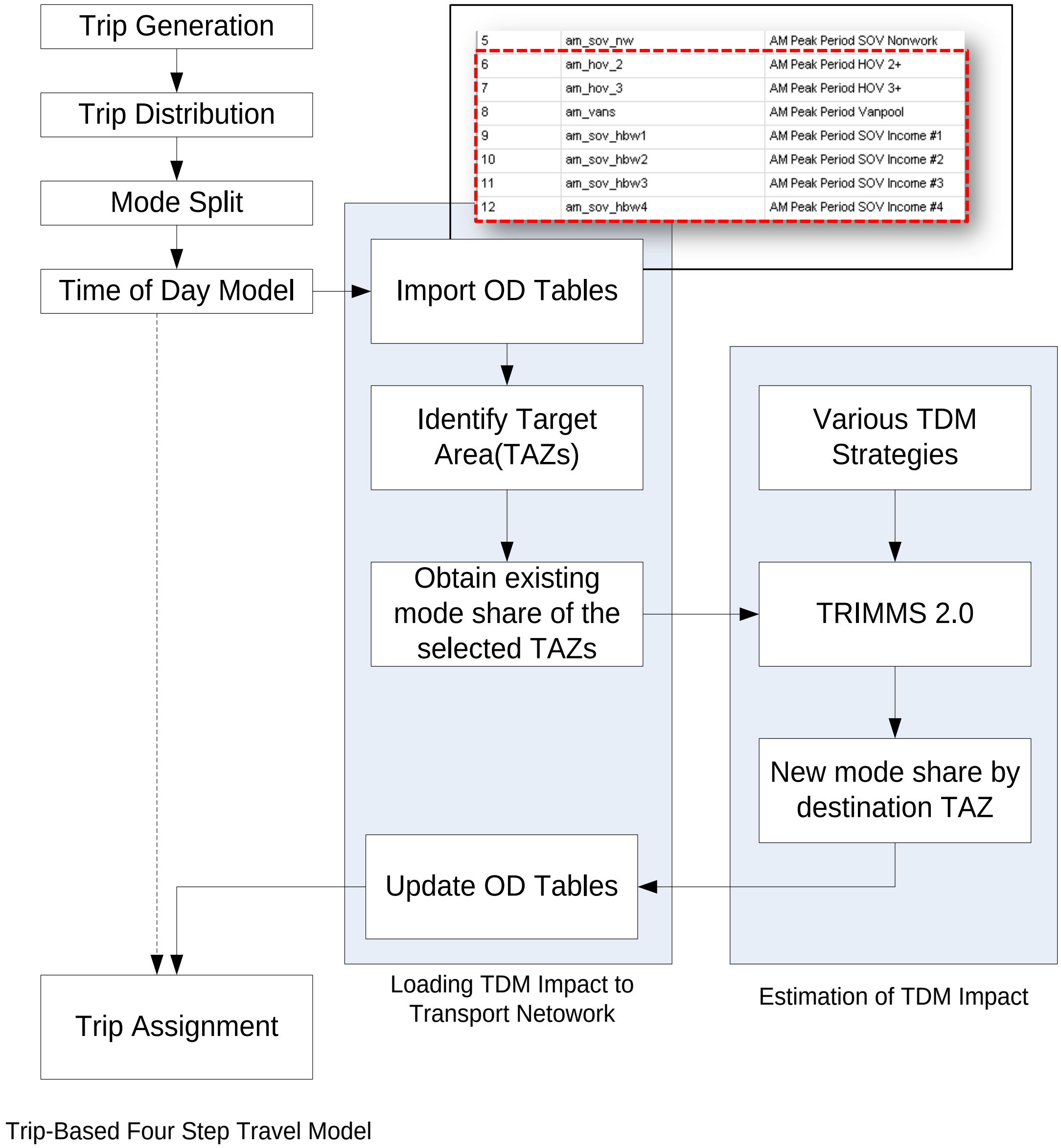


Figure 4 - TDMAP Processes Relative to the Four-step Travel Demand Model

CHAPTER 3 - METHODOLOGY

This chapter describes the processes of TDMAP:

I. Modeshare Macro Import Process
   A. Importing O/D Person Trip Tables from the Travel Demand Model
   B. Aggregating Trip Tables by Mode in Suitable Format for Exporting to TRIMMS© 2.0
II. Running TRIMMS© 2.0 Using Batch Processor
   A. Setting-up the Batch Processor
   B. Running TRIMMS© 2.0 in Batch Mode
   C. Retrieving the Results
III. Modeshare Macro Export Process
   A. Updating O/D Tables with Modified Mode Split
   B. Exporting updated O/D Tables into the Travel Demand Model

I - MODESHARE MACRO IMPORT PROCESS

To assess the impact of employer-based TDM programs on transport network, a proper linkage has to be established between the travel demand model and TDMAP. Using for example, the trip-based PSRC travel demand model produces multiple O/D tables as a result of the Home-Based Work Mode Choice Model. According to the PSRC Travel Model Documentation, PSRC's mode choice model uses the multinomial logit formulation which estimates the probabilities of a decision-makers choice of travel modes among a finite set of alternatives.

IA - IMPORTING O/D PERSON TRIP TABLES FROM A TRAVEL DEMAND MODEL

The following OD tables can be obtained for AM Home-based work trips:

1. AM_sov_hbw1 (AM Peak Period SOV income #1)
2. AM_sov_hbw2 (AM Peak Period SOV income #2)
3. AM_sov_hbw3 (AM Peak Period SOV income #3)
4. AM_sov_hbw4 (AM Peak Period SOV income #4)
5. AM_hov_2 (AM Peak Period HOV 2)
6. AM_hov_3 (AM Peak Period HOV 3 or 3+)
7. AM_vans (AM Peak Period Vanpool)
8. AM_transit (AM Peak Period Public Transit)
9. AM_bike (AM Peak Period Public Transit)
10. AM_walk (AM Peak Period Walk)

First, O/D tables will be imported to the "Modeshare Update" tool and aggregate to compatible modes in TRIMMS. TRIMMS currently has the following predefined modes:

1. Auto – Drive Alone
2. Auto – Rideshare
3. Vanpool
4. Public Transport

5. Cycling
6. Walking
7. Other

Second, mode share at each targeted destination zone will be calculated and put into the proper format that can be compatible to run TRIMMS© in batch process. TRIMMS estimates mode share changes per each zone based on various inputs and assumptions, as discussed in the previous chapter.

Third, the "Modeshare update" process will distribute the estimated mode share changes to associated origin zones. The aggregated O/D tables will be updated first and this will be disaggregated to initial O/D tables which can be fed back into Travel Demand Model. The following section presents a step-by-step demo to use "Modeshare Update".

Step 1

Open the excel file Modeshare Update_v_1.0.xlsm and the screen appears as seen in Figure 5.

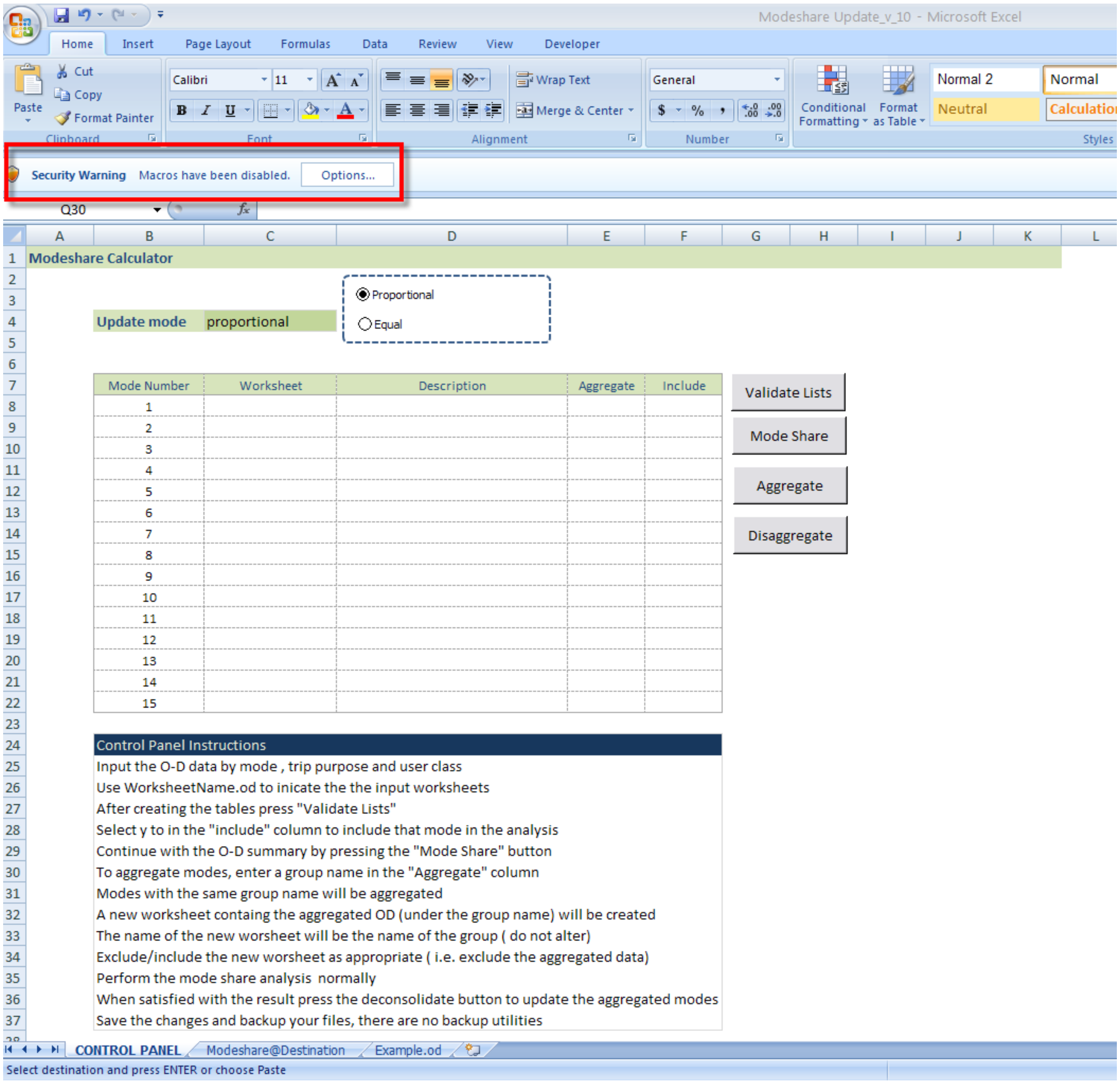


Figure 5 – Modeshare Update Starting Screen

Step 2

Click on the Options box highlighted in the above view and check “Enable this content” in the dialog box that opens (Figure 6).

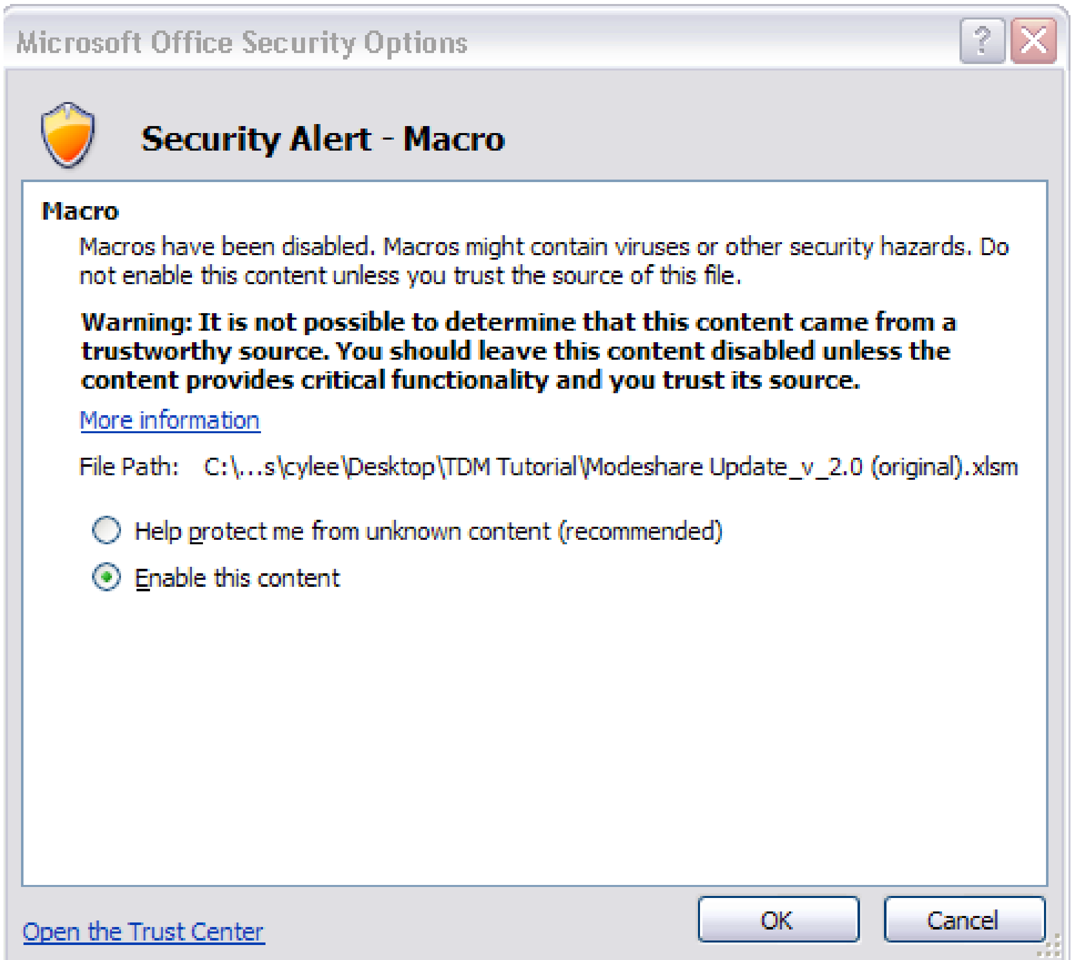


Figure 6 – Enables Macros Function

Step 3

As seen in step 1, there are two default worksheets in the tool named ‘Control panel’ and ‘Modeshare@Destination’.

O/D tables by mode (from travel demand model) can be added into the tool. Each worksheet will hold an O/D table by mode. For example, if the travel demand model produces 10 different O/D tables based on modes, then 10 worksheets will be added to the tool (Figure 7).

	A	B	C	D	E	F	G	H	I	J	K	FJ	FK	FL	FM	FN	FO
1	Zones	1	2	3	4	5	6	7	8	9	10	165	166	167	168	169	170
2	1	6.79	0.37	0.35	0.32	0.39	0.29	0.03	1.5	0.17	1.23	0.15	0.12	0.16	0.21	0.01	0.06
3	2	0.76	0.33	0.39	0.09	0.14	0.13	0.01	0.68	0.14	0.78	0.05	0.04	0.05	0.07	0	0.02
4	3	1.38	0.83	1.66	0.34	0.41	0.5	0.05	2.3	0.46	1.36	0.14	0.03	0.12	0.21	0.01	0.06
5	4	0.33	0.06	0.1	0.76	0.36	0.25	0.04	0.98	0.09	0.18	0.04	0.01	0.03	0.06	0	0.02
6	5	0.92	0.16	0.24	0.77	8.7	3.2	0.23	5.45	0.21	0.57	0.18	0.04	0.17	0.26	0.01	0.07
7	6	0.32	0.07	0.14	0.22	1.35	3.76	0.23	2.04	0.1	0.26	0.1	0.02	0.09	0.14	0.01	0.04
8	7	0.1	0.02	0.04	0.07	0.26	0.58	0.26	0.59	0.03	0.08	0.03	0.01	0.03	0.05	0	0.01
9	8	0.48	0.13	0.34	0.29	1	0.66	0.1	4.9	0.24	0.36	0.08	0.02	0.06	0.11	0.01	0.03
10	9	0.49	0.11	0.29	0.21	0.25	0.28	0.03	1.39	0.55	0.58	0.08	0.03	0.07	0.12	0	0.04
11	10	1.69	0.52	0.45	0.2	0.29	0.36	0.04	1.3	0.28	4	0.13	0.08	0.13	0.18	0.01	0.05
12	11	0.52	0.05	0.05	0.05	0.07	0.07	0.01	0.34	0.03	0.25	0.04	0.02	0.04	0.05	0	0.02
13	12	0.15	0.02	0.02	0.02	0.03	0.03	0	0.12	0.01	0.1	0.01	0	0.01	0.02	0	0.01
14	13	0.29	0.07	0.07	0.03	0.06	0.05	0.01	0.21	0.04	0.34	0.04	0.01	0.03	0.05	0	0.02
15	14	0.27	0.05	0.08	0.04	0.06	0.06	0.01	0.22	0.04	0.21	0.05	0.05	0.05	0.07	0	0.02
16	15	0.72	0.16	0.43	0.17	0.24	0.19	0.03	1	0.23	0.65	0.09	0.07	0.08	0.14	0	0.04
17	16	0.59	0.16	0.51	0.16	0.3	0.22	0.04	0.61	0.27	0.59	0.07	0.05	0.06	0.1	0	0.03
18	17	0.37	0.07	0.14	0.27	0.74	0.71	0.08	3.53	0.12	0.3	0.12	0.04	0.11	0.16	0.01	0.05
19	18	0.12	0.02	0.03	0.06	0.22	0.44	0.03	0.83	0.03	0.09	0.04	0.01	0.04	0.06	0	0.02
20	19	0.09	0.01	0.02	0.04	0.13	0.21	0.04	0.42	0.02	0.06	0.04	0.02	0.04	0.05	0	0.01
21	20	0.03	0.01	0.01	0.02	0.06	0.1	0.01	0.18	0.01	0.02	0.03	0.01	0.03	0.04	0	0.01
22	21	0.09	0.02	0.03	0.05	0.16	0.24	0.04	0.49	0.03	0.07	0.07	0.03	0.07	0.08	0	0.02
23	22	0.19	0.03	0.05	0.09	0.36	0.43	0.06	0.95	0.04	0.11	0.1	0.02	0.09	0.16	0.01	0.05
24	23	0.09	0.01	0.02	0.04	0.15	0.21	0.04	0.42	0.02	0.06	0.04	0.02	0.04	0.07	0	0.02
25	24	0.11	0.02	0.04	0.1	0.25	0.26	0.03	1.41	0.03	0.09	0.09	0.04	0.09	0.16	0.01	0.05
26	25	0.33	0.11	0.4	0.18	0.39	0.21	0.04	0.51	0.28	0.36	0.04	0.04	0.04	0.07	0	0.02
27	26	0.32	0.06	0.06	0.04	0.06	0.07	0.01	0.38	0.03	0.13	0.06	0.05	0.06	0.09	0	0.02
28	27	0.62	0.09	0.08	0.05	0.08	0.08	0.01	0.3	0.06	0.24	0.09	0.07	0.08	0.13	0.01	0.04
29	28	0.22	0.03	0.03	0.03	0.04	0.05	0.01	0.2	0.02	0.16	0.04	0.01	0.03	0.06	0	0.03
30	29	0.25	0.03	0.04	0.01	0.03	0.02	0	0.08	0.02	0.08	0.03	0.01	0.02	0.05	0	0.02
163	162	0.02	0.01	0.01	0	0.01	0	0	0	0	0.01	0.03	0.1	0.03	0.06	0.02	0.09
164	163	0.02	0.01	0.02	0	0.02	0.01	0	0.01	0.01	0.02	0.02	0.01	0.02	0.09	0.06	0.11
165	164	0.01	0	0.01	0	0.01	0	0	0.01	0	0.01	0.38	0.05	0.1	0.09	0.03	0.08
166	165	0.01	0	0.01	0	0.01	0	0	0	0	0.01	0	0	0	0.02	0.02	0.04
167	166	0.01	0	0	0	0	0	0	0	0	0	0	0.03	0	0.01	0	0.02
168	167	0.01	0	0.01	0	0.01	0	0	0	0	0.01	0	0	0	0.02	0.01	0.02
169	168	0.01	0	0.01	0	0.01	0.01	0	0.02	0.01	0.01	0.17	0.1	0.14	2.58	0.13	0.87
170	169	0	0	0	0	0	0	0	0.01	0	0	0.22	0.02	0.11	0.73	0.3	0.4
171	170	0.01	0	0	0	0.01	0.01	0	0.01	0	0.01	0.36	0.18	0.22	2.11	0.13	1.68
172																	

SOV1.od | SOV2.od | SOV3.od | SOV4.od | HOV2.od | HOV3.od | Transit.od | VAN.od | Bike.od | Walk.od | CONTROL PANEL | Modeshare@Destination

Ready

Figure 7 – Import O/D Tables into Worksheets

Notes:

a. 10 worksheets added with the O/D data in the excel file.
b. The tool only reads worksheets labeled “*.od” to be recognized by the tool as O/D.
c. Each tab has row 1 corresponding to destination zones and column A corresponding to origin zones. (In this example there are 170 zones).
d. User needs to make sure the size of the O/D tables is the same in all worksheets.

Step 4

The added data is validated in this step (Figure 8). Open the ‘CONTROL PANEL’ worksheet and click ‘Validate Lists’. A small dialog box pops up and click “Yes”.

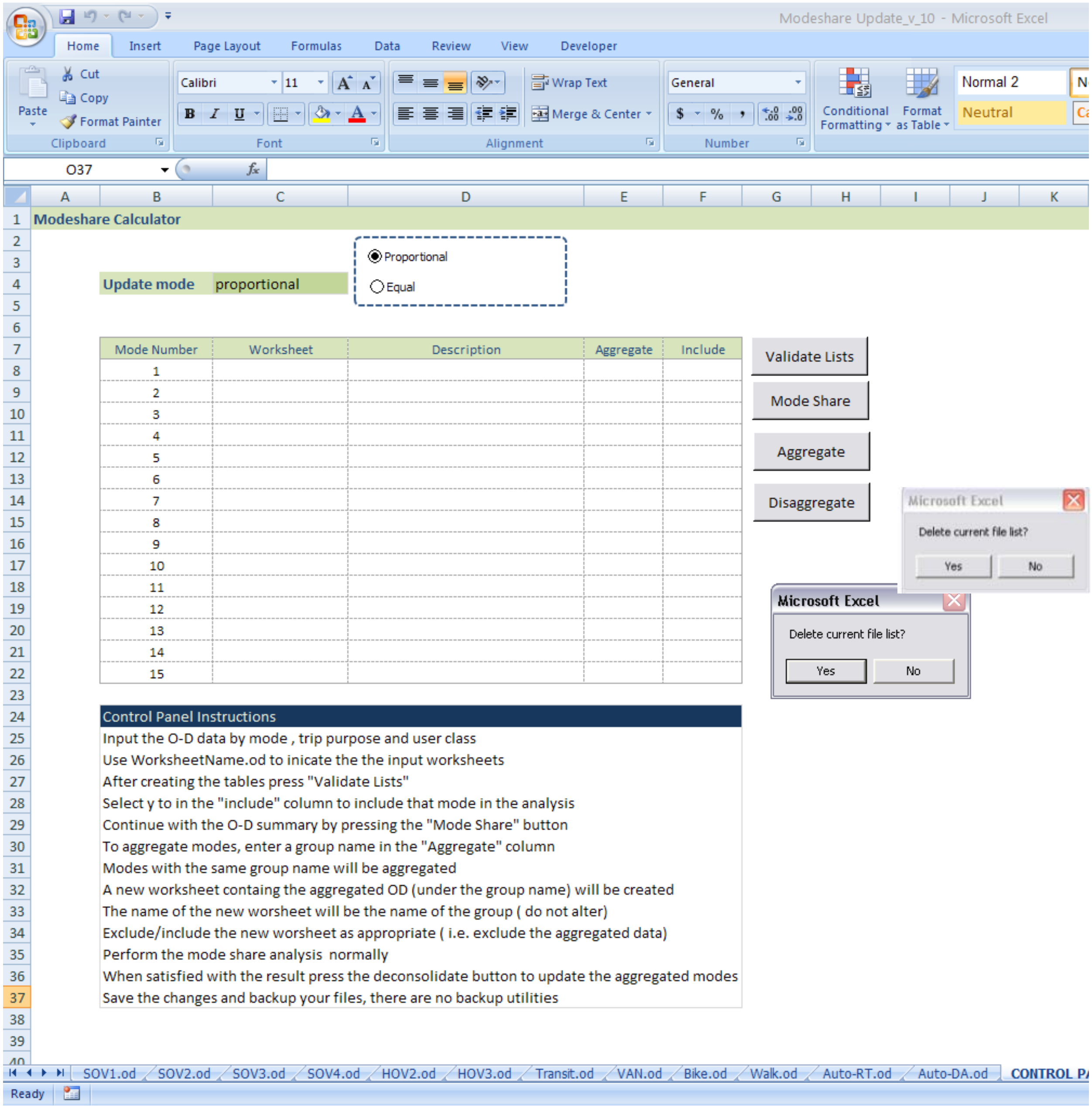


Figure 8 – Read “*.od” Worksheet

Note: Validating the list refreshes the “*.od” mode data worksheets added in the file and makes it available to be used for analysis.

IB - AGGREGATING TRIP TABLES BY MODE IN SUITABLE FORMAT FOR EXPORTING TO TRIMMS© 2.0

Step 1

User adds 'worksheet' names of modes that need to be aggregated. The worksheet names are available in the drop down box. For example, modes #1 to #6 are added in the worksheet column. User specifies the name of the aggregated mode under which individual modes will be aggregated. For example, modes SOV1, SOV2, SOV3, and SOV4 are aggregated under mode name 'AUTO-DA' and modes HOV2 and HOV3 under the mode name 'Auto-RT'.

Click on 'Aggregate' (In CONTROL PANEL worksheet) and a new worksheet corresponding to the names given in previous step is created (Figure 9). For example, two new worksheets with 'Auto-RT.od' and 'Auto-DA.od' are created containing the aggregated data.

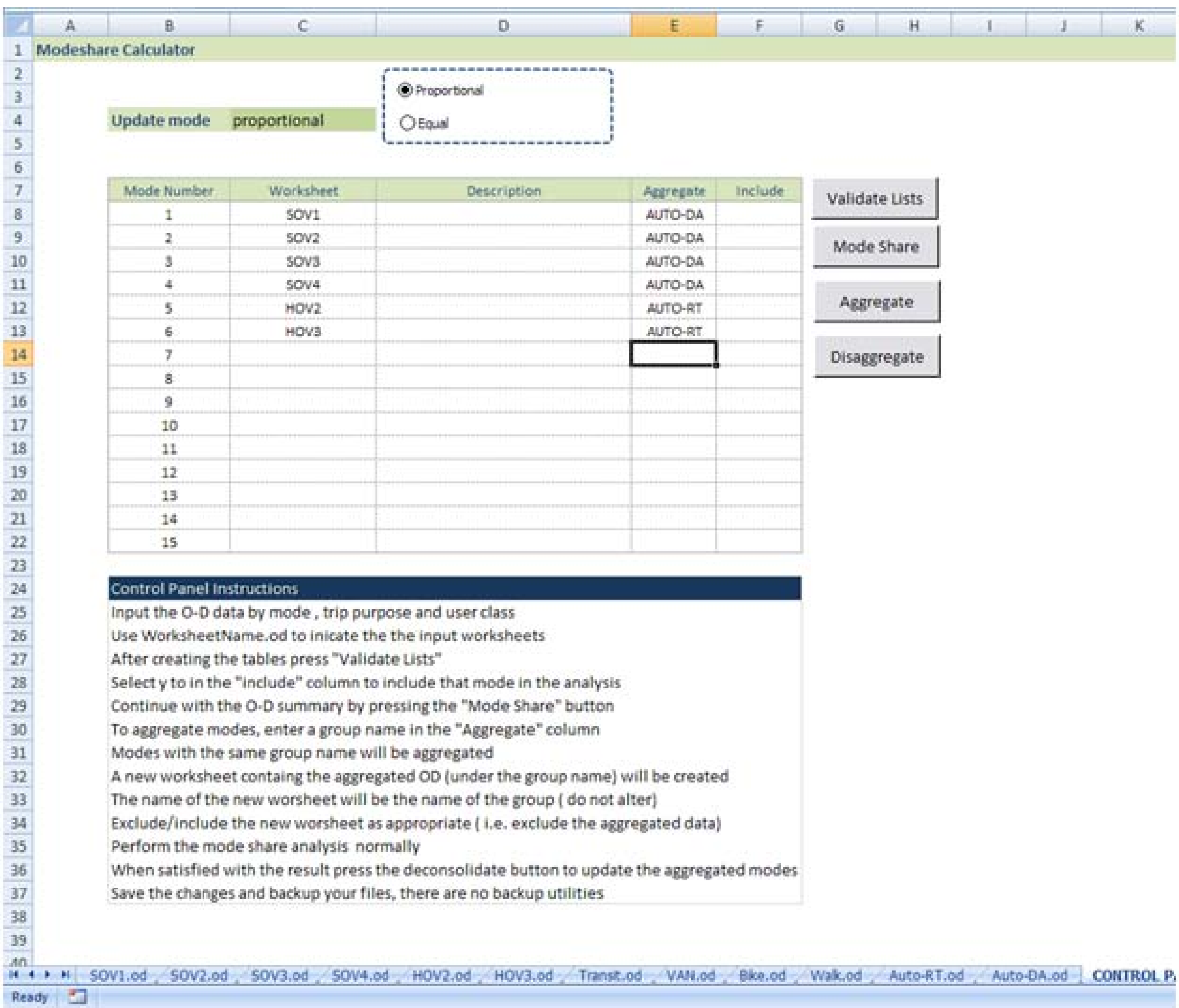


Figure 9 – Aggregation of O/D Tables

Notes:

a. New worksheet/s containing aggregated data is/are created in this step.
b. The names of the newly created worksheet should not be changed.

Step 2

Add the newly created worksheets and other modes which do not require aggregation. Make sure the sequence of mode names in same as it appears in TRIMMS© 2.0. For example add 'Auto-DA' and 'Auto-RT' (newly created worksheets) and Van, Transit and Bike (in this order). 'Walk and 'other' would follow if they were used in the PSRC model.

Select Y to include the modes to be inputted in TRIMMS© 2.0 for analysis and click 'Mode Share' (Figure 10).

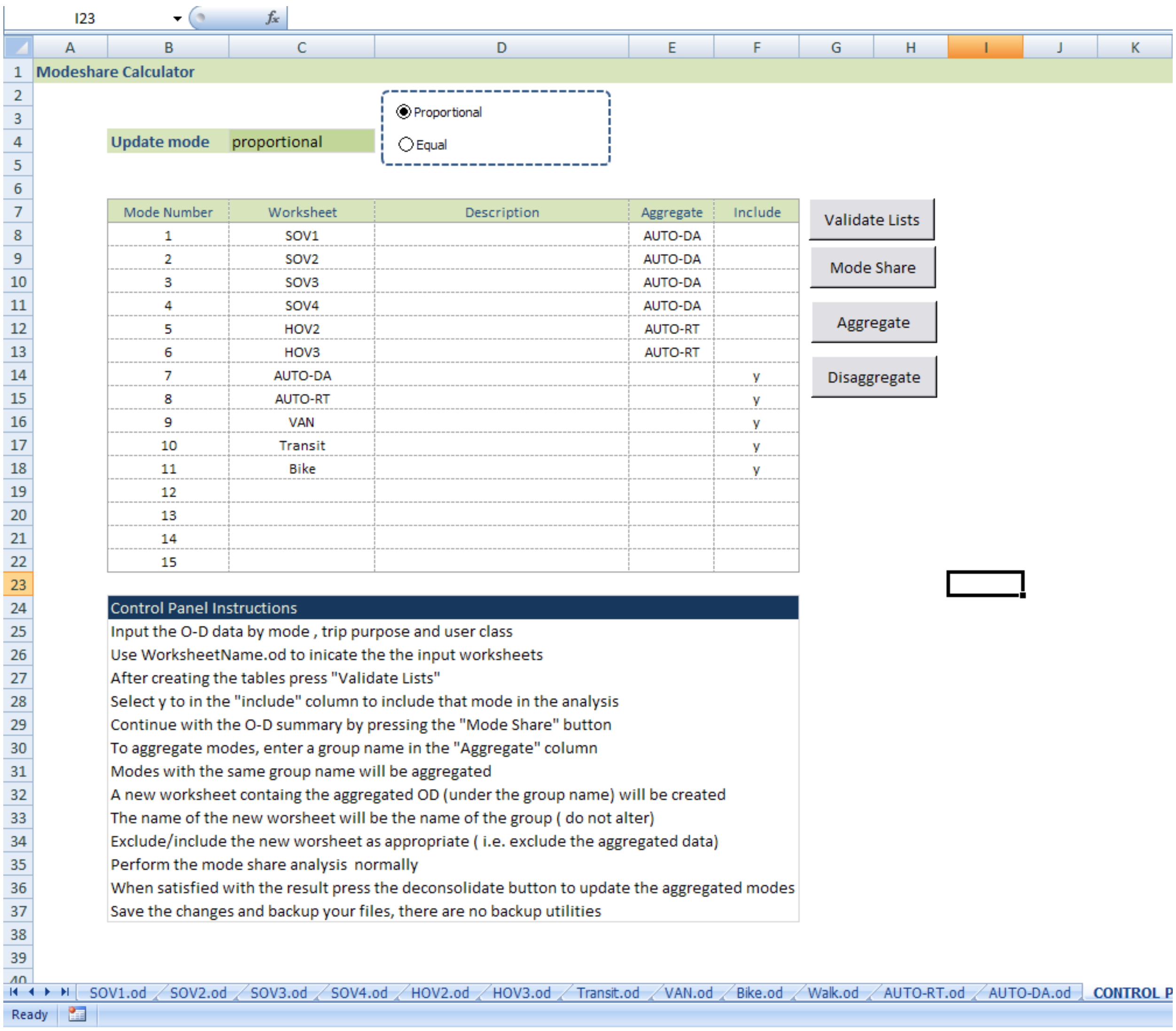


Figure 10 – Calculation of Mode share

Note: Validating the list refreshes the "*.od" mode data worksheets added in the file and makes it available to be used for analysis.

Step 3

Open the 'Mode@Destination' tab (Figure 11), the aggregated mode share will be available to run TRIMMS© 2.0. Columns A-F, starting with row 2, can be copied and pasted directly into column C and columns AR-AV of the ScenarioSheet part of the TRIMMS© 2.0 batch processor.

Zone	Auto-DA	Auto-RT	VAN	Transit	Bike	Total
1	0.4815	0.2764	0.0000	0.2060	0.0361	1.0000
2	0.3579	0.4065	0.0000	0.1614	0.0741	1.0000
3	0.3456	0.4659	0.0000	0.1424	0.0462	1.0000
4	0.3348	0.3709	0.0000	0.1509	0.1433	1.0000
5	0.4310	0.3340	0.0000	0.1808	0.0542	1.0000
6	0.4726	0.2817	0.0000	0.2090	0.0367	1.0000
7	0.2820	0.5473	0.0000	0.1299	0.0408	1.0000
8	0.5106	0.2176	0.0002	0.2284	0.0433	1.0000
9	0.3052	0.4606	0.0000	0.1337	0.1005	1.0000
10	0.4188	0.3619	0.0000	0.1732	0.0461	1.0000
11	0.3294	0.4480	0.0000	0.1518	0.0708	1.0000
12	0.2591	0.5697	0.0000	0.1208	0.0504	1.0000
13	0.3490	0.3465	0.0000	0.1611	0.1434	1.0000
14	0.4197	0.3539	0.0000	0.1860	0.0404	1.0000
15	0.4650	0.2911	0.0000	0.2011	0.0428	1.0000
16	0.4734	0.2849	0.0006	0.2019	0.0392	1.0000
17	0.5053	0.2451	0.0000	0.2154	0.0343	1.0000
18	0.3587	0.4034	0.0000	0.1592	0.0787	1.0000
19	0.3750	0.4268	0.0000	0.1531	0.0450	1.0000
20	0.3148	0.4947	0.0000	0.1437	0.0468	1.0000
21	0.3749	0.3757	0.0000	0.1610	0.0884	1.0000
22	0.4331	0.3358	0.0000	0.1862	0.0449	1.0000
23	0.4408	0.3134	0.0000	0.2008	0.0449	1.0000
24	0.3844	0.4005	0.0000	0.1641	0.0510	1.0000
25	0.5279	0.1872	0.0014	0.2371	0.0463	1.0000
26	0.3824	0.3822	0.0000	0.1732	0.0622	1.0000
27	0.4139	0.3409	0.0000	0.1872	0.0580	1.0000
28	0.2529	0.5799	0.0000	0.1108	0.0564	1.0000
29	0.4274	0.3357	0.0000	0.1982	0.0387	1.0000
30	0.4154	0.3474	0.0000	0.1757	0.0616	1.0000
31	0.2839	0.4261	0.0000	0.1332	0.1568	1.0000
32	0.4184	0.3479	0.0000	0.1799	0.0538	1.0000
33	0.3655	0.3858	0.0000	0.1614	0.0873	1.0000
34	0.3864	0.3824	0.0000	0.1828	0.0484	1.0000
35	0.4174	0.3458	0.0017	0.1815	0.0536	1.0000
36	0.3970	0.3804	0.0000	0.1731	0.0496	1.0000
37	0.3813	0.3861	0.0000	0.1659	0.0667	1.0000

Figure 11 – Aggregated Mode Share

Note: By following the above steps, mode share has been aggregated into modes suited for TRIMMS© 2.0 analysis.

II - RUNNING TRIMMS© 2.0 USING THE BATCH PROCESSOR

Although TRIMMS© 2.0 could be run manually for each TAZ, this would be burdensome for estimating changes in large number of traffic analysis zones (TAZs). The batch processor is designed to reduce this burden, by enabling the user to use software to compile and format the input data, copy the data in to the batch processor, run TRIMMS© 2.0 for each TAZ, and save the results in machine-readable form for further analysis. The batch processor is embedded within the TRIMMS© 2.0 workbook, and acts as a "shell" around the TRIMMS© 2.0 calculations.

Use of the batch processor requires entering or copying data into a spreadsheet, one row for each TAZ. The data to be entered include an identifier for each TAZ; the mode split for person-trips arriving in the TAZ, as estimated by the regional transportation model, generally from a run of the regional model; and a variety of optional information about the those trips and about TDM elements intended to modify the mode split. The batch processor clears previous results from the output spreadsheet; reads the data provided for each TAZ/row; transfers it to TRIMMS© 2.0, which estimates the change in the mode split; and then copies the TAZ identifier and changed mode split into an output spreadsheet, from which the results for all TAZs can be copied and fed back into the regional model.

TRIMMS© 2.0 processes each destination TAZ independently of all other TAZs. Therefore, it is not necessary to run every destination TAZ from the regional model through TRIMMS© 2.0, if the TDM program being analyzed applies only to a subset of the region's TAZs (for example, destinations within a specific transportation corridor of interest). It also is not necessary to set the same TDM policy for all TAZs being processed in a run of the batch processor. If, for example, the analysis is to estimate the effects of imposing payment for parking, and such payments already exist in some TAZs but at a level different than what is being proposed, then fees can be set to reflect existing or planned variation in the price of parking. Finally, it is not necessary to set values for all of the TDM options available to the analyst. For example, if a TDM strategy focuses on parking, and no changes are proposed for other program elements (such as subsidies for the use of alternative modes), only the values pertaining to parking need to be entered, and the remaining values should be left blank.

SETTING UP THE BATCH PROCESSOR

Data are to be entered into the sheet labeled ScenarioSheet in the tabs at the lower left of the workbook, starting in row 6. Rows 1-5 of this sheet contain headings and comments describing the contents of each column, plus a hard-wired example in row 5 illustrating values and format for the data to be entered.

Although the batch processor is set up to enable full use of TRIMMS© 2.0, the integration with the regional transportation model does not require using some of the TRIMMS© 2.0 options. The description below indicates where these options are to be skipped. The description cross-references screens and text are from TRIMMS© 2.0 (13).

Column A must contain 1 in row 6, 2 in row 7 and so forth sequentially through all rows in which data is entered. Thus, for an analysis of 100 TAZs, enter data into rows 6-105, and cell A105 will be set to 100. The values in column A *must* be integer values and *must not be formulas*. The batch processor uses these values to maintain control during the processing, and they must be re-created for each batch processed. An invalid value (formula, blank, non-numeric value) will cause the processor to stop before processing all TAZs.

Columns B-E correspond to Step 1, Figure 2.3 in TRIMMS© 2.0 (13).

> Column B: identifier for the batch; may be agency name, policy name, or other identifier.
>
> Column C: unique identifier for each TAZ; this will be copied to the output spreadsheet with the new mode split.
>
> Column D: identifier for the person setting up and running the analysis.
>
> Column E: date, use format illustrated in cell E5.

Columns F-G correspond to portions of Step 2, Figure 2.4 in TRIMMS© 2.0 (13).

> Column F: Must be “Area-Wide” (without the quotation marks); use the format illustrated in cell F5.
>
> Column G: Region identifier. For Washington State, must use one of the following:
>
> > Seattle--Tacoma--Bremerton, WA CMSA
> > Spokane, WA MSA
> > Portland--Salem, OR--WA CMSA

Column H-AB: leave these columns blank (these control calculations and options not used or saved in this application of TRIMMS 2.0)

Columns AC-AQ correspond to the portions of Step 3 illustrated in Figure 2.6 in TRIMMS© 2.0 (13), and described there

> Columns AC-AQ: These indicate the type of employers located in the TAZ and subject to the policies being analyzed (employer types listed in cells AC4-AQ4). Enter 1 if the employer type is present in the TAZ, or leave blank if not. Leaving columns AC-AP blank and entering 1 in column AQ will use all employment in the TAZ.

Columns AR-BF correspond to Step 4, Figure 2.7 in TRIMMS© 2.0 (13)

> Columns AR-AX: Enter the base or modeled mode split (the split to be altered through TDM measures), ordered by mode type as indicated in row 4, as proportions, not as percentages. For example if 6.1 percent of trips to the TAZ are made by transit, enter .061 for the transit mode share in column AU. If zero,

enter 0.0. Note that if a mode's share of trips to a TAZ is 0 in these columns, it will be 0 for this TAZ in the TRIMMS 2.0 results. Mode types are listed in cells AR4-AX4.

Columns AY-BE: Enter the average trip length in miles, by mode, for trips to the TAZ, if known. If not known, leave blank. Mode types are listed in cells AY4-BE4.

Column BF: Enter the percentage of the commute trips, to the TAZ being analyzed in this run of TDMAP and TRIMMS© 2.0, which occur under peak-period conditions. For example, if the mode split from the regional transportation model (and entered into columns AR-AX) was calculated for all or a portion of the morning peak, then enter 100.00 for 100 percent. If the mode split being analyzed includes travel outside a peak period, then enter the proportion of commute travel that occurs within the peak period, as for example 85.00 for 85%

Columns BG-BK correspond to Step 5, Figure 2.8 in TRIMMS© 2.0 (13)

Columns BG-BK: Set to 1 if subsidies are being offered as part of the TDM program for employees traveling to the TAZ (either as part of an existing program, or as part of the one to be implemented to change the mode split), and leave blank if subsidies are not being offered. Mode types are listed in BG4-BK4.

Columns BL-BM correspond to "Program Support Evaluation," Figure 2.9 in TRIMMS© 2.0 (13)

Column BL: set to 1 if carpool matching is offered to employees traveling to the TAZ (either as part of the existing program or as part of the one to be implemented); leave blank if it is not offered.

Column BM: set to 1 if guaranteed ride home/emergency ride home service is offered to employees traveling to the TAZ (either as part of the existing program or as part of the one to be implemented); leave blank if it is not offered.

Column BN: leave blank (this column applies to worksite-specific, not areawide, analyses).

Columns BO-BQ correspond to "Program Support Evaluation", Figure 2.10 in TRIMMS© 2.0 (13)

Column BO: set to 1 if flex time (shifting work hours earlier or later in the workday) is offered to employees traveling to the TAZ (either as part of the existing program or as part of the one to be implemented); leave blank if it is not offered.

Column BP: set to 1 if compressed workweeks (such as a schedule of working 4 10-hour days a week instead of 5 8-hour days) is offered to employees traveling to the TAZ (either as part of the existing program or as part of the one to be implemented); leave blank if it is not offered.

Column BQ: set to 1 if telework is offered to employees traveling to the TAZ (either as part of the existing program or as part of the one to be implemented); leave blank if it is not offered.

Columns BR-CE: leave blank (these columns apply to worksite-specific, not areawide, analyses).

Columns CF-CZ correspond to Step10, Figure 2.15 in TRIMMS© 2.0 (13)

Columns CF-CH: set to the current (or projected before TDM) cost to park a car, carpool, or vanpool in the TAZ ($/vehicle); enter 0 if parking is free. Mode types are listed in CF4-CH4.

Columns CI-CK: set to the cost ($/vehicle) to park a car, carpool, or vanpool in the TAZ as part of the TDM policy (can be the same as the present cost in columns CF-CH if the policy does not change the cost of parking a vehicle type); enter 0 if parking is to be free as part of the TDM policy. Mode types are listed in CI4-CK4.

Columns CL-CR: set to the average present (or projected before the TDM changes being considered) cost to an employee commuting to the TAZ, by each mode. If subsidies are currently being offered for alternative modes, the costs entered should include the effects of these subsidies). Mode types are listed in cells CL4-CR4.

Columns CQ-CY: set to the average projected cost to an employee commuting to the TAZ after implementation of the TDM program. Mode types are listed in cells CQ4-CY4.

Column CZ: set to the percent of the employees, commuting to the TAZ being analyzed in this run of TDMAP and TRIMMS© 2.0, affected by the changes in trip costs between columns CL-CR and CQ-CY. Leave blank if 0.

Columns DA-EC correspond to Step11, Figure 2.16 in TRIMMS© 2.0 (13)

Columns DA-DG: set to the present average time, in minutes, required to access each mode for travel to the TAZ, for each mode. Leave blank if 0. Mode types are listed in cells DA4-DG4.

Columns DH-DN: set to the average time, in minutes, required to access each mode for travel to the TAZ, as part of the TDM program. Leave blank if 0. Mode types are listed in cells DH4-DN4. Examples of changes in access times might include providing a new park-and-ride lot, or an additional bus route, or sidewalks to bus stops. Changes to frequency of transit service, to reduce bus headways, should be incorporated into travel times, below, rather than in access time.

Columns DO-DU: set to the present (or projected before the TDM changes being considered) average travel time, in minutes, required to travel to the TAZ on each mode. Leave blank if 0. Mode types are listed in cells DO4-DU4.

Columns DV-EB: set to the travel average time, in minutes, required to travel to the TAZ on each mode. Leave blank if 0. Mode types are listed in cells DV4-EB4.

Column EC: set to the percent of the employees, commuting to the TAZ being analyzed in this run of TDMAP and TRIMMS 2.0, affected by the changes in trip access or commute between columns DA-DA/DO-DU and columns DB-DN/DV-EB. Leave blank if 0.

RUNNING TRIMMS© 2.0 IN BATCH MODE

Once the data have been entered into ScenarioSheet, switch to the Introduction sheet and click on the Batch Processing button (Figure 16). The batch processors will then feed each TAZ's data into TRIMMS© 2.0, calculate results, and save them.

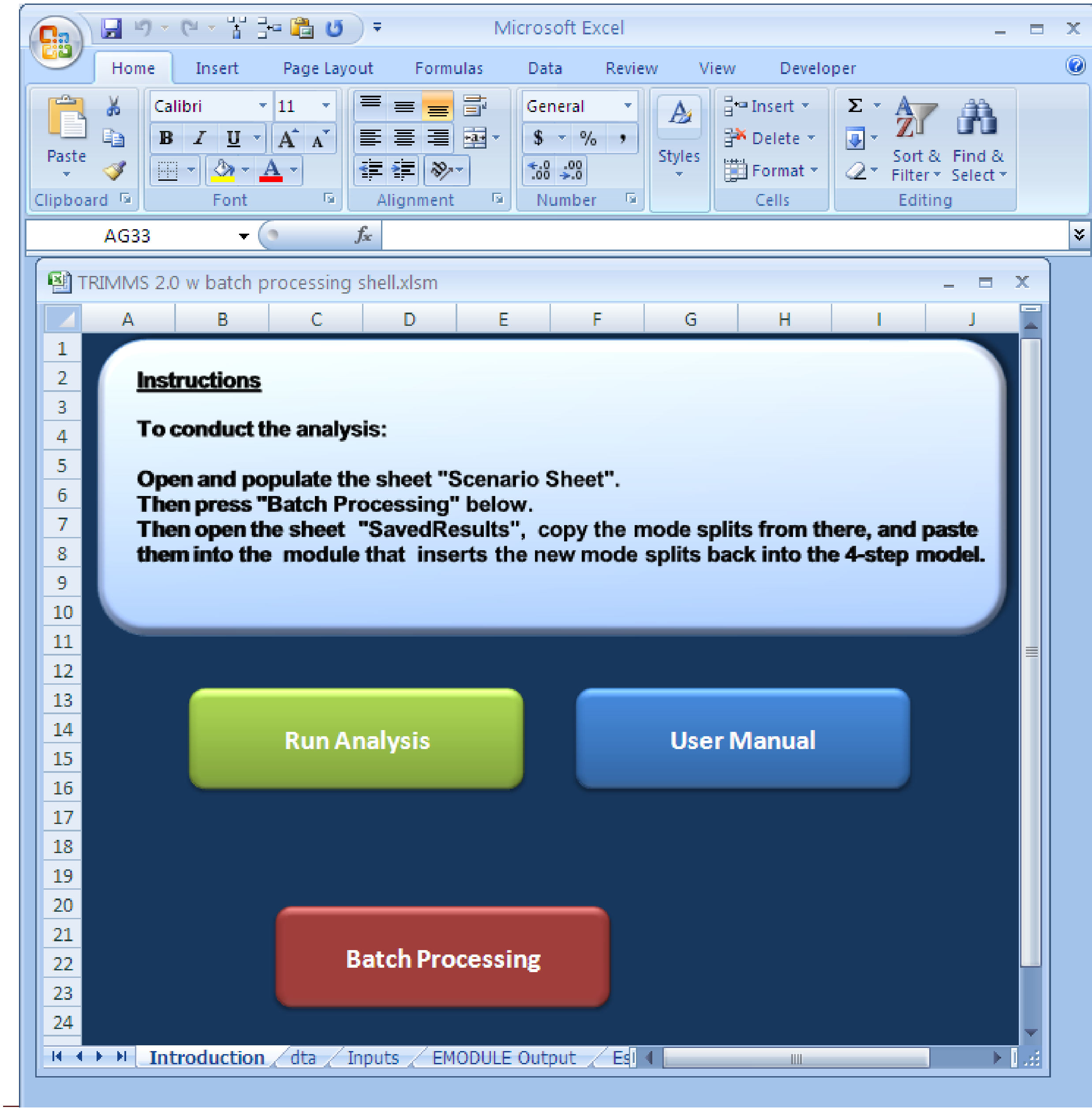
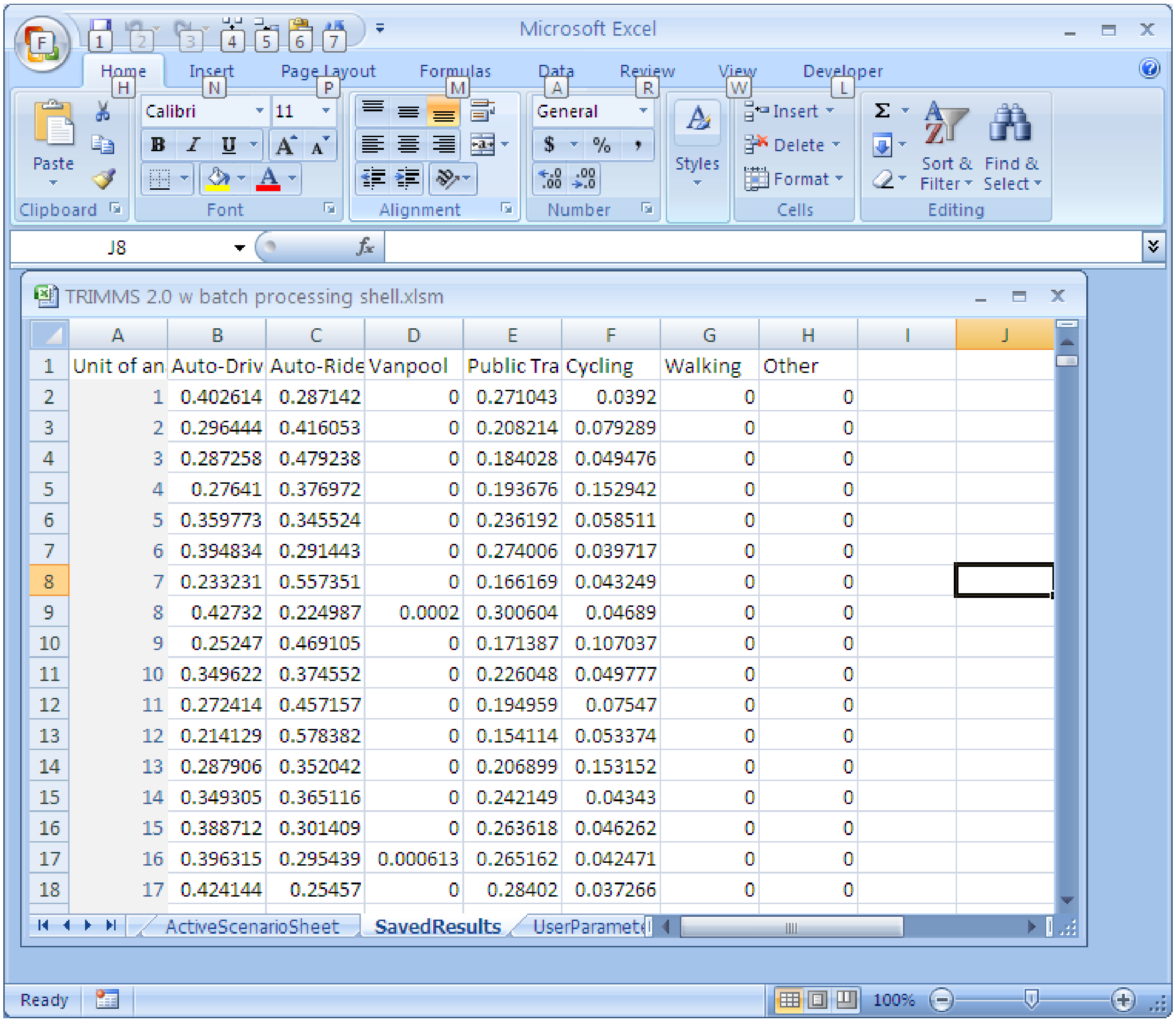


Figure 12 – Opening Screen to TRIMMS© 2.0 with Batch Processor

RETRIEVING THE RESULTS

Results are stored in the worksheet Saved Results, with a header row indicating the mode, and subsequent rows listing the TAZ identifier in column A and the mode shares for the different modes in columns B-H (Figure 17). These can be selected and pasted into the next step of TDMAP.



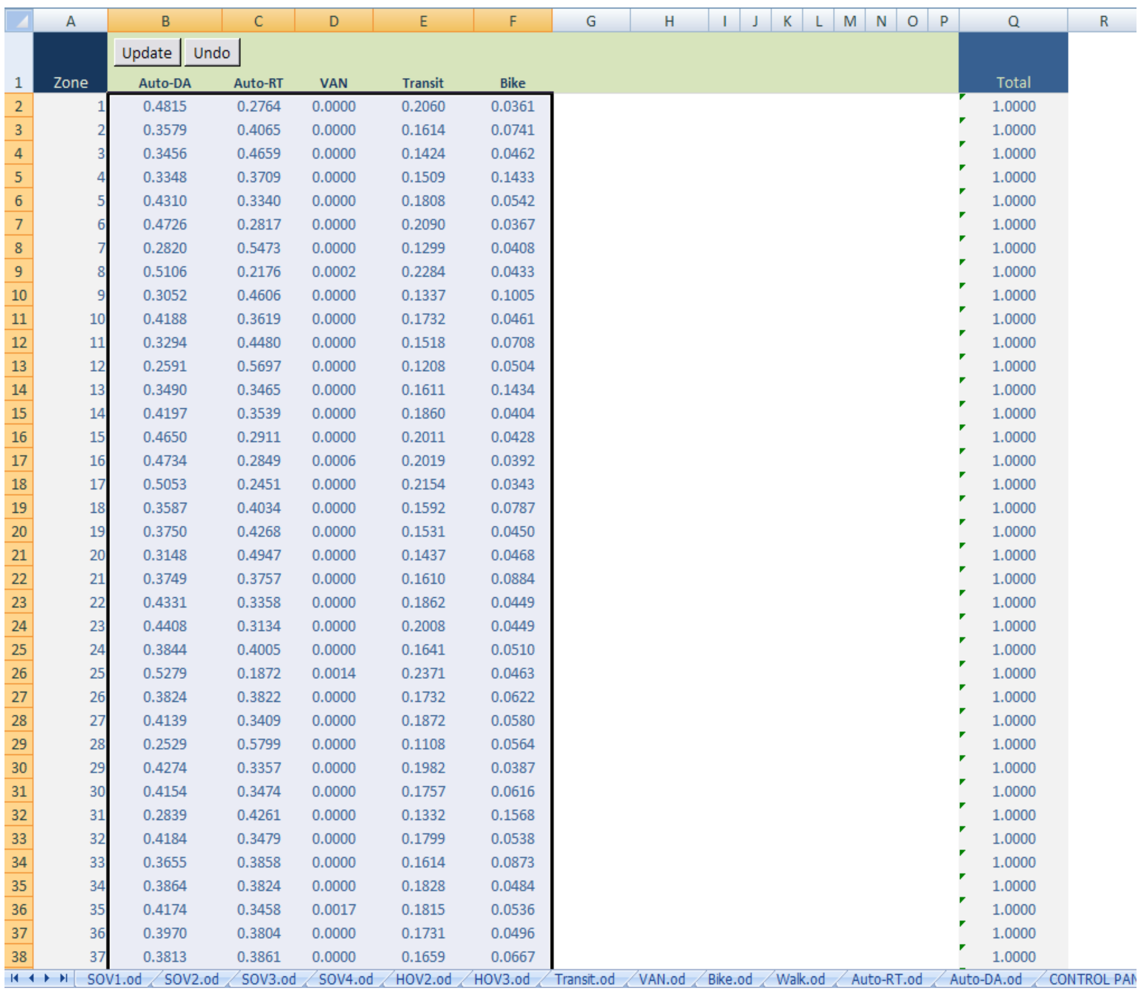
	A	B	C	D	E	F	G	H	I	J
1	Unit of an	Auto-Driv	Auto-Ride	Vanpool	Public Tra	Cycling	Walking	Other		
2	1	0.402614	0.287142	0	0.271043	0.0392	0	0		
3	2	0.296444	0.416053	0	0.208214	0.079289	0	0		
4	3	0.287258	0.479238	0	0.184028	0.049476	0	0		
5	4	0.27641	0.376972	0	0.193676	0.152942	0	0		
6	5	0.359773	0.345524	0	0.236192	0.058511	0	0		
7	6	0.394834	0.291443	0	0.274006	0.039717	0	0		
8	7	0.233231	0.557351	0	0.166169	0.043249	0	0		
9	8	0.42732	0.224987	0.0002	0.300604	0.04689	0	0		
10	9	0.25247	0.469105	0	0.171387	0.107037	0	0		
11	10	0.349622	0.374552	0	0.226048	0.049777	0	0		
12	11	0.272414	0.457157	0	0.194959	0.07547	0	0		
13	12	0.214129	0.578382	0	0.154114	0.053374	0	0		
14	13	0.287906	0.352042	0	0.206899	0.153152	0	0		
15	14	0.349305	0.365116	0	0.242149	0.04343	0	0		
16	15	0.388712	0.301409	0	0.263618	0.046262	0	0		
17	16	0.396315	0.295439	0.000613	0.265162	0.042471	0	0		
18	17	0.424144	0.25457	0	0.28402	0.037266	0	0		

Figure 13 – Output Spreadsheet from TRIMMS© 2.0 Batch Processor

III - MODESHARE MACRO EXPORT PROCESS

IIIA - UPDATE O/D TABLES WITH MODIFIED MODE SPLIT FROM TRIMMS© 2.0

Revised mode shares obtained from the Saved Results spreadsheet in the TRIMMS 2.0 batch processor should be pasted into columns B-F of the 'Modeshare@Destination' worksheet and then click 'Update'. This will update the aggregated O/D tables. The mode share change by destination zone will be distributed across all associated origin zones proportionally. However, there is no existing trip per mode between O/D pairs; the O/D pairs will not be affected by change of mode share.



Zone	Auto-DA	Auto-RT	VAN	Transit	Bike	Total
1	0.4815	0.2764	0.0000	0.2060	0.0361	1.0000
2	0.3579	0.4065	0.0000	0.1614	0.0741	1.0000
3	0.3456	0.4659	0.0000	0.1424	0.0462	1.0000
4	0.3348	0.3709	0.0000	0.1509	0.1433	1.0000
5	0.4310	0.3340	0.0000	0.1808	0.0542	1.0000
6	0.4726	0.2817	0.0000	0.2090	0.0367	1.0000
7	0.2820	0.5473	0.0000	0.1299	0.0408	1.0000
8	0.5106	0.2176	0.0002	0.2284	0.0433	1.0000
9	0.3052	0.4606	0.0000	0.1337	0.1005	1.0000
10	0.4188	0.3619	0.0000	0.1732	0.0461	1.0000
11	0.3294	0.4480	0.0000	0.1518	0.0708	1.0000
12	0.2591	0.5697	0.0000	0.1208	0.0504	1.0000
13	0.3490	0.3465	0.0000	0.1611	0.1434	1.0000
14	0.4197	0.3539	0.0000	0.1860	0.0404	1.0000
15	0.4650	0.2911	0.0000	0.2011	0.0428	1.0000
16	0.4734	0.2849	0.0006	0.2019	0.0392	1.0000
17	0.5053	0.2451	0.0000	0.2154	0.0343	1.0000
18	0.3587	0.4034	0.0000	0.1592	0.0787	1.0000
19	0.3750	0.4268	0.0000	0.1531	0.0450	1.0000
20	0.3148	0.4947	0.0000	0.1437	0.0468	1.0000
21	0.3749	0.3757	0.0000	0.1610	0.0884	1.0000
22	0.4331	0.3358	0.0000	0.1862	0.0449	1.0000
23	0.4408	0.3134	0.0000	0.2008	0.0449	1.0000
24	0.3844	0.4005	0.0000	0.1641	0.0510	1.0000
25	0.5279	0.1872	0.0014	0.2371	0.0463	1.0000
26	0.3824	0.3822	0.0000	0.1732	0.0622	1.0000
27	0.4139	0.3409	0.0000	0.1872	0.0580	1.0000
28	0.2529	0.5799	0.0000	0.1108	0.0564	1.0000
29	0.4274	0.3357	0.0000	0.1982	0.0387	1.0000
30	0.4154	0.3474	0.0000	0.1757	0.0616	1.0000
31	0.2839	0.4261	0.0000	0.1332	0.1568	1.0000
32	0.4184	0.3479	0.0000	0.1799	0.0538	1.0000
33	0.3655	0.3858	0.0000	0.1614	0.0873	1.0000
34	0.3864	0.3824	0.0000	0.1828	0.0484	1.0000
35	0.4174	0.3458	0.0017	0.1815	0.0536	1.0000
36	0.3970	0.3804	0.0000	0.1731	0.0496	1.0000
37	0.3813	0.3861	0.0000	0.1659	0.0667	1.0000

Figure 14 – Update Mode Share

Note: You will be overwriting on the previous data so it necessary to update before you proceed.

Next, Go to 'CONTROL PANEL' and click 'Disaggregate'. The individual mode data "*.od" files are updated with revised mode share values.

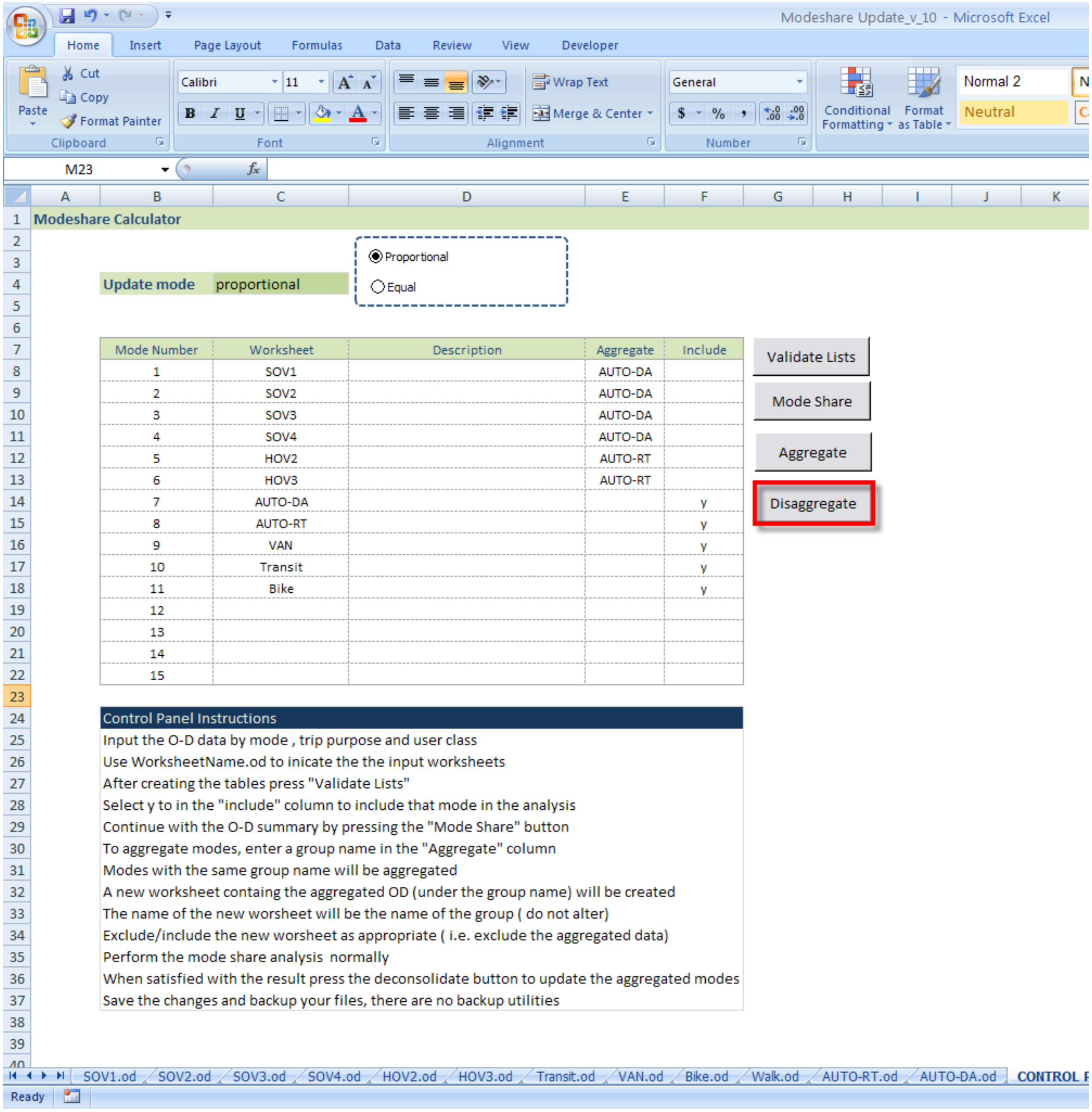


Figure 15 – Disaggregate the Result to Original O/D tables

Note: Save the changes and backup your files as there are no backup utilities.

IIIB - EXPORT UPDATED O/D TABLES INTO THE TRAVEL DEMAND MODEL

The updated O/D tables can be exported and utilized by the travel demand model professionals for traffic assignment. Depending on the travel demand model, it may be necessary to reformat the tables. With the completion of traffic assignment, the impact of TDM programs on the transport network can be quantified with various measures.

CHAPTER 4 - DEMONSTRATION

To better illustrate TDMAP, the research team selected a demonstration region within the Puget Sound that encompasses the west end of SR 520 with 170 TAZs.

BACKGROUND ON THE DEMONSTRATION AREA

To demonstrate the operation of TDMAP, we selected part of the area generating employment traffic on the State Route 520 Bridge across Lake Washington.

The SR 520 Bridge is one of two crossing the lake, and as a result it is a major travel corridor. Approximately 5 miles east of the bridge, roughly 36,000 persons work in central Redmond, more than half of these at Microsoft's main campus there (15). Approximately 4 miles to the west and south is downtown Seattle, employing roughly 155,000 persons. And approximately 1 mile to the west of the bridge, and slightly north, is the University of Washington, with a daily population of roughly 17,000 faculty and staff, and more than 32,000 students. The bridge also provides access from the west to downtown Bellevue, where another 35,000 persons work, although the I-90 bridge across the lake is an alternative for many of the persons who commute there from the west.

Completed in 1963, the bridge has two lanes in each direction and experiences high levels of congestion. Replacement of the bridge has been discussed since at least the late 1990s to increase capacity, maintain the reliability of the corridor during severe weather, and improve survivability of the structure and access to it in the event of a major earthquake (16). Traffic volumes on the bridge are approximately equal in both directions during both the morning and evening peak periods, with westbound peak hour traffic volumes commonly in the range of 3,700-3,900 vehicles per hour (17).

The Washington State DOT, in partnership with King County, cities within the county (including Seattle, Redmond, and Bellevue), and large employers in the area, operates a CTR program to commuters to use modes other than driving alone. Unfortunately, the bridge infrastructure is not very supportive of alternative modes. The two lanes in each direction leave no room for dedicated bicycle, transit, or HOV lanes. Parking remains free in Redmond and much of Bellevue, although there is some paid parking in downtown Bellevue. Little if any free parking is available in downtown Seattle or near the University of Washington, although it is possible to park for free or at very low cost in much of the rest of the city. Although the CTR program applies to only about 25 percent of employment in the county, a greater percentage of employers in downtown Seattle, in Redmond, and the University are affected by the program. In addition, the Growth and Transportation Efficiency Centers program, a modified version of the CTR program, now works with all employment in these areas and in downtown Bellevue (15). The CTR program also actively promotes vanpooling, and it has led to the development area-wide transit passes in some areas, which many employers provide to their employees either for free or at greatly reduced cost.

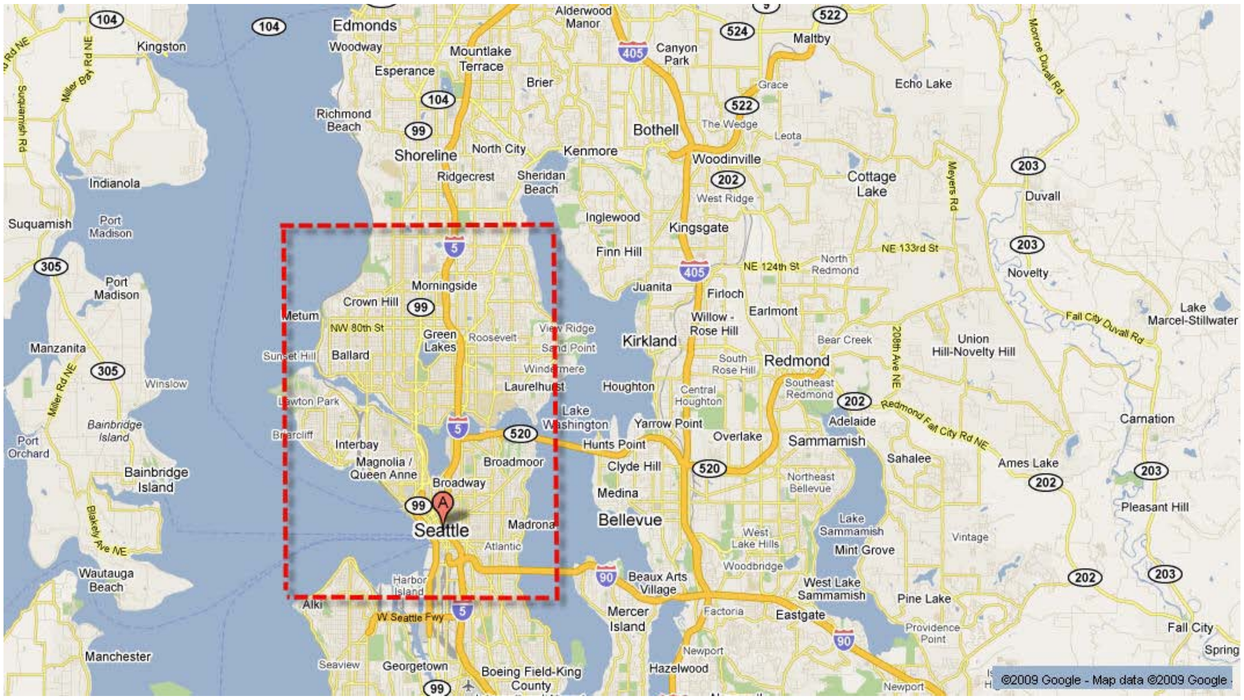


Figure 16 – Area Used in Demonstration

The total number of person-trips estimated by the PSRC model into these TAZs during the morning 6-9 am workday peak period is slightly more than 110,000.

For the demonstration, we assumed that parking in and near the Seattle CBD (TAZs 71-86; 93-112; 117-152; 157-168), and in and around the University of Washington (TAZs 54, 56, and 59), was $20 per day per vehicle, for both carpools and single-occupant vehicles, and TDM policy would not change this. We assumed a $7.50/day charge to park a vanpool in these TAZs, and assumed that TDM policy would find a way to reduce this to $0. In other TAZs, we assumed that parking is now free for all vehicles, but that TDM policy would increase the cost of parking to $5.00 per vehicle for carpools and single-occupant vehicles, and leave it free for vanpools.

We also assumed that TDM activities would provide financial incentives and subsidies to change the cost per person (exclusive of parking) of making a commute trip to any of these TAZs, as follows (Table 2):

Table 2 – Cost per Person Trip, By Mode

Mode	Present cost/person trip	Cost/person trip with TDM program
Drive-alone	$8.00	$8.00
Carpool	$4.00	$2.00
Vanpool	$4.50	$4.00
Public transit	$4.00	$1.00
Biking	$0.20	$0.00

We would also have done this for walking and "other" modes, but the PSRC regional model does not include them in its mode split.

This scenario was designed solely to demonstrate use of the procedure. An actual analysis would estimate the average cost of parking for each TAZ, and also the average cost per trip by mode for each TAZ, given the existing availability of incentives through the state's Commute Trip Reduction Program, and any tolls planned for the SR 520 Bridge. For example, the average cost of a public transportation trip in the demonstration ignores the fact that a sizeable (but, to us, unknown) proportion of employees working in downtown Seattle have transit passes, provided by their employers, which make the out-of-pocket cost of a transit trip to work effectively $0.00.

RESULTS FROM THE DEMONSTRATION

Because TRIMMS© 2.0 works with elasticities, which calculate percentage changes as a function of other percentage changes, it is more useful to examine the results in terms of changes in the percent of trips made by different modes (the difference between the original mode share and the resulting mode share, divided by the original mode share), rather than the difference in percentage points (the difference between the original mode share and the resulting mode share) for specific modes.

Table 3 presents the results for all TAZs in the demonstration. Rows highlighted in light gray (CBD, University of Washington, and areas nearby) are those where we assumed no change in parking costs for driving alone or carpooling, and a reduction in parking costs for vanpooling. Rows without highlighting are those we assumed had increases in parking for driving alone and carpooling, but not for vanpooling.

Results tend to mirror this division of the TAZs.

TAZs where the demonstration increased parking prices all showed reductions in driving alone, *and* increases in the other four modes. These TAZs showed average decreases in driving alone of 16.9 percent, with increases in carpooling of 2.7 percent; in vanpooling of 3.2 percent; in public transportation use of 29.7 percent; and in bicycling of 7.3 percent.

TAZs where parking prices were already high, and did not change in the demonstration except to reduce the cost of parking for vanpools; all showed reductions in all modes except public transportation, which showed an increase. For these TAZs, driving alone decreased by 9.7 percent; carpooling by 4.5 percent; vanpooling by 5 percent; and bicycling by 4.5 percent; while public transportation use increased by 21.6 percent.

These results may seem counter-intuitive, but in the former case the impetus for change was an increase in the cost of both driving and carpooling, which had the effect of “pushing” people out of driving and into other modes; there was at the same time a large reduction in the cost of public transportation which attracted most of the former drivers, and smaller reductions in the costs of other modes. In the latter case, the impetus was a large decrease in the cost of using public transportation, with a small reduction in the costs of other modes. The large decrease in the cost of using public transportation attracted people out of all other modes, including those whose costs had decreased in the demonstration.

Using assumptions about vehicle occupancy consistent with the way that WSDOT processes its employee survey data, we estimated that 64,250 vehicle trips entered the 170 TAZs in the base conditions, and approximately 58,300 under the parking and subsidy measures assumed for the demonstration, for a reduction of about 5,900 trips. Not all of these would come off of the SR520 bridge, and further analysis would be required to estimate how many would.

Table 3 – Changes in Mode Split

	Updated (by TDMAP)					Original					Absolute change in percentage points					Relative change in percent				
TAZ	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike
1	40.3%	28.7%	0.0%	27.1%	3.9%	48.1%	27.6%	0.0%	20.6%	3.6%	-7.9%	1.1%	0.0%	6.5%	0.3%	-16.4%	3.9%	-	31.6%	8.5%
2	29.6%	41.6%	0.0%	20.8%	7.9%	35.8%	40.6%	0.0%	16.1%	7.4%	-6.1%	1.0%	0.0%	4.7%	0.5%	-17.2%	2.4%	-	29.0%	6.9%
3	28.7%	47.9%	0.0%	18.4%	4.9%	34.6%	46.6%	0.0%	14.2%	4.6%	-5.8%	1.3%	0.0%	4.2%	0.3%	-16.9%	2.9%	-	29.3%	7.1%
4	27.6%	37.7%	0.0%	19.4%	15.3%	33.5%	37.1%	0.0%	15.1%	14.3%	-5.8%	0.6%	0.0%	4.3%	1.0%	-17.4%	1.6%	-	28.3%	6.7%
5	36.0%	34.6%	0.0%	23.6%	5.9%	43.1%	33.4%	0.0%	18.1%	5.4%	-7.1%	1.1%	0.0%	5.5%	0.4%	-16.5%	3.4%	-	30.6%	8.0%
6	39.5%	29.1%	0.0%	27.4%	4.0%	47.3%	28.2%	0.0%	20.9%	3.7%	-7.8%	1.0%	0.0%	6.5%	0.3%	-16.5%	3.5%	-	31.1%	8.1%
7	23.3%	55.7%	0.0%	16.6%	4.3%	28.2%	54.7%	0.0%	13.0%	4.1%	-4.9%	1.0%	0.0%	3.6%	0.2%	-17.3%	1.8%	-	27.9%	6.1%
8	42.7%	22.5%	0.0%	30.1%	4.7%	51.1%	21.8%	0.0%	22.8%	4.3%	-8.3%	0.7%	0.0%	7.2%	0.4%	-16.3%	3.4%	3.1%	31.6%	8.4%
9	25.2%	46.9%	0.0%	17.1%	10.7%	30.5%	46.1%	0.0%	13.4%	10.0%	-5.3%	0.9%	0.0%	3.8%	0.7%	-17.3%	1.8%	-	28.2%	6.5%
10	35.0%	37.5%	0.0%	22.6%	5.0%	41.9%	36.2%	0.0%	17.3%	4.6%	-6.9%	1.3%	0.0%	5.3%	0.4%	-16.5%	3.5%	-	30.5%	7.9%
11	27.2%	45.7%	0.0%	19.5%	7.5%	32.9%	44.8%	0.0%	15.2%	7.1%	-5.7%	0.9%	0.0%	4.3%	0.5%	-17.3%	2.1%	-	28.5%	6.6%
12	21.4%	57.8%	0.0%	15.4%	5.3%	25.9%	57.0%	0.0%	12.1%	5.0%	-4.5%	0.9%	0.0%	3.3%	0.3%	-17.3%	1.5%	-	27.6%	5.9%
13	28.8%	35.2%	0.0%	20.7%	15.3%	34.9%	34.6%	0.0%	16.1%	14.3%	-6.1%	0.6%	0.0%	4.6%	1.0%	-17.5%	1.6%	-	28.4%	6.8%
14	34.9%	36.5%	0.0%	24.2%	4.3%	42.0%	35.4%	0.0%	18.6%	4.0%	-7.0%	1.1%	0.0%	5.6%	0.3%	-16.8%	3.2%	-	30.2%	7.6%
15	38.9%	30.1%	0.0%	26.4%	4.6%	46.5%	29.1%	0.0%	20.1%	4.3%	-7.6%	1.0%	0.0%	6.2%	0.4%	-16.4%	3.5%	-	31.1%	8.2%
16	39.6%	29.5%	0.1%	26.5%	4.2%	47.3%	28.5%	0.1%	20.2%	3.9%	-7.7%	1.1%	0.0%	6.3%	0.3%	-16.3%	3.7%	3.1%	31.3%	8.4%
17	42.4%	25.5%	0.0%	28.4%	3.7%	50.5%	24.5%	0.0%	21.5%	3.4%	-8.1%	1.0%	0.0%	6.9%	0.3%	-16.1%	3.9%	-	31.9%	8.7%
18	29.7%	41.3%	0.0%	20.5%	8.4%	35.9%	40.3%	0.0%	15.9%	7.9%	-6.1%	1.0%	0.0%	4.6%	0.6%	-17.1%	2.4%	-	29.0%	7.0%
19	31.2%	44.1%	0.0%	19.9%	4.8%	37.5%	42.7%	0.0%	15.3%	4.5%	-6.3%	1.4%	0.0%	4.6%	0.3%	-16.7%	3.2%	-	29.8%	7.5%
20	26.0%	50.5%	0.0%	18.4%	5.0%	31.5%	49.5%	0.0%	14.4%	4.7%	-5.4%	1.1%	0.0%	4.1%	0.3%	-17.3%	2.1%	-	28.4%	6.4%
21	31.1%	38.6%	0.0%	20.8%	9.5%	37.5%	37.6%	0.0%	16.1%	8.8%	-6.4%	1.0%	0.0%	4.7%	0.6%	-17.0%	2.6%	-	29.4%	7.3%
22	36.1%	34.7%	0.0%	24.3%	4.8%	43.3%	33.6%	0.0%	18.6%	4.5%	-7.2%	1.1%	0.0%	5.7%	0.4%	-16.6%	3.4%	-	30.5%	7.9%
23	36.7%	32.3%	0.0%	26.2%	4.8%	44.1%	31.3%	0.0%	20.1%	4.5%	-7.4%	1.0%	0.0%	6.1%	0.3%	-16.8%	3.1%	-	30.4%	7.7%
24	32.0%	41.3%	0.0%	21.3%	5.5%	38.4%	40.1%	0.0%	16.4%	5.1%	-6.5%	1.2%	0.0%	4.9%	0.4%	-16.8%	3.0%	-	29.7%	7.4%
25	44.2%	19.3%	0.1%	31.3%	5.0%	52.8%	18.7%	0.1%	23.7%	4.6%	-8.6%	0.6%	0.0%	7.5%	0.4%	-16.2%	3.3%	3.2%	31.8%	8.5%
26	31.7%	39.2%	0.0%	22.4%	6.7%	38.2%	38.2%	0.0%	17.3%	6.2%	-6.5%	1.0%	0.0%	5.1%	0.4%	-17.1%	2.6%	-	29.4%	7.2%

	Updated (by TDMAP)					Original					Absolute change in percentage points					Relative change in percent				
TAZ	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike
27	34.4%	35.1%	0.0%	24.3%	6.2%	41.4%	34.1%	0.0%	18.7%	5.8%	-7.0%	1.0%	0.0%	5.6%	0.4%	-16.9%	2.9%	-	29.9%	7.5%
28	20.9%	58.9%	0.0%	14.1%	6.0%	25.3%	58.0%	0.0%	11.1%	5.6%	-4.4%	0.9%	0.0%	3.1%	0.3%	-17.2%	1.6%	-	27.7%	6.0%
29	35.5%	34.6%	0.0%	25.8%	4.2%	42.7%	33.6%	0.0%	19.8%	3.9%	-7.2%	1.0%	0.0%	6.0%	0.3%	-16.9%	2.9%	-	30.1%	7.4%
30	34.6%	35.9%	0.0%	22.9%	6.6%	41.5%	34.7%	0.0%	17.6%	6.2%	-6.9%	1.1%	0.0%	5.3%	0.5%	-16.7%	3.2%	-	30.3%	7.8%
31	23.4%	43.0%	0.0%	17.0%	16.6%	28.4%	42.6%	0.0%	13.3%	15.7%	-5.0%	0.4%	0.0%	3.6%	0.9%	-17.7%	1.0%	-	27.4%	6.1%
32	34.9%	35.9%	0.0%	23.4%	5.8%	41.8%	34.8%	0.0%	18.0%	5.4%	-7.0%	1.1%	0.0%	5.4%	0.4%	-16.7%	3.2%	-	30.3%	7.8%
33	30.3%	39.5%	0.0%	20.8%	9.4%	36.5%	38.6%	0.0%	16.1%	8.7%	-6.3%	0.9%	0.0%	4.7%	0.6%	-17.1%	2.4%	-	29.1%	7.1%
34	32.0%	39.2%	0.0%	23.6%	5.2%	38.6%	38.2%	0.0%	18.3%	4.8%	-6.6%	1.0%	0.0%	5.4%	0.3%	-17.2%	2.5%	-	29.3%	6.9%
35	34.8%	35.7%	0.2%	23.6%	5.8%	41.7%	34.6%	0.2%	18.1%	5.4%	-7.0%	1.1%	0.0%	5.5%	0.4%	-16.7%	3.1%	2.4%	30.2%	7.7%
36	33.0%	39.2%	0.0%	22.5%	5.3%	39.7%	38.0%	0.0%	17.3%	5.0%	-6.7%	1.1%	0.0%	5.2%	0.4%	-16.8%	3.0%	-	29.9%	7.5%
37	31.7%	39.7%	0.0%	21.5%	7.2%	38.1%	38.6%	0.0%	16.6%	6.7%	-6.5%	1.1%	0.0%	4.9%	0.5%	-16.9%	2.8%	-	29.5%	7.3%
38	32.4%	38.8%	0.0%	22.0%	6.8%	38.9%	37.7%	0.0%	17.0%	6.3%	-6.6%	1.1%	0.0%	5.0%	0.5%	-16.9%	2.8%	-	29.7%	7.4%
39	27.4%	45.3%	0.0%	19.1%	8.2%	33.1%	44.4%	0.0%	14.9%	7.7%	-5.7%	1.0%	0.0%	4.2%	0.5%	-17.2%	2.1%	-	28.6%	6.7%
40	27.5%	46.3%	0.0%	19.5%	6.7%	33.3%	45.3%	0.0%	15.1%	6.3%	-5.7%	1.0%	0.0%	4.3%	0.4%	-17.2%	2.2%	-	28.6%	6.6%
41	35.0%	34.0%	0.0%	24.2%	6.8%	42.1%	33.0%	0.0%	18.6%	6.3%	-7.1%	1.0%	0.0%	5.6%	0.5%	-16.8%	3.0%	-	30.1%	7.7%
42	35.8%	35.6%	0.0%	23.5%	5.1%	42.8%	34.4%	0.0%	18.0%	4.8%	-7.1%	1.2%	0.0%	5.5%	0.4%	-16.5%	3.5%	-	30.6%	8.0%
43	25.8%	38.0%	0.0%	18.3%	17.9%	31.3%	37.6%	0.0%	14.3%	16.8%	-5.5%	0.5%	0.0%	4.0%	1.1%	-17.6%	1.2%	-	27.8%	6.4%
44	29.1%	44.8%	0.0%	20.1%	6.0%	35.1%	43.7%	0.0%	15.6%	5.6%	-6.0%	1.1%	0.0%	4.5%	0.4%	-17.1%	2.5%	-	29.0%	6.9%
45	25.7%	46.6%	0.0%	18.1%	9.6%	31.1%	45.8%	0.0%	14.1%	9.0%	-5.4%	0.8%	0.0%	4.0%	0.6%	-17.3%	1.8%	-	28.2%	6.5%
46	39.1%	29.0%	0.0%	27.3%	4.6%	46.8%	28.1%	0.0%	20.8%	4.3%	-7.7%	0.9%	0.0%	6.4%	0.3%	-16.5%	3.4%	-	31.0%	8.1%
47	39.1%	27.4%	0.0%	28.1%	5.4%	47.0%	26.6%	0.0%	21.5%	5.0%	-7.8%	0.8%	0.0%	6.6%	0.4%	-16.7%	3.1%	-	30.8%	7.9%
48	39.4%	28.9%	0.0%	27.7%	4.0%	47.2%	27.9%	0.0%	21.2%	3.7%	-7.8%	0.9%	0.0%	6.6%	0.3%	-16.5%	3.4%	-	31.0%	8.0%
49	31.0%	35.7%	0.0%	22.2%	11.0%	37.5%	35.0%	0.0%	17.2%	10.3%	-6.5%	0.8%	0.0%	5.0%	0.7%	-17.3%	2.1%	-	29.0%	7.1%
50	27.1%	44.4%	0.0%	18.1%	10.4%	32.7%	43.5%	0.0%	14.1%	9.7%	-5.6%	0.9%	0.0%	4.0%	0.7%	-17.2%	2.1%	-	28.6%	6.8%
51	36.1%	35.3%	0.0%	23.9%	4.6%	43.3%	34.1%	0.0%	18.3%	4.3%	-7.1%	1.2%	0.0%	5.6%	0.3%	-16.5%	3.5%	-	30.6%	8.0%
52	54.6%	8.7%	0.3%	34.6%	1.8%	64.0%	8.3%	0.3%	25.7%	1.7%	-9.4%	0.4%	0.0%	8.9%	0.2%	-14.7%	4.4%	4.8%	34.4%	10.1%
53	29.6%	38.6%	0.0%	21.4%	10.4%	35.8%	37.8%	0.0%	16.6%	9.7%	-6.2%	0.8%	0.0%	4.8%	0.7%	-17.3%	2.0%	-	28.7%	6.8%
54	50.3%	14.6%	0.4%	31.7%	2.9%	55.5%	15.3%	0.4%	25.8%	2.9%	-5.2%	-0.6%	0.0%	5.9%	0.0%	-9.4%	-4.2%	-4.2%	22.7%	0.6%

	Updated (by TDMAP)					Original					Absolute change in percentage points					Relative change in percent				
TAZ	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike
55	32.7%	39.2%	0.0%	22.9%	5.2%	39.4%	38.2%	0.0%	17.7%	4.8%	-6.7%	1.1%	0.0%	5.2%	0.4%	-17.0%	2.8%	-	29.7%	7.3%
56	45.1%	23.5%	0.0%	27.8%	3.5%	49.5%	24.3%	0.0%	22.6%	3.5%	-4.4%	-0.8%	0.0%	5.2%	0.0%	-8.9%	-3.3%	-	22.9%	1.2%
57	31.7%	38.1%	0.0%	22.0%	8.2%	38.2%	37.1%	0.0%	17.0%	7.7%	-6.5%	1.0%	0.0%	5.0%	0.6%	-17.0%	2.6%	-	29.4%	7.3%
58	26.9%	49.2%	0.0%	18.0%	5.8%	32.5%	48.1%	0.0%	14.0%	5.5%	-5.5%	1.2%	0.0%	4.0%	0.4%	-17.1%	2.4%	-	28.7%	6.7%
59	39.7%	33.2%	0.0%	22.5%	4.6%	43.3%	33.9%	0.0%	18.3%	4.5%	-3.6%	-0.8%	0.0%	4.3%	0.1%	-8.2%	-2.3%	-	23.3%	1.9%
60	35.1%	36.1%	0.0%	23.4%	5.4%	42.1%	34.9%	0.0%	18.0%	5.0%	-7.0%	1.2%	0.0%	5.5%	0.4%	-16.6%	3.3%	-	30.4%	7.8%
61	24.8%	42.2%	0.0%	18.0%	15.1%	30.1%	41.6%	0.0%	14.1%	14.2%	-5.3%	0.5%	0.0%	3.9%	0.9%	-17.6%	1.2%	-	27.7%	6.2%
62	35.7%	34.5%	0.0%	24.3%	5.5%	42.8%	33.4%	0.0%	18.6%	5.1%	-7.1%	1.1%	0.0%	5.7%	0.4%	-16.7%	3.2%	-	30.4%	7.8%
63	30.8%	43.0%	0.0%	21.1%	5.0%	37.2%	41.9%	0.0%	16.3%	4.7%	-6.3%	1.2%	0.0%	4.8%	0.3%	-17.0%	2.8%	-	29.4%	7.1%
64	45.8%	17.3%	0.0%	32.8%	4.1%	54.6%	16.7%	0.0%	24.9%	3.8%	-8.8%	0.5%	0.0%	8.0%	0.3%	-16.2%	3.3%	-	32.0%	8.5%
65	42.7%	21.7%	0.0%	30.7%	4.8%	51.1%	21.1%	0.0%	23.3%	4.5%	-8.4%	0.7%	0.0%	7.3%	0.4%	-16.4%	3.2%	-	31.5%	8.3%
66	42.9%	20.9%	0.0%	31.6%	4.7%	51.4%	20.2%	0.0%	24.1%	4.3%	-8.5%	0.6%	0.0%	7.5%	0.4%	-16.5%	3.0%	-	31.3%	8.1%
67	41.3%	24.0%	0.1%	29.7%	4.9%	49.5%	23.2%	0.1%	22.6%	4.5%	-8.2%	0.7%	0.0%	7.1%	0.4%	-16.5%	3.2%	2.8%	31.2%	8.2%
68	40.4%	25.1%	0.0%	28.6%	6.0%	48.4%	24.3%	0.0%	21.8%	5.5%	-8.0%	0.8%	0.0%	6.8%	0.5%	-16.5%	3.2%	-	31.1%	8.2%
69	36.0%	32.6%	0.0%	25.4%	6.0%	43.2%	31.7%	0.0%	19.5%	5.6%	-7.3%	0.9%	0.0%	5.9%	0.4%	-16.8%	3.0%	-	30.2%	7.7%
70	31.6%	36.9%	0.0%	23.9%	7.6%	38.2%	36.1%	0.0%	18.5%	7.1%	-6.6%	0.8%	0.0%	5.4%	0.5%	-17.3%	2.2%	-	29.0%	6.8%
71	39.0%	25.0%	1.3%	27.3%	7.3%	43.0%	26.0%	1.4%	22.4%	7.2%	-4.0%	-1.0%	-0.1%	5.0%	0.1%	-9.2%	-3.8%	-4.1%	22.2%	0.9%
72	53.5%	9.9%	0.0%	32.8%	3.7%	59.1%	10.4%	0.0%	26.8%	3.7%	-5.6%	-0.5%	0.0%	6.1%	0.0%	-9.5%	-4.7%	-4.4%	22.7%	0.5%
73	47.3%	9.1%	0.2%	29.3%	14.1%	52.3%	9.6%	0.2%	24.0%	13.9%	-5.0%	-0.5%	0.0%	5.3%	0.2%	-9.6%	-4.8%	-4.4%	22.2%	1.1%
74	47.0%	21.2%	0.0%	28.4%	3.4%	51.6%	21.9%	0.0%	23.0%	3.4%	-4.6%	-0.7%	0.0%	5.3%	0.0%	-8.9%	-3.4%	-	23.0%	1.2%
75	34.2%	40.8%	0.0%	20.3%	4.7%	37.2%	41.7%	0.0%	16.5%	4.6%	-3.0%	-0.9%	0.0%	3.8%	0.1%	-8.0%	-2.2%	-	23.1%	1.9%
76	42.3%	28.2%	0.0%	25.9%	3.5%	46.4%	29.1%	0.0%	21.1%	3.5%	-4.0%	-0.8%	0.0%	4.8%	0.0%	-8.7%	-2.9%	-	23.0%	1.4%
77	52.3%	13.2%	1.3%	31.2%	2.0%	57.6%	13.7%	1.3%	25.4%	2.0%	-5.3%	-0.6%	-0.1%	5.9%	0.0%	-9.1%	-4.0%	-3.9%	23.0%	0.8%
78	39.4%	33.5%	0.0%	22.5%	4.5%	43.0%	34.3%	0.0%	18.2%	4.4%	-3.5%	-0.8%	0.0%	4.3%	0.1%	-8.2%	-2.3%	-	23.3%	1.9%
79	35.5%	35.5%	0.0%	20.7%	8.3%	38.6%	36.3%	0.0%	16.8%	8.2%	-3.2%	-0.9%	0.0%	3.9%	0.2%	-8.2%	-2.5%	-	23.1%	2.0%
80	53.1%	9.9%	0.0%	34.1%	2.9%	58.9%	10.4%	0.0%	27.8%	2.9%	-5.7%	-0.5%	0.0%	6.2%	0.0%	-9.7%	-4.9%	-4.7%	22.4%	0.2%
81	26.5%	49.9%	0.0%	15.7%	7.9%	28.6%	50.9%	0.0%	12.8%	7.7%	-2.1%	-1.0%	0.0%	3.0%	0.2%	-7.4%	-2.0%	-	23.2%	2.3%
82	51.4%	14.2%	0.0%	31.6%	2.8%	56.6%	14.8%	0.0%	25.7%	2.8%	-5.3%	-0.6%	0.0%	5.9%	0.0%	-9.3%	-4.2%	-4.2%	22.8%	0.7%

	Updated (by TDMAP)					Original					Absolute change in percentage points					Relative change in percent				
TAZ	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike
83	33.1%	38.8%	0.0%	19.8%	8.3%	36.0%	39.7%	0.0%	16.1%	8.2%	-2.9%	-1.0%	0.0%	3.7%	0.2%	-8.1%	-2.4%	- -	23.0%	2.0%
84	50.3%	15.3%	0.0%	30.9%	3.4%	55.5%	15.9%	0.0%	25.2%	3.4%	-5.1%	-0.6%	0.0%	5.7%	0.0%	-9.3%	-4.0%	- -	22.8%	0.8%
85	41.0%	18.8%	0.0%	23.8%	16.4%	44.9%	19.5%	0.0%	19.4%	16.1%	-4.0%	-0.7%	0.0%	4.4%	0.3%	-8.9%	-3.7%	- -	22.6%	1.9%
86	46.2%	21.3%	0.0%	28.0%	4.5%	50.7%	22.0%	0.0%	22.8%	4.5%	-4.5%	-0.7%	0.0%	5.2%	0.1%	-8.9%	-3.4%	- -	23.0%	1.2%
87	43.0%	20.3%	0.0%	32.3%	4.4%	51.6%	19.7%	0.0%	24.6%	4.1%	-8.6%	0.6%	0.0%	7.7%	0.3%	-16.6%	2.9%	2.7%	31.2%	8.0%
88	33.3%	36.0%	0.0%	24.1%	6.6%	40.1%	35.1%	0.0%	18.6%	6.2%	-6.9%	0.9%	0.0%	5.5%	0.4%	-17.1%	2.6%	- -	29.6%	7.2%
89	30.3%	38.0%	0.0%	22.3%	9.4%	36.7%	37.2%	0.0%	17.3%	8.8%	-6.4%	0.8%	0.0%	5.0%	0.6%	-17.3%	2.1%	- -	28.8%	6.8%
90	31.8%	38.7%	0.0%	21.6%	7.9%	38.3%	37.7%	0.0%	16.6%	7.4%	-6.5%	1.0%	0.0%	4.9%	0.5%	-17.0%	2.7%	- -	29.5%	7.4%
91	36.6%	31.7%	0.0%	25.9%	5.9%	43.9%	30.7%	0.0%	19.8%	5.5%	-7.4%	0.9%	0.0%	6.0%	0.4%	-16.8%	3.0%	- -	30.3%	7.7%
92	27.9%	46.3%	0.0%	20.3%	5.5%	33.7%	45.4%	0.0%	15.8%	5.1%	-5.8%	1.0%	0.0%	4.5%	0.3%	-17.3%	2.2%	- -	28.6%	6.5%
93	40.8%	29.3%	0.0%	24.3%	5.6%	44.6%	30.1%	0.0%	19.8%	5.5%	-3.8%	-0.8%	0.0%	4.6%	0.1%	-8.6%	-2.8%	- -	23.1%	1.6%
94	49.0%	16.7%	0.1%	31.5%	2.7%	54.1%	17.5%	0.1%	25.7%	2.7%	-5.1%	-0.7%	0.0%	5.8%	0.0%	-9.4%	-4.1%	-4.3%	22.6%	0.6%
95	39.8%	24.1%	0.2%	25.4%	10.6%	43.7%	25.0%	0.2%	20.7%	10.5%	-3.9%	-0.9%	0.0%	4.7%	0.1%	-9.0%	-3.5%	-3.8%	22.5%	1.4%
96	39.4%	31.7%	0.0%	22.2%	6.6%	42.9%	32.5%	0.0%	18.0%	6.5%	-3.5%	-0.8%	0.0%	4.2%	0.1%	-8.3%	-2.4%	- -	23.3%	2.0%
97	33.3%	40.7%	0.0%	20.6%	5.5%	36.3%	41.6%	0.0%	16.7%	5.4%	-2.9%	-1.0%	0.0%	3.8%	0.1%	-8.1%	-2.4%	- -	23.0%	1.8%
98	32.7%	38.8%	0.0%	21.8%	6.8%	35.7%	39.9%	0.0%	17.7%	6.7%	-3.0%	-1.1%	0.0%	4.0%	0.1%	-8.4%	-2.8%	- -	22.6%	1.5%
99	41.4%	16.1%	0.0%	35.7%	6.8%	46.4%	17.1%	0.0%	29.6%	6.9%	-5.0%	-1.0%	0.0%	6.1%	-0.1%	-10.8%	-5.9%	-5.8%	20.6%	-0.8%
100	27.6%	45.1%	0.0%	21.6%	5.7%	30.1%	46.6%	0.0%	17.7%	5.6%	-2.5%	-1.5%	0.0%	3.9%	0.1%	-8.4%	-3.1%	- -	22.1%	1.1%
101	45.8%	13.2%	0.0%	35.5%	5.5%	51.2%	14.0%	0.0%	29.3%	5.5%	-5.4%	-0.8%	0.0%	6.2%	0.0%	-10.5%	-5.6%	- -	21.2%	-0.5%
102	36.6%	21.1%	0.0%	34.7%	7.6%	41.0%	22.4%	0.0%	28.9%	7.7%	-4.5%	-1.3%	0.0%	5.8%	-0.1%	-10.9%	-5.8%	- -	20.2%	-0.9%
103	47.9%	11.9%	0.1%	35.6%	4.5%	53.4%	12.6%	0.1%	29.3%	4.5%	-5.6%	-0.7%	0.0%	6.3%	0.0%	-10.4%	-5.5%	-5.3%	21.5%	-0.4%
104	40.7%	18.2%	0.0%	34.5%	6.7%	45.5%	19.2%	0.0%	28.5%	6.7%	-4.8%	-1.1%	0.0%	5.9%	0.0%	-10.6%	-5.5%	- -	20.8%	-0.6%
105	40.2%	16.8%	0.0%	36.0%	7.0%	45.2%	17.9%	0.0%	29.9%	7.0%	-5.0%	-1.1%	0.0%	6.1%	-0.1%	-11.0%	-6.0%	-6.0%	20.4%	-1.0%
106	41.6%	18.9%	0.0%	33.0%	6.4%	46.4%	20.0%	0.0%	27.2%	6.5%	-4.8%	-1.0%	0.0%	5.8%	0.0%	-10.3%	-5.1%	-5.2%	21.3%	-0.2%
107	43.3%	18.6%	0.0%	33.6%	4.5%	48.2%	19.6%	0.0%	27.7%	4.5%	-4.9%	-1.0%	0.0%	5.9%	0.0%	-10.2%	-5.0%	-5.1%	21.4%	-0.2%
108	33.7%	22.7%	0.0%	35.6%	7.9%	38.0%	24.2%	0.0%	29.8%	8.0%	-4.2%	-1.5%	0.0%	5.8%	-0.1%	-11.1%	-6.2%	- -	19.6%	-1.4%
109	40.7%	13.2%	0.0%	39.3%	6.8%	46.1%	14.1%	0.0%	32.8%	6.9%	-5.4%	-1.0%	0.0%	6.5%	-0.1%	-11.7%	-6.9%	-6.6%	19.7%	-1.7%
110	24.7%	47.2%	0.0%	20.4%	7.8%	26.9%	48.7%	0.0%	16.7%	7.7%	-2.2%	-1.6%	0.0%	3.7%	0.1%	-8.2%	-3.2%	- -	22.1%	1.2%

	Updated (by TDMAP)					Original					Absolute change in percentage points					Relative change in percent				
TAZ	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike
111	32.6%	32.4%	0.0%	27.1%	8.0%	36.0%	33.8%	0.0%	22.3%	7.9%	-3.4%	-1.4%	0.0%	4.8%	0.0%	-9.5%	-4.2%	-4.6%	21.4%	0.4%
112	38.9%	26.0%	0.1%	28.2%	6.7%	42.9%	27.1%	0.1%	23.2%	6.7%	-4.1%	-1.1%	0.0%	5.1%	0.0%	-9.4%	-4.0%	-4.4%	22.0%	0.7%
113	36.4%	33.2%	0.0%	25.0%	5.4%	43.7%	32.1%	0.0%	19.1%	5.0%	-7.3%	1.0%	0.0%	5.8%	0.4%	-16.6%	3.2%	- -	30.5%	7.9%
114	22.6%	54.7%	0.0%	16.0%	6.7%	27.3%	53.8%	0.0%	12.5%	6.4%	-4.7%	0.9%	0.0%	3.5%	0.4%	-17.3%	1.6%	- -	27.8%	6.1%
115	31.3%	36.6%	0.0%	22.2%	9.9%	37.7%	35.8%	0.0%	17.2%	9.3%	-6.5%	0.8%	0.0%	5.0%	0.7%	-17.2%	2.3%	- -	29.1%	7.1%
116	32.1%	37.8%	0.0%	22.8%	7.3%	38.7%	36.8%	0.0%	17.6%	6.8%	-6.6%	0.9%	0.0%	5.2%	0.5%	-17.1%	2.6%	- -	29.4%	7.2%
117	40.3%	30.5%	0.0%	25.1%	4.1%	44.1%	31.4%	0.0%	20.5%	4.0%	-3.8%	-0.9%	0.0%	4.7%	0.1%	-8.7%	-2.9%	- -	22.9%	1.4%
118	30.4%	36.5%	0.0%	21.7%	11.4%	33.2%	37.8%	0.0%	17.7%	11.3%	-2.8%	-1.2%	0.0%	3.9%	0.2%	-8.6%	-3.3%	- -	22.2%	1.4%
119	36.5%	24.9%	0.1%	31.0%	7.5%	40.6%	26.2%	0.1%	25.6%	7.5%	-4.1%	-1.3%	0.0%	5.4%	0.0%	-10.1%	-4.9%	-5.1%	21.0%	-0.1%
120	39.4%	17.7%	0.2%	34.4%	8.3%	44.1%	18.8%	0.2%	28.6%	8.3%	-4.7%	-1.1%	0.0%	5.9%	-0.1%	-10.7%	-5.7%	-5.7%	20.6%	-0.7%
121	32.1%	23.9%	0.0%	34.2%	9.8%	36.1%	25.5%	0.0%	28.6%	9.9%	-4.0%	-1.6%	0.0%	5.6%	-0.1%	-11.0%	-6.1%	- -	19.7%	-1.2%
122	33.6%	29.4%	0.0%	29.4%	7.6%	37.3%	30.8%	0.0%	24.3%	7.6%	-3.7%	-1.4%	0.0%	5.1%	0.0%	-9.9%	-4.6%	- -	21.0%	0.0%
123	38.9%	15.5%	0.5%	37.8%	7.4%	43.9%	16.6%	0.5%	31.5%	7.5%	-5.0%	-1.1%	0.0%	6.2%	-0.1%	-11.4%	-6.6%	-6.4%	19.8%	-1.5%
124	32.3%	19.6%	0.1%	37.0%	11.0%	36.5%	21.1%	0.1%	31.1%	11.2%	-4.2%	-1.5%	0.0%	5.9%	-0.2%	-11.6%	-6.9%	-6.8%	19.0%	-1.8%
125	36.7%	16.2%	0.1%	38.1%	9.0%	41.5%	17.4%	0.1%	31.9%	9.1%	-4.8%	-1.2%	0.0%	6.2%	-0.2%	-11.6%	-6.9%	-6.7%	19.4%	-1.7%
126	30.1%	39.1%	0.0%	24.7%	6.1%	33.1%	40.6%	0.0%	20.3%	6.0%	-3.0%	-1.5%	0.0%	4.4%	0.0%	-9.0%	-3.6%	- -	21.7%	0.7%
127	25.3%	40.3%	0.1%	25.4%	8.9%	27.9%	42.2%	0.1%	21.0%	8.9%	-2.6%	-1.8%	0.0%	4.4%	0.0%	-9.2%	-4.4%	-4.7%	21.0%	0.2%
128	31.7%	31.2%	0.0%	28.7%	8.4%	35.2%	32.7%	0.0%	23.7%	8.4%	-3.4%	-1.5%	0.0%	5.0%	0.0%	-9.8%	-4.6%	-5.0%	20.9%	0.0%
129	33.8%	17.7%	0.1%	38.1%	10.4%	38.3%	19.1%	0.1%	32.0%	10.6%	-4.5%	-1.4%	0.0%	6.1%	-0.2%	-11.8%	-7.1%	-6.9%	18.9%	-1.9%
130	37.9%	16.4%	1.1%	37.2%	7.5%	42.7%	17.5%	1.1%	31.1%	7.6%	-4.8%	-1.1%	-0.1%	6.2%	-0.1%	-11.3%	-6.5%	-6.3%	19.8%	-1.4%
131	29.6%	36.9%	0.0%	25.8%	7.7%	32.7%	38.5%	0.0%	21.3%	7.6%	-3.0%	-1.6%	0.0%	4.5%	0.0%	-9.3%	-4.0%	- -	21.4%	0.4%
132	30.6%	33.4%	0.0%	28.1%	7.9%	33.8%	35.0%	0.0%	23.2%	7.9%	-3.3%	-1.6%	0.0%	4.9%	0.0%	-9.7%	-4.5%	- -	21.0%	0.0%
133	30.7%	37.1%	0.0%	25.0%	7.1%	33.8%	38.5%	0.0%	20.6%	7.1%	-3.1%	-1.4%	0.0%	4.5%	0.0%	-9.1%	-3.7%	- -	21.7%	0.7%
134	35.9%	18.9%	0.0%	38.2%	7.1%	40.6%	20.2%	0.0%	32.0%	7.2%	-4.7%	-1.4%	0.0%	6.2%	-0.1%	-11.6%	-6.7%	- -	19.4%	-1.8%
135	30.5%	24.9%	0.0%	34.2%	10.3%	34.3%	26.6%	0.0%	28.6%	10.5%	-3.8%	-1.7%	0.0%	5.6%	-0.1%	-11.0%	-6.2%	-6.3%	19.5%	-1.3%
136	31.8%	19.1%	0.2%	37.1%	11.7%	36.0%	20.6%	0.3%	31.2%	12.0%	-4.2%	-1.4%	0.0%	5.9%	-0.2%	-11.6%	-7.0%	-6.9%	18.9%	-1.9%
137	35.7%	16.2%	0.0%	39.5%	8.6%	40.6%	17.5%	0.0%	33.2%	8.8%	-4.8%	-1.3%	0.0%	6.3%	-0.2%	-11.9%	-7.2%	- -	18.9%	-2.1%
138	25.3%	38.1%	0.0%	26.6%	10.0%	27.9%	40.0%	0.0%	22.1%	10.0%	-2.7%	-1.9%	0.0%	4.6%	0.0%	-9.5%	-4.7%	-5.0%	20.6%	-0.1%

	Updated (by TDMAP)					Original					Absolute change in percentage points					Relative change in percent				
TAZ	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike
139	44.5%	9.9%	0.0%	38.9%	6.7%	50.3%	10.7%	0.0%	32.3%	6.8%	-5.7%	-0.7%	0.0%	6.5%	-0.1%	-11.4%	-6.7%	-	20.2%	-1.4%
140	35.4%	26.4%	0.1%	31.3%	6.8%	39.4%	27.8%	0.1%	25.9%	6.8%	-4.0%	-1.4%	0.0%	5.4%	0.0%	-10.2%	-4.9%	-5.2%	20.9%	-0.3%
141	18.8%	54.8%	0.0%	17.4%	9.0%	20.3%	56.5%	0.0%	14.3%	8.9%	-1.5%	-1.8%	0.0%	3.2%	0.1%	-7.5%	-3.1%	-	22.2%	1.5%
142	36.9%	16.8%	0.3%	37.9%	8.1%	41.7%	18.0%	0.3%	31.7%	8.2%	-4.8%	-1.2%	0.0%	6.2%	-0.1%	-11.5%	-6.7%	-6.6%	19.5%	-1.6%
143	26.8%	36.4%	0.0%	23.9%	12.8%	29.5%	38.0%	0.0%	19.7%	12.8%	-2.7%	-1.6%	0.0%	4.2%	0.1%	-9.1%	-4.2%	-4.5%	21.3%	0.6%
144	0.0%	6.2%	92.5%	0.0%	1.3%	0.0%	6.3%	92.5%	0.0%	1.3%	0.0%	-0.1%	0.0%	0.0%	0.1%	-	-1.1%	0.0%	-	4.9%
145	30.8%	35.5%	0.0%	26.7%	7.0%	34.0%	37.0%	0.0%	22.0%	7.0%	-3.2%	-1.5%	0.0%	4.7%	0.0%	-9.4%	-4.1%	-	21.3%	0.3%
146	30.8%	33.8%	1.3%	27.5%	6.7%	34.0%	35.3%	1.3%	22.7%	6.7%	-3.2%	-1.5%	-0.1%	4.8%	0.0%	-9.5%	-4.3%	-4.7%	21.2%	0.2%
147	40.0%	11.7%	0.6%	40.5%	7.2%	45.4%	12.6%	0.6%	34.0%	7.3%	-5.4%	-0.9%	0.0%	6.6%	-0.1%	-12.0%	-7.3%	-6.9%	19.3%	-2.0%
148	41.9%	15.1%	1.3%	35.4%	6.3%	46.9%	16.0%	1.4%	29.3%	6.3%	-5.0%	-0.9%	-0.1%	6.1%	0.0%	-10.7%	-5.8%	-5.6%	20.8%	-0.7%
149	33.7%	17.5%	0.1%	38.8%	9.9%	38.2%	18.9%	0.1%	32.7%	10.1%	-4.5%	-1.4%	0.0%	6.1%	-0.2%	-11.9%	-7.2%	-7.1%	18.8%	-2.1%
150	40.0%	19.2%	0.1%	29.4%	11.3%	44.3%	20.2%	0.1%	24.2%	11.3%	-4.3%	-0.9%	0.0%	5.2%	0.1%	-9.8%	-4.7%	-4.7%	21.6%	0.5%
151	51.0%	13.4%	0.2%	32.8%	2.6%	56.4%	14.0%	0.2%	26.8%	2.6%	-5.4%	-0.6%	0.0%	6.0%	0.0%	-9.6%	-4.5%	-4.4%	22.5%	0.4%
152	33.8%	32.2%	0.0%	21.4%	12.6%	36.9%	33.2%	0.0%	17.5%	12.4%	-3.1%	-1.0%	0.0%	3.9%	0.2%	-8.5%	-3.1%	-	22.6%	1.7%
153	18.0%	60.9%	0.0%	13.9%	7.3%	21.8%	60.4%	0.0%	10.9%	6.9%	-3.8%	0.5%	0.0%	2.9%	0.4%	-17.5%	0.8%	-	26.9%	5.4%
154	22.4%	52.7%	0.0%	15.4%	9.5%	27.1%	51.9%	0.0%	12.1%	9.0%	-4.7%	0.8%	0.0%	3.3%	0.6%	-17.3%	1.5%	-	27.7%	6.1%
155	24.2%	53.6%	0.0%	16.9%	5.4%	29.2%	52.6%	0.0%	13.2%	5.0%	-5.0%	1.0%	0.0%	3.7%	0.3%	-17.3%	1.9%	-	28.1%	6.3%
156	43.2%	21.3%	0.0%	32.5%	3.1%	51.8%	20.6%	0.0%	24.7%	2.8%	-8.6%	0.6%	0.0%	7.7%	0.2%	-16.6%	3.0%	-	31.3%	8.0%
157	49.0%	14.9%	0.0%	31.9%	4.2%	54.2%	15.5%	0.0%	26.1%	4.2%	-5.2%	-0.7%	0.0%	5.8%	0.0%	-9.6%	-4.4%	-	22.4%	0.5%
158	35.3%	34.6%	0.0%	26.0%	4.0%	38.9%	35.8%	0.0%	21.3%	4.0%	-3.5%	-1.2%	0.0%	4.7%	0.0%	-9.1%	-3.4%	-	22.1%	0.8%
159	37.1%	27.1%	0.0%	30.3%	5.5%	41.1%	28.4%	0.0%	25.0%	5.5%	-4.1%	-1.3%	0.0%	5.3%	0.0%	-9.9%	-4.5%	-4.9%	21.4%	0.0%
160	52.7%	11.3%	0.1%	34.9%	1.0%	58.5%	11.9%	0.1%	28.5%	1.0%	-5.8%	-0.6%	0.0%	6.4%	0.0%	-9.9%	-4.9%	-4.8%	22.3%	-0.1%
161	47.6%	23.2%	0.0%	27.7%	1.5%	52.1%	23.9%	0.0%	22.4%	1.5%	-4.5%	-0.7%	0.0%	5.2%	0.0%	-8.7%	-3.0%	-3.5%	23.3%	1.3%
162	49.8%	15.2%	0.0%	32.3%	2.6%	55.1%	15.9%	0.1%	26.4%	2.6%	-5.3%	-0.7%	0.0%	5.9%	0.0%	-9.6%	-4.4%	-4.4%	22.5%	0.4%
163	49.1%	20.3%	0.0%	29.1%	1.5%	53.9%	21.0%	0.0%	23.6%	1.5%	-4.8%	-0.7%	0.0%	5.5%	0.0%	-8.9%	-3.3%	-3.7%	23.2%	1.1%
164	56.3%	8.9%	0.0%	33.2%	1.6%	62.1%	9.3%	0.0%	27.0%	1.5%	-5.8%	-0.4%	0.0%	6.2%	0.0%	-9.3%	-4.6%	-4.3%	23.0%	0.5%
165	55.5%	10.1%	0.1%	33.3%	1.0%	61.2%	10.6%	0.1%	27.1%	1.0%	-5.7%	-0.5%	0.0%	6.2%	0.0%	-9.3%	-4.5%	-4.3%	22.9%	0.4%
166	37.0%	28.3%	0.1%	31.0%	3.7%	41.0%	29.7%	0.1%	25.5%	3.7%	-4.1%	-1.3%	0.0%	5.4%	0.0%	-10.0%	-4.5%	-5.0%	21.3%	-0.1%

	Updated (by TDMAP)					Original					Absolute change in percentage points					Relative change in percent				
TAZ	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike	Auto-DA	Auto-RT	VAN	Transit	Bike
167	52.9%	13.4%	0.0%	32.1%	1.6%	58.3%	14.0%	0.0%	26.1%	1.5%	-5.4%	-0.6%	0.0%	6.0%	0.0%	-9.3%	-4.2%	-4.2%	22.9%	0.6%
168	40.9%	32.8%	0.0%	23.0%	3.4%	44.5%	33.5%	0.0%	18.6%	3.3%	-3.7%	-0.8%	0.0%	4.4%	0.1%	-8.2%	-2.2%	- -	23.4%	1.9%
169	28.7%	43.7%	0.0%	20.5%	7.1%	34.7%	42.7%	0.0%	15.9%	6.7%	-6.0%	1.0%	0.0%	4.6%	0.4%	-17.3%	2.2%	- -	28.7%	6.7%
170	42.1%	21.1%	0.0%	31.8%	5.1%	50.5%	20.5%	0.0%	24.2%	4.7%	-8.5%	0.6%	0.0%	7.5%	0.4%	-16.7%	2.8%	- -	31.0%	7.9%

CHAPTER 5 – DISCUSSION AND RECOMENDATIONS

The study objective was to develop methods to help WSDOT plan TDM strategies as part of its overall transportation planning process. Although the results of this project will help, they fall short of what the research team thinks ultimately believes would be most useful to WSDOT and the TDM community, if it could be developed. Ideally, someone wanting to use TDM in a corridor would like to choose the most cost-effective mix of program elements for conditions in that corridor, and for the desired level of change in vehicle traffic, and see how the cost and mix varies with the desired level of change. Building such a tool requires additional research, and improved data, on the cost and effectiveness of TDM program elements under different conditions. The following recommendations for research and data development would help bring this goal to fruition.

RECOMMENDATIONS FOR FUTURE RESEARCH AND DEVELOPMENT

Two operational issues remain to be resolved.

First, additional work is needed to assess the usability and usefulness of the TDMAP module within a "production" environment, where the regional model is used frequently for a wide variety of analyses, some involving the use of TDMAP and others not. To enhance the proposed procedure, it would be desirable to perform additional tests with local data, including the validation and calibration of embedded parameters and collecting feedback from MPO and WSDOT staff. This kind of production experience is beyond the scope of a research study. However, the project staff is interested in learning about experience in using TDMAP and what changes might make it easier to use.

Second, both PSRC's present regional transportation model and TDMAP can model the effects of changing the costs of parking, or the costs of using different travel modes. Where these are the only TDM elements to be analyzed, and when they are to be applied and analyzed for the whole region, they could be modeled as at present, or left to TDMAP. Additional experience and sensitivity analysis are needed to determine which would be preferable. Where these are the only elements to be analyzed, and are to be examined for small areas or groups of employers, TDMAP may be preferable. Where an analysis involves other TDM elements, whether for the whole region or not, and whether linked to policies that influence trip costs or not, then the TDMAP module would be preferable.

Ideally, the next generation of methods would also help identify and assess the most cost-effective mix of program elements for conditions in a corridor, and for the desired level of change in vehicle traffic, and see how the cost and mix varies with the desired level of change. Building such a tool requires additional research, and improved data, on the cost and effectiveness of TDM program elements under different conditions. Though the developed TDMAP procedure with TRIMMS© 2.0 provides significant improvements over other existing approaches, additional work is needed to improve data quality, improve the modeling, and understand commuter behavior. The following areas need attention:

DATA

1. Improve quality control of CTR data. WSDOT is fortunate to have a robust data collection system as part of the CTR program, and the development of TRIMMS relied on some of the CTR data. However, we encountered difficulty in analyzing the CTR data because of quality control issues. For example, the total amounts that CTR employers reported paying in subsidies and incentives through the CTR program's employer cost survey do not match well the amounts calculated using the transit mode share (from the employee surveys) and the amount of subsidy offered by the employer (from the program plans/annual reports). As another example, information reported by individual employers in the annual reports, and in the employer cost surveys, often is not consistent from year to year. It is not possible at this time, now that several years have passed since the employers reported the data, to determine whether the differences reflect real changes in programs and expenses, or reporting error. The ability to use WSDOT CTR data for analysis would be greatly enhanced if the information collected could be compared, as it is received, with data from earlier years and other collection systems, with discrepancies between current and recent data followed up by discussions with the employer.

2. Improve data on the costs of TDM programs. A key need when planning TDM projects is to know the cost as well as the effectiveness of implementing individual TDM program elements, or of implementing common combinations of elements. Data are needed both on expenditures by employers, and on expenditures by public agencies or others to encourage, require, or otherwise support employer implementation. We had hoped to provide a cost-estimation module as part of this project, and we spent considerable time attempting to correlate employer investments into strategies as an indicator of change. Again, the main obstacle was the quality of the data, the lack of data on public expenditures linked to private efforts, and links to the effects of these efforts.

3. Better data are needed on the relative costs and effectiveness of different ways of implementing TDM program elements. For example, the employers in the Washington CTR program historically have provided continuing financial incentives to their employees to encourage or reward use of alternative modes. The areawide transit pass program (FlexPass/ORCA) in the central Puget Sound region is one example, as are payments for each day that an employee uses an alternative. This is the type of subsidy/incentive program that TRIMMS 2.0 uses. But there are other ways of providing financial incentives that appear to be effective and may be less costly, such as providing a one-time incentive payment to an employee after s/he has used an alternative mode regularly for a couple of months. Better data are needed on the persistence of such effects, controlling for the impact of employee turnover, in order to compare the cost effectiveness of this approach with what CTR employers have used in the past.

IMPROVEMENTS TO MODELING OF IMPACTS

1. Consider using the origin-destination pair instead of the employer as the unit of analysis for estimating impacts. For reasons of convenience and practicality,

most analysis of workplace-based TDM has collected and analyzed data using the employer as the unit of analysis. However, the results of TDM that one observes at a worksite depend in part upon where the employees commute from, and the opportunities available to them to use alternative modes. For example, the use of several alternative modes is strongly related either to commute distance (walking for short distances, vanpooling for very long distances) or service infrastructure (public transportation use is related to where the service is provided and the level of service; bicycling may show similar relationships with bike paths and lanes). This suggests that modeling changes in commute behavior using the origin-destination pair as the unit of analysis, rather than using the worksite as the unit of analysis, could improve some aspects of the modeling. CUTR researchers attempted fitting several such models during our analysis of the CTR data, and the results appear promising. However, like the worksite-based unit of analysis, origin-destination-based analysis still requires better data describing what the employer end of the origin-destination pair is doing.

2. Improve the representation of non-motorized modes in the four-step planning process. Although TDM promotes biking and walking, as well as motorized modes such as carpooling or riding transit, travel demand modeling practice generally does not place great deal of emphasis on non-motorized modes. Relatively little effort is made to collect data on these modes or model them at the same level of detail as the motorized modes. This limits the ability to assess the impact of TDM on the transport network. It would be desirable to have more accurate and up-to-date information regarding non-motorized trips, and better representation of these modes in the modeling system. This would include better representation of infrastructure, such as bike paths and lanes, and park-and-ride lots, for these modes. It also would include better modeling of intermodal trips, such as bike-to-bus, which most regional models do not do.

3. Develop a way to differentiate TAZs by level of current participation in TDM programs. The current level of participation in various TDM programs in a particular TAZ can affect results. Market penetration of new programs may have different effects between seemingly comparable TAZs.

4. Develop a complementary tool to help estimate the costs to the public and private sector for implementing the demand management programs (the cost estimation module referred to in (3) above, which would depend on the data improvements discussed there). The most effective mix of tactics may not be the most cost effective. Developing this tool will require more reliable data on the cost of program elements and the effects of different combinations of elements. This also will require greater attention to the effectiveness of different approaches to these elements.

IMPROVE UNDERSTANDING OF COMMUTER BEHAVIOR

1. Seek to identify changes in behavior at the individual employee level. Although the CTR program collects data for reporting and compliance purposes,

improvements could allow for better models. Foremost, there is no identifier between records from consecutive trip reduction plan cycles which would to identify which individuals changed behavior. The use of aggregated data to forecast changes in behavior may actually be the result of changes in residence and/or turnover among the site's work force rather than changes in travel behavior due to trip reduction programs and incentives/disincentives. We recognize that this would not control for exogenous events such as rising or falling gas prices.

2. More research should be done on the importance of employer work-life friendly programs, such as compressed workweek programs and telework influence to determine when or if a commute trip is made. These alternative work hour programs could influence the trip generation step of the four-step process. Clearly, many TDM strategies work synergistically; for example, the ability of employees to ride transit or adjust to traveler information system alerts depends on the existence of work hour policies at the employer level.

3. Seek data to account for the impact of changes in travel behavior due to non-commuting related demand management efforts. More non-employer voluntary travel behavior change projects are being carried out and demonstrating their ability to change behavior. Future enhancements to TDM models and forecasting tools should begin to consider strategies implemented by communities, not just employers. Most of the TDM models in use reflect the types of programs offered by large employers (generally 100 or more employees) for commuting employees. This is due, in part, to the availability of data on these kinds of programs. However, community-based demand management programs, including school pool programs and programs like Seattle's One Less Car Challenge (http://www.seattle.gov/waytogo/onelesscar.htm) strive to manage demand for any type of trip. Community-based travel behavior change programs function like other social marketing programs (e.g., smoking cessation) with targeted, personalized interventions. They are being deployed and demonstrating effectiveness in changing travel behavior by mode, time of day, route, etc. While the effects of these programs may not be limited entirely to reducing peak hour congestion, such strategies could be important in the management of greenhouse gas emissions.

REFERENCES

(1) Commute Trip Reduction Program home page at http://www.wsdot.wa.gov/TDM/CTR/default.htm

(2) Washington State Department of Transportation, "2007 Commute Trip Reduction Board Interim Report," accessed January 2010 at http://wsdot.wa.gov/TDM/CTRInterimReport07.htm

(3) Puget Sound Regional Council, (2009), "Transportation 2040 - Data Analysis and Forecasting at the PSRC New Tools within an Integrated Modeling Framework. Accessed January 28, 2010 at http://www.psrc.org/assets/1819/models_overview_0309.pdf

(4) California Air Resources Board. "Determining the Cost-Effectiveness of Employer TDM Programs." Accessed January 2010 at http://www.arb.ca.gov/planning/tsaq/eval/eval.htm.

(5) Federal Highway Administration, "Travel Demand Management Evaluation Model". Accessed January 2010 at http://www.fhwa.dot.gov/environment/cmaqeat/descriptions_tcm_commuter_choice_model.htm

(6) United States Environmental Protection Agency. "Commuter Model v2.0 User Manual." Accessed January 2010 at http://www.epa.gov/otaq/stateresources/policy/transp/commuter/commuter-v20.zip

(7) Center for Urban Transportation Research at University of South Florida. "Worksite Trip Reduction Model." Accessed January 2010 at http://www.nctr.usf.edu/worksite/

(8) Center for Urban Transportation Research at University of South Florida, (2007), "Evaluation of COMMUTER Model and Worksite Trip Reduction Model Based on Washington State CTR Data," Metropolitan Washington (DC) Council of Governments.

(9) DKS Associates, (2005) "Washington state TDM Effectiveness Estimation Methodology (TEEM) Model," Washington State Department of Transportation.

(10) Phil Winters, Nevine Labib Georggi, Sachin Rai, and Liren Zhou, National Center for Transit Research at Center for Urban Transportation Research, University of South Florida, (2007), "Impact of Employer-based Programs on Transit System Ridership and Transportation System Performance." Accessed January 2010 at http://www.nctr.usf.edu/pdf/77605.pdf

(11) Concas, Sisinnio and Philip L. Winters, National Center for Transit Research at Center for Urban Transportation Research, University of South Florida, (2007), "Economics of Travel Demand Management: Comparative Cost Effectiveness and Public Investment," Florida Department of Transportation. Accessed January 2010 at http://www.nctr.usf.edu/pdf/77704.pdf

(12) (Federal Highway Administration, (2008) "Final Guidance on the Congestion Mitigation and Air Quality (CMAQ) Improvement Program under the Safe,

Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users: Final Program Guidance'. Accessed January 2010 at http://www.fhwa.dot.gov/environment/cmaqpgs/cmaq08gd.pdf

(13) Concas, Sisinnio and Philip L. Winters, National Center for Transit Research at Center for Urban Transportation Research, University of South Florida, (2009), "Quantifying Net Social Benefits of Vehicle Trip Reduction Impacts to Make Existing Road Infrastructure Perform Better– Guidance for Customizing the TRIMMS Model to Aid Local, Regional and State Decision Makers." Florida Department of Transportation. Accessed January 2010 at http://www.nctr.usf.edu/pdf/77805.pdf

(14) Sisinnio Concas, 2009, "TRIMMS - Trip Reduction Impact of Mobility Management Strategies," Session 46: Transportation Demand Management Models, ITE 2009 Annual Meeting and Exhibit, August 9-12, 2009 in San Antonio, TX, USA. Accessed February 2010 at http://www.ite.org/meetcon/2009AM/Session%2046_Sisinnio%20Concas.pdf

(15) WSDOT, 2009. Growth and Transportation Efficiency Center Program: 2009 Report to the Legislature, http://www.wsdot.wa.gov/NR/rdonlyres/CEDBB8A1-686F-410A-BED2-282B61E43584/0/GTECProgramReport2009.pdf

(16) FHWA, WSDOT, and Sound Transit, 2006. SR 520 Bridge Replacement and HOV Project: Draft Environmental Impact Statement. August, 2006, http://www.wsdot.wa.gov/Projects/SR520Bridge/DraftEIS.htm#deis

(17) WSDOT, n.d. Peak Hour Report 2008, http://www.wsdot.wa.gov/mapsdata/tdo/PDF_and_ZIP_Files/Peak_Hour_Report_2008.pdf