Three Essays on Travel Demand Management Strategies for Traffic Congestion Mitigation

by

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(ABSTRACT)

This dissertation provides three essays. In the first essay, a model with two linguistic variables is built to demonstrate the joint effect of multiple linguistic variables in a dynamic modeling context. Triangular membership function is used to represent the linguistic variables and the joint effect is captured through fuzzy inference method. In this essay, the results obtained by employing fuzzy concepts are compared with the results that one would obtain using generic lookup functions.

The second essay develops a system dynamics model by which policy makers can assess the impact of various travel demand management interventions within a metropolitan area and as a consequence understand the complex behavior of affected transportation-socioeconomic systems. This essay builds on a previously formulated approach where fuzzy concepts are used to represent five linguistic variables used in the model. We also compare the level of traffic congestion under the scenarios with and without traffic congestion pricing.

The third essay is based on the second essay where different scenarios of the travel demand management policies are evaluated and analyzed. There are two parts in this essay. The first part addresses the construction of a Management Flight Simulator (MFS) that is used to do policy analysis for travel demand management policies. By using the Management Flight Simulator, the second part of the essay describes the evaluation of alternative travel demand management policies.

In this research, we found that the revenue generated from congestion pricing does increase mass transit capacity even with the aging of mass transit capacity. However, in the short term traffic congestion is mitigated while in the long term the proposed travel demand management policy actually deteriorates the traffic situation.

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DEDICATION

To my parents

To my wife Haixiang Tang and my kids Shuren Liu and Shuyi Liu

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Chapter 1 Introduction

There are two sections in this chapter. The first section presents the introduction of each of three essays in this research and how they are connected. Section two provides a roadmap for the whole document that is used to navigate through the main sections of this dissertation. It also offers the organization of this document.

1.1 Research Content

This dissertation is composed of three essays which are described as follows. The first essay is entitled "*A Fuzzy Representation of Multiple Linguistic Variables in System Dynamics Modeling*". The second essay is entitled "*Evaluation of Travel Demand Management Policies: Part I-Modeling Traffic Congestion*" while the last essay is the "*Evaluation of Travel Demand Management Policies: Part II-Policy Analysis"*. The sequence of these three papers is such that each essay is based on the work documented in the previous essay.

The first essay examines the representation and the combined effect of multiple linguistic variables for a system dynamics modeling environment. Linguistic variable in many situations describe a situation or phenomenon that has no precise and quantifiable measurement. For example, in the second essay, the system dynamics model contains five linguistic variables, i.e. perception with respect to the level of congestion, perception with respect to the ratio of driving cost to budget, perception with respect to the ratio of bus supply to demand, perception with respect to the ratio of trail supply to demand, and the perception with respect to the ratio of metro rail supply to demand. In the first essay a relatively simple model is used to address how to represent and integrate multiple linguistic variables in a system dynamics model. Therefore, one of the tasks of the first essay is to explore the possibility of incorporating a linguistic variable into a model established in the context of system dynamics in the Vensim Simulation Environment using concepts from fuzzy set theory since this theory is commonly used in literature to represent linguistic variables. Triangular membership function is employed to represent

the linguistic variable. Having done this, the scenario of two variables that jointly affect a single variable is examined by employing the standard three steps in fuzzy logic, which are fuzzification, fuzzy rule definition, and defuzzification. This mechanism is illustrated using a model that is based on two existing model molecules in the Vensim Simulation Software.

The second essay evaluates the impact of congestion pricing policy once it is implemented for the cordon based Washington D.C. metropolitan area. The major consideration of this model is that individual behavior is affected by the level of congestion and the supply and demand associated with mass transit. Perceptions were captured by five separate linguistic variables. Modeling their interactions requires the definition of 315 fuzzy rules. It is assumed that population, tourism and employment growth are exogenous factors that affect demand. This system dynamics model is based on the data available in Census of Bureau and Washington D.C. Census data. Since there is no traffic congestion pricing policy being implemented in the Washington D.C. metropolitan area, many assumptions related to data are made to run the model. These assumptions include but are not limited to projection of population growth, size of the bus fleet, social networking related parameters such as contact rates, etc. For details, please refer to Appendix C for relevant data and Appendix E for the relevant formulations.

Based on the system dynamics model built in the second essay, the third essay constructs a Management Flight Simulator for evaluating travel demand management policies. Different parameter values representing policy alternatives are chosen to run the Management Flight Simulator. The results are graphically displayed to let the user find the best policy alternatives. By using the management flight simulator policy makers can test their mental model or the scenarios generated from their experience. The data used in the policy analysis are partially from Census data. Other data are based on the assumptions made such as maximum and minimum values for bus fleet size, metro carrying capacity, etc.

It is found that the funding distributed to improve mass transit capacity does improve capacity of the different mass transit modes even with the aging of the mass

transit capacity. However, this improvement that is hampered by construction delays, budget allocation limits, and assumptions about carrying capacities does not effectively meet the demand for mobility created by social networking activities and as a result the congestion pricing policy may not resolve the root issue of traffic congestion over the long term. Moreover, the induced social networking activities due to improved mass transit capacity actually create more demand for different transportation modes, which worsens the traffic situation.

1.2 Roadmap for Reviewing This Dissertation

This dissertation contains seven parts. Chapter 1 provides a brief introduction of the three essays and how they are connected as well as the organization of this dissertation. Chapter 2 provides the literature review related to all three essays. Chapter 3 contains the first essay, "A Fuzzy Representation of Multiple Linguistic Variables in System Dynamics Modeling". Chapter 4 provides the second essay, "Evaluation of Travel Demand Management Policies: Part I-Modeling Traffic Congestion". Chapter 5 presents the third essay, "Evaluation of Travel Demand Management Policies: Part II-Policy Analysis". Part 6 provides the bibliography for these three essays. The last part of the dissertation are the Appendices that list all relevant materials and results related to the three essays such as software code, system behaviors, etc. Please refer to Figure 1.1 for the organization of the dissertation.

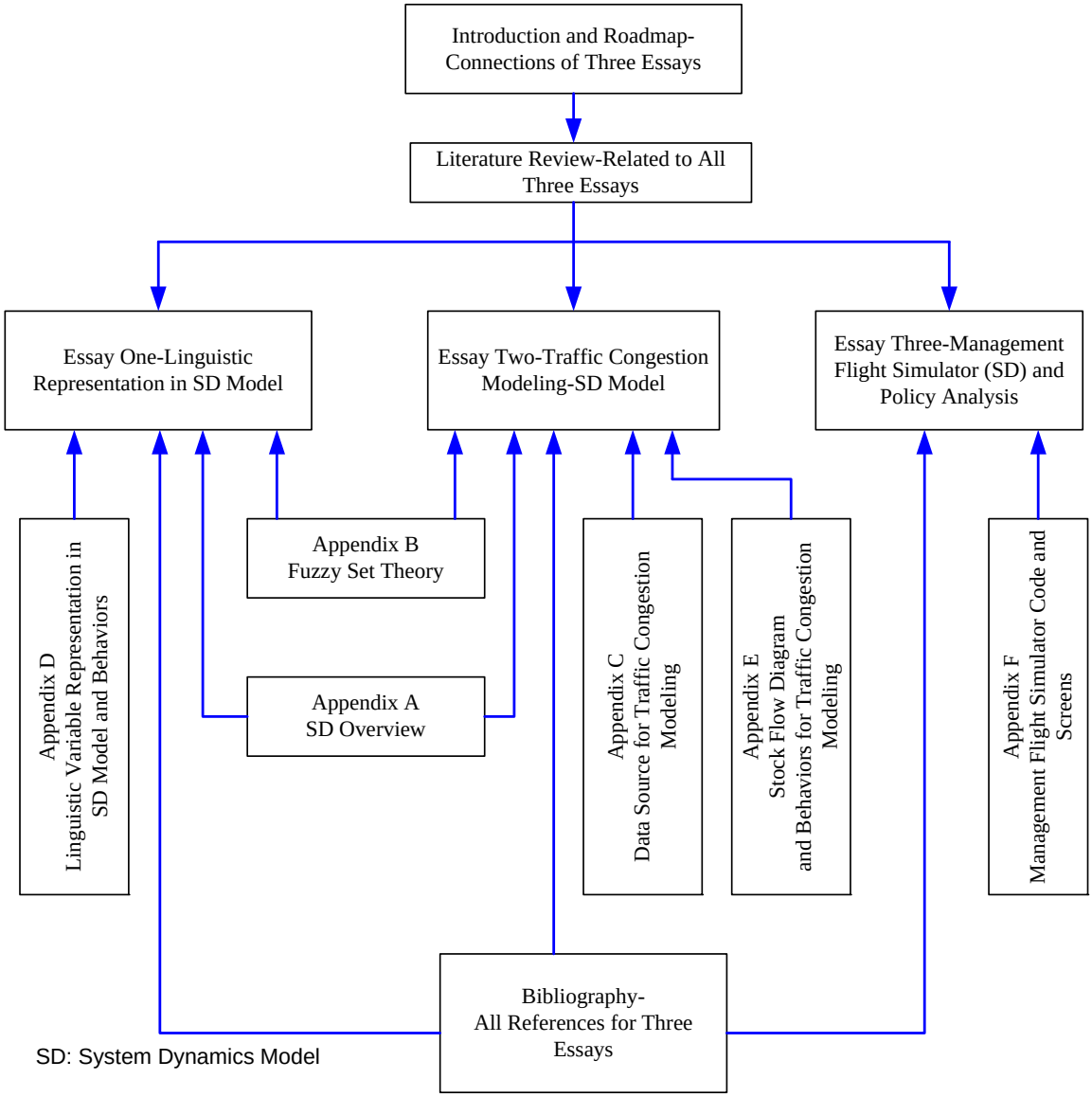


Figure 1.1: Organization of Dissertation

Chapter 2 Literature Review

This chapter focuses on a review of the literature related to traffic congestion, travel demand management policies (TDMs), traffic congestion pricing, and applications of system dynamics and fuzzy set theory to transportation modeling. Couples of tables are included in this chapter, which compare this research with the previous literature in terms of using system dynamics as an approach to model the dynamics associated with transportation socioeconomic system as well as the dynamics of a cordon based dynamic traffic congestion pricing policy.

2.1 Evolution of Theory of Traffic Congestion and Congestion Pricing

Congestion pricing is one of the many travel demand management (TDM) schemes. TDM (Travel Demand Management) strategies use a variety of mechanisms to change travel patterns, including facility design, improved transport options, pricing, and land use changes. These affect travel behavior in various ways, including changes in trip scheduling, route choice, destination choice, and trip frequency, plus traffic speed, mode choice and land use patterns.

A table in the following link provides a few of the typical TDM strategies (http://www.vtpi.org/tdm/tdm14.htm#Toc22109688#Toc221096_88). In this table, nine travel demand strategies are reviewed. The mechanisms by which different travel demand management strategies exert effects on the improvement of traffic situation are listed in the second column. The third column describes the impacts of implementing different TDMs strategies. Each TDM uses alternative mechanisms, and thus cause different travel changes. For example, road/congestion pricing, which will be used in this research, uses pricing mechanisms to shift travel demand from peak to off-peak periods or reduces vehicle travel demand on a particular roadway.

Different TDM strategies can be combined into a comprehensive TDM that builds on the strengths of different strategies and potentially realizes synergetic effects. This dissertation will evaluate combinations of several TDMs, namely the cordon-based

congestion pricing, improvement of alternative transportation modes, and subsidization of the under-privileged population.

2.1.1 Overview of Congestion Pricing History

Road user pricing as a means of mitigating congestion dates back to 1844, by Dupuit. Thereafter, in the early 1920s, economists Pigou (1920) and Knight (1924) continued to enhance the theory of traffic congestion pricing. In the 1960s, a resurrection of research interests in congestion pricing appeared thanks to the initiative of Nobel Economist laureate William Vickrey (1969). Simultaneously, the publication of The Smeed Report (Ministry of Transport, 1964) also boosted the resurgence in traffic congestion pricing research. The foreword of The Smeed Report states that "charges would be in the nature of prices for using the roads, the prices varying from one place and time to another according to the costs, notably the congestion costs, involved in driving in a particular area at a particular time." It also indicates that "when a pricing system is used on the roads, a useful general rule upon which to base prices is that the road user should pay a sum equal to the costs he imposes upon others" (Ministry of Transport, 1964, p. 2).

Owing to the rapidly increased traffic congestion resulting from the growth of economic activities and declining revenue generated from motor fuel taxes related to travel, application of congestion pricing accelerated in 1980s and 1990s. Many schemes were attempted during 1980s and 1990s. Among these, some failed to be implemented after deliberate planning, such as Electronic Road Pricing (ERP) in Hong Kong, China (Hau, 1990), Rekening Rijden in the Netherlands (Stoelhorst and Zandbergen, 1990), road pricing in Stockholm, Sweden (Anlstrand, 1998), and congestion metering in Cambridge, UK (Ison, 1996). A few schemes have been successfully implemented, namely the Area Licensing Scheme in Singapore (Behbehani et al., 1984), the toll rings in Norway (Larsen, 1995), the London Congestion Charging (2003), and Congestion Pricing in Stockholm (2006).

Although Singapore, London, and some other European cities have adopted congestion pricing scheme with some success, it has been seldom tested in the United States. The reason for this is that it is difficult to get political support. There are only

two cases of congestion pricing in the U.S., i.e., the SR-91 Express Lane in Orange County (Southern California, U.S., 1995) and the I-15 demonstration congestion pricing project in Northern San Diego County (California, 1996).

Vickrey (1969) provided twelve principles on how to implement efficient congestion pricing for using roads and parking. Actually, principles 1 to 6 will be considered in this research.

1) Charges should reflect as closely as possible the marginal social cost of each trip in terms of the impacts on others.
2) Charges should vary smoothly over time.
3) Efficient charges cannot be determined solely by conditions at the time of the individual trip, but must take into account the impact of the trip on other traffic from the time the trip is made until the end of the congestion period.
4) Efficiency can be enhanced, for a given level of data collected, by charging on the basis of the trip segment from one observation point to the next, rather than by merely the passage of an observation point.
5) There is much to be said for charging on an ex post, strict liability basis in terms of the actual impact that a trip can be calculated to have had on the traffic as actually experienced, over the balance of the day, rather than according to some schedule fixed in advance.
6) All vehicles should be charged without exception, including trucks, doctors' cars, press cars, and cars of public officials and diplomats, among others.
7) Taxicabs present a special problem of ascertaining the charge at the time of incurrence, so that it can be charged to the customer.
8) Curb parking, where permitted at all, should be charged on the basis of clearing the market.
9) One simple and inexpensive method of collection would be by means of parking cards.
10) Another method would use parking ticket vending machines.
11) Delivery vehicles and other vehicles making frequent short stops need special treatment, such as by using on-vehicle meters.

12) Political interference and bureaucratic bungling can spoil the game.

Source William Vickrey *(1992, http://www.vtpi.org/vickrey.htm)*

In the follow section, some typical congestion theories and detailed applications are introduced.

2.1.2 Two Recent Congestion Pricing Schemes

In this section, two recent congestion pricing schemes are presented to indicate the future research of congestion pricing theories and practices.

A Credit-Based Congestion Pricing (CBCP) Scheme

The credit-based congestion pricing policy, which is based on "credit allowance", is in many ways similar to the "tradable" emission credits advanced by the 1990 Clean Air Act Amendments (CAAA, 1990). This contribution to the congestion pricing approach was made by Kockelman (2003). For the Credit-Based Congestion Pricing Policy, a subsidy will be allocated to each driver to use on the roads once a month. Prices of using roads vary based on drivers' different demands and the associated adverse externalities such as pollution and noise, etc.

Under the CBCP policy, out of pocket expenses for drivers will be unnecessary if they do not use up the allowance provided to them. Credits can be used later or cashed for money if drivers spend less than the given allotted time. For those disadvantaged, such as low-income commuters and the disabled, more credits can be allocated. Since drivers will have a choice to spend their subsidy or save credits based on their specific travel needs, the CBCP has the potential to be an equitable and effective congestion pricing policy. Moreover, CBCP tends to be a revenue neutral policy by which the monthly revenues will be allotted back to drivers in the form of credit subsidies. As far as the feasibility of implementing the policy is concerned, with the improvements in techniques of Electronic Toll Pricing and Dynamic Pricing, CBCP is heading for a realistic application.

An Auction-Based Congestion Pricing Policy

The idea of auction-based congestion pricing was first proposed by Iwanowski (2000). This method allocates the rights to drive on certain road sections at certain time slots. Periodically transacted auctions will determine the distribution of these rights to participating road users. The software of AUCTIONEER (Iwanowski, 2000) is used to execute the corresponding auctions. The distribution mechanism is to allot the road using rights to different road segments for differing time slots. The number of vehicles allotted to a certain road section during a certain time slot will be restricted by the capacity of the corresponding road segment and the designated level of service of that section. A Vehicle/Driver Unit (called VDU) is an independent software characterizing each driver's interests. The function of an individual VDU is to make bids on the favorable routes requested by each driver. Upon completion of each auction, VDU will attain the expected route or part of it within the required time slots. Under the auction-based congestion pricing policy, the roads are distributed according to demand and supply, which is a market-based principle. As Iwanowski points out, "The most important feature of the auction-based technique is that the drivers have influence in the assignments by choosing the strategies for making the bids without a need for justification."(Iwanowski, 2003, p. 407)

The auction-based pricing mechanism can be applied to both toll roads and toll-free roads. For toll roads, the fees for using a gained road section in the auction will be paid to the road operator. In case of toll-free roads, a virtual bid is going to be employed. Although this technique can not impact the choice of routes, the virtual auction is used as a tool to evaluate the degrees of preferences of different drivers.

2.1.3 Practical Applications of Different Congestion Pricing Scenarios

1) Singapore

Singapore has the longest experience with a congestion pricing scheme. The scheme was initiated in 1975, in the form of an Area Licensing Scheme (ALS), and then was updated in 1998 to an Electronic Road Pricing (ERP) system. Using the electronic system, vehicles are automatically charged through a pre-paid smart card when they pass an ERP gantry. To date, a total of 45 gantries are installed among which 28 are

distributed around the central area Restricted Zone (RZ), 12 are located on selected highway sections and five others on radial arterial roads. Except for the time between 10:00AM and 12:00 noon, charging periods at the central area cover most of the daytime hours from 7:30 AM to 7:00 PM. For other roads, charges only apply during the morning peak period from 7:30AM to 9:30 AM. With more than 30 years' operation, the Singapore experience can provide scholars with abundant data on the impact of congestion pricing.

2) Hong Kong

Due to the fast growth in the economy, local road capacity can not satisfy the demand for car travel. From July 1983 to March 1985, Hong Kong tested the technical, economic, and administrative viability of Electronic Road Pricing. Vehicles integrated with an Automatic Vehicle Identification (AVI) had electronic number plates underneath. When the vehicle passed a boundary during the trial period, a circuit loop stimulated its AVI, sending a message to a roadside recorder. The trial program was operated over five different intervals: the morning peak (8:00-9:30), the afternoon peak (17:00-19:00), the shoulder peaks (immediately before and after the morning and evening peaks) and the inter-peak.

3) London Congestion Charging

Ken Livingstone, Mayor of London, initiated the first major cordon-based congestion charging scheme in Britain on February 17th 2003. The charging area covers only 21km^2, representing 1.3% of London's total 1579 km^2. Drivers are charged £5, recently increased to £8 , to drive into or within the charging zone between 7:00AM and 6:30PM, Monday through Friday, excluding public holidays (Transport for London, 2003). Regulated by law, the revenues are invested in the improvement of London's transport infrastructure and services. In order to enforce the scheme, 700 video cameras are installed to recognize the rear number-plates of vehicles entering, circulating or parking within the charging zone during charging period. Payment can be made through phone, Internet, at shops or petrol stations. There are 150 pay-points at retail stores, 100

machines in car parking lots, 112 BT Internet Kiosks within the zone. Charges can be paid on the day of travel before, during or after the journey. Failure to pay the charge before the midnight will lead to a fine of £80. The fine falls to £40 if it is paid within 14 days. Otherwise, it rises to £120 if the charge is not paid within four weeks. At present, the punishment for failing to pay the charge on time has been changed. "The charge is £8 if you pay by 10.00pm on the day of travel. An additional £2 surcharge will apply if you pay from 10.00pm until midnight on the day of travel. The total charge for paying between 10pm and midnight is £10. This is to encourage early payment (Transport for London, 2006, http://www.cclondon.com/)."

Exemptions and discounts apply to the following cases:

- All alternative fuel vehicles, namely natural gas, electric and fuel cell vehicles;
- Vehicles operated by or carrying disabled people who have registered for a 100% discount;
- Emergency vehicles (fire, police and ambulance);
- Vehicles with nine or more seats;
- Motorbikes and mopeds;
- Black cabs and London-licensed mini-cabs;
- Residents within the charging zone (90% discount)

With the implementation of congestion charging scheme, the Transport for London also has been providing an impact monitoring report. This report will be made annually to analyze the impacts of congestion charging on traffic patterns, public transport and travel behavior, social impacts, business and economic impacts, and accidents and the environment. This undoubtedly provides research professionals and practitioners with a wealth of data to study the broad range of impacts of congestion pricing. In this research, discounts and exemptions will be examined. Specifically, the local residents within the charging period have 60% discount and vehicles carrying individuals with disabilities have 100% discount.

4) California I-15 in U.S.

Though U.S. scholars were among the earliest that proposed the congestion pricing theory, this theory was not implemented before the 1990s. However, the projects of SI-91 and San Diego I-15 in California have provided scholars with some useful data on the feasibility of implementing congestion pricing schemes in US. In this discussion, only the San Diego I-15 congestion pricing project will be detailed. This project was started on an 8.5 mile stretch of Interstate Route 15 in Northern San Diego County, California in 1996. Under this scheme, solo drivers are allowed to pay to use two underutilized reversible high occupancy vehicle (HOV) lanes, known as the "Express Lanes".

Located northeast of the main employment centers in San Diego, the corridor has the obvious unidirectional commuting patterns (southbound in the morning and northbound in the evening). The Express Lanes are operated in the southbound direction from 5:30 to 10:00 AM and in the northbound direction from 2:30 to 7:30 PM. There are two implementation phases for this demonstration project. During the first period (from December 1996 to March 1998), the Express Lanes were used without any limits by solo drivers when they bought monthly passes. Carpoolers paid nothing for using the Express Lanes.

For the second period (from March 1998 up to now), a windshield-mounted transponder is given to each subscriber. FasTrak is the unique name of the second phase. A per-trip fee is debited to the users' account once they use the Express Lanes. The fee is displayed on changeable message signs at the entrance. In order to maintain relatively free-flow conditions in the Express Lanes, the fee is adjusted accordingly. There is an independent evaluation (initiated in 1997) being carried out to assess the project's impacts on congestion, local business activity, land use, emissions, media coverage, and other areas.

2.2 Impacts and Issues of Traffic Congestion Pricing

2.2.1 The Evaluation of Impacts of Traffic Congestion Pricing

The implementation of congestion pricing has broad-range and long-term impacts on an individual's driving behavior, the society, the economy, the environment, the transportation system itself as well as the political system. This section briefly reviews the literature in terms of these impacts.

In order to examine how different groups of people are affected by a congestion pricing scheme, Levine and Garb (2002) divided the users into three groups: drivers who drove before and remain on the road afterward, drivers who used the road before and do not use it after the implementation of pricing, and drivers who did not use the road before and start to drive with the improved mobility. The first two groups may end up being worse off with congestion pricing.

An article from the website of Victoria Transport Policy Institute (2005) indicates that travel demand management (TDMs) including congestion pricing tend to provide energy conservation and emission reduction. Congestion pricing and improvement of mass transit attempts to reduce the per capita surface coverage, and hence encourage efficient land use patterns.

Giuliano (1992) pointed out that road pricing is one of the few effective means to reduce the use of automobile, and thus reduce air pollution. Banister (2002) noted that, due to the implementation of congestion charging, land values and rent levels in the city center would fall, which cause the ever-increased dispersal of activity from the city center.

It is worth noting that the heavily congested downtowns areas are competitively disadvantaged now because of congestion (Giuliano, 1992). For the economic impacts of congestion charging, Whitehead (2002) presented two scenarios by which several major economic sectors are evaluated. Scenario A assumes that there would be no change in the provision of public transport and environmental quality with the introduction of congestion pricing, while scenario B presumes that congestion charging revenues would be invested in public transportation and the environment of the city center. The sectors being evaluated include retail, tourism, and residential functions. As far as the retail

function is concerned, it is thought to be one of the most sensitive sectors (Whitehead, 2002). Retail sectors would be negatively affected by Scenario A since drivers would be discouraged by a charge and it would lead to loss of the traditional customer base. Under scenario B, the retail activity in the city center would have relatively increases with a short-term fluctuation before full-fledged improvements are made.

For large metropolitan areas such as New York and Washington D.C area, tourism is critical to many local economies. Therefore, tourists could be deterred by the congestion, low-efficiency mass transit, and poor environment possibly caused by favoring scenario A. Since scenario B can improve the prosperity of the local economy and the environmental quality and the public transport, the tourism industry would be significantly boosted. In terms of residential functions, there is one point of view that scenario A tends to stifle residential living whereas scenario B would be positive for the city center residential sector in terms of quality of life.

With respect to the use of revenues from congestion pricing scheme, Goodwin (1990) recommended that the revenues should be invested in three areas: road construction, tax relief, and public transit improvement. However, road capacity expansion may induce additional potential demand for car and thus offset the improvement. Tax relief is good for mitigating the financial burden of drivers. Improvement in mass transit is a key way to guarantee the accessibility of those being worse off by the charging scheme. Of course, the improvement of mass transit needs a long-term construction period.

In this research, the revenues from congestion charging scheme are distributed to improve mass transit and trail capacity. In addition, the delays in mass transit capacity construction will be examined in the model accordingly. If sufficient improvements are made, theoretically it is possible that the mass transit system will attract more passengers from the pool of previous drivers who choose not to drive (Gonzales, 2005). The London congestion charging scheme so far is a successful case in changing driving behavior. One third fewer cars are entering the city center and 16% more buses are on the streets compared to the period before the pricing scheme was instituted (Santos and Shaffer, 2004).

Litman (1996) also investigated the use of congestion pricing revenue by analyzing horizontal[2] and vertical[3] equity. His analysis indicates the following points regarding the distribution of congestion pricing revenues.

I. Without considering the horizontal equity and external impacts, the revenue should be returned to each user class according to their respective payments. The benefits could be delivered in the forms of road transportation improvement, cash rebates or tax reductions to car users.

II. Given that the facts of the horizontal equity and external impacts such as the vehicle related pollution, the revenues should first be used to offset the external cost. The formats of revenue distribution could be adopted including: support for alternative modes such at transit, bicycling and walking; residual revenues could be used for road improvement or tax reductions for car drivers.

III. Considering vertical equity, revenues should be used to benefit low income drivers and the disadvantaged. This could be done by funding facilities for the disadvantaged people or by giving subsidies to low income residents.

2.2.2 Relationship between Transportation and Social Networks[4]

Social life is networked. With the information revolution, such ever-increasing extensive social networks are exploding. This phenomenon resembles a chain reaction within an atomic reactor, which can only be well-functioning through even more frequent meetings. *"These moments of physical copresence and face-to-face conversation, are crucial to patterns of social life that occur 'at-a-distance', whether for business, leisure, family life, politics, pleasure or friendships"(Urry, 2003, p. 155).* However, copresence can not happen without getting together. Consequently, all kinds of travel modes and forms become the critical media to establish and maintain different social networks.

[2] Horizontal Equity is concerned with fairness between individuals and classes with comparable needs and resources. It assumes that "like should be treated alike".

[3] Vertical Equity is concerned with the treatment of individuals and classes that are unlike. By this principle, the distribution of costs and benefits should reflect people's needs and abilities.

[4] A social network is a social structure between actors, mostly individuals or organizations. It indicates the ways in which they are connected through various social familiarities ranging from causal acquaintance to close familial bonds. The term was first coined in 1954 by J. A. Barnes (in: Class and Committees in a Norwegian Island Parish, "Human Relations").

Since World War II, the average distance between where people live within social networks has increased exponentially in the U.S., which results from the motorization, urban sprawl, airline deregulation, spread of the internet, and frequent use of mobile equipment. Social networks are not so closely tied as before. People are widely distributed in residences and activities. Therefore, people have to travel long distances to have face-to-face meetings (Axhausen, 2002).

The interactions between transportation and social networks are assumed to be complex, and can be viewed as overlapping[5], tightly coupled, and dynamic. Copresence requires the provision of transportation, while travel activities themselves create their own social spaces which produce new entities in the social network, such as hotels, travel stations, airports, leisure complexes, and resorts, etc. Although mobility provided by transportation system satisfies all kind of social needs and improves the quality of life of people, mobility at the same time produces enormous costs for the environment, detrimental accidents, and longer time in the automobile, which on the other side reduces the social welfare. Moreover, transportation problems such as congestion are affecting social activities. Therefore, as for the transportation and its impacts, people have conflicting feelings. On one hand, people can realize their ever-increasing social goals with improved mobility. On the other hand, people have to bear the adverse impacts of their extensive travels.

In order to keep the sustainable development of society and transportation, policy makers are in many respects making efforts to reduce the adverse impact of transportation. What they are attempting to facilitate is the maximization of social welfare[6] by the provision of transportation services. Of course, the implementation of different policies could bring up new adverse short-term or long-term impacts. For example, without good planning, congestion pricing strategies could cause severe social

[5] Within the transportation socioeconomic system, two or more partners' (could be friends) social networks tend to converge and end up overlapping to the great extent.

[6] Social welfare can be taken to mean the welfare or well-being of a society. In economics, this is the utility of people considered in aggregate. For social welfare in the economic sense, the social welfare function is the provision of a wide range of social services, for the benefit of individual citizens. This use of the term is closely related to the idea of the welfare state. http://www.google.com/search?hl=en&lr=&oi=defmore&defl=en&q=define:social+welfare

exclusion[7] problems. Therefore, it is necessary to evaluate the transportation policies holistically in the social network systems.

2.3 Application of System Dynamics in Transportation Modeling

2.3.1 Dynamic Complexity of the Transportation Socioeconomic System

Abbas and Bell (1994) investigated the dynamic complexity of the transportation socioeconomic system. Transport problems come from the interactions of different agents from within and outside the transportation system. Complex feedback linkages exist between transport and other systems, namely the social, the economic, the political, and the environmental subsystems. Therefore, the impacts of transportation polices are not unidirectional. Transportation polices may not only change the transportation system behavior but also change the other related systems. In addition, the policy making and planning of transportation require understanding the complex, long-term intra-and interactions between transportation system and other related systems. Furthermore, the three dynamically changing areas in a transportation system also exhibit dynamic complexity. These are the demand for travel, the technology and level of supply of transport services and facilities, and the policy-making criteria.

2.3.2 Specific Applications of System Dynamics to Transportation Modeling

Since the inception of system dynamics, it has been extensively used in transportation modeling. Royce and Goldstone (1966) attempted an application of system dynamics to regional transportation planning. The main considerations of this research are the demographic and economic sectors. In this research, interactions between population and employment growth are explored for a region. Furthermore,

[7] Social exclusion means the various ways in which people are excluded (economically, politically, socially, and culturally) from the accepted norms within a society. In the transportation problem, social exclusion occurs by excluding low-income group from using certain transport mode. And thus, their mobility need can not be realized.

future patterns of behavior over time of the regional population and employment growth act as inputs to transportation planning.

The 1970s saw the swift dissemination of system dynamics in transportation modeling. Parthasarathi (1974) offered a model for urban public transit operations in which seven sections including a transit fund sub model, transit fleet, transit ridership, automobile ridership, transit satisfaction, automobile ownership satisfaction, and population/urban area were examined. The purpose of this research is to investigate the cause and effect relationship of the various elements of the urban transportation system to uncover the dynamic nature of the complex interactions among different elements of this system. The ultimate aim is to search and evaluate applicable decisions which lead to the optimization of the urban transportation system.

Chen (1975) examined six diverse transportation problem areas with the goal to review, apply and evaluate the system dynamics methodology for transportation system analysis. The six areas contain the traffic stream, signalization analysis, port operations, highway transportation, urban public transit, and transportation and land use. Drew et al (1975), Wadhwa (1975), and Drew (1978) published a series of papers showing the application of system dynamics to regional infrastructure planning. These papers include the six areas for a region, which are the agricultural sector, the industrial sector, the transportation sector, the waste resources sector, population growth, and urban development. Through modeling the system consisting of above subsystems, these studies looked at the impact of the infrastructure on the development process and show the suitability of applying system dynamics to infrastructure planning related to transportation.

Hansen and Kahne (1975) proposed a framework for a generic transportation ecology model which represents the environment of transportation systems. This model addresses four areas including: the transportation system design sector, the economic, the environmental, and the energy supply sectors. Hirsh (1977) also presented an urban bus transit model which is different from what was done by Parthasarathi (1974). In this model, the author examined four areas containing: transit ridership, fare price level, net transit funds, and bus fleet and bus trips/service. The intent was to investigate the

insights gained through employing system dynamics and assess a broad range of impacts of the bus transit operating policies.

Application of system dynamics to the trucking industry was made by Wright (1978) with the purpose of suggesting high leverage policies for a trucking company. In this research, four areas are considered, which are service reputation, capacity acquisition, special sales efforts and daily operations. Wadhwa and Demoulin (1978) exhibited the application of system dynamics to economic and transport planning for the area of North Queensland in Australia. The system under study is composed of three sub models: population, economic, and transportation. By exploiting the model, various transport policies and their impacts on economic development and performance of the transport system are examined.

Tran (1979) applied system dynamics to transportation with the objective to demonstrate the potential of system dynamics as a methodology in transportation planning. The model build by Tran includes six components related to transportation and urban development, which are:

1) The urban socio-economic activity component;
2) The highway transportation component;
3) The bus transit component;
4) The vanpool component;
5) The air pollution component; and
6) The transportation fuel consumption component.

In this research, Tran (1979) listed the deficiencies of conventional transportation planning approach, which are: 1) devoid of the consideration of feedback relations within the considered transportation system; 2) the lack of consideration for the interactions between socioeconomic system and transportation system. The ultimate aim of this research was to evaluate the significance of system dynamics in evaluating transportation policies other than to assess specific transportation policies.

System dynamics was applied to transportation planning for Bangkok Metropolitan Area, Thailand by Tanaboriboon (1979). Two major activities were considered in the above application, specifically socioeconomic activity (urban/rural

population, pollution, industry, residences) and urban bus transit activity. In this research, the author tried to use System Dynamics to evaluate different policies associated with the transport and urban development. Wadhwa (1979) applied system dynamics to transport energy demand modeling with the objectives to: 1) evaluate the future fuel demand for passenger transportation in Australia; 2) assess the effects of incomes, prices and care ownership on travel demand. There are two sub models in this model, which are passenger task sub model and energy intensiveness sub model.

Due to the extensive dissemination of system dynamics in transportation modeling in the 1970s, the 1980s witnessed in-depth applications of system dynamics in modeling arena of transportation. Ali et al. (1980) presented a system dynamics model for transportation planning of San Francisco Bay Area, U.S.A., which includes socioeconomic subsystem (population and employment) and transportation subsystem (link capacity, travel time). This model is useful in helping the transportation planner understand the complicated interactions between the socioeconomic and the transport system in a given region. It also serves as a valuable tool for transportation planning.

In Venezuela, Bencosme and Dajian (1980) explored the utilization of system dynamics in regional infrastructure planning by considering an infrastructure subsystem (penetration roads, irrigation facilities) and a socioeconomic environment subsystem (population, agricultural land, and capital). This model assessed the reciprocal impacts of infrastructure and region. Adler et al. (1980, 1980a and b) provided research papers emphasizing the application of system dynamics to transportation energy use modeling. The major areas taken into consideration include the passenger travel, the automobile, the transit, the highway, the carpool, the demographic, and the cost sectors. These papers have a number of objectives which are summarized as follows:

1) To present a dynamic tool for analyzing a broad range of transportation and energy-related policies;
2) To analyze the complex interactions between energy supply and transportation-related energy use;
3) To have an in-depth understanding of the transportation-related policies on energy use;

4) To illustrate some important issues associated with the transportation-related energy use;
5) To evaluate the impacts of energy prices and availability on travel and mobility.

Stephanedes (1980; 1981) and Adler et al. (1980c) modeled a public transit system containing a work-trip sub model (demand, supply, and resource) and shopping-trip sub model (demand, supply, and resource) in Northern New England rural area of New Hampshire. This model was used to evaluate the impacts of alternative operating policies and transportation strategies on the rural transit system over time. In order to assess the transportation policy impacts on the transport mobility sector, Stephanedes and Amin (1980) extended the former model made by Stephanedes (1980; 1981) by adding mobility sub model. Budhu (1981; 1984; 1986) and Hobeika et al. (1981; 1982) explored the models used for transportation planning for rural regions in developing countries by using system dynamics as modeling tool. These models basically include three major areas: the rural demographic (population, housing), the rural economic (agriculture), and the transport (roads, trucks) sectors. The main purpose of this research was to recognize the socioeconomic impacts of variable investment scenarios in transportation and relevant inputs.

Shirazian (1981) developed a system dynamics model of transportation planning, which was applied to the area of Gadsden, Alabama, USA. This model was composed of the area (population and land-use subcomponents) and travel (pollution, fuel consumption, and trip rate subcomponents). The major motivation of this research was to use this model to project the future transportation requirements. Similar to Shirazian's work, Khanna et al. (1985), Khanna (1986), and Khanna et al.'s (1986a and b; 1989) models investigated the following four areas which include the socioeconomic, transportation, environment, and energy sectors. This model was also used to evaluate different transportation polices.

In order to evaluate the impacts of urban policies on the transportation sector, Budhu and Tran (1982), and Budhu and Grissom (1985) created system dynamics models that were applied to Charlotte, North Carolina. In these models, there are eight sub

models: population, housing, business, heavy manufacturing, light manufacturing, government, agricultural, and transportation respects. Impacts under assessment involved physical, economic, social, energy use, and environmental aspects. Yang (1989) explored the application of system dynamics to model transport investments. His model addressed seven sectors: heavy industry, light industry, agriculture, building industry, commerce, and transportation. Different investment combinations were evaluated to portray how transportability affects other industries. In modeling urban road traffic systems, Charlesworth (1985; 1987), Charlesworth and Gunawan (1987), and Gunaman (1984) considered traffic flow, network geometry, and driver's behavior.

In the 1990s and 2000s, the application of system dynamics in transportation experienced renewed interest. Abbas (1990a and b; 1991) and Abbas et al. (1990) modeled the management system for the road infrastructure. These models essentially considered the following seven sub models: road funds allocation, road administration, road construction, routine road maintenance, road restoration, periodic road maintenance, and road funds saved and recycled. These models served as the tools to better understand the dynamic feedback nature of road system and evaluate different road strategies for the physical development of road systems. Abbas and Bell (1994) reviewed and evaluated the strengths and weakness of system dynamics in terms of its suitability and appropriateness in transportation modeling. This paper demonstrated how system dynamics can contribute to a better understanding of the complicated interactions between the transport system and its environment. Additionally, it also indicated how to better employ system dynamics to build constructive tools for testing all kinds of alternative transport-associated policies.

Bearing in mind the objective of building an efficient tool in highway infrastructure management, Kim (1996) constructed a highway management system model, namely the HMS Model. The HMS Model considers subsystems to be considered: the physical (pavement management system and bridge management system), the evaluation, the functional, the financial, and the administration subsystems. Haghani et al. (2003) first made the attempt to model the interactions between transportation and land use using system dynamics. There were seven sub models in this system: namely

the population, population migration, household, job-growth/employment/land availability, housing development, travel demand, and traffic congestion level. This paper suggested that the proposed method is a promising approach to copy with the complex urban land use and transportation modeling.

With the emergence of the concept of sustainable transportation[8], Yevdokimov (2003) explored the possibility of applying the system dynamics to model a sustainable transportation system. Generally, a sustainable transportation system needs to recognize three dimensions: namely the economic, social, and environmental. Similarly, in order to explore the notion of sustainable level, Raux (2003) constructed a model architecture based on system dynamics and econometrics. Three sub models were examined in his research, which are public transport finance, modal split, and combined assignment and time of departure choice. The objective of this research was to evaluate the medium- and long-term impacts of urban transport policy on sustainable travel. For detailed literature regarding to application of system dynamics to transportation modeling, please refer to Tables 2.7-2.18. In these tables, the following information is listed: references, major area of application, structure of the system dynamic model, computer software, place of application, type of impact[9], and purpose/objective.

Additionally, in order to compare the difference between the current research and literature, Tables 2.18, 2.19 are provided. Following the format shown in Tables 2.5 to 2.17, Table 2.18 provides this research with the main application area, the structure of system, computer software, place of application, type of impact, and purpose/objectives. In Tables 2.18 and 2.19, six pieces of literature, which are mostly related to this research, are listed in terms of region of research application, key assumptions, key hypotheses, key policies, key performance indicators, model structure system/subsystems/sub-subsystems with key stock variables, important conclusions, parts could be borrowed, and

[8] Sustainable transportation is an aspect of global sustainability, which involves meeting present needs without reducing the ability of future generations to meet their needs (Yevdokimov, 2003, p. 5).

[9] Impacts of urban transportation system could be grouped into five categories: physical, economic, social, environmental, and energy use. Other views suggest three impacts: which are physical, economic, and social. Physical impacts include aspects of ecological change, air quality, noise, and energy changes. Economic impact relates to the accessibility to jobs/raw material/markets and the transportation industry as an economic activity which involves construction jobs and auto/manufacturing industry. Social impact refers to the family and social ties, neighborhood disruption, and reaction of the business community. http://gemini.tntech.edu/~dbadoe/cee466/466lect5.html

the definition of transportation socioeconomic system, and key impacts within the system boundary.

Table 2.1: Literature on the Application of System Dynamics to Transportation Planning

Source: (Abbas and Bell, 1994, pp. 391-400) for Tables 2-5 through 2-16

Reference	**Main Area of Application (Major Category)**	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Abbas, 1989	Role of Transport in development	(Review Paper)				1. To show the need for a comprehensive transport system planning in developing countries in the context of new cities in Egypt 2. To explore the utility of System Dynamics methodology to satisfy this need.
Abbas and Bell, 1994	Role of System Dynamics in Modeling Transportation System	(Review Paper)				1. To review the strengths and weakness of system dynamics in modeling transportation system. 2. To show how system dynamics can contribute to the better understanding of transportation problems.
Ali et al. 1980	Urban transportation planning	1. Socioeconomic subsystem(population, employment) 2. Transportation subsystem (link capacity, travel time, friction factor)	DYNAMO	San Francisco Bay Area (urban)	Physical Social Economic	1. To introduce and utilize the System Dynamics methodology as a potential tool for transportation planning. 2. To utilize dynamic system analysis and simulation along with existing static transportation modeling techniques to study the interaction between the socioeconomic and the transport subsystem in a given urban environment. 3. To develop a potential tool for transportation planning.
Khanna et al., 1985; Khanna, 1986; Khanna et al., 1986a and b, 1989	Urban transportation planning	1. Socioeconomic sector 2. Transportation sector 3. Environment sector 4. Energy sector	DYNAMO	Delhi urban area, India (urban)	Physical Social Economic Environmental Energy use	1. To construct a simulation model to be used as a policy analysis tool by transportation planners. 2. To carry out policy planning experiments to compare the effects of a wide range of transportation policy structures.

Table 2.2: Literature on the Application of System Dynamics to Transportation Planning

Reference	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Shirazian, 1981	Urban transportation planning	1. The area component (population and land-use subcomponents) 2. The travel component (pollution, fuel consumption and trip rate subcomponents)	DYNAMO	Gadsden, Alabama USA (urban)	Physical Social Economic Environmental Energy use	1. To develop a trip generation model capable of taking into account the causal variables of transportation planning. 2. To develop a System Dynamics model to project future transportation requirements. 3. To provide a more rational and scientific basis for the planning of an urban transportation system.
Tanaboriboon, 1979	Urban transportation planning	1. Socioeconomic activity (urban/rural population, pollution, industry, residences) 2. Urban bus transit activity	DYNAMO	Bangkok Metropolitan area, Thailand (urban)	Physical Social Economic Environmental	1. To make use of System Dynamics to forecast socioeconomic activities which provides the basis for estimating future trip generation rates 2. To provide a dynamic instrumentality for evaluating transportation development and urban development alternatives consistent with the national policies. 3. To provide a means of appraising policies without detailed transportation studies of the classical type which involve the collection and analysis of huge volume of data
Tran, 1979	Urban transportation policy planning	1. Urban socioeconomic activity component 2. Highway transportation component 3. Bus transit component 4. Van pool component 5. Air pollution component 6. Transportation fuel consumption	DYNAMO	Northern Virginia Area, USA (regional)	Physical Social Economic Environmental Energy use	1. To apply system concepts in general and the methodology of System Dynamics in particular to transportation policy planning and analysis. 2. To demonstrate the potential of System Dynamics as a transportation planning methodology.

Table 2.3: Literature on the Application of System Dynamics to Transportation Planning

Reference	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Bencome, 1979; Bencome and Dajian, 1980	Regional transportation planning	1. Infrastructure subsystem (penetration roads, irrigation facilities) 2. Socioeconomic environment subsystem (population, agricultural land, capital)	DYNAMO	The Andes Region Venezuela (regional)	Physical Social Economic	1.To provide the infrastructure planner with a forecasting tool that facilitates the a priori assessment of the dynamics of the reciprocal impacts of infrastructure and environment. 2. To attempt to shed some light on the extent to which infrastructure investment can indeed contribute to the regional development.
Boyce and Goldstone , 1966	Regional transportation planning	1. Demographic sector (population) 2. Economic sector (employment)	DYNAMO	A large river basin in the eastern USA (regional) part of a water resources planning study	Social Economic	1. To treat population and employment growth as interacting processes. 2. To forecast the path of population and employment growth for the region through time to act as inputs to transportation planning. 3. To test the significance of alternative assumptions regarding growth rates and interactions of regional activities.
Drew et al., 1975; Drew, 1978; Wadhwa, 1975	Regional transportation planning	1. Agricultural sector 2. Industry sector 3. Transportation sector 4. Water resources sector 5. Population growth 6. Urban development	DYNAMO	The Bicol River basin region, Philippines (regional)	Physical Social Economic	1. To show the applicability of system modeling in infrastructure with emphasis on transportation. 2. To provide a conceptual framework for integrating the principal sectors within the region, thereby providing a powerful technique for regional policy formulation. 3. To identify data requirements useful to provide comprehensive information to support program management at the operational level. 4. To provide a framework for organizing a continuous

Table 2.4: Literature on the Application of System Dynamics to Transportation Planning

Reference	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Budhu, 1981, 1984, 1986; Hobeika et al., 1981 and 1982	Transportation planning for rural regions in developing countries	1. Rural demographic sector (population, housing) 2. Rural economic sector (agriculture) 3. Transport (roads, trucks) 4. Urban demographic sector (population, housing) 5. Urban economic sector (business, services, wharfs)	DYNAMO	Essequibo Coastal Region/ Georgetown City, Guyana (rural, urban regional, national)	Physical Social Economic	1. To explicitly incorporate the transportation activity (variable) in a comprehensive system model (RURTRAN) 2. To study and evaluate the socioeconomic impacts of various investment strategies in transportation and related inputs. 3. To use the model to identify an appropriate date base for comprehensive and coordinated transportation planning. 4. To investigate a strategy in transport and related investments in rural regions that provides the most beneficial indirect and spatial impacts
Budhu and Tran, 1982; Budhu and Grissom, 1985	Impacts of urban growth on transportation	1. population sub model 2. Housing sub model 3. Business sub model 4. Heavy manufacturing sub model 5. Light Manufacturing sub model 6. Government sub model 7. Agricultural sub model 8. Transportation sub model	DYNAMO	Charlotte, North Carolina, USA (regional)	Physical Social Economic Environmental Energy use	1. To understand the possible causal relationships, feedbacks and interactions between the different sectors of the region. 2. To evaluate the impacts of urban policies on the transportation sector. 3. To use the model as a planning tool to understand and study the direction in which the economy is likely to go and especially the impacts of a given urbanization policy on the transportation sector.
Hansen and Kahne, 1975	Transportation ecology	1. The transportation system design sector 2. The economic sector 3. The environmental sector 4. The energy supply sector	This study puts forth a conceptual foundation for a general transportation ecology model (a model representing the functional environment of transportation systems). The empirical and theoretical considerations necessary for the foundations, as well as the expectations of the model concept, are explored.			

Table 2.5: Literature on the Application of System Dynamics to Transportation Planning

Reference	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Wadhwa and Demoulin, 1978	Economic and transport planning	1. Population sub model 2. Economic sub model 3. Transportation sub model	FORTRAN	North Queensland Australia (Interregional)	Physical Social Economic	1. To provide an instrumentality for policy design for economic and transport planning 2. To test various transport policies and predict their impact on the economic development of interacting regions as well as on the performance of the transport system. 3. To identify and evaluate policies for an integrated interregional development
Yang, 1989	Transport investment	1. Heavy industry 2. Light industry 3. Agriculture 4.Building industry 5. Commerce 6. Transportation	DYNAMO	China (national)	Social Economic	1. To simulate the dynamic characteristics of the system at different alternatives of investment combinations. 2. To help people know the importance of transportation in national economies and government to make policies.
Coyle, 1978b	Oil company supply system	1. Crude oil demand 2. Crude oil production 3. Crude oil supply (shipping)	DYNAMO	Oil supply system for a company operating in the early 1970s (International)	Physical Economic	1. To determine the basic dynamic characteristics of an oil company supply system and for which various design alternatives could be investigated. 2. To study possible future courses for oil companies in the early 1970s in the light of the changing conditions they were facing. 3. To provide helpful answers to managerial questions of oil companies.
Krallmann and Nestaas, 1979	Tanker market	1. Demand sector 2. Supply sector 3. Capital sector 4. Tanker-market sector 5. Ship construction sector	FORTRAN	Tanker market (international)	Physical Economic	1. The main objective of the study consists in making a contribution to overcome the crisis on the tanker market.

Table 2.6: Literature on the Application of System Dynamics to Transportation Planning

Reference	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Pugh-Roberts, 1978, 1979a and 1979d	Shipbuilding industry	1. Ship design and Construction 2. Employment 3. Productivity 4. Financial performance 5. Program performance 6. Orders 7. Material	DYNAMO	USA shipbuilding industry, USA (national and international)	Physical Economic	1. To be helpful in better defining and understanding the industry's problems 2. To examine the managerial technological and governmental practices and policies that most significantly influence the commercial competitiveness of US shipbuilding. 3. To serve as a vehicle for exploring the US shipbuilding industry performance under a variety of alternative policies and scenarios.
Raff, 1960	Tankship industry	1. Supply department 2. Chartering department 3. Tankship brokers 4. Coordination department 5. Independent owners 6. Operating department 7. Shipyard sector	DYNAMO	World oil tankship industry (international)	Physical	1. To investigate the nature and cause of the qualitative behavior of the world oil tankship industry
Taylor, 1976	Shipping industry	1. Freight rates-laid-up Tonnage 2. Freight rates-ship build order 3. Profits-expenditure on New ships	Develop a descriptive model of the shipping industry behavior from the viewpoint of an observer.			1. To explore the possibilities of applying System Dynamics methodology the shipping business. 2. To identify the dynamic characteristics and causal mechanisms of the shipping industry. 3. To provide an insight into the operation of the shipping industry in a descriptive sense.
Wijnolst, 1975	Shipping	1. The demand for ship tonnage and the earning from export 2. National fleet 3. Seamen 4. Shipbuilding 5. Seaport terminals	DYNAMO	National fleet of a hypothetical developing country (national)	Physical	1. To illustrate the dynamic relationships between national objectives and national fleet development of a hypothetical country. 2. To provide a tool to show possible consequences of different policy alternatives, or the influences of exogenous development on the planning of the maritime industry.

Table 2.7: Literature on the Application of System Dynamics to Transportation Planning

Reference	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Charlesworth, 1985	Urban road traffic systems	(Review paper)				1. To explore the extent to which these models take account of dynamic behavior. 2. To explore various areas in which System Dynamics might play a useful role in overcoming some of the problems encountered in the modeling of traffic systems.
Charlesworth, 1987 Charlesworth and Gunawan, 1987	Urban road traffic systems	1. Traffic flow 2. Network geometry 3. Drivers' behavior	DYSMAP	A hypothetical simple road test network	Physical Social	1. To investigate the behavioral dynamics of a simple traffic network subjected to a medium-term disturbance such as roadworks. 2. To provide estimates of the delay over a period of time when users of the network are adjusting their route choice. 3. To investigate the sensitivity of the results to the parameterizations employed.
Gunawan, 1984	Urban road traffic systems	1. Traffic flow 2. Network geometry 3. Drivers' behavior	DYSMAP	A hypothetical simple road test network	Physical Social	1. To demonstrate the applicability of System Dynamics in the area of traffic management. 2. To apply System Dynamics in analyzing the problem of delays caused by incidents with emphasis on real-time behavior.
Stephanedes and Amin, 1980	Individual mobility	1. Work-trips sub model (demand, supply, resource) 2. Shopping trips sub model (demand, supply, resource) 3. Mobility sub model	DYNAMO	Rural Cloquet, Northern Minnesota USA (rural)	Physical Social Economic	1. To examine the transportation policy's impacts on the transportation mobility sector.

Table 2.8: Literature on the Application of System Dynamics to Transportation Planning

Reference	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Hirsh, 1977	Urban bus transit	1. Transit ridership 2. Fare price level 3. Net transit funds 4. Bus fleet and bus trips, Services	DYNAMO	A large urban bus transit system (urban)	Physical Social Economic	1. To examine the insights that can be gained through the use of System Dynamics. 2. To evaluate a broad range of urban bus transit operating policies.
Parthasarathi, 1974	Urban public transit operations	1. Transit fund sub model 2. Transit rolling stock 3. Transit rider 4. Automobile ridership 5. Transit satisfaction 6. Automobile ownership satisfaction 7. Population and urban area	FORTRAN DYNAMO	N/A	Physical Social Economic	1. To determine the cause and effect relationship of the various elements of the urban transportation system. 2. To expose the dynamic nature of the interacting complex functional elements of the urban transportation system. 3. To search alternative decision processes insofar as they are applicable to the urban transportation system; which will lead to optimization of the system.
Stephanedes, 1978, 1979a, 1979b, 1980, and 1981; Adler et al., 1980c	Public transit systems in rural areas	1. Work-trips sub model (demand, supply, resource) 2. Shopping trips sub model (demand, supply, resource)	DYNAMO	Northern New England Rural Transit system, New Hampshire &Vermont, USA (rural)	Physical Social Economic	1. To develop a planning tool (TRANSIT2) to be used by management and funding agencies to assist in rural transit program management. 2. To evaluate alternative operating policies and financial (control) transportation strategies that are of interests to transportation policy makers by analyzing their impacts on the rural transit system performance through time. 3. To analyze short-term and long-term effects of proposed policies. 4. To determine how public transit systems in rural areas can be designed so as to be maximally efficient and effective in providing transportation services.

Table 2.9: Literature on the Application of System Dynamics to Transportation Planning

Reference	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Bradley, 1985	Household car ownership and usage	1. Car ownership 2. Mobility 3. Travel perception		A household unit	Physical Social	1. To simulate household data as a basis for hypothesis testing 2. To represent and study existing dynamic hypothesis and generate new ones of household car travel 3. To provide a flexible framework for simulating desired combinations of household travel decision processes and studying the types of behavior patterns which arise due to inter-related transport policies or changing of the travel environments.
Pugh-Roberts, 1979b	Automotive industry	1. Automobile industry sector 2. Automobile consumer sector	DYNAMO	USA Automobile industry (national)	Physical Social Economic Environmental Energy use	1. To conduct an analysis of automobile industry behavior under a variety of policies and economic scenarios.
Young et al., 1985	Car parking	1. Urban activity /travel sector 2. Model split sector 3. Parking sector 4. Traffic/parking interaction sector 5. Financial management sector		Kaohsiung City, Taiwan (urban)	Physical Social Economic	1. To provide the city administrators with a policy lab for parking systems management. 2. To provide an understanding about the complicated behavior in the parking management systems. 3. To generate future scenarios for policy experimentation. 4. To help in the evaluation of some of the potential parking management strategies.
Young and Santoso, 1988	Car ownership	1. Car ownership module 2. Traffic module 3. Parking module		Taiwan (national)	Physical Social	1. To analyze the trend of car ownership with the inclusion of feedbacks from the traffic and parking condition and the consideration of possible changes in the car ownership system environment.

Table 2.10: Literature on the Application of System Dynamics to Transportation Planning

Reference	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Gottschalk, 1982	Railways	1. Track module 2. Equipment module 3. Market module 4. Finance module		Consolidated rail corporation (conrail), USA (regional)	Physical Economic	1. To increase understanding of problems facing the railroad. 2. To aid in developing strategies for addressing their problems 3. To forecast railroad performance. 4. To aid in developing more effective policies for railroad management. 5. To evaluate impacts of public policy on railroad performance.
Pugh-Roberts, 1979c	Railroad	1. Track wear 2. Track maintenance 3. Track classification and train speed 4. Track-caused accidents 5. Freight volume and revenues 6. Operating costs 7. Profit and investment 8. Government policy options	DYNAMO	USA Railroad industry (national)	Physical Social Economic	1. To evaluate the impact of various government policy options on railroad safety and operations 2. To show what new data would be most useful for assessing policy impact. 3. To show how policy impact will affected by trends in the railroad industry 4. To show how short-term and long-term policy impacts will differ.
Shmidt, 1989	Railway	1. Railstock capacity Module 2. Market share and wear-and-tear calculations 3. Budget module 4. Turnover, costs and proportional profits		German federal railway (national)	Physical Economic	1. To provide a valuable article in which strategic decisions which are often based on uncertain information can now be founded on a sound basis and therefore the decision process can be effectively supported. 2. To support the development and assessment of corresponding strategies adopted to solve these problems.

Table 2.11: Literature on the Application of System Dynamics to Transportation Planning

Reference	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Geinzer, 1979; Adler et al., 1979, 1980a and b; Adler and Ison, 1981; Ison, 1980	Transportation Energy Use	1. Passenger travel Sector 2. Automobile sector 3. Transit sector 4. Highway sector 5. Car-pool sector 6. Demographic sector 7. Cost sector	DYNAMO	Australia (national)	Physical Social Economic Energy use	1. To analyze the interaction between energy supply and transportation-related energy use. 2. To develop a better understanding of the long-term effects of transportation-related policies on energy use. 3. To evaluate the impacts of transportation-related policies on energy use and availability. 4. To evaluate the impacts of energy price and availability on travel and mobility. 5. To test the effects of various exogenously specified scenarios.
Wadhwa, 1979	Transportation Energy Demand	1. Passenger task sub model 2. Energy intensiveness sub model	DYNAMO	A large urban bus transit system (urban)	Physical Social Economic Energy use	1. To assess the future fuel demand for passenger transport in Australia. 2. To simulate the effects of incomes, prices and car ownership levels on travel demand.
Abbas, 1990a and b,	Management system for the road infrastructure	1. Road funds allocation 2. Road administration 3. Road construction 4. Routine road maintenance 5. Road restoration 6. Periodic road maintenance 7. Road funds saved and recycled	FORTRAN/ DYNAMO	Tenth of Ramadan New City, Egypt (regional)	Physical Economic	1. To model the process involved in the allocation of road funds 2. To provide better insight and understanding of the dynamic feedback nature of the road system. 3. To act as an experimental management tool for assessing the consequences of different road strategies on the physical development of the road system. 4. To assist in the management and control of the road system.

Table 2.12: Literature on the Application of System Dynamics to Transportation Planning

Reference	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Chen, 1975	Six diverse transportation problem areas	1. Traffic stream 2. Signalization analysis 3. Port operations 4. Highway transportation 5. Urban public transit 6. Transportation and land use	DYNAMO	Taipei, Taiwan (urban)	Physical Social Economic	1. To review, apply and evaluate the System Dynamics methodology for transportation systems analysis
Kim, 1996	Transportation Infrastructure Management	1. Physical subsystem (pavement management system, and bridge management system) 2. Evaluation subsystem 3. Functional subsystem 4. Financial subsystem 5. Administration subsystem	DYNAMO	I-81, Virginia, USA (regional)	Physical Social Economic	1. To use System Dynamics as an instrumentality for generating scenarios to facilitate the management, policy making, planning, and budgeting as well as the programming of a regional highway system. 2. To study and evaluate various sub models which define the highway system of a region.
Haghani, et al., 2003	Transportation performance	Population/migration of population/household/job growth-employment-land availability, housing development, travel demand, and traffic congestion level.	DYNAMO	Montgomery County, MD, (regional)	Physical Social Economic	1. To use System Dynamics to model transportation system by simultaneously considering land use and transportation system performance.
Raux, 2003	Allocation of public resources	1. Public transport finance 2. Modal split 3. Combined assignment and time of departure choice	VENSIM	N/A	Physical Economic	1. To evaluate the impact of scarcity of public resources and the consequences they have on the operations of public transport.
Yevdokimov, 2003	Role of System Dynamics in Evaluating Sustainable Transportation System	(Paper review)				1. To explore the possibility of using System Dynamic to study and evaluate sustainable transportation.

Table 2.13: Current Research Perspectives

Current Research	Main Area of Application (Major Category)	Structure of the System Dynamics Model	Computer Software	Place of application	Type of impact	Purpose/Objective
Liu, S. Y. (2006) PhD Dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA	Urban Transportation Policy Evaluation	Transportation subsystem Social subsystem Economic Subsystem Political subsystem This research involves the following respects: 1. Investment (redistributions of revenues from congestion charging scheme) 2. Physical transportation (congestion mitigation) 3. Social network (social activity and networks) 4. Behavior (social/travel) 5. Political (policy issuing) 6. Equity (horizontal/vertical) 7. Quality of life (community) 8. Demographic (residents of cordon-based area)	VENSIM	Potential area Washington D.C	Physical Social Economic	1. To provide a conceptual framework that describes the manifestation of traffic congestion problems in the transportation socioeconomic system. 2. To explicitly demonstrate and understand the causal and feedback relationships and interactions between different subsystems and agents of transportation socioeconomic system. 3. To provide the policy makers with a tool to demonstrate the behavior the transportation-socioeconomic system after the intervention of congestion pricing policy. To help policy makers understand the implication of dynamic complexity of the large scale system and to prepare for the implementation of congestion pricing scheme in an urban area. Specifically, to investigate the effect of congestion pricing and the redistribution of congestion charging revenues on the mitigation of congestion level within the cordon based area. 4. To understand the uncertainties within transportation socioeconomic system and to explore the possibility of integrating fuzzy set theory into system dynamics model to catch these uncertainties. 5. To generalize this research to apply it different area and to design a management flight simulator to compress the time and space to test the policy-makers' mental models and alternative policies in mitigating congestion problems. 6. To provide a useful framework for the future practitioners to practice policy evaluation using system dynamics.

Table 2.14: Difference between Current Research and the Five Mostly Related References

Research Title	Liu, S.Y. (2006), Evaluation of the Impacts of the Policy of Cordon-Based Dynamic Traffic Congestion Pricing Combined with Improvement in Alternative Modes	Tran, T. K.(1979), *An Urban Transportation Policy Planning Methodology: System Dynamics Approach*, PhD Dissertation of Virginia Polytechnic Institute and State University, Blacksburg, VA.	Tanaboriboon Y. (1979), *A Transportation Planning Strategy for the Bangkok Metropolitan Area*, Ph.D Dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA
Region of Research Application	Expected area: Washington D. C	Northern Virginia Region (Arlington County, Fairfax County, Prince William county, city of Alexandria, Fairfax city, and Falls Church city)	Bangkok Metropolitan area, Thailand (urban)
Key Assumptions and/or Key Hypotheses	Assumptions: 1. fixed road capacity 2. time horizon 20 years Hypotheses: 1. Revenues generated from congestion pricing scheme will significantly improve the alternative modes and necessary services to satisfy the population mobility needs. 2. Improvement of alternative modes will have positive impacts on the mitigation of congestion a cordon-based area.	1. The Urban area is composed of four main sectors: population, industry, housing and land. 2. For highway travel demand: a) only the morning peak travel is studied; b) the principal type of trips is work trips. 3. For bus transit: a) the growth of the bus fleet is motivated by the bus travel demand; b) the bus transit fund supports bus operations and determines the fare structure.	The model assumes that as industry grows, jobs will be created, and thus, more traffic will be generated, until zero growth or steady-state development is reached.
Key Policy(ies)	1.Cordon based dynamic congestion charging with the improvement of alternative modes and public security 2. To evaluate different revenue distribution scenarios	1. To implement a vanpool program in 1980; 2. To add a reserve lane for buses in 1995; 3. To promote a carpool program in 1980; 4. To decontrol the price of fuel and ration gasoline in 1980; and 5. To apply a stricter pollution control policy.	Corridor development was chosen as the development pattern over the polycentric development alternatives.
Model structure System/Subsystems/Sub	Six Subsystems: economic subsystem, political subsystem, , transportation subsystem, and social system	Six Subsystems: 1. Urban socio-economic activity; 2. Highway transportation;	1. Socioeconomic sub system that includes the following sub subsystems: urban/rural population, pollution, industry, residential)

Subsystems with Key Stock Variables		3. Bus transit: 4. Vanpool: 5. Air pollution; and 6. Transportation fuel consumption.	2. Urban bus transit subsystem
Key performance indicators	Average congestion level/ pollutions/ratio of mass transit demand to supply/	Miles of road; number of houses; number of jobs; auto ownership; urban highway density, travel delay	Bus travel time; motor vehicle travel time; population; vehicles; jobs
Part (s) could be used by current research	N/A	Modal Split Analysis	The travel time determination
Definition of transportation socioeconomic system	Transportation-socioeconomic system denotes the system constructed by the subsystems, namely, economic subsystem, political subsystem, environmental subsystem, transportation subsystem, and social system, and their interactions. That is to say that the transportation socioeconomic system not only considers transportation system but also the feedback linkages between transportation system and other systems, by which the large system concepts can examine the impacts of transportation system change on it environment as well as the impacts of the environment change on the transportation system.	No specific definition is incorporated. The transportation socioeconomic system includes the economic, social and transportation sectors, where the economic subsystem includes housing, employment, urban land, industries, and fuel consumption; the social sub system considers the demographic factor and the environment.	In this research, the transportation socioeconomic system considers the urban and rural population, pollution, industry, and residential factors.
Key impacts within the system boundary	Physical Social Economic	Physical Social Economic Environmental Energy use	Physical Social Economic Environmental

Table 2.15: Difference between Current Research and the Five Mostly Related References

Research Title	Shirazian G. R. (1981), Trip Generation Analysis in Transportation Planning: A System Dynamics Approach, Ph.D Dissertation, Auburn University, AL.	Budhu, G.(1981), A System Dynamics Approach to Rural Transportation Planning in Less Developed Countries, Ph.D Dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA	Haghani, A, et al. (2003), A System Dynamics Approach to Land Use/Transportation System Performance Modeling, Journal of Advanced Transportation, Vol. 37, No.1, pp, 1-82
Region of Research Application	Gadsden, Alabama USA (urban)	Essequibo Coastal (Guyana, Region)	Montgomery County, MD, (regional)
Key Assumptions and/or Key Hypotheses	Population increase (natural population growth plus migration)	1. The boundary of influence of the investment is defined with respect to the immediate region in which the investment is made and the regions that will possibly be affected by in- or out-migration as a result of the impacts of such investments. 2. The main interest in the urban region (i.e., zones to which population are attracted) is its perceived employment characteristics.	1. Increase of population causes more households, more travel demand, and more traffic congestion. 2. Land availability controls housing development, the growth of industry and business.
Key Policy(ies)	There were not explicit policy analyses in this research. Following two recommendations are provided: 1. Encourage business construction 2. To provide better job opportunities and better housing conditions	Alternative investment policies 1. “Do nothing” 2. Investment in “road” 3. Investments in roads, drainage and irrigation	Evaluate the impacts of highway capacity expansion on land use and transportation performance
Model structure System/Subsystems/Sub Subsystems with Key Stock Variables	Area subsystem with the following sub-subsystems: population (population, labor, job and income (stocks)) land use (houses, industries, business, transportation land, public land, urban area land and land fraction occupied (stocks)) Travel subsystem with pollution, fuel consumption, and trip rate as key stocks	1. Rural demographic subsystem (population, housing (sub subsystems)) 2. Rural economic subsystem (agriculture sub subsystem) 3. Transport subsystem (roads, trucks (stocks)) 4. Urban demographic sub system (population, housing (sub subsystems)) 5. Urban economic subsystem (business, services, wharfs (sub	Subsystems include: Population, migration of population, household, job growth-employment-land availability, housing development, travel demand, and traffic congestion level.

		subsystems)	
Key performance indicators	Population size, number of jobs, number of houses, land size for: house/manufacturing/transportation, pollution emission	Population level, housing level, rice harvest	Population, number of households, employment, land availability
Part (s) could be used by current research	Pollution emission model that captures pollution emission metrics	Analysis of different investment alternatives	Land development model; Congestion Level model
Definition of transportation socioeconomic system	No specific definition is used. However, this research includes the population, business, and transportation aspects of the socio-economic system.	No specific definition is used. However, this research includes the following concepts: population, business, transportation, and housing.	Not included.
Key impacts within the system boundary	Physical Social Economic Environmental Energy use	Physical Social Economic	Physical Social Economic

2.4 Applications of Fuzzy Set Theory in Transportation Modeling

This section provides an overview of uncertainty and application regarding how it is represented in the transportation modeling process, i.e. the application of fuzzy set theory in transportation modeling. In addition, the possibility of integrating fuzzy set theory into system dynamics modeling to represent uncertainty in the transportation socioeconomic system is briefly explored.

2.4.1 Overview of Uncertainty

"Uncertainty implies that in a certain situation a person does not dispose about information which quantitatively and qualitatively is appropriate to describe, prescribe or predict deterministically and numerically a system, its behavior or other characteristics" (Zimmermann, 2000, p. 192). Moreover, Zimmermann (2000) presented six causes for uncertainty, where the most frequent cause is lack of information. The second cause is the abundance of information, which is owing to the human beings' limited mental capacity in simultaneously perceiving and processing large amount of data. With the existence of conflicting evidence, the available information has different meanings, which confuses the observer. This is the third cause for uncertainty. Actually, under this situation, more information may not be conducive for reducing uncertainty. Therefore, it may be necessary to remove some pieces of information to eliminate uncertainty. The fourth cause for uncertainty is the linguistic information that comes from natural languages. Generally, natural languages have diverse meanings in different contexts. Engineering measurement is another cause for uncertainty. In reality, due to technological constraints, no property can be measured exactly as it should be. The last cause for uncertainty originates from belief, by which all available information may be biased due to the subjective way of observing situations.

In order to identify and reduce uncertainty, many theories have been explored. Based on classic set theory, Hartley (1928) was the first person to explore measurement of uncertainty. Thereafter, Shannon (1948), the pioneer of information theory, used probability theory to measure uncertainty. In 1965, Zadeh proposed fuzzy set theory to quantify uncertainty. Later, Shafer (1976) presented evidence theory to model

uncertainty. More recently, Dubois and Prade (1988) employed possibility theory to study uncertainty.

The following section reviews the modeling of uncertainty in transportation socioeconomic system.

2.4.2 Uncertainty in Transportation Socioeconomic System

In transportation modeling process, many parameters are characterized by uncertainty and ambiguity. Fuzzy set theory can model subjective or linguistic information. Pappis and Mamdani (1977) published the first paper in which fuzzy logic was used to solve a practical traffic problem. In this paper, the authors explored the application of a fuzzy controller to a traffic junction. Nakatsuyama et al (1983), Sugeno and Nishida (1985) and Sasaki and Akiyama (1986, 1987, and 1988) developed a series of fuzzy control models for urban traffic applications, which respectively focused on the fuzzy controller for traffic junction, fuzzy control of the model car, and fuzzy traffic control system for an expressway.

Kikuchi et al. (1990) pioneered the application of fuzzy logic into traffic and transportation in the U.S. Starting from the early 1990s, interests in application of fuzzy logic in transportation modeling were widespread in the world. Please refer to Table 2.21 for the literature that deals with uncertainty in transportation and methodologies to measure uncertainty.

Table 2.16: Uncertainty in Transportation System and Methodologies to Measure Uncertainty

References	Main Area of Application	Uncertainties	Methodology	Comments	Part (s) could be use for current research
Chakroborty, P. and Kikuchi, S. ,1990	Analysis of capacity and level of service of highways	Determination of capacity and level of service of highway facilities; Causes of uncertainty: ambiguities and vagueness	Fuzzy set theory	Input variables, such as ideal capacity, sight distance, volume of traffic, headway between cars, can be represented by fuzzy numbers; output variables, such as adjustment factors, actual capacity, level of service criteria (volume to capacity ratio or reserved capacity) can also be represented by fuzzy numbers.	Fuzzy number representing the level of service.
Chong, K. P. et al., 1993	Uncertainty modeling and analysis in civil Infrastructure	Review Paper		30 NSF (National Science Foundation) supported projects are presented. Major theme focuses on the uncertainty analyses in civil engineering areas including structure, construction process, earthquake engineering, building system, solid mechanics, geomechanics and environmental engineering.	N/A
Deb, S. K., 1993	Mass transit mode choice	Satisfaction level; Causes of uncertainty: human perception and belief	Fuzzy set approach	Satisfaction level viewed by different interest groups (income group) bears values from 0 to 1.	1. Satisfaction level determination 2. Income group classification
Henn, V., 2000	Route choice model for traffic assignment	Predicted cost of a path; Causes of uncertainty: imprecision and ambiguity	Fuzzy set theory	Comparing normalized fuzzy costs under different conditions, namely, normal, congestion, and incident.	Normalized fuzzy cost
Henn, V. and Ottomanelli, M. ,2003	Driver uncertainty in traffic assignment models	Route choice behavior which a decision making process is determined by the perceptions of the drivers and random events (such as accident); Causes of uncertainty: lack of information, randomness	Possibility theory	Unlike classic random utility, the possibility theory does not require the additivity of the choice consequences, which is more realistic for modeling driver's perception.	N/A
Hoogendoorn, S., Lanser, S.H. and Schuurman, H. ,2000	Fuzzy perspectives in Traffic Engineering	Review paper		The application areas of fuzzy logic in transport engineering are reviewed, which include traffic monitoring and state estimation, modeling driving behavior, route choice model, and traffic state estimation. Moreover, merits and drawbacks of fuzzy logic approach are briefly discussed. At last, this paper	Discussions on merits and drawbacks of fuzzy logic. Direction of applying fuzzy logic in traffic engineering

				presents some points on the direction of applying fuzzy logic in traffic engineering.	
Kalic, M. and Teodorovic, D., 2003	Trip distribution modeling	Travel demand prediction; Causes of uncertainty: imprecision and lack of information	Fuzzy logic and genetic algorithm	Fuzzy rules are generated to determine the number of trips. And then, the searching of best fuzzy rule is examined by genetic algorithm	Generation of fuzzy rule to determine the travel demand
Kikuchi, S. et al., 1998	Treatment of uncertainty in study of transportation: fuzzy set theory and evidence theory	Review paper		Examples of vagueness (fuzziness) and ambiguity in transportation analysis. Fuzziness prevailing in transportation planning process in the forms of perception, linguistic expression, and lack of information. Ambiguity exists in the process of evaluation, classification, and choice. Fuzziness and ambiguity are respectively caught by fuzzy set theory and evidence theory.	Basic concepts
Kikuchi, S. and Chakroborty, P., 2005	Transportation analysis	Uncertainties exist in the following aspects of transportation analysis: data and information, knowledge base or the model, interpretation of the results, and objectives and goals; The causes for these uncertainties: perception, belief, imprecision, and vagueness	Possibility theory	For data and information, most of data are coming from statistics, which often are filtered by perception. For the knowledge base or the model of transportation, it is to a large extent empirical. In terms of interpretations of the results, most of them are approximate. As far as the objective and goals are concerned, they are vaguely defined. Possibility theory is suitable for dealing with the uncertainties existing in the information and analysis situations. Information aspects include desire (desired departure time/arrival time), satisfaction and acceptability (satisfactory cost, acceptable cost, willing to pay), perceptions and quantities (travel time/distance/appearance/condition), descriptive condition (traffic congestion, comfort, safety, level of service), and imprecise values (sight distance, reaction time, and value of time). The analysis situations contain classification (assigning the current or future traffic condition to a level of service category), justification of investment (comparing the estimated transit ridership with a threshold ridership value to justify the investment), feasibility (comparing the estimated arrival time with the	Basic concepts

				desired arrival time), and preference and ordering (comparing the predicted performance and the desired performance).	
Lanser, S.H. and Hoogendoorn, S.P., 2001	Travel choice behavior in public transport networks	Traveler's choice behavior and travelers' appraisal of trip chain attributes; Causes of uncertainties: perception, belief, and lack of information.	Fuzzy genetic approach	Fuzzy Limited rule base Travel Choice Model (FLiRT-Model) is presented. And then, it is calibrated by applying a Genetic Algorithm to establish the best fuzzy rule.	FLiRT-Model
Olaru, D. and Smith, B., 2005	Modeling behavioral rules for daily activity scheduling	Travel behavioral responses to activity schedule; Causes of uncertainty: imprecision of data in the survey	Fuzzy logic	Fuzzy Rule-Based System (FRBS) is used to examine the survey data with linguistic information.	Fuzzy Rule-Based System
Ozawa, Y. et al.,	Impact analysis of congestion pricing	Decision process of trip makers; Causes of uncertainty: human perception	Fuzzy set theory	Fuzzy logic models were built to estimate the travel patterns for the individual trip by trip	Basic concepts
Teodorovic, D., 1999	Transportation engineering	Review paper		Quite a few of papers were reviewed to show that the fuzzy logic is a very promising methodology to model traffic and transportation processes characterized by imprecision, ambiguity, and vagueness.	Literatures
Teodorovic, D. and Kikuchi, S., 1990	Transportation route choice	Driver's perception on travel time; Cause of uncertainty: human perception	Fuzzy inference technique	Fuzzy number is used to represent the perceived travel of driver on two alternative routes in a highway network.	Perceived travel time as fuzzy number
Wu, J.P., Brackstone, M. and McDonald, M., 2000	Motorway microscopic simulation	Driver decision processes, specifically, the car following an d lane-changing process; Cause of uncertainty: human perception	Fuzzy sets and systems	Car-following and lane-changing modes were presented to show the application of fuzzy logic to modeling travel behavior.	Modeling process

Chapter 3 A Fuzzy Representation of Multiple Linguistic Variables in System Dynamics Modeling

Abstract

In dynamic modeling, one may encounter multiple linguistic variables (e.g., perception with respect to service provided) that require definition and appropriate mechanisms to consider their joint effects. This paper proposes an approach that borrows concepts from fuzzy set theory to represent and operate on these variables. A simple example is used to illustrate the procedures necessary to define linguistic variables using the concept of a triangular membership function for a system dynamics model within the *Vensim Simulation Environment*. Thereafter, we illustrate the operations of the linguistic variables through a model where two linguistic variables, i.e. customer satisfaction with respect to service and lead time associated with a product impact the conversion from potential customers to customers. For this example, we compare the results obtained by employing fuzzy concepts with the results one would obtain using generic lookup functions and describe the insights obtained when using these two methods.

Keywords:

Linguistic Variable, System Dynamics, Fuzzy Logic, Operation of Linguistic Variable, Fuzzy Rules, Triangular Membership Function, Lookup Function

1.0 Introduction and Context

"Uncertainty implies that in a certain situation a person does not dispose about information which quantitatively and qualitatively is appropriate to describe, prescribe or predict deterministically and numerically a system, its behavior or other characteristics"

(Zimmermann, 2000, p. 192).

Uncertainty is often encountered in the representation and the design of complex systems. This uncertainty manifests itself in the definition and measurement of important variables, in the events that affects system behavior, and in the decisions that affect system design and performance. The focus of this research is the uncertainty associated with the representation of information for which there is no precise and quantifiable measurement. In other words the emphasis is on variables that describe a perception or feeling about a situation or phenomenon that are often referred to as linguistic variables.

In order to capture uncertainty, many theories have been proposed in the literature. Hartley (1928) explored the measurement of uncertainty using classic set theory. Thereafter, Shannon (1948) used probability theory to measure uncertainty. In 1965, Zadeh proposed fuzzy set theory. Later, Shafer (1976) presented evidence theory and more recently Dubois and Prade (1988) employed possibility theory. In the literature, fuzzy set theory has been used extensively to represent linguistic variables because of its flexibility to represent multiple characteristics associated with a specific variable or phenomenon. For example, the characteristics of very cold, cold, mild, hot and very hot are typically associated with the feeling of temperature. One of the basic premises of fuzzy logic is to represent the degree of truth or relevance associated with a specific phenomenon. "*The member in a fuzzy set is not a matter of affirmation or denial, but rather a matter of a degree (Klir and Yuan 1995, p.11).*" Within this context one can represent the state of a phenomenon with gradual transitions, which can describe measurement uncertainties (Klir and Yuan, 1995).

In dynamic modeling, researchers typically need to represent attributes or characteristics of phenomena (variables) that change over time. In fact, one can argue that it is the relevant and not absolute measurement of these variables that is important to capture. These variables can impact the decisions that are made and consequently the performance of the system over time. For example, in transportation engineering, the perception of drivers with respect to the highway Level of Service (LOS) will impact the choice of the time of departure and the route selection or

even the transportation mode. This perception may be expressed by many gradual states such as, very satisfied, satisfied, and not satisfied. If the highway LOS is relatively poor, then drivers in urban areas may select an alternative mode of transportation such as metro. These potential changes will most likely affect traffic flow during certain times of the day and consequently the average congestion level.

The representation of linguistic variables in system dynamic modeling (Sterman, 2000) has been incorporated through the use of Lookup or Table functions. Even though these functions are very versatile they typically are not used to represent many characteristics of the same phenomenon (variable) concurrently. Furthermore, Sterman (2000) provides a brief description of a fuzzy min and fuzzy max function. However, the variables that are being modeled are not linguistic variables and these functions are used in the situation where the effect of a constraint is gradually realized.

There have been other attempts of applying fuzzy set theory in system dynamics modeling. Tessem and Davidsen (1994) proposed the use of fuzzy numbers to capture the uncertainty in system dynamics model. This research only uses ranges to represent characteristics (low, very low …etc.) without using any other fuzzy concepts. Ghazanfari, et al. (2003) proposed the concept of using fuzzy relations in system dynamics models without implementing this concept in a system dynamics model. Although Sousa-Poza, et al. (2003) suggest using fuzzy set theory and system dynamics to investigate work satisfaction, there are no specifics on how to integrate fuzzy set theory into a system dynamics model. Bourguet, R. E. and Soto R. (2002), in their abstract, suggest the application of fuzzy logic for policy analysis in a system dynamics model without carrying this notion further. Johnson, P. et al. (2000) mention fuzzy logic rules that can represent physiological and psychosocial disease parameters in system dynamics model without any specifics.

This paper differentiates itself from the rest of the literature in the following ways. First, it provides an approach for the representation of linguistic variables by employing typical triangular membership functions. An example is used to demonstrate this approach in the *Vensim Simulation Environment*. Second, specific operations that may be pertinent when capturing the interactions of multiple linguistic variables are provided. These operations are illustrated with an example where two linguistic variables, i.e., customer satisfaction with respect

to service and lead time associated with the delivery of a product impact the conversion from potential customers to customers.

In section 2, definitions of typical fuzzy membership functions are provided and a simple stock flow diagram is used to illustrate how these functions can be represented in a system dynamics model. Simulation results are provided that illustrate the implementation of the fuzzy membership functions in a system dynamics context. Section 3 presents a system dynamics model where two linguistic variables interact with each other through a fuzzy Max-Min inference method and this is illustrated through an example that uses two molecules from the system dynamics literature (Vensim Simulation Software Version 5.6, System Files). In Section 4, for the example presented in Section 3, we compare the results obtained by employing fuzzy concepts with the results one would obtain using generic lookup functions and describe the insights obtained when using these two methods. Section 5 concludes this research by reiterating basic conclusions of this paper and discusses some of the advantages of this approach as well as some of its modeling and implementation challenges. It also describes the implementation roadmap for the proposed fuzzy framework for practitioners that are interested in this type of research.

2.0 Representation of Fuzzy Membership Function in System Dynamics Model

In this section, a typical fuzzy triangular membership function is integrated into a system dynamics context and an example illustrating this representation is provided.

2.1 Membership Functions

Generally, there are three types of fuzzy membership functions that are widely used in the literature, i.e., the triangular, trapezoid, and bell-shaped functions. Among the three fuzzy member functions, the triangular fuzzy membership function is the most commonly used and is the one that will be used to illustrate all the concepts throughout this paper.

A typical triangular membership function is given as:

$$\text{f(x; a, b, c)} = \mu_T(x) = \begin{cases} \dfrac{x-a}{b-a} & a \le x < b \\ \dfrac{c-x}{c-b} & b \le x \le c \end{cases} \qquad (3.1)$$

Where a, b, c are the boundary values. As an example, let us consider the feeling with respect to temperature. There may be three or more characteristics associated with a person's feeling with respect to temperature. In this research, we consider three characteristics as being low, medium and high. The boundary values for each characteristic are defined for each individual. Among which, x denotes the measured temperature and $\mu_{TL}(x)$ is the degree of belonging to the specific characteristic for a measured temperature in degrees Celsius.

(Low): $$\mu_{TL}(x) = \begin{cases} 1 & x \le 0 \\ \dfrac{15 - x}{15} & 0 < x \le 15 \end{cases} \quad (3.2)$$

(Medium) $$\mu_{TM}(x) = \begin{cases} \dfrac{x}{15} & 0 < x \le 15 \\ \dfrac{30 - x}{15} & 15 < x \le 30 \end{cases} \quad (3.3)$$

(High): $$\mu_{TH}(x) = \begin{cases} \dfrac{x - 15}{15} & 15 < x \le 30 \\ 1 & x \ge 30 \end{cases} \quad (3.4)$$

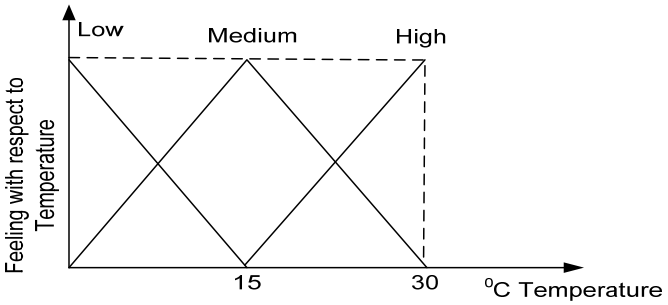


Figure 3.1: Representation of Linguistic Variable Using Triangular Membership Functions

2.2 Representation of a Linguistic Variable in a System Dynamics Modeling Context

The previous example will be used to demonstrate how an individual's feeling with respect to temporal changes in temperature can be captured in system dynamics model. For the sake of brevity, a simple stock and flow structure is provided (Figure 3.2). The three boundary values that delimitate each characteristic are provided by the parameters starttemp, midtemp and endtemp. This stock and flow structure allows for the representation of all three characteristics through the Subscript function in the VENSIM simulation environment. It is assumed that

temperature increases over time (from 0 to 30 C^0) according to a ramp function (see Figure 3.3). The feeling with respect to temperature in the same time range (refer to Figure 3.4) is represented by each characteristic separately. The degree of belonging (truth) for feeling that the temperature is low starts at one for 0 ^{0}C (at time zero minutes) and declines linearly to zero at temperature 15 ^{0}C (at time 100 minutes). The same type of behavior is exhibited for the degree of belonging or truth associated with the feeling that the temperature is medium. This starts at zero for 0 ^{0}C (at time zero minutes) and increases linearly to 1 at temperature 15 ^{0}C (at time 100 minutes) and then declines linearly to zero at temperature 30 ^{0}C (at time 200 minutes). Because of these very straightforward linear representations of temperature change and of the membership functions associated with each characteristic the change of the degree of belonging over time for each characteristic resembles the membership functions of Figure 3.1. However, in general this is not expected to be the case. Furthermore, it should be noted that throughout this presentation the definition of each linguistic variable with its associated characteristics do not change over time, i.e., the fuzzy representation of the linguistic variable remains the same throughout the analytical time horizon.

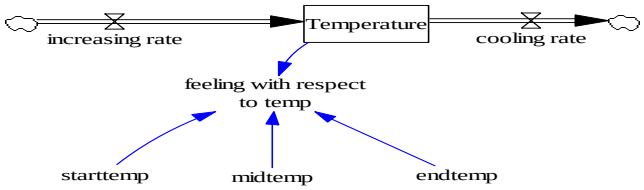


Figure 3.2: Stock Flow Diagram Representing a Linguistic Variable Represented by a Triangular Membership Function

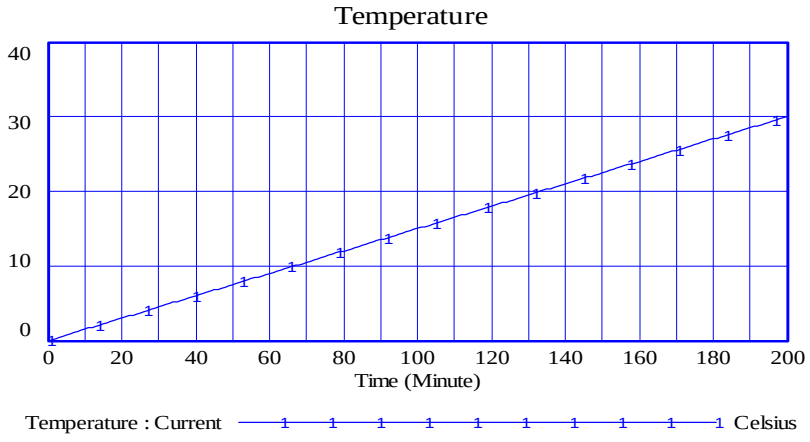


Figure 3.3: Change of Temperature over Time

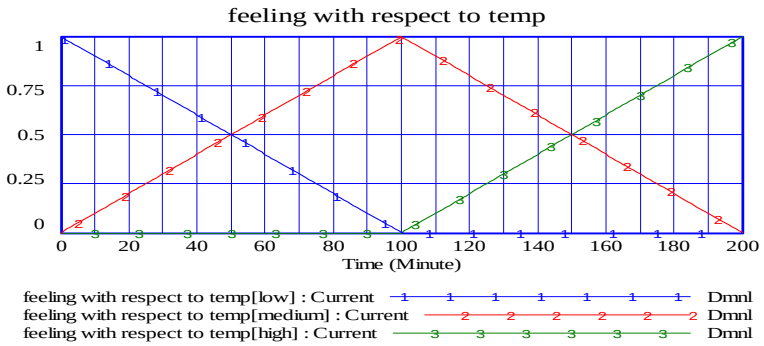


Figure 3.4: Degree of Membership with Respect to Temperature over Time

In the context of dynamic modeling, the linguistic variables described above are combined either additively or multiplicatively with other variables to represent joint effect. When the combination is with other crisp variables then the manipulations are straight forward. However, the challenge remains when one attempts to capture the combined effect of two or more linguistic variables. In the next section we demonstrate how one could potentially account for their joint effect.

3.0 Operations of Multiple Linguistic Variables

In this section, triangular membership functions are employed to represent two different linguistic variables. Having provided a fuzzy based definition of a linguistic variable in a system dynamics modeling context in the previous section, the main focus of this section is to discuss how two linguistic variables can be combined. The ensuing approach requires three procedures to take place namely fuzzy representation or fuzzification, fuzzy rule definition, and defuzzification. In the previous section we explored the fuzzy representation or fuzzification. In the following discussion, we mainly address the steps of fuzzy rule definition and defuzzification. The fuzzy rule definition will use the Max-Min inference method (Klir and Yuan, 1995). As far as the defuzzification step is concerned, for the sake of simplicity, the Largest of Maximum degree of truth will be used. Same as in the previous example in this part, there are two linguistic variables each having three characteristics i.e. Low, Medium, and High, which describe the different perceptions of person with respect to their value level respectively. In order to cover all the possible combinations of these characteristics, nine rules need to be defined and evaluated accordingly. The fuzzy rule definitions are provided in Table 3.1.

Before discussing the fuzzy rule definition, we need to discuss the dynamic model (stock and flow structure) of the example. Figure 3.6 provides the stock and flow structure of the example. In order to make the example easy to understand, two commonly used molecules are borrowed from the Vensim Simulation Environment. They are the product diffusion and shipping backlog model. Since the molecule models are relatively mature models that have been analyzed and tested, this paper does not provide the complete analysis of the key loops, sensitivity, and system behavior analyses. In this model, the rate of converting potential customers to customers is determined by the aggregate referral fruitfulness concept, which is the probability that a contact can encourage a person from being a potential customer to being a customer multiplied by the number of contacts of noncustomers with customers. A higher converting rate leads to more customers. With increased customers, more orders are generated, which increase the product backlog. Since each customer has a relatively constant demand for the product, the increased customer base augments profit. With the augmented profit, investment is made to increase the production capacity and product service level (service hours). Due to the increased capacity, order lead time is reduced or the inverse of the lead time, which is labeled as timeliness increases. In this model, both service hours and timeliness are normalized. Then the triangular membership function is used to fuzzify the normalized service hours and timeliness. Through process of the fuzzy rule definition (in Table 3.1) and defuzzification, the combined effect of the two variables is indicated by a variable which is called the defuzzified effect on referral fruitfulness. The product of referral fruitfulness and the defuzzified effect on referral fruitfulness is the aggregate referral fruitfulness.

The definitions of perceived Level of Service in terms of normalized service hours and perceived timeliness are provided next. The representation of the perceived level of service is shown in Figure 3.5.

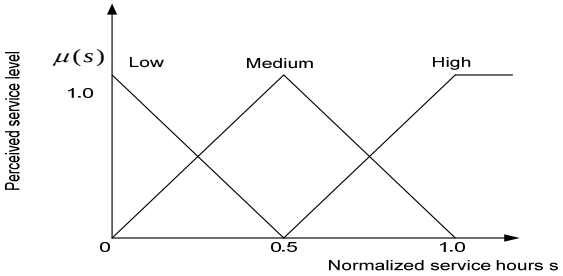


Figure 3.5: Perceived Service Situation

The definition of the linguistic variable of perceived level of service with three characteristics low, medium, and high is provided next. The representation and definition of perceived timeliness is exactly the same as that of the perceived level of service.

(Low): $$\mu_{PS}(s) = \begin{cases} 1 & s = 0 \\ \dfrac{0.5 - s}{0.5} & 0 < s \leq 0.5 \end{cases} \quad (3.5)$$

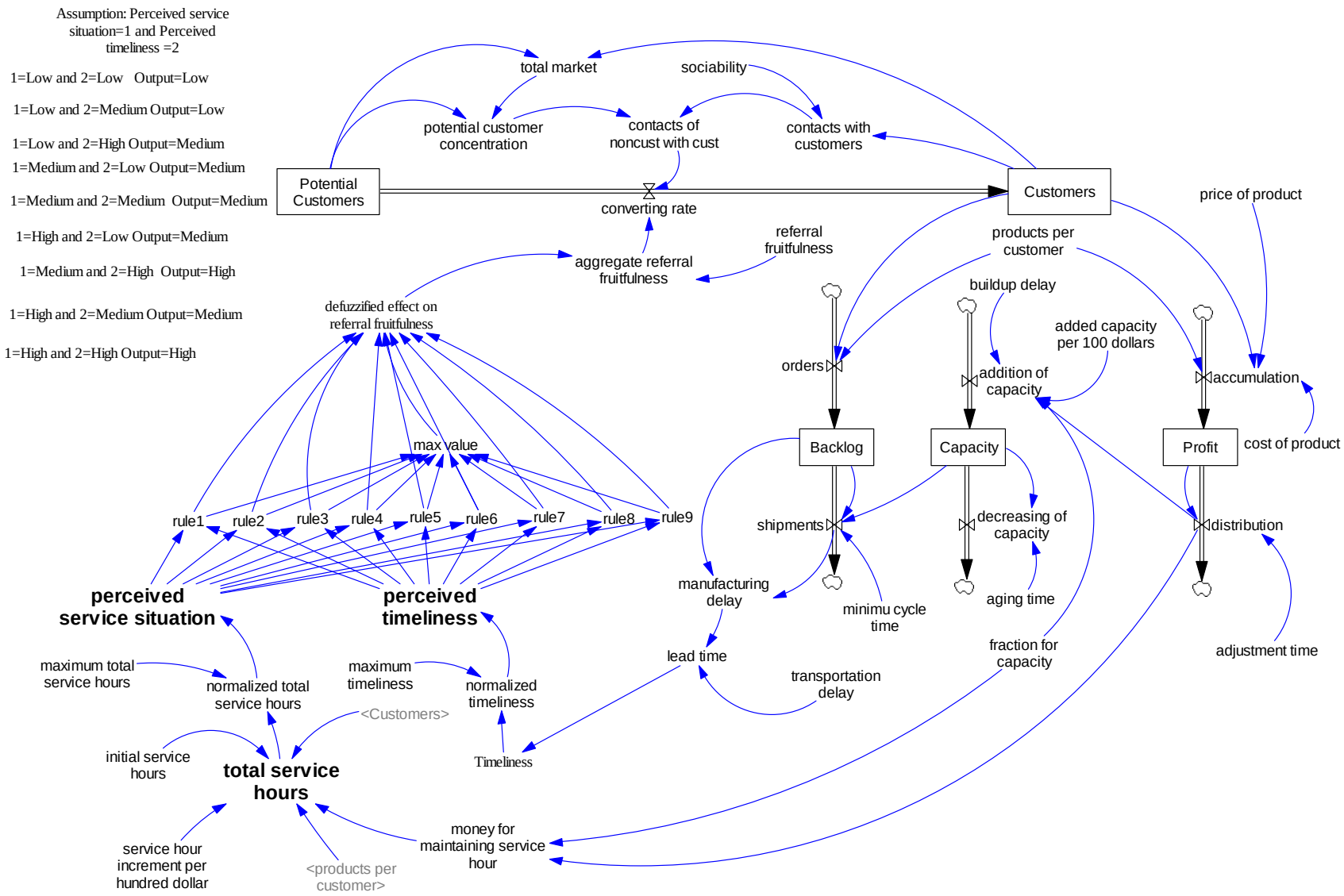


Figure 3.6: Stock Flow Diagram Demonstrating the Combined Effect of Two Linguistic Variables

(Medium) $$\mu_{PS}(s) = \begin{cases} \dfrac{s}{0.5} & 0 < x \le 0.5 \\ \dfrac{1.0 - x}{0.5} & 0.5 < x \le 1.0 \end{cases} \quad (3.6)$$

(High): $$\mu_{PS}(s) = \begin{cases} \dfrac{x - 0.5}{0.5} & 0.5 < s \le 1.0 \\ 1 & s = 1 \end{cases} \quad (3.7)$$

3.1 Definition of Fuzzy Rules

The objective of using fuzzy rules is to capture combined effects of multiple linguistic variables. In the proposed example, the fuzzy rules are provided in Table 3.1. These definitions are usually obtained from the decision makers and can be based on many factors such as the preferences of the decision makers with respect to each variable. In this simple example, decision makers give more preference to the perceived service situation. In terms of the structure of each rule, the combined effect of the two linguistic variables gives rise to a third variable overall service (output) that also has three characteristics.

Table 3.1: Fuzzy Rule Definition

Rule #	Perceived Service Situation (Input)	Perceived Timeliness (Input)	Perceived Effect on Referral Fruitfulness (Output)
Rule1	Low	Low	Low
Rule2	Low	Medium	Low
Rule3	Low	High	Medium
Rule4	Medium	Low	Medium
Rule5	Medium	Medium	Medium
Rule6	Medium	High	High
Rule7	High	Low	Medium
Rule8	High	Medium	High
Rule9	High	High	High

The number of rules increases exponentially with increase in the number of linguistic variables and their characteristics. In this example, we have two linguistic variables and each of them has three characteristics. Therefore, nine rules need to be evaluated. Assuming that each linguistic variable has the same number of characteristics, the number of rules follows the simple

relationship of $r=c^v$, where r is the number of rules, c is the number of characteristics for each variable, and v is the number of variables. The increase in the number of variables and their associated characteristics greatly increases the requisite number of rules. In the context of dynamic modeling, this turns out to be a challenge in terms of the resulting model structure, the computational requirements, and simulation result analysis.

Having defined the fuzzy rules, one can account for the combined effect of the linguistic variables as it changes over time. Within the context of the dynamic model, one can capture the overall change of perception with respect to service over time. In order to use the output of the inference provided by the rules of Table 1, one needs to convert this output to a single crisp value so that it can be used in the simulation process in a meaningful way. This is discussed in the next section.

Figure 6 graphically represents the use of the rules along with the conversion of the output to a single crisp value (max-min inference LOM defuzzification method). In this figure, only three example rules are evaluated to illustrate the concept. The first two graphical representations of each row represent the degree of membership ("truth") associated with each characteristic for each linguistic variable. The vertical axes for these graphs represent the degree of membership and the horizontal axes are the actual physical variables for which the perceptions are defined. In this case, the X axis is the normalized total service hours whereas the Y axis is the normalized timeliness. The output variable which is the perceived effect on referral fruitfulness is represented by the third graph of each row where the vertical axis is the degree of belonging and the horizontal axis Z represents the effect on referral fruitfulness that is assumed to vary between zero and 3.

3.2 The Defuzzification Process

For the sake of simplicity, the Largest of Maximum (LOM) defuzzification approach is used in this research (please refer to Appendix 3.3 for LOM). This corresponds to the largest value among all maximum-minimum values obtained for all rules. In Figure 6, the combined results obtained from each rule form the depicted area. By employing the Largest of Maximum principle, the maximum degree of belonging $\mu_o(z_0)$ when considering all rules is obtained. As shown in Figure 3.7, once the output position, $\mu_o(z_0)$ is known one can find the corresponding value z1 using Equation (3.1).

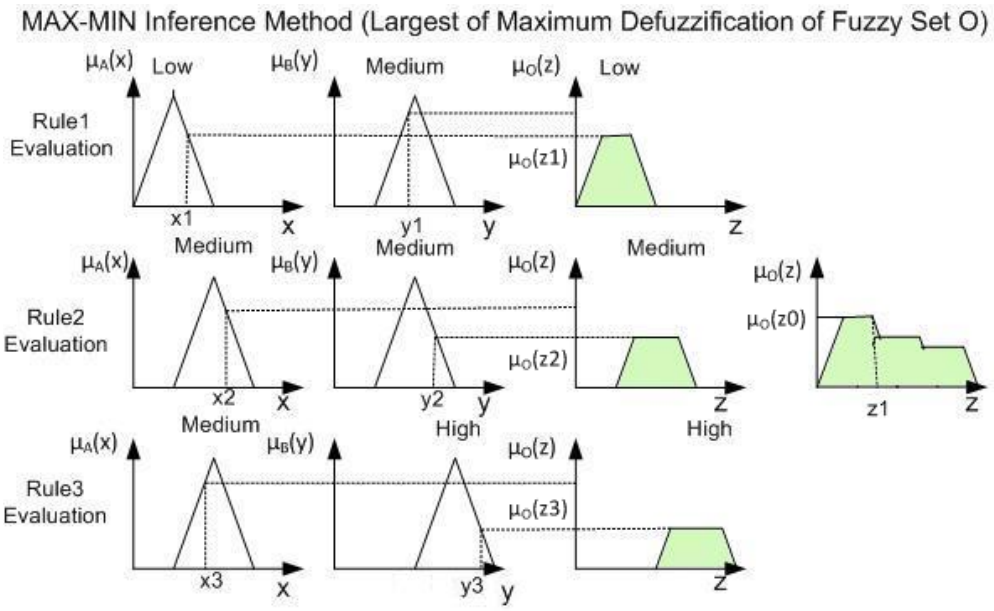


Figure 3.7: Max-Min Inference Defuzzification Method

According to the principle of LOM, it is possible to have the three scenarios since the output variable of perceived referral fruitfulness has three characteristics that are low, medium, and high. The three scenarios are as follows.

Scenario One (Figure 3.8): The perceived effect on referral fruitfulness is obtained when the largest of maximum corresponds to the degree of membership characterizing by the low characteristic. The associated crisp value corresponding to $\mu_o(z_0)$ is at point z_{L0} and is given by:

$$z_{L0=1.5 * (1-}\mu_{o(}z_{L0))} \qquad (3.8)$$

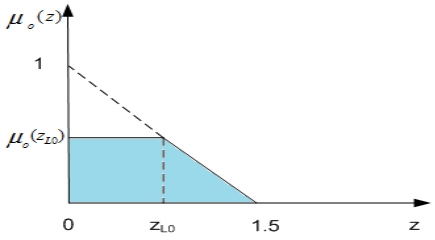


Figure 3.8: Point z_{L0} Corresponding to LOM ($\mu_o(z_0)$) Characterized by Characteristic Low

Scenario Two (Figure 3.9): The perceived effect on referral fruitfulness is obtained when the largest maximum corresponds to the degree of membership characterizing by the medium characteristic. The associated crisp value corresponding to $\mu_o(z_0)$ is at point z_{M0} which is given by:

$$z_{M0}= 3-1.5* \mu_{o(}z_{M0)} \qquad (3.9)$$

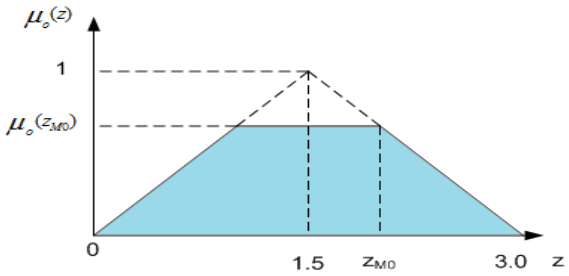


Figure 3.9: Point z_{M0} Corresponding to LOM ($\mu_o(z_0)$) Characterized by Characteristic Medium

Scenario Three (Figure 3.10): The perceived effect on referral fruitfulness is obtained when the largest maximum corresponds to the degree of membership is characterized by the high characteristic. The associated crisp value corresponding to $\mu_o(z_0)$ is at point z_{H0} which is given by:

$$z_{H0}=3 \qquad (3.10)$$

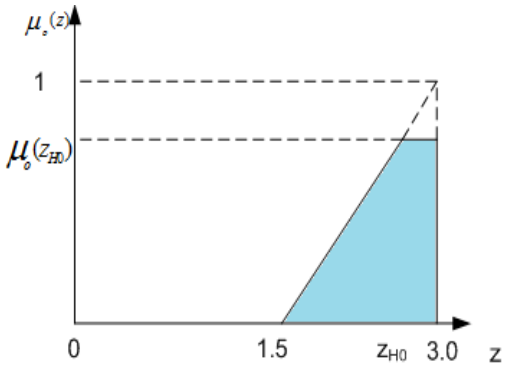


Figure 3.10: Point z_{H0} Corresponding to LOM ($\mu_o(z_0)$) Characterized by Characteristic High

3.3 Simulation Results

In this section, we provide selected simulation results for some variables. For the sake of brevity, not all results are provided. However, additional results are provided in Appendix 3.2. We focus our attention on the variables that demonstrate how the integration of multiple linguistic variables affects the system behavior. The model was run for a time horizon of 100 weeks.

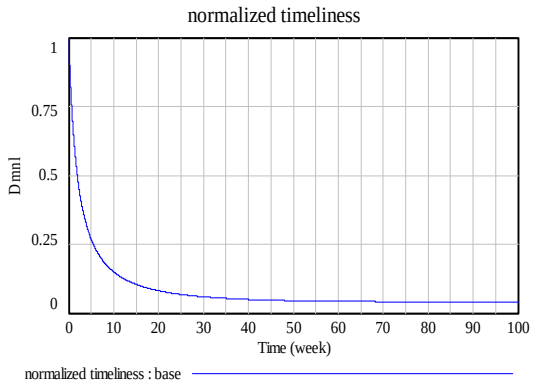


Figure 3.11: Normalized Timeliness

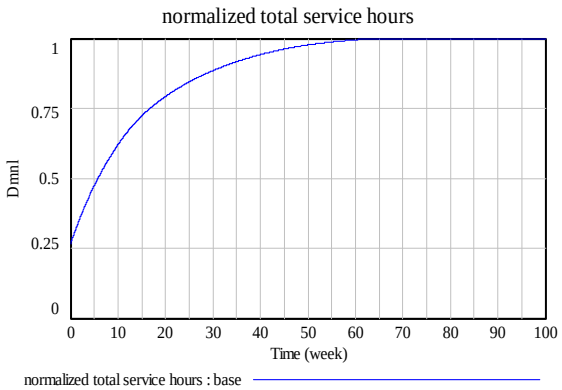


Figure 3.13: Normalized Total Service Hour

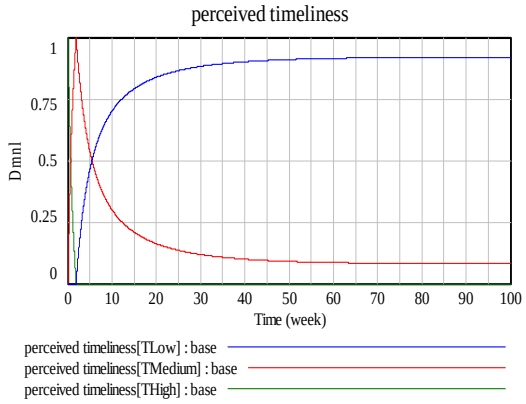


Figure 3.12: Perceived Timeliness

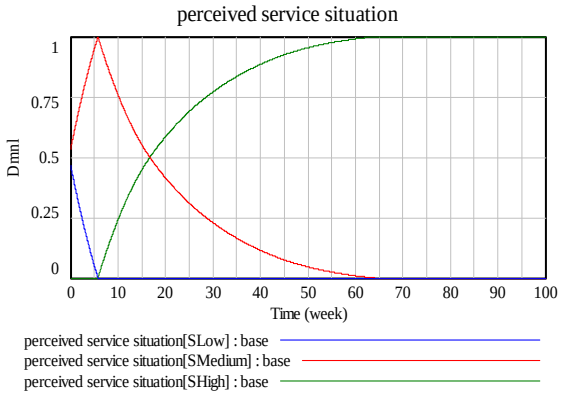


Figure 3.14: Perceived Service Situation

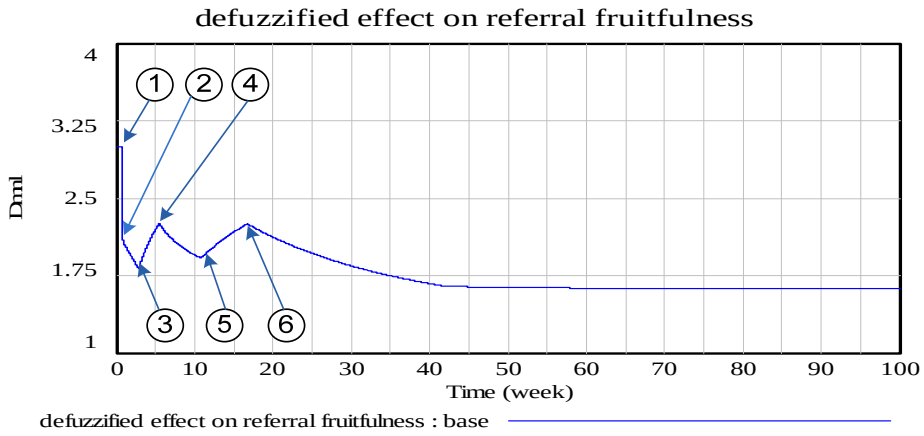


Figure 3.15: Defuzzified Effect on Referral Fruitfulness

In Appendix 3.2, one can see that the profit increases with the increase of customers. Furthermore, as more customers are coming in, this generates more product orders. Consequently, the backlog rises. Although the production capacity increases, it does not accommodate the increase of the backlog because the increment of capacity cannot catch up with the increase of backlog. Therefore, the increasing backlog lengthens the lead time to deliver the products to customers. As the inverse of lead time, the timeliness declines over time. Even though the money for maintaining and improving service level is increasing, with the increment of customer base, the average service hours per product do not change much as shown in Figure A.3.2.7 of Appendix 3.2.

The behavior of total service hours and timeliness (Appendix 3.2) determines the behaviors of the normalized timeliness and normalized total service hours in Figures 3.11 and 3.12 respectively. It is necessary to analyze why the perceived timeliness and perceived service situation behave as shown in Figures 3.13 and 3.14. From the simulation result table in the Vensim Software, one can identify each simulation result stored at each time step. In Figure 3.11, normalized timeliness decreases to value below 0.5 after time 1.91406. By virtue of the definitions (3.5), (3.6), and (3.7) for the perceived timeliness behavior only the "low" characteristic attains the value zero before time 1.91406. After time point 1.91406, the "high" characteristic attains the value zero. In Figure 3.13, the normalized total service hour exceeds 0.5 after time point 5.77344. Again by virtue of the definitions (3.5), (3.6), and (3.7) perceived service situation displays "high" characteristic after time point 5.77344. Beyond this time point, the "low" characteristic assumes the value of zero.

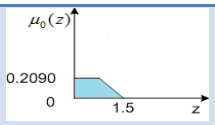
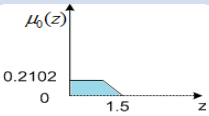
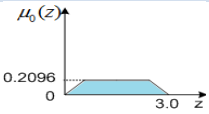
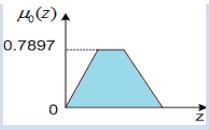
Let's take a time point as an example to illustrate why the defuzzified effect on referral fruitfulness behaves as depicted in Figure 3.15. One needs to refer to the definition of triangular member function in Section 2.0 for the perceived service situation and perceived timeliness (refer to Figure 3.6 along with equations (3.5), (3.6), and (3.7)). Let's choose two typical turning points 3 and 6 in Figure 3.15 to explain the concept of this proposed method. The chosen time points are at time 2.88281 and 16.695 with values of 1.815 and 2.249 respectively. In Table 3.2 the instantaneous values for perceived timeliness and perceived service situation at the two time points 2.88281 and 16.6953 respectively are denoted

Table 3.2: Values of Three Variables at Time Points 2.88281 and 16.6953

Time	Defuzzified Effect on Referral Fruitfulness	Perceived Timeliness		Perceived Service Situation	
		TLow	0.2096	Slow	0.2102
2.88281	1.815	TMedium	0.7903	SMedium	0.7897
		Thigh	0	SHigh	0
		TLow	0.8100	Slow	0
16.6953	2.249	TMedium	0.1899	SMedium	0.5006
		Thigh	0	SHigh	0.4993

Having provided the values of the variables of perceived timeliness and perceived service situation, it is necessary to illustrate how one obtains the value of the defuzzified effect on referral fruitfulness. Please refer to Table 3.1 and Figures 3.8, 3.9, 3.10 and Equations (3.8), (3.9) and (3.10). Please also refer to Figure 3.7 for the MAX-Min Inference Defuzzification Approach. The following Table 3.3 is used to show evaluation process for the nine rules of Table 3.1.

Table 3.3: Evaluation of Nine Rules Based on the Value at Time Point 2.88281

Rule #	Perceived service situation	Perceived timeliness	Effect on Referral Fruitfulness	
Rule1	Low: 0.2102	Low: 0.2096	Low:	
Rule2	Low: 0.2102	Medium: 0.7903	Low:	
Rule3	Low: 0.2102	High: 0	Medium:	0
Rule4	Medium: 0.7897	Low: 0.2096	Medium:	
Rule5	Medium: 0.7897	Medium: 0.7903	Medium:	
Rule6	Medium: 0.7897	High: 0	High:	0
Rule7	High: 0	Low: 0.2096	Medium:	0
Rule8	High: 0	Medium: 0.7903	High:	0
Rule9	High: 0	High: 0	High:	0

Since we use the Largest of Maximum (LOM) defuzzification approach, the maximum value is 0.7897. Given that this corresponds to the medium characteristic we use Equation (3.9) to calculate the largest the corresponding value of the effect of referral fruitfulness, i.e., .z_{M0}= 3-1.5* $\mu_{o(z_{M0})}$ =3-1.5*0.7897=1.815. In a similar fashion one can obtain the corresponding values for perceived timeliness, perceived service situation and the corresponding crisp value of the effect of referral fruitfulness for time point 16.6953.

One might notice that the defuzzified effect on referral fruitfulness initially exhibits somewhat oscillatory behavior occurring at several turning points over time indicated by the values 1, 2, 3, 4, etc. in Figure 3.15. The turning points are a function of the combination of the definitions of the characteristics, the fuzzy rules and the defuzzification method. In terms of the number of characteristics, the more the attributes are used to define a linguistic variable the more precise is its definition within a designated value range. As far as the fuzzy rules are concerned, one can observe that the output can be characterized by different attributes as one goes from one rule to the next. The final crisp value is a function of the characteristic for which the Highest of Maximum degree of belonging is ascribed to.

4.0 Preliminary Comparison: Representation of Linguistic Variables using Table versus Fuzzy Membership Functions

In this section, we focus on a preliminary descriptive comparison of the results and insights obtained when using table versus membership functions to represent linguistic variables. Traditionally, linguistic variables are modeled using Table Functions in system dynamics model. Table functions are created where the modeler needs to define an anchor point, shape, slopes, and saturation points so as to accurately represent typical non-linear relationships between two variables. As mentioned earlier, the Table Function does not easily accommodate multiple characteristics for linguistic variables something that fuzzy methods can readily do.

4.1 Comparison of Simulation Results Using Table and Fuzzy Membership Functions

In this section the simulation results for aggregate referral fruitfulness is obtained by using fuzzy triangular membership and table functions are presented using the same example of the previous section. This variable is key since it affects the conversion rate from non customers

to customers. Since there are two linguistic variables, one has to consider the combined effect of two table functions. We choose several typical operations of table functions, which are Max, Min, Sum, Absolute Value of Subtraction, Multiplication, Average, and Square Root of two variables. Each of these operations has a different conceptual connotation. Nevertheless, the results using all of these operations are shown in Figure 3.16 along with the representation of aggregate referral fruitfulness based on a fuzzy representation described in the previous section. The difference in magnitude between the fuzzy and table function representations is in part explained by the original definitions of both representations, i.e., the anchor and saturation points for the Table functions and the domain definition associated with the characteristics defining the membership function of the results of the fuzzy rules. In terms of shape as well as key turning points it should be noted that the sum, table max and absolute subtraction resemble the behavior of the fuzzy representation. Nevertheless, the turning points are more pronounced and occur further out in the simulation with the fuzzy representation.

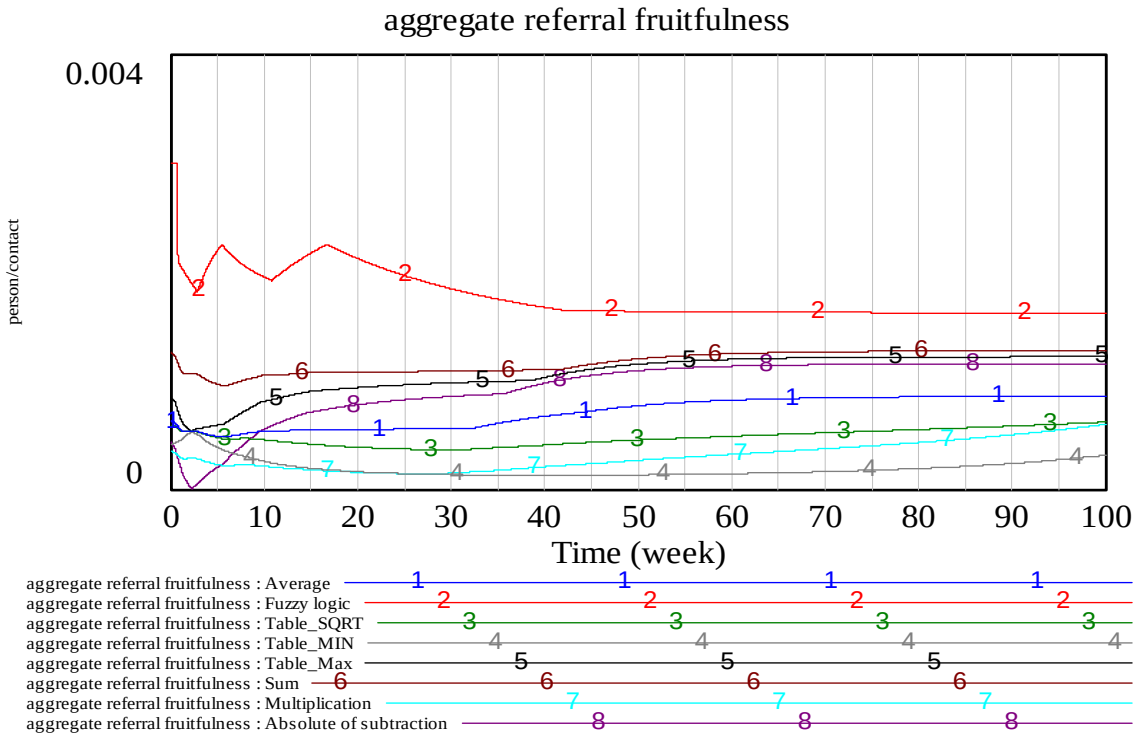


Figure 3.16: Simulation Results Using Different Table Function and a Fuzzy Based Representation

4.2 Uncertainty

In order to obtain additional insights as to the differences between the two modeling approaches, a sensitivity analysis was completed using specific assumptions about the stochastic behavior of the variable aggregate referral fruitfulness using the fuzzy based and the sum of the two linguistic table function representations. The reason to choose sum of two linguistic variables is based on the analysis in Section 4.1 because the sum operation results in the behavior that resembles behavior obtained using fuzzy approach. The example model is based on a diffusion process for a product where diffusion in this research is the spontaneous net movement of customers from an area of high concentration (non customers) to an area of low concentration (customers). One can notice that the uncertainty associated with aggregate referral fruitfulness is greater during the initial stages of the simulation and then decreases over time (Figure 3.17). As one can see from Figures 3.11 and 3.13, timeliness gets worse while the service situation improves. Based on the fuzzy rules, this leads to varying output results for the variable aggregate referral fruitfulness. Therefore, as expected initially, the uncertainty associated with this variable is evident in the first twenty five weeks of the simulation rather than later when the output results do not change. However for the results using the sum of the two linguistic table function representations (Figure 3.18) show a growing uncertainty for the first twenty five weeks. Initially, the assumed value for the sum of the table function representation is not too large but increases over time along with its uncertainty until stabilizes after week twenty five.

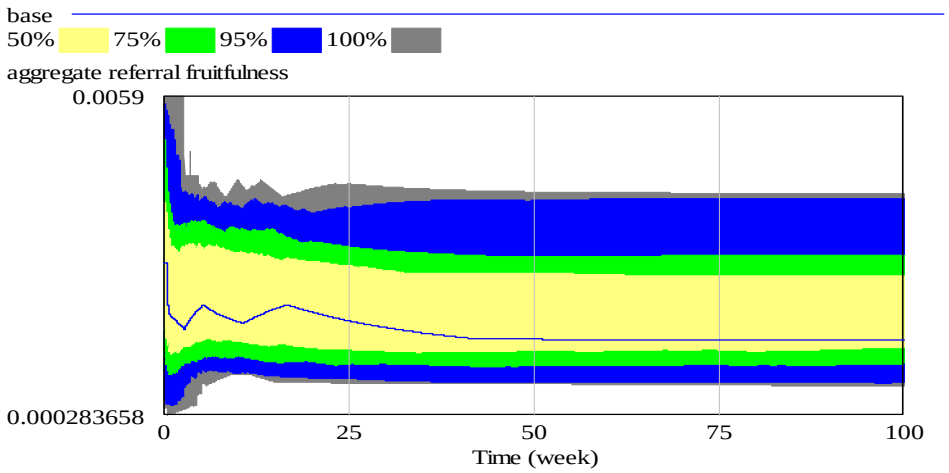


Figure 3.17: Sensitivity Analysis for Aggregate Referral Fruitfulness under a Fuzzy Approach

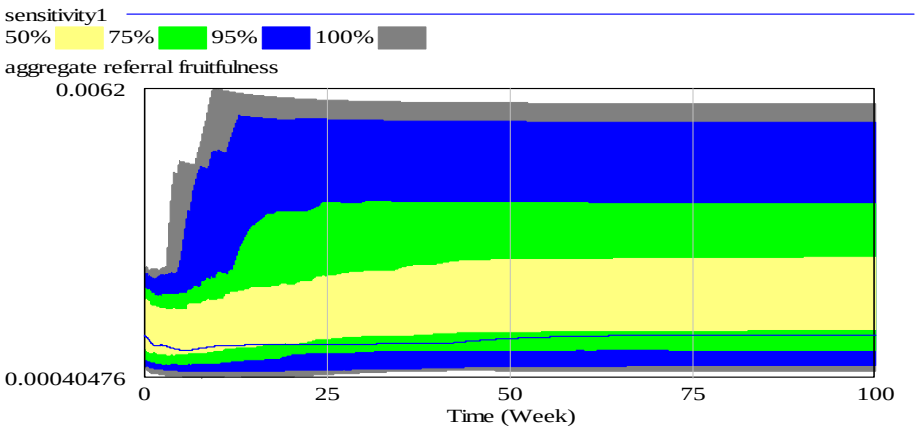


Figure 3.18: Sensitivity Analysis for Aggregate Referral Fruitfulness under Table Function Approach (Sum Operation of Two Table Functions)

4.3 Issues Associated with Using Membership and Table Function Representations in System Dynamics Modeling

Data requirements are similar and equally challenging for both approaches. Data for Table functions are typically obtained by eliciting expert opinion representing individual user preferences. In the case when one uses fuzzy concepts, data, for instance the perception with respect to different situations, could be obtained through a series of surveys or interviews. Once obtained, this data can be translated into appropriate membership functions. The definition of fuzzy rules can also be supported through survey data or interviews. Furthermore, there are many defuzzification approaches available to support the definition of a final crisp value.

The utilization of fuzzy concepts in a system dynamics context requires extensive computational capacity. For example, there are a total of 3125 rules that require evaluation for a model with five variables where each variable has five characteristics (Liu and Triantis 2007). This requires extensive storage capacity, especially for sensitivity analysis. For example, in the previous case, the comprehensive sensitivity data file occupied 3.6 Gigabytes of disk space.

The conceptual interpretation of the results associated with both approaches, requires a very strong link between the virtual and the real world. In general, it is difficult to interpret the combined effect of multiple table function representations. However, the meaningful interpretation of fuzzy representations is a function of accurately and effectively capturing decision makers' preferences and beliefs when defining membership functions. Furthermore, the

meaningful inference associated with the fuzzy rules is a function of how well the rules capture the understanding and preferences associated with perceptions.

5.0 Conclusions

This paper proposes an approach based of fuzzy methods as a way to handle the combined effect of multiple linguistic variables in a system dynamics context. This method follows the usual three-step process found when completing fuzzy inference that includes fuzzification, fuzzy rule definition and defuzzification. In this paper, we first provide examples to demonstrate how to represent a linguistic variable using membership functions in a dynamic modeling context. This representation allows one to capture temporal changes of the degree of belonging or "truth" of each characteristics associated with a linguistic variable. Next, the consideration of joint interactions of multiple linguistic variables is provided as part of an example model where two linguistic variables interact through a set of fuzzy rules and their joint impact is modeled using the Max-Min Inference method (with largest of maximum-LOM is used for defuzzification). Last we compare simulation results obtained for the same model structure using table function and fuzzy representations of the linguistic variables.

Though fuzzy methods provide an alternative approach of representing linguistic variables in dynamics modeling process, many challenges remain to make this kind of research meaningful and useful. These include but are not limited to the specification of the membership function, the process by which fuzzy rules are defined, the choice of the defuzzification method, an appropriate mechanism for dynamic system behavior analysis and interpretation when linguistic variables are present, the appropriate expert elicitation and data acquisition approaches that can be effectively used when dealing with linguistic variables, and computational requirements.

In the similar research field, one could experiment with other fuzzy membership functions such as trapezoidal and bell-shaped membership functions. Another issue is to explore the defuzzification approach in system dynamic context. As one knows, in Vensim Simulation Environment, it is hard to realize Integral Operation over other variable other than time. Therefore, we chose the simplest defuzzification approach based on the Largest of Maximum (LOM) principle. One could attempt to manipulate other defuzzification approaches such as the Center of Gravity (COG) method.

Another point worth investigating is the situation where the combined effects in the case of multiple linguistic variables in conjunction with other variables in a single model structure. Researchers could use real life application to test and validate the usefulness of this approach in the case where information about linguistic variables is captured through surveys. This would have implications for survey design, data explanation, data conversion and integration. We offered a qualitative and descriptive comparison of table function and fuzzy based representations of linguistic variables. In the future, it would be useful to propose and complete a more comprehensive quantitative time series based statistical evaluation.

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Appendix 3.1: Model Formulations

1. accumulation=(price of product-cost of product)*Customers*products per customer
   Units: dollar/week
2. added capacity per 100 dollars=2 Units: gadget/dollar
3. addition of capacity=fraction for capacity*(distribution*added capacity per 100 dollars/100)/buildup delay
   Units: gadget/week/week
4. adjustment time=10 Units: week
5. aggregate referral fruitfulness=defuzzified effect on referral fruitfulness*referral fruitfulness
   Units: person/contact
6. aging time=260 Units: week
7. Backlog= INTEG (orders-shipments, 1000) Units: gadget
8. buildup delay=52 Units: week
9. Capacity= INTEG (addition of capacity-decreasing of capacity, 1000) Units: gadget/week
10. contacts of noncust with cust=contacts with customers*potential customer concentration
    Units: contact/week
11. contacts with customers=Customers*sociability Units: contact/week
12. converting rate=contacts of noncust with cust*aggregate referral fruitfulness
    Units: person/week
13. cost of product=50 Units: dollar/gadget
14. Customers= INTEG (converting rate, 500) Units: person
15. decreasing of capacity=Capacity*0.4/aging time Units: gadget/week/week
16. defuzzified effect on referral fruitfulness=if then else (rule1=max value:OR:rule2=max value, 1.5*(1-max value), if then else((rule3=max value:OR:rule4=max value:OR:rule5=max value:OR:rule7=max value :OR:rule8=max value):OR:((rule1=max value:OR:rule2=max value):AND:(rule3=max value :OR:rule4=max value:OR:rule5=max value:OR:rule7=max value:OR:rule8=max value)), 3-1.5*max value, if then else ((rule6=max value:OR:rule9=max value):OR:((rule1=max value:OR:rule2=max value):AND:(rule6=max value:OR:rule9=max value)):OR:((rule3=max value:OR:rule4=max value:OR:rule5=max value:OR:rule7=max value:OR:rule8=max value):AND:(rule6=max value:OR:rule9=max value)):OR:((rule1=max value:OR:rule2=max value):AND:(rule3=max value:OR:rule4=max value:OR:rule5=max value:OR:rule7=max value:OR:rule8=max value):AND:(rule6=max value:OR:rule9=max value)), 3, 1)))
    Units: Dmnl
17. distribution=0.5*Profit/adjustment time Units: dollar/week
18. FINAL TIME = 100 Units: week
    The final time for the simulation.
19. fraction for capacity=0.75 Units: Dmnl
20. initial service hours=0.1 Units: hour/gadget

21. INITIAL TIME = 0 Units: week

    The initial time for the simulation.

22. lead time=manufacturing delay+ transportation delay Units: week
23. manufacturing delay=XIDZ(Backlog, shipments, 0) Units: week
24. max value=MAX(rule1, MAX(rule2, MAX(rule3, MAX(rule4, MAX(rule5, MAX(rule6, MAX(rule7, MAX(rule8,rule9)))))))) Units: Dmnl
25. maximum timeliness=0.5 Units: 1/week
26. maximum total service hours=0.47 Units: hour/gadget
27. minimum cycle time=1 Units: week
28. money for maintaining service hour=(1-fraction for capacity)*distribution

    Units: dollar/week

29. normalized timeliness=MIN (1,Timeliness/maximum timeliness) Units: Dmnl
30. normalized total service hours=MIN(1, total service hours/maximum total service hours)

    Units: Dmnl

31. orders=Customers*products per customer Units: gadget/week
32. perceived service situation[SLow]=if then else (normalized total service hours<=0, 1, if then else (normalized total service hours>=0:AND: normalized total service hours<=0.5, (0.5-normalized total service hours)/0.5, 0))

    perceived service situation[SMedium]=if then else (normalized total service hours>=0 :AND: normalized total service hours<=0.5, normalized total service hours/0.5, if then else (normalized total service hours>=0.5:AND:normalized total service hours<=1, (1-normalized total service hours)/0.5, 0))

    perceived service situation[SHigh]=if then else (normalized total service hours>=0.5:AND:normalized total service hours<=1, (normalized total service hours-0.5)/0.5, if then else (normalized total service hours>=1, 1, 0))

    Units: Dmnl

33. perceived timeliness[TLow]=if then else (normalized timeliness<=0, 1, if then else (normalized timeliness >=0:AND:normalized timeliness<=0.5, (0.5-normalized timeliness)/0.5, 0))

    perceived timeliness[TMedium]=if then else (normalized timeliness>=0:AND:normalized timeliness<=0.5, normalized timeliness/0.5, if then else (normalized timeliness>=0.5 :AND: normalized timeliness<=1, (1-normalized timeliness)/0.5, 0))

    perceived timeliness[THigh]=if then else (normalized timeliness>=0.5:AND:normalized timeliness<=1, (normalized timeliness-0.5)/0.5, if then else (normalized timeliness>=1, 1, 0))

    Units: Dmnl

34. potential customer concentration=Potential Customers/total market Units: Dmnl
35. Potential Customers= INTEG (-converting rate, 1e+008) Units: person
36. price of product=100 Units: dollar/gadget

37. products per customer=4 Units: gadget/person/week
38. Profit= INTEG (accumulation-distribution, 100000) Units: dollar
39. referral fruitfulness=0.001 Units: person/contact
40. rule1=MIN(perceived service situation[SLow], perceived timeliness[TLow])
    Units: Dmnl
41. rule2=MIN(perceived service situation[SLow], perceived timeliness[TMedium])
    Units: Dmnl
42. rule3=MIN(perceived service situation[SLow], perceived timeliness[THigh])
    Units: Dmnl
43. rule4=MIN(perceived service situation[SMedium], perceived timeliness[TLow])
    Units: Dmnl
44. rule5=MIN(perceived service situation[SMedium], perceived timeliness[TMedium])
    Units: Dmnl
45. rule6=MIN(perceived service situation[SMedium], perceived timeliness[THigh])
    Units: Dmnl
46. rule7=MIN(perceived service situation[SHigh], perceived timeliness[TLow])
    Units: Dmnl
47. rule8=MIN(perceived service situation[SHigh], perceived timeliness[TMedium])
    Units: Dmnl
48. rule9=MIN(perceived service situation[SHigh], perceived timeliness[THigh])
    Units: Dmnl
49. SAVEPER = TIME STEP Units: week [0,?]
    The frequency with which output is stored.
50. service hour increment per hundred dollar=4 Units: hour/dollar
51. Service hours: SLow, SMedium, SHigh
52. shipments=MIN(Backlog/minimum cycle time, Capacity) Units: gadget/week
53. sociability=10 Units: contact/person/week
54. TIME STEP = 0.0078125 Units: week [0,?]
    The time step for the simulation.
55. timelineness perception: TLow, TMedium, THigh
56. Timeliness=1/lead time Units: 1/week [6.02558e-044,?]
57. total market=Potential Customers +Customers Units: person
58. total service hours=initial service hours+((money for maintaining service hour/(Customers*products per customer))/100)*service hour increment per hundred dollar Units: hour/gadget
59. transportation delay=1 Units: week

Appendix 3.2: Additional Simulation Results

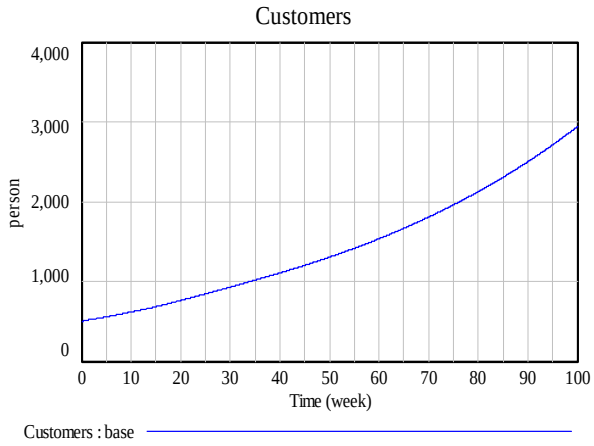

Figure A.3.2.1: Customers

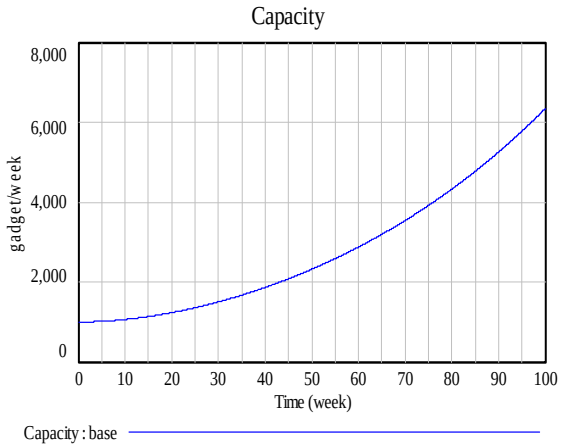

Figure A.3.2.2: Capacity

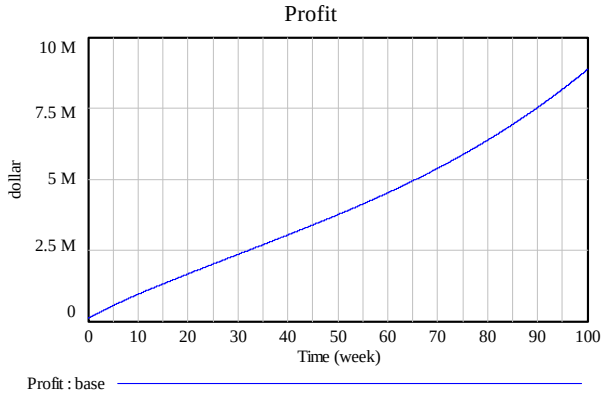

Figure A.3.2.3: Profit

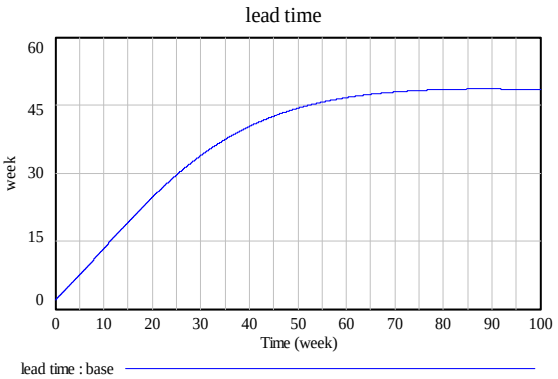

Figure A.3.2.4: Lead Time

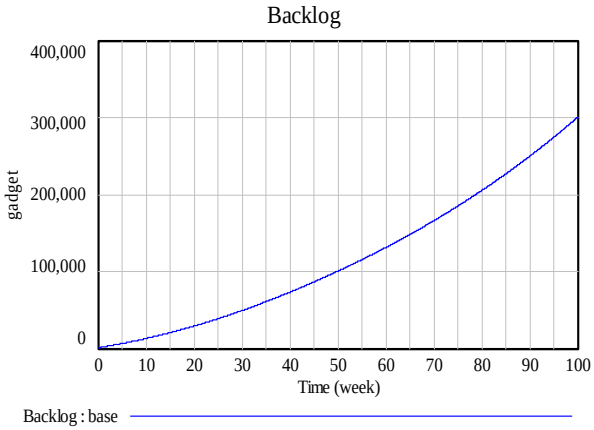

Figure A.3.2.5: Backlog

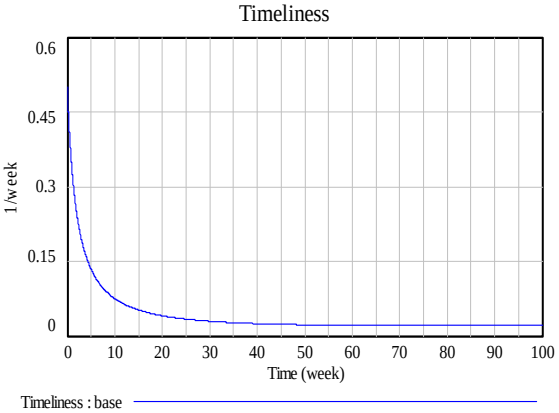

Figure A.3.2.6: Timeliness

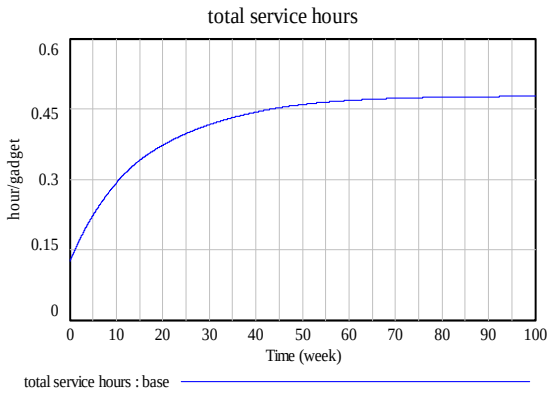

Figure A.3.2.7: Service Hours

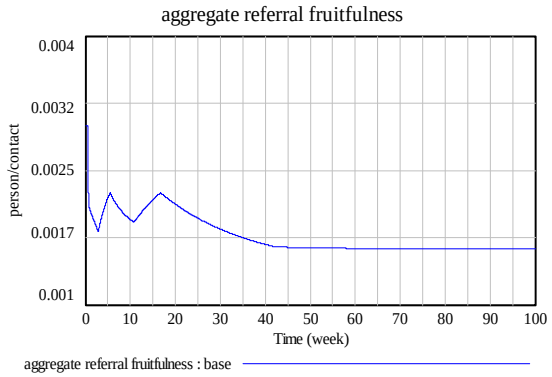

Figure A.3.2.8: Aggregate Referral Fruitfulness

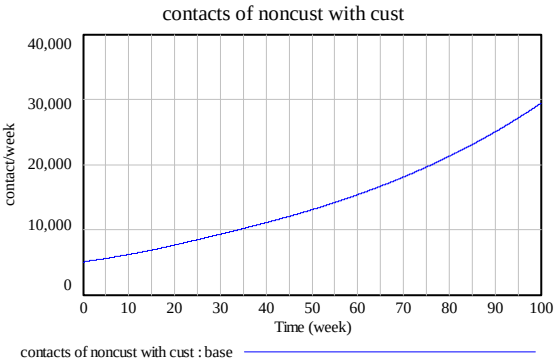

Figure A.3.2.9: Contacts of Non-customers with Customers

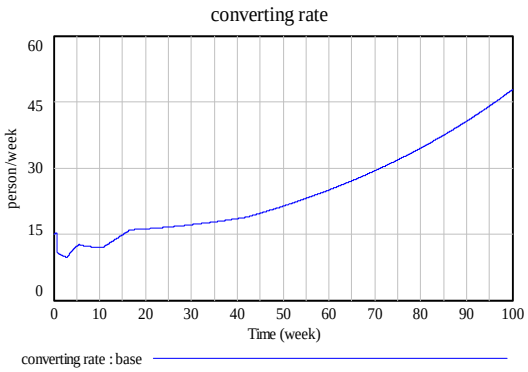

Figure A.3.2.10: Converting Rate

Appendix 3.3: Fuzzy Set Theory and Fuzzy Logic

Fuzzy Set Theory Fundamental:

Fuzzy set theory was first put forth by Zadeh in 1965. Fuzzy set is "a class with a continuum of grades of membership" (Zadeh, 1965). In the concept, it is a generalization of a classical set where an element either belongs or does not belong to the set. Dr. Zadeh (1965) gave the mathematical definition for fuzzy set as follows. Let X be a space of pints (objects), with a generic element of X denoted by x. Thus, X={x}. A fuzzy set (class) A in X is characterized by a membership (characteristic) function $\mu_A(x)$ which associates with each point in X a real number in the interval [0,1], with the value of $f_A(x)$ at x, i.e. A={x, $\mu_A(x)$}.

Largest of Maximum (LOM) Defuzzification Method:

LOM returns the largest of maximum defuzzification of fuzzy set *A*. LOM=13 in this case.

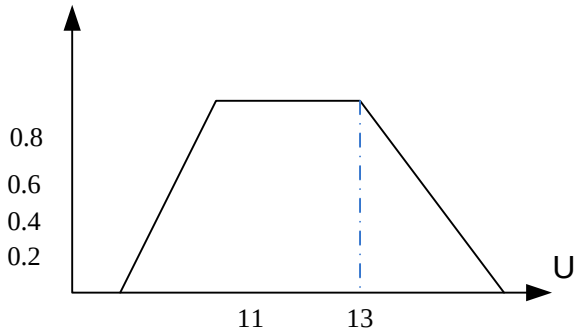

Figure A.3.3.1: Largest of Maximum Defuzzification

Appendix 3.4: Table Value for Two Variables

Table A.3.4.1 Functions of Service Hours

Point	1	2	3	4	5	6	76	8	9	10	11
Input	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Output	0	0.15	0.4	0.55	0.6	0.7	0.85	0.925	1	1.8	3

Table A.3.4.2: Lookup Functions of Timeliness

Point	1	2	3	4	5	6	7	8	9	10	11
Input	0	0.1	0.2	0.3	0.4	0.5	0.6	0.8	0.85	0.95	1
Output	0.3	0.5	0.6	0.8	0.85	0.9	0.95	1	1.8	2.4	3

Tables A.3.4.1 and A.3.4.2 provide the values for the lookup function for service hours and timeliness respectively. The inputs are normalized values for service hours and timeliness that ranges from 0 to 1. The outputs represent the effect of these two variables exert on the aggregate referral fruitfulness. To define the lookup functions, one needs to find the anchor points such as input=0, output=0; input=1, output=3. For other point, it is actually determined by the pragmatic experience, special needs for a specific research, or even result from survey.

Chapter 4 Evaluation of Travel Demand Management Policies: Part I-Modeling Traffic Congestion

Abstract

This paper presents a dynamic modeling framework by which policy makers can assess the impact of various travel demand management interventions within a metropolitan area and as a consequence understand the complex behavior of affected transportation-socioeconomic systems. In the proposed dynamic representation, two scenarios with respect to system structure and behaviors are evaluated, i.e., the cases with and without travel demand management policy. In this research, it is assumed that revenue obtained from the congestion charging scheme is redistributed so as to improve mass transit capacity and to subsidize local residents within a cordon-based metropolitan area. This constitutes the combination of travel demand management interventions that define the overall policy. Additionally, work travel and social networking activities are assumed to generate the travel demand dynamics, which are affected by consumers' satisfaction in terms of the demand and supply of different transportation modes, their perception of the congestion level, and the associated traveling value and cost. It is assumed that the population, tourism and employment growth are exogenous factors that affect demand. Furthermore, this paper builds on a previously formulated approach where fuzzy concepts are used to represent linguistic variables used in this model.

Keywords: Travel Demand Management Policy, System Dynamics, Social Networking, Demand Dynamics, Supply Dynamics, Transportation –Socioeconomic System, Fuzzy Logic, Linguistic Variables

1.0 Introduction, Context and Objectives

Traffic congestion is getting worse for most highways and urban areas in the US as well as in other countries in the world. An increasing number of U.S. highways and roads experience overwhelming traffic congestion problems, even though most Interstate physical and safety conditions have been improved. According to a report from the Texas Transportation Institute

(TTI) which measures traffic congestion trends from 1982 to 2003, traffic congestion is costing Americans, in selected 85 urban areas, $78 billion in wasted time and fuel annually, out of which $63.1 billion is in extra fuel consumption. According to the GAO Report "…rush hour travel time on urban Interstates increased 12 percent from 1990 through 2000. State officials in nearly half of the states reported that urban congestion is already high, and officials from 41 states predicted that it will be high 10 years from now. State officials reported high rural congestion in only 1 state now, but expected it in 18 states within 10 years" (GAO Report, 2002, p. 27).

Traffic congestion creates a number of costs. First of all, there are the time costs such as increased average travel time and unexpected delays. Second, one can identify physical costs such as extra fuel costs and faster depreciation of vehicles. Third, there are environmental costs associated with noise and air pollution. Last but not least, one of the unintended consequences of traffic congestion is the detrimental effect for community life. "In round numbers, the evidence suggests that each additional ten minutes in daily commuting time cuts involvement in community affairs by ten percent" (Putnam, 2000, p. 213).

Traditionally, "predict and provide" was the basic policy to manage transportation problems. Nevertheless, the theory of induced travel demand contends that the aforementioned policy will induce additional growth in traffic. Since traffic flows continue to outpace the current resources available to improve the infrastructure and facilities, researchers and policy makers have begun to consider strategies that focus on travel demand management (TDM) to encourage travelers that use the existing transportation system in ways that are less likely to generate congestion. This has the advantage that it does not require costly new road-building. TDM (Travel Demand Management) strategies use a variety of mechanisms to change travel patterns, including facility design, improved transport options, pricing, and land use changes. These affect travel behavior in various ways, including changes in trip scheduling, route, mode, destination, and frequency choice and land use patterns. So far, TDM has dominated the governmental agendas in many countries across the world (Santos, 2000). There are various TDM programs that include but are not limited to congestion pricing, transit improvement, ridesharing promotion, staggered working hours, pedestrian and bicycle facility improvement, telecommuting, and transportation-efficient land use and so forth. Congestion pricing, having long been advocated by economists uses market mechanisms to regulate more efficient use of transportation resources. Efficient congestion pricing define the full cost of providing

transportation facilities or services and the value that the users place on using them. Even though this strategy is being used extensively, there is no single solution to controlling the growth in traffic congestion (Lomax, 2003). The effective implementation of congestion pricing scheme potentially necessitates a more comprehensive policy that requires the combination of different TDM schemes. This research considers the combination of congestion pricing along with the improvement alternative transportation modes and providing a subsidy for local residents and disabled populations as one such comprehensive policy.

As it has been widely known, the implementation of congestion charging policy in London (2003, http://www.cclondon.com/) and Stockholm (2006) is successful in mitigating traffic congestion to some point (http://www.stockholmforsoket.se/templates/page.aspx?id=183). Especially, in London, the above website offers details of the congestion charging scheme as does the year's performance monitoring report since 2003. The process of implementing congestion pricing schemes involves the selection of specific charging schemes, price setting, the redistribution of the revenues obtained from the scheme, and the short- and long term impacts on the economy and traffic congestion, etc. These aspects have to be studied elaborately to prevent the problem of social exclusion that can cause public aversion to a congestion pricing strategy. Giuliano (1992) introduces the political aspect when evaluating a congestion pricing policy. May and Nash (1996) define a series of objectives of an urban transportation policy that simultaneously consider environmental, economic, social, and transportation aspects. Therefore, policy-makers need to understand the impacts of the to-be-implemented policy over both the short- and long term. It is also necessary to understand the multiple interactions of key concepts over time (dynamic complexity) of the transportation socioeconomic system. This transportation socioeconomic system is an integrated system that not only considers the transportation system itself but also includes the social, economic, and environmental sub systems as well. An approach to learning about and understanding the dynamic complexity of systems is System Dynamics (Forrester, 1961). With system dynamics, modelers investigate the structure and behavior of complex systems. As a rigorous modeling methodology, system dynamics enables users to execute formal computer simulations and employ them to design more effective policies and focus on performance improvement. One of the important advantages of this approach is the ability to create management flight simulators that can be used for policy analysis. Decision

makers can understand the potential long-run side effects of different decisions before implementing them.

The objective of this research is to provide a modeling framework employing the system dynamics approach by which policy makers can understand the dynamic and complex nature of a transportation socioeconomic system representation of a metropolitan area. More importantly, this framework provides policy makers with an assessment platform that will demonstrate the long-term system behaviors caused by a cordon-based congestion pricing policy by simultaneously considering transportation and socioeconomic systems. This framework also provides decision makers the ability to evaluate other demand –based transportation policies.

There are quite a lot of researchers using the system dynamics approach to evaluate different transportation policies. However, there is very limited research that evaluates the dynamics associated with the impact of a congestion pricing policy on the transportation and socioeconomic system within a cordon based metropolitan area. In this research, we consider revenue redistribution as a mechanism to improve mass transit and to change passengers' behaviors based on their perception of supply and demand of different transportation modes. This research also examines the impacts of improved mass transit on the social networking activities, and vice versa. There are two major hypotheses needing to be addressed here. One of them is that the capacity of mass transit is improved due to investment coming from the revenue accumulated by implementing traffic congestion policy. The other on is that, in the long term, traffic congestion is able to be mitigated.

There are two major contribution of this paper. First, this research provides a conceptual framework that describes the manifestation of traffic congestion behavior of the transportation socioeconomic system for an urban area over time. Through the understanding of the system's behavior and its performance, a cordon-based congestion pricing policy can be evaluated accordingly. Compared with conventional transportation planning and evaluating methodologies, the application of system dynamics to assess transportation policies can provide additional insights to the traditional methods, such as a static consideration of the congestion problem from a traditional O-D (Origin-Destination) perspective. The second contribution of this research is the fundamental consideration of uncertainty associated with the representation of people's perceptions in terms of congestion and its impacts. This uncertainty in this research is captured by fuzzy set theory concepts that builds on the approach described by Liu and Triantis (2007a)

and represents an augmentation to the current system dynamics modeling paradigm for a practical system modeling application.

This paper and modeling paradigm address three major issues. First, it is the understanding of the dynamic long-term behavior of key transportation and socioeconomic variables with and without congestion pricing. Second, it is the understanding of the implication of funding public transit initiatives using the revenue generated by congestion pricing. And the third is an understanding of how social networking activities induce the mobility demand of people living around a Metropolitan area and how consumers' perceptions with respect to the congestion level, ratio of travel value to cost, and ratio of mass transit supply to demand affect the switching behavior of consumers among different transportation modes.

In this section we provided the problem statement in the context of travel demand management policies, the objectives and contribution of this research. The next section reviews the relevant literature on congestion pricing, social networking, dynamic modeling of transportation systems modeling as well as the application of fuzzy set theory in transportation system modeling. Section 3 of this paper provides the profile of the designated system and subsystems. This section also describes the basic macro-level qualitative model (causal loop diagram) along with a discussion of the supply and demand dynamics when integrating the congestion pricing policy. We describe linguistic representations of perceived user assessments that are used in the dynamic model as well as the behavior of critical variable and the associated sensitivity analyses. Section 4 presents the comparative analysis when congestion pricing policy is not integrated into the system structure. Section five concludes this research, summarizes insights obtained, and revisits the hypotheses made in the context of the simulation results. It proposes future research steps in terms of visualization approaches and policy analysis and provides some recommendations for both practitioners and researchers.

2.0 Congestion Pricing, Social Networking, Dynamic Modeling and Fuzzy Methods

Road user pricing as a means of mitigating congestion dates back to 1844, by Dupuit. Thereafter, economists Pigou (1920) and Knight (1924) continue to enhance the theory of congestion pricing. In the 1960s, a resurrection of research interests in congestion pricing

appears thanks to the initiative of Nobel Economist Laureate William Vickrey (1969) as well as the publication of The Smeed Report (Ministry of Transport, 1964). During 1980s and 1990s, many congestion pricing schemes are attempted. Among which, some fail to be implemented after deliberate planning, such as Electronic Road Pricing (ERP) in Hong Kong (Hau, 1990), Rekening Rijden in the Netherlands (Stoelhorst and Zandbergen, 1990), road pricing in Stockholm, Sweden (Anlstrand, 1998), and congestion metering in Cambridge, UK (Ison, 1996). A few schemes have been successfully implemented up until now, namely the Area Licensing Scheme in Singapore (Behbehani et al., 1984), the toll rings in Norway (Larsen, 1995), the London Congestion Charging (2003), and the Stockholm Road Charging (2006). There are two cases of congestion pricing in the U.S., i.e., the SR-91 Express Lane in Orange County (Southern California, 1995) and the I-15 demonstration congestion pricing project in Northern San Diego County (California, 1996).

In the literature, many studies consider different factors that affect congestion. In order to examine how different groups of people are affected by a congestion pricing scheme, Levine and Garg (2002) divide the users into three groups: drivers who drove before and remain on the road afterward, drivers who used the road before and do not use it after the implementation of pricing, drivers who did not use the road before and start to drive with the improved mobility. The conclusion of this research is that the first two groups many end up being worse off with congestion pricing. An article from the website of Victoria Transport Policy Institute (2005) indicates that travel demand management strategies (TDMs) including congestion pricing tend to provide energy conservation and emission reduction. This is consistent with the conclusions raised by Giulian (1992) who states that road pricing is one of the few effective means to reduce the use of automobile, and thus reduce air pollution.

Congestion pricing and improvement of mass transit attempts to reduce the per capita surface coverage, and hence encourage efficient land use patterns. There are additional economic, social, and environmental impacts as well. Banister (2002) argues that, due to the implementation of congestion charging, land values and rental levels in the city center would fall, which cause the ever-increased dispersal of activity from the city center. On the other hand, Giuliano (1992) indicates that the heavily populated downtown areas are competitively disadvantaged now because of congestion. For a more detailed discussion of the economic impacts of congestion pricing, Whitehead (2002) presents two scenarios by which several major

economic sectors are evaluated. Scenario A assumes that there would be no change in the provision of public transport and environmental quality with the introduction of congestion pricing, while scenario B presumes that congestion charging revenues would be invested in public transportation and the environment of the city center. The economic sectors being evaluated include retail, tourism, and residential functions. As far as the retail function is concerned, it is considered as one of the most sensitive sectors (Whitehead, 2002). Retail would be negatively affected by Scenario A since drivers would be discouraged by a charge to come to the downtown area and it would lead to a loss of the traditional customer base. Under Scenario B, the retail activity in the city center could increase with short-term fluctuations before full-fledged improvements are made. For large metropolitan areas such as Washington D.C. area, tourism is critical to local economies. Therefore, tourists could be deterred by traffic congestion, low performance of mass transit, and a poor environment under scenario A. On the other hand, since under scenario B the prosperity of the local economy, the environmental quality, and the public transport, would improve, the tourism industry could be boosted.

In terms of the use of the revenues obtained from congestion pricing schemes, Goodwin (1990) recommends that the revenues should be invested in three areas: road construction, tax relief, and public transit improvement. In this research, the revenues are assumed to be distributed to improve mass transit including bus, trail, and metro rail capacity. If sufficient improvements are made, theoretically it is possible for the mass transit system to attract more passengers from the pool of previous drivers who choose not to drive (Gonzales, 2005). As empirical evidence indicates, the London congestion charging scheme so far is a successful case in changing driving behaviors. One third fewer cars are entering the city center and 16% more buses are on the streets compared to the period before the pricing scheme was instituted (Santos and Shaffer, 2004).

Furthermore, the social networking activities of people rely more on different transportation modes especially, for a metropolitan area. "*These moments of physical copresence and face-to-face conversation, are crucial to patterns of social life that occur 'at-a-distance', whether for business, leisure, family life, politics, pleasure or friendships*" (Urry, 2003, p. 155). However, copresence cannot happen without getting together. Consequently, all kinds of travel modes and forms are critical for establishing and maintaining different social networks. Since World War II, the average distance between where people live within social networks has

increased exponentially in the U.S., which has resulted from motorization, urban sprawl, airline deregulation, spread of the internet, and frequent use of mobile equipment. Social networks are not as tight as before. People are widely distributed in residential areas and the activities that they pursue. Therefore, people have to travel long distances to have face-to-face meetings (Axhausen, 2002).

The interaction between transportation and social networks are assumed to be complex and dynamic. Co-presence requires the provision of transportation, while travel activities themselves create their own social spaces that produce new entities in the social network such as hotels, travel stations, airports, leisure complexes, resorts, etc. Although mobility provided by the transportation system satisfies all kinds of social needs and improves quality of life, mobility, at the same time, generates enormous costs for the environment, accidents, and longer time in the automobile, which reduces social welfare. In order to maintain the sustainable development of society and of transportation networks, policy makers in many respects are making efforts to reduce the adverse impact of transportation. What they are attempting to facilitate is the maximization of social welfare through providing transportation services. Of course, the implementation of different policies can generate new short- and long-term adverse impacts. For example, without good planning and understanding of the congestion pricing strategy, congestion pricing could cause severe social exclusion problems. Therefore, there is the necessity to evaluate the transportation policies within the context of a social network system.

In order to obtain an understanding of the different transportation policies, a number of researchers use the system dynamics approach to do transportation modeling. However, as mentioned earlier, there is very limited research that evaluates the dynamics associated with the impact of a congestion pricing policies. The 1970s saw the dissemination of system dynamics in transportation modeling (see for example, Parthasarathi (1974), Chen (1975)). Some researchers focus on regional infrastructure planning (Drew et al. (1975), Wadhwa (1975), and Drew (1978)) others apply system dynamics modeling to economic and transport planning (Wadhwa and Demoulin (1978), Tanaboriboon (1979)). The modeling of the 1980s focuses on evaluating operational and transportation policies in public transit (Stephanedes (1980, 1981) and Adler et al. (1980c)), on the investigation of the complexity of the transportation and socioeconomic systems (Abbas and Bell (1994), the additional consideration of the energy and environment sectors (Khanna et al. (1985, 1986a and b, 1989) and Khanna (1986)), on traffic flow, network

geometry, and driver's behavior for urban road traffic systems (Charlesworth (1985, 1987), Charlesworth and Gunawan (1987), and Gunaman (1984)), and on the interaction between transportation and land use (Haghani et al. (2003)).

As far as the application of fuzzy concepts to transportation system modeling is concerned, we provide a brief overview of related papers. Teodorovic and Kikuchi (1990) use a fuzzy inference technique to characterize the driver's perception on travel time. Deb (1993) proposes a research of mass transit mode choice problem in which human perception and belief with respect to different transit modes are represented by a fuzzy set approach. Lanser and Hoogendoorn (2001) employ a fuzzy approach to model the travel choice behavior in public transport networks. So far, there is very little in the literature demonstrating the application of fuzzy concepts in system dynamics modeling context for the understanding of transportation related social issues.

3.0 System/Subsystem Definitions, Transportation and Social Networking

Traffic congestion issues are affecting people's travel behavior, social activity of people, transportation system, economic and even political systems. Similarly, the policies used to mitigate traffic congestion also have impacts on the aforementioned aspects. In order to evaluate impacts of the travel demand management policies, one needs to define the system and subsystem to incorporate these policies into the system structure that includes pertinent factors. The proposed structure determines the research domain for the policies that are evaluated and analyzed.

The systems involved in this research primarily include the transportation, social, political and economic systems. The domain of the political system includes the transportation related policies, i.e. the traffic congestion pricing policy, the distribution of revenue obtained from the congestion charging scheme and the appropriate interventions (such as, subsidies) that counter social exclusion that arises from the implementation of the transportation policy. The transportation system includes a definition of the cordon-based area, the determination of the supply and demand of mass transit, the measurement of the congestion level, the determination of people's travel behavior and of the average travel expenses. The social system provides a representation of social networking activities, of decision rules that address social equity, and the determination of peoples' perceptions with respect to the traffic congestion level and the ratio of

supply to demand of mass transit. Within this system the impacts of social networking activities and the perceptions of people with respect to mass transit situations (and vice versa) and their impact on travel are captured. Population growth is assumed to be exogenously determined and this affects the potential passengers around the designated charging area. The economic system considers the investment of mass transit that includes the improvement of metro rail, bus, and trail capacity within the cordon-based area. The growth of tourist base and employment base exogenously affect the congestion level of the designated area. It is assumed that social networking activities induce travel demand and thereby the congestion level.

We now discuss the details of the traffic congestion pricing policy. In this research, it is assumed that the traffic congestion pricing policy is implemented within a metropolitan area such as Washington D.C. Metropolitan Area during the weekday. The reason to choose Washington D.C. Metropolitan Area as target area relies on the availability of data since there is no specific traffic congestion pricing policy being implemented in U.S. Metropolitan Areas. Charging time is from 6 AM to 6 PM every weekday. It is assumed that the charging price is determined by the average congestion level within the charging area during the charging period. In literature, it is widely recognized that efficient congestion prices consider the full cost of providing transportation facilities or services and the value the users place on using these services. Litman (2005) proposes that congestion charging price should reflect the marginal social cost imposed by the driver. In this research, the charging price is linked to congestion level (Littman, 1999). As for the charging revenue redistribution, the base scenario (base simulation) considers the allocation of 40 per cent of the revenue for improving bus capacity, 45 percent of the revenue for improving metro rail capacity, 10 per cent for trail capacity improvement, and the rest for the pricing scheme implementation. However, in order to conduct a complete policy analysis (Liu and Triantis, 2007b) several scenarios need to be evaluated. Moreover, in order to counter social exclusion issues (such as deprived mobility due to unavailability of transit), the policy considers discounts for local residents and the exemption from congestion pricing for disabled residents within the charging area. It is assumed that within the designated cordon based congestion charging area, the percentage of passengers from local residents is 40 percent and discount is 40 per cent of the congestion price. The percent of disabled driver is assumed to be 1 per cent. In this research the time horizon extends for 20 years which is 7200 days in total.

Figure 4.1 is a macro-level system/subsystem representation (it is not a CLD since we do not have link polarities) that illustrates the interactions of the systems and includes the main components of a traffic congestion pricing policy. With the implementation of traffic congestion charging policy within the Washington D.C. metropolitan area, revenues are accumulated and distributed to improve mass transit capacity and to subsidize some user groups. Therefore, the improved mass transit capacity and improved affordability for travel boost the satisfaction of different user groups. The satisfied user groups generate more social networking activities that undoubtedly stimulate more demand for different transportation modes. As a result, this reduces the ratio of supply to demand of mass transit. This lowers user satisfaction. The increased demand for different transportation modes increases the congestion level that influences the switching behavior among different transportation modes. Consequently, the switching changes the demand for different transportation modes. With the extra cost being placed on the driver, drivers tend to switch to mass transit, which reduces the number of single driving car and the congestion level accordingly. However improvement of bus transit essentially increases the congestion level.

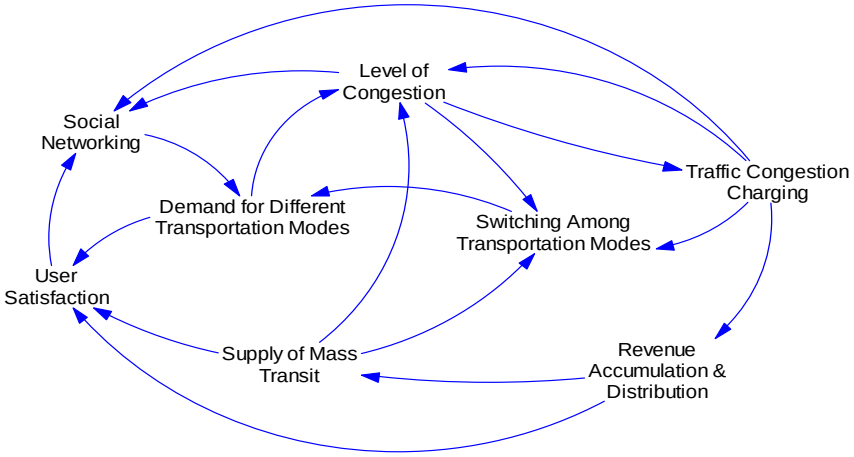

Figure 4.1: Macro-level System/Subsystem Representation

This research assumes that one of major components of travel demand arises from social networking activities that induce people to move within and around the designated congestion charging area. In order to show the demand side dynamics, Figure 4.2 (please refer to Appendix 4.4 for the formulations) shows the stock flow diagram that is extracted from the large transportation system dynamics model (Appendix 4.1) for evaluating the congestion pricing policy. A brief explanation of the stock flow diagram in Figure 4.2 follows.

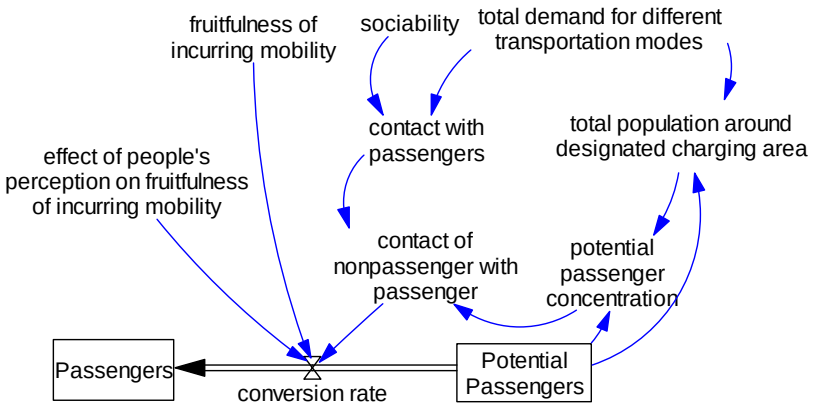

Figure 4.2: Mobility Induced by Social Networking Activities

The social networking concept considers the induced mobility needs for different transportation modes due to the contact of non passengers with passengers. In this diagram, one can see that the conversion rate from potential passengers to passengers is determined by the contact of non passenger with passenger and the fruitfulness of incurring mobility. The fruitfulness of incurring mobility captures the idea that not every contact (social networking) can induce mobility. The fruitfulness of incurring mobility denotes the probability that a contact between a non-passenger and passenger can induce mobility. The effect of people's perception on the fruitfulness of incurring mobility captures the extent to which an individual's perception affects an individual's travel choice and behavior. The number of contacts of non passenger with passenger is calculated through the product of contact with passengers and the potential passenger concentration. Potential passenger concentration is obtained through the division of potential passenger over total population around the designated charging area. We assume that this population is a fairly large number such as 300 million. Contact with customers describes the contacts that occur among the existing customers which is determined by the sociability and total passengers for the different transportation modes. Sociability is a constant that accounts for the number of contacts of one could make during a period.

4.0 The Supply and Demand Dynamics[10]

In this research, the supply and demand dynamics of the system presented in the previous section are in part determined from the transportation infrastructure as well as from the implementation of a traffic congestion pricing policy for a cordon based metropolitan area. The proposed policy is combined with other interventions such as, the improvement of mass transit as well as the subsidization of local resident and disabled drivers. This means that the revenue accumulated from the traffic congestion pricing policy is distributed to finance the charging scheme itself and improve mass transit capacity, namely, that of bus, metro rail, and trail. Because of the improved mass transit capacity and related services, people tend to switch from solo driving to mass transit. As a result of the switching form solo car driving to mass, the average traffic congestion level is mitigated over long run. Furthermore, people that live and work around the designated traffic congestion charging area tend to have more social networking activities (co-presence, which is realized by using different transportation modes) that determine individuals' mobility needs. As a result, this increases the demand for mass transit. After some delay, individual perceptions change with the declining ratio of mass transit supply to demand. Because of mobility needs, people could switch back to solo driving. This increases the amount of revenue that is obtained through the traffic congestion charging policy and thereby the revenue available for the supply of mass transit capacity. The dynamics described herein have been obtained from the dynamic model found in Appendix 4.1 where traffic congestion pricing policy is implemented. This dynamic behavior can be compared to the case where the congestion pricing policy is not implemented (Appendix 4.2). In this model, we assume that some amount of money is still appropriated from the government to finance the improvement of mass transit capacity even without congestion pricing policy. However, compared with the revenue accumulated from pricing scheme, it is an inadequate resource to deal with the severe congestion problem around Washington D.C. metropolitan area.

[10] For the formulations used for the simulation model with and without traffic congestion policy (there are more 100 pages for the formulation, this paper does not provide the formulations. Since there is no traffic congestion pricing policy being implemented within Washington D.C. metropolitan area, therefore, there are not much data available related to this research. Based on the available information obtained from census of Washington D.C. area such as populations, number of car driving per day, size of bus fleet, etc, some assumptions are made in the formulations, for instance, the projection of population, size of bus fleet etc. For detail, please refer to Dissertation (Liu, 2007, Three Essays Related to Dynamic System Model, Virginia Tech) or contact Shiyong Liu by: shliu2@vt.edu.

4.1 System Structure and Dynamic Hypotheses[11]

Since the dynamics of the previous section are in part a function of the system structure we address several critical loops. Since the improvement loops for metro rail, bus, and trail do not differ much, we choose one typical mode of the mass transit to discuss the relevant issues. In this paper, we consider bus transit and the switching behavior between car and bus. There is another reason for selecting bus related loops since bus travel has two different effects on the system. On the one hand, it can reduce passenger car unit (PCU) with holding more passengers than that of solo car driving. On the other hand, if there are too many buses on the road they can increase the number of PCUs because one bus is equivalent to several PCUs while a car is only equivalent to one PCU. Figure 4.3 displays the loops that help explain how the increase of bus capacity actually worsens the congestion situation. It also shows the carrying capacity loop which is a balancing loop constricting the capacity increase within the cordon based area.

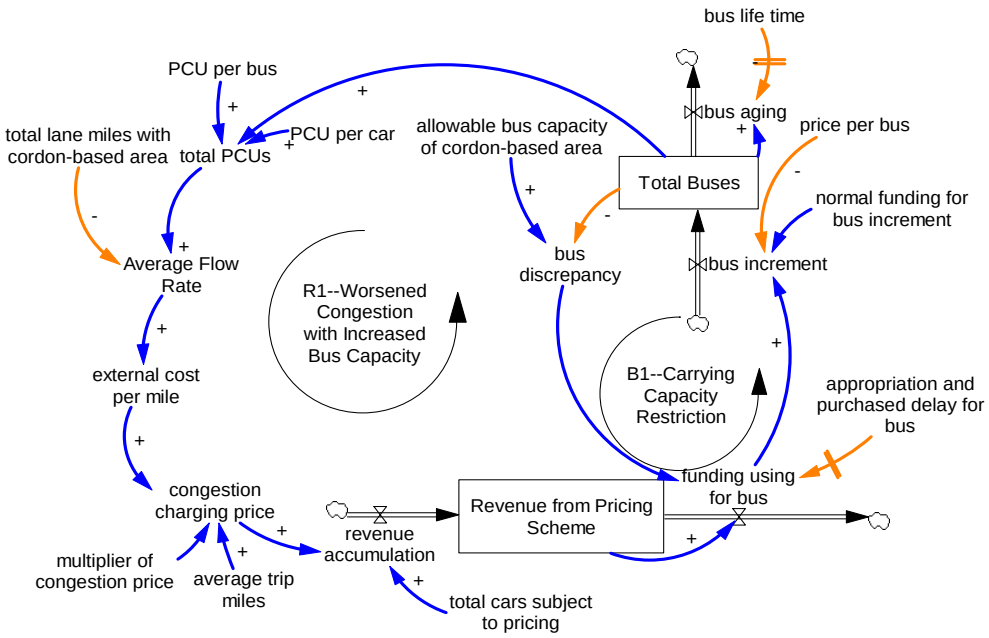

Figure 4.3: Bus Capacity Change Effects on Congestion Pricing

In loop R1, the increased number of passenger car units (PCUs) within the cordon based area leads to a higher average flow rate (# of PCUs divided by total lane miles and total charging hours per day) which represents the level of service during the charging period. The increase in the average flow rate leads to an increase in the external cost per mile and a subsequent increase

[11] For Figures 4.3, 4.4, and 4.5, please refer to Appendix 4.4 for the formulations.

of the congestion charging price. With increased congestion charging price, more revenues can be generated. The total bus capacity running within the charging area is increased accordingly. The increased number of buses running within the cordon based area undoubtedly boosts the total PCUs. Compared with the increase of capacity of other transit options such as metro rail, the increase of bus capacity has an effect in deteriorating traffic congestion. The balancing loop B1 constricts the increase of buses due to the existence of an allowable bus carrying capacity within the designated traffic congestion charging area.

Figure 4.4 depicts that the number of passenger within congestion pricing area increases due to the improvement of bus capacity (Reinforcing loop R2). The higher the ratio of bus supply to demand (in terms of passengers), the higher the perceived satisfaction with respect to the level of service represented by the normalized ratio of bus supply to and demand is. This increases the conversion rate from potential passengers to passengers due to the social networking activities (refer to Figure 4.2). The new "Converted" passenger could take any transportation mode. The new demand for travel need also increases the demand for car and consequently the total PCUs which gives rise to increased revenues from congestion pricing and an increased bus capacity that amplifies the ratio of bus supply to demand. Actually, Loop B was discussed in Figure 4.2.

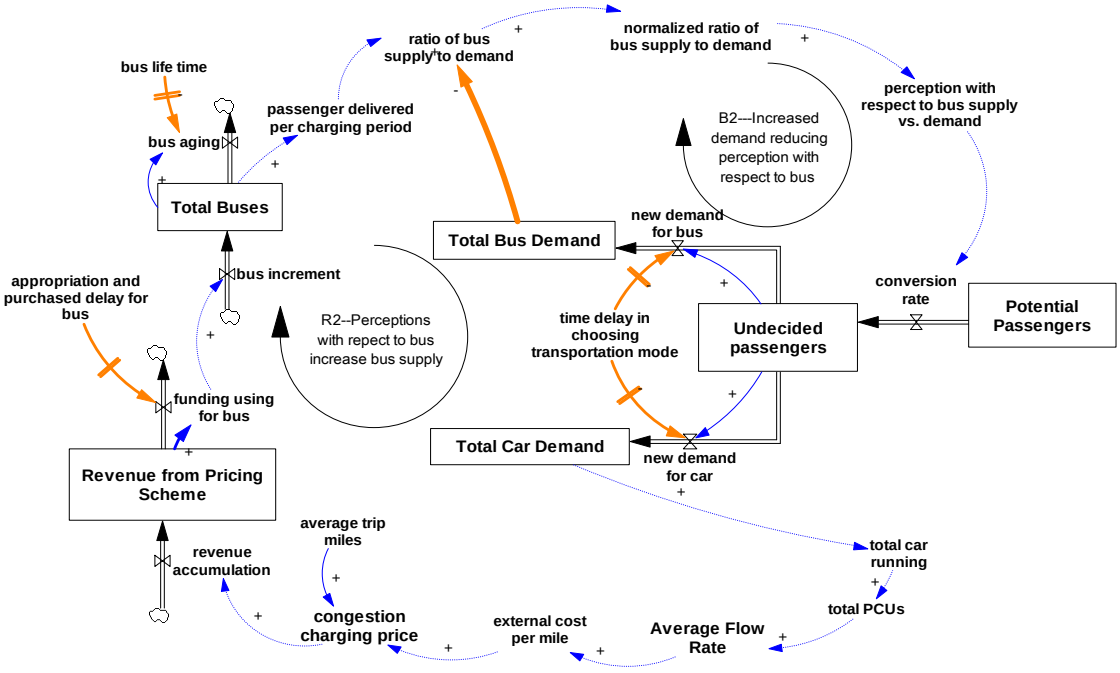

Figure 4.4: Bus Demand, Bus Capacity and Service Perceptions

In Figure 4.5 we examine the impact of indviduals' perceptions of the level of service (associated with the bus supply and demand) and of the congestion level (captured by the average flow rate) on the switching behavior from car to bus (balancing loop B5). With increased bus capacity, passengers tend to have better perception with respect to the bus level of service (represented by the ratio of bus supply to demand). This encourages the switching behavior from driving a car to taking the bus. This switching reduces the demand for car and decreases the total PCUs running within the designated charging area and the level of traffic congestion as a result. This leads to the reduction of the amount of revenue generated from congestion charging scheme. Ultimately, the funding for financing bus capacity improvement is reduced. In the balancing loop B4, one can see that the higher the demand for car, the worse the congestion is. The worsened traffic situation makes passengers have a bad perception with respect to congestion. This promotes the switching behavior from car driving to bus riding and as a consequence reduces the demand for car driving. In loop B3 the unrestrained switching from other transportation modes to the bus is limited. In loop B2, due to the switching behavior from the car to bus, demand for bus service increases. This diminishes the ratio of bus supply to demand and leaves a worse-than-before perception with respect to the ratio of bus supply to demand. Consequently, individuals exhibit less switching behavior than before.

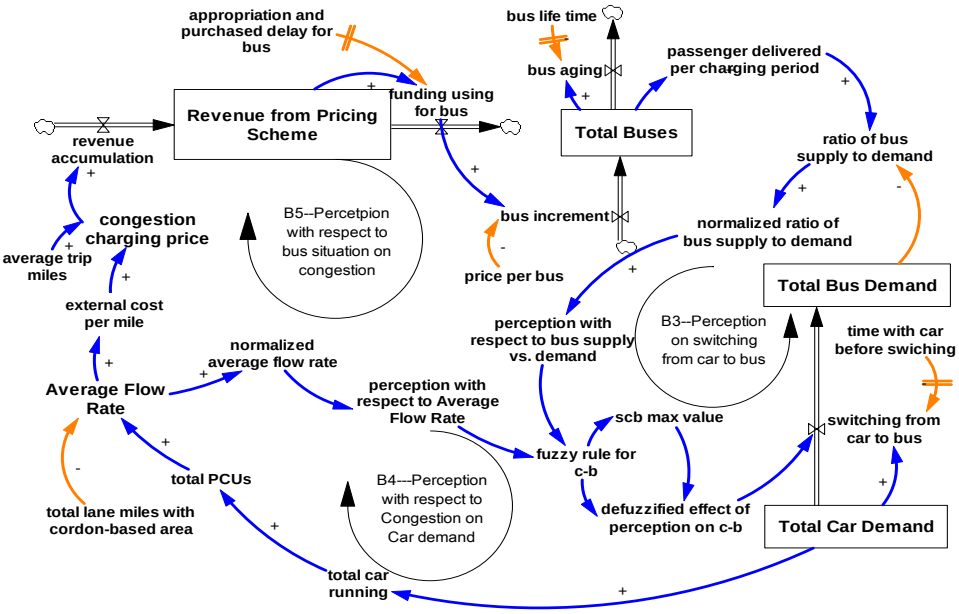

Figure 4.5: Switching Behavior between Bus and Car

In the following section, some critical variables are selected and analyzed. The chosen variables reflect the basic tenet of this paper i.e., the demand and supply dynamics, social networking activities, and traffic congestion affect and are affected by congestion charging policy. Moreover, some related assumptions are also presented when it is necessary.

4.2 Representation and Impact of Linguistic Variables

Individuals' perceptions can be represented by linguistic variables that are defined over multiple characteristics (each linguistic variable is assumed to have three characteristics in this research, i.e., low, medium, and high). We address the impact of individual linguistic variables as well as their combined effect. This paper adopts the techniques introduced by Liu and Triantis (2007a). In this paper, fuzzy variables are used to represent linguistic variables and relevant fuzzy rules are defined to compute the combined effect of multiple linguistic variables.

In the model presented in this research, there are five linguistic variables that describe people's perception with respect to supply and demand of mass transit, level of congestion, and driving cost versus its value. Specifically, they are: the perception with respect to level of congestion, perception with respect to the ratio of metro rail supply to demand, perception with respect to the ratio of bus supply to demand, perception with respect to the ratio of trail supply to demand, and perception with respect to the ratio of driving cost to value. All five linguistic variables have a combined effect on the conversion rate from potential passengers to passengers. Each of these linguistic variables is defined over three characteristics, i.e, low, medium, and high. Therefore, 243 fuzzy rules are defined so as to account for the combined effects of the five linguistic variables. Individuals' perceptions also affect the switching behavior among different transportation modes. Due to the difference of all kinds of combination, it is necessary to define individual fuzzy rules for different switching. For example, there are two linguistic variables that exert effect on the switching from trail to bus (there are 9 rules here). Taking another example, there are one linguistic variable that applies effect on the switching from bus to metro rail (there are 3 rules here). Totally, 315 fuzzy rules are defined in this model.

4.3 Analysis of the Behavior of Critical Variables

In this section, we describe the behaviors of the average flow rate, total buses, total metro cars, total trail miles, total demand of bus, metro, trail, and car demand, and the conversion rate from non passengers to passengers. The reason for choosing these nine variables is that they

represent different aspects of the transportatios/socio economic system. The average flow rate is a measure of congestion. Total buses, metro rail, cars, and trail miles denote the supply dynamics associated with the different transportation modes. The total demand for bus, metro, trail, and car characterize the demand dynamics. Last but not the least the conversion rate from non passengers to passengers indicates the impact of peoples' perceptions with respect to the ratio of mass transit supply to demand and the impact of congestion on the social networking activities. This conversion rate represents the induced mobility need due to changing social networking activities.

Figure 4.6 shows the supply behavior of different transportation modes. They are differentiated by private car and mass transit. The private car is different from mass transit in the way that the supply is obtained. In this research, it is assumed that people can get a car when they have a demand for car driving. Therefore, the demand for a car is met instantaneously. However, for the mass transit such as bus, the supply may or may not be satisfied even though the bus transit demand may be large. This is due to funding constraints and building delays for bus. One can see that in Figure 4.6 the behavior of total car running exhibits different behavior from mass transit modes. This is in part because of the two assumptions made when the model was built. One of the assumptions is that there is no congestion charging policy during the weekend period. The other assumption is that a certain percentage of people who will not go to work during weekend period.

Furthermore, the selection of simulation time horizon and time step both play a role in the depiction of car driving behavior. In Figure 4.6, the depicted behavior for car driving is jumping back and forth because there is a lower demand for car during the weekend than during the weekday. The very dense lines for 7200 days make the area between the upper and lower curves look like a surface. The upper curve represents cars running during weekdays while the lower curve is for the cars running during weekends. Initially, with the implementation of the traffic congestion pricing policy, the increased cost discourages people from choosing solo driving and they tend to switch to different modes of mass transit.

Even though there is continuous funding for building up mass transit capacity, the existence of construction delays does not allow the increased capacity to accommodate the

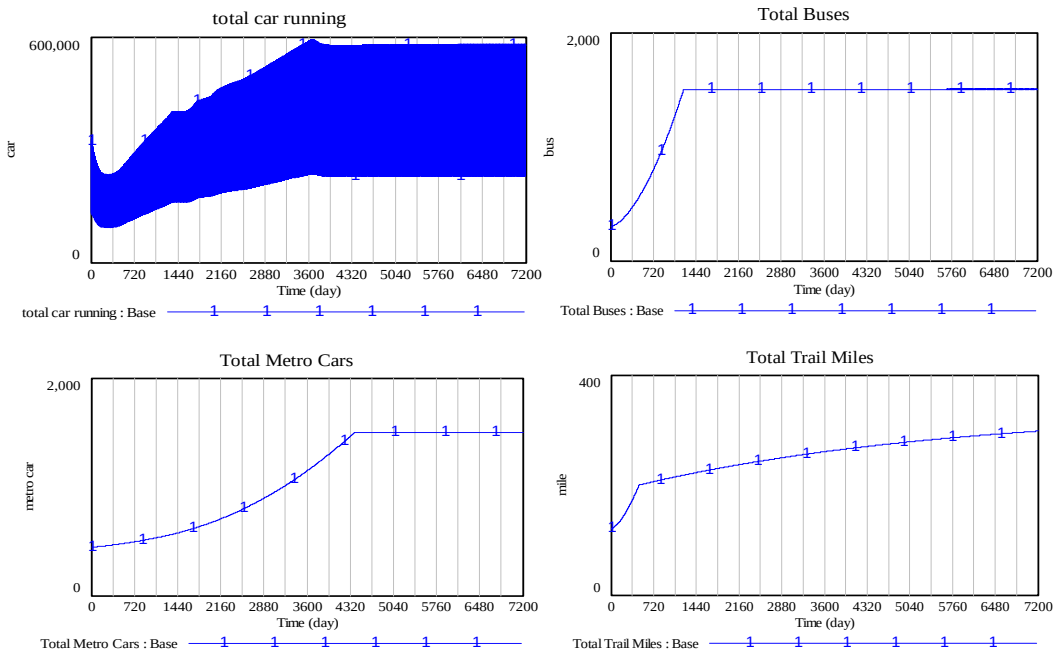

Figure 4.6: Supply Dynamics of Different Transportation Modes

increase of demand for mass transit. This undoubtedly increases the demand for car driving before the time when the total buses reach their carrying capacity. Now combining Figures 4.6 and 4.7, one can observe that the average flow rate follows the similar pattern of behavior as that of total car running. The reason is that the major contribution to traffic congestion is the solo driving cars within the cordon-based area. Notwithstanding the fact that the increased bus capacity deteriorates the traffic situation, it does not contribute very much to the traffic congestion since the total bus carrying capacity is only 1500 buses and each bus is assumed to be equivalent to 2.5 PCUs.

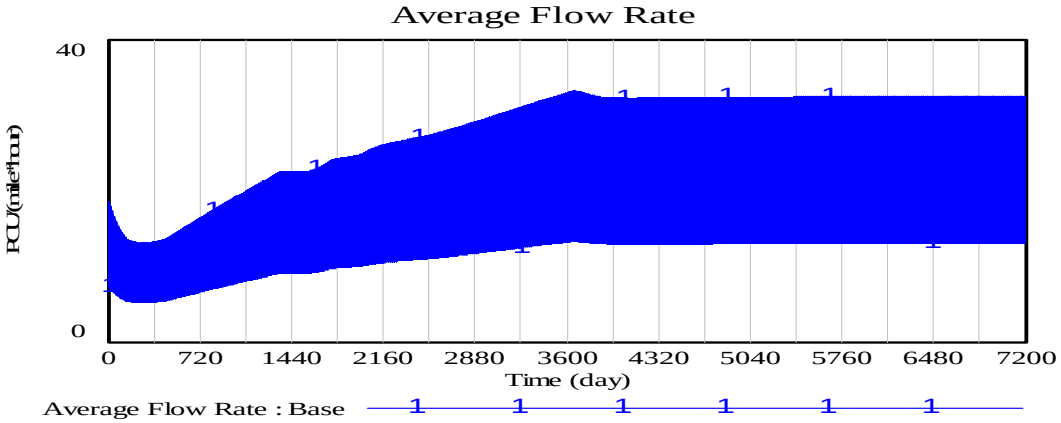

Figure 4.7: Average Traffic Flow Rate

With the implementation of congestion charging, more costs will be imposed on solo-drivers. Therefore, car drivers tend to decrease and switch to mass transit. In Figure 4.7, the average flow rate decreases in short term within the first years. The pricing policy discourages social networking activities. Attractiveness of city increases with the decline of average flow rate. Due to the decrease of average flow rate, the charging price also declines. This encourages some previous drivers to bounce back to driving and social activities increase as well. The total number of buses reaches its carrying capacity number at year 4, and does not contribute much to the reduction of the traffic flow. Because of the long delay associated with the buildup of metro rail capacity, metro rail capacity starts to increase exponentially at about 2000 days. Average flow rate tends to become flat at that point because the new supply tends to offset the increased demand. However, the new supply undoubtedly stimulates the new demand. Even when metro rail capacity still increases, it cannot handle the increased demand. Due to the delay of the adjustment of peoples' perceptions (with respect to traffic congestion, level of service in terms of mass transit supply to demand), traffic flow reaches the maximum value at 3600 days (10 years). The declining attractiveness of city discourages the mobility needs for social networking activities. So after the peak at 10 years, the average traffic flow rate stays at high level. Therefore, the congestion charging policy actually does not accomplish the expected mitigation of traffic congestion for the cordoned based area over the long-run in the sense it does not decrease average traffic flow. However, the policy maintains a certain level of congestion after the peak is achieved. This is just the behavior under one scenario, i.e., with a metro rail building delay of ten years and one million dollars cost per metro rail car. One can reduce both of these parameters to see if the average traffic flow decreases.

Figure 4.8 displays the simulation result for the demand of different transportation modes. As mensioned previously, the demand for car has same behavior as the behavior of supply of total running cars.

Let's discuss the graphs in Figures 4.8 and 4.9 together. The behavior of conversion rate is due to the different demand characteristics during weekends and weekdays. The conversion rate is affected by the combined effect of the five linguistic variables. Basically, the conversion rate increases before day 3600. This indicates that the demand for car, bus, trail, and metro rail continuously increase. Due to the bus capacity reaches its carrying capacity at 2000 days, the perception of people with respect to the ratio of bus supply to demand discourages further

increases for bus demand for bus. The demand for bus does not rise any more after day 3600. In the case of metro rail demand, because of a long building delay, the metro rail capacity increases after ten years. Even though, the conversion rate does not change after day 3600. The increased metro rail capacity accommodates the new demands coming from the exogenous variables of employment and tourism.

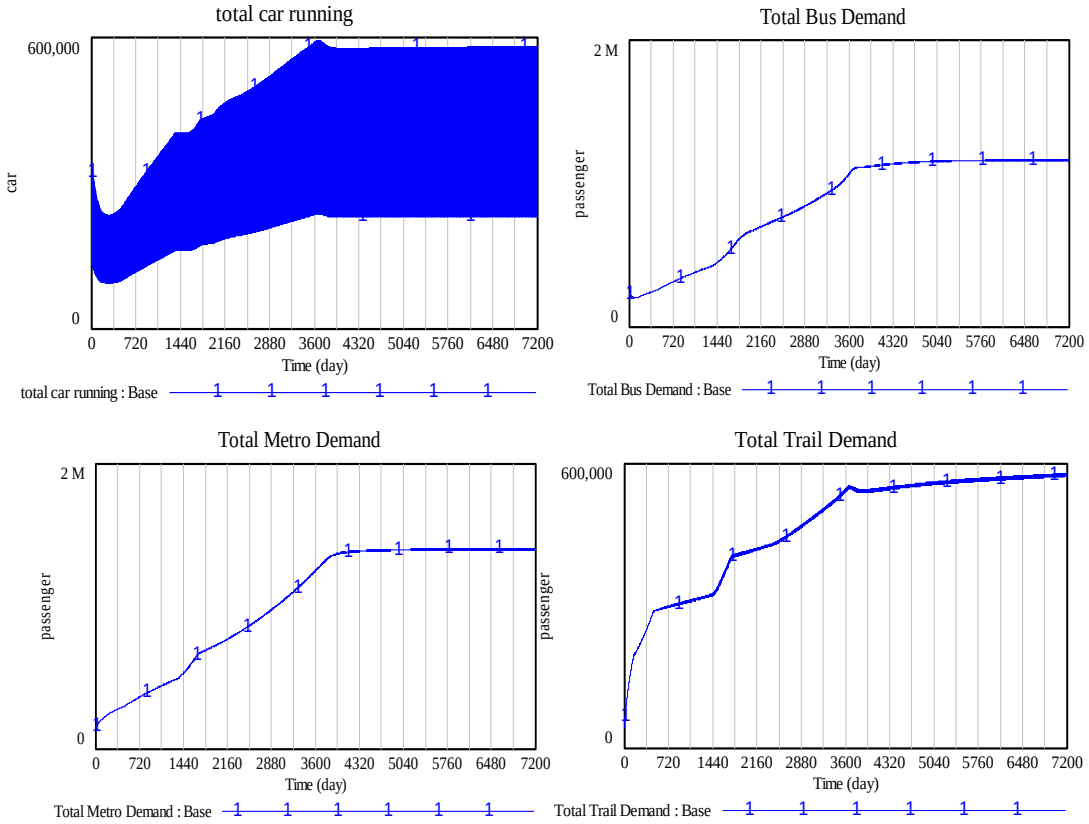

Figure 4.8: Demand Dynamics

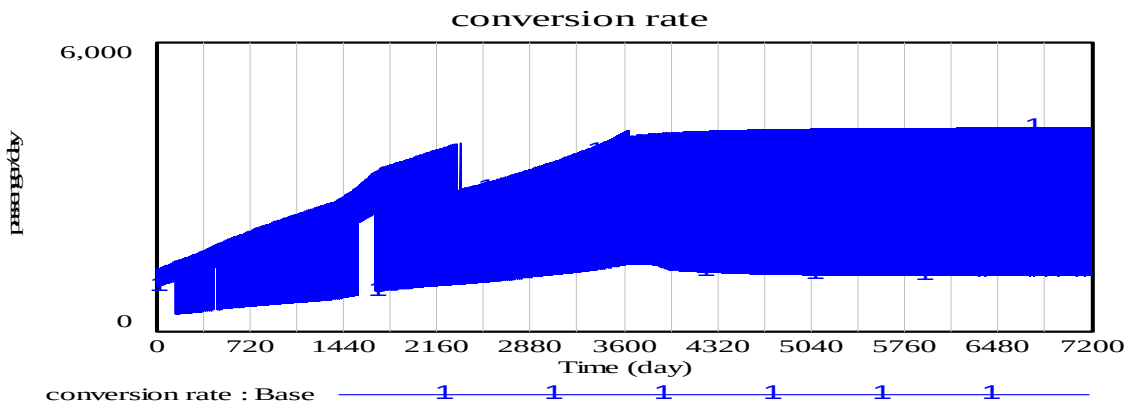

Figure 4.9: The Conversion of Non-passengers to Passengers

4.4 Uncertainty and Sensitivity Analysis

Since there is no specific traffic congestion pricing policy being implemented with Washington D.C. area, therefore there is no appropriate data available to do the sensitivity analysis (definition of the maximum and minimum value). These values in Appendix 4.3 are assumptions made by the authors.

Since the objective of the implementation of traffic congestion pricing is to mitigate traffic congestion, we focus on the average traffic flow as the bench mark variable to present the sensitivity analysis.

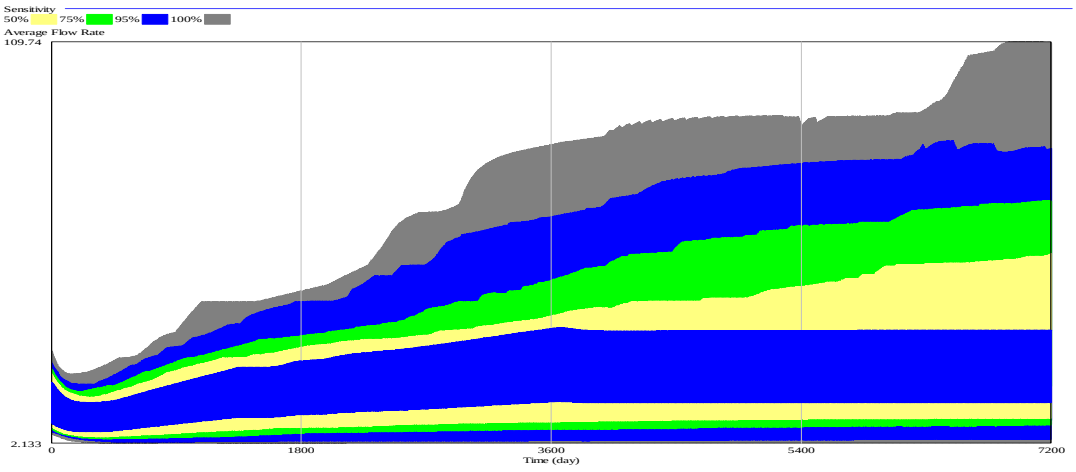

Figure 4.10: Sensitivity Analysis for Average Flow Rate

Figure 4.10 shows the dynamic confidence bounds from multivariate sensitivity analysis which employs the way of Monte Carlo Simulation. Please refer to the table in Appendix 4.3 which lists different parameters and their value range which is populated according to the

transportation related data for the Washington D.C. Metropolitan area. In Vensim Simulation Environment, it is generically assumed that the 50%, 75%, 95%, and 100% confidence bounds are to be examined. Moreover, the points are assumed to be normally and independently distributed. Figure 4.10 illustrates the 50%, 75%, and 95% confidence bounds for average flow rate in a sample of 200 simulations. All the parameters listed in Appendix 4.3 are assumed to be normally and independently distributed with standard deviation of 25% of their base case values.

Basically, one can observe that the confidence intervals widen as time goes. The uncertainty in the average flow rate is much greater at the end of the simulation because the social networking practice is a diffusion process[12]. The other reason causing the increased uncertainty is the combined effect of the different linguistic variables. Owing to the existence of mass transit carrying capacity, after some time, the mass transit reaches its carrying capacity. This to a great extent affects the changes of peoples' perceptions with respect to supply and demand of different mass transit modes. Moreover, it is due to definition of the fuzzy rules, the determination of the defuzzified effect value of individuals' perceptions on the fruitfulness of incurring mobility. For the details of how different characteristics contribute to uncertainty, please refer to the paper (Liu and Triantis, 2007): **"***A Fuzzy Representation of Multiple Linguistic Variables in System Dynamics Modeling*".

5.0 Comparison of System Behavior under the Two Scenarios: With and Without Congestion Pricing policy

This section investigates the scenario when congestion pricing is not implemented for the cordon based Washington D.C. metropolitan area. When congestion pricing is implemented for the designated area, the accumulated revenue is used to improve the mass transit capacity. At the same time, it is assumed that there are some normal funding being budgeted by local and federal government and used to improve mass transit. In this section, only the normal funding is used to improve mass transit capacity. Compared with the revenue generated from congestion pricing scheme, the normal funding is very small. Taking the changes of the bus capacity as an example,

[12] Diffusion process generally describes "the trajectory of a molecule, which is embedded in a flowing fluid and at the same time subject to random displacements due to collisions with other molecule" (Wikipedia definition). In research and actual application, it is usually describes the manner in which a product or needs (such as mobility) is disseminated in the marketplace.

please refer to Figure 4.11. The bus capacity does not reach the carrying capacity until the end of the simulation time horizon. Similarly, for metro rail and trail they can not reach their capacity.

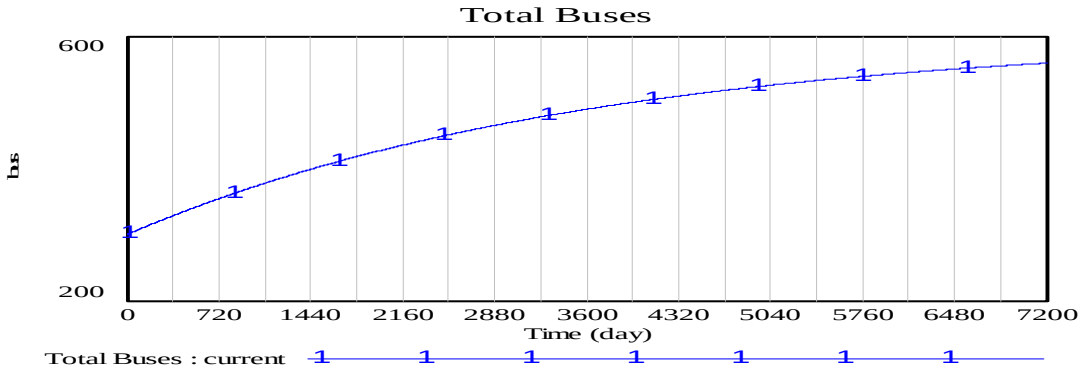

Figure 4.11: Total Buses (without congestion pricing)

The low ratio of mass transit supply to demand discourages the increase of social networking activities thereby the demand for different transportation modes. This situation eventually reduces the total PCUs running within the cordon based area during the proposed charging period. Consequently, this reduction decreases the average traffic flow rate within that area i.e., that is the congestion level (Figure 4.12). Comparing the behaviors of average traffic flow rate with and without congestion pricing (Figure 4.7), it is evident that the congestion pricing policy in conjunction with the improvement of mass transit actually deteriorates the traffic situation. The reason is that the improved mass transit capacity actually stimulates more social networking activities that induce more travel demand for different transportation modes. Even though the mass transit capacity increases, it still cannot accommodate the increased demand for different transportation modes. So, the proposed policy intervention begets the unexpected adverse side effect.

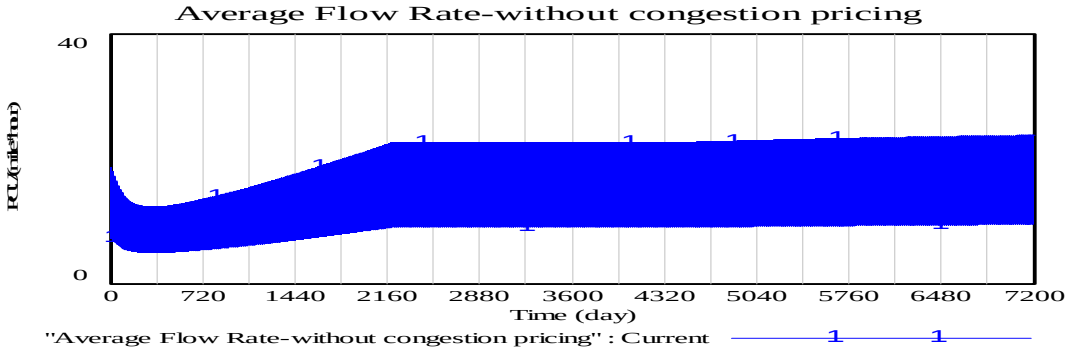

Figure 4.12: Behavior of Average Flow Rate

The scenarios with and without congestion pricing policy show that under the proposed assumptions such as having a limit on the mass transit carrying capacity and the delay associated with building the capacity for bus, metro rail, and trail, congestion pricing with a redistribution of the pricing revenues can not work well in mitigating traffic congestion when social networking activities are taken into account. In a subsequent research (Liu and Triantis, 2007b) a comprehensive policy analysis is conducted that investigates combinations of key policy variables that tries to find optimal policy alternatives which to the great extent mitigate traffic congestion and improve quality of life.

6.0 Conclusions and Future Research

This paper evaluates the impact of congestion pricing policy once it is implemented for the cordon based Washington D.C. metropolitan area. The major consideration of this model is that individual behavior is affected by the level of congestion and the supply and demand associated mass transit. Perceptions were captured by five separate linguistic variables. Modeling their interactions required the definition of 315 fuzzy rules.

It is found that the funding distributed to improve mass transit capacity does improve capacity of the different mass transit modes. However, this improvement that is hampered by construction delays, budget allocation limits, and assumptions about carrying capacities does not effectively meet the demand for mobility generated by social networking activities and as a result the congestion pricing may not resolve the root issue of traffic congestion over the long term. Therefore, a comprehensive policy analysis that investigates combinations of key policy variables that would realize the desired traffic congestion mitigation through congestion pricing policy plus the improvement of mass transit capacity is required. Furthermore, one could assess the impact of supplementary strategies such as, new road construction, staggered work shifts, and telecommuting considered individually or in any combination.

Tracing back to the hypotheses presented in Section 1, one can notice that the simulation results and analysis support the first hypothesis, which states that the revenue generated from congestion pricing can increase mass transit capacity and improve social networking activities along with the associated mobility needs. However, in the short term traffic congestion improves

while in the long term the proposed travel demand management policy actually deteriorates the traffic situation.

Though we did not find the expected results, this model and this framework can be very useful when evaluating various travel demand management strategies and/or their combinations. The approach can be broadly used in other transportation related fields such as airport transportation and marine transportation even to address internet traffic congestion problems. The integration and operation of multiple linguistic variables in a system dynamics provides an alternative way to represent the linguistic variables in social system modeling.

At last, there are a number of future directions associated with this research. One direction is to expand the scale of this model to evaluate congestion pricing's impact on environment, land use, the local economy, population dynamics, and the concepts of sustainability and resilience of a metropolitan area to extreme events. Another direction is to do in-depth analysis once several linguistic variables are integrated in this transportation system dynamics model. One can experiment with different fuzzy membership functions other than the triangular membership function used in this model. One might identify the different fuzzy rules whenever appropriate data are available. However, this would require some combination of expert opinion elicitation, interviews, survey data, and comprehensive group modeling exercises. Another direction can be the exploration of uncertainty associated with people's behavior in transportation system using other theoretical paradigms such as possibility theory. As the validation and verification is concerned, one could adopt many different modeling techniques to compare the results obtained by this modeling paradigm. In this situation, it will be possible to extract complementary insights that can be potentially useful for decision makers.

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Appendix 4.1 Transportation System Structure with Intervention of Congestion Pricing Policy

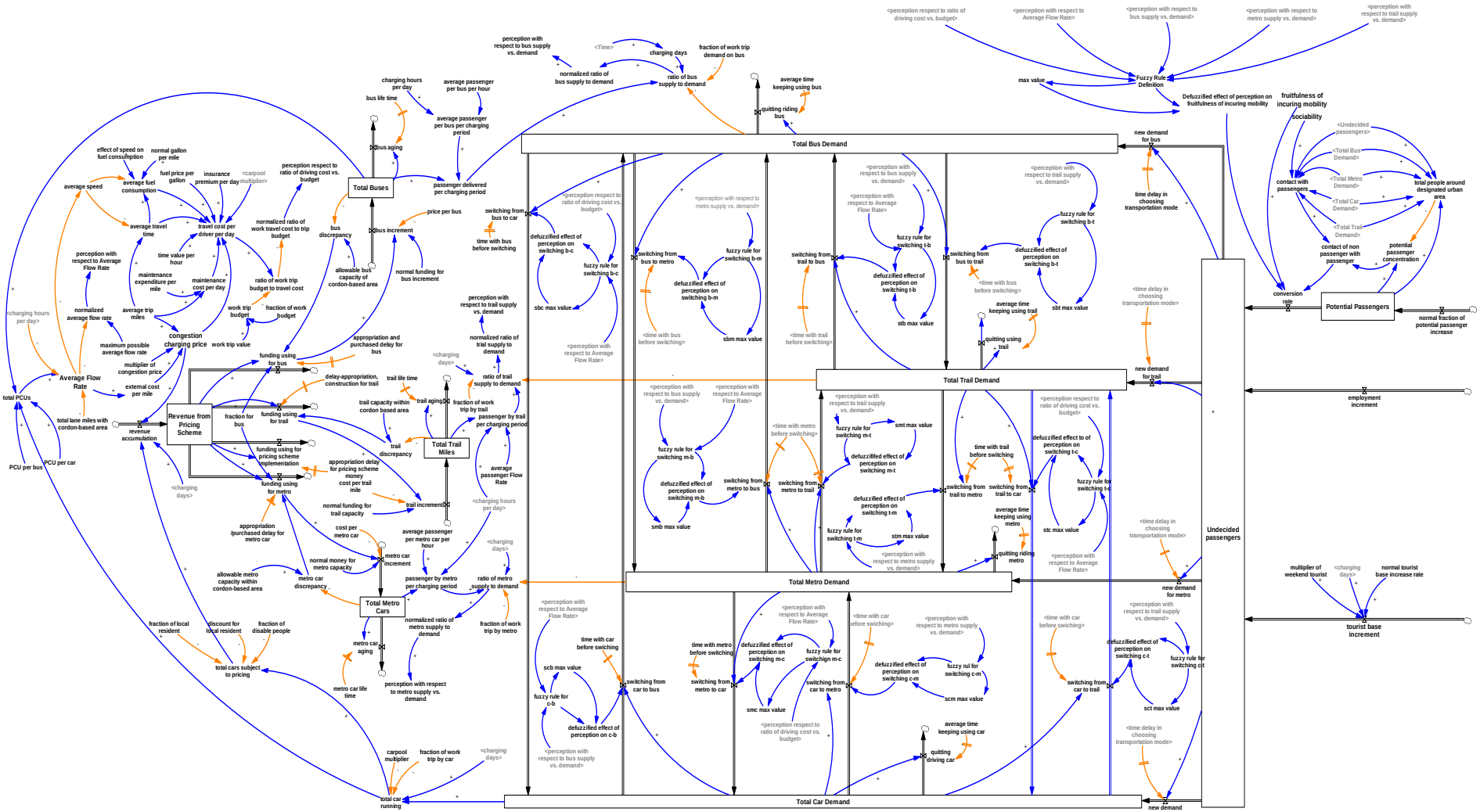


Figure A.4.1.1: Stock and Flow Diagram for the System Structure with Invention of Congestion Pricing Policy

Appendix 4.2 Transportation System Structure without Intervention of Congestion Pricing Policy

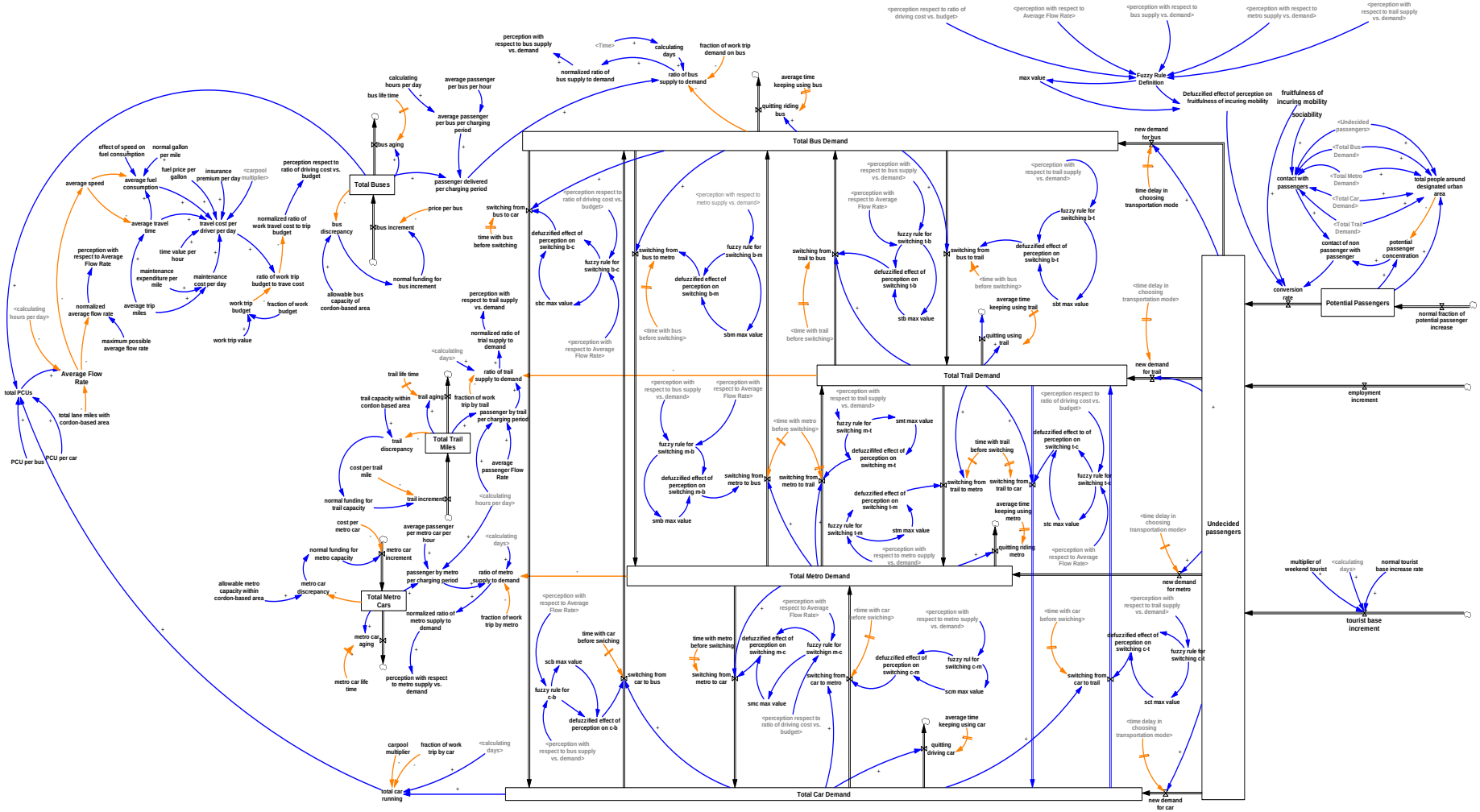


Figure A.4.1.2: Stock and Flow Diagram for the System Structure with Invention of Congestion Pricing Policy

Appendix 4.3: Variables and their Respective Ranges (for the case with Congestion Pricing)

Table A.4.3.1: Variables and Their Respective Range_with Congestion Pricing

Variable-Parameter	Initial Base Value	Minimum Value	Maximum Value
Allowable metro rail capacity (metro car)	1500	1200	3000
Allowable bus capacity (bus)	1500	1200	3000
Average passenger per bus per hour (passenger/bus/hour)	45	30	55
Average passenger per metro rail car per hour (passenger/metro car/hour)	68	50	98
Average time keeping taking bus (day)	1800	1440	2160
Average time keeping using car (day)	3600	2880	5400
Average time keeping using metro rail (day)	1800	1440	2880
Average time keeping using trail (day)	1080	720	1440
Average passenger flow rate (passenger/hour/mile) note: trail mile	30	20	40
Average trip miles (mile/car/day)	25	20	35
Bus life time (day)	3600	2880	4320
Carpool multiplie (passenger/car)	1.2	1.1	1.4
Cost per metro rail car (dollar/metro car)	1000000	900000	1200000
Cost per trail mile (dollar/mile) note: trail mile	80000	60000	90000
Employment increment (passenger /day)	8.1	6	10
Fraction of work budget (Dmnl)	0.15	0.12	0.18
Fraction of work trip by car (Dmnl)	0.6	0.5	0.7
Fraction of work trip by metro rail (Dmnl)	0.6	0.5	0.7
Fraction of work trip by trail (Dmnl)	0.66	0.6	0.75
Fraction of work trip demand on bus (Dmnl)	0.66	0.6	0.75
Fruitfulness of incurring mobility (person/contact)	0.0005	0.0002	0.0008
Fuel price per gallon (dollar/gallon)	2.5	2	3
Insurance premium per day (dollar/car/day)	2.5	2	3
Maintenance expenditure per mile (dollar/car/day)	0.029	0.02	0.035
Maximum possible average flow rate (PCU/mile/hour)	90	60	95
Metro rail car life time (day)	7200	5400	10800
Multiplier of congestion price ((Dmnl)	1	1	1.2
Multiplier of weekend tourist ((Dmnl)	1.5	1.2	1.8
Normal gallon per mile (gallon/mile)	0.0452	0.04	0.05
Normal money for metro rail capacity (dollar/day)	100000	80000	120000
Normal tourist base increase rate (passenger/day)	97.4	80	110
PCU per bus (PCU/bus)	2.5	2	3
PCU per car (PCU/car)	1	1	1.1
Price per bus (dollar/bus)	300000	250000	350000
Sociability (contact/passenger/day)	1	0.8	1.2
Time delay in choosing transportation mode (day)	180	90	270
Time value per hour (dollar/hour)	20	15	25
Time with bus before switching (day)	720	540	1080
Time with car before switching (day)	1440	1080	1800
Time with metro rail before switching (day)	720	540	1080
Time with trail before switching (day)	1080	720	1440
Total lane miles with cordon-based area (miles)	1500	1200	1800
Trail capacity within cordon based area (mile)	200	150	250
Trail life time (day)	5400	3600	7200
Work trip value (dollar/passenger/day)	160	120	200

Appendix 4.4: Formulations

Formulation for Figure 4.2

1. contact of non-passenger with passenger =contact with passengers*potential passenger concentration
   Units: contact/day
2. contact with passengers =sociability*(Total Bus Demand +Total Car Demand +Total Metro Demand +Total Trail Demand +Undecided passengers) Units: contact/day
3. conversion rate =contact of non passenger with passenger*Defuzzified effect of perception on
4. fruitfulness of incurring mobility*fruitfulness of incurring mobility Units: passenger/day
5. FINAL TIME = 100 Units: Month
   The final time for the simulation.
6. fruitfulness of incurring mobility = 0.0005 Units: person/contact
7. INITIAL TIME = 0 Units: Month
   The initial time for the simulation.
8. Passengers = INTEG (conversion rate+employment increment+tourist base increment-new demand for bus-new demand for car-new demand for metro-new demand for trail, 10000) Units: passenger
9. potential passenger concentration =Potential Passengers/total people around designated urban area
   Units: Dmnl
10. Potential Passengers = INTEG (+normal fraction of potential passenger increase-conversion rate, 3e+008)
    Units: passenger
11. SAVEPER = TIME STEP Units: Month [0,?]
    The frequency with which output is stored.
12. sociability =1 Units: contact/passenger/day
13. TIME STEP = 1 Units: Month [0,?]
    The time step for the simulation.
14. total population around designated charging area =Potential Passengers+Total Bus Demand+Total Car Demand+Total Metro Demand+Total Trail Demand+Undecided passenger Units: person

Formulation for Figure 3

1. "allowable bus capacity of cordon-based area"=1500 Units: bus
2. appropriation and purchased delay for bus=540 Units: day
3. Average Flow Rate =total PCUs/charging hours per day/"total lane miles with cordon-based area"
   Units: PCU/hour/mile
4. average trip miles=25 Units: mile/car/day
5. bus aging=Total Buses/bus life time Units: bus/day

6. bus discrepancy="allowable bus capacity of cordon-based area"-Total Buses Units: bus
7. bus increment=(funding using for bus+normal funding for bus increment)/price per bus
   Units: bus/day
8. bus life time=3600 Units: day
9. Bus S and D: BLow, BMedium, BHigh
10. congestion charging price=average trip miles*external cost per mile*multiplier of congestion price
    Units: dollar/car/day
11. external cost per mile=if then else(Average Flow Rate=0, 0, if then else (Average Flow Rate<=10, 0.15, if then else (Average Flow Rate<=25, 0.254, if then else (Average Flow Rate <=30, 0.3, if then else (Average Flow Rate<=40, 0.35, if then else (Average Flow Rate <=50, 0.4, if then else (Average Flow Rate<=60, 0.5, if then else (Average Flow Rate <=65, 0.7, if then else (Average Flow Rate<=70, 0.9, if then else (Average Flow Rate <=80, 1, 2)))))))))) Units: dollar/mile
12. FINAL TIME = 7200 Units: day
    The final time for the simulation.
13. Flow Rate: FLow, FMedium, FHigh
14. funding using for bus=if then else (bus discrepancy>=0, Revenue from Pricing Scheme*fraction for bus /appropriation and purchased delay for bus, 0) Units: dollar/day
15. INITIAL TIME = 0 Units: day
    The initial time for the simulation.
16. Metro S and D: MLow, MMedium, MHigh
17. multiplier of congestion price=1 Units: Dmnl
18. normal funding for bus increment=50000 Units: dollar/day
19. PCU per bus=2.5 Units: PCU/bus
20. PCU per car=1 Units: PCU/car
21. price per bus=300000 Units: dollar/bus
22. Range: (r1-r243)
23. revenue accumulation=congestion charging price*total cars subject to pricing*charging days
    Units: dollar/day
24. Revenue from Pricing Scheme= INTEG (+revenue accumulation-funding using for bus-funding using for metro-funding using for pricing scheme implementation-funding using for trail, 10000)
    Units: dollars
25. SAVEPER = TIME STEP Units: day [0,?]
    The frequency with which output is stored.
26. switching bus to car: bcr1, bcr2, bcr3, bcr4, bcr5, bcr6, bcr7, bcr8, bcr9
27. switching bus to metro: sbmr1, sbmr2, sbmr3
28. switching bus to trail: sbtr1, sbtr2, sbtr3

29. switching car to bus: cbr1, cbr2, cbr3, cbr4, cbr5, cbr6, cbr7,cbr8, cbr9
30. switching car to metro: scmr1, scmr2, scmr3
31. switching car to trail: sctr1, sctr2, sctr3
32. switching metro to bus: smbr1, smbr2, smbr3, smbr4, smbr5, smbr6, smbr7,smbr8,smbr9
33. switching metro to car: smcr1, smcr2, smcr3, smcr4, smcr5, smcr6, smcr7, smcr8, smcr9
34. switching metro to trail: smtr1, smtr2, smtr3
35. switching trail to bus: stbr1, stbr2, stbr3,stbr4, stbr5, stbr6,stbr7,stbr8,stbr9
36. switching trail to car: stcr1, stcr2, stcr3, stcr4, stcr5, stcr6, stcr7, stcr8, stcr9
37. switching trail to metro: stmr1,stmr2,stmr3
38. TIME STEP = 0.25 Units: day [0,?]
    The time step for the simulation.
39. Total Buses= INTEG (+bus increment-bus aging, 300) Units: bus
40. total cars subject to pricing=total car running*(1-fraction of disable people)*((1-fraction of local resident)+fraction of local resident*(1-discount for local resident) Units: car
41. "total lane miles with cordon-based area"=1500 Units: miles
42. total PCUs=total car running*PCU per car+Total Buses*PCU per bus Units: PCU
43. Trail S and D: TLow, TMedium, THigh
44. Trip Value and Cost: TVCLow, TVCMedium, TVCHigh

Formulation for Figure 4.4

1. appropriation and purchased delay for bus=540 Units: day
2. Average Flow Rate=total PCUs/charging hours per day/"total lane miles with cordon-based area"
   Units: PCU/hour/mile
3. average trip miles=25 Units: mile/car/day
4. bus aging=Total Buses/bus life time Units: bus/day
5. bus increment=(funding using for bus+normal funding for bus increment)/price per bus
   Units: bus/day
6. bus life time=3600 Units: day
7. Bus S and D: BLow, BMedium, BHigh
8. congestion charging price=average trip miles*external cost per mile*multiplier of congestion price
   Units: dollar/car/day
9. conversion rate=contact of non passenger with passenger*Defuzzified effect of perception on fruitfulness of incuring mobility*fruitfulness of incuring mobility
   Units: passenger/day
10. external cost per mile=if then else(Average Flow Rate=0, 0, if then else (Average Flow Rate<=10, 0.15, if then else (Average Flow Rate<=25, 0.254, if then else (Average Flow Rate <=30, 0.3, if then else (Average Flow Rate<=40, 0.35, if then else (Average Flow Rate

<=50, 0.4, if then else (Average Flow Rate<=60, 0.5, if then else (Average Flow Rate <=65, 0.7, if then else (Average Flow Rate<=70, 0.9, if then else (Average Flow Rate <=80, 1, 2))))))))) Units: dollar/mile

11. FINAL TIME = 7200 Units: day
    The final time for the simulation.
12. Flow Rate: FLow, FMedium, FHigh
13. funding using for bus=if then else (bus discrepancy>=0, Revenue from Pricing Scheme*fraction for bus /appropriation and purchased delay for bus, 0) Units: dollar/day
14. INITIAL TIME = 0 Units: day
    The initial time for the simulation.
15. Metro S and D: MLow, MMedium, MHigh
16. new demand for bus= Undecided passengers/time delay in choosing transportation mode Units: passenger/day
17. new demand for car=Undecided passengers/time delay in choosing transportation mode Units:passenger/day
18. normalized ratio of bus supply to demand=if then else (ratio of bus supply to demand<=0.85, ratio of bus supply to demand, 1) Units: Dmnl
19. passenger delivered per charging period=average passenger per bus per charging period*Total Buses Units: passenger
20. "perception with respect to bus supply vs. demand"[BLow]=if then else (normalized ratio of bus supply to demand=0, 1, if then else (normalized ratio of bus supply to demand>=0 :AND:normalized ratio of bus supply to demand<=0.5, (0.5-normalized ratio of bus supply to demand)/0.5, 0))
    "perception with respect to bus supply vs. demand"[BMedium]=if then else (normalized ratio of bus supply to demand>=0 :AND:normalized ratio of bus supply to demand<=0.5, normalized ratio of bus supply to demand/0.5, if then else (normalized ratio of bus supply to demand>=0.5 :AND:normalized ratio of bus supply to demand<=1, (1-normalized ratio of bus supply to demand)/0.5, 0))
    "perception with respect to bus supply vs. demand"[BHigh]=if then else (normalized ratio of bus supply\ to demand>=0.5 :AND:normalized ratio of bus supply to demand<=1, (normalized ratio of bus supply to demand-0.5)/0.5, if then else (normalized ratio of bus supply to demand>=1, 1, 0)) Units: Dmnl
21. Potential Passengers= INTEG (+normal fraction of potential passenger increase-conversion rate, 3e+008) Units: passenger
22. Range: (r1-r243)
23. ratio of bus supply to demand=if then else (charging days<>0, passenger delivered per charging period/Total Bus Demand, passenger delivered per charging period/(Total Bus Demand*(1-fraction of work trip demand on bus))) Units: Dmnl
24. revenue accumulation=congestion charging price*total cars subject to pricing*charging days Units: dollar/day

25. Revenue from Pricing Scheme= INTEG (+revenue accumulation-funding using for bus-funding using for metro- funding using for pricing scheme implementation-funding using for trail, 10000)
    Units: dollars
26. SAVEPER = TIME STEP Units: day [0,?]
    The frequency with which output is stored.
27. switching bus to car: bcr1, bcr2, bcr3, bcr4, bcr5, bcr6, bcr7, bcr8, bcr9
28. switching bus to metro: sbmr1, sbmr2, sbmr3
29. switching bus to trail: sbtr1, sbtr2, sbtr3
30. switching car to bus: cbr1, cbr2, cbr3, cbr4, cbr5, cbr6, cbr7,cbr8, cbr9
31. switching car to metro: scmr1, scmr2, scmr3
32. switching car to trail: sctr1, sctr2, sctr3
33. switching metro to bus: smbr1, smbr2, smbr3, smbr4, smbr5, smbr6, smbr7,smbr8,smbr9
34. switching metro to car: smcr1, smcr2, smcr3, smcr4, smcr5, smcr6, smcr7, smcr8, smcr9
35. switching metro to trail: smtr1, smtr2, smtr3
36. switching trail to bus: stbr1, stbr2, stbr3,stbr4, stbr5, stbr6,stbr7,stbr8,stbr9
37. switching trail to car: stcr1, stcr2, stcr3, stcr4, stcr5, stcr6, stcr7, stcr8, stcr9
38. switching trail to metro: stmr1,stmr2,stmr3
39. time delay in choosing transportation mode= 180 Units: day
40. TIME STEP = 0.25 Units: day [0,?]
    The time step for the simulation.
41. Total Bus Demand= INTEG (new demand for bus+switching from car to bus+switching from metro to bus+switching from trail to bus-quitting riding bus-switching from bus to car-switching from bus to metro-switching from bus to trail, 247770) Units: passenge
42. Total Buses= INTEG (+bus increment-bus aging, 300) Units: bus
43. Total Car Demand= INTEG (new demand for car+switching from bus to car+switching from metro to car+ switching from trail to car-quitting driving car-switching from car to bus-switching from car to metro-switching from car to trail, 401319) Units: passenger
44. total car running=if then else (charging days<>0, Total Car Demand/carpool multiplier, (Total Car Demand/(carpool multiplier)*(1-fraction of work trip by car))) Units: car
45. total PCUs=total car running*PCU per car+Total Buses*PCU per bus Units: PCU
46. Trail S and D: TLow, TMedium, THigh
47. Trip Value and Cost: TVCLow, TVCMedium, TVCHigh
48. Undecided passengers= INTEG (conversion rate+employment increment+tourist base increment-new demand for bus -new demand for car-new demand for metro- new demand for trail, 10000)
    Units: passenger

Formulation for Figure 4.5

1. appropriation and purchased delay for bus=540 Units: day

2. Average Flow Rate=total PCUs/charging hours per day/"total lane miles with cordon-based area"
   Units: PCU/hour/mile
3. average trip miles=25 Units: mile/car/day
4. bus aging=Total Buses/bus life time Units: bus/day
5. bus increment=(funding using for bus+normal funding for bus increment)/price per bus
   Units: bus/day
6. bus life time=3600 Units: day
7. Bus S and D:BLow, BMedium, BHigh
8. congestion charging price=average trip miles*external cost per mile*multiplier of congestion price
   Units: dollar/car/day
9. conversion rate=contact of non passenger with passenger*Defuzzified effect of perception on fruitfulness of incuring mobility*fruitfulness of incuring mobility Units: passenger/day
10. external cost per mile=if then else(Average Flow Rate=0, 0, if then else (Average Flow Rate<=10, 0.15, if then else (Average Flow Rate<=25, 0.254, if then else (Average Flow Rate <=30, 0.3, if then else (Average Flow Rate<=40, 0.35, if then else (Average Flow Rate <=50, 0.4, if then else (Average Flow Rate<=60, 0.5, if then else (Average Flow Rate <=65, 0.7, if then else (Average Flow Rate<=70, 0.9, if then else (Average Flow Rate <=80, 1, 2)))))))))) Units: dollar/mile
11. FINAL TIME = 7200 Units: day
    The final time for the simulation.
12. Flow Rate:FLow, FMedium, FHigh
13. funding using for bus=if then else (bus discrepancy>=0, Revenue from Pricing Scheme*fraction for bus /appropriation and purchased delay for bus, 0) Units: dollar/day
14. INITIAL TIME = 0 Units: day
    The initial time for the simulation
15. Metro S and D: MLow, MMedium, MHigh
16. new demand for bus=Undecided passengers/time delay in choosing transportation mode
    Units: passenger/day
17. new demand for car=Undecided passengers/time delay in choosing transportation mode
    Units: passenger/day
18. normalized ratio of bus supply to demand=if then else (ratio of bus supply to demand<=0.85, ratio of bus supply to demand , 1) Units: Dmnl
19. passenger delivered per charging period=average passenger per bus per charging period*Total Buses
    Units: passenger
20. "perception with respect to bus supply vs. demand"[BLow]=
    if then else (normalized ratio of bus supply to demand=0, 1, if then else
    (normalized ratio of bus supply to demand>=0 :AND:normalized ratio of bus supply to demand

<=0.5, (0.5-normalized ratio of bus supply to demand)/0.5, 0))

"perception with respect to bus supply vs. demand"[BMedium]=if then else (normalized ratio of bus supply to demand>=0 :AND:normalized ratio of bus supply to demand<=0.5, normalized ratio of bus supply to demand/0.5, if then else (normalized ratio of bus supply to demand>=0.5 :AND:normalized ratio of bus supply to demand<=1, (1-normalized ratio of bus supply to demand)/0.5, 0))

"perception with respect to bus supply vs. demand"[BHigh]=if then else (normalized ratio of bus supply to demand>=0.5 :AND:normalized ratio of bus supply to demand<=1, (normalized ratio of bus supply to demand-0.5)/0.5, if then else (normalized ratio of bus supply to demand>=1, 1, 0)) Units: Dmnl

21. Potential Passengers= INTEG (+normal fraction of potential passenger increase-conversion rate, 3e+008) Units: passenger
22. Range:(r1-r243)
23. ratio of bus supply to demand=if then else (charging days<>0, passenger delivered per charging period/Total Bus Demand , passenger delivered per charging period/(Total Bus Demand*(1-fraction of work trip demand on bus))) Units: Dmnl
24. revenue accumulation=congestion charging price*total cars subject to pricing*charging days Units: dollar/day
25. Revenue from Pricing Scheme= INTEG (+revenue accumulation-funding using for bus-funding using for metro-funding using for pricing scheme implementation-funding using for trail, 10000) Units: dollars
26. SAVEPER = TIME STEP Units: day [0,?]
27. The frequency with which output is stored.
28. switching bus to car: bcr1, bcr2, bcr3, bcr4, bcr5, bcr6, bcr7, bcr8, bcr9
29. switching bus to metro: sbmr1, sbmr2, sbmr3
30. switching bus to trail: sbtr1, sbtr2, sbtr3
31. switching car to bus: cbr1, cbr2, cbr3, cbr4, cbr5, cbr6, cbr7,cbr8, cbr9
32. switching car to metro: scmr1, scmr2, scmr3
33. switching car to trail: sctr1, sctr2, sctr3
34. switching metro to bus: smbr1, smbr2, smbr3, smbr4, smbr5, smbr6, smbr7,smbr8,smbr9
35. switching metro to car: smcr1, smcr2, smcr3, smcr4, smcr5, smcr6, smcr7, smcr8, smcr9
36. switching metro to trail: smtr1, smtr2, smtr3
37. switching trail to bus: stbr1, stbr2, stbr3,stbr4, stbr5, stbr6,stbr7,stbr8,stbr9
38. switching trail to car: stcr1, stcr2, stcr3, stcr4, stcr5, stcr6, stcr7, stcr8, stcr9
39. switching trail to metro: stmr1,stmr2,stmr3
40. time delay in choosing transportation mode=180 Units: day
41. TIME STEP = 0.25 The time step for the simulation Units: day [0,?]
42. Total Bus Demand= INTEG (new demand for bus+switching from car to bus+switching from metro to

bus+switching from trail to bus-quitting riding bus-switching from bus to car-switching from bus to metro-switching from bus to trail, 247770) Units: passenger

43. Total Buses= INTEG (+bus increment-bus aging, 300) Units: bus
44. Total Car Demand= INTEG (new demand for car+switching from bus to car+switching from metro to car+ switching from trail to car-quitting driving car-switching from car to bus-switching from car to metro switching from car to trail, 401319) Units: passenger
45. total car running=if then else (charging days<>0, Total Car Demand/carpool multiplier, (Total Car Demand/(carpool multiplier)*(1-fraction of work trip by car))) Units: car
46. total PCUs=total car running*PCU per car+Total Buses*PCU per bus Units: PCU
47. Trail S and D: TLow, TMedium, THigh
48. Trip Value and Cost: TVCLow, TVCMedium, TVCHigh
49. Undecided passengers= INTEG (conversion rate+employment increment+tourist base increment-new demand for bus-new demand for car-new demand for metro- new demand for trail, 10000) Units: passenger

Chapter 5 Evaluation of Travel Demand Management Policies: II-Policy Analysis

Abstract

Two initiatives are presented in this research. First a management flight simulator that has been developed to evaluate congestion pricing policy is described. This simulator is built using the Venapp function in the Vensim Simulation Environment and is based on a previously formulated dynamic simulation model (Liu and Triantis, 2007). Second, the management flight simulator is utilized to evaluate alternative scenarios associated with the travel demand management policies. Insights obtained from the development of the simulator as well as from the policy analysis are provided.

Keywords: Management Flight Simulator, Congestion Pricing Policy, Policy Analysis, Impact Evaluation, Transportation System

1.0 Introduction and Context

One of the key objectives of building a dynamic system model is to execute a comprehensive policy analysis. In the case of this research, this translates in obtaining a deeper understanding of the impact of travel demand management strategies on mitigating traffic congestion for a cordon based downtown area. This translates to assessing the behavior of a transportation-socio-economic system that is to some degree representative of the cordon based downtown area in terms of the transportation infrastructure, the congestion pricing and revenue allocation mechanisms, and social networking. Therefore, we build on the dynamic model that has been described by Liu and Triantis (2007). In this model, congestion pricing is considered along with the improvement of mass transit capacity, and the provision of subsidies to local residents of the downtown area. In the initial analysis, this travel demand management policy is compared with one where only improvement in mass transit is carried out.

Having constructed the dynamic model for the identified problem (in this case traffic congestion), one needs to evaluate different policy alternatives and find the best policy option. Nagel (1999, pp.1-2) indicates that policy analysis is to "*determine which of various alternative policies will most achieve a given set of goals in light of the relations between the policies and the goals*." Generally speaking, policy analysis has two different domains. Among which, one is to explain a policy and its development that includes both its analytical and descriptive characteristics. The other one is to formulate and evaluate different policies and their combinations depending on the research problem on hand. The current research focuses on formulating a policy that is a combination of several travel demand management policies, i.e., traffic congestion charging, improvements in mass transit capacity along with the provision of subsidies of local residents and disabled people. The performance goal of this travel demand management policy is to improve mass transit capacity, mitigate congestion, and improve quality of life of a designated cordon based metropolitan area.

In terms of evaluating policies at the appropriate scale level, three popular levels (Buhrs and Bartlett 1993) exist, .i.e., the micro-scale, mesa-scale, and meta-scale. Just as its name implies, the first level focuses on individual problems and its solutions. The major focus of the second level is the political processes and its stakeholders. The third level takes into consideration all political, economic, social and cultural aspects that influence the policy process. The pursuit of the solutions that can arise from the implementation of specific policies may involve changing the system structure. As far as the current research is concerned, the focus will be in terms of the third level of policy analysis since the traffic congestion problem is examined in a system that considers political, social, economic, and transportation systems.

For policy analysis, both qualitative and quantitative methods can be used (Nagel, 1999). This research principally uses a quantitative model that has been constructed from a formalized mechanism of model building that includes the following steps: the identification of the problem, the actual building of the quantitative model, the building of the management flight simulator, the selection of different policies, the evaluation of different policy scenarios, and monitoring of the implementation of the evaluated policies. The last step is beyond the scope of this paper.

The domain of the policy analysis involved in this research is transportation related. As the transportation system interacts with other systems such as the environment and social networks, transportation policies are affected by factors coming from other systems (Litman,

2006). Furthermore, these policies simultaneously affect the behaviors and even the structure of all related subsystems. For example, the existing transportation modes and sectors provide the mobility needs for people who need to have access to jobs and social opportunities in an equitable way. The investment in and operation of different transportation modes has strong implications for the quality of life of people in their communities (Parry, 2002). Therefore, the accessibility and affordability issues associated with different transportation modes may create issues for the community and even the society as a whole (Litman, 2006). The improvement of transportation could boost the development of the local and national economy, speared by tourism, and industrial growth. The rapid increases of transportation infrastructure and vehicles, at the same time, generate unexpected outcomes that include but are not limited to air and noise pollution, accidents, social exclusion, congestion delay, waste of fuel and time, and the deterioration of the quality of life. Consequently, policy analysis should incorporate varying combinations of all of the factors mentioned above. This research evaluates a policy that is designed to mitigate one of those outcomes, i.e., traffic congestion. In general, policies that attempt to mitigate traffic congestion include but are not limited to: traffic congestion charging, efficient land use, telecommuting, staggered work shifts, and improvement of mass transit, etc. The focus of the policy analysis presented in this paper is to evaluate the impact of traffic congestion pricing combined with improvement of mass transit capacity, and the provision of subsidies to disadvantaged members of the community.

The rest of this paper is organized as follows. The next section provides an overview of policy analysis related to congestion pricing and how management flight simulators and decision support systems facilitate policy analysis. In Section 3, we present the steps used to develop the management flight simulator along with insights obtained during the building of this application system. In section 4, a policy analysis is conducted based on the platform provided this decision support system whereas the final section discusses future research issues and concludes.

2.0 Background

There are many research papers that address congestion pricing. The implementation of congestion pricing has broad-range and long-term impact on an individual's driving behavior, society, the economy, the environment, the transportation system itself as well as the political system. The London congestion charging scheme is a successful case where the behavior of

drivers changed. One third fewer cars are currently entering the city center and 16% more buses are on the streets compared to the period before the pricing scheme was instituted (Santos and Shaffer, 2004).

Giuliano (1992) pointed out that road pricing is one of the few effective means to reduce the use of automobile, and thus reduce air pollution. He also noted that the heavily congested downtown areas are competitively disadvantaged now because of congestion. Banister (2002) indicated that, due to the implementation of congestion charging, land values and rent levels in the city center could fall. This would potentially cause the reduction of activity from the city center. An article from the website of Victoria Transport Policy Institute (2005) indicates that travel demand management (TDM) strategies including congestion pricing tend to provide energy conservation and emission reduction.

With respect to the use of revenues from a congestion pricing scheme, Goodwin (1990) recommended that the revenues should be invested in three areas: road construction, tax relief, and public transit improvement. Litman (1996) investigated the use of congestion pricing revenue by analyzing horizontal[13] and vertical[14] equity. In order to analyze the acceptability of traffic pricing policy, Ruax and Sourche (2004) employed an analytical framework that considers four factors, i.e., economic efficiency, spatial equity, vertical and horizontal equity. Safirova, *et al.* (2003) used a strategic transportation planning model to compare the welfare and distributional effect of three pricing schemes: value pricing (HOT lanes), limited congestion pricing, and comprehensive congestion pricing.

Furthermore, in order to examine how different groups of people are affected by a congestion pricing scheme, Levine and Garb (2002) divided the users into three groups: drivers who drove before and remain on the road afterward, drivers who used the road before and do not use it after the implementation of congestion pricing, and drivers who did not use the road before and start to drive with improved mobility. They concluded that the first two groups may end up being worse off with congestion pricing. Gonzales (2005) pointed out that, if sufficient improvements are made, theoretically it is possible that the mass transit system to attract more passengers from the pool of previous drivers who choose not to drive.

[13] Horizontal equity is concerned with the fairness among individuals and classes with comparable needs and resources.

[14] Vertical equity is concerned with the treatment of individuals and classes that are unlike. The distribution of costs and benefits should reflect peoples' needs and abilities.

When presenting the economic impacts of congestion charging, Whitehead (2002) provided two scenarios by which several major economic sectors are evaluated. Scenario A assumes that there would be no change in the provision of public transportation and environmental quality with the introduction of congestion pricing, while scenario B presumes that congestion charging revenues would be invested in public transportation and the environment of the city center. The sectors being evaluated include: retail, tourism, and residential. As far as the retail activity is concerned, it is thought to be one of the most sensitive sectors (Whitehead, 2002). The retail sector could be affected negatively by Scenario A since drivers would be discouraged by the congestion charge and this could lead to a loss of the traditional customer base. Under scenario B, the retail activity in the city center would have a relative increase of the customer base with short-term fluctuations before full-fledged improvements are made.

In this research, just as other researchers have assumed the revenues obtained from the congestion charging scheme are assumed to be distributed to improve mass transit capacity. However, unlike previous researchers, the focus is on the dynamic changes of the average congestion level as well as changes to social networking activities as a consequence of congestion pricing, revenue re-distribution and subsidy provision to disadvantaged groups. The key stakeholder groups evaluated are the passengers, non-passengers, and solo drivers.

In Liu and Triantis (2007), a model that simulates the dynamics of congestion pricing is described. However, policy makers and transportation planners who are not familiar with the essence of the software environment employed for this model cannot easily perform model analysis easily under different scenarios. As one may know, the ultimate objective of modeling a problem is to provide insights obtained from the analysis process to the users of the model. Even more importantly, the simulation environment can provide a mechanism by which policy or decision makers can observe the impact of their decisions prior to implementing them. Generically, this kind of simulation environment is called a Management Flight Simulator that could also be called a Decision Support System, an Executive Support System, a Leaning Environment, Games, Microworlds, Menu Driven Interfaces, Packed Application, and Scenario Generators (Vensim DSS Reference Supplement, p. 11). Throughout the presentation of this paper, we use the term of Management Flight Simulator to denote the controlled environment in which policy makers can observe the impact of their decisions without having to be

knowledgeable of the underlying software environment. Within this environment, the policy makers or generic users can learn about the basics of the model, experiment with different assumptions and policy scenarios to observe the short- and long term dynamic effects of those different decisions.

So far, in the literature there is no System Dynamics-based Management Flight Simulator that analyzes travel demand management based transportation policies that potentially mitigate traffic congestion for a cord-based metropolitan area. In current research, the designed Management Flight Simulator evaluates how different revenue distribution scenarios, differences of the carrying capacity of transportation modes and building delays associated with the increase of mass transit capacity can affect the average level of traffic congestion and the behavior of different stakeholders.

However, in the literature Decision Support Systems (DSSs) are primarily used to evaluate different transportation policies. For example, Bielli (1992) presents a DSS model that includes approaches such as resource optimization models, traffic simulation and evaluation models. It is used as the tool for urban traffic management by decision makers, policy makers, or planner in the field of transportation planning of different institutions or governments. Yang and Koutsopoulos (1996) build a Microscopic Traffic SIMulator (MITSIM) to evaluate dynamic traffic management systems. Ben-Akiva, *et al.* (1997) came up with a simulation lab that includes four integrated components. By considering the dynamic and stochastic nature of road networks, this lab helps generate different scenarios by which the system performance is evaluated under different scenarios. For the sake of finding optimal highway alignment, Jha (2003) developed a Criteria-based Decision Support System to evaluate different alignment scenarios that avoid the adverse impacts on environment and quality of life of local residents. Chassiakos, *et al.* (2005) propose a DSS that allocates resources to improve highway safety by evaluating maintenance priorities for different areas according to the severity of prior accidents. Tsamboulas and Mikroudis (2006) offer a Decision Support System called TRANS-POL that evaluates the impacts of different transportation projects and policies once they are implemented.

3.0 The Management Flight Simulator

As mentioned previously we describe the Management Flight Simulator that evaluates different scenarios for travel demand management policies. This simulator is built using the

Vensim Simulation Software by employing the Venapp function in this Simulation Environment. Venapp allows different users to have access to a model in an easily understandable way. In this application, the model described by Liu and Triantis (2007) is loaded and the system behaviors are displayed only through pressing the buttons that are found in different screens. By using this application, one who does not necessarily know the model can easily handle parameter changes as well as different policies that are found in different screens and observe the dynamic behavior of various variables.

There are several objectives for building this management flight simulator for the evaluation of travel demand management policies. First and foremost is the evaluation of the impact of congestion pricing along with different revenue distribution schemes that are designed to improve mass transit capacity and subsidize stakeholders that are much worse off. By using the developed platform, the decision makers can find an optimal combination of the proposed travel demand management policies that can successfully reduce the traffic congestion within the designated metropolitan area. The approach considers the redistribution of the generated revenues from the traffic congestion charging scheme, the building delay associated with mass transit capacity coming on line, the increased carrying capacity for mass transit, and the increased social networking activities of individuals who are able to use both roads along with public transportation.

Second, this simulator could be used in an interactive learning environment through which users or decision makers can address and understand the structure and the dynamics of the transportation system as a demand management policy being considered for implementation. The simulator uses a series of input boxes and buttons to convert an underlying complex mathematical model so that the user can have easy-to-operate screens where different functions are realized. They can also use the simulator to challenge their mental models. Through revising their assumptions and proposed policies, the policy makers can have a better understanding the dynamic impact of proposed policy implementations over time.

Most travel demand management policies influence the quality of life of people within the affected areas. Moreover, the acceptability of a travel demand management policy for a specified area is initially determined by the political support from the government of that area. In order to get governmental support, the researchers of relevant policies need to persuade the politicians to accept these policies and push for their implementation. The simulator can act as a

visual mechanism that demonstrates the benefits of employing a travel demand management policy. The benefits could consist of the mitigation of the level of traffic congestion, improved mass transit capacity, and improved mobility of affected people, etc. Without using verbose statements, the simulator can graphically show the aforementioned benefits.

3.1 The Development of the Management Flight Simulator

Having presented the objectives of developing the management flight simulator for travel demand management policy, this section provides an overview of the tasks followed during the development of the simulator (Figure 5.1).

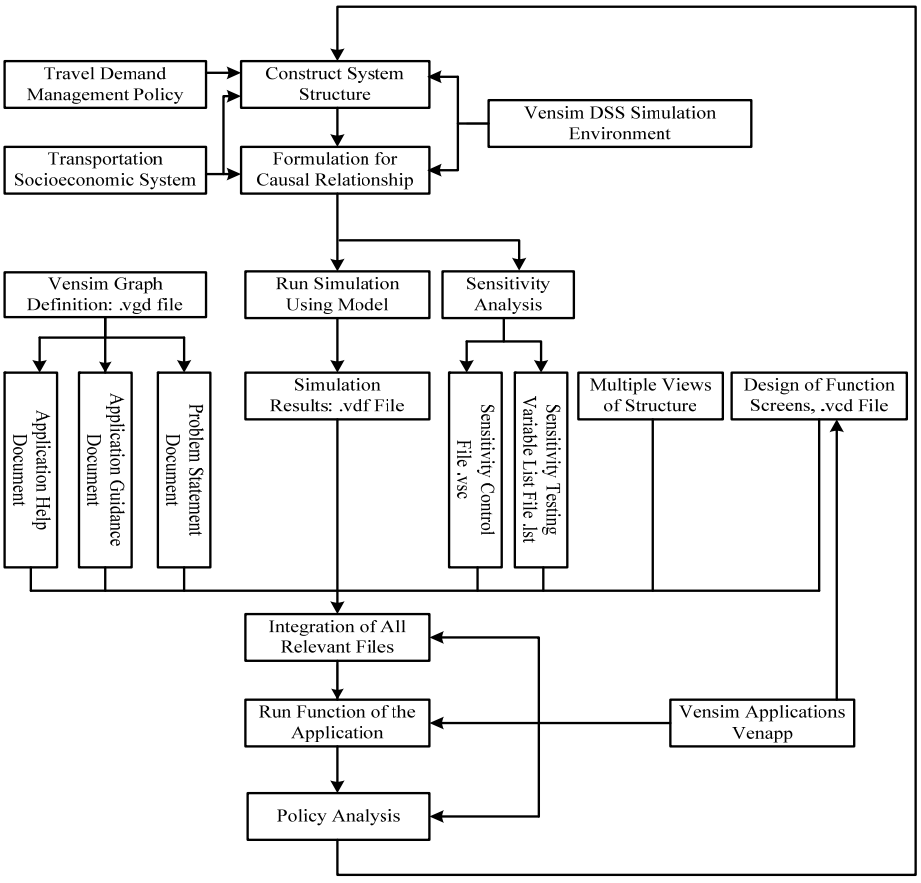


Figure 5.1: The Development of the Management Flight Simulator

According to the characteristics of the transportation system and the travel demand management policies, the system structure is constructed in the Vensim Simulation Environment. Thereafter, equation formulations characterizing the relationships between variables are provided. After finishing the compilation of equations, the next step is to test the simulation function of the

model by running the model. By assigning the value for different parameters, the sensitivity analysis is also completed. The results for both the basic and sensitivity runs are saved in .vdf (Vensim Dataset File), .vsc (Vensim Sensitivity Control File), and .lst (Vensim Sensitivity Variable Save List File) formats respectively.

Then, several tasks are carried out concurrently. One of these tasks is to design the screen layout in the Vensim Applications Environment (Venapp), which contains a series of buttons and input boxes. The second task is to document the problem statement, the application guidance, and application help files in the form of .vgd (Vensim Text Graph Definition). The other task is to build the multiple views of the system structure, which address some specific feedback loops. Having done these tasks, the next step is to integrate all the above-built applications into the management flight simulator. The following step involves using the simulator to do model simulation and sensitivity analyses. The last but not least task is the policy analysis using this application.

Therefore, the management flight simulator for travel demand management policy evaluation is a Vensim Simulation Environment-based software application that employs the Venapp function to develop an easy-to-use interactive learning platform. It can exhibit multiple views of the system structure. Due to the size of the system structure, it is not possible to see the system structure in one view. Therefore, here, we choose to isolate several feedback loops to show the tenet of the system structure. This simulator allows users to do simulation and complete policy analysis and sensitivity analyses under different parameter assumptions and policy scenarios. This application also possesses functions that allow users to do causal tracing of variables and comparison of different variable behaviors for multiple runs.

3.2 Insights from Developing the Current Management Flight Simulator

The development of an easy-to-use interactive learning platform faces multiple challenges since the primary objective of building a simulator is to have the clients accept it. Further, there are many software applications in the market or incubators waiting for field experimentation. The following insights were obtained during the development process.

First was the selection of the key performance indicators that need to be used by the simulator. These indicators should arise from the problem definition and should reflect the major issues. Even if there are many “important” indicators, it is best to choose just 5 to 8

factors on one screen. Otherwise, the screen looks messy. Similarly, the selection of important assumptions and policies is equally difficult and one should focus on the most reasonable ones that are represented by the input boxes on the evaluation screen. Having too many assumptions and policies visually provides the users with a very complex picture to work from. Therefore, just like the dashboard of a vehicle, it is necessary to choose critical factors to monitor and observe.

The second issue is to design and emphasize the interactivity when it is being used. The application cannot have the user input too many parameters. The layout of the buttons and boxes should lead users to where they want to go. The definition of the names for the buttons and boxes should not be ambiguous. For each click on the screen or the button, there should have appropriate response and prompts. The layout of the buttons should allow the users to visit the desired screen in the shortest time. The other issue is the adaptability of this simulator. This means that it should easy to integrate new policies, a changed system structure, new key performance indicators, assumptions, and policy variables.

4.0 Policy Analysis and Key Insights

In this section, results under different scenarios will be compared with a base case simulation described in detail by Liu and Triantis (2007). All the initial values on the screen in the Management Flight Simulator for Travel Demand Management Policy are the values used in the base case. We will also compare the results in the case where travel demand management policies are not implemented. However, it is not possible to explore all potential combinations of assumptions and policies due to the enormous number of possible permutations. Therefore, in this paper, we present some rather straightforward combinations. In order to have relatively consistent results, the average traffic flow that represents the level of congestion for a cordon-based metropolitan area is selected as the comparison dynamic variable. We also compare the results obtained with different scenarios with the results obtained when travel demand management policies are not integrated into the system structure.

In this model, social networking activities generate continuous travel demand and are affected by the people's perception with respect to the ratio of supply to emand of mass transit as well as traffic congestion. Therefore, social networking activities reflect the dynamics of the demand side for travel. In the first case, we choose the variables related to social networking

activity, which involve two constant variables, i.e. sociability (contact(s) per passenger per day) and fruitfulness of incurring mobility (dimensionless, how individuals' perceptions can affect their mobility). It is assumed that other variable values do not change when we change these two variables. Please refer to Table 5.1 for the initial values and the change settings. In this table, V1 and V2 represent the variables sociability and fruitfulness of incurring mobility respectively.

Table 5.1: Parameter Value Settings for Sociability (V1) and Fruitfulness of Incurring Mobility (V2) with the Implementation of the Travel Demand Management Policy

Scenarios	Scenario1		Scenario2		Scenario3		Scenario4		Scenario5	
	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2
Parameter Values	1	0.0005	0.5	0.0005	1	0.00025	0.5	0.00025	1.5	0.0008

Under the designated values, the behavior of the average traffic flow is displayed in Figure 5.2. The upper and lower lines of the designated areas represent the weekday and weekend behaviors of average flow rate since there it is assumed that there are no work trips and congestion pricing during weekend. Scenario 5 has the largest average flow rate (the worst congestion level) because it has the largest value settings for sociability and fruitfulness of incurring mobility. However, scenario 4 has the lowest average flow rate (the best level of congestion) as the above-mentioned two variable bear the lowest value among those five scenarios. More importantly, the average flow rate under scenario 4 tends to decrease over time. Under scenarios 2 and 3, average flow rate has nearly the same behavior. This means that reducing the value by the same percentage for both parameters has same effect on the behavior of average flow rate. Furthermore, with the reduced value in sociability and fruitfulness of incurring mobility, the average flow rate tends to be less under scenarios 2 and 3 than that of scenario 1. Therefore, as expected one can conclude that the congestion is mitigated if people tend to have less social networking activities. However, reduced mobility means that the quality of life declines.

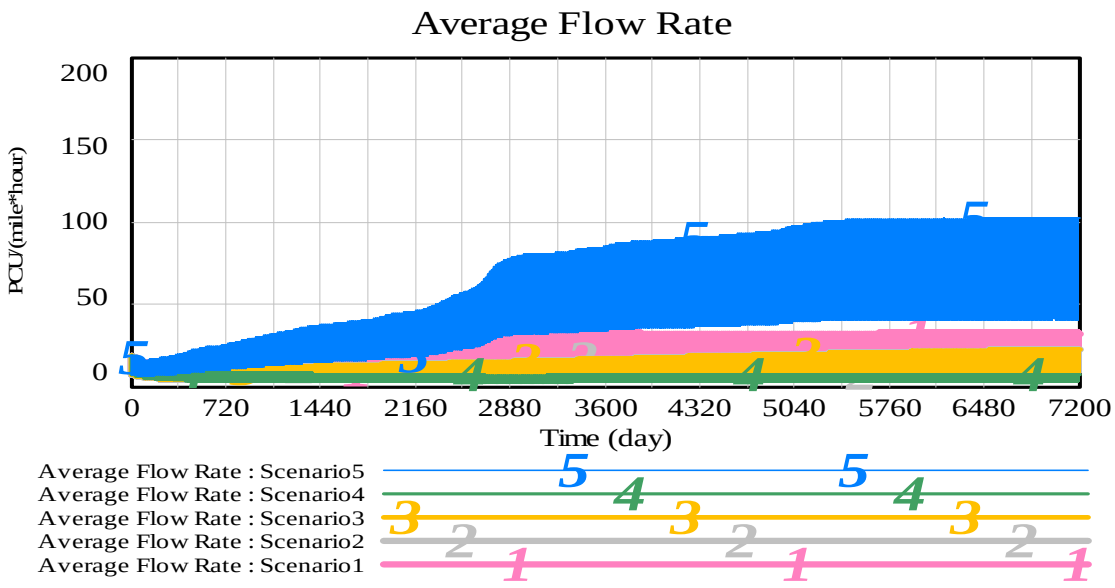


Figure 5.2: Average Flow Rate under Five Different Scenarios Representing Social Networking with the Implementation of the Travel Demand Strategy

Next, we compare the behavior in Figure 5.2 with the situation without travel demand policy being integrated in the system structure. In Table 5.2, we evaluate three scenarios corresponding to scenarios 1, 4, and 5 in Table 5.1.

Table 5.2: Parameter Value Settings for Sociability (V1) and Fruitfulness of Incurring Mobility (V2) in the Case without the Implementation of the Travel Demand Management Policy

Scenarios	Scenario 1		Scenario 4		Scenario 5	
	V1	V2	V1	V2	V1	V2
Parameter Values	1	0.0005	0.5	0.00025	1.5	0.0008

Figure 5.3 displays the behaviors of average flow rate under the three scenarios of Table5.2 in the case where travel demand management policy is not implemented. For scenario 5, one can recognize that the increased value of the social networking activities related parameters has more impact on the congestion level in the case with the implementation of the travel demand management policy as opposed to the case where it is not implemented. Referring to scenario 4, the average flow rate when the policy is not implemented is larger than when it is implemented. This is because the improved mass transit capacity can offset the continuous demand for travel before the carrying capacity of mass transit is reached. However, without the

travel demand management policy, the normal funding for improving mass transit capacity is very small as compared with the case with the implementation of the travel demand management policy. Therefore, even though mass transit capacity increases, apparently, it is not an effective "adjuster".

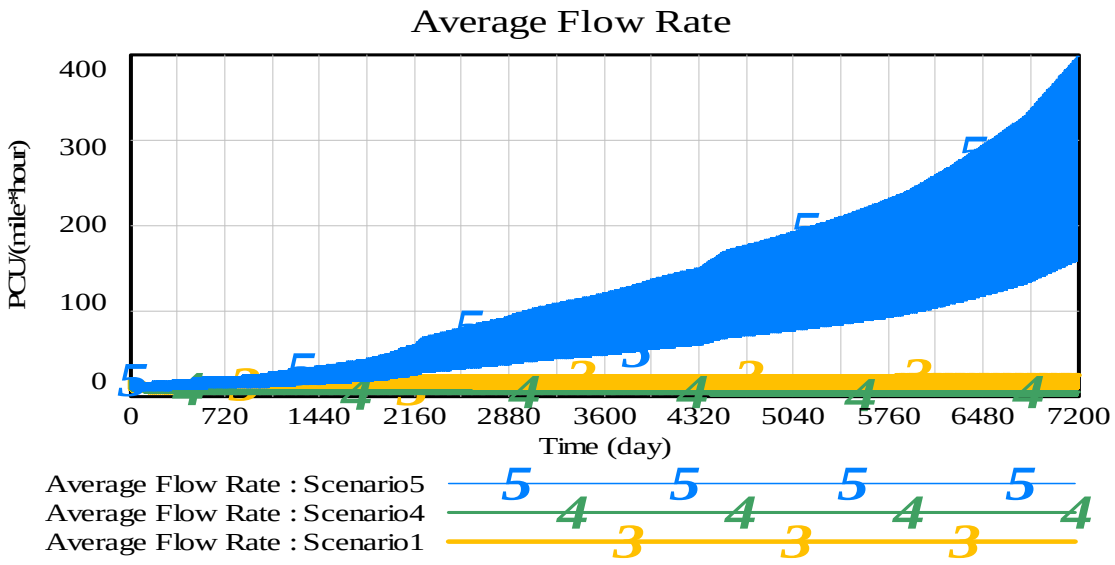


Figure 5.3: Average Flow Rate under Three Different Scenarios without the Implementation of the Travel Demand Management Policy

As one knows, the provision of transportation infrastructure is to improve mobility and the quality of life. *"These moments of physical copresence and face-to-face conversation, are crucial to patterns of social life that occur 'at-a-distance', whether for business, leisure, family life, politics, pleasure or friendships"(Urry, 2003, p. 155).* Consequently, the social networking activities are important indicator of the quality of life. People are typically widely geographically distributed. Thus, people have to travel long distances to have face-to-face meetings (Axhausen, 2002). In the above analysis, it seems that the travel demand management policy worsens traffic congestion. The real reason is that the abundant funding from congestion pricing scheme boosts the capacity of mass transit that stimulates the need for more travel. The initial improved quality of life encourages the use of improved travel conditions. As a result, the continuous demand for travel worsens the traffic situation which in turn reduces the quality of life in the long run.

Having made analysis with respect to the demand side, the ensuing discussion addresses the effect of the mass transit supply on the average level of congestion. First of all, we need to

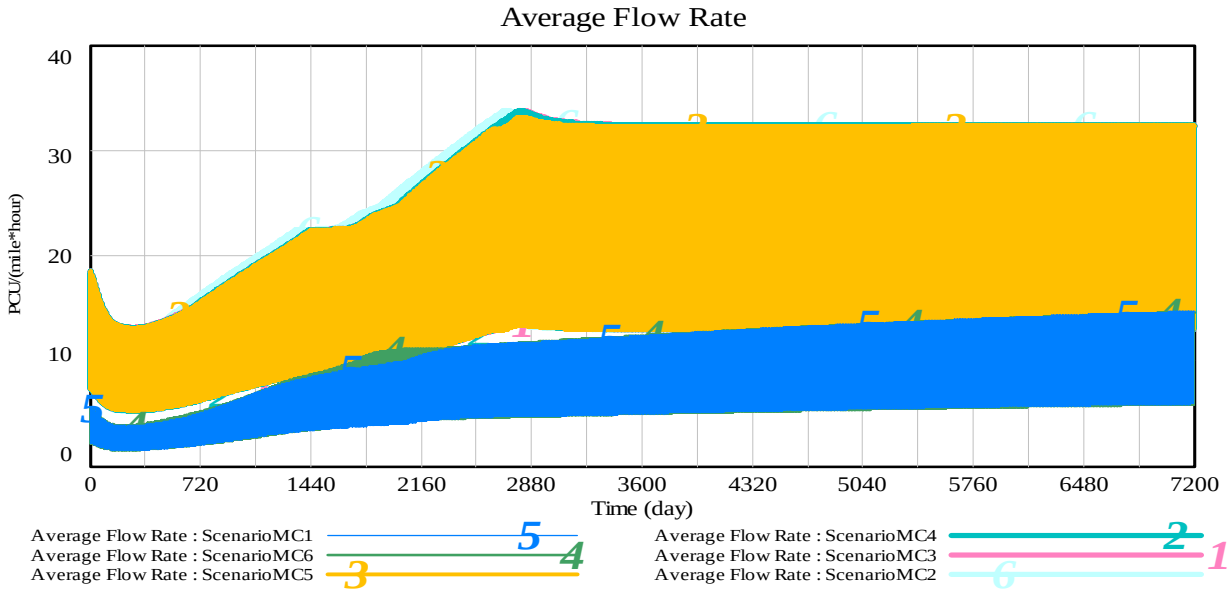
examine the effect of increased metro rail car capacity on the congestion level since metro rail has the trait that the increased supply of metro rail does not contribute to the total PCUs running on the road surface within the cordon-based metropolitan area. It is assumed that other factors except those in the proposed scenarios do not change. Several factors related to metro rail need to be considered, i.e., the carrying capacity for a metro rail car, life time expectancy of a metro rail car, average passenger per metro rail car per hour, delay associated with the building of metro rail capacity, and the metro rail car price. As we consider the metro rail car capacity, several scenarios address the proportion of money being distributed to metro, bus capacity, and trail capacity. Please refer to Table 5.3 for the scenarios. In this table, we adopt six scenarios in which one scenario uses the initial parameter settings of the model. The other scenarios take into account the augmentation of metro rail carrying capacity, the increase of metro rail car life time expectancy, reduced metro rail car price, reduced delay associated with building of metro rail capacity, the increase as well as the decrease of fraction of revenue distributed to bus. In scenario 6, we consider the expansion of the total lane miles within the cordon based metropolitan area.

Table 5.3: Parameter Value Settings for Metro Rail Related Parameters and the Revenue Distribution Fraction for Mass Transit with the Implementation of the Travel Demand Management Policy

Scenarios	Carrying Capacity	Life Time	Average passenger	Price of Metro Rail Car	Building Delay	Bus Fraction	Trail Fraction	Total Lane
Scenario1	1500	7200	68	1Million	3600	0.4	0.1	1500
Scenario2	5000	7200	150	0.5 Million	1800	0.4	0.1	1500
Scenario3	5000	7200	150	0.5 Million	1800	0.6	0.05	1500
Scenario4	5000	7200	150	0.5 Million	1800	0.1	0.05	1500
Scenario5	8000	10800	150	0.5 Million	1000	0.1	0.05	1500
Scenario6	8000	10800	150	0.5 Million	1000	0.1	0.05	5000

Figure 5.4 exhibits the behaviors of average flow rate under the six different scenarios. In Figure 5.4, the average flow rate does not change much under scenarios 1, 2, 3, 4, and 5 because the increased demand is almost exactly met by the increased metro rail capacity. However, in scenario 6, it is assumed that total lane miles within the cordon based area have been increased from 1500 to 5000 miles. This to a great extent reduces the traffic congestion. Nevertheless, the

trend of average flow rate still goes up due to increased travel demand stimulated by the improved mass transit capacity and traffic situation.



Figur 5.4: Behaviors of Average Flow Rate under Six Different Scenarios with the Implementation of the Travel Demand Management Policy

Next, we consider four scenarios in Table 5.4. Figure 5.5 displays the average flow rate under aforementioned four (1, 2, 5 and 6) scenarios in the case without travel demand management policy being integrated into the model. The selected values do not change from what they are in Table 5.3. Please refer to Figure 5.5 for the average flow rate under the designated scenarios in Table 5.4.

Table 5.4: Parameter Value Settings for Metro Rail Related Parameters and Distribution Fraction for Mass Transit without the Implementation of the Travel Demand Management Policy

Scenarios	Carrying Capacity	Life Time	Average passenger	Price of Metro Rail Car	Buildup Delay	Total Lane
Scenario1	1500	7200	68	1Million	3600	1500
Scenario2	5000	7200	150	0.5 Million	1800	1500
Scenario5	8000	10800	150	0.5 Million	1000	1500
Scenario6	8000	10800	150	0.5 Million	1000	5000

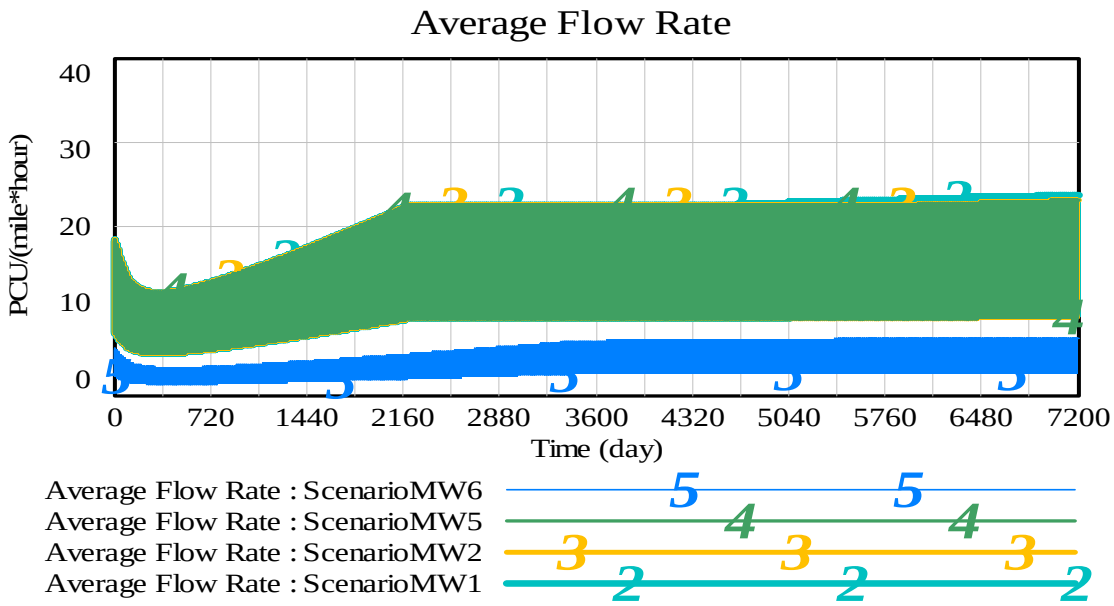


Figure 5.5: Behaviors of Average Flow Rate under Four Different Scenarios without the Implementation of the Travel Demand Management Policy

Under scenarios 1, 2, and 5, the average flow rate nearly exhibits the same behavior but less than the values in Figure 5.3. Scenario 5 in Figure 5.5 reveals the reduction in the level of traffic congestion, which is similar to the situation in Figure 5.3. Likewise, at the same time point the average flow rate under scenario 5 in Figure 5 is smaller than that of in Figure 5.3. The reason is still due to the fact that the improvement of mass transit stimulates new demand for different transportation modes thus deteriorating traffic congestion.

In the previous discussion, we discovered that the supply of metro rail does not contribute to the congestion on the surface traffic congestion. The other benefit of increased metro rail car capacity is that the increased capacity can handle very large mass transit demand. Next, four scenarios are designed to find out how the improved trail and bus capacity affect the traffic congestion level. However, the advocacy of increased bus capacity is a double-edge sword. On one hand, bus has the advantage of holding many more passenger than of sedan and/ or SUV vehicles. One the other hand, the increase of bus capacity running within the cordon-based metropolitan also contributes to the surface traffic congestion. We compare the behaviors of average flow rate in the case with and without the implementation of the travel demand management policy.

Table 5.5: Parameter Value Settings for Bus and Trail Related Parameters with the Implementation of the Travel Demand Management Policy

Scenarios	Scenario1	Scenario2	Scenario3	Scenario4
Bus Carrying Capacity	1500	3000	8000	8000
Trail Carrying Capacity	200	500	1000	1000
Total Lane Miles	1500	1500	1500	5000
Bus Life Time	3600	5400	5400	5400
Trail Life Time	5400	7200	7200	7200
Fraction for Bus	0.4	0.4	0.5	0.5
Fraction for Trail	0.1	0.1	0.1	0.1
Average Passenger/Hr/B	45	60	60	60
Average Passenger Flow Rate for Trail	30	45	45	45
Buildup Delay for Bus	540	360	360	360
Buildup Delay for Trail	1800	900	900	900

In the scenarios of Table 5.5, scenario 1 represents the initial values of the model. Starting from scenario 2, the carrying capacity and life time for both bus and trail are increased while the delays associated with the building of new capacity are reduced. Scenarios 3 and 4 have similar value settings except that the total lane miles are amplified in scenario 4. Based on the different scenario settings in Table 5.5, Figure 5.6 provides the behavior of average flow rate accordingly.

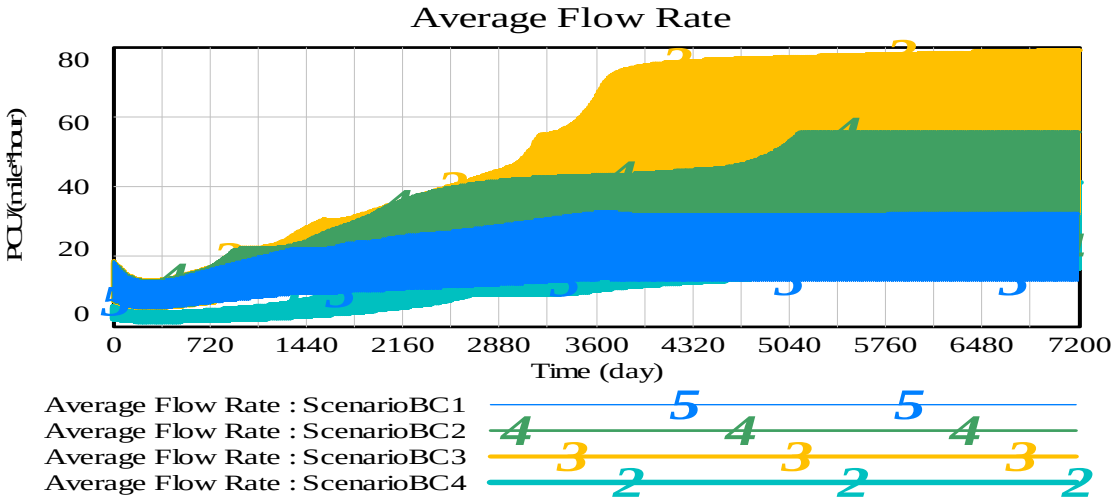


Figure 5.6: Average Flow Rate under Four Different Scenarios with the Implementation of the Travel Demand Management Policy

Obviously, scenario 3 produces the most severe traffic congestion because this scenario has increased bus and trial capacity without increasing the assumed total lane miles within the cordon-based metropolitan area. Scenario 2 has the second highest average flow rate because the value settings for bus carrying capacity is less than that of scenario 3. The total lane miles are not increased in scenario 2 either. Compared with scenario1under the initial value settings the average flow rate is higher in scenario 2 and 3 than that of in Scenario1. The reason is still due to the induced mass transit demand with the increases of the bus capacity. The average flow rate under scenario 4 is lower than that of scenario 1 approximately before time 4320. After time point 4320, average flow rate under scenario 4 is larger than that of scenario 1. This is due to the decreased level of congestion creating the demand for different transportation modes. Thus, this affects the average flow rate negatively.

In the ensuing discussion, we provide the values for the four scenarios in Table 5.6 since we wish to compare to the behavior of average flow rate in the case without the implementation of the travel demand management policy. Please refer to the scenarios in Table 5.6 and Figure 5.7.

Table 5.6: Parameter Value Settings for Bus and Trail Related Parameters without the Implementation of the Travel Demand Management Policy (Bus and Trail Supply)

Scenarios	Scenario1	Scenario2	Scenario3	Scenario4
Bus Carrying Capacity	1500	3000	8000	8000
Trail Carrying Capacity	200	500	1000	1000
Total Lane Miles	1500	1500	1500	5000
Bus Life Time	3600	5400	5400	5400
Trail Life Time	5400	7200	7200	7200
Average Passenger/Hr/B	45	60	60	60
Average Passenger Flow Rate for Trail	30	45	45	45

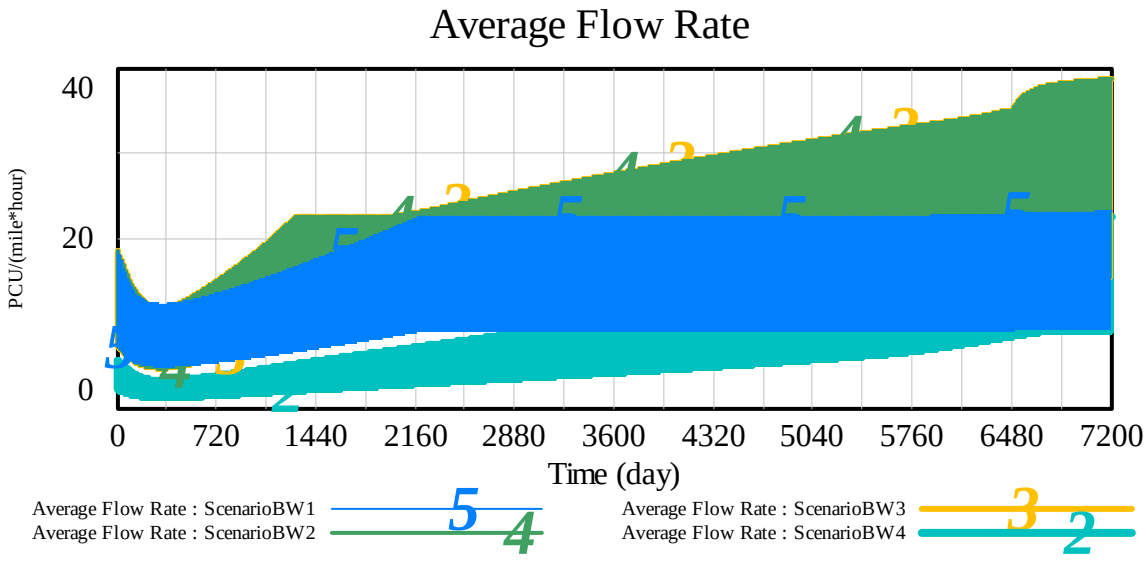


Figure 5.7: Average Flow Rate under Four Different Scenarios without the Implementation of the Travel Demand Management Policy (Bus and Trail Supply)

The value of average flow rate for each scenario in Figure 5.7 is lower than that of in Figure 5.6. Therefore, compared with the case where the travel demand management policy is not implemented, the improved mass transit capacity induces more demand and exacerbates congestion.

In order to validate the above statement, during the next task we investigate if the increased mass transit capacity really induces more demand for different transportation modes. We use three variables to illustrate the case, which are the conversion rate, total metro rail demand, and switching from car to metro rail. The conversion rate is the rate that changes the potential passengers to passengers for a cordon based metropolitan area. The conversion rate is affected by the people's perception with respect to the ratio of mass transit supply to demand.. Total metro rail demand is determined from new demand and from the switching behavior of individuals from other transportation modes. In the model, we simultaneously investigate how the improved mass transit capacity can affect the switching behavior of people. Since there is adequate funding from the congestion pricing scheme, the designated range of carrying capacity for mass transit can always be reached. Table 5.7 offers value settings for three scenarios so as to investigate how the improved mass transit capacity changes the behaviors of the conversion rate, total metro rail demand, and switching from car to metro rail. Figures 5.8, 5.9, and 5.10

show the behaviors of the conversion rate, total metro rail demand, and switching from car to metro rail respectively under three scenarios provided in Table 5.7.

Table 5.7: Value Settings for Mass Transit Related Parameters for Testing Inducement of Mass Transit Demand by Increase Mass Transit Capacity

Scenarios	Scenario1	Scenario2	Scenario3
Metro Rail Carrying Capacity	1500	3000	6000
Bus Carrying Capacity	1500	3000	6000
Trail Carrying Capacity	200	500	1000

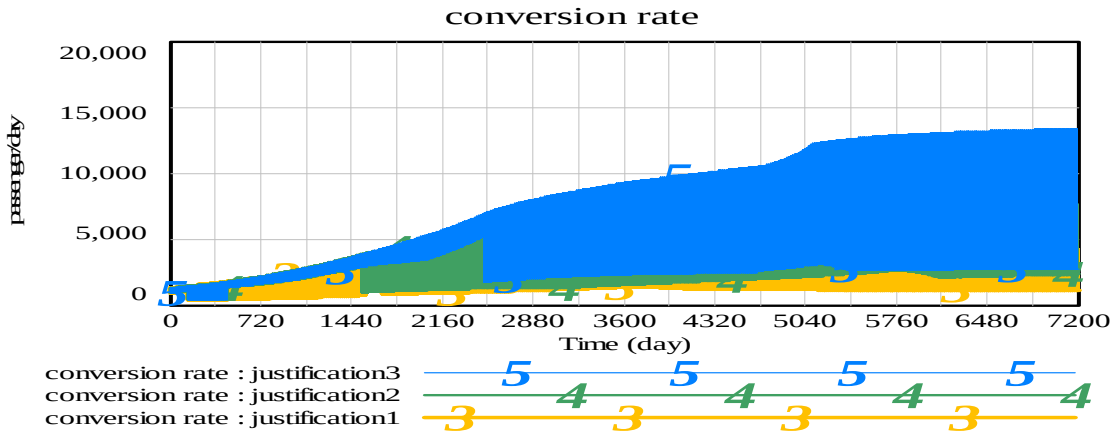


Figure 5.8: Conversion Rate under Three Designated Scenarios

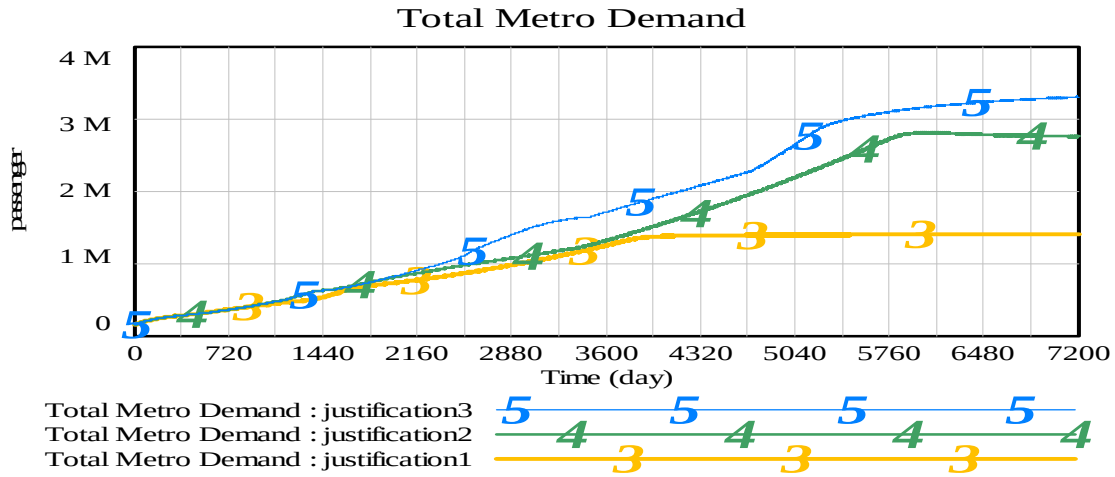


Figure 5.9: Total Metro Rail Demand under Three Designated Scenarios

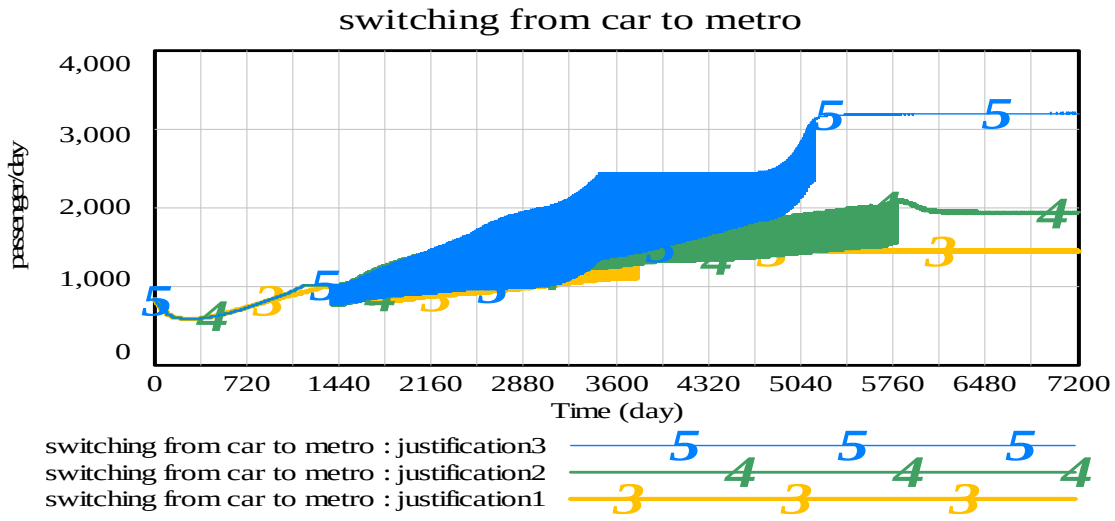


Figure 5.10: Switching from Car to Metro for the Three Designated Scenarios

Note: the upper line means the weekday result and lower line denotes the weekend result.

Apparently, from Figures 5.8, 5.9, and 5.10, one can see that the values of the three variables, i.e. conversion rate, total metro rail demand, and switching from car to metro rail increase with the improved mass transit capacity. This result validates the aforementioned statement that the increased mass transit capacity stimulates more demand for the mass transit. Moreover, the increase in mass transit capacity also encourages the switching from private car to mass transit.

From the analysis, one can find that the improved mass transit capacity actually induces more demand from potential social networking activities. In the long term, the proposed travel demand management policy (congestion pricing, mass transit improvement and subsidization of local resident) deteriorates the traffic congestion over time. There are several scenarios which have potential to mitigate traffic congestion. One scenario is to reduce the social networking activities without affecting quality of life, which could be realized through telecommuting, mobile service, teleconference, and enhancement for function of local community. That is say that the government tries to provide more facilities to let people have more virtual "co-presence" instead of unnecessary face-to-face contact which induces the mobility need. The other scenario is to invest more money on the metro rail because it does not increase the total PCUs within the cordon-based metropolitan area. The last but not the least one is that the policy makers should encourage the appropriate increase of bus capacity (not fast, it does increase the total PCUs), fast

increase of metro rail, and the expansion of road capacity (overbridge or underground tunnel) of metropolitan area.

5.0 Conclusions and Future Research

This paper provides an overview of the development of a management flight simulator for travel demand management policies such as congestion pricing among others. Afterwards, the management flight simulator is employed to explore possible policies associated with parameter assumptions. We explore parameter variations related to social networking activities, increase in metro, bus, and trail capacities, and revenue distribution for bus and trail capacity improvement. The impact of these parameter variations on the average level of traffic congestion measured as average traffic flow is provided. For these scenarios, we compare the situation where the traffic demand management policy is implemented versus the situation where it is not.

From the simulation results, it is found that the improved mass transit capacity induces more demand for different transportation modes. The implementation of traffic congestion charging provides funding for the improvement of mass transit capacity for the designated cordon-based metropolitan area. The improved mass transit capacity encourages more demand for the social networking activities which in turn stimulates the mobility needs for different transportation modes. Thus, the implementation of the travel demand management policy ultimately leads to the deterioration of traffic congestion for the designated area.

We also explore three scenarios associated with the conversion rate, total metro rail demand, and switching from car to metro rail. The results indicate that the implementation of travel demand policy actually acts as a double-edge sword. The increased mass transit capacity stimulates more demand for the mass transit. Moreover, the increase in mass transit capacity also encourages the switching from private car to mass transit. So within the same strategy, one can both increase and decrease average traffic congestion.

Practitioners and researchers can extend this management flight simulator to evaluate other transportation related policies. One could integrate a new policy into the system structure by having appropriate changes to the system structure. The other possible extension is to do policy analysis using available data (such as congestion charging data from Stockholm, London, and Singapore). More importantly, this management flight simulator can work as an evaluation tool for the metropolitan area in which the travel demand management policy is not implemented.

The decision maker can have a better understanding for the dynamics of transportation system by testing their assumptions and scenarios.

Moreover, one possible consideration is to integrate this management flight simulator into existing transportation Decision Support Systems (DSSs). The other thought is integrate the current simulator with Intelligence Transportation System (ITS) or Geographic Information System (GIS) systems by obtaining real time data to do real-time analyses. Another possible extension to current management flight simulator is to incorporate additional sectors including but are not limited to land use, environment, and economy, etc.

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Appendix A: Overview of System Dynamics

AA.1 Overview of System Dynamics

The major theme of modern times is change. Due to the accelerating changes in every corner of the society, our world is experiencing the transformation from the tangible-the consequence of modern communication technology on the way people work to the profound-the effect of greenhouse gases on the global climate. These changes in many respects are either wonderful to the world by improving overall social welfare or evil to the humanity by threatening the survival of human beings. All of the humankinds' conventional belief, value concepts, and institutions are being challenged. However, most of these changes are due to consequences of the intended and unintended interventions of people themselves to the system in which they reside. Every now and then, good-will efforts to address emerging problems result in policy resistance, where the constituted policies are delayed, diluted, or beaten by the unpredicted reactions of other people or of nature. More often than not, the best efforts of human beings to solve a problem actually make it worse. Therefore, exploring new ways of thinking and acting becomes the major career pursuit of a steady stream of philosophers, management gurus, and scientists. Among those scholars, many of them advocate the development of system thinking which promote the outlook of viewing world as a complex system, in which things are not independent and interacting with each other. With a holistic worldview, people could take action in harmonious with the long-run best interests of the system as a whole. High leverage points could be identified and policy resistance could be avoided accordingly. Nevertheless, for each field from a small organization to the whole planet as a whole, applicable tools and processes about system thinking are needed to help people understand the complexity and initiate better operational interventions to systems which they are interested in.

System Dynamics is a methodology to boost learning in complex system, which was pioneered by Dr. Jay W. Forrester in 1950s. During that period, he applied the concepts and theory of system dynamics to various systems. Those application experiences lead to the birth of 3 masterpieces in System Dynamics, which are Industrial Dynamics (1961, Forrester), Urban Dynamics (1969, Forrester) and World Dynamics (1971, Forrester). Thereafter, with the extensive exploitation in system dynamics, this methodology is coming to consummation. Those scholars include but not limited to Graham, A. (1977), Senge, P.(1980s, 1990s), Homer,

J.(1970s, 1980s, 1990s), Meadows, D.L. (1970s,1980s.1990s), and Sterman, J. (1980s, 1990s, 2000s).

With system dynamics, people can easily comprehend the structure and dynamics of a complex system. As a rigorous modeling methodology, system dynamics enables users to execute formal computer simulations for complex system and employ them to design more effective policies and create efficient organizations. The major advantage of using this method is to create management flight simulator by which space and time can be compressed and slowed so that decision makers can experience the long-run side effects of different decisions, speed learning, develop their understanding of complex systems, and design structures and strategies for greater success.

System dynamics is rooted in the theory of non-linear dynamics and feedback control developed in mathematics, physics, and engineering. The modeling process of system dynamics is to locate and characterize the feedback process. Actually, most of patterns of system behaviors are due to the interactions (feedbacks) among the subsystems and components of the system, not coming from the complexity of subsystem and components themselves. All dynamics of system behavior hail from the interactions of only two types of feedback loops positive (or self-reinforcing) and negative (or self-correcting) loops.

Appendix B: Fuzzy Set Theory

AB.1 Fundamentals of Fuzzy Set Theory

Fuzzy set theory was first put forth by Zadeh in 1965. Fuzzy set is "a class with a continuum of grades of membership" (Zadeh, 1965). In the concept, it is a generalization of a classical set where an element either belongs or does not belong to the set. Dr. Zadeh (1965) gave the mathematical definition for fuzzy set as follows. Let X be a space of pints (objects), with a generic element of X denoted by x. Thus, X={x}. A fuzzy set (class) A in X is characterized by a membership (characteristic) function $\mu_A(x)$ which associates with each point in X a real number in the interval [0,1], with the value of $f_A(x)$ at x, i.e. A={x, $\mu_A(x)$}.

In reality, there exit many uncertainties, vagueness, and imprecision which cannot be quantified by conventional mathematical theory. Especially, the linguistic information in daily life of human has too many subjective aspects to be modeled. Within the past forty years, all kinds of theories were explored to explain the uncertainty phenomena. These theories include but not limited to: Fuzzy set theory (Zadeh, 1965, 1996; Klir and Folger, 1988; Zimmermann, 1991; Kosko, 1992b; Bezdek and Pal, 1992, Bezdek, 1993, 1994), evidence theory (Shafer, 1976), imprecise probabilities (Kruse and Meyer, 1987), possibility theory (Dubois and Prade, 1988), rough sets (Pawlak, 1991), and fuzzy measures (Wang and Klir, 1992).

Appendix C: Data

AC1 Data Collection Sources

The following sources are the major resources for collecting all research related data. These data include demographic, economic indicator, environmental, passenger travel, and transportation planning and development data. The model development and application are actually to be limited due to data availability.

1. http://factfinder.census.gov/servlet/ACSSAFFFacts?_event=Search&_lang=en&_sse=on&geo_id=04000US11&_state=04000US11
   U.S. Census Bureau, District of Columbia
   - Demographic, Social, Economic, and Housing Characteristics
   - population, demographic, and housing information
   - Population Projections to 2030

2. http://brc.dc.gov/resources/facts.asp (Market Facts and Statistics)
   District of Columbia (The Washington, DC Government Main Web Site)
   - Census data
   - Economic Indicators
   - DC by the numbers
   - Labor market information

3. http://dcgis.dc.gov/dcgis/site/default.asp
   District of Columbia Geographic information System
   - Environmental
   - Public Safety
   - Real Property
   - Transportation
   - Socioeconomics and demographics
   - Planning and economic development

4. http://www.bts.gov/publications/state_transportation_profiles/district_of_columbia/
   District of Columbia Transportation Profile
   - Registered vehicles and vehicle miles traveled
   - Employment

- Environment
- Passenger travel

5. http://www.trbcensus.com/

   Census Data for Transportation Planning

6. http://www.dot.gov/ctpp
   US DOT Website that provides the Census Transportation Planning Package (CTPP):

7. http://www.trbcensus.com

   TRB Census Subcommittee Website:

8. http://www.fhwa.dot.gov/planning/census/

   Transportation Planning related Census Issues:

9. http://www.transtats.bts.gov/

   CTPP 1990 and CTPP 2000 access via BTS (Bureau of Transportation Statistics)

10. http://www.census.gov/population/www/socdemo/journey.html
    Census Bureau Journey to Work Website:

11. http://www.census.gov/population/www/cen2000/commuting.html

    County Flow Data

12. http://www.census.gov/main/www/cen2000.html

    Census 2000 Gateway:

13. http://factfinder.census.gov/
    American Fact Finder:

14. http://www2.census.gov/census_2000/datasets/

    FTP Site for SF 1, SF 3, and Demographic Profiles

15. http://www.census.gov/Press-Release/www/2003/PUMS5.html

    5% Public Use Microdata Sample (PUMS):

16. http://www.census.gov/Press-Release/www/2003/PUMS.html

    1% Public Use Microdata Sample (PUMS) files

17. http://www.census.gov/Press-Release/www/2001/sumfile1.html

    Summary File 1 (SF 1)

18. http://www.census.gov/Press-Release/www/2002/demoprofiles.html

    Demographic Profiles (DP)

19. http://www.census.gov/Press-Release/www/2002/sumfile3.html

    Summary File 3

20 http://www.census.gov/population/www/cen2000/SF3-pop.html and

http://www.census.gov/population/www/cen2000/SF3-housing.html
Table Specifications

21. http://www.census.gov/prod/cen2000/doc/

    Documentation for most Census Products

22. http://www.sdcbidc.iupui.edu/index.html

    A good source for Standard Products is the SDC/BIDC website

23. http://mcdc2.missouri.edu/data/pums2000/Readme.html

    Public Use Microdata Sample-2000 Census MCDC (Missouri Census Data Center)

    Filetype: pums 2000

24. http://www.census.gov/geo/www/tiger/index.html

    TIGER/Line 2000 files

25. http://www.census.gov/geo/www/cob/bdy_files.html
    "Generalized" Boundary files in different GIS formats:

    Note: "Generalized" files contain approximate boundaries. Data are stored as one file per geographic detail (e.g.: urbanized areas, TAZs (Traffic Analysis Zones) for the nation.

26. http://www.esri.com/data/download/census2000_tigerline/index.html

    ESRI Geography Network

Additionally, as part of the interface with both the Federal Highway Administration's Office of Transportation Policy Studies as well as with University of Virginia's Virginia Transportation Research Council's System Operations and Traffic Engineering Group, additional data resources will be sought. To the possible extent, group modeling sessions will be conducted with the involvement of both groups along with the Virginia Tech research group composed of researchers in the System Performance Laboratory and Advanced Transportation groups in Northern Virginia. At the very minimum, it is anticipated that both groups will be consulted in terms of the validation and verification of the models developed and the results achieved in this research.

Appendix D: Representation and Operation of Multiple Linguistic Variables in System Dynamics Model

AD1: VENSIM Representation of a Triangular Membership Function

Before defining the equations for the above stock flow diagram, an important concept should be illustrated. It is “Subscript” function in Vensim Ventana Professional Simulation Software Environment. The function of “Subscript” allows a variable represent several different concepts such as the feeling with respect to temperature which has three different characteristics as low, medium, and high. For details, please refer to pp. 241-256 in the Vensim User’ Guide.

The following window appears after clicking the [sub] on the top right of Vensim. The subscript name here is “feeling”. It is shown in figure AD.1.

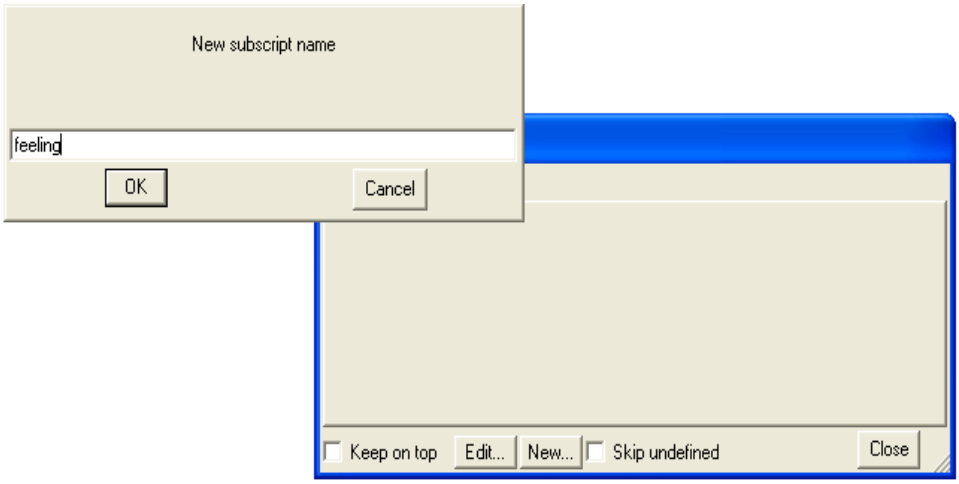

Figure AD.1: Subscript Definition for the Feeling on Temperature

After clicking “OK” button, the system let you define the characteristics of feeling, which are low, medium, and high shown in Figure AD.2. The characteristics appear in the Subscript Control windows as shown in Figure AD.3. The next step is to apply the subscript to the variables which need to be used. By choosing all required variables using shift-click and clicking the “Set Subscript”, the”feeling subscripts characteristics” will be applied to all selected variables. Please see the Figure AD.4.

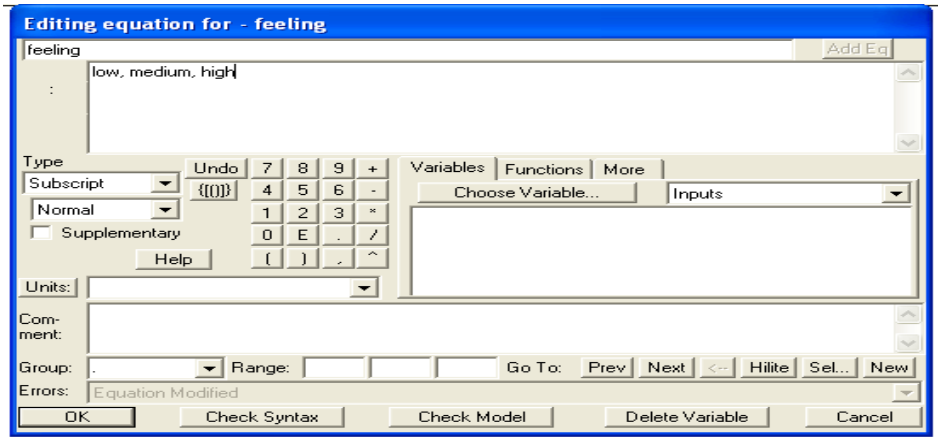

Figure AD.2: Characteristics of the Linguistic Variable

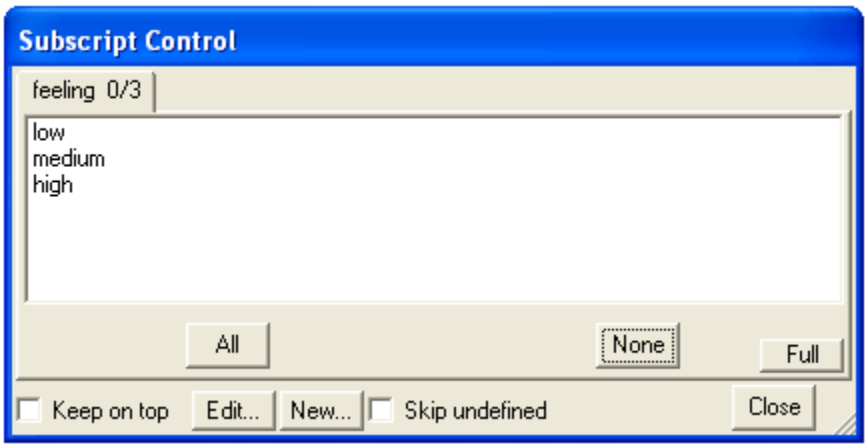

Figure AD.3: Subscript Control Window

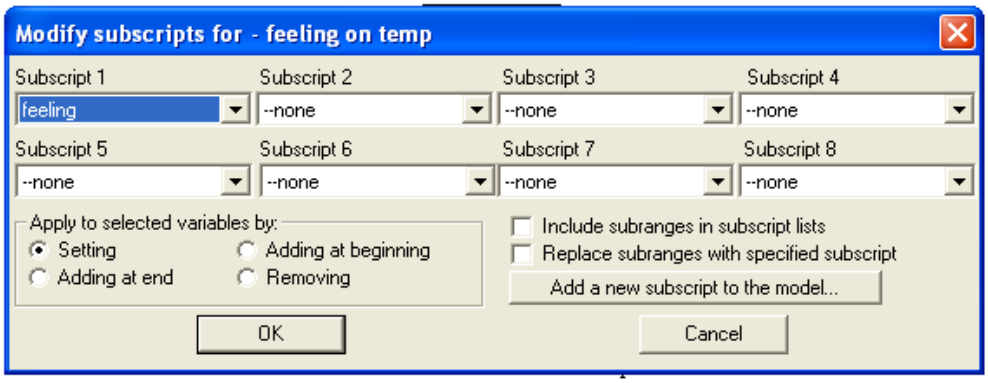

Figure AD.4: Applying the Subscripts to Relevant Variables

For the triangular membership function, the variables “starttemp, midtemp, and endtemp” denote the start, middle and end points of temperature range respectively, which possess the

array function. That is to say that one variable can have multiple values which are used for representing boundary points under different characteristics i.e. feel with respect to temperature low, medium, and high. The following Figure AD.5 shows how the “startemp” is defined. Three start points for the triangular function with characteristics low, medium, and high have to be assigned respectively. Similarly, values for “midstemp” and “endtemp” can be assigned.

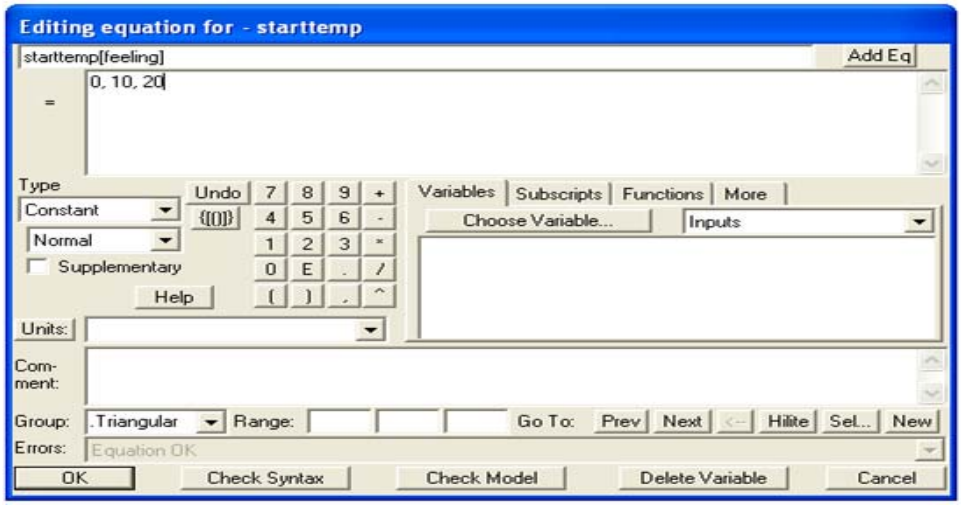

Figure AD.5: Boundary Definition for Startemp Variable

AD2: Trapezoidal and Bell-Shaped Membership Function

A: Trapezoidal Membership Function

Generic f (x; a, b, c, d) = $\mu_T(x) = \begin{cases} \dfrac{x-a}{b-a} & a \le x < b \\ 1 & b \le x < c \\ \dfrac{d-x}{d-c} & c \le x < d \end{cases}$ Equation AD.1

(Low) $\mu_{TL}(x) = \begin{cases} \dfrac{x-7.5}{7.5} & 0 \le x < 7.5 \\ 1 & 7.5 \le x < 12.5 \\ \dfrac{20-x}{7.5} & 12.5 \le x < 20 \end{cases}$ Equation AD.2

(Medium) $\mu_{TL}(x) = \begin{cases} \dfrac{x-10}{7.5} & 10 \le x < 17.5 \\ 1 & 17.5 \le x < 22.5 \\ \dfrac{30-x}{7.5} & 22.5 \le x < 30 \end{cases}$ Equation AD.3

(High) $\mu_{TL}(x) = \begin{cases} \dfrac{x-20}{7.5} & 20 \le x < 27.5 \\ 1 & 27.5 \le x < 32.5 \\ \dfrac{40-x}{7.5} & 32.5 \le x < 40 \end{cases}$ Equation AD.4

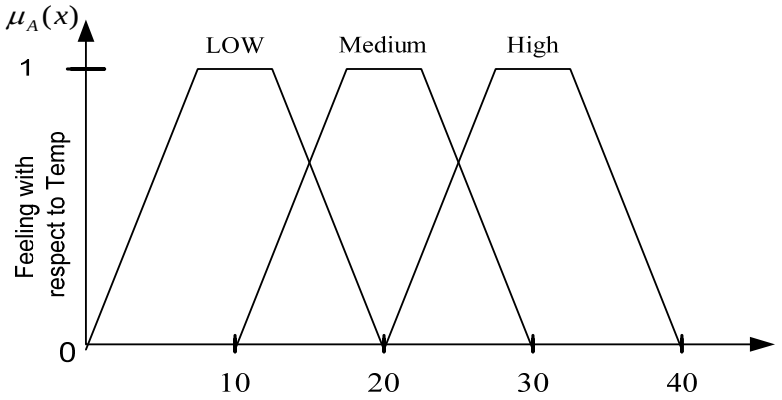

Figure AD.6: Representation of Linguistic Variable Using Trapezoidal Membership Function

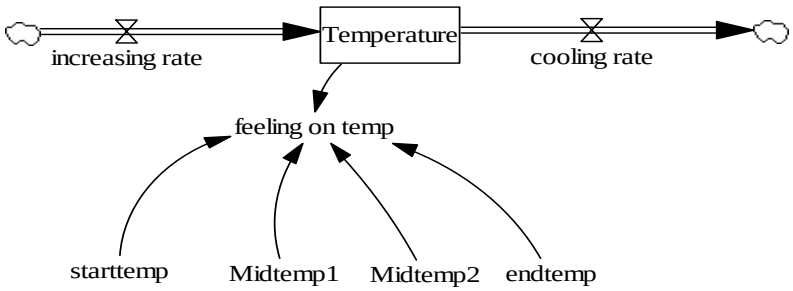

Figure AD.7: Stock Flow Diagram for Representing Trapezoidal Membership Function

Same temperature change behavior is showed in Figure 2.8. For the formulation, please refer to Appendix II.

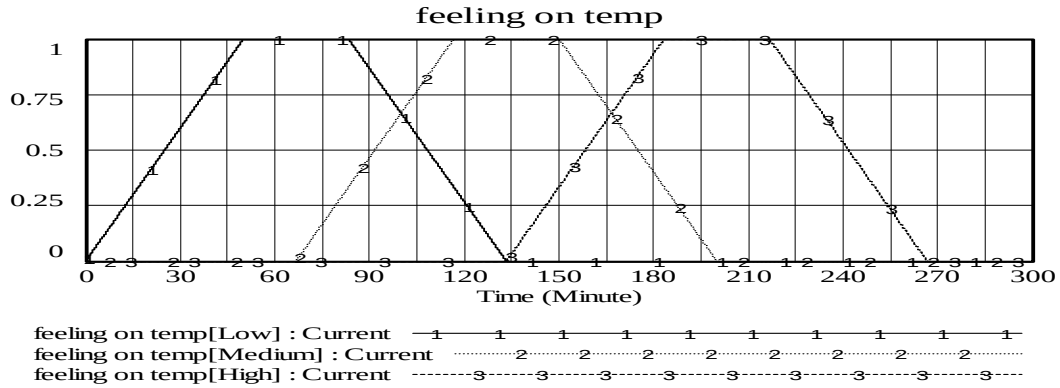

Figure AD.8: Simulation Result for Trapezoidal Membership Function

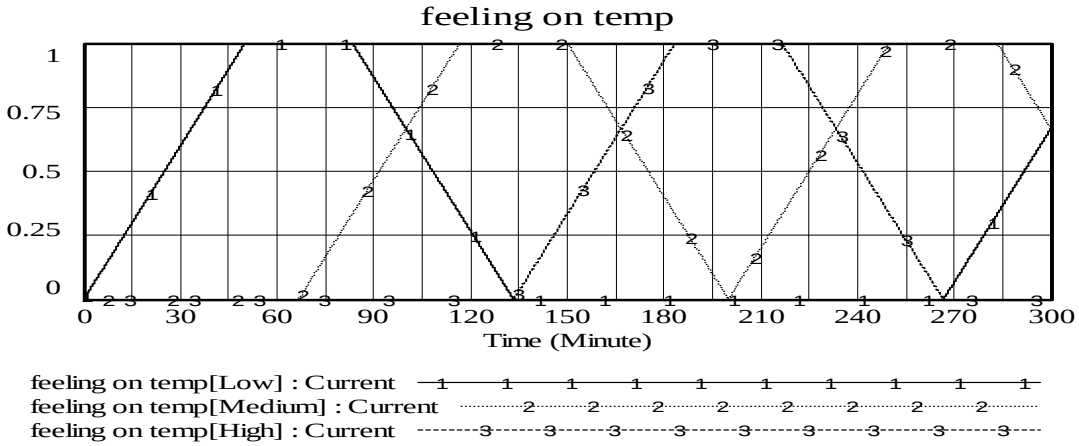

Figure AD.9: Simulation Result for Trapezoidal Membership Function with Introduction of Step Function

B: Bell-Shaped Membership Function

Generic f(x; a, b) = $\mu_T(x) = e^{-(x-a)^2/b}$

(Low) $\mu_{TL}(x) = e^{-(x-10)^2/16.4}$ $0 \le x < 20$ Equation 2.9

(Medium) $\mu_{TM}(x) = e^{-(x-20)^2/16.4}$ $10 \le x < 30$ Equation 2.10

(High) $\mu_{tH}(x) = e^{-(x-30)^2/16.4}$ $20 \le x < 40$ Equation 2.11

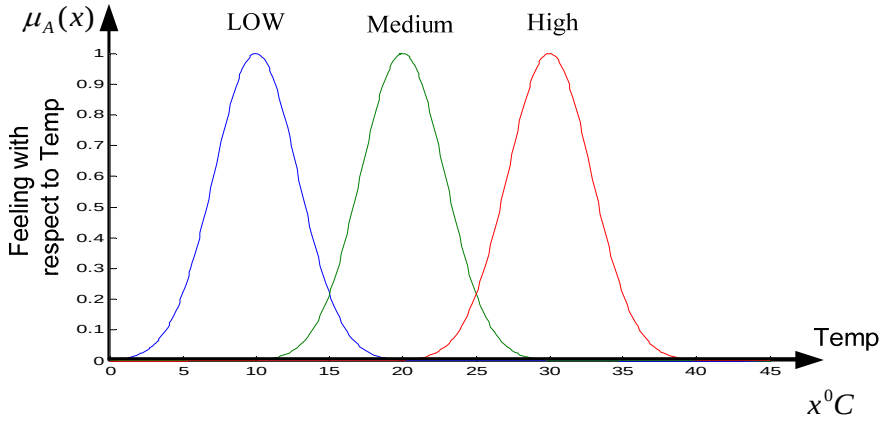

Figure AD.10: Representation of Linguistic Variable Using Trapezoidal Membership Function

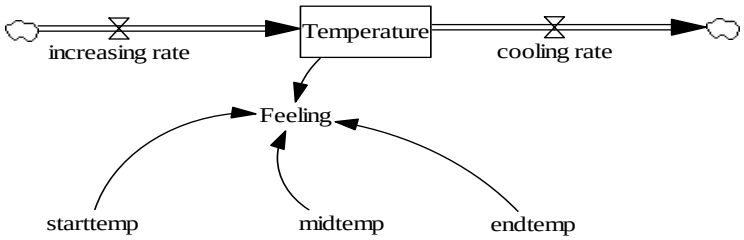

Figure AD.11: Stock Flow Diagram for Representing Bell-shaped Membership Function

Same temperature change behavior is showed in Figure 2.8. For the formulation, please refer to Appendix II.

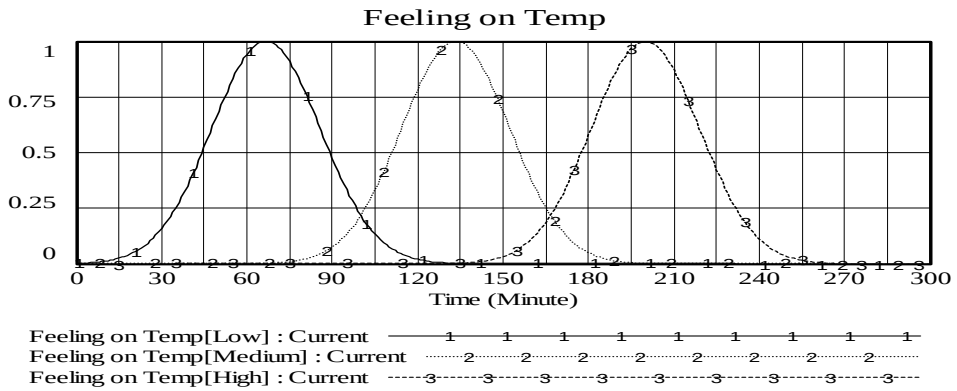

Figure AD.12: Simulation Result for Bell-shaped Membership Function

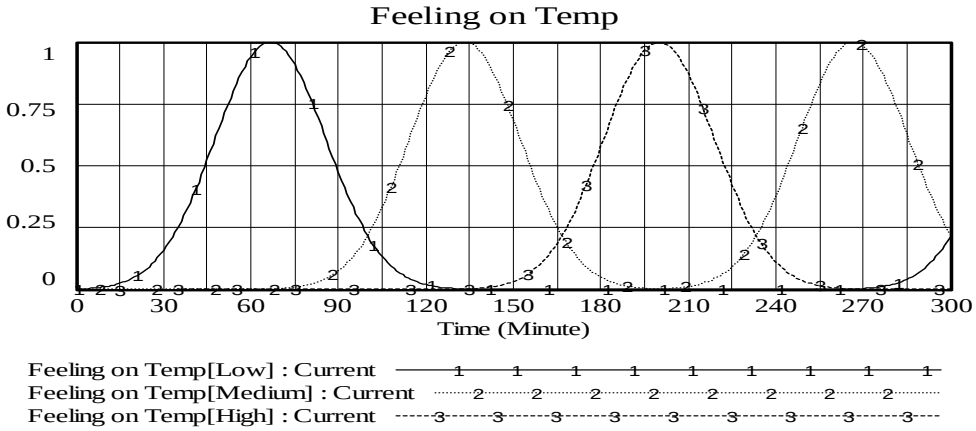

Figure AD.13: Simulation Result for Bell-shaped Membership Function with Introduction of Step Function

AD3: Formulations for Stock Flow Diagrams for Trapezoidal and Bell-Shaped Membership Function

Formulation I: Triangular Membership Function

1. cooling rate=0.85 Units: Celsius/Minute
2. endtemp[feeling]=15,30,30 Units: Celsius
3. feeling: low, medium, high Units: dmnl
4. feeling with respect to temp[feeling]=if then else(Temperature<midtemp[feeling] :AND: Temperature>= starttemp[feeling], XIDZ((Temperature-starttemp[feeling]), (midtemp[feeling]- starttemp[feeling]), 1), if then else (Temperature<endtemp[feeling]:AND: Temperature>=midtemp [feeling], XIDZ((endtemp[feeling]-Temperature), (endtemp[feeling]-midtemp[feeling]), 1), 0)) Units: Dmnl
5. FINAL TIME = 200 Units: Minute
   The final time for the simulation.
6. increasing rate=1 Units: Celsius/Minute
7. INITIAL TIME = 0 Units: Minute
   The initial time for the simulation.
8. midtemp[feeling]=0, 15, 30 Units: Celsius
9. SAVEPER =TIME STEP Units: Minute [0,?]
   The frequency with which output is stored.
10. starttemp[feeling]=0, 0, 15 Units: Celsius
11. Temperature= INTEG (increasing rate-cooling rate, 0) Units: Celsius
12. TIME STEP = 1 Units: Minute [0,?]
    The time step for the simulation.

Formulation II: Trapezoidal Membership Function

1. cooling rate=0.85 Units: Celsius/ Minute
2. endtemp[feeling]=20,30,40 Units: Celsius
3. feeling: Low, Medium, High
4. feeling on temp[feeling]=if then else(Temperature<Midtemp1[feeling] :AND: Temperature>= starttemp[feeling], (Temperature-starttemp[feeling])/(Midtemp1[feeling]-starttemp[feeling]), if then else (Temperature<Midtemp2[feeling]:AND: Temperature >=Midtemp1[feeling], 1, if then else (Temperature<endtemp [feeling]:AND:Temperature >=Midtemp2[feeling],(endtemp[feeling]Temperature)/(endtemp [feeling] -Midtemp2[feeling]), 0))) Units: Dmnl
   FINAL TIME = 300 Units: Minute
   The final time for the simulation
5. increasing rate=1 Units: Celsius/ Minute
   INITIAL TIME = 0 Units: Minute
   The initial time for the simulation
6. Midtemp1[feeling]=7.5,17.5,27.5 Units: Celsius
7. Midtemp2[feeling]=12.5,22.5,32.5 Units: Celsius
   SAVEPER = TIME STEP Units: Minute [0,?]
   The frequency with which output is stored
8. starttemp[feeling]=0,10,20 Units: Celsius
9. Temperature= INTEG (+increasing rate-cooling rate,0) Units: Celsius
10. TIME STEP = 0.0078125 The time step for the simulation Units: Minute [0,?]

Formulation III: Bell-shaped Membership Function

1. cooling rate=0.85 Units: Celsius/ Minute
2. endtemp=40 Units: Celsius
3. Feeling[Feeling with Respect to Temperature]=IF THEN
   ELSE(Temperature>=starttemp :AND: Temperature<=endtemp, EXP(-(Temperature-
   midtemp[Feeling with Respect to Temperature])^2/16.4), 0) Units: Dmnl
4. Feeling with Respect to Temperature: Low, Medium, High
5. FINAL TIME = 300 Units: Minute
   The final time for the simulation
6. increasing rate=1 Units: Celsius/ Minute
7. INITIAL TIME = 0 Units: Minute
   The initial time for the simulation
8. midtemp[Feeling with Respect to Temperature]=10, 20, 30 Units: Celsius
   SAVEPER = TIME STEP Units: Minute [0,?]
   The frequency with which output is stored
9. starttemp=0 Units: Celsius
10. Temperature= INTEG (+increasing rate-cooling rate, 0) Units: Celsius
    TIME STEP = 1 Units: Minute [0,?]

AD4: Stock and Flow Diagram for Multiple Model with Linguistic Variables Using Fuzzy Logic

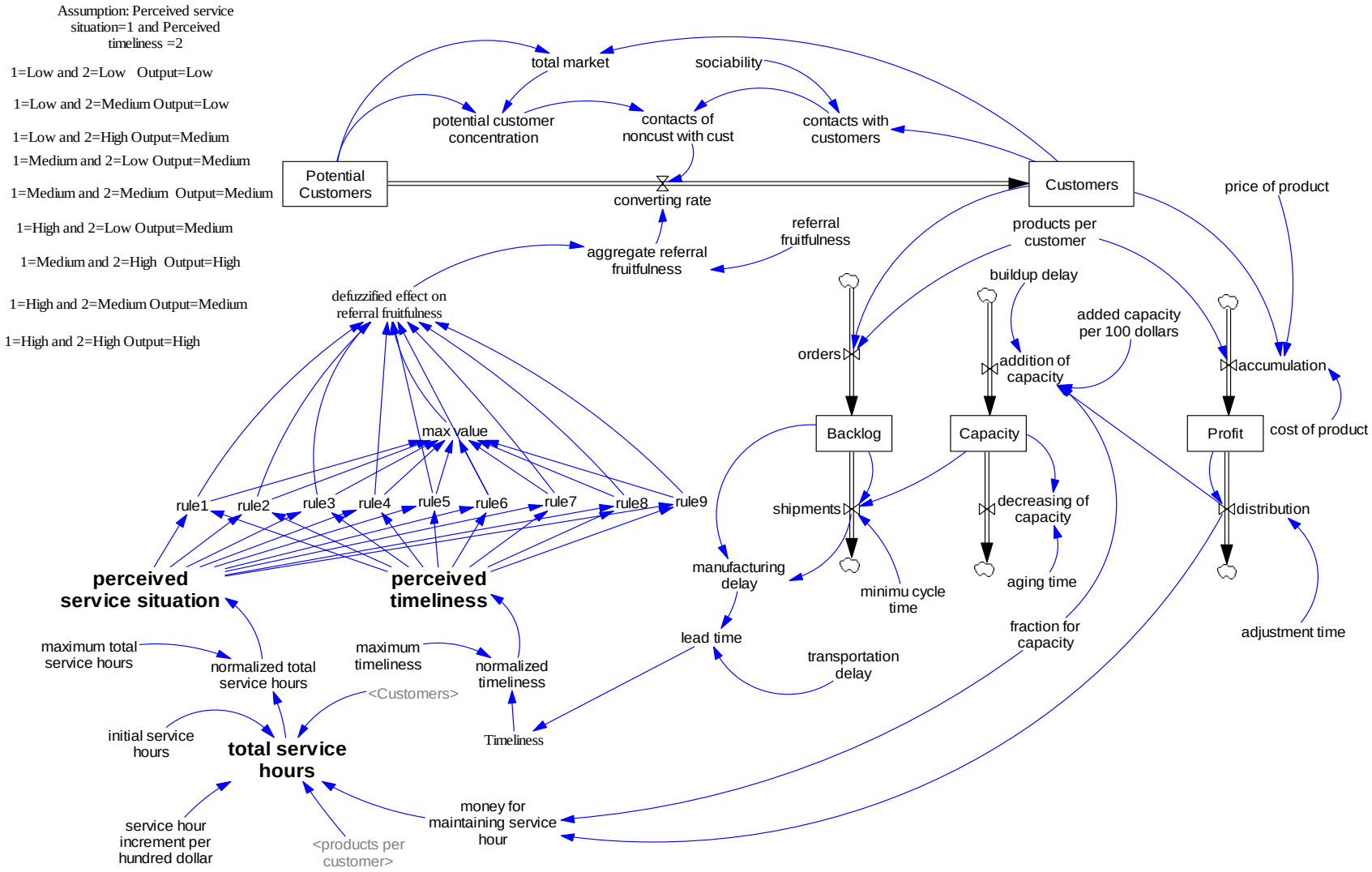

Figure AD.14: Stock and Flow Diagram for Multiple Model with Linguistic Variables Using Fuzzy Logic

AD5: Formulation for Model with Multiple Linguistic Variables Using Fuzzy Logic

1. accumulation=(price of product-cost of product)*Customers*products per customer
   Units: dollar/week
2. added capacity per 100 dollars=2 Units: gadget/dollar
3. addition of capacity=fraction for capacity*(distribution*added capacity per 100 dollars/100)/buildup delay Units: gadget/week/week
4. adjustment time=10 Units: week
5. aggregate referral fruitfulness=defuzzified effect on referral fruitfulness*referral fruitfulness
   Units: person/contact
6. aging time=260 Units: week
7. Backlog= INTEG (orders-shipments, 1000) Units: gadget
8. buildup delay=52 Units: week
9. Capacity= INTEG (addition of capacity-decreasing of capacity, 1000)
   Units: gadget/week
10. contacts of noncust with cust=contacts with customers*potential customer concentration
    Units: contact/week
11. contacts with customers=Customers*sociability Units: contact/week
12. converting rate=contacts of noncust with cust*aggregate referral fruitfulness
    Units: person/week
13. cost of product=50 Units: dollar/gadget
14. Customers= INTEG (converting rate, 500) Units: person
15. decreasing of capacity=Capacity*0.4/aging time Units: gadget/week/week
16. defuzzified effect on referral fruitfulness=if then else (rule1=max value:OR:rule2=max value, 1.5*(1-max value), if then else((rule3=max value:OR:rule4=max value:OR:rule5=max value:OR:rule7=max value :OR:rule8=max value):OR:((rule1=max value:OR:rule2=max value):AND:(rule3=max value :OR:rule4=max value:OR:rule5=max value:OR:rule7=max value:OR:rule8=max value)), 3-1.5*max value, if then else ((rule6=max value:OR:rule9=max value):OR:((rule1=max value:OR:rule2=max value):AND:(rule6=max value:OR:rule9=max value)):OR:((rule3=max value:OR:rule4=max value:OR:rule5=max

value:OR:rule7=max value:OR:rule8=max value):AND:(rule6=max value:OR:rule9=max value)):OR:((rule1=max value:OR:rule2=max value):AND:(rule3=max value:OR:rule4=max value:OR:rule5=max value:OR:rule7=max value:OR:rule8=max value):AND:(rule6=max value:OR:rule9=max value)), 3, 1))) Units: Dmnl

17. distribution=0.5*Profit/adjustment time Units: dollar/week
18. FINAL TIME = 100 Units: week
    The final time for the simulation.
19. fraction for capacity=0.75 Units: Dmnl
20. initial service hours=0.1 Units: hour/gadget
21. INITIAL TIME = 0 Units: week
    The initial time for the simulation.
22. lead time=manufacturing delay+ transportation delay Units: week
23. manufacturing delay=XIDZ(Backlog, shipments, 0) Units: week
24. max value=MAX(rule1, MAX(rule2, MAX(rule3, MAX(rule4, MAX(rule5, MAX(rule6, MAX(rule7, MAX(rule8,rule9)))))))) Units: Dmnl
25. maximum timeliness=0.5 Units: 1/week
26. maximum total service hours=0.47 Units: hour/gadget
27. minimum cycle time=1 Units: week
28. money for maintaining service hour=(1-fraction for capacity)*distribution Units: dollar/week
29. normalized timeliness=MIN (1,Timeliness/maximum timeliness) Units: Dmnl
30. normalized total service hours=MIN(1, total service hours/maximum total service hours) Units: Dmnl
31. orders=Customers*products per customer Units: gadget/week
32. perceived service situation[SLow]=if then else (normalized total service hours<=0, 1, if then else (normalized total service hours>=0:AND: normalized total service hours<=0.5, (0.5-normalized total service hours)/0.5, 0))
    perceived service situation[SMedium]=if then else (normalized total service hours>=0 :AND: normalized total service hours<=0.5, normalized total service hours/0.5, if then else

(normalized total service hours>=0.5:AND:normalized total service hours<=1, (1-normalized total service hours)/0.5, 0))
perceived service situation[SHigh]=if then else (normalized total service hours>=0.5:AND:normalized total service hours<=1, (normalized total service hours-0.5)/0.5, if then else (normalized total service hours>=1, 1, 0)) Units: Dmnl

33. perceived timeliness[TLow]=if then else (normalized timeliness<=0, 1, if then else (normalized timeliness
>=0 :AND: normalized timeliness<=0.5, (0.5-normalized timeliness)/0.5, 0))
perceived timeliness[TMedium]=if then else (normalized timeliness>=0:AND:normalized timeliness<=0.5, normalized timeliness/0.5, if then else (normalized timeliness>=0.5 :AND:normalized timeliness<=1, (1-normalized timeliness)/0.5, 0))
perceived timeliness[THigh]=if then else (normalized timeliness> =0.5:AND:normalized timeliness<=1, (normalized timeliness-0.5)/0.5, if then else (normalized timeliness>=1, 1, 0))
Units: Dmnl
34. potential customer concentration=Potential Customers/total market
Units: Dmnl
35. Potential Customers= INTEG (-converting rate, 1e+008) Units: person
36. price of product=100 Units: dollar/gadget
37. products per customer=4 Units: gadget/person/week
38. Profit= INTEG (accumulation-distribution, 100000) Units: dollar
39. referral fruitfulness=0.001 Units: person/contact
40. rule1=MIN(perceived service situation[SLow], perceived timeliness[TLow])
Units: Dmnl
41. rule2=MIN(perceived service situation[SLow], perceived timeliness[TMedium])
Units: Dmnl
42. rule3=MIN(perceived service situation[SLow], perceived timeliness[THigh])
Units: Dmnl
43. rule4=MIN(perceived service situation[SMedium], perceived timeliness[TLow])
Units: Dmnl
44. rule5=MIN(perceived service situation[SMedium], perceived timeliness[TMedium])
Units: Dmnl

45. rule6=MIN(perceived service situation[SMedium], perceived timeliness[THigh])
Units: Dmnl
46. rule7=MIN(perceived service situation[SHigh], perceived timeliness[TLow])
Units: Dmnl
47. rule8=MIN(perceived service situation[SHigh], perceived timeliness[TMedium])
Units: Dmnl
48. rule9=MIN(perceived service situation[SHigh], perceived timeliness[THigh])
Units: Dmnl
49. SAVEPER = TIME STEP Units: week [0,?]
The frequency with which output is stored.
50. service hour increment per hundred dollar=4 Units: hour/dollar
51. Service hours: SLow, SMedium, SHigh
52. shipments=MIN(Backlog/minimum cycle time, Capacity) Units: gadget/week
53. sociability=10 Units: contact/person/week
54. TIME STEP = 0.0078125 Units: week [0,?]
The time step for the simulation.
55. timeliness perception: TLow, TMedium, THigh
56. Timeliness=1/lead time Units: 1/week [6.02558e-044,?]
57. total market=Potential Customers+ Customers Units: person
58. total service hours=initial service hours+((money for maintaining service hour/(Customers*products per customer))/100)*service hour increment per hundred dollar
Units: hour/gadget
59. transportation delay=1 Units: week

AD6: Stock and Flow Diagram Model with Multiple Linguistic Variables Using Table Function

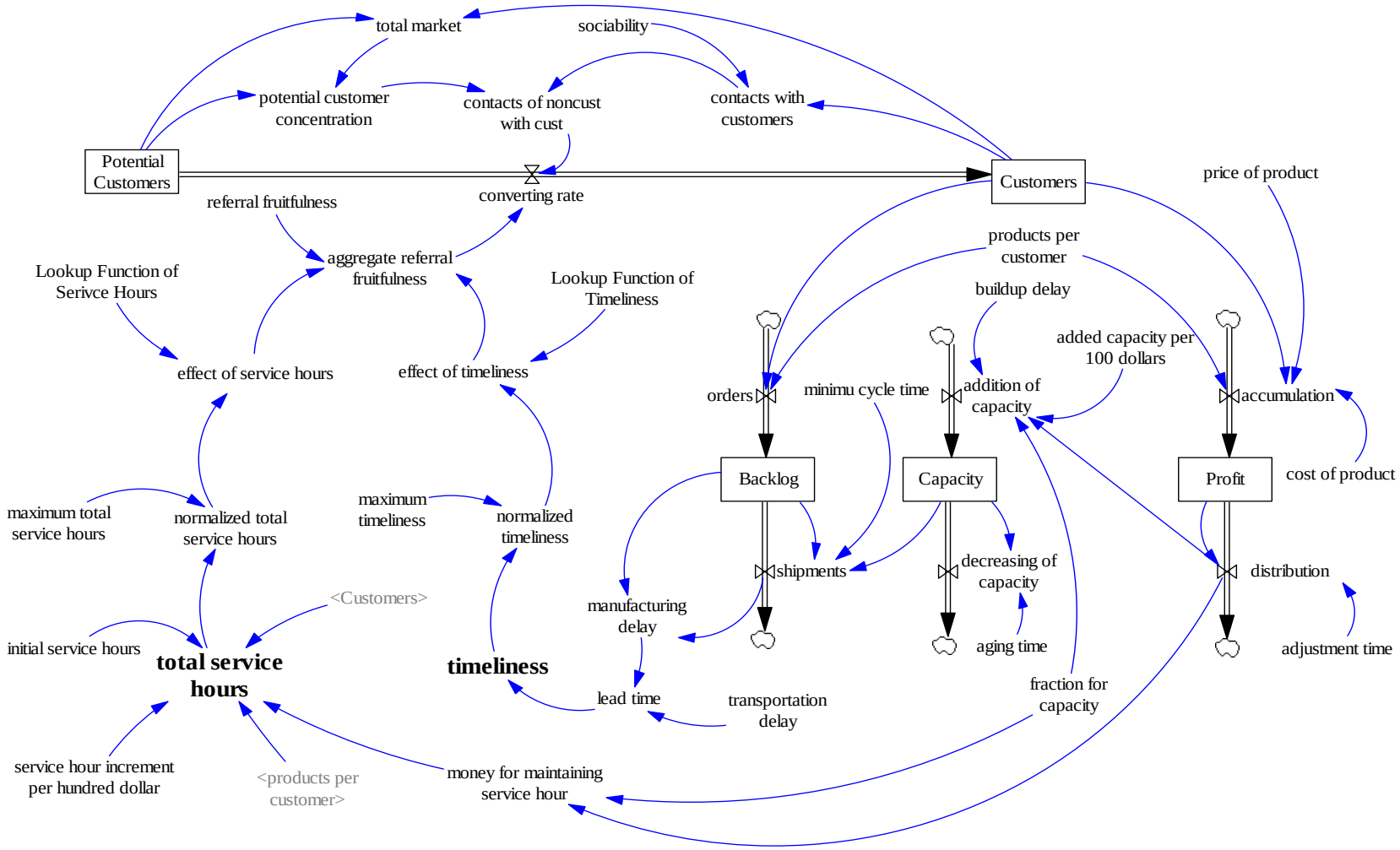

Figure AD.15: Stock and Flow Diagram Model with Multiple Linguistic Variables Using Table Function

AD7: Formulation for Model with Multiple Linguistic Variables Using Fuzzy Logic

1. accumulation=(price of product-cost of product)*Customers*products per customer
   Units: dollar/Week
2. added capacity per 100 dollars=2 Units: gadget/dollar
3. addition of capacity=fraction for capacity*(distribution*added capacity per 100 dollars/100)/buildup delay Units: gadget/Week/Week
4. adjustment time=10 Units: Week
5. aggregate referral fruitfulness=referral fruitfulness*(effect of service hours+ effect of timeliness) Units: person/contact
6. aging time=260 Units: Week
7. Backlog= INTEG (orders-shipments,1000) Units: gadget
8. buildup delay=52 Units: Week
9. Capacity= INTEG (addition of capacity-decreasing of capacity,1000)
   Units: gadget/Week
10. contacts of noncust with cust=contacts with customers*potential customer concentration
    Units: contact/Week
11. contacts with customers=Customers*sociability Units: contact/Week
12. converting rate=contacts of noncust with cust*aggregate referral fruitfulness
    Units: person/Week
13. cost of product=50 Units: dollar/gadget
14. Customers= INTEG (converting rate,500) Units: person
15. decreasing of capacity=Capacity*0.4/aging time Units: gadget/Week/Week
16. distribution=0.5*Profit/adjustment time Units: dollar/Week
17. effect of service hours=Lookup Function of Service Hours(normalized total service hours)
    Units: Dmnl
18. effect of timeliness=Lookup Function of Timeliness(normalized timeliness)
    Units: Dmnl
19. FINAL TIME = 100 Units: Week

The final time for the simulation.

20. fraction for capacity=0.75 Units: Dmnl
21. initial service hours=0.1 Units: hour/gadget
22. INITIAL TIME = 0 Units: Week

    The initial time for the simulation.

23. lead time=manufacturing delay+ transportation delay Units: Week
24. Lookup Function of Service Hours([(0,0)-(1,10)],(0,0),(0.05,0.1),(0.1,0.15), (0.15, 0.3), (0.2,0.4),(0.25,0.45),(0.3,0.55),(0.4,0.6),(0.45,0.7),(0.5,0.8),(0.55,0.85),(0.6,0.9),(0.65,0.925),(0.7,0.95),(0.75,0.975),(0.8,1),(0.85,1.3),(0.9,1.8),(0.95,2.5),(1,3))

    Units: Dmnl
25. Lookup Function of Timeliness([(0,0)-(1,10)],(0,0),(0.1,0.3),(0.2,0.5),(0.3,0.6),(0.4,0.8), (0.5,0.85),(0.6,0.9),(0.7,0.95),(0.8,1),(0.85,1.8),(0.9,2.4),(1,3))

    Units: Dmnl
26. manufacturing delay=XIDZ(Backlog, shipments, 0) Units: Week
27. maximum timeliness=1 Units: 1/Week
28. maximum total service hours=0.6 Units: hour/gadget
29. minimum cycle time=1 Units: Week
30. money for maintaining service hour=(1-fraction for capacity)*distribution

    Units: dollar/Week
31. normalized timeliness=timeliness/maximum timeliness Units: Dmnl
32. normalized total service hours=total service hours/maximum total service hours

    Units: Dmnl
33. orders=Customers*products per customer Units: gadget/Week
34. potential customer concentration=Potential Customers/total market

    Units: Dmnl
35. Potential Customers= INTEG (-converting rate, 1e+008) Units: person
36. price of product=100 Units: dollar/gadget
37. products per customer=4 Units: gadget/person/Week
38. Profit= INTEG (accumulation-distribution,100000) Units: dollar
39. referral fruitfulness=0.001 Units: person/contact

    SAVEPER = TIME STEP Units: Week [0,?]

The frequency with which output is stored.

40. service hour increment per hundred dollar=4 Units: hour/dollar
41. shipments=MIN(Backlog/minimum cycle time, Capacity) Units: gadget/Week
42. sociability=10 Units: contact/person/Week
43. TIME STEP = 0.0078125 Units: Week [0,?]

    The time step for the simulation.
44. timeliness=1/lead time Units: 1/Week
45. total market=Potential Customers+ Customers Units: person
46. total service hours=initial service hours+((money for maintaining service hour/(Customers*products per customer))/100)*service hour increment per hundred dollar Units: hour/gadget
47. transportation delay=1 Units: Week

AD8: Molecules Used in the First Essay

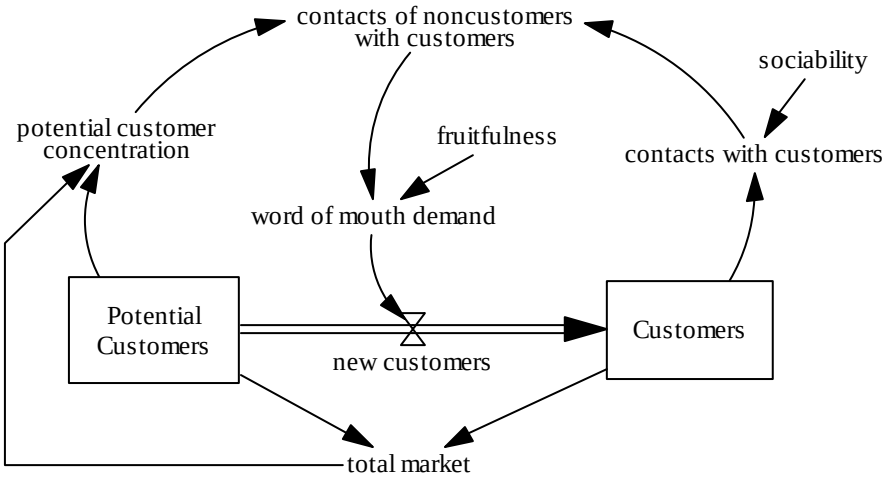

Figure AD.16: Conversion from Potential Customers to Customers

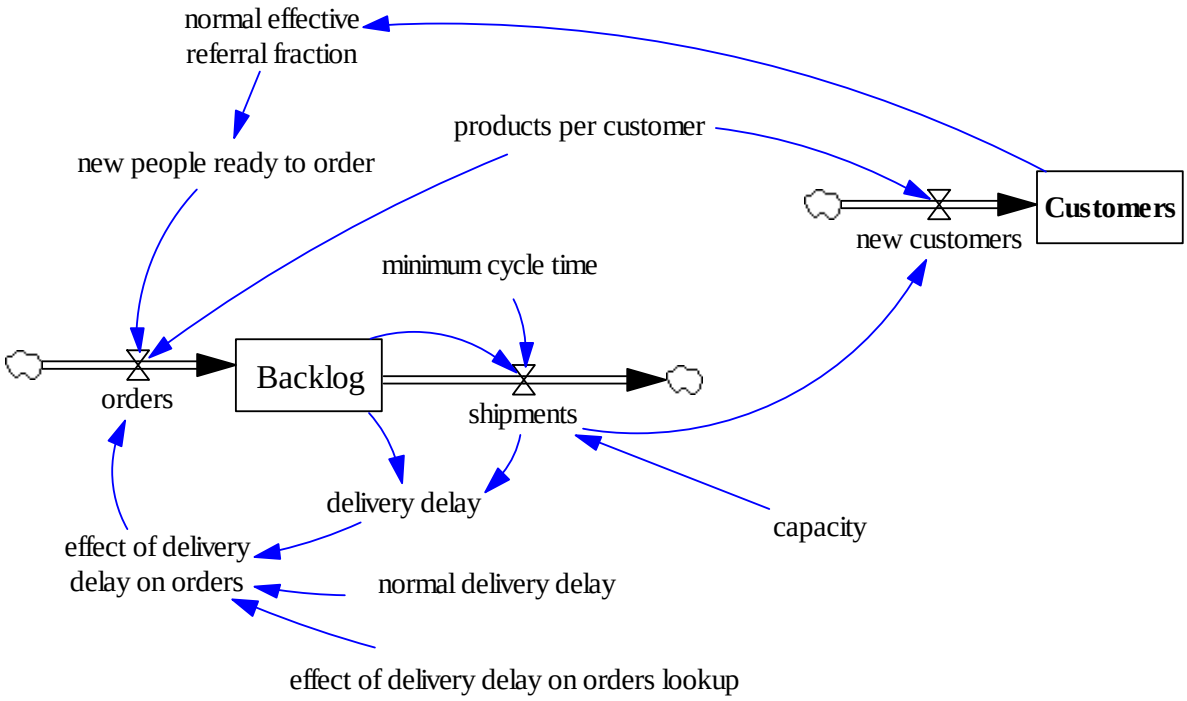

Figure AD.17: Backlog Modeling Example

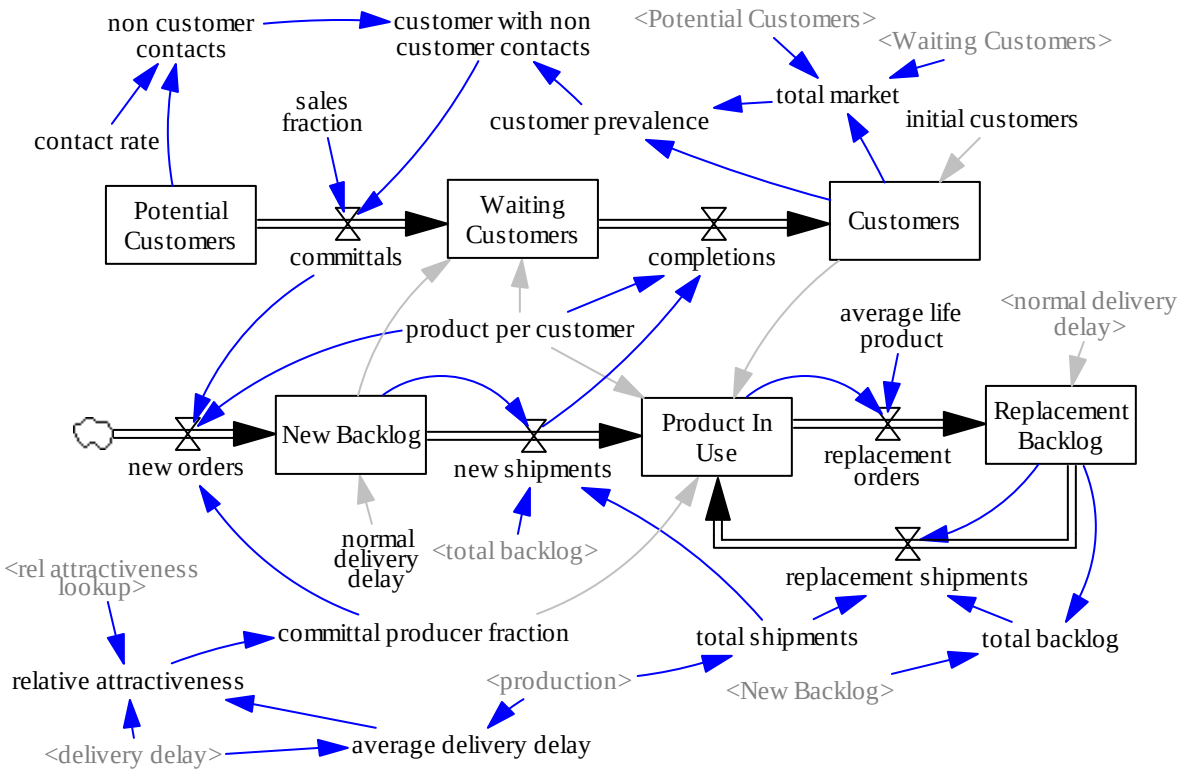

Figure AD.18: Customer Conversion and Backlog Modeling

AD9: Formulations for the Third Model in AD8

1. contacts of noncustomers with customers = contacts with customers*potential customer concentration Units: contact/Month
2. contacts with customers = Customers*sociability Units: contact/Month
3. Customers = INTEG(new customers,1000) Units: person
4. FINAL TIME = 100 Units: Month
   The final time for the simulation.
5. fruitfulness = 0.01 Units: person/contact
6. INITIAL TIME = 0 Units: Month
   The initial time for the simulation.
7. new customers = word of mouth demand Units: person/Month
8. potential customer concentration = Potential Customers/total market Units: dmnl
9. Potential Customers = INTEG(- new customers,1e+006) Units: person
10. SAVEPER =TIME STEP Units: Month
    The frequency with which output is stored.
11. sociability = 20 Units: contact/person/Month
12. TIME STEP = 1 Units: Month
    The time step for the simulation.
13. total market = Customers+ Potential Customers Units: person
14. word of mouth demand = contacts of noncustomers with customers*fruitfulness Units: person/Month

AD10: Behaviors of Variables for the Model with Multiple Linguistic Variables Using Fuzzy Logic

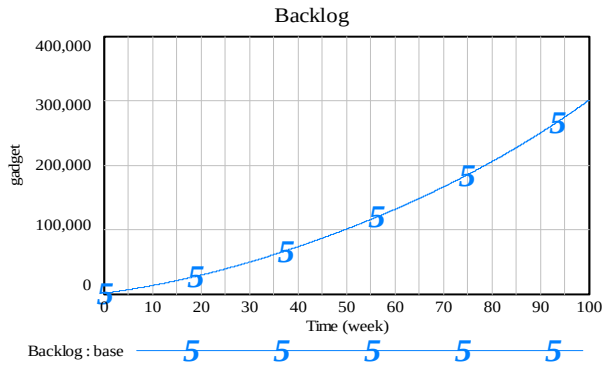

Figure AD.19: Behavior of Backlog

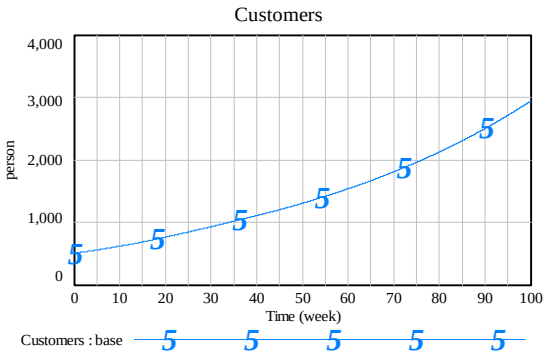

Figure AD.22: Behavior of Customer

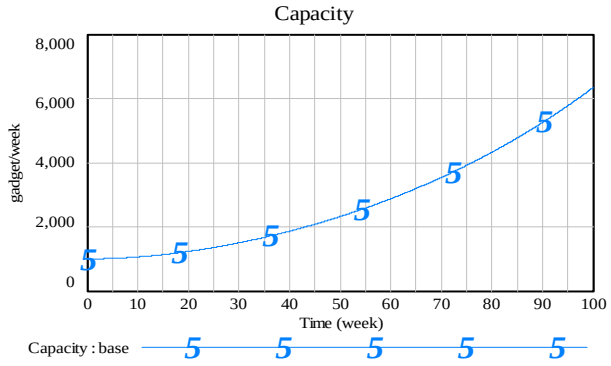

Figure AD.20: Behavior of Capacity

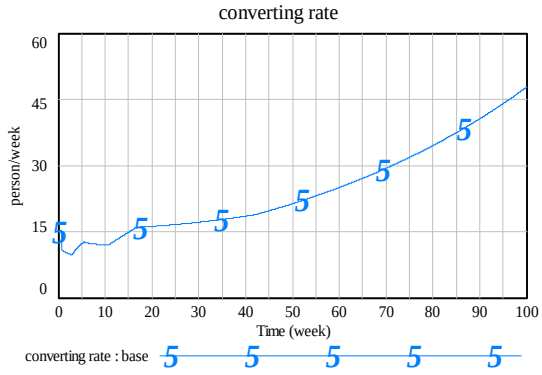

Figure AD.23: Behavior of Converting Rate

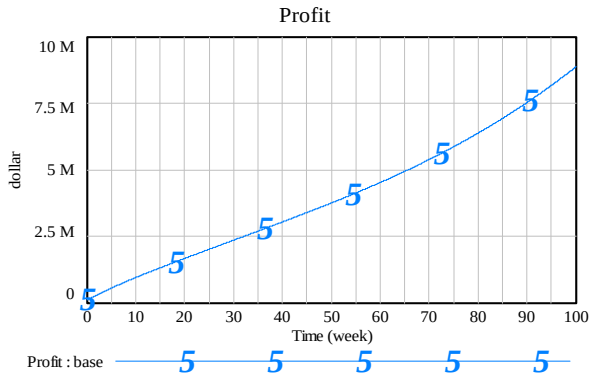

Figure AD.21: Behavior of Profit

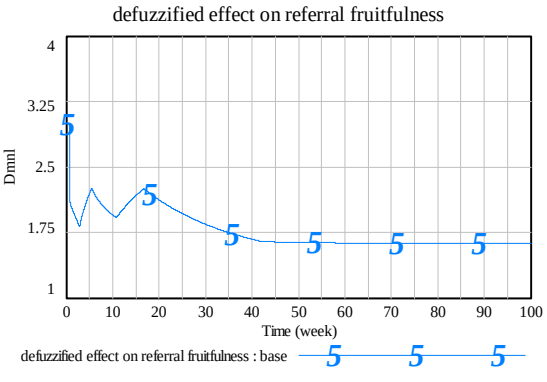

Figure AD.24: Behavior of Defuzzified Effect on Referral Fruitfulness

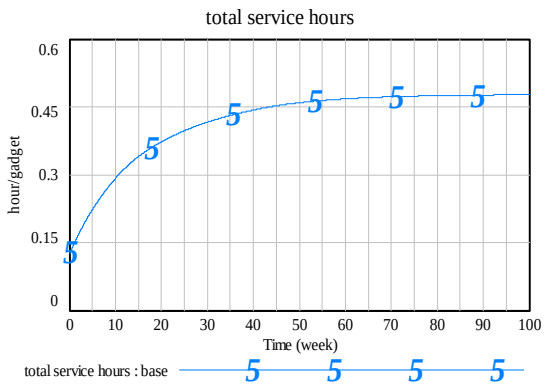

Figure AD.25: Behavior of Total Service Hours

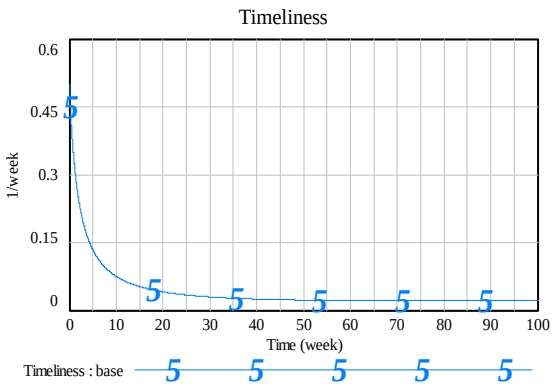

Figure AD.27: Behavior of Timeliness

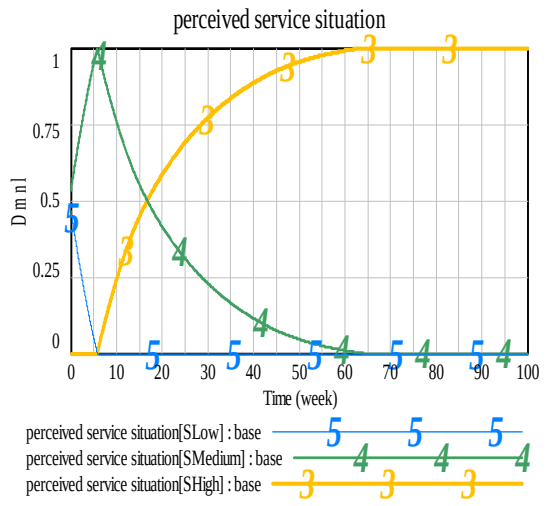

Figure AD.26: Behavior of Perceived Service Situation

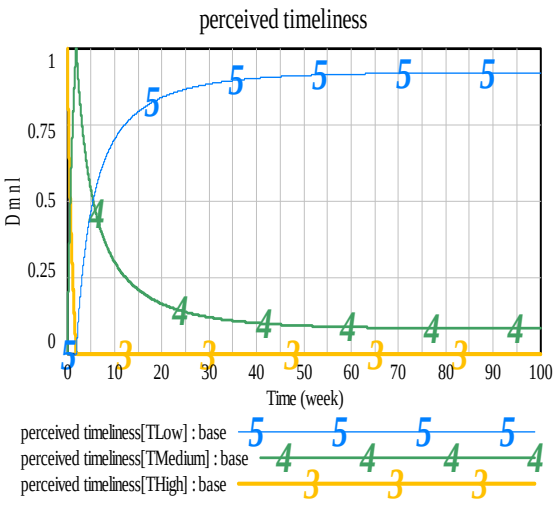

Figure AD.28: Behavior of Perceived Timeliness

AD11: Parameter Sensitivity Analysis for the Model with Multiple Linguistic Variables Using Fuzzy Logic

Number of Simulations: 200

Noise Seed: 1234

Distribution: Random_ Uniform

Table AD.1: Parameters Setting for Different Variables Using Fuzzy Logic

Variable-Parameter Sensitivity Analysis (Fuzzy Logic)	Designated value	Minimum Value	Maximum Value
Added capacity per 100 dollars (gadget/week/week)	2	1	3
Adjustment time (week)	10	5	15
Aging time (week)	260	200	300
Buildup delay (week)	52	26	78
Cost of product (dollar/gadget)	50	40	60
Fraction for capacity (Dmnl)	0.75	0.5	0.9
Initial service hours (hour/gadget)	0.1	0.05	0.15
Minimum cycle time (week)	1	0.8	2
Price of product (dollar/gadget)	100	80	120
Products per customer (gadget/person/week)	4	2	6
Referral fruitfulness (person/contact)	0.001	0.0005	0.002
Service hour increment per 100 dollars (hour/dollar)	4	3	6
Sociability (contact/person/week)	10	6	15
Transportation delay (week)	1	0.8	1.2

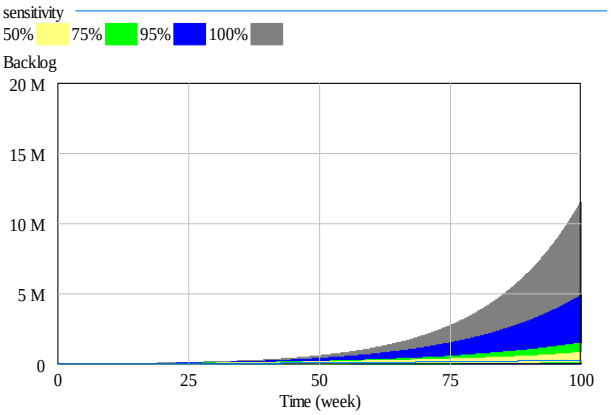

Figure AD.29: Sensitivity Analysis for Backlog

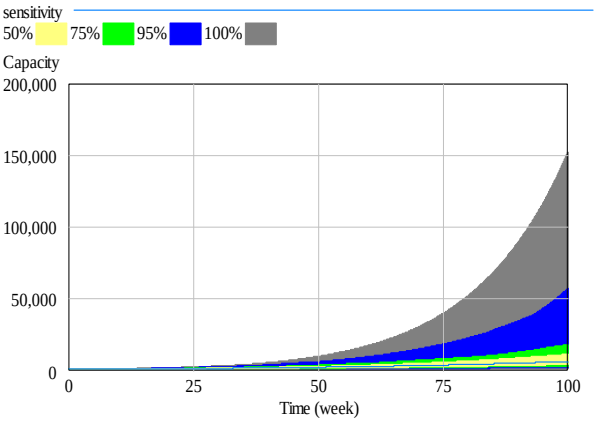

Figure AD.30: Sensitivity Analysis for Capacity

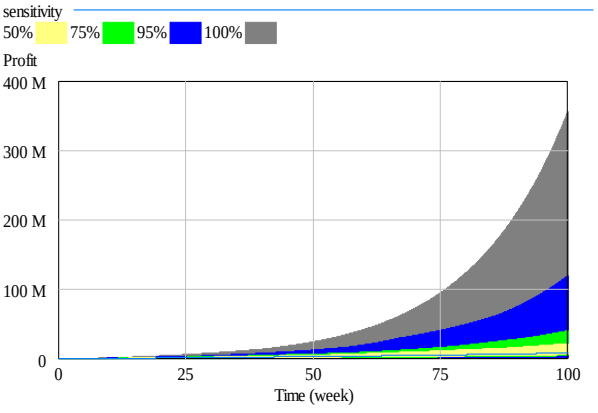

Figure AD.31: Sensitivity Analysis for Profit

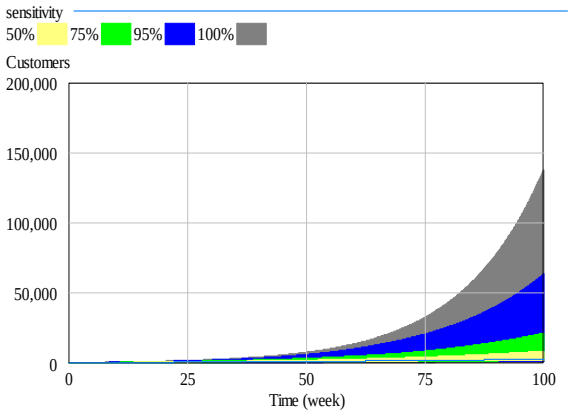

Figure AD.32: Sensitivity Analysis for Customers

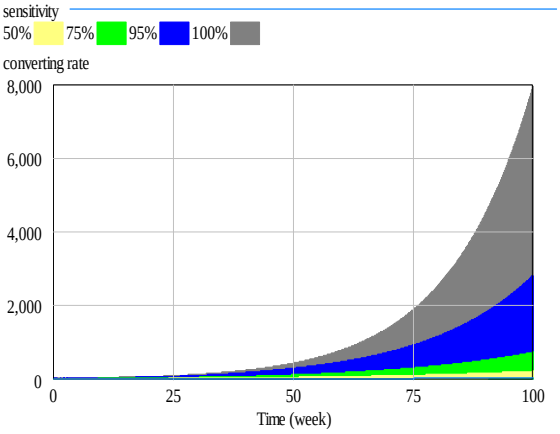

Figure AD.33: Sensitivity Analysis for Converting Rate

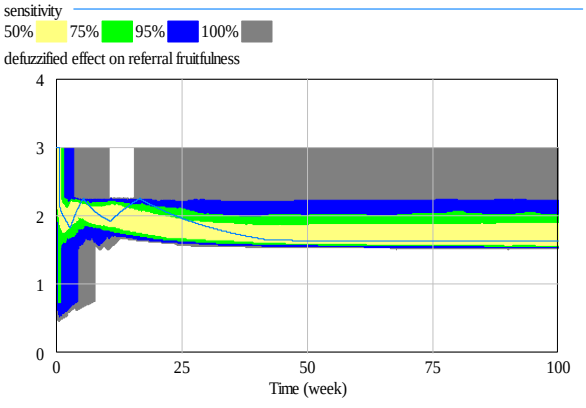

Figure AD.34: Sensitivity Analysis for Defuzzified Effect

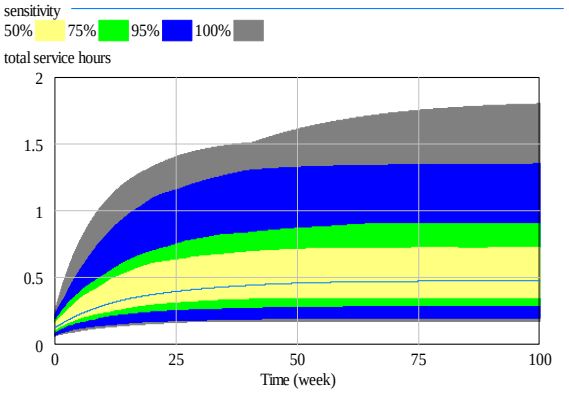

Figure AD.35: Sensitivity Analysis for Total Service Hours

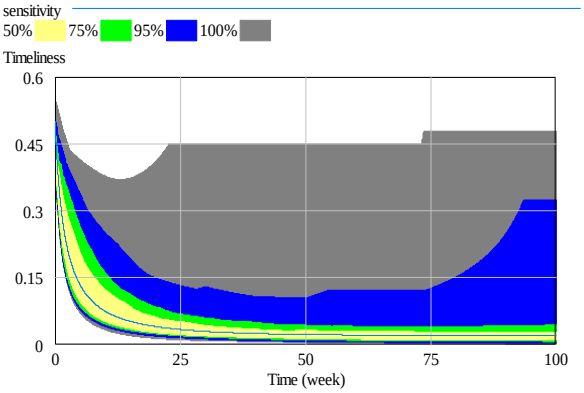

Figure AD.37: Sensitivity Analysis for Timeliness

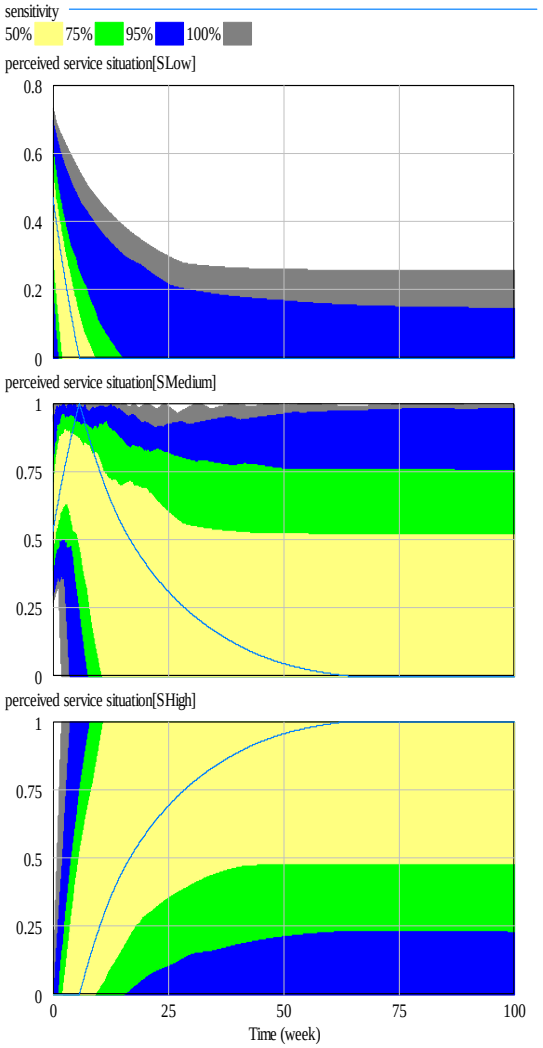

Figure AD.36: Sensitivity Analysis for Perceived Service Situation

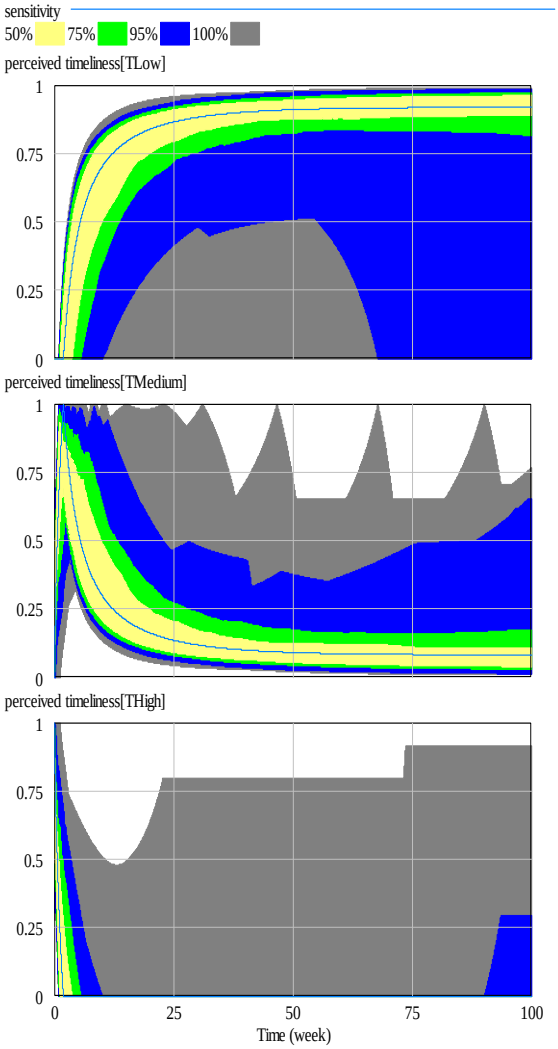

Figure AD.38: Sensitivity Analysis for Perceived Timeliness

AD12: Behavior of Variables for the Model with Multiple Linguistic Variables Using Table Function

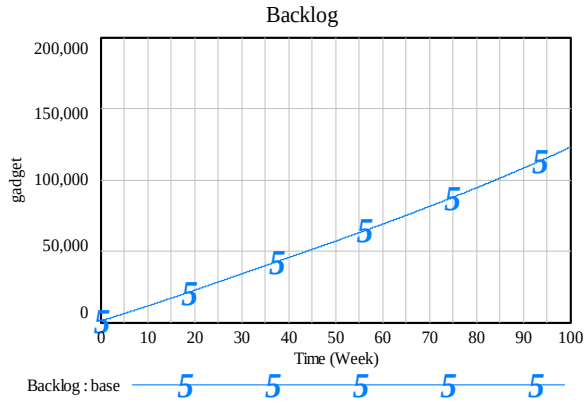

Figure AD.39: Backlog

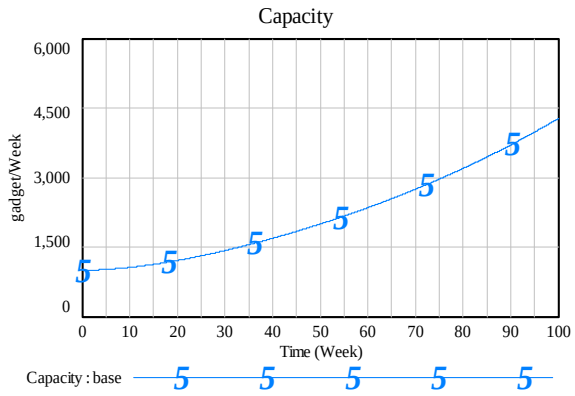

Figure AD.40: Capacity

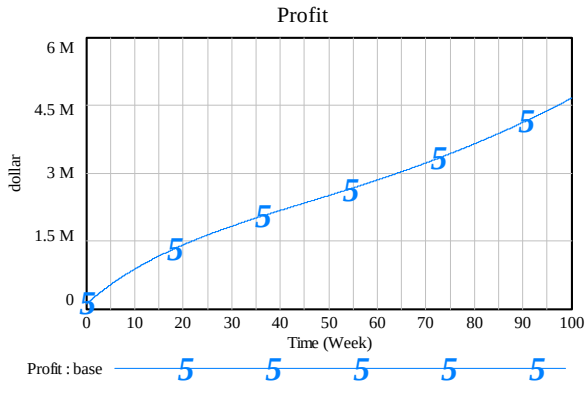

Figure AD.41: Profit

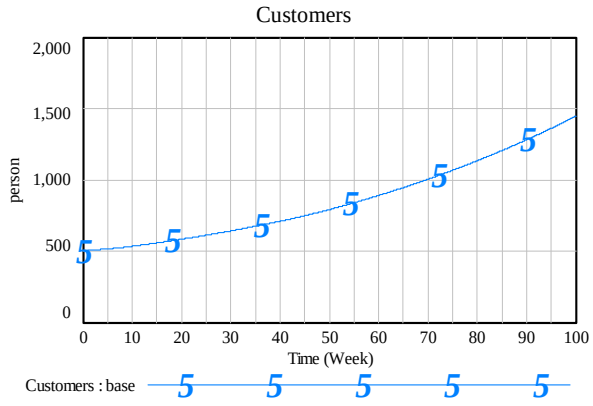

Figure AD.42: Customer

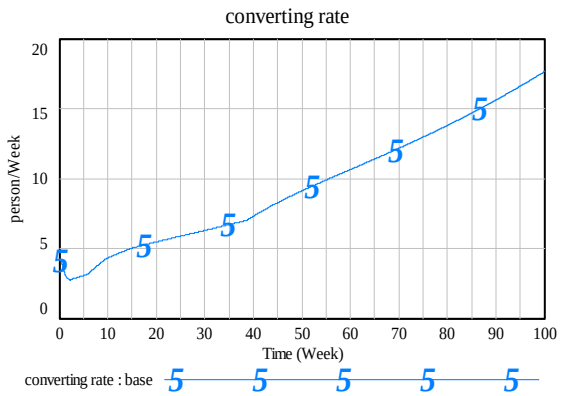

Figure AD.43: Converting Rate

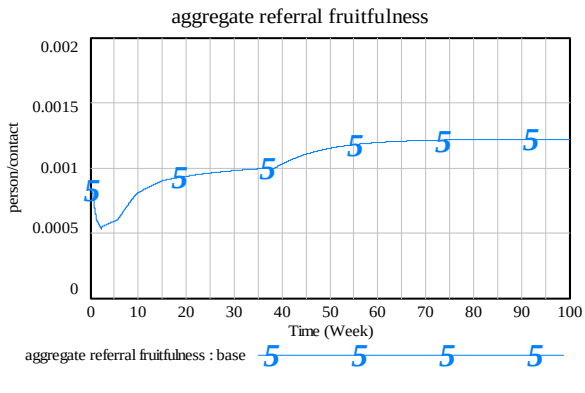

Figure AD.44: Aggregate Effect on Referral Fruitfulness

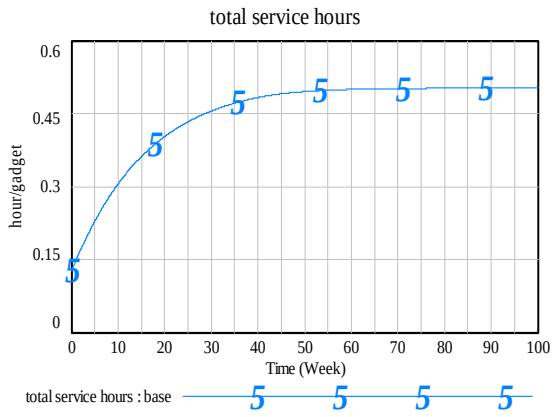

Figure AD.45: Total Service Hours

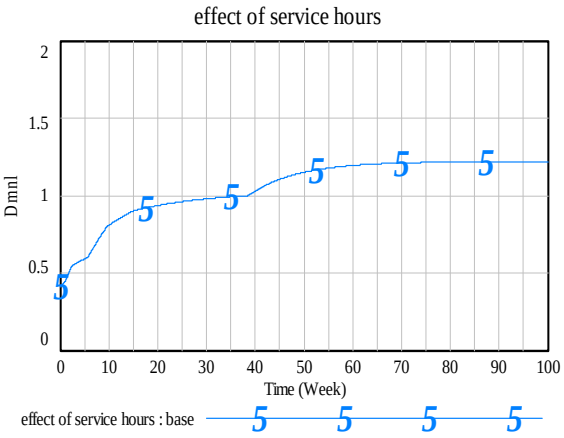

Figure AD.46: Effect of Service Situation

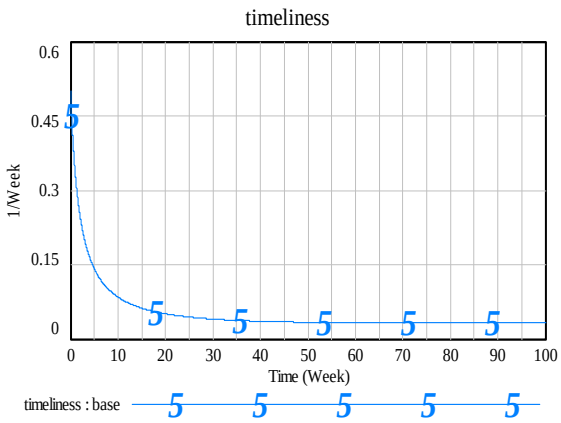

Figure AD.47: Timeliness

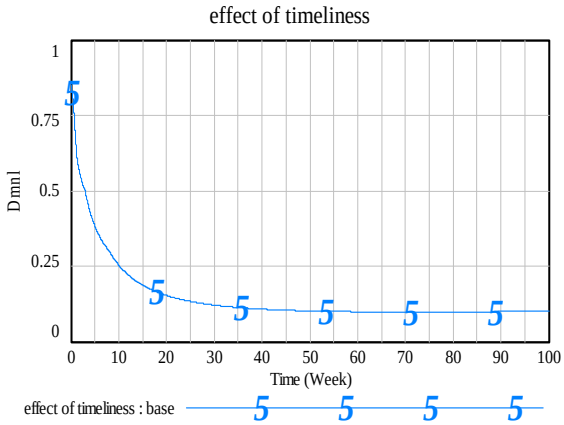

Figure AD.48: Effect of Timeliness

AD13: Parameter Sensitivity Analysis for the Model with Multiple Linguistic Variables Using Table Function

Number of Simulations: 200

Noise Seed: 1234

Distribution: Random_ Uniform

Table AD.2: Parameter Setting for Different Variables Using Table Function

Variable-Parameter Sensitivity Analysis (Table Function)	Designated value	Minimum Value	Maximum Value
Added capacity per 100 dollars (gadget/dollar)	2	1	3
Adjustment time (week)	10	5	15
Aging time (week)	260	200	300
Buildup delay (week)	52	26	78
Cost of product (dollar/gadget)	50	40	60
Fraction for capacity (Dmnl)	0.75	0.5	0.9
Initial service hours (hour/gadget)	0.1	0.05	0.15
Minimum cycle time (week)	1	0.8	2
Price of product (dollar/gadget)	100	80	120
Products per customer (gadget/person/week)	4	2	6
Referral fruitfulness (person/contact)	0.001	0.0005	0.002
Service hour increment per 100 dollars (hour/dollar)	4	3	6
Sociability (contact/person/week)	10	6	15
Transportation delay (week)	1	0.8	1.2

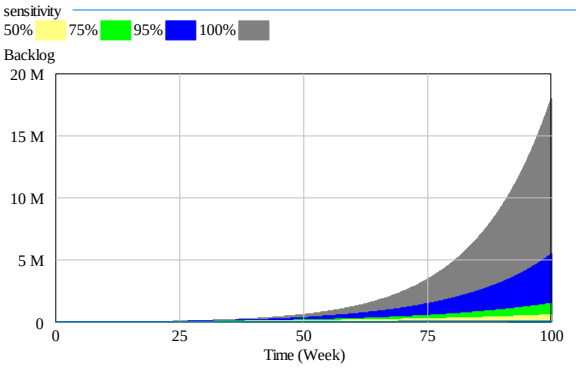

Figure AD.49: Sensitivity Analysis for Backlog

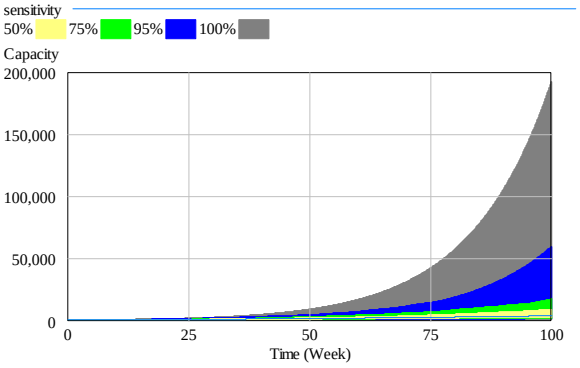

Figure AD.50: Sensitivity Analysis for Capacity

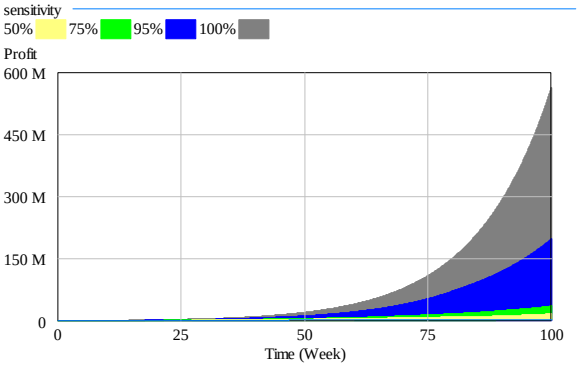

Figure AD.51: Sensitivity Analysis for Profit

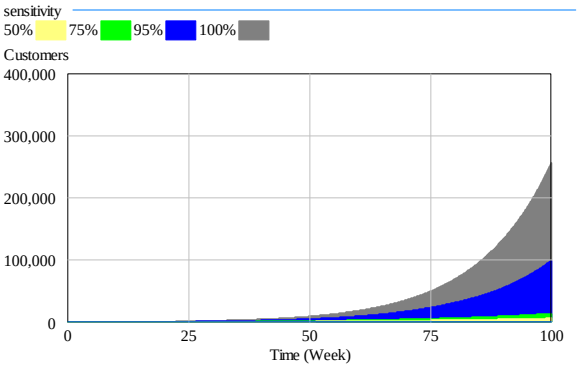

Figure AD.52: Sensitivity Analysis for Customers

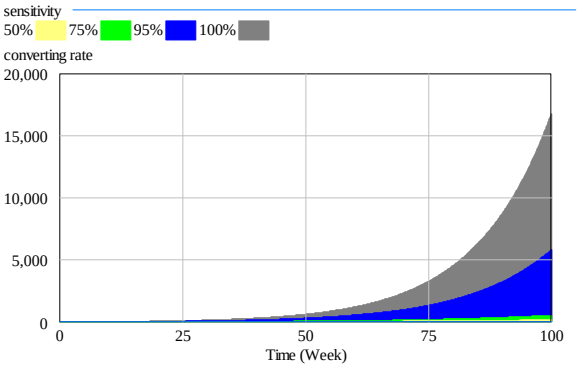

Figure AD.53: Sensitivity Analysis for Converting Rate

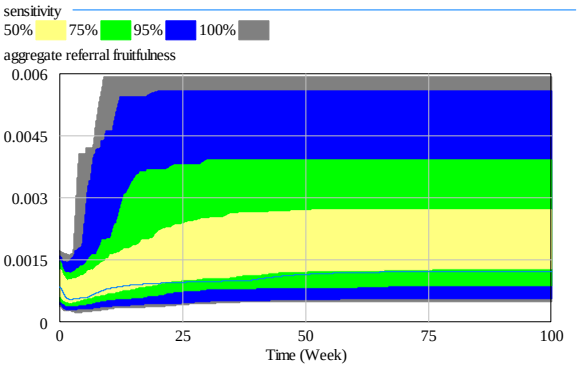

Figure AD.54: Sensitivity Analysis for Aggregate Effect

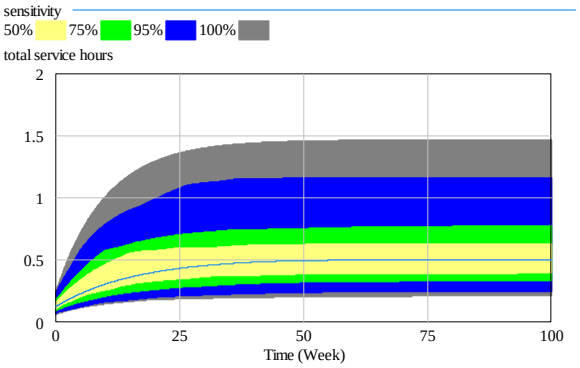

Figure AD.55: Sensitivity Analysis for Total Service Hours

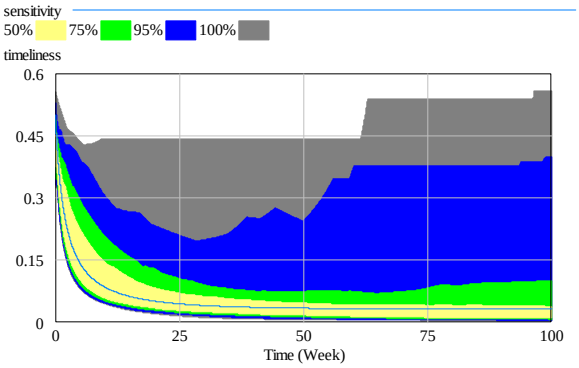

Figure AD.57: Sensitivity Analysis for Timeliness

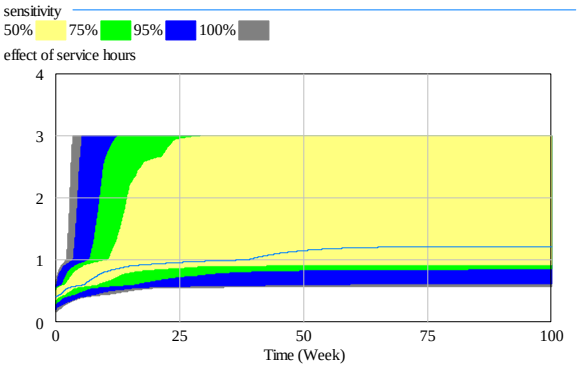

Figure AD.56: Sensitivity Analysis for Effect of Service Situation

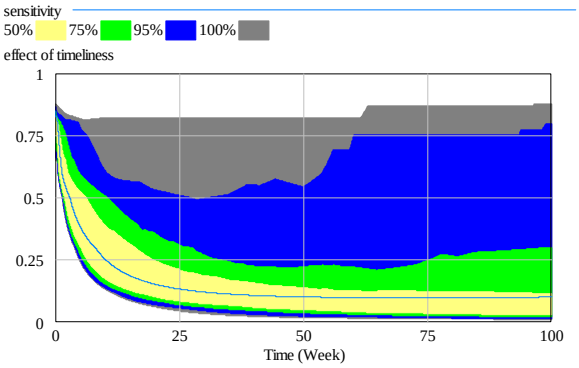

Figure AD.58: Sensitivity Analysis for Effect of Timeliness

Appendix E: Transportation System Model with Travel Demand Management Policy

AE1: Stock and Flow Diagram for Transportation System Model with Travel Demand Management Policy

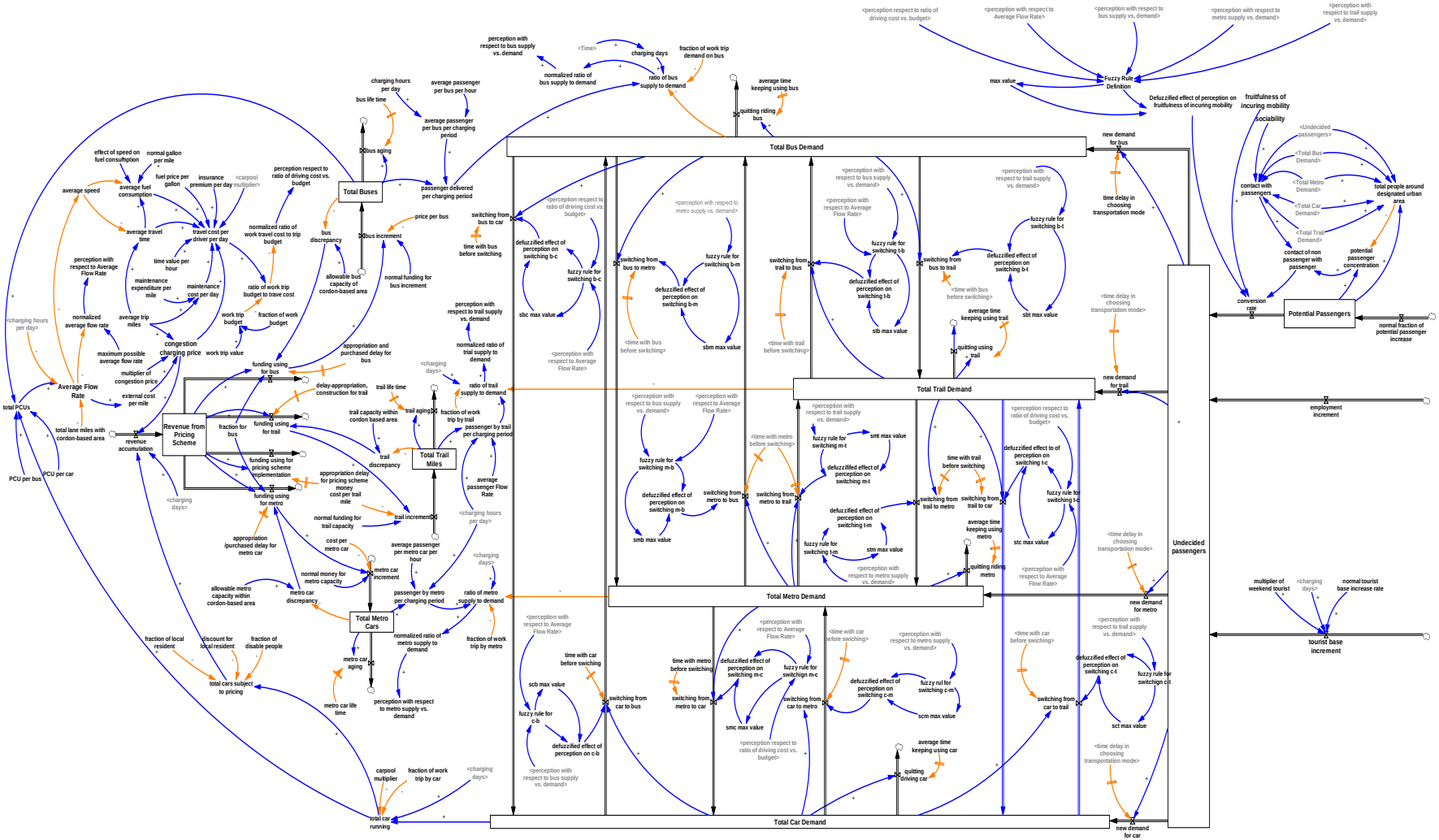

Figure AE.1: Stock and Flow Diagram for Transportation System Model with Travel Demand Management Policy

AE2: Formulation for Transportation System Model with Travel Demand Management Policy

1. "allowable bus capacity of cordon-based area"=1500 Units: bus
2. "allowable metro capacity within cordon-based area"=1500 Units: metro car
3. "appropriation /purchased delay for metro car"=3600 Units: day
4. appropriation and purchased delay for bus=540 Units: day
5. appropriation delay for pricing scheme money=180 Units: day
6. Average Flow Rate=total PCUs/charging hours per day/"total lane miles with cordon based area" Units: PCU/hour/mile
7. average fuel consumption=effect of speed on fuel consumption(average speed)*average travel time*average speed*normal gallon per mile Units: gallon/car/day
8. average passenger Flow Rate =30 Units: passenger/hour/mile
9. average passenger per bus per charging period=average passenger per bus per hour*charging hours per day Units: passenger/bus
10. average passenger per bus per hour=45 Units: passenger/bus/hour
11. average passenger per metro car per hour=68 Units: passenger/hour/metro car
12. average speed=if then else (Average Flow Rate<=10, 55, if then else(Average Flow Rate<=25, 50, if then else (Average Flow Rate<=30, 45, if then else (Average Flow Rate <=40, 40, if then else (Average Flow Rate<=50, 35, if then else (Average Flow Rate <=60, 25, 15)))))) Units: mile/hour
13. average time keeping using bus=1800 Units: day
14. average time keeping using car=3600 Units: day
15. average time keeping using metro=1800 Units: day
16. average time keeping using trail=1080 Units: day
17. average travel time=average trip miles/average speed Units: hour/car/day
18. average trip miles=25 Units: mile/car/day
19. bus aging=Total Buses/bus life time Units: bus/day
20. bus discrepancy="allowable bus capacity of cordon-based area"-Total Buses Units: bus

21. bus increment=(funding using for bus+normal funding for bus increment)/price per bus
    Units: bus/day
22. bus life time=3600 Units: day
23. Bus S and D: BLow, BMedium, BHigh
24. carpool multiplier=1.2 Units: passenger/car
25. charging days=if then else (MODULO(Time, 7)<2, 0,1) Units: Dmnl
26. charging hours per day=12 Units: hour
27. congestion charging price=average trip miles*external cost per mile*multiplier of congestion price Units: dollar/car/day
28. contact of non passenger with passenger=contact with passengers*potential passenger concentration Units: contact/day
29. contact with passengers=sociability*(Total Bus Demand+Total Car Demand+Total Metro Demand+Total Trail Demand+Undecided passengers) Units: contact/day
30. conversion rate=contact of non passenger with passenger*Defuzzified effect of perception on fruitfulness of incuring mobility*fruitfulness of incuring mobility
    Units: passenger/day
31. cost per metro car=1e+006 Units: dollar/metro car
32. cost per trail mile=80000 Units: dollar/mile
33. "defuzzified effect of perception on c-b"=if then else ("fuzzy rule for c-b"[cbr2]=scb max value:OR:"fuzzy rule for c-b"[cbr3]=scb max value, 1.5-1.5*scb max value, if then else (("fuzzy rule for c-b"[cbr1]=scb max value:OR:"fuzzy rule for c-b"[cbr4]=scb max value:OR:"fuzzy rule for c-b"[cbr5]=scb max value:OR:"fuzzy rule for c-b"[cbr6]=scb max value:OR:"fuzzy rule for c-b"[cbr9]=scb max value):OR:(("fuzzy rule for c-b"[cbr1]=scb max value:OR:"fuzzy rule for c-b"[cbr4]=scb max value:OR:"fuzzy rule for c-b"[cbr5]=scb max value:OR:"fuzzy rule for c-b"[cbr6]=scb max value:OR:"fuzzy rule for c-b"[cbr9]=scb max value):AND:("fuzzy rule for c-b"[cbr2]=scb max value:OR:"fuzzy rule for c-b"[cbr3]=scb max value)), 3-1.5*scb max value, if then else ("fuzzy rule for c-b"[cbr7]=scb max value:OR:"fuzzy rule for c-b"[cbr8]=scb max value:OR:(("fuzzy rule for c-b"[cbr2]=scb max value:OR:"fuzzy rule for c-b"[cbr3]=scb max value):AND:("fuzzy rule for c-b"[cbr7]=scb max value:OR:"fuzzy rule for c-b"[cbr8]=scb max value)):OR:(("fuzzy rule for c-b"[cbr1]=scb max value:OR:"fuzzy rule

for c-b"[cbr4]=scb max value:OR:"fuzzy rule for c-b"[cbr5]=scb max value:OR:"fuzzy rule for c-b"[cbr6]=scb max value:OR:"fuzzy rule for c-b"[cbr9]=scb max value):AND:("fuzzy rule for c-b"[cbr7]=scb max value:OR:"fuzzy rule for c-b"[cbr8]=scb max value)):OR:(("fuzzy rule for c-b"[cbr7]=scb max value:OR:"fuzzy rule for c-b"[cbr8]=scb max value):AND:("fuzzy rule for c-b"[cbr1]=scb max value:OR:"fuzzy rule for c-b"[cbr4]=scb max value:OR:"fuzzy rule for c-b"[cbr5]=scb max value:OR:"fuzzy rule for c-b"[cbr6]=scb max value:OR:"fuzzy rule for c-b"[cbr9]=scb max value):AND:("fuzzy rule for c-b"[cbr2]=scb max value:OR:"fuzzy rule for c-b"[cbr3]=scb max value)), 3, 1))) Units: Dmnl

34. Defuzzified effect of perception on fruitfulness of incuring mobility=
if then else ((Fuzzy Rule Definition[r28]=max value:OR:Fuzzy Rule Definition[r29]=max value:OR:Fuzzy Rule Definition[r31]=max value:OR:Fuzzy Rule Definition[r32]=max value:OR:Fuzzy Rule Definition[r34]=max value:OR:Fuzzy Rule Definition[r37]=max value:OR:Fuzzy Rule Definition[r38]=max value:OR:Fuzzy Rule Definition[r39]=max value:OR:Fuzzy Rule Definition[r40]=max value:OR:Fuzzy Rule Definition[r43]=max value:OR:Fuzzy Rule Definition[r46]=max value:OR:Fuzzy Rule Definition[r55]=max value:OR:Fuzzy Rule Definition[r56]=max value:OR:Fuzzy Rule Definition[r57]=max value:OR:Fuzzy Rule Definition[r58]=max value:OR:Fuzzy Rule Definition[r59]=max value:OR:Fuzzy Rule Definition[r60]=max value:OR:Fuzzy Rule Definition[r61]=max value:OR:Fuzzy Rule Definition[r62]=max value:OR:Fuzzy Rule Definition[r63]=max value:OR:Fuzzy Rule Definition[r64]=max value:OR:Fuzzy Rule Definition[r65]=max value:OR:Fuzzy Rule Definition[r66]=max value:OR:Fuzzy Rule Definition[r67]=max value:OR:Fuzzy Rule Definition[r70]=max value:OR:Fuzzy Rule Definition[r73]=max value:OR:Fuzzy Rule Definition[r74]=max value:OR:Fuzzy Rule Definition[r76]=max value:OR:Fuzzy Rule Definition[r82]=max value:OR:Fuzzy Rule Definition[r83]=max value:OR:Fuzzy Rule Definition[r84]=max value:OR:Fuzzy Rule Definition[r85]=max value:OR:Fuzzy Rule Definition[r86]=max value:OR:Fuzzy Rule Definition[r87]=max value:OR:Fuzzy Rule Definition[r88]=max value:OR:Fuzzy Rule Definition[r89]=max value:OR:Fuzzy Rule Definition[r91]=max value:OR:Fuzzy Rule Definition[r92]=max value:OR:Fuzzy Rule Definition[r94]=max value:OR:Fuzzy Rule Definition[r95]=max value:OR:Fuzzy Rule Definition[r96]=max value:OR:Fuzzy Rule Definition

[r97]=max value:OR:Fuzzy Rule Definition[r100]=max value:OR:Fuzzy Rule Definition [r101]=max value:OR:Fuzzy Rule Definition[r103]=max value:OR:Fuzzy Rule Definition[r106]=max value:OR:Fuzzy Rule Definition[r109]=max value:OR:Fuzzy Rule Definition[r110]=max value:OR:Fuzzy Rule Definition[r111]=max value:OR:Fuzzy Rule Definition[r112]=max value:OR:Fuzzy Rule Definition[r113]=max value:OR:Fuzzy Rule Definition[r114]=max value:OR:Fuzzy Rule Definition[r115]=max value:OR:Fuzzy Rule Definition[r116]=max value:OR:Fuzzy Rule Definition[r117]=max value:OR:Fuzzy Rule Definition[r118]=max value:OR:Fuzzy Rule Definition[r119]=max value:OR:Fuzzy Rule Definition[r120]=max value:OR:Fuzzy Rule Definition[r121]=max value:OR:Fuzzy Rule Definition[r122]=max value:OR:Fuzzy Rule Definition[r124]=max value:OR:Fuzzy Rule Definition[r127]=max value:OR:Fuzzy Rule Definition[r128]=max value:OR:Fuzzy Rule Definition[r129]=max value:OR:Fuzzy Rule Definition[r130]=max value:OR:Fuzzy Rule Definition[r131]=max value:OR:Fuzzy Rule Definition[r136]=max value:OR:Fuzzy Rule Definition[r137]=max value:OR:Fuzzy Rule Definition[r138]=max value:OR:Fuzzy Rule Definition[r139]=max value:OR:Fuzzy Rule Definition[r140]=max value:OR:Fuzzy Rule Definition[r141]=max value:OR:Fuzzy Rule Definition[r142]=max value:OR:Fuzzy Rule Definition[r143]=max value:OR:Fuzzy Rule Definition[r144]=max value:OR:Fuzzy Rule Definition[r145]=max value:OR:Fuzzy Rule Definition[r146]=max value:OR:Fuzzy Rule Definition[r147]=max value:OR:Fuzzy Rule Definition[r148]=max value:OR:Fuzzy Rule Definition[r151]=max value:OR:Fuzzy Rule Definition[r154]=max value:OR:Fuzzy Rule Definition[r155]=max value:OR:Fuzzy Rule Definition[r156]=max value:OR:Fuzzy Rule Definition[r157]=max value:OR:Fuzzy Rule Definition[r160]=max value:OR:Fuzzy Rule Definition[r163]=max value:OR:Fuzzy Rule Definition[r164]=max value:OR:Fuzzy Rule Definition[r165]=max value:OR:Fuzzy Rule Definition[r166]=max value:OR:Fuzzy Rule Definition[r167]=max value:OR:Fuzzy Rule Definition[r168]=max value:OR:Fuzzy Rule Definition[r169]=max value:OR:Fuzzy Rule Definition[r171]=max value:OR:Fuzzy Rule Definition[r172]=max value:OR:Fuzzy Rule Definition[r173]=max value:OR:Fuzzy Rule Definition[r174]=max value:OR:Fuzzy Rule Definition[r175]=max value:OR:Fuzzy Rule Definition[r178]=max value:OR:Fuzzy Rule Definition[r181]=max value:OR:Fuzzy Rule Definition[r182]=max value:OR:Fuzzy Rule Definition[r183]=max value:OR:Fuzzy Rule Definition[r184]=max value:OR:Fuzzy Rule Definition[r187]=max value:OR:Fuzzy Rule

Definition[r190]=max value:OR:Fuzzy Rule Definition[r191]=max value:OR:Fuzzy Rule Definition[r192]=max value:OR:Fuzzy Rule Definition[r193]=max value:OR:Fuzzy Rule Definition[r194]=max value:OR:Fuzzy Rule Definition[r195]=max value:OR:Fuzzy Rule Definition[r196]=max value:OR:Fuzzy Rule Definition[r197]=max value:OR:Fuzzy Rule Definition[r199]=max value:OR:Fuzzy Rule Definition[r200]=max value:OR:Fuzzy Rule Definition[r201]=max value:OR:Fuzzy Rule Definition[r202]=max value:OR:Fuzzy Rule Definition[r205]=max value:OR:Fuzzy Rule Definition[r208]=max value:OR:Fuzzy Rule Definition[r209]=max value:OR:Fuzzy Rule Definition[r211]=max value:OR:Fuzzy Rule Definition[r214]=max value:OR:Fuzzy Rule Definition[r217]=max value:OR:Fuzzy Rule Definition[r218]=max value:OR:Fuzzy Rule Definition[r219]=max value:OR:Fuzzy Rule Definition[r220]=max value:OR:Fuzzy Rule Definition[r221]=max value:OR:Fuzzy Rule Definition[r222]=max value:OR:Fuzzy Rule Definition[r223]=max value:OR:Fuzzy Rule Definition[r224]=max value:OR:Fuzzy Rule Definition[r225]=max value:OR:Fuzzy Rule Definition[r226]=max value:OR:Fuzzy Rule Definition[r227]=max value:OR:Fuzzy Rule Definition[r228]=max value:OR:Fuzzy Rule Definition[r229]=max value:OR:Fuzzy Rule Definition[r230]=max value:OR:Fuzzy Rule Definition[r232]=max value:OR:Fuzzy Rule Definition[r233]=max value:OR:Fuzzy Rule Definition[r235]=max value:OR:Fuzzy Rule Definition[r236]=max value:OR:Fuzzy Rule Definition[r237]=max value:OR:Fuzzy Rule Definition[r238]=max value:OR:Fuzzy Rule Definition[r241]=max value), (1.5-1.5*max value), if then else ((Fuzzy Rule Definition[r1]=max value:OR:Fuzzy Rule Definition [r2]=max value:OR:Fuzzy Rule Definition[r3]=max value:OR:Fuzzy Rule Definition [r4]=max value:OR:Fuzzy Rule Definition[r5]=max value:OR:Fuzzy Rule Definition [r7]=max value:OR:Fuzzy Rule Definition[r8]=max value:OR:Fuzzy Rule Definition [r10]=max value:OR:Fuzzy Rule Definition[r11]=max value:OR:Fuzzy Rule Definition [r13]=max value:OR:Fuzzy Rule Definition[r15]=max value:OR:Fuzzy Rule Definition [r16]=max value:OR:Fuzzy Rule Definition[r17]=max value:OR:Fuzzy Rule Definition [r19]=max value:OR:Fuzzy Rule Definition[r20]=max value:OR:Fuzzy Rule Definition [r22]=max value:OR:Fuzzy Rule Definition[r23]=max value:OR:Fuzzy Rule Definition [r25]=max value:OR:Fuzzy Rule Definition[r30]=max value:OR:Fuzzy Rule Definition [r33]=max value:OR:Fuzzy Rule Definition[r35]=max value:OR:Fuzzy Rule Definition [r36]=max value:OR:Fuzzy Rule Definition[r41]=max value:OR:Fuzzy Rule Definition

[r42]=max value:OR:Fuzzy Rule Definition[r44]=max value:OR:Fuzzy Rule Definition
[r47]=max value:OR:Fuzzy Rule Definition[r49]=max value:OR:Fuzzy Rule Definition
[r50]=max value:OR:Fuzzy Rule Definition[r52]=max value:OR:Fuzzy Rule Definition
[r53]=max value:OR:Fuzzy Rule Definition[r68]=max value:OR:Fuzzy Rule Definition
[r69]=max value:OR:Fuzzy Rule Definition[r71]=max value:OR:Fuzzy Rule Definition
[r72]=max value:OR:Fuzzy Rule Definition[r75]=max value:OR:Fuzzy Rule Definition
[r77]=max value:OR:Fuzzy Rule Definition[r78]=max value:OR:Fuzzy Rule Definition
[r79]=max value:OR:Fuzzy Rule Definition[r80]=max value:OR:Fuzzy Rule Definition
[r90]=max value:OR:Fuzzy Rule Definition[r93]=max value:OR:Fuzzy Rule Definition
[r98]=max value:OR:Fuzzy Rule Definition[r99]=max value:OR:Fuzzy Rule Definition
[r102]=max value:OR:Fuzzy Rule Definition[r104]=max value:OR:Fuzzy Rule
Definition[r105]=max value:OR:Fuzzy Rule Definition[r107]=max value:OR:Fuzzy Rule
Definition[r123]=max value:OR:Fuzzy Rule Definition[r125]=max value:OR:Fuzzy Rule
Definition[r126]=max value:OR:Fuzzy Rule Definition[r131]=max value:OR:Fuzzy Rule
Definition[r132]=max value:OR:Fuzzy Rule Definition[r134]=max value:OR:Fuzzy Rule
Definition[r149]=max value:OR:Fuzzy Rule Definition[r150]=max value:OR:Fuzzy Rule
Definition[r152]=max value:OR:Fuzzy Rule Definition[r153]=max value:OR:Fuzzy Rule
Definition[r158]=max value:OR:Fuzzy Rule Definition[r159]=max value:OR:Fuzzy Rule
Definition[r161]=max value:OR:Fuzzy Rule Definition[r170]=max value:OR:Fuzzy Rule
Definition[r176]=max value:OR:Fuzzy Rule Definition[r177]=max value:OR:Fuzzy Rule
Definition[r179]=max value:OR:Fuzzy Rule Definition[r180]=max value:OR:Fuzzy Rule
Definition[r185]=max value:OR:Fuzzy Rule Definition[r186]=max value:OR:Fuzzy Rule
Definition[r188]=max value:OR:Fuzzy Rule Definition[r198]=max value:OR:Fuzzy Rule
Definition[r203]=max value:OR:Fuzzy Rule Definition[r204]=max value:OR:Fuzzy Rule
Definition[r206]=max value:OR:Fuzzy Rule Definition[r207]=max value:OR:Fuzzy Rule
Definition[r210]=max value:OR:Fuzzy Rule Definition[r212]=max value:OR:Fuzzy Rule
Definition[r213]=max value:OR:Fuzzy Rule Definition[r215]=max value:OR:Fuzzy Rule
Definition[r231]=max value:OR:Fuzzy Rule Definition[r234]=max value:OR:Fuzzy Rule
Definition[r239]=max value:OR:Fuzzy Rule Definition[r240]=max value:OR:Fuzzy Rule
Definition[r242]=max value) , (3-1.5*max value), if then else ((Fuzzy Rule Definition
[r6]=max value:OR:Fuzzy Rule Definition[r9]=max value:OR:Fuzzy Rule Definition

[r12]=max value:OR:Fuzzy Rule Definition[r14]=max value:OR:Fuzzy Rule Definition [r18]=max value:OR:Fuzzy Rule Definition[r21]=max value:OR:Fuzzy Rule Definition [r24]=max value:OR:Fuzzy Rule Definition[r26]=max value:OR:Fuzzy Rule Definition [r27]=max value:OR:Fuzzy Rule Definition[r45]=max value:OR:Fuzzy Rule Definition [r48]=max value:OR:Fuzzy Rule Definition[r51]=max value:OR:Fuzzy Rule Definition [r54]=max value:OR:Fuzzy Rule Definition[r81]=max value:OR:Fuzzy Rule Definition [r108]=max value:OR:Fuzzy Rule Definition[r135]=max value:OR:Fuzzy Rule Definition[r162]=max value:OR:Fuzzy Rule Definition[r189]=max value:OR:Fuzzy Rule Definition[r216]=max value:OR:Fuzzy Rule Definition[r243]=max value), 3, if then else ((Fuzzy Rule Definition[r28]=max value:OR:Fuzzy Rule Definition[r29]=max value :OR:Fuzzy Rule Definition[r31]=max value:OR:Fuzzy Rule Definition[r32]=max value :OR:Fuzzy Rule Definition[r34]=max value:OR:Fuzzy Rule Definition[r37]=max value :OR:Fuzzy Rule Definition[r38]=max value:OR:Fuzzy Rule Definition[r39]=max value :OR:Fuzzy Rule Definition[r40]=max value:OR:Fuzzy Rule Definition[r43]=max value :OR:Fuzzy Rule Definition[r46]=max value:OR:Fuzzy Rule Definition[r55]=max value :OR:Fuzzy Rule Definition[r56]=max value:OR:Fuzzy Rule Definition[r57]=max value :OR:Fuzzy Rule Definition[r58]=max value:OR:Fuzzy Rule Definition[r59]=max value :OR:Fuzzy Rule Definition[r60]=max value:OR:Fuzzy Rule Definition[r61]=max value :OR:Fuzzy Rule Definition[r62]=max value:OR:Fuzzy Rule Definition[r63]=max value :OR:Fuzzy Rule Definition[r64]=max value:OR:Fuzzy Rule Definition[r65]=max value :OR:Fuzzy Rule Definition[r66]=max value:OR:Fuzzy Rule Definition[r67]=max value :OR:Fuzzy Rule Definition[r70]=max value:OR:Fuzzy Rule Definition[r73]=max value :OR:Fuzzy Rule Definition[r74]=max value:OR:Fuzzy Rule Definition[r76]=max value :OR:Fuzzy Rule Definition[r82]=max value:OR:Fuzzy Rule Definition[r83]=max value :OR:Fuzzy Rule Definition[r84]=max value:OR:Fuzzy Rule Definition[r85]=max value :OR:Fuzzy Rule Definition[r86]=max value:OR:Fuzzy Rule Definition[r87]=max value :OR:Fuzzy Rule Definition[r88]=max value:OR:Fuzzy Rule Definition[r89]=max value :OR:Fuzzy Rule Definition[r91]=max value:OR:Fuzzy Rule Definition[r92]=max value :OR:Fuzzy Rule Definition[r94]=max value:OR:Fuzzy Rule Definition[r95]=max value :OR:Fuzzy Rule Definition[r96]=max value:OR:Fuzzy Rule Definition[r97]=max value

:OR:Fuzzy Rule Definition[r100]=max value:OR:Fuzzy Rule Definition[r101]=max value:OR:Fuzzy Rule Definition[r103]=max value:OR:Fuzzy Rule Definition[r106]=max value:OR:Fuzzy Rule Definition[r109]=max value:OR:Fuzzy Rule Definition[r110]=max value:OR:Fuzzy Rule Definition[r111]=max value:OR:Fuzzy Rule Definition[r112]=max value:OR:Fuzzy Rule Definition[r113]=max value:OR:Fuzzy Rule Definition[r114]=max value:OR:Fuzzy Rule Definition[r115]=max value:OR:Fuzzy Rule Definition[r116]=max value:OR:Fuzzy Rule Definition[r117]=max value:OR:Fuzzy Rule Definition[r118]=max value:OR:Fuzzy Rule Definition[r119]=max value:OR:Fuzzy Rule Definition[r120]=max value:OR:Fuzzy Rule Definition[r121]=max value:OR:Fuzzy Rule Definition[r122]=max value:OR:Fuzzy Rule Definition[r124]=max value:OR:Fuzzy Rule Definition[r127]=max value:OR:Fuzzy Rule Definition[r128]=max value:OR:Fuzzy Rule Definition[r129]=max value:OR:Fuzzy Rule Definition[r130]=max value:OR:Fuzzy Rule Definition[r131]=max value:OR:Fuzzy Rule Definition[r136]=max value:OR:Fuzzy Rule Definition[r137]=max value:OR:Fuzzy Rule Definition[r138]=max value:OR:Fuzzy Rule Definition[r139]=max value:OR:Fuzzy Rule Definition[r140]=max value:OR:Fuzzy Rule Definition[r141]=max value:OR:Fuzzy Rule Definition[r142]=max value:OR:Fuzzy Rule Definition[r143]=max value:OR:Fuzzy Rule Definition[r144]=max value:OR:Fuzzy Rule Definition[r145]=max value:OR:Fuzzy Rule Definition[r146]=max value:OR:Fuzzy Rule Definition[r147]=max value:OR:Fuzzy Rule Definition[r148]=max value:OR:Fuzzy Rule Definition[r151]=max value:OR:Fuzzy Rule Definition[r154]=max value:OR:Fuzzy Rule Definition[r155]=max value:OR:Fuzzy Rule Definition[r156]=max value:OR:Fuzzy Rule Definition[r157]=max value:OR:Fuzzy Rule Definition[r160]=max value:OR:Fuzzy Rule Definition[r163]=max value:OR:Fuzzy Rule Definition[r164]=max value:OR:Fuzzy Rule Definition[r165]=max value:OR:Fuzzy Rule Definition[r166]=max value:OR:Fuzzy Rule Definition[r167]=max value:OR:Fuzzy Rule Definition[r168]=max value:OR:Fuzzy Rule Definition[r169]=max value:OR:Fuzzy Rule Definition[r171]=max value:OR:Fuzzy Rule Definition[r172]=max value:OR:Fuzzy Rule Definition[r173]=max value:OR:Fuzzy Rule Definition[r174]=max value:OR:Fuzzy Rule Definition[r175]=max value:OR:Fuzzy Rule Definition[r178]=max value:OR:Fuzzy Rule Definition[r181]=max value:OR:Fuzzy Rule Definition[r182]=max value:OR:Fuzzy Rule Definition[r183]=max value:OR:Fuzzy Rule Definition[r184]=max value:OR:Fuzzy Rule Definition[r187]=max value:OR:Fuzzy Rule Definition[r190]=max

value:OR:Fuzzy Rule Definition[r191]=max value:OR:Fuzzy Rule Definition[r192]=max value:OR:Fuzzy Rule Definition[r193]=max value:OR:Fuzzy Rule Definition[r194]=max value:OR:Fuzzy Rule Definition[r195]=max value:OR:Fuzzy Rule Definition[r196]=max value:OR:Fuzzy Rule Definition[r197]=max value:OR:Fuzzy Rule Definition[r199]=max value:OR:Fuzzy Rule Definition[r200]=max value:OR:Fuzzy Rule Definition[r201]=max value:OR:Fuzzy Rule Definition[r202]=max value:OR:Fuzzy Rule Definition[r205]=max value:OR:Fuzzy Rule Definition[r208]=max value:OR:Fuzzy Rule Definition[r209]=max value:OR:Fuzzy Rule Definition[r211]=max value:OR:Fuzzy Rule Definition[r214]=max value:OR:Fuzzy Rule Definition[r217]=max value:OR:Fuzzy Rule Definition[r218]=max value:OR:Fuzzy Rule Definition[r219]=max value:OR:Fuzzy Rule Definition[r220]=max value:OR:Fuzzy Rule Definition[r221]=max value:OR:Fuzzy Rule Definition[r222]=max value:OR:Fuzzy Rule Definition[r223]=max value:OR:Fuzzy Rule Definition[r224]=max value:OR:Fuzzy Rule Definition[r225]=max value:OR:Fuzzy Rule Definition[r226]=max value:OR:Fuzzy Rule Definition[r227]=max value:OR:Fuzzy Rule Definition[r228]=max value:OR:Fuzzy Rule Definition[r229]=max value:OR:Fuzzy Rule Definition[r230]=max value:OR:Fuzzy Rule Definition[r232]=max value:OR:Fuzzy Rule Definition[r233]=max value:OR:Fuzzy Rule Definition[r235]=max value:OR:Fuzzy Rule Definition[r236]=max value:OR:Fuzzy Rule Definition[r237]=max value:OR:Fuzzy Rule Definition[r238]=max value:OR:Fuzzy Rule Definition[r241]=max value):AND: (Fuzzy Rule Definition[r1]= max value:OR:Fuzzy Rule Definition[r2]=max value:OR:Fuzzy Rule Definition[r3]=max value:OR:Fuzzy Rule Definition[r4]=max value:OR:Fuzzy Rule Definition [r5]=max value:OR:Fuzzy Rule Definition[r7]=max value:OR:Fuzzy Rule Definition [r8]=max value:OR:Fuzzy Rule Definition[r10]=max value:OR:Fuzzy Rule Definition [r11]=max value:OR:Fuzzy Rule Definition[r13]=max value:OR:Fuzzy Rule Definition [r15]=max value:OR:Fuzzy Rule Definition[r16]=max value:OR:Fuzzy Rule Definition [r17]=max value:OR:Fuzzy Rule Definition[r19]=max value:OR:Fuzzy Rule Definition [r20]=max value:OR:Fuzzy Rule Definition[r22]=max value:OR:Fuzzy Rule Definition [r23]=max value:OR:Fuzzy Rule Definition[r25]=max value:OR:Fuzzy Rule Definition [r30]=max value:OR:Fuzzy Rule Definition[r33]=max value:OR:Fuzzy Rule Definition [r35]=max value:OR:Fuzzy Rule Definition[r36]=max value:OR:Fuzzy Rule Definition [r41]=max value:OR:Fuzzy Rule Definition[r42]=max value:OR:Fuzzy Rule Definition

[r44]=max value:OR:Fuzzy Rule Definition[r47]=max value:OR:Fuzzy Rule Definition [r49]=max value:OR:Fuzzy Rule Definition[r50]=max value:OR:Fuzzy Rule Definition [r52]=max value:OR:Fuzzy Rule Definition[r53]=max value:OR:Fuzzy Rule Definition [r68]=max value:OR:Fuzzy Rule Definition[r69]=max value:OR:Fuzzy Rule Definition [r71]=max value:OR:Fuzzy Rule Definition[r72]=max value:OR:Fuzzy Rule Definition [r75]=max value:OR:Fuzzy Rule Definition[r77]=max value:OR:Fuzzy Rule Definition [r78]=max value:OR:Fuzzy Rule Definition[r79]=max value:OR:Fuzzy Rule Definition [r80]=max value:OR:Fuzzy Rule Definition[r90]=max value:OR:Fuzzy Rule Definition [r93]=max value:OR:Fuzzy Rule Definition[r98]=max value:OR:Fuzzy Rule Definition [r99]=max value:OR:Fuzzy Rule Definition[r102]=max value:OR:Fuzzy Rule Definition [r104]=max value:OR:Fuzzy Rule Definition[r105]=max value:OR:Fuzzy Rule Definition[r107]=max value:OR:Fuzzy Rule Definition[r123]=max value:OR:Fuzzy Rule Definition[r125]=max value:OR:Fuzzy Rule Definition[r126]=max value:OR:Fuzzy Rule Definition[r131]=max value:OR:Fuzzy Rule Definition[r132]=max value:OR:Fuzzy Rule Definition[r134]=max value:OR:Fuzzy Rule Definition[r149]=max value:OR:Fuzzy Rule Definition[r150]=max value:OR:Fuzzy Rule Definition[r152]=max value:OR:Fuzzy Rule Definition[r153]=max value:OR:Fuzzy Rule Definition[r158]=max value:OR:Fuzzy Rule Definition[r159]=max value:OR:Fuzzy Rule Definition[r161]=max value:OR:Fuzzy Rule Definition[r170]=max value:OR:Fuzzy Rule Definition[r176]=max value:OR:Fuzzy Rule Definition[r177]=max value:OR:Fuzzy Rule Definition[r179]=max value:OR:Fuzzy Rule Definition[r180]=max value:OR:Fuzzy Rule Definition[r185]=max value:OR:Fuzzy Rule Definition[r186]=max value:OR:Fuzzy Rule Definition[r188]=max value:OR:Fuzzy Rule Definition[r198]=max value:OR:Fuzzy Rule Definition[r203]=max value:OR:Fuzzy Rule Definition[r204]=max value:OR:Fuzzy Rule Definition[r206]=max value:OR:Fuzzy Rule Definition[r207]=max value:OR:Fuzzy Rule Definition[r210]=max value:OR:Fuzzy Rule Definition[r212]=max value:OR:Fuzzy Rule Definition[r213]=max value:OR:Fuzzy Rule Definition[r215]=max value:OR:Fuzzy Rule Definition[r231]=max value:OR:Fuzzy Rule Definition[r234]=max value:OR:Fuzzy Rule Definition[r239]=max value:OR:Fuzzy Rule Definition[r240]=max value:OR:Fuzzy Rule Definition[r242]=max value) , (3-1.5*max value), if then else (((Fuzzy Rule Definition[r28]=max value:OR:Fuzzy Rule Definition [r29]=max value:OR:Fuzzy Rule Definition[r31]=max value:OR:Fuzzy Rule Definition

[r32]=max value:OR:Fuzzy Rule Definition[r34]=max value:OR:Fuzzy Rule Definition
[r37]=max value:OR:Fuzzy Rule Definition[r38]=max value:OR:Fuzzy Rule Definition
[r39]=max value:OR:Fuzzy Rule Definition[r40]=max value:OR:Fuzzy Rule Definition
[r43]=max value:OR:Fuzzy Rule Definition[r46]=max value:OR:Fuzzy Rule Definition
[r55]=max value:OR:Fuzzy Rule Definition[r56]=max value:OR:Fuzzy Rule Definition
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Definition[r106]=max value:OR:Fuzzy Rule Definition[r109]=max value:OR:Fuzzy Rule
Definition[r110]=max value:OR:Fuzzy Rule Definition[r111]=max value:OR:Fuzzy Rule
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Definition[r116]=max value:OR:Fuzzy Rule Definition[r117]=max value:OR:Fuzzy Rule
Definition[r118]=max value:OR:Fuzzy Rule Definition[r119]=max value:OR:Fuzzy Rule
Definition[r120]=max value:OR:Fuzzy Rule Definition[r121]=max value:OR:Fuzzy Rule
Definition[r122]=max value:OR:Fuzzy Rule Definition[r124]=max value:OR:Fuzzy Rule
Definition[r127]=max value:OR:Fuzzy Rule Definition[r128]=max value:OR:Fuzzy Rule
Definition[r129]=max value:OR:Fuzzy Rule Definition[r130]=max value:OR:Fuzzy Rule

Definition[r131]=max value:OR:Fuzzy Rule Definition[r136]=max value:OR:Fuzzy Rule Definition[r137]=max value:OR:Fuzzy Rule Definition[r138]=max value:OR:Fuzzy Rule Definition[r139]=max value:OR:Fuzzy Rule Definition[r140]=max value:OR:Fuzzy Rule Definition[r141]=max value:OR:Fuzzy Rule Definition[r142]=max value:OR:Fuzzy Rule Definition[r143]=max value:OR:Fuzzy Rule Definition[r144]=max value:OR:Fuzzy Rule Definition[r145]=max value:OR:Fuzzy Rule Definition[r146]=max value:OR:Fuzzy Rule Definition[r147]=max value:OR:Fuzzy Rule Definition[r148]=max value:OR:Fuzzy Rule Definition[r151]=max value:OR:Fuzzy Rule Definition[r154]=max value:OR:Fuzzy Rule Definition[r155]=max value:OR:Fuzzy Rule Definition[r156]=max value:OR:Fuzzy Rule Definition[r157]=max value:OR:Fuzzy Rule Definition[r160]=max value:OR:Fuzzy Rule Definition[r163]=max value:OR:Fuzzy Rule Definition[r164]=max value:OR:Fuzzy Rule Definition[r165]=max value:OR:Fuzzy Rule Definition[r166]=max value:OR:Fuzzy Rule Definition[r167]=max value:OR:Fuzzy Rule Definition[r168]=max value:OR:Fuzzy Rule Definition[r169]=max value:OR:Fuzzy Rule Definition[r171]=max value:OR:Fuzzy Rule Definition[r172]=max value:OR:Fuzzy Rule Definition[r173]=max value:OR:Fuzzy Rule Definition[r174]=max value:OR:Fuzzy Rule Definition[r175]=max value:OR:Fuzzy Rule Definition[r178]=max value:OR:Fuzzy Rule Definition[r181]=max value:OR:Fuzzy Rule Definition[r182]=max value:OR:Fuzzy Rule Definition[r183]=max value:OR:Fuzzy Rule Definition[r184]=max value:OR:Fuzzy Rule Definition[r187]=max value:OR:Fuzzy Rule Definition[r190]=max value:OR:Fuzzy Rule Definition[r191]=max value:OR:Fuzzy Rule Definition[r192]=max value:OR:Fuzzy Rule Definition[r193]=max value:OR:Fuzzy Rule Definition[r194]=max value:OR:Fuzzy Rule Definition[r195]=max value:OR:Fuzzy Rule Definition[r196]=max value:OR:Fuzzy Rule Definition[r197]=max value:OR:Fuzzy Rule Definition[r199]=max value:OR:Fuzzy Rule Definition[r200]=max value:OR:Fuzzy Rule Definition[r201]=max value:OR:Fuzzy Rule Definition[r202]=max value:OR:Fuzzy Rule Definition[r205]=max value:OR:Fuzzy Rule Definition[r208]=max value:OR:Fuzzy Rule Definition[r209]=max value:OR:Fuzzy Rule Definition[r211]=max value:OR:Fuzzy Rule Definition[r214]=max value:OR:Fuzzy Rule Definition[r217]=max value:OR:Fuzzy Rule Definition[r218]=max value:OR:Fuzzy Rule Definition[r219]=max value:OR:Fuzzy Rule Definition[r220]=max value:OR:Fuzzy Rule Definition[r221]=max value:OR:Fuzzy Rule Definition[r222]=max value:OR:Fuzzy Rule Definition[r223]=max value:OR:Fuzzy Rule

Definition[r224]=max value:OR:Fuzzy Rule Definition[r225]=max value:OR:Fuzzy Rule Definition[r226]=max value:OR:Fuzzy Rule Definition[r227]=max value:OR:Fuzzy Rule Definition[r228]=max value:OR:Fuzzy Rule Definition[r229]=max value:OR:Fuzzy Rule Definition[r230]=max value:OR:Fuzzy Rule Definition[r232]=max value:OR:Fuzzy Rule Definition[r233]=max value:OR:Fuzzy Rule Definition[r235]=max value:OR:Fuzzy Rule Definition[r236]=max value:OR:Fuzzy Rule Definition[r237]=max value:OR:Fuzzy Rule Definition[r238]=max value:OR:Fuzzy Rule Definition[r241]=max value):AND:(Fuzzy Rule Definition[r6]=max value:OR:Fuzzy Rule Definition[r9]=max value:OR:Fuzzy Rule Definition[r12]=max value:OR:Fuzzy Rule Definition[r14]=max value:OR:Fuzzy Rule Definition[r18]=max value:OR:Fuzzy Rule Definition[r21]=max value:OR:Fuzzy Rule Definition[r24]=max value:OR:Fuzzy Rule Definition[r26]=max value:OR:Fuzzy Rule Definition[r27]=max value:OR:Fuzzy Rule Definition[r45]=max value:OR:Fuzzy Rule Definition[r48]=max value:OR:Fuzzy Rule Definition[r51]=max value:OR:Fuzzy Rule Definition[r54]=max value:OR:Fuzzy Rule Definition[r81]=max value:OR:Fuzzy Rule Definition[r108]=max value:OR:Fuzzy Rule Definition[r135]=max value:OR:Fuzzy Rule Definition[r162]=max value:OR:Fuzzy Rule Definition[r189]=max value:OR:Fuzzy Rule Definition[r216]=max value:OR:Fuzzy Rule Definition[r243]=max value)), 3, 1)))))

Units: Dmnl

35. "defuzzified effect of perception on switching b-c"=if then else ("fuzzy rule for switching b-c"[bcr6]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr8]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr9]=sbc max value,1.5-1.5*sbc max value, if then else ("fuzzy rule for switching b-c"[bcr2]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr3]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr4]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr5]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr7]=sbc max value:OR:(("fuzzy rule for switching b-c"[bcr6]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr8]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr9]=sbc max value):AND:("fuzzy rule for switching b-c"[bcr2]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr3]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr4]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr5]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr7]=sbc max value)), 3-1.5*sbc max value, if then else ("fuzzy rule for switching b-c"[bcr1]=sbc max value:OR:(("fuzzy rule for

switching b-c"[bcr6]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr8]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr9]=sbc max value):AND:("fuzzy rule for switching b-c"[bcr1]=sbc max value)):OR:(("fuzzy rule for switching b-c"[bcr2]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr3]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr4]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr5]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr7]=sbc max value):AND:("fuzzy rule for switching b-c"[bcr1]=sbc max value)):OR:(("fuzzy rule for switching b-c"[bcr1]=sbc max value):AND:("fuzzy rule for switching b-c"[bcr6]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr8]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr9]=sbc max value):AND:("fuzzy rule for switching b-c"[bcr2]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr3]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr4]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr5]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr7]=sbc max value)), 3, 1))) Units: Dmnl

36. "defuzzified effect of perception on switching b-m"=if then else ("fuzzy rule for switching b-m"[sbmr1]=sbm max value, 1.5-1.5*sbm max value, if then else ("fuzzy rule for switching b-m"[sbmr2]=sbm max value:OR:(("fuzzy rule for switching b-m"[sbmr2]=sbm max value):AND:("fuzzy rule for switching b-m"[sbmr1]=sbm max value)), 3-1.5*sbm max value, if then else ("fuzzy rule for switching b-m"[sbmr3]=sbm max value:OR:(("fuzzy rule for switching b-m"[sbmr3]=sbm max value):AND:("fuzzy rule for switching b-m"[sbmr3]=sbm max value)), 3, 1))) Units: Dmnl
37. "defuzzified effect of perception on switching b-t"=if then else ("fuzzy rule for switching b-t"[sbtr1]=sbt max value, 1.5-1.5*sbt max value, if then else ("fuzzy rule for switching b-t"[sbtr2]=sbt max value:OR:("fuzzy rule for switching b-t"[sbtr1]=sbt max value:AND:"fuzzy rule for switching b-t"[sbtr2]=sbt max value), 3-1.5*sbt max value, if then else ("fuzzy rule for switching b-t"[sbtr3]=sbt max value:OR:("fuzzy rule for switching b-t"[sbtr2]=sbt max value:AND:"fuzzy rule for switching b-t"[sbtr3]=sbt max value), 3, 1))) Units: Dmnl
38. "defuzzified effect of perception on switching c-m"=if then else ("fuzzy rul for switching c-m"[scmr1]=scm max value, 1.5-1.5*scm max value, if then else ("fuzzy rul for switching c-m"[scmr2]=scm max value:OR:("fuzzy rul for switching c-m"[scmr2]=scm max value:AND:"fuzzy rul for switching c-m"[scmr1]=scm max value), 3-1.5*scm max

value, if then else ("fuzzy rul for switching c-m"[scmr3]=scm max value:OR:("fuzzy rul for switching c-m"[scmr2]=scm max value:AND:"fuzzy rul for switching cm"[scmr3]=scm max value), 3, 1))) Units: Dmnl

39. "defuzzified effect of perception on switching c-t"=if then else ("fuzzy rule for switchign c-t"[sctr1]=sct max value, 1.5-1.5*sct max value, if then else ("fuzzy rule for switchign c-t"[sctr1]=sct max value:OR: ("fuzzy rule for switchign c-t"[sctr1]=sct max value:AND:"fuzzy rule for switchign c-t"[sctr2]=sct max value), 3-1.5*sct max value, if then else ("fuzzy rule for switchign c-t"[sctr2]=sct max value:OR:("fuzzy rule for switching c-t"[sctr2]=sct max value:AND:"fuzzy rule for switchign c-t"[sctr3]=sct max value), 3, 1))) Units: Dmnl
40. "defuzzified effect of perception on switching m-b"=if then else ("fuzzy rule for switching m-b"[smbr2]=smb max value:OR:"fuzzy rule for switching m-b"[smbr3]=smb max value, 1.5-1.5*smb max value, if then else (("fuzzy rule for switching m-b"[smbr1]=smb max value:OR:"fuzzy rule for switching m-b"[smbr4]=smb max value :OR:"fuzzy rule for switching m-b"[smbr5]=smb max value:OR:"fuzzy rule for switching m-b"[smbr6]=smb max value:OR:"fuzzy rule for switching m-b"[smbr9]=smb max value):OR:(("fuzzy rule for switching m-b"[smbr1]=smb max value:OR:"fuzzy rule for switching m-b"[smbr2]=smb max value:OR:"fuzzy rule for switching m-b"[smbr3]=smb max value:OR:"fuzzy rule for switching m-b"[smbr4]=smb max value:OR:"fuzzy rule for switching m-b"[smbr9]=smb max value):AND:("fuzzy rule for switching m-b"[smbr5]=smb max value:OR:"fuzzy rule for switching m-b"[smbr6]=smb max value:OR:"fuzzy rule for switching m-b"[smbr8]=smb max value)), 3-1.5*smb max value, if then else ("fuzzy rule for switching m-b"[smbr7]=smb max value:OR:(("fuzzy rule for switching m-b"[smbr1]=smb max value:OR:"fuzzy rule for switching m-b"[smbr2]=smb max value:OR:"fuzzy rule for switching m-b"[smbr3]=smb max value:OR:"fuzzy rule for switching m-b"[smbr4]=smb max value:OR:"fuzzy rule for switching m-b"[smbr9]=smb max value):AND:("fuzzy rule for switching m-b"[smbr7]=smb max value)):OR:(("fuzzy rule for switching m-b"[smbr5]=smb max value:OR:"fuzzy rule for switching m-b"[smbr6]=smb max value:OR:"fuzzy rule for switching m-b"[smbr8]=smb max value):AND:("fuzzy rule for switching m-b"[smbr7]=smb max value)):OR:(("fuzzy rule for switching m-b"[smbr5]=smb max

value:OR:"fuzzy rule for switching m-b"[smbr6]=smb max value:OR:"fuzzy rule for switching m-b"[smbr8]=smb max value):AND:("fuzzy rule for switching m-b"[smbr7]=smb max value):AND:("fuzzy rule for switching m-b"[smbr1]=smb max value:OR:"fuzzy rule for switching m-b"[smbr2]=smb max value:OR:"fuzzy rule for switching m-b"[smbr3]=smb max value:OR:"fuzzy rule for switching m-b"[smbr4]=smb max value:OR:"fuzzy rule for switching m-b"[smbr9]=smb max value)), 3, 1)))

Units: Dmnl

41. "defuzzified effect of perception on switching m-c"=if then else ("fuzzy rule for switchign m-c"[smcr5]:OR:"fuzzy rule for switchign m-c"[smcr6]:OR:"fuzzy rule for switchign m-c"[smcr8]:OR:"fuzzy rule for switchign m-c"[smcr9], 1.5-1.5*smc max value, if then else (("fuzzy rule for switchign m-c"[smcr3]:OR:"fuzzy rule for switchign m-c"[smcr4]:OR:"fuzzy rule for switchign m-c"[smcr7]):OR:(("fuzzy rule for switchign m-c"[smcr5]:OR:"fuzzy rule for switchign m-c"[smcr6]:OR:"fuzzy rule for switchign m-c"[smcr8]:OR:"fuzzy rule for switchign m-c"[smcr9]):AND:("fuzzy rule for switchign m-c"[smcr3]:OR:"fuzzy rule for switchign m-c"[smcr4]:OR:"fuzzy rule for switchign m-c"[smcr7])), 3-1.5*smc max value, if then else(("fuzzy rule for switchign m-c"[smcr1]:OR:"fuzzy rule for switchign m-c"[smcr2]):OR:(("fuzzy rule for switchign m-c"[smcr1]:OR:"fuzzy rule for switchign m-c"[smcr2]):AND:("fuzzy rule for switchign m-c"[smcr3]:OR:"fuzzy rule for switchign m-c"[smcr4]:OR:"fuzzy rule for switchign m-c"[smcr7])):OR:(("fuzzy rule for switchign m-c"[smcr3]:OR:"fuzzy rule for switchign m-c"[smcr4]:OR:"fuzzy rule for switchign m-c"[smcr7]):AND:("fuzzy rule for switchign m-c"[smcr1]:OR:"fuzzy rule for switchign m-c"[smcr2])):OR:(("fuzzy rule for switchign m-c"[smcr1]:OR:"fuzzy rule for switchign m-c"[smcr2]):AND:("fuzzy rule for switchign m-c"[smcr3]:OR:"fuzzy rule for switchign m-c"[smcr4]:OR:"fuzzy rule for switchign m-c"[smcr7]):AND:("fuzzy rule for switchign m-c"[smcr5]:OR:"fuzzy rule for switchign m-c"[smcr6]:OR:"fuzzy rule for switchign m-c"[smcr8]:OR:"fuzzy rule for switchign m-c"[smcr9])), 3, 1)))

Units: Dmnl

42. "defuzzified effect of perception on switching t-b"=if then else("fuzzy rule for switching t-b"[stbr2]=stb max value:OR:"fuzzy rule for switching t-b"[stbr3]=stb max value, 1.5-1.5*stb max value, if then else (("fuzzy rule for switching t-b"[stbr1]=stb max value:OR:"fuzzy rule for switching t-b"[stbr4]=stb max value:OR:"fuzzy rule for

switching t-b"[stbr6]=stb max value:OR:"fuzzy rule for switching t-b"[stbr9]=stb max value):OR:(("fuzzy rule for switching t-b"[stbr2]=stb max value:OR:"fuzzy rule for switching t-b"[stbr3]=stb max value):AND:("fuzzy rule for switching t-b"[stbr1]=stb max value:OR:"fuzzy rule for switching t-b"[stbr4]=stb max value:OR:"fuzzy rule for switching t-b"[stbr6]=stb max value:OR:"fuzzy rule for switching t-b"[stbr9]=stb max value)), 3-1.5*stb max value, if then else (("fuzzy rule for switching t-b"[stbr5]=stb max value:OR:"fuzzy rule for switching t-b"[stbr7]=stb max value:OR:"fuzzy rule for switching t-b"[stbr8]=stb max value):OR:(("fuzzy rule for switching t-b"[stbr2]=stb max value:OR:"fuzzy rule for switching t-b"[stbr3]=stb max value):AND:("fuzzy rule for switching t-b"[stbr5]=stb max value:OR:"fuzzy rule for switching t-b"[stbr7]=stb max value :OR:"fuzzy rule for switching t-b"[stbr8]=stb max value)):OR:(("fuzzy rule for switching t-b"[stbr1]=stb max value:OR:"fuzzy rule for switching t-b"[stbr4]=stb max value :OR:"fuzzy rule for switching t-b"[stbr6]=stb max value:OR:"fuzzy rule for switching t-b"[stbr9]=stb max value):AND:("fuzzy rule for switching t-b"[stbr5]=stb max value:OR:"fuzzy rule for switching t-b"[stbr7]=stb max value:OR:"fuzzy rule for switching t-b"[stbr8]=stb max value)):OR:(("fuzzy rule for switching t-b"[stbr2]=stb max value:OR:"fuzzy rule for switching t-b"[stbr3]=stb max value):AND:("fuzzy rule for switching t-b"[stbr1]=stb max value:OR:"fuzzy rule for switching t-b"[stbr4]=stb max value :OR:"fuzzy rule for switching t-b"[stbr6]=stb max value:OR:"fuzzy rule for switching t-b"[stbr9]=stb max value):AND:("fuzzy rule for switching t-b"[stbr5]=stb max value:OR:"fuzzy rule for switching t-b"[stbr7]=stb max value:OR:"fuzzy rule for switching t-b"[stbr8]=stb max value)), 3, 1))) Units: Dmnl

43. "defuzzified effect of perception on switching t-m"=if then else ("fuzzy rule for switching t-m"[stmr1]=stm max value, 1.5-1.5*stm max value, if then else ("fuzzy rule for switching t-m"[stmr2]=stm max value:OR:("fuzzy rule for switching t-m"[stmr1]=stm max value :AND:"fuzzy rule for switching t-m"[stmr2]=stm max value), 3-1.5*stm max value, if then else ("fuzzy rule for switching t-m"[stmr3]=stm max value:OR:("fuzzy rule for switching t-m"[stmr2]=stm max value:AND:"fuzzy rule for switching t-m"[stmr3]=stm max value), 3, 1))) Units: Dmnl
44. "defuzzified effect to of perception on switching t-c"=if then else ("fuzzy rule for switching t-c"[stcr5]=stc max value:OR:"fuzzy rule for switching t-c"[stcr6]=stc max

value:OR:"fuzzy rule for switching t-c"[stcr8]=stc max value:OR:"fuzzy rule for switching t-c"[stcr9]=stc max value, 1.5-1.5*stc max value, if then else (("fuzzy rule for switching t-c"[stcr2]=stc max value:OR:"fuzzy rule for switching t-c"[stcr3]=stc max value:OR:"fuzzy rule for switching t-c"[stcr4]=stc max value:OR:"fuzzy rule for switching t-c"[stcr7]=stc max value):OR:(("fuzzy rule for switching t-c"[stcr5]=stc max value:OR:"fuzzy rule for switching t-c"[stcr6]=stc max value:OR:"fuzzy rule for switching t-c"[stcr8]=stc max value:OR:"fuzzy rule for switching t-c"[stcr9]=stc max value):AND:("fuzzy rule for switching t-c"[stcr2]=stc max value:OR:"fuzzy rule for switching t-c"[stcr3]=stc max value:OR:"fuzzy rule for switching t-c"[stcr4]=stc max value:OR:"fuzzy rule for switching t-c"[stcr7]=stc max value)), 3-1.5*stc max value, if then else ("fuzzy rule for switching t-c"[stcr1]=stc max value:OR:("fuzzy rule for switching t-c"[stcr1]=stc max value:AND:("fuzzy rule for switching t-c"[stcr5]=stc max value:OR:"fuzzy rule for switching t-c"[stcr6]=stc max value:OR:"fuzzy rule for switching t-c"[stcr8]=stc max value:OR:"fuzzy rule for switching t-c"[stcr9]=stc max value)):OR:("fuzzy rule for switching t-c"[stcr1]=stc max value:AND:("fuzzy rule for switching t-c"[stcr2]=stc max value:OR:"fuzzy rule for switching t-c"[stcr3]=stc max value:OR:"fuzzy rule for switching t-c"[stcr4]=stc max value:OR:"fuzzy rule for switching t-c"[stcr7]=stc max value)):OR:("fuzzy rule for switching t-c"[stcr1]=stc max value :AND:("fuzzy rule for switching t-c"[stcr5]=stc max value:OR:"fuzzy rule for switching t-c"[stcr6]=stc max value:OR:"fuzzy rule for switching t-c"[stcr8]=stc max value:OR:"fuzzy rule for switching t-c"[stcr9]=stc max value):AND:("fuzzy rule for switching t-c"[stcr2]=stc max value:OR:"fuzzy rule for switching t-c"[stcr3]=stc max value:OR:"fuzzy rule for switching t-c"[stcr4]=stc max value:OR:"fuzzy rule for switching t-c"[stcr7]=stc max value)), 3, 1))) Units: Dmnl

45. "defuzzifife effect of perception on switching m-t"=if then else ("fuzzy rule for switching m-t"[smtr1]=smt max value, 1.5-1.5*smt max value, if then else ("fuzzy rule for switching m-t"[smtr2]=smt max value:OR: ("fuzzy rule for switching m-t"[smtr1]=smt max value:AND:"fuzzy rule for switching m-t"[smtr2]=smt max value), 3-1.5*smt max value, if then else ("fuzzy rule for switching m-t"[smtr3]=smt max value :OR:("fuzzy rule for switching m-t"[smtr2]=smt max valu:AND:"fuzzy rule for switching m-t"[smtr3]=smt max value), 3, 1))) Units: Dmnl

46. "delay-appropriation, construction for trail"=1800 Units: day
47. discount for local resident=0.4 Units: Dmnl
48. effect of speed on fuel consumption([(0,0)-(80,2)],(0,0),(15,1.5),(25,1.4),(35,1.2),(45,1),(55,0.9),(60,0.88))
Units: Dmnl
49. employment increment=8.1 Units: passenger/day
50. external cost per mile=if then else(Average Flow Rate=0, 0, if then else (Average Flow Rate<=10,0.15, if then else (Average Flow Rate<=25, 0.254, if then else (Average Flow Rate<=30, 0.3, if then else (Average Flow Rate<=40, 0.35, if then else (Average Flow Rate<=50, 0.4, if then else (Average Flow Rate<=60, 0.5, if then else (Average Flow Rate<=65, 0.7, if then else (Average Flow Rate<=70, 0.9, if then else (Average Flow Rate<=80, 1, 2)))))))))
Units: dollar/mile
51. FINAL TIME = 7200 Units: day
The final time for the simulation.
52. Flow Rate: FLow, FMedium, FHigh
53. fraction for bus=0.4 Units: Dmnl
54. fraction of disable people=0.01 Units: Dmnl
55. fraction of local resident=0.4 Units: Dmnl
56. fraction of work budget=0.15 Units: Dmnl
57. fraction of work trip by car=0.6 Units: Dmnl
58. fraction of work trip by metro=0.6 Units: Dmnl
59. fraction of work trip by trail=0.66 Units: Dmnl
60. fraction of work trip demand on bus=0.66 Units: Dmnl
61. fruitfulness of incuring mobility=0.0005 Units: person/contact
62. fuel price per gallon=2.5 Units: dollar/gallon
63. funding using for bus=if then else (bus discrepancy>=0, Revenue from Pricing Scheme*fraction for bus/appropriation and purchased delay for bus, 0)
Units: dollar/day
64. funding using for metro=if then else (metro car discrepancy>=0, (0.85-fraction for bus)*Revenue from Pricing Scheme/"appropriation /purchased delay for metro car", 0)
Units: dollar/day

65. funding using for pricing scheme implementation=0.05*Revenue from Pricing Scheme/appropriation delay for pricing scheme money Units: dollar/day
66. funding using for trail=if then else (trail discrepancy>=0, 0.1*Revenue from Pricing Scheme/"delay-appropriation, construction for trail", 0) Units: dollar/day
67. "fuzzy rul for switching c-m"[scmr1]="perception with respect to metro supply vs. demand"[MLow]"fuzzy rul for switching c-m"[scmr2]="perception with respect to metro supply vs. demand"[MMedium]"fuzzy rul for switching c-m"[scmr3]="perception with respect to metro supply vs. demand"[MHigh] Units: Dmnl
68. Fuzzy Rule Definition[r1]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))
69. Fuzzy Rule Definition[r2]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
70. Fuzzy Rule Definition[r3]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
71. Fuzzy Rule Definition[r4]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))
72. Fuzzy Rule Definition[r5]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

73. Fuzzy Rule Definition[r6]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
74. Fuzzy Rule Definition[r7]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))
75. Fuzzy Rule Definition[r8]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
76. Fuzzy Rule Definition[r9]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
77. Fuzzy Rule Definition[r10]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))
78. Fuzzy Rule Definition[r11]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

79. Fuzzy Rule Definition[r12]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
80. Fuzzy Rule Definition[r13]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))
81. Fuzzy Rule Definition[r14]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))
82. Fuzzy Rule Definition[r15]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
83. Fuzzy Rule Definition[r16]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))
84. Fuzzy Rule Definition[r17]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

85. Fuzzy Rule Definition[r18]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh]))))
86. Fuzzy Rule Definition[r19]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow]))))
87. Fuzzy Rule Definition[r20]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow]))))
88. Fuzzy Rule Definition[r21]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow]))))
89. Fuzzy Rule Definition[r22]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium]))))
90. Fuzzy Rule Definition[r23]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

91. Fuzzy Rule Definition[r24]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
92. Fuzzy Rule Definition[r25]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))
93. Fuzzy Rule Definition[r26]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
94. Fuzzy Rule Definition[r27]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
95. Fuzzy Rule Definition[r28]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))
96. Fuzzy Rule Definition[r29]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

97. Fuzzy Rule Definition[r30]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
98. Fuzzy Rule Definition[r31]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))
99. Fuzzy Rule Definition[r32]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))
100. Fuzzy Rule Definition[r33]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
101. Fuzzy Rule Definition[r34]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))
102. Fuzzy Rule Definition[r35]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

103. Fuzzy Rule Definition[r36]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

104. Fuzzy Rule Definition[r37]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

105. Fuzzy Rule Definition[r38]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

106. Fuzzy Rule Definition[r39]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

107. Fuzzy Rule Definition[r40]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

108. Fuzzy Rule Definition[r41]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

109. Fuzzy Rule Definition[r42]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

110. Fuzzy Rule Definition[r43]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

111. Fuzzy Rule Definition[r44]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

112. Fuzzy Rule Definition[r45]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

113. Fuzzy Rule Definition[r46]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

114. Fuzzy Rule Definition[r47]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

115. Fuzzy Rule Definition[r48]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

116. Fuzzy Rule Definition[r49]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

117. Fuzzy Rule Definition[r50]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

118. Fuzzy Rule Definition[r51]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

119. Fuzzy Rule Definition[r52]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

120. Fuzzy Rule Definition[r53]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh]))))

121. Fuzzy Rule Definition[r54]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

122. Fuzzy Rule Definition[r55]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

123. Fuzzy Rule Definition[r56]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

124. Fuzzy Rule Definition[r57]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

125. Fuzzy Rule Definition[r58]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

126. Fuzzy Rule Definition[r59]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

127. Fuzzy Rule Definition[r60]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

128. Fuzzy Rule Definition[r61]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

129. Fuzzy Rule Definition[r62]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

130. Fuzzy Rule Definition[r63]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

131. Fuzzy Rule Definition[r64]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

132. Fuzzy Rule Definition[r65]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

133. Fuzzy Rule Definition[r66]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

134. Fuzzy Rule Definition[r67]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

135. Fuzzy Rule Definition[r68]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

136. Fuzzy Rule Definition[r69]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

137. Fuzzy Rule Definition[r70]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

138. Fuzzy Rule Definition[r71]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

139. Fuzzy Rule Definition[r72]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

140. Fuzzy Rule Definition[r73]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

141. Fuzzy Rule Definition[r74]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

142. Fuzzy Rule Definition[r75]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

143. Fuzzy Rule Definition[r76]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

144. Fuzzy Rule Definition[r77]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

145. Fuzzy Rule Definition[r78]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

146. Fuzzy Rule Definition[r79]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

147. Fuzzy Rule Definition[r80]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

148. Fuzzy Rule Definition[r81]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

149. Fuzzy Rule Definition[r82]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

150. Fuzzy Rule Definition[r83]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

151. Fuzzy Rule Definition[r84]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

152. Fuzzy Rule Definition[r85]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

153. Fuzzy Rule Definition[r86]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

154. Fuzzy Rule Definition[r87]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

155. Fuzzy Rule Definition[r88]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

156. Fuzzy Rule Definition[r89]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

157. Fuzzy Rule Definition[r90]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

158. Fuzzy Rule Definition[r91]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

159. Fuzzy Rule Definition[r92]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

160. Fuzzy Rule Definition[r93]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

161. Fuzzy Rule Definition[r94]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

162. Fuzzy Rule Definition[r95]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

163. Fuzzy Rule Definition[r96]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

164. Fuzzy Rule Definition[r97]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

165. Fuzzy Rule Definition[r98]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

166. Fuzzy Rule Definition[r99]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

167. Fuzzy Rule Definition[r100]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

168. Fuzzy Rule Definition[r101]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

169. Fuzzy Rule Definition[r102]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

170. Fuzzy Rule Definition[r103]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

171. Fuzzy Rule Definition[r104]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

172. Fuzzy Rule Definition[r105]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

173. Fuzzy Rule Definition[r106]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

174. Fuzzy Rule Definition[r107]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh]))))

175. Fuzzy Rule Definition[r108]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

176. Fuzzy Rule Definition[r109]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

177. Fuzzy Rule Definition[r110]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

178. Fuzzy Rule Definition[r111]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

179. Fuzzy Rule Definition[r112]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

180. Fuzzy Rule Definition[r113]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

181. Fuzzy Rule Definition[r114]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

182. Fuzzy Rule Definition[r115]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

183. Fuzzy Rule Definition[r116]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

184. Fuzzy Rule Definition[r117]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

185. Fuzzy Rule Definition[r118]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

186. Fuzzy Rule Definition[r119]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

187. Fuzzy Rule Definition[r120]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

188. Fuzzy Rule Definition[r121]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

189. Fuzzy Rule Definition[r122]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

190. Fuzzy Rule Definition[r123]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

191. Fuzzy Rule Definition[r124]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

192. Fuzzy Rule Definition[r125]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

193. Fuzzy Rule Definition[r126]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

194. Fuzzy Rule Definition[r127]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

195. Fuzzy Rule Definition[r128]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

196. Fuzzy Rule Definition[r129]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

197. Fuzzy Rule Definition[r130]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

198. Fuzzy Rule Definition[r131]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

199. Fuzzy Rule Definition[r132]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

200. Fuzzy Rule Definition[r133]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

201. Fuzzy Rule Definition[r134]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

202. Fuzzy Rule Definition[r135]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

203. Fuzzy Rule Definition[r136]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

204. Fuzzy Rule Definition[r137]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

205. Fuzzy Rule Definition[r138]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

206. Fuzzy Rule Definition[r139]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

207. Fuzzy Rule Definition[r140]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

208. Fuzzy Rule Definition[r141]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

209. Fuzzy Rule Definition[r142]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

210. Fuzzy Rule Definition[r143]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

211. Fuzzy Rule Definition[r144]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

212. Fuzzy Rule Definition[r145]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

213. Fuzzy Rule Definition[r146]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

214. Fuzzy Rule Definition[r147]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

215. Fuzzy Rule Definition[r148]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

216. Fuzzy Rule Definition[r149]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

217. Fuzzy Rule Definition[r150]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

218. Fuzzy Rule Definition[r151]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

219. Fuzzy Rule Definition[r152]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

220. Fuzzy Rule Definition[r153]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

221. Fuzzy Rule Definition[r154]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

222. Fuzzy Rule Definition[r155]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

223. Fuzzy Rule Definition[r156]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

224. Fuzzy Rule Definition[r157]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

225. Fuzzy Rule Definition[r158]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

226. Fuzzy Rule Definition[r159]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

227. Fuzzy Rule Definition[r160]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

228. Fuzzy Rule Definition[r161]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

229. Fuzzy Rule Definition[r162]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

230. Fuzzy Rule Definition[r163]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

231. Fuzzy Rule Definition[r164]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

232. Fuzzy Rule Definition[r165]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

233. Fuzzy Rule Definition[r166]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

234. Fuzzy Rule Definition[r167]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

235. Fuzzy Rule Definition[r168]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

236. Fuzzy Rule Definition[r169]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

237. Fuzzy Rule Definition[r170]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

238. Fuzzy Rule Definition[r171]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

239. Fuzzy Rule Definition[r172]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

240. Fuzzy Rule Definition[r173]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

241. Fuzzy Rule Definition[r174]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

242. Fuzzy Rule Definition[r175]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

243. Fuzzy Rule Definition[r176]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

244. Fuzzy Rule Definition[r177]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

245. Fuzzy Rule Definition[r178]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

246. Fuzzy Rule Definition[r179]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

247. Fuzzy Rule Definition[r180]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

248. Fuzzy Rule Definition[r181]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

249. Fuzzy Rule Definition[r182]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

250. Fuzzy Rule Definition[r183]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

251. Fuzzy Rule Definition[r184]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

252. Fuzzy Rule Definition[r185]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

253. Fuzzy Rule Definition[r186]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

254. Fuzzy Rule Definition[r187]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

255. Fuzzy Rule Definition[r188]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

256. Fuzzy Rule Definition[r189]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

257. Fuzzy Rule Definition[r190]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

258. Fuzzy Rule Definition[r191]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

259. Fuzzy Rule Definition[r192]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

260. Fuzzy Rule Definition[r193]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

261. Fuzzy Rule Definition[r194]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

262. Fuzzy Rule Definition[r195]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

263. Fuzzy Rule Definition[r196]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

264. Fuzzy Rule Definition[r197]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

265. Fuzzy Rule Definition[r198]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

266. Fuzzy Rule Definition[r199]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

267. Fuzzy Rule Definition[r200]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

268. Fuzzy Rule Definition[r201]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

269. Fuzzy Rule Definition[r202]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

270. Fuzzy Rule Definition[r203]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

271. Fuzzy Rule Definition[r204]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

272. Fuzzy Rule Definition[r205]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

273. Fuzzy Rule Definition[r206]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

274. Fuzzy Rule Definition[r207]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

275. Fuzzy Rule Definition[r208]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

276. Fuzzy Rule Definition[r209]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

277. Fuzzy Rule Definition[r210]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

278. Fuzzy Rule Definition[r211]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

279. Fuzzy Rule Definition[r212]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

280. Fuzzy Rule Definition[r213]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

281. Fuzzy Rule Definition[r214]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

282. Fuzzy Rule Definition[r215]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh]))))

283. Fuzzy Rule Definition[r216]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

284. Fuzzy Rule Definition[r217]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

285. Fuzzy Rule Definition[r218]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

286. Fuzzy Rule Definition[r219]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

287. Fuzzy Rule Definition[r220]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

288. Fuzzy Rule Definition[r221]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

289. Fuzzy Rule Definition[r222]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

290. Fuzzy Rule Definition[r223]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

291. Fuzzy Rule Definition[r224]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

292. Fuzzy Rule Definition[r225]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

293. Fuzzy Rule Definition[r226]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

294. Fuzzy Rule Definition[r227]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

295. Fuzzy Rule Definition[r228]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

296. Fuzzy Rule Definition[r229]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

297. Fuzzy Rule Definition[r230]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

298. Fuzzy Rule Definition[r231]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

299. Fuzzy Rule Definition[r232]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

300. Fuzzy Rule Definition[r233]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

301. Fuzzy Rule Definition[r234]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

302. Fuzzy Rule Definition[r235]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

303. Fuzzy Rule Definition[r236]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

304. Fuzzy Rule Definition[r237]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

305. Fuzzy Rule Definition[r238]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

306. Fuzzy Rule Definition[r239]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

307. Fuzzy Rule Definition[r240]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

308. Fuzzy Rule Definition[r241]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

309. Fuzzy Rule Definition[r242]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

310. Fuzzy Rule Definition[r243]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh]))) Units: Dmnl

311. "fuzzy rule for c-b"[cbr1]=MIN ("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FLow])

312. "fuzzy rule for c-b"[cbr2]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FMedium])

313. "fuzzy rule for c-b"[cbr3]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FHigh])

314. "fuzzy rule for c-b"[cbr4]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FLow])

315. "fuzzy rule for c-b"[cbr5]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FMedium])
316. "fuzzy rule for c-b"[cbr6]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FHigh])
317. "fuzzy rule for c-b"[cbr7]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FLow])
318. "fuzzy rule for c-b"[cbr8]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FMedium])
319. "fuzzy rule for c-b"[cbr9]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FHigh])

Units: Dmnl

320. "fuzzy rule for switchign c-t"[sctr1]="perception with respect to trail supply vs. demand"[TLow]
321. "fuzzy rule for switchign c-t"[sctr2]="perception with respect to trail supply vs. demand"[TMedium]
322. "fuzzy rule for switchign c-t"[sctr3]="perception with respect to trail supply vs. demand"[THigh] Units: Dmnl
323. "fuzzy rule for switchign m-c"[smcr1]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FLow])
324. "fuzzy rule for switchign m-c"[smcr2]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FMedium])
325. "fuzzy rule for switchign m-c"[smcr3]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FHigh])
326. "fuzzy rule for switchign m-c"[smcr4]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FLow])
327. "fuzzy rule for switchign m-c"[smcr5]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FMedium])
328. "fuzzy rule for switchign m-c"[smcr6]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FHigh])
329. "fuzzy rule for switchign m-c"[smcr7]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate[FLow])

330. "fuzzy rule for switchign m-c"[smcr8]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate[FMedium])

331. "fuzzy rule for switchign m-c"[smcr9]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate[FHigh])

Units: Dmnl

332. "fuzzy rule for switching b-c"[bcr1]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow], perception with respect to Average Flow Rate[FLow])

333. "fuzzy rule for switching b-c"[bcr2]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow], perception with respect to Average Flow Rate[FMedium])

334. "fuzzy rule for switching b-c"[bcr3]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow], perception with respect to Average Flow Rate[FHigh])

335. "fuzzy rule for switching b-c"[bcr4]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FLow])

336. "fuzzy rule for switching b-c"[bcr5]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FMedium])

337. "fuzzy rule for switching b-c"[bcr6]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], perception with respect to Average Flow Rate[FHigh])

338. "fuzzy rule for switching b-c"[bcr7]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], perception with respect to Average Flow Rate[FLow])

339. "fuzzy rule for switching b-c"[bcr8]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], perception with respect to Average Flow Rate[FMedium])

340. "fuzzy rule for switching b-c"[bcr9]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], perception with respect to Average Flow Rate[FHigh])

Units: Dmnl

341. "fuzzy rule for switching b-m"[sbmr1]="perception with respect to metro supply vs. demand"[MLow]

342. "fuzzy rule for switching b-m"[sbmr2]="perception with respect to metro supply vs. demand"[MMedium]

343. "fuzzy rule for switching b-m"[sbmr3]="perception with respect to metro supply vs. demand"[MHigh] Units: Dmnl

344. "fuzzy rule for switching b-t"[sbtr1]="perception with respect to trail supply vs. demand"[TLow]

345. "fuzzy rule for switching b-t"[sbtr2]="perception with respect to trail supply vs. demand"[TMedium]

346. "fuzzy rule for switching b-t"[sbtr3]="perception with respect to trail supply vs. demand"[THigh] Units: Dmnl

347. "fuzzy rule for switching m-b"[smbr1]=MIN ("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FLow])

348. "fuzzy rule for switching m-b"[smbr2]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FMedium])

349. "fuzzy rule for switching m-b"[smbr3]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FHigh])

350. "fuzzy rule for switching m-b"[smbr4]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FLow])

351. "fuzzy rule for switching m-b"[smbr5]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FMedium])

352. "fuzzy rule for switching m-b"[smbr6]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FHigh])

353. "fuzzy rule for switching m-b"[smbr7]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FLow])

354. "fuzzy rule for switching m-b"[smbr8]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FMedium])

355. "fuzzy rule for switching m-b"[smbr9]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FHigh]) Units: Dmnl

356. "fuzzy rule for switching m-t"[smtr1]="perception with respect to trail supply vs. demand"[TLow]

357. "fuzzy rule for switching m-t"[smtr2]="perception with respect to trail supply vs. demand"[TMedium]

358. "fuzzy rule for switching m-t"[smtr3]="perception with respect to trail supply vs. demand"[THigh]

Units: Dmnl

359. "fuzzy rule for switching t-b"[stbr1]=MIN(perception with respect to Average Flow Rate[FLow],"perception with respect to bus supply vs. demand"[BLow])
360. "fuzzy rule for switching t-b"[stbr2]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FMedium])
361. "fuzzy rule for switching t-b"[stbr3]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FHigh])
362. "fuzzy rule for switching t-b"[stbr4]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FLow])
363. "fuzzy rule for switching t-b"[stbr5]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FMedium])
364. "fuzzy rule for switching t-b"[stbr6]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FHigh])
365. "fuzzy rule for switching t-b"[stbr7]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FLow])
366. "fuzzy rule for switching t-b"[stbr8]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FMedium])
367. "fuzzy rule for switching t-b"[stbr9]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FHigh])

Units: Dmnl

368. "fuzzy rule for switching t-c"[stcr1]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FLow])
369. "fuzzy rule for switching t-c"[stcr2]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FMedium])
370. "fuzzy rule for switching t-c"[stcr3]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FHigh])
371. "fuzzy rule for switching t-c"[stcr4]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FLow])
372. "fuzzy rule for switching t-c"[stcr5]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FMedium])

373. "fuzzy rule for switching t-c"[stcr6]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FHigh])
374. "fuzzy rule for switching t-c"[stcr7]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate[FLow])
375. "fuzzy rule for switching t-c"[stcr8]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate[FMedium])
376. "fuzzy rule for switching t-c"[stcr9]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate[FHigh])
Units: Dmnl
377. "fuzzy rule for switching t-m"[stmr1]="perception with respect to metro supply vs. demand"[MLow]
378. "fuzzy rule for switching t-m"[stmr2]="perception with respect to metro supply vs. demand"[MMedium]
379. "fuzzy rule for switching t-m"[stmr3]="perception with respect to metro supply vs. demand"[MHigh] Units: Dmnl
380. INITIAL TIME = 0 Units: day
The initial time for the simulation.
381. insurance premium per day=2.5 Units: dollar/car/day
382. maintenance cost per day=average trip miles*maintenance expenditure per mile
Units: dollar/car/day
383. maintenance expenditure per mile=0.029 Units: dollar/mile
384. max value=VMAX(Fuzzy Rule Definition[Range!]) Units: Dmnl
385. maximum possible average flow rate=90 Units: PCU/hour/mile
386. metro car aging=Total Metro Cars/metro car life time Units: metro car/day
387. metro car discrepancy="allowable metro capacity within cordon-based area"-Total Metro Cars Units: metro car
388. metro car increment=(funding using for metro+normal money for metro capacity)/cost per metro car Units: metro car/day
389. metro car life time=7200 Units: day
390. Metro S and D: MLow, MMedium, MHigh
391. multiplier of congestion price=1 Units: Dmnl

392. multiplier of weekend tourist=1.5 Units: Dmnl
393. new demand for bus=Undecided passengers/time delay in choosing transportation mode Units: passenger/day
394. new demand for car=Undecided passengers/time delay in choosing transportation mode Units: passenger/day
395. new demand for metro=Undecided passengers/time delay in choosing transportation mode Units: passenger/day
396. new demand for trail=Undecided passengers/time delay in choosing transportation mode Units: passenger/day
397. normal fraction of potential passenger increase=0.001/360 Units: passenger/day
398. normal funding for bus increment=50000 Units: dollar/day
399. normal funding for trail capacity=5000 Units: dollar/day
400. normal gallon per mile=0.0452 Units: gallon/mile
401. normal money for metro capacity=100000 Units: dollar/day
402. normal tourist base increase rate=97.4 Units: passenger/day
403. normalized average flow rate=MIN(1, Average Flow Rate/maximum possible average flow rate) Units: Dmnl
404. normalized ratio of bus supply to demand=if then else (ratio of bus supply to demand<=0.85, ratio of bus supply to demand, 1) Units: Dmnl
405. normalized ratio of metro supply to demand=if then else (ratio of metro supply to demand<=0.85, ratio of metro supply to demand, 1) Units: Dmnl
406. normalized ratio of trial supply to demand=if then else (ratio of trail supply to demand<=0.6, ratio of trail supply to demand, 1) Units: Dmnl
407. normalized ratio of work travel cost to trip budget=if then else (ratio of work trip budget to trave cost>=0.9, 1, ratio of work trip budget to trave cost) Units: Dmnl
408. passenger by metro per charging period=Total Metro Cars*average passenger per metro car per hour*charging hours per day Units: passenger
409. passenger by trail per charging period=Total Trail Miles*charging hours per day*average passenger Flow Rate Units: passenger

410. passenger delivered per charging period=average passenger per bus per charging period*Total Buses Units: passenger

411. PCU per bus=2.5 Units: PCU/bus

412. PCU per car=1 Units: PCU/car

413. "perception respect to ratio of driving cost vs. budget"[TVCMedium]=if then else (normalized ratio of work travel cost to trip budget>=0 :AND:normalized ratio of work travel cost to trip budget<=0.5, normalized ratio of work travel cost to trip budget/0.5, if then else (normalized ratio of work travel cost to trip budget>=0.5:AND:normalized ratio of work travel cost to trip budget<=1, (1-normalized ratio of work travel cost to trip budget)/0.5, 0))

414. "perception respect to ratio of driving cost vs. budget"[TVCLow]=if then else (normalized ratio of work travel cost to trip budget=0, 1, if then else(normalized ratio of work travel cost to trip budget>=0 :AND:normalized ratio of work travel cost to trip budget<=0.5, (0.5-normalized ratio of work travel cost to trip budget)/0.5, 0))

415. "perception respect to ratio of driving cost vs. budget"[TVCHigh]=if then else (normalized ratio of work travel cost to trip budget>=0.5 :AND:normalized ratio of work travel cost to trip budget<=1, (normalized ratio of work travel cost to trip budget-0.5)/0.5, if then else (normalized ratio of work travel cost to trip budget>=1, 1, 0))
Units: Dmnl

416. perception with respect to Average Flow Rate[FLow]=if then else (normalized average flow rate=0, 1, if then else (normalized average flow rate>=0 :AND:normalized average flow rate<=0.5, (0.5-normalized average flow rate)/0.5, 0))

417. perception with respect to Average Flow Rate[FMedium]=if then else (normalized average flow rate>=0:AND:normalized average flow rate<=0.5, normalized average flow rate/0.5, if then else (normalized average flow rate>=0.5:AND:normalized average flow rate<=1, (1-normalized average flow rate)/0.5, 0))

418. perception with respect to Average Flow Rate[FHigh]=if then else (normalized average flow rate>=0.5:AND:normalized average flow rate<=1, (normalized average flow rate-0.5)/0.5, if then else (normalized average flow rate>=1, 1, 0))
Units: Dmnl

419. "perception with respect to bus supply vs. demand"[BLow]=if then else (normalized ratio of bus supply to demand=0, 1, if then else (normalized ratio of bus supply to demand>=0 :AND:normalized ratio of bus supply to demand<=0.5, (0.5-normalized ratio of bus supply to demand)/0.5, 0))

420. "perception with respect to bus supply vs. demand"[BMedium]=if then else (normalized ratio of bus supply to demand>=0 :AND:normalized ratio of bus supply to demand<=0.5, normalized ratio of bus supply to demand/0.5, if then else (normalized ratio of bus supply to demand>=0.5 :AND:normalized ratio of bus supply to demand<=1, (1-normalized ratio of bus supply to demand)/0.5, 0))

421. "perception with respect to bus supply vs. demand"[BHigh]=if then else (normalized ratio of bus supply to demand>=0.5 :AND:normalized ratio of bus supply to demand<=1, (normalized ratio of bus supply to demand-0.5)/0.5, if then else (normalized ratio of bus supply to demand>=1, 1, 0)) Units: Dmnl

422. "perception with respect to metro supply vs. demand"[MLow]=if then else (normalized ratio of metro supply to demand=0, 1, if then else(normalized ratio of metro supply to demand>=0 :AND:normalized ratio of metro supply to demand<=0.5, (0.5-normalized ratio of metro supply to demand)/0.5, 0))

423. "perception with respect to metro supply vs. demand"[MMedium]=if then else (normalized ratio of metro supply to demand>=0 :AND:normalized ratio of metro supply to demand<=0.5, normalized ratio of metro supply to demand/0.5, if then else (normalized ratio of metro supply to demand>=0.5 :AND:normalized ratio of metro supply to demand<=1, (1-normalized ratio of metro supply to demand)/0.5, 0))

424. "perception with respect to metro supply vs. demand"[MHigh]=if then else (normalized ratio of metro supply to demand>=0.5 :AND:normalized ratio of metro supply to demand <=1, (normalized ratio of metro supply to demand-0.5)/0.5, if then else (normalized ratio of metro supply to demand>=1, 1, 0)) Units: Dmnl

425. "perception with respect to trail supply vs. demand"[TLow]=if then else (normalized ratio of trial supply to demand=0, 1, if then else(normalized ratio of trial supply to demand>=0 :AND: normalized ratio of trial supply to demand<=0.5, (0.5-normalized ratio of trial supply to demand)/0.5, 0))

426. "perception with respect to trail supply vs. demand"[TMedium]=if then else (normalized ratio of trial supply to demand>=0 :AND:normalized ratio of trial supply to demand<=0.5, normalized ratio of trial supply to demand/0.5, if then else (normalized ratio of trial supply to demand>=0.5 :AND:normalized ratio of trial supply to demand<=1, (1-normalized ratio of trial supply to demand)/0.5, 0))

427. "perception with respect to trail supply vs. demand"[THigh]=if then else (normalized ratio of trial supply to demand>=0.5 :AND: normalized ratio of trial supply to demand

428. <=1, (normalized ratio of trial supply to demand-0.5)/0.5, if then else (normalized ratio of trial supply to demand>=1, 1, 0)) Units: Dmnl

429. potential passenger concentration=Potential Passengers/total people around designated urban area Units: Dmnl

430. Potential Passengers= INTEG (+normal fraction of potential passenger increase-conversion rate,3e+008) Units: passenger

431. price per bus=300000 Units: dollar/bus

432. quitting driving car=Total Car Demand/average time keeping using car Units: passenger/day

433. quitting riding bus=Total Bus Demand/average time keeping using bus Units: passenger/day

434. quitting riding metro=Total Metro Demand/average time keeping using metro Units: passenger/day

435. quitting using trail=Total Trail Demand/average time keeping using trail Units: passenger/day

436. Range: (r1-r243)

437. ratio of bus supply to demand=if then else (charging days<>0, passenger delivered per charging period/Total Bus Demand, passenger delivered per charging period/(Total Bus Demand*(1-fraction of work trip demand on bus))) Units: Dmnl

438. ratio of metro supply to demand=if then else (charging days<>0, passenger by metro per charging period/Total Metro Demand, passenger by metro per charging period/(Total Metro Demand*(1-fraction of work trip by metro))) Units: Dmnl

439. ratio of trail supply to demand=if then else (charging days<>0, passenger by trail per charging period/Total Trail Demand, passenger by trail per charging period/(Total Trail Demand*(1-fraction of work trip by trail))) Units: Dmnl

440. ratio of work trip budget to trave cost=travel cost per driver per day/work trip budget Units: Dmnl

441. revenue accumulation=congestion charging price*total cars subject to pricing*charging days Units: dollar/day

442. Revenue from Pricing Scheme= INTEG (+revenue accumulation-funding using for bus-funding using for metro-funding using for pricing scheme implementation-funding using for trail,10000) Units: dollars

443. SAVEPER = TIME STEP Units: day [0,?]
The frequency with which output is stored.

444. sbc max value=VMAX("fuzzy rule for switching b-c"[switching bus to car!]) Units: Dmnl

445. sbm max value=VMAX("fuzzy rule for switching b-m"[switching bus to metro!]) Units: Dmnl

446. sbt max value=VMAX("fuzzy rule for switching b-t"[switching bus to trail!]) Units: Dmnl

447. scb max value=VMAX("fuzzy rule for c-b"[switching car to bus!]) Units: Dmnl

448. scm max value=VMAX("fuzzy rul for switching c-m"[switching car to metro!]) Units: Dmnl

449. sct max value=VMAX("fuzzy rule for switchign c-t"[switching car to trail!]) Units: Dmnl

450. smb max value=VMAX("fuzzy rule for switching m-b"[switching metro to bus!]) Units: Dmnl

451. smc max value=VMAX("fuzzy rule for switchign m-c"[switching metro to car!]) Units: Dmnl

452. smt max value=VMAX("fuzzy rule for switching m-t"[switching metro to trail!]) Units: Dmnl

453. sociability=1 Units: contact/passenger/day

454. stb max value=VMAX("fuzzy rule for switching t-b"[switching trail to bus!])
Units: Dmnl

455. stc max value=VMAX("fuzzy rule for switching t-c"[switching trail to car!])
Units: Dmnl

456. stm max value=VMAX("fuzzy rule for switching t-m"[switching trail to metro!])
Units: Dmnl

457. switching bus to car: bcr1, bcr2, bcr3, bcr4, bcr5, bcr6, bcr7, bcr8, bcr9

458. switching bus to metro: sbmr1, sbmr2, sbmr3

459. switching bus to trail: sbtr1, sbtr2, sbtr3

460. switching car to bus: cbr1, cbr2, cbr3, cbr4, cbr5, cbr6, cbr7,cbr8, cbr9

461. switching car to metro: scmr1, scmr2, scmr3

462. switching car to trail: sctr1, sctr2, sctr3

463. switching from bus to car=(Total Bus Demand/time with bus before switching)*"defuzzified effect of perception on switching b-c"
Units: passenger/day

464. switching from bus to metro=(Total Bus Demand/time with bus before switching)*"defuzzified effect of perception on switching b-m"
Units: passenger/day

465. switching from bus to trail=(Total Bus Demand/time with bus before switching)*"defuzzified effect of perception on switching b-t"
Units: passenger/day

466. switching from car to bus=(Total Car Demand/time with car before swiching)*"defuzzified effect of perception on c-b" Units: passenger/day

467. switching from car to metro=(Total Car Demand/time with car before swiching)*"defuzzified effect of perception on switching c-m"
Units: passenger/day

468. switching from car to trail=(Total Car Demand/time with car before swiching)*"defuzzified effect of perception on switching c-t"
Units: passenger/day

469. switching from metro to bus=(Total Metro Demand/time with metro before switching)*"defuzzified effect of perception on switching m-b"

Units: passenger/day

470. switching from metro to car=(Total Metro Demand/time with metro before switching)*"defuzzified effect of perception on switching m-c"

Units: passenger/day

471. switching from metro to trail=(Total Metro Demand/time with metro before switching)*"defuzzififed effect of perception on switching m-t"

Units: passenger/day

472. switching from trail to bus=(Total Trail Demand/time with trail before switching)*"defuzzified effect of perception on switching t-b"

Units: passenger/day

473. switching from trail to car=(Total Trail Demand/time with trail before switching)*"defuzzified effect to of perception on switching t-c"

Units: passenger/day

474. switching from trail to metro=(Total Trail Demand/time with trail before switching)*"defuzzified effect of perception on switching t-m"

Units: passenger/day

475. switching metro to bus: smbr1, smbr2, smbr3, smbr4, smbr5, smbr6, smbr7,smbr8,smbr9

476. switching metro to car: smcr1, smcr2, smcr3, smcr4, smcr5, smcr6, smcr7, smcr8, smcr9

477. switching metro to trail: smtr1, smtr2, smtr3

478. switching trail to bus: stbr1, stbr2, stbr3,stbr4, stbr5, stbr6,stbr7,stbr8,stbr9

479. switching trail to car: stcr1, stcr2, stcr3, stcr4, stcr5, stcr6, stcr7, stcr8, stcr9

480. switching trail to metro: stmr1,stmr2,stmr3

481. time delay in choosing transportation mode=180 Units: day

482. TIME STEP = 0.25 Units: day [0,?]

The time step for the simulation.

483. time value per hour=20 Units: dollar/hour

484. time with bus before switching=720 Units: day

485. time with car before swiching=1440 Units: day

486. time with metro before switching=720 Units: day

487. time with trail before switching=1080 Units: day

488. Total Bus Demand= INTEG (new demand for bus+switching from car to bus+switching from metro to bus+switching from trail to bus-quitting riding bus-switching from bus to car-switching from bus to metro-switching from bus to trail,247770) Units: passenger

489. Total Buses= INTEG (+bus increment-bus aging,300) Units: bus

490. Total Car Demand= INTEG (new demand for car+switching from bus to car+switching from metro to car+switching from trail to car-quitting driving car-switching from car to bus-switching from car to metro-switching from car to trail,401319) Units: passenger

491. total car running=if then else (charging days<>0, Total Car Demand/carpool multiplier, (Total Car Demand/(carpool multiplier)*(1-fraction of work trip by car))) Units: car

492. total cars subject to pricing=total ca running*(1-fraction of disable people)*((1-fraction of local resident)+fraction of local resident*(1-discount for local resident)) Units: car

493. "total lane miles with cordon-based area"=1500 Units: miles

494. Total Metro Cars= INTEG (+metro car increment-metro car aging,446) Units: metro car

495. Total Metro Demand= INTEG (new demand for metro+switching from bus to metro+switching from car to metro+switching from trail to metro-quitting riding metro-switching from metro to bus-switching from metro to car-switching from metro to trail, 143320) Units: passenger

496. total PCUs=total car running*PCU per car+Total Buses*PCU per bus Units: PCU

497. total people around designated urban area=Potential Passengers+Total Bus Demand+Total Car Demand+Total Metro Demand+Total Trail Demand+Undecided passengers Units: person

498. Total Trail Demand= INTEG (new demand for trail+switching from bus to trail+switching from car to trail+switching from metro to trail-quitting using trail-switching from trail to bus-switching from trail to car-switching from trail to metro,

42998) Units: passenger

499. Total Trail Miles= INTEG (+trail increment-trail aging,120)
Units: mile

500. tourist base increment=if then else(charging days<>0, normal tourist base increase rate, multiplier of weekend tourist*normal tourist base increase rate)
Units: passenger/day

501. trail aging=Total Trail Miles/trail life time Units: mile/day

502. trail capacity within cordon based area=200 Units: mile

503. trail discrepancy=trail capacity within cordon based area-Total Trail Miles
Units: mile

504. trail increment=(funding using for trail+normal funding for trail capacity)/cost per trail mile Units: mile/day

505. trail life time=5400 Units: day

506. Trail S and D: TLow, TMedium, THigh

507. travel cost per driver per day=(time value per hour*average travel time+average fuel consumption*fuel price per gallon+congestion charging price+insurance premium per day+maintenance cost per day)/carpool multiplier Units: dollar/passenger/day

508. Trip Value and Cost: TVCLow, TVCMedium, TVCHigh

509. Undecided passengers= INTEG (conversion rate+employment increment+tourist base increment-new demand for bus-new demand for car-new demand for metro-new demand for trail,10000) Units: passenger

510. work trip budget=fraction of work budget*work trip value
Units: dollar/passenger/day

511. work trip value=160 Units: dollar/passenger/day

AE3: Fuzzy Rule DefintionTransportation System Model with Travel Demand Management Policy

Table AE.1: Fuzzy Rule Definition for Effect on Social Networking Activities

Fuzzy Rule Definition for Transportation Socioeconomic System						
	Perception with respect to ratio driving cost vs. budget	Perception with respect to average flow rate	Perception with respect to ratio of bus supply vs. demand	Perception with respect to ratio of metro supply to demand	Perception with respect to ratio of trail supply to demand	Output
1	Low	Low	Low	Low	Low	Medium
2	Low	Low	Low	Medium	Low	Medium
3	Low	Low	Low	High	Low	Medium
4	Low	Low	Low	Low	Medium	Medium
5	Low	Low	Low	Medium	Medium	Medium
6	Low	Low	Low	High	Medium	High
7	Low	Low	Low	Low	High	Medium
8	Low	Low	Low	Medium	High	Medium
9	Low	Low	Low	High	High	High
10	Low	Low	Medium	Low	Low	Medium
11	Low	Low	Medium	Medium	Low	Medium
12	Low	Low	Medium	High	Low	High
13	Low	Low	Medium	Low	Medium	Medium
14	Low	Low	Medium	Medium	Medium	High
15	Low	Low	Medium	High	Medium	Medium
16	Low	Low	Medium	Low	High	Medium
17	Low	Low	Medium	Medium	High	Medium
18	Low	Low	Medium	High	High	High
19	Low	Low	High	Low	Low	Medium
20	Low	Low	High	Medium	Low	Medium

21	Low	Low	High	High	Low	High
22	Low	Low	High	Low	Medium	Medium
23	Low	Low	High	Medium	Medium	Medium
24	Low	Low	High	High	Medium	High
25	Low	Low	High	Low	High	Medium
26	Low	Low	High	Medium	High	High
27	Low	Low	High	High	High	High
28	Low	Medium	Low	Low	Low	Low
29	Low	Medium	Low	Medium	Low	Low
30	Low	Medium	Low	High	Low	Medium
31	Low	Medium	Low	Low	Medium	Low
32	Low	Medium	Low	Medium	Medium	Low
33	Low	Medium	Low	High	Medium	Medium
34	Low	Medium	Low	Low	High	Low
35	Low	Medium	Low	Medium	High	Medium
36	Low	Medium	Low	High	High	Medium
37	Low	Medium	Medium	Low	Low	Low
38	Low	Medium	Medium	Medium	Low	Low
39	Low	Medium	Medium	High	Low	Low
40	Low	Medium	Medium	Low	Medium	Low
41	Low	Medium	Medium	Medium	Medium	Medium
42	Low	Medium	Medium	High	Medium	Medium
43	Low	Medium	Medium	Low	High	Low
44	Low	Medium	Medium	Medium	High	Medium
45	Low	Medium	Medium	High	High	High
46	Low	Medium	High	Low	Low	Low
47	Low	Medium	High	Medium	Low	Medium
48	Low	Medium	High	High	Low	High
49	Low	Medium	High	Low	Medium	Medium
50	Low	Medium	High	Medium	Medium	Medium
51	Low	Medium	High	High	Medium	High

52	Low	Medium	High	Low	High	Medium
53	Low	Medium	High	Medium	High	Medium
54	Low	Medium	High	High	High	High
55	Low	High	Low	Low	Low	Low
56	Low	High	Low	Medium	Low	Low
57	Low	High	Low	High	Low	Low
58	Low	High	Low	Low	Medium	Low
59	Low	High	Low	Medium	Medium	Low
60	Low	High	Low	High	Medium	Low
61	Low	High	Low	Low	High	Low
62	Low	High	Low	Medium	High	Low
63	Low	High	Low	High	High	Low
64	Low	High	Medium	Low	Low	Low
65	Low	High	Medium	Medium	Low	Low
66	Low	High	Medium	High	Low	Low
67	Low	High	Medium	Low	Medium	Low
68	Low	High	Medium	Medium	Medium	Medium
69	Low	High	Medium	High	Medium	Medium
70	Low	High	Medium	Low	High	Low
71	Low	High	Medium	Medium	High	Medium
72	Low	High	Medium	High	High	Medium
73	Low	High	High	Low	Low	Low
74	Low	High	High	Medium	Low	Low
75	Low	High	High	High	Low	Medium
76	Low	High	High	Low	Medium	Low
77	Low	High	High	Medium	Medium	Medium
78	Low	High	High	High	Medium	Medium
79	Low	High	High	Low	High	Medium
80	Low	High	High	Medium	High	Medium
81	Low	High	High	High	High	High
82	Medium	Low	Low	Low	Low	Low

83	Medium	Low	Low	Medium	Low	Low
84	Medium	Low	Low	High	Low	Low
85	Medium	Low	Low	Low	Medium	Low
86	Medium	Low	Low	Medium	Medium	Low
87	Medium	Low	Low	High	Medium	Low
88	Medium	Low	Low	Low	High	Low
89	Medium	Low	Low	Medium	High	Low
90	Medium	Low	Low	High	High	Medium
91	Medium	Low	Medium	Low	Low	Low
92	Medium	Low	Medium	Medium	Low	Low
93	Medium	Low	Medium	High	Low	Medium
94	Medium	Low	Medium	Low	Medium	Low
95	Medium	Low	Medium	Medium	Medium	Low
96	Medium	Low	Medium	High	Medium	Low
97	Medium	Low	Medium	Low	High	Low
98	Medium	Low	Medium	Medium	High	Medium
99	Medium	Low	Medium	High	High	Medium
100	Medium	Low	High	Low	Low	Low
101	Medium	Low	High	Medium	Low	Low
102	Medium	Low	High	High	Low	Medium
103	Medium	Low	High	Low	Medium	Low
104	Medium	Low	High	Medium	Medium	Medium
105	Medium	Low	High	High	Medium	Medium
106	Medium	Low	High	Low	High	Low
107	Medium	Low	High	Medium	High	Medium
108	Medium	Low	High	High	High	High
109	Medium	Medium	Low	Low	Low	Low
110	Medium	Medium	Low	Medium	Low	Low
111	Medium	Medium	Low	High	Low	Low
112	Medium	Medium	Low	Low	Medium	Low
113	Medium	Medium	Low	Medium	Medium	Low

114	Medium	Medium	Low	High	Medium	Low
115	Medium	Medium	Low	Low	High	Low
116	Medium	Medium	Low	Medium	High	Low
117	Medium	Medium	Low	High	High	Low
118	Medium	Medium	Medium	Low	Low	Low
119	Medium	Medium	Medium	Medium	Low	Low
120	Medium	Medium	Medium	High	Low	Low
121	Medium	Medium	Medium	Low	Medium	Low
122	Medium	Medium	Medium	Medium	Medium	Low
123	Medium	Medium	Medium	High	Medium	Medium
124	Medium	Medium	Medium	Low	High	Low
125	Medium	Medium	Medium	Medium	High	Medium
126	Medium	Medium	Medium	High	High	Medium
127	Medium	Medium	High	Low	Low	Low
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129	Medium	Medium	High	High	Low	Low
130	Medium	Medium	High	Low	Medium	Low
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133	Medium	Medium	High	Low	High	Low
134	Medium	Medium	High	Medium	High	Medium
135	Medium	Medium	High	High	High	High
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137	Medium	High	Low	Medium	Low	Low
138	Medium	High	Low	High	Low	Low
139	Medium	High	Low	Low	Medium	Low
140	Medium	High	Low	Medium	Medium	Low
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144	Medium	High	Low	High	High	Low

145	Medium	High	Medium	Low	Low	Low
146	Medium	High	Medium	Medium	Low	Low
147	Medium	High	Medium	High	Low	Low
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150	Medium	High	Medium	High	Medium	Medium
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152	Medium	High	Medium	Medium	High	Medium
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157	Medium	High	High	Low	Medium	Low
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161	Medium	High	High	Medium	High	Medium
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163	High	Low	Low	Low	Low	Low
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174	High	Low	Medium	High	Low	Low
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178	High	Low	Medium	Low	High	Low
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238	High	High	High	Low	Medium	Low
239	High	High	High	Medium	Medium	Medium
240	High	High	High	High	Medium	Medium
241	High	High	High	Low	High	Low
242	High	High	High	Medium	High	Medium
243	High	High	High	High	High	High

Table AE.2: Fuzzy Rule Definition for Switching from Bus to Car

	Fuzzy Rule Definition for Transportation Socioeconomic System		**Output**
	Perception with respect to ratio driving cost vs. budget	Perception with respect to average flow rate	
1	Low	Low	High
2	Low	Medium	Medium
3	Low	High	Medium
4	Medium	Low	Medium
5	Medium	Medium	Medium
6	Medium	High	Low
7	High	Low	Medium
8	High	Medium	Low
9	High	High	Low

Table AE.3: Fuzzy Rule Definition for Switching from Car to Bus

Fuzzy Rule Definition for Transportation Socioeconomic System			
	Perception with respect to ratio of bus supply vs. demand	Perception with respect to average flow rate	
1	Low	Low	Medium
2	Low	Medium	Low
3	Low	High	Low
4	Medium	Low	Medium
5	Medium	Medium	Medium
6	Medium	High	Medium
7	High	Low	High
8	High	Medium	High
9	High	High	Medium

Table AE.4: Fuzzy Rule Definition for Switching from Bus to Metro

Fuzzy Rule Definition for Transportation Socioeconomic System		
	Perception with respect to ratio of metro supply to demand	Output
1	Low	Low
2	Medium	Medium
3	High	High

Table AE.5: Fuzzy Rule Definition for Switching from Metro to Bus

Fuzzy Rule Definition for Transportation Socioeconomic System			
	Perception with respect to ratio of bus supply vs. demand	Perception with respect to average flow rate	
1	Low	Low	Medium
2	Low	Medium	Low
3	Low	High	Low
4	Medium	Low	Medium
5	Medium	Medium	Medium
6	Medium	High	Medium
7	High	Low	High
8	High	Medium	High
9	High	High	Medium

Table AE.6: Fuzzy Rule Definition for Switching from Trail to Bus

Fuzzy Rule Definition for Transportation Socioeconomic System			
	Perception with respect to ratio of bus supply vs. demand	Perception with respect to average flow rate	
1	Low	Low	Medium
2	Low	Medium	Low
3	Low	High	Low
4	Medium	Low	High
5	Medium	Medium	Medium
6	Medium	High	Medium
7	High	Low	High
8	High	Medium	High
9	High	High	Medium

Table AE.7: Fuzzy Rule Definition for Switching from Trail to Bus

Fuzzy Rule Definition for Transportation Socioeconomic System		
	Perception with respect to ratio of trail supply to demand	Output
1	Low	Low
2	Medium	Medium
3	High	High

Table AE.8: Fuzzy Rule Definition for Switching from Metro to Trail

Fuzzy Rule Definition for Transportation Socioeconomic System		
	Perception with respect to ratio of trail supply to demand	Output
1	Low	Low
2	Medium	Medium
3	High	High

Table AE.9: Fuzzy Rule Definition for Switching from Trail to Metro

Fuzzy Rule Definition for Transportation Socioeconomic System		
	Perception with respect to ratio of metro supply to demand	Output
1	Low	Low
2	Medium	Medium
3	High	High

Table AE.10: Fuzzy Rule Definition for Switching from Trail to Car

	Fuzzy Rule Definition for Transportation Socioeconomic System		Output
	Perception with respect to ratio driving cost vs. budget	Perception with respect to average flow rate	
1	Low	Low	High
2	Low	Medium	Medium
3	Low	High	Medium
4	Medium	Low	Medium
5	Medium	Medium	Medium
6	Medium	High	Low
7	High	Low	Medium
8	High	Medium	Low
9	High	High	Low

Table AE.11: Fuzzy Rule Definition for Switching from Car to Trail

	Fuzzy Rule Definition for Transportation Socioeconomic System	
	Perception with respect to ratio of trail supply to demand	Output
1	Low	Low
2	Medium	Medium
3	High	High

Table AE.12: Fuzzy Rule Definition for Switching from Car to Metro

	Fuzzy Rule Definition for Transportation Socioeconomic System	
	Perception with respect to ratio of metro supply to demand	Output
1	Low	Low
2	Medium	Medium
3	High	High

Table AE.13: Fuzzy Rule Definition for Switching from Metro to Car

	Fuzzy Rule Definition for Transportation Socioeconomic System		**Output**
	Perception with respect to ratio driving cost vs. budget	Perception with respect to average flow rate	
1	Low	Low	High
2	Low	Medium	High
3	Low	High	Medium
4	Medium	Low	Medium
5	Medium	Medium	Low
6	Medium	High	Low
7	High	Low	Medium
8	High	Medium	Low
9	High	High	Low

AE4: Behavior for Variables in Transportation System Model with Travel Demand Management Policy

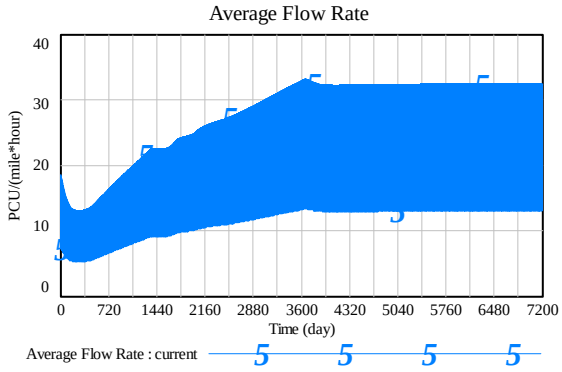


Figure AE.2: Average Traffic Flow Rate

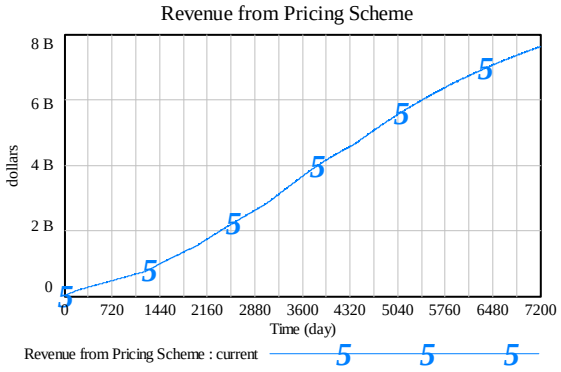


Figure AE.5: Revenue from Pricing Scheme

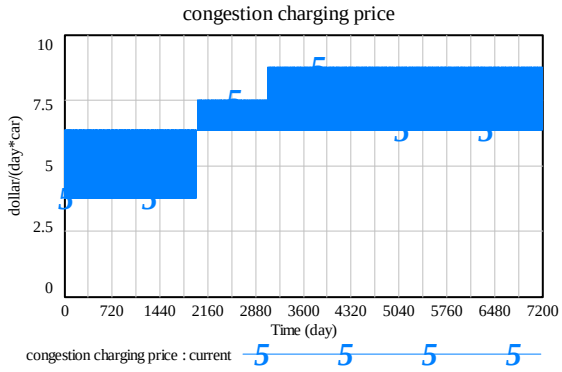


Figure AE.3: Congestion Charging Price

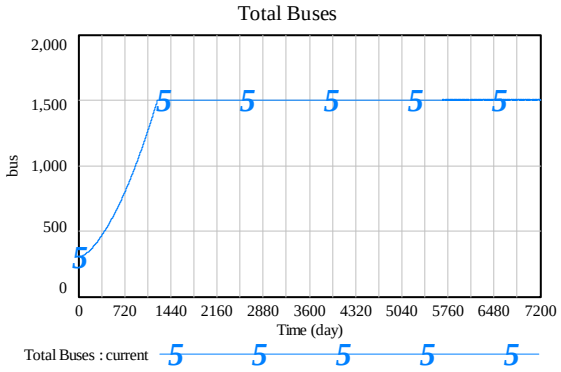


Figure AE.6: Total Buses

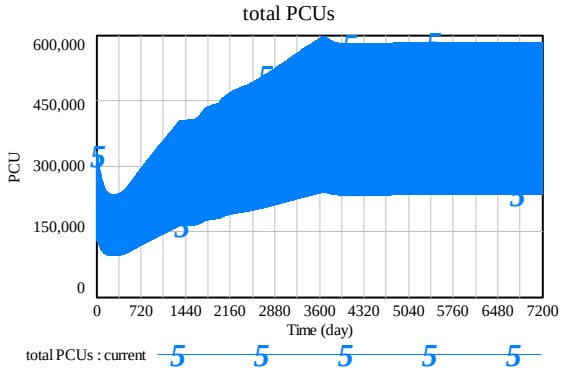


Figure AE.4: Total PCUs

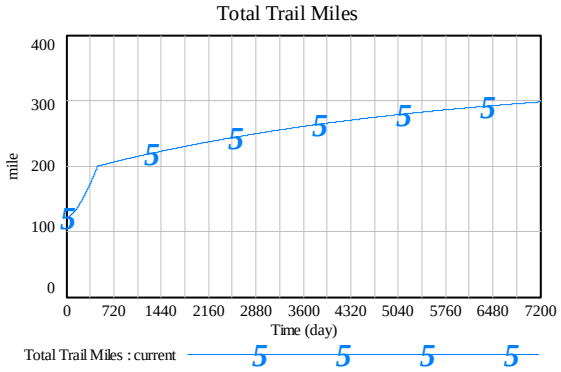


Figure AE.7: Total Trail Miles

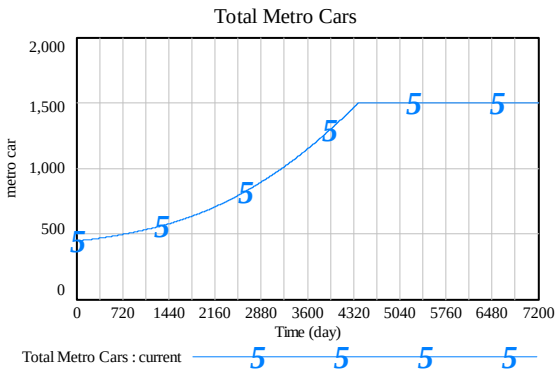


Figure AE.8: Total Metro Rail Cars

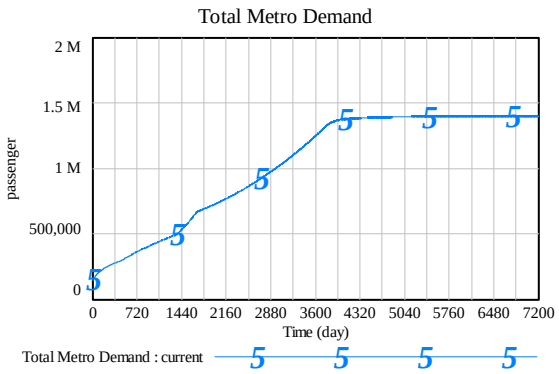


Figure AE.11: Total Metro Demand

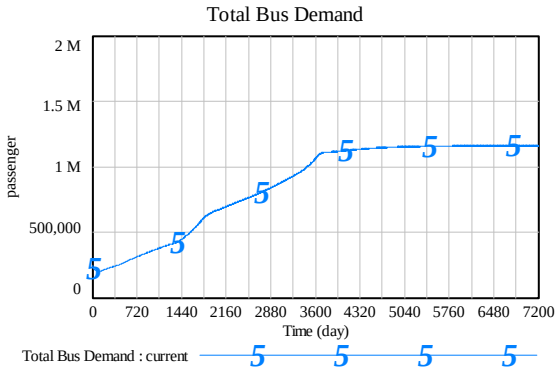


Figure AE.9: Total Bus Demand

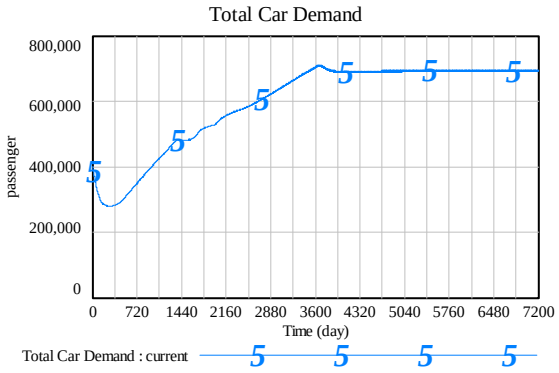


Figure AE.12: Total Car Demand

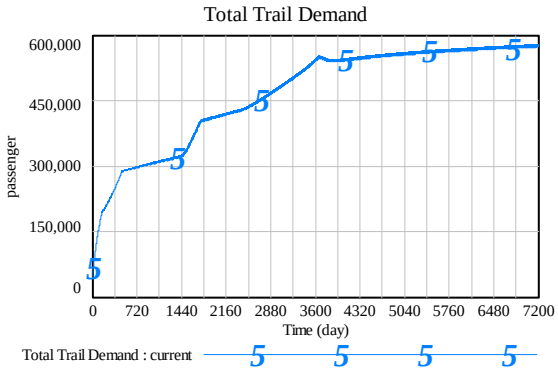


Figure AE.10: Total Trail Demand

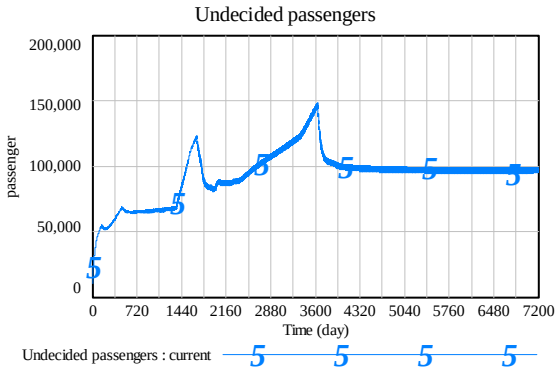


Figure AE.13: Undecided Passengers

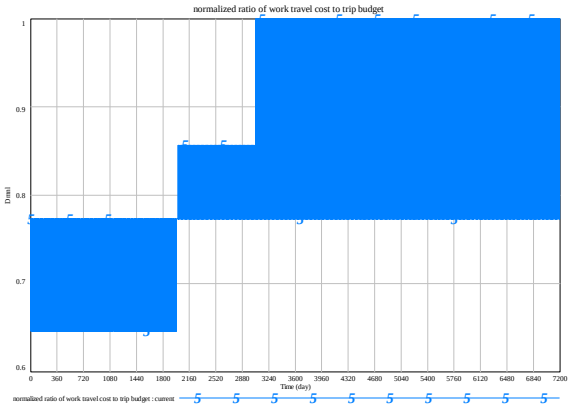


Figure AE.14: Normalized Ratio of Work Travel Cost to Trip Budget

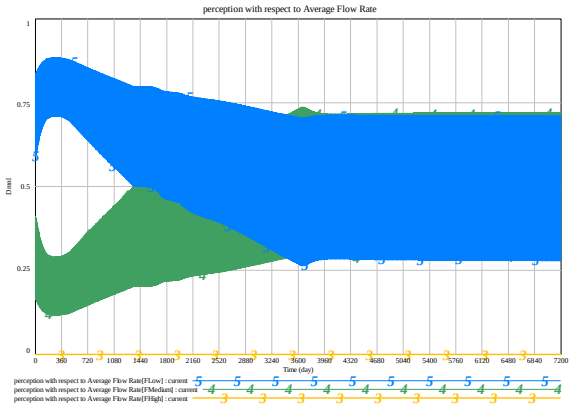


Figure AE.17: Perception with Respect to Average Flow Rate

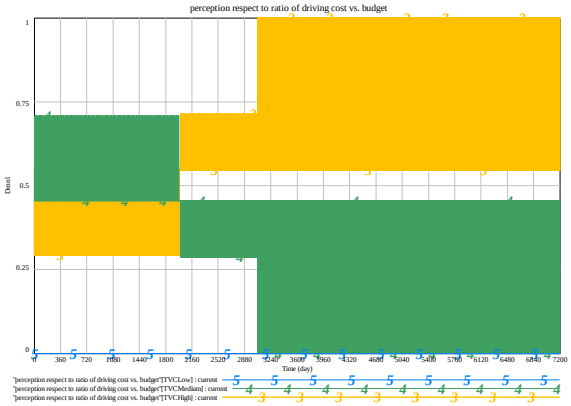


Figure AE.15: Perception with respect to Ratio of Driving Cost vs. Budget

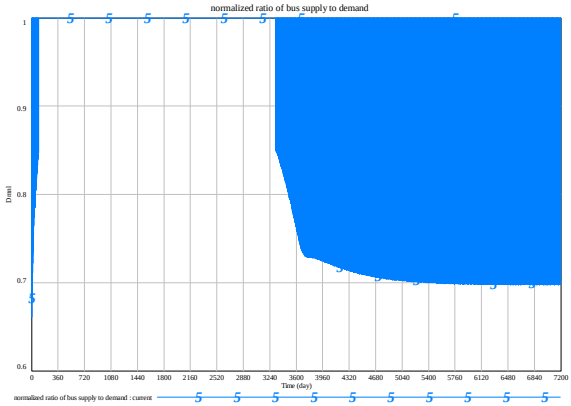


Figure AE.18: Normalized Ratio of Bus Supply to Demand

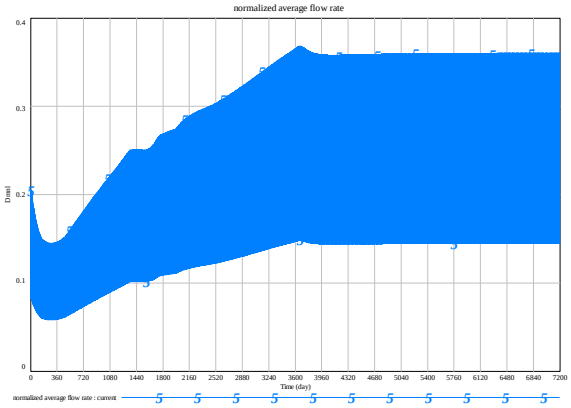


Figure AE.16: Normalized Average Flow Rate

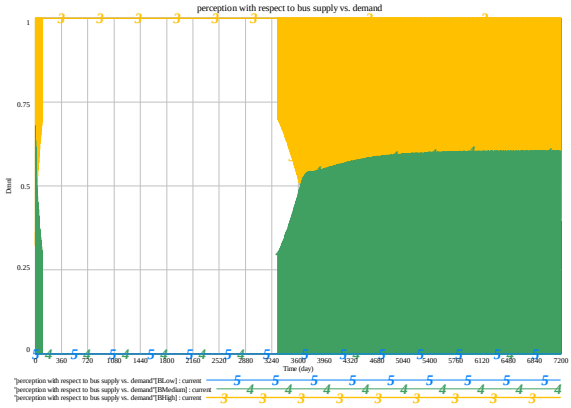


Figure AE.19: Perception with respect to Bus Supply vs. Demand

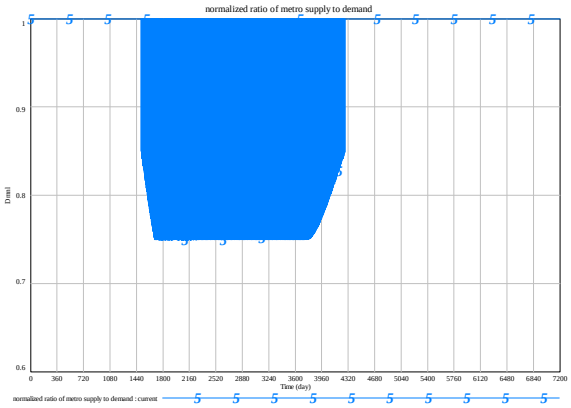


Figure AE.20: Normalized Ratio of Metro Supply to Demand

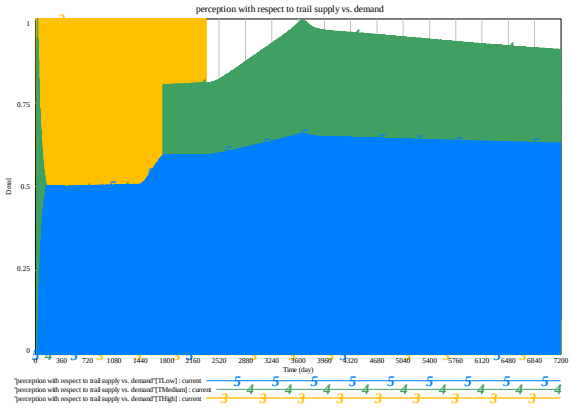


Figure AE.23: Perception with respect to Trail Supply vs. Demand

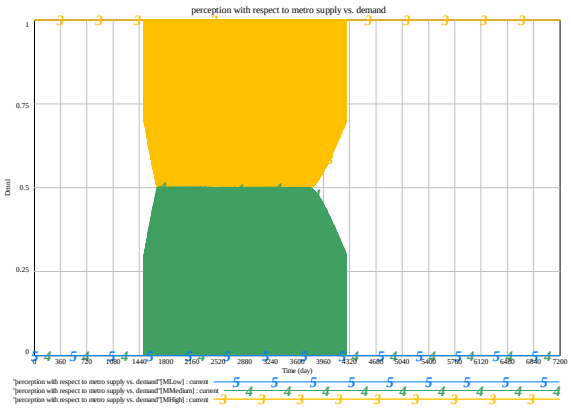


Figure AE.21: Perception with respect to Metro Supply vs. Demand

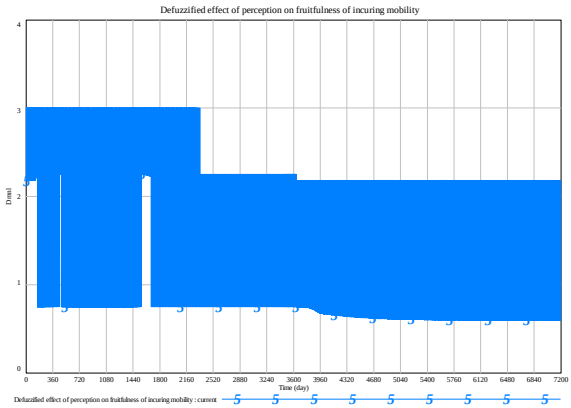


Figure AE.24: Defuzzified Effect of Perception on Fruitfulness of Incurring Mobility

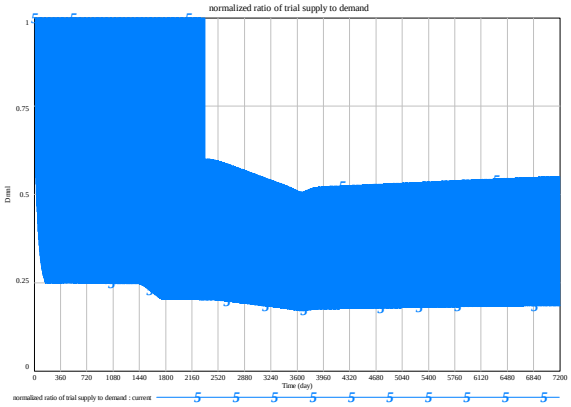


Figure AE.22: Normalized Ratio of Trial Supply to Demand

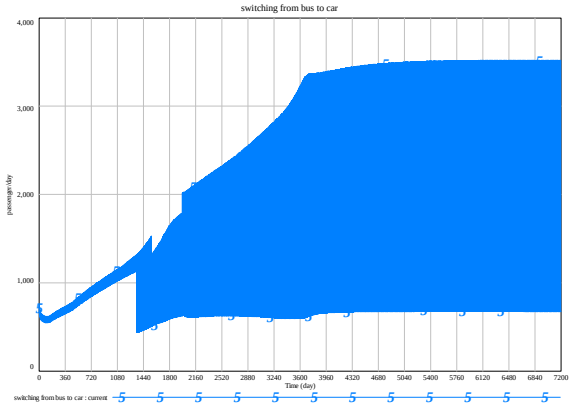


Figure AE.25: Switching from Bus to Car

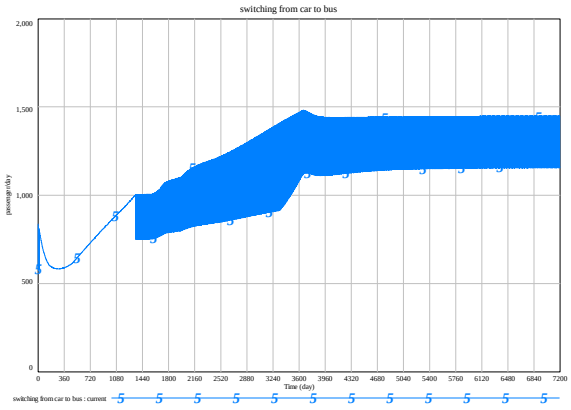


Figure AE.26: Switching from Car to Bus

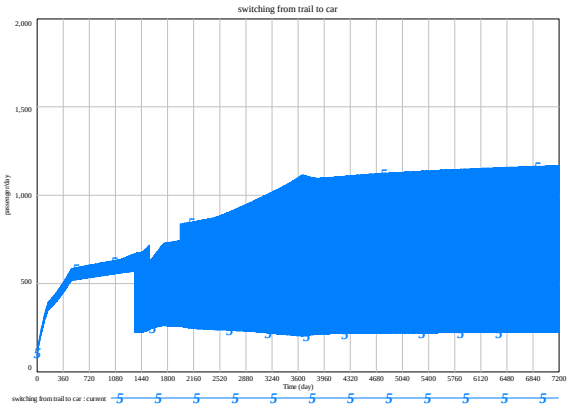


Figure AE.29: Switching from Trail to Car

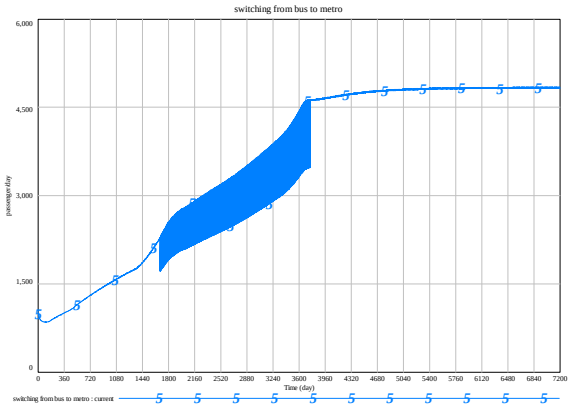


Figure AE.27: Switching from Bus to Metro Rail

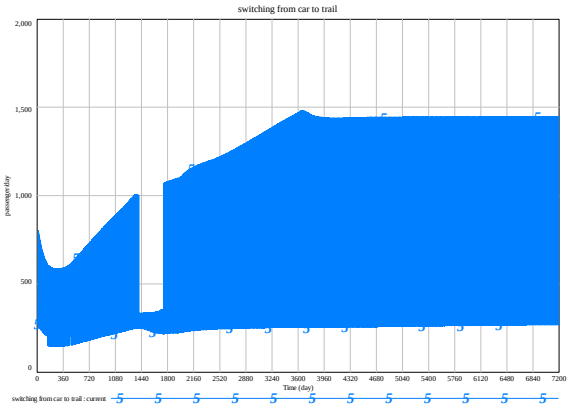


Figure AE.30: Switching from Car to Trail

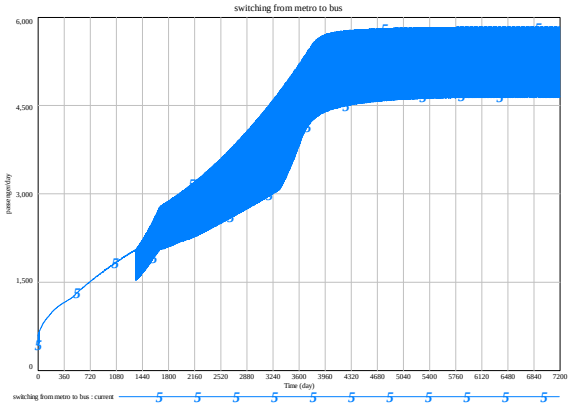


Figure AE.28: Switching from Metro Rail to Bus

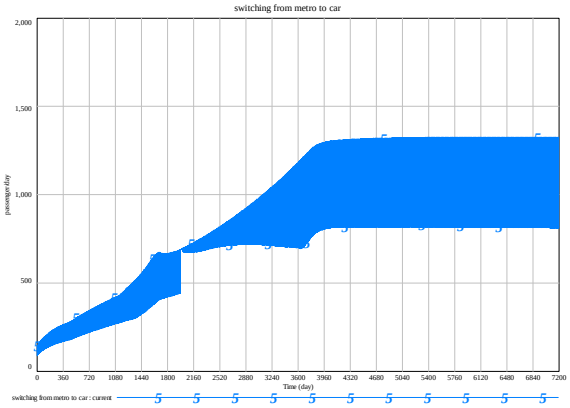


Figure AE.31: Switching from Metro Rail to Car

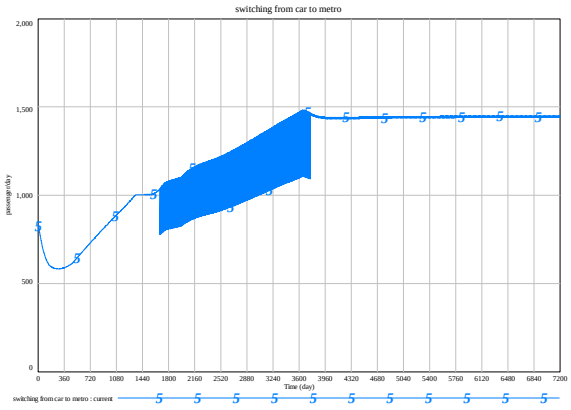


Figure AE.32: Switching from Car to Metro Rail

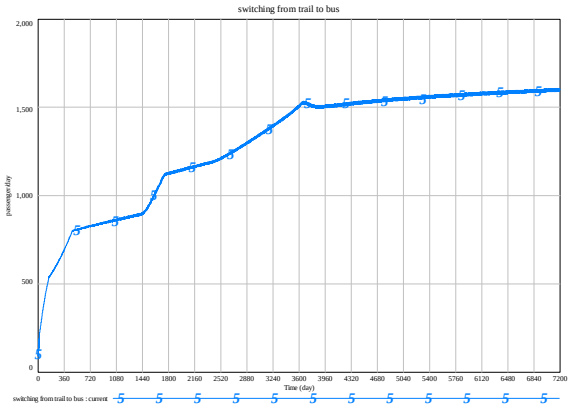


Figure AE.33: Switching from Trail to Bus

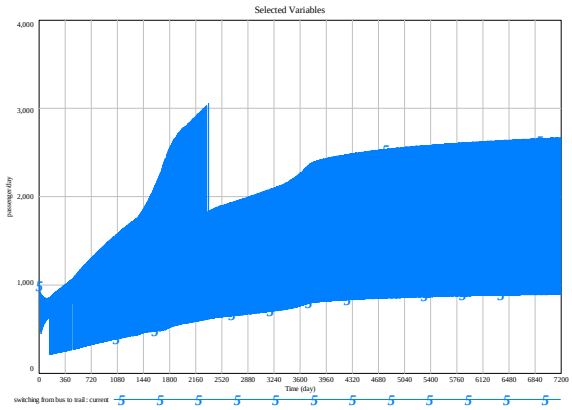


Figure AE.34: Behavior of Switching from Bus to Trail

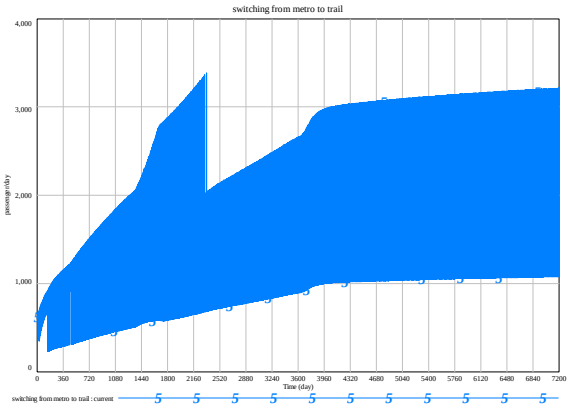


Figure AE.35: Switching from Metro Rail to Trail

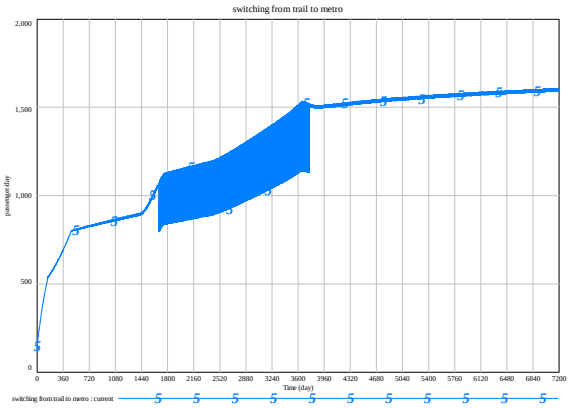


Figure AE.36: Switching from Trail to Metro Rail

AE5: Behavior for Parameter Sensitivity Analysis in Transportation System Model with Travel Demand Management Policy

Number of Simulations: 200

Noise Seed: 1234

Parameter Distribution: Random_Uniform

Table AE.14: Parameter Setting for Sensitivity Analysis

Variable-Parameter Sensitivity with Congestion Pricing	Designated value	Minimum Value	Maximum Value
allowable metro capacity within cordon-based area (metro car)	1500	1200	3000
allowable bus capacity of cordon-based area (bus)	1500	1200	3000
appropriation /purchased delay for metro car (day)	3600	1800	5400
appropriation and purchased delay for bus (day)	540	360	720
average passenger per bus per hour (passenger/bus/hour)	45	30	55
average passenger per metro car per hour (passenger/metro car/hour)	68	50	98
average time keeping using bus (day)	1800	1440	2160
average time keeping using car (day)	3600	2880	5400
average time keeping using metro (day)	1800	1440	2880
average time keeping using trail (day)	1080	720	1440
average passenger flow rate (passenger/mile/hour) note: trail mile	30	20	40
average trip miles (mile)	25	20	35
bus life time (day)	3600	2880	4320
carpool multiplier (passenger/car)	1.2	1.1	1.4
cost per metro car (dollar/metro car)	1000000	900000	1200000
cost per trail mile (dollar/mile) note: trail mile	80000	60000	90000

delay-appropriation, construction for trail (day)	1800	1080	2160
discount for local resident (Dmnl)	0.4	0.3	0.5
employment increment (passenger/day)	8.1	6	10
fraction for bus (Dmnl)	0.4	0.3	0.5
fraction of disable people (Dmnl)	0.01	0.008	0.012
fraction of local resident (Dmnl)	0.4	0.3	0.5
fraction of work budget (Dmnl)	0.15	0.12	0.18
fraction of work trip by car (Dmnl)	0.6	0.5	0.7
fraction of work trip by metro (Dmnl)	0.6	0.5	0.7
fraction of work trip by trail (Dmnl)	0.66	0.6	0.75
fraction of work trip demand on bus (Dmnl)	0.66	0.6	0.75
fruitfulness of incurring mobility (person/contact)	0.0005	0.0002	0.0008
fuel price per gallon (dollar/gallon)	2.5	2	3
insurance premium per day (dollar/car/day)	2.5	2	3
maintenance expenditure per mile (dollar/car/day)	0.029	0.02	0.035
maximum possible average flow rate (PCU/mile/hour)	90	60	95
metro car life time (day)	7200	5400	10800
multiplier of congestion price (Dmnl)	1	1	1.2
multiplier of weekend tourist (Dmnl)	1.5	1.2	1.8
normal funding for bus increment (dollar/day)	50000	35000	80000
normal funding for trail capacity (dollar/day)	5000	3000	8000
normal gallon per mile (gallon/mile)	0.0452	0.04	0.05
normal money for metro capacity (dollar/day)	100000	80000	120000

normal tourist base increase rate (passenger/day)	97.4	80	110
PCU per bus (PCU/bus)	2.5	2	3
PCU per car (PCU/car)	1	1	1.1
price per bus (dollar/bus)	300000	250000	350000
Sociability (contact/passenger/day)	1	0.8	1.2
time delay in choosing transportation mode (day)	180	90	270
time value per hour (dollar/hour)	20	15	25
time with bus before switching (day)	720	540	1080
time with car before switching (day)	1440	1080	1800
time with metro before switching (day)	720	540	1080
time with trail before switching (day)	1080	720	1440
total lane miles with cordon-based area (mile)	1500	1200	1800
trail capacity within cordon based area (mile)	200	150	250
trail life time (day)	5400	3600	7200
work trip value (dallar/passenger/day)	160	120	200

Following this Table of parameter settings, the following graphs show the behaviors of the sensitivity analysis for different variables.

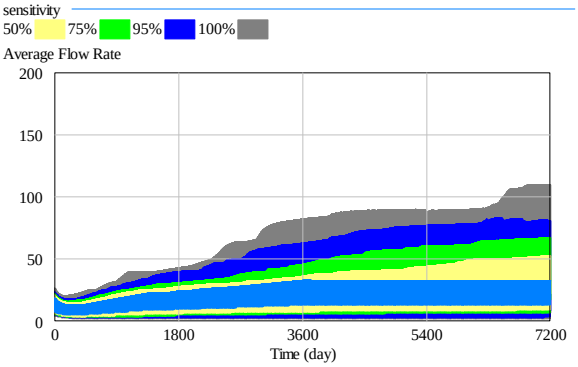


Figure AE.37: Sensitivity Analysis for Average Traffic Flow Rate

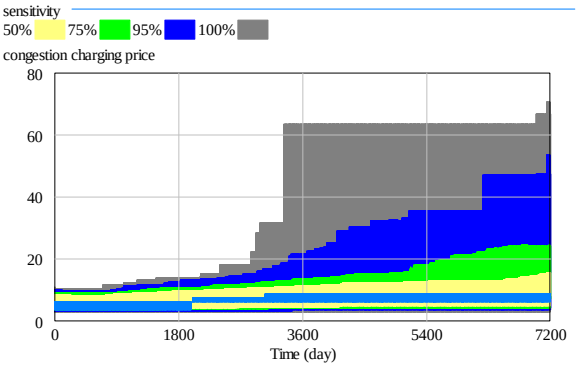


Figure AE.38: Sensitivity Analysis for Congestion Charging Price

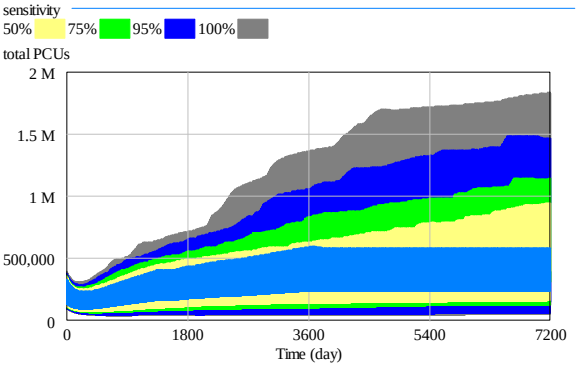


Figure AE.39: Sensitivity Analysis for Total PCUs

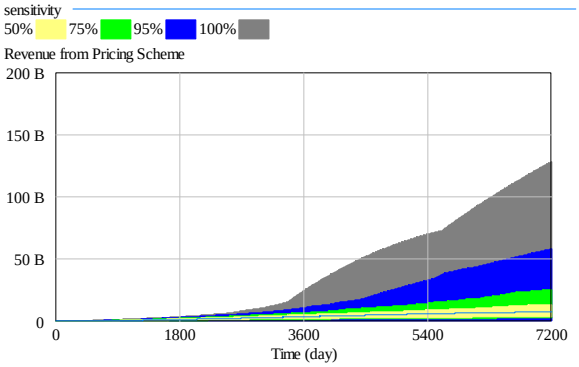


Figure AE.40: Sensitivity Analysis for Revenue from Pricing Scheme

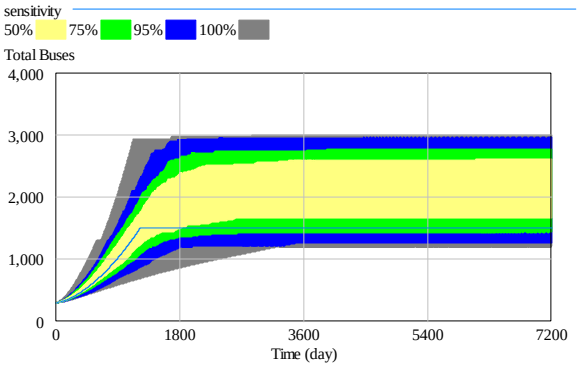


Figure AE.41: Sensitivity Analysis for Total Buses

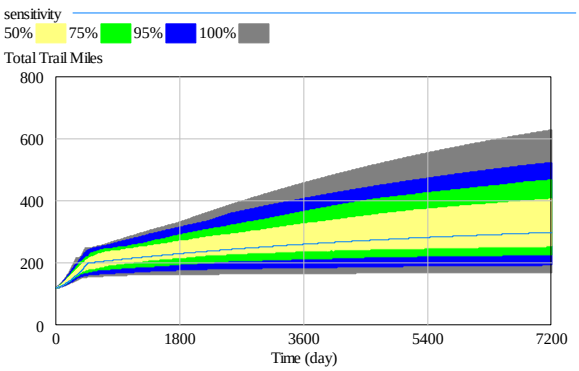


Figure AE.42: Sensitivity Analysis for Total Trail Miles

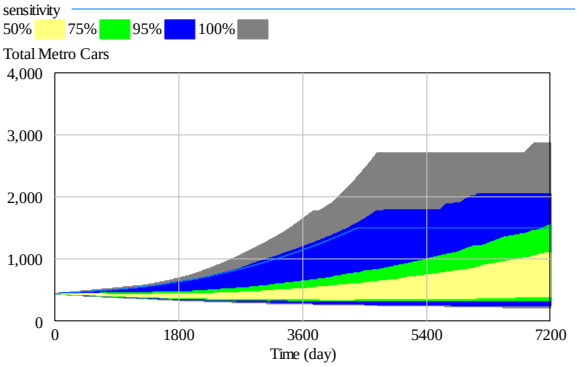


Figure AE.43: Sensitivity Analysis for Total Metro Rail Cars

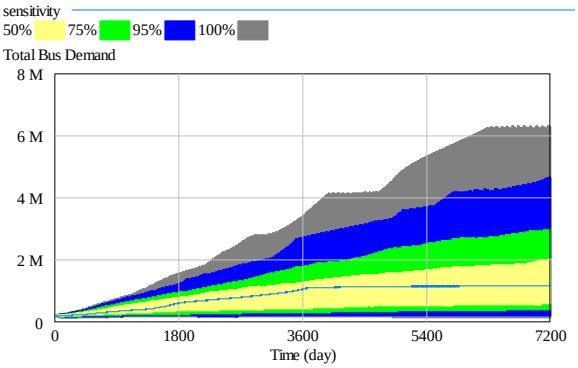


Figure AE.44: Sensitivity Analysis for Total Bus Demand

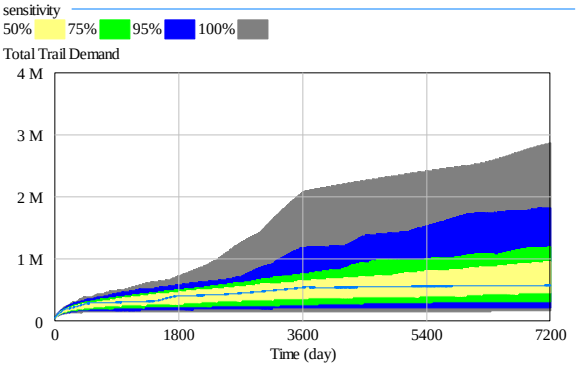


Figure AE.45: Sensitivity Analysis for Total Trail Demand

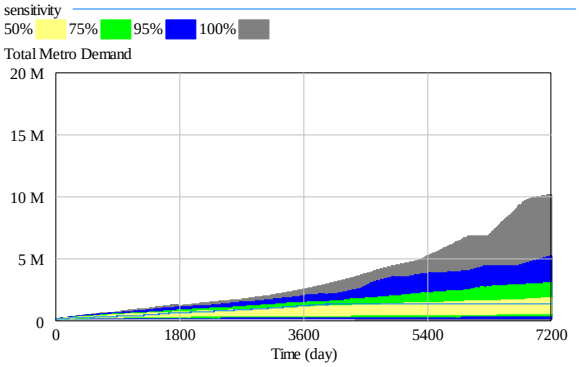


Figure AE.46: Sensitivity Analysis for Total Metro Rail Demand

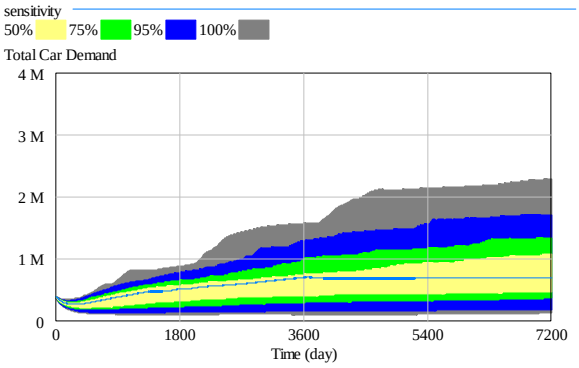


Figure AE.47: Sensitivity Anlaysis for Total Car Demand

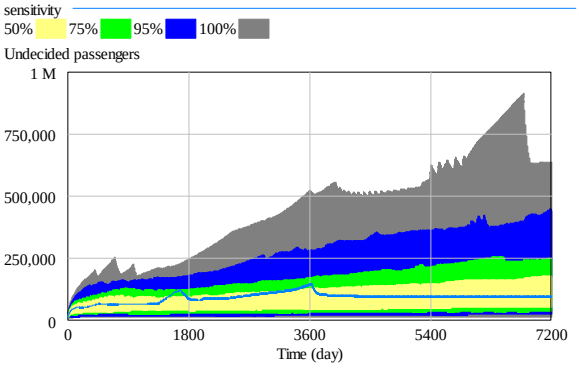


Figure AE.48: Sensitivity Analysis for Undecided Passengers

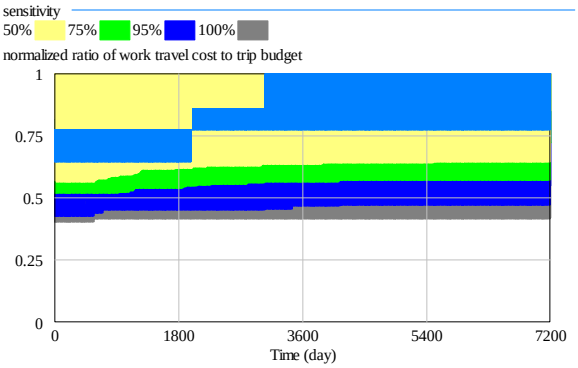


Figure AE.49: Sensitivity Analysis for Normalized Ratio of Work Travel cost to Trip Budget

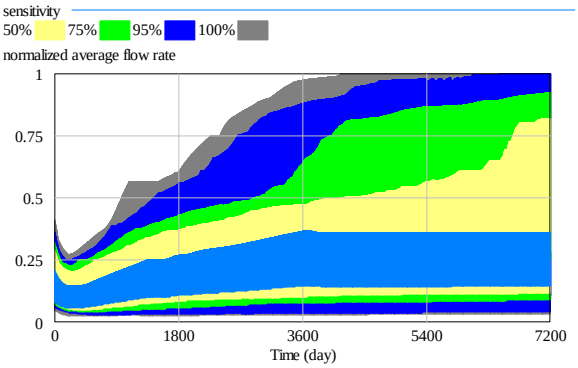


Figure AE.51: Sensitivity Analysis for Normalized Average Traffic Flow Rate

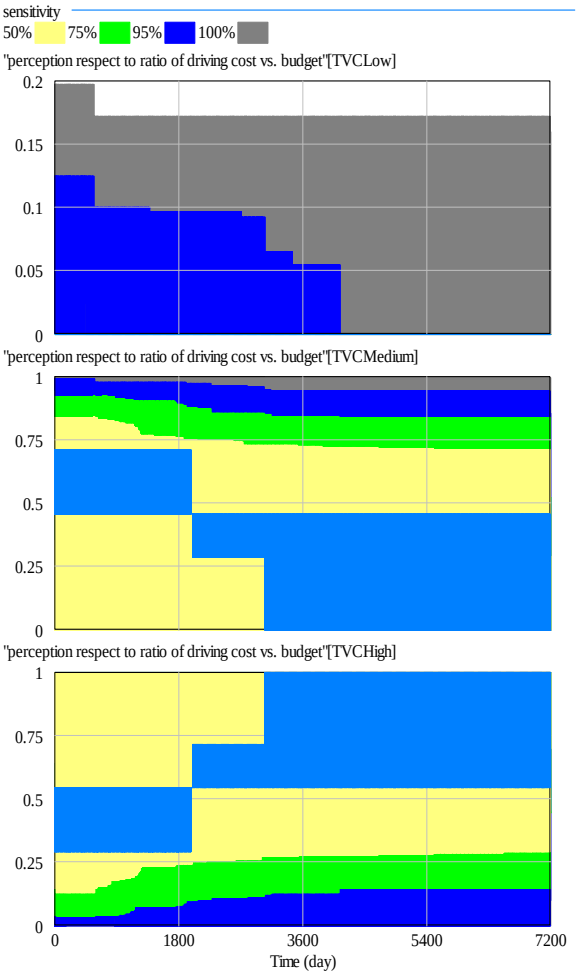


Figure AE.50: Sensitivity Analysis for Perception with respect to Ratio of Driving Cost vs. Budget

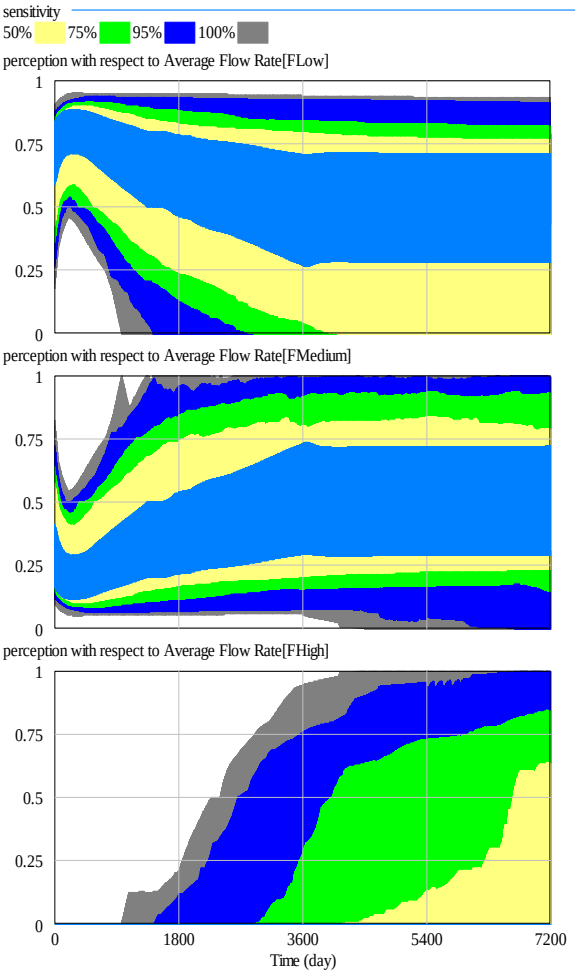


Figure AE.52: Sensitivity Analysis for Perception with respect to Average Traffic Flow Rate

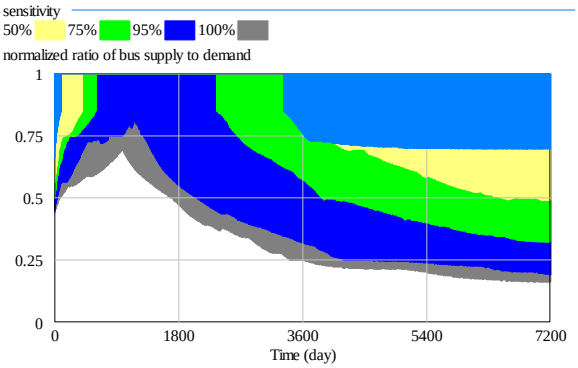


Figure AE.53: Sensitivity Analysis for Normalized Ratio of Bus Supply to Demand

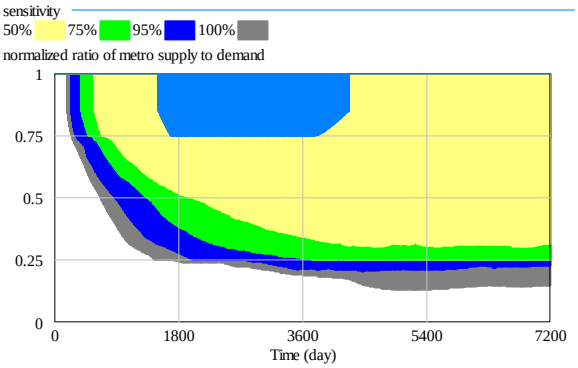


Figure AE.55: Sensitivity Analysis for Normalized Ratio of Metro Supply to Demand

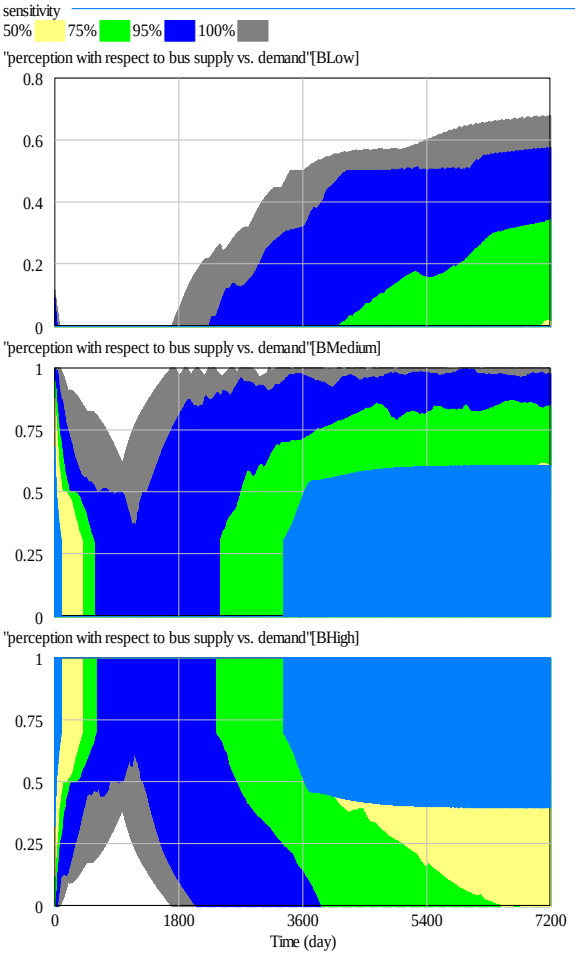


Figure AE.54: Sensitivity Analysis for Perception with respect Bus Supply vs. Demand

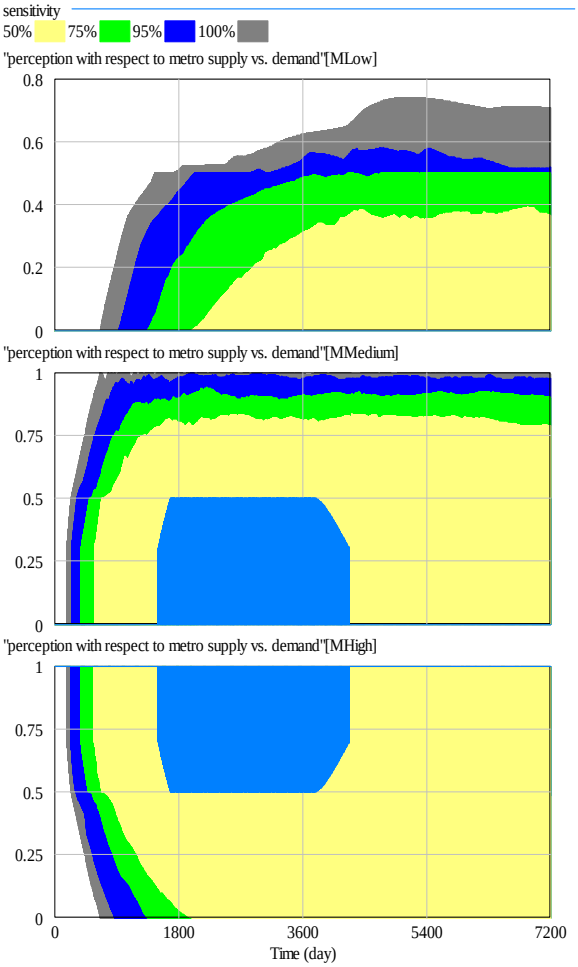


Figure AE.56: Sensitivity Analysis for Perception with respect to Metro Supply vs. Demand

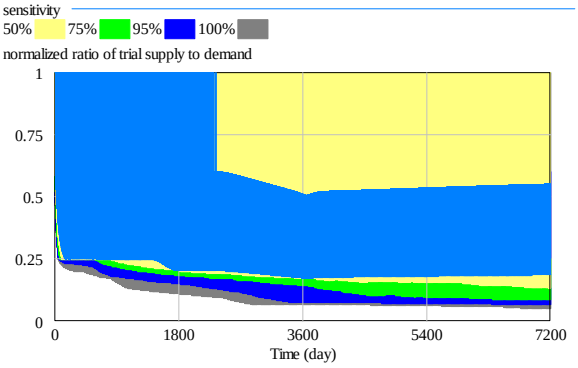


Figure AE.57: Sensitivity Analysis for Normalized Ratio of Trail Supply to Demand

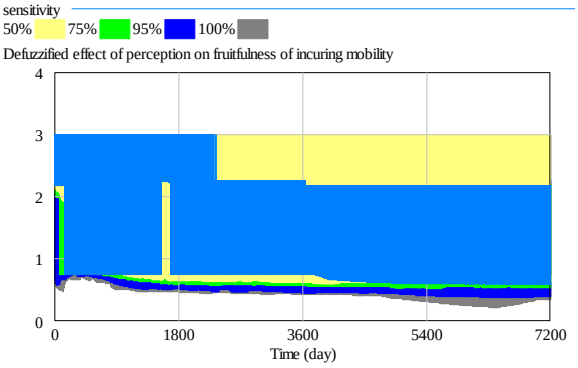


Figure AE.59: Sensitivity Analysis for Defuzzified Effect of Perception on Fruitfulness of Incurring Mobility

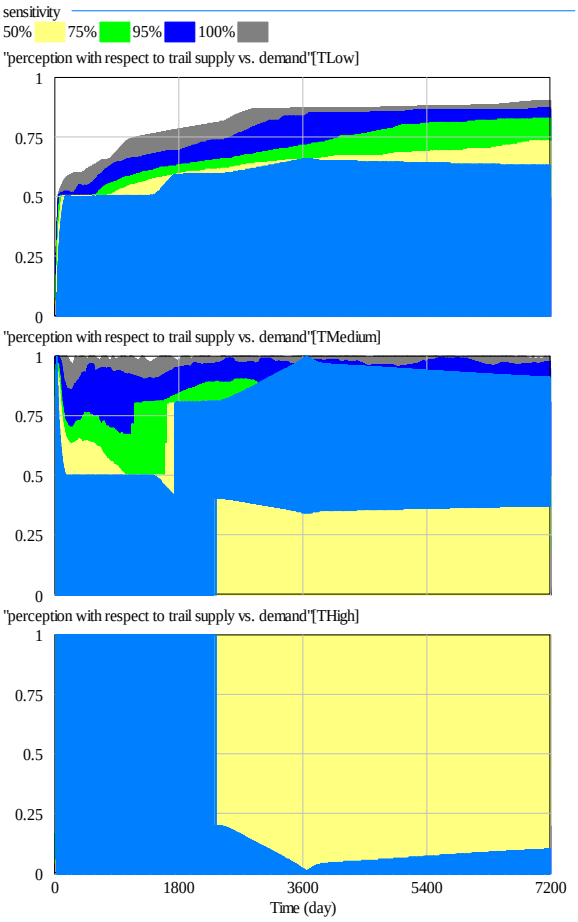


Figure AE.58: Sensitivity Analysis for Perception with respect to Trail Supply vs. Demand

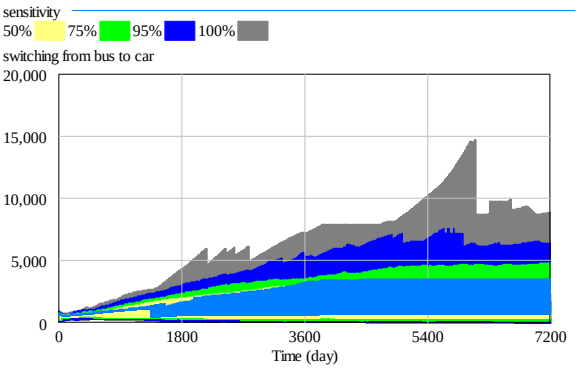


Figure AE.60: Sensitivity Anlaysis for Switching from Bus to Car

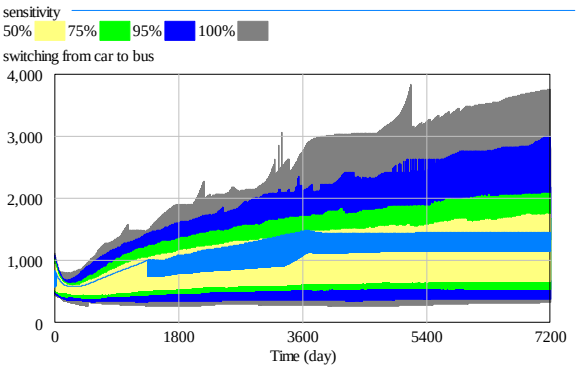


Figure AE.61: Sensitivity Analysis for Switching from Car to Bus

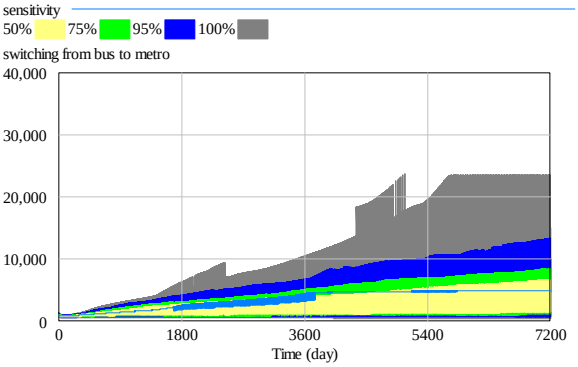


Figure AE.62: Sensitivity Analysis for Switching from Bus to Metro Rail

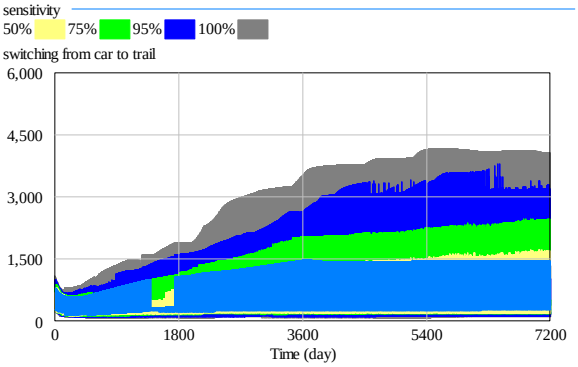


Figure AE.65: Sensitivity Analysis for Switching from Car to Trail

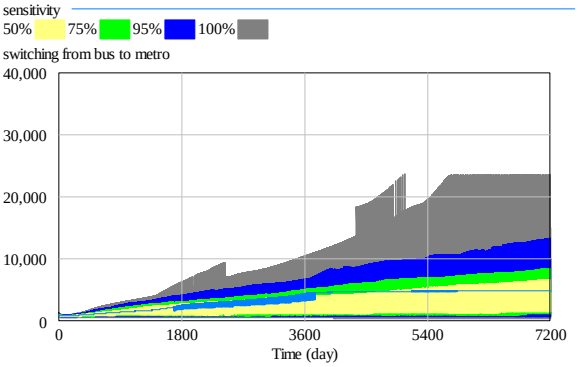


Figure AE.63: Sensitivity Analysis for Switching from Metro Rail to Bus

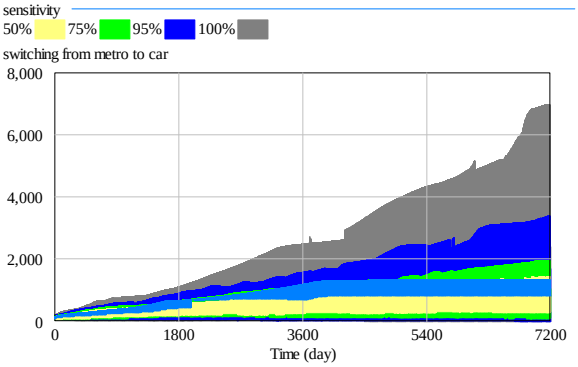


Figure AE.66: Sensitivity Analysis for Switching from Metro Rail to Car

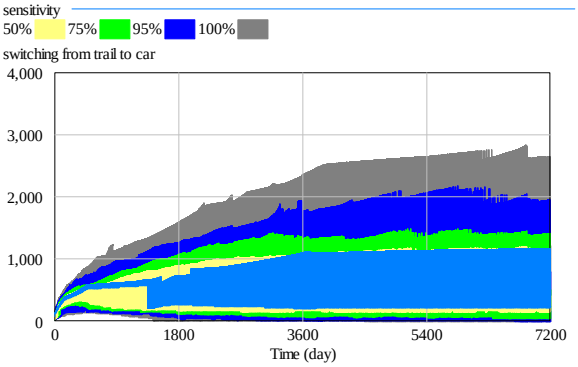


Figure AE.64: Sensitivity Analysis for Switching from Trail to Car

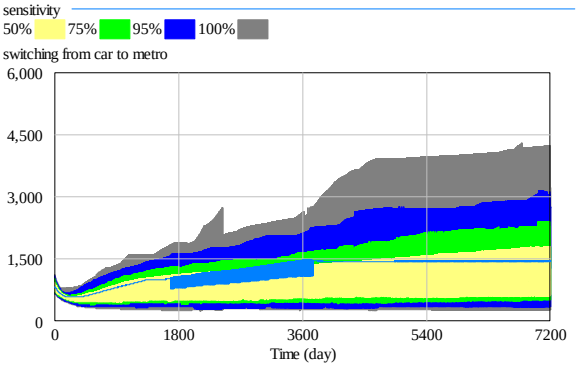


Figure AE.67: Sensitivity Analysis for Switching from Car to Metro Rail

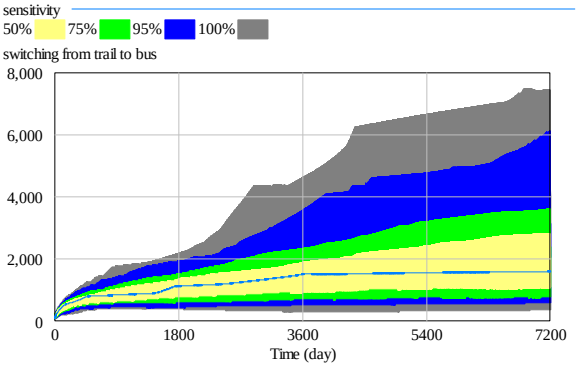


Figure AE.68: Sensitivity Analysis for Switching from Trail to Bus

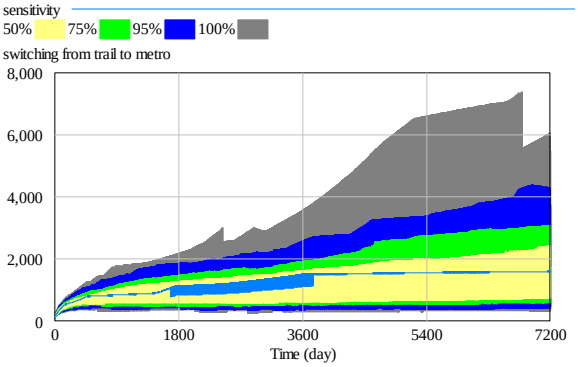


Figure AE.71: Sensitivity Analysis for Switching from Trail to Metro Rail

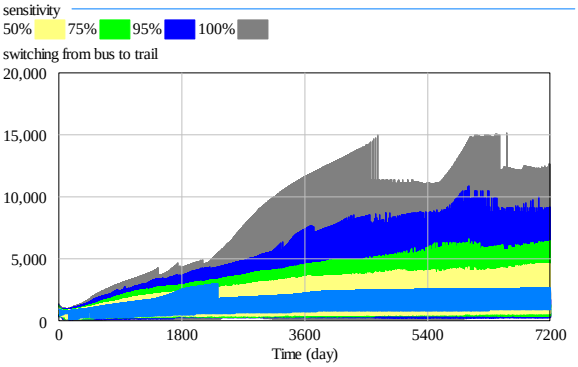


Figure AE.69: Sensitivity Analysis for Switching from Bus to Trail

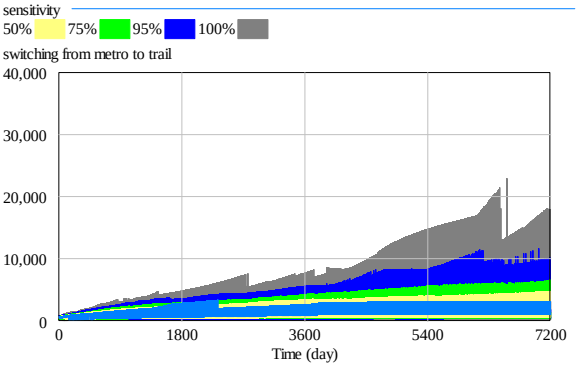


Figure AE.70: Sensitivity Analysis for Switching from Metro Rail to Trail

AE6: Stock and Flow Diagram for Transportation System Model without Travel Demand Management Policy

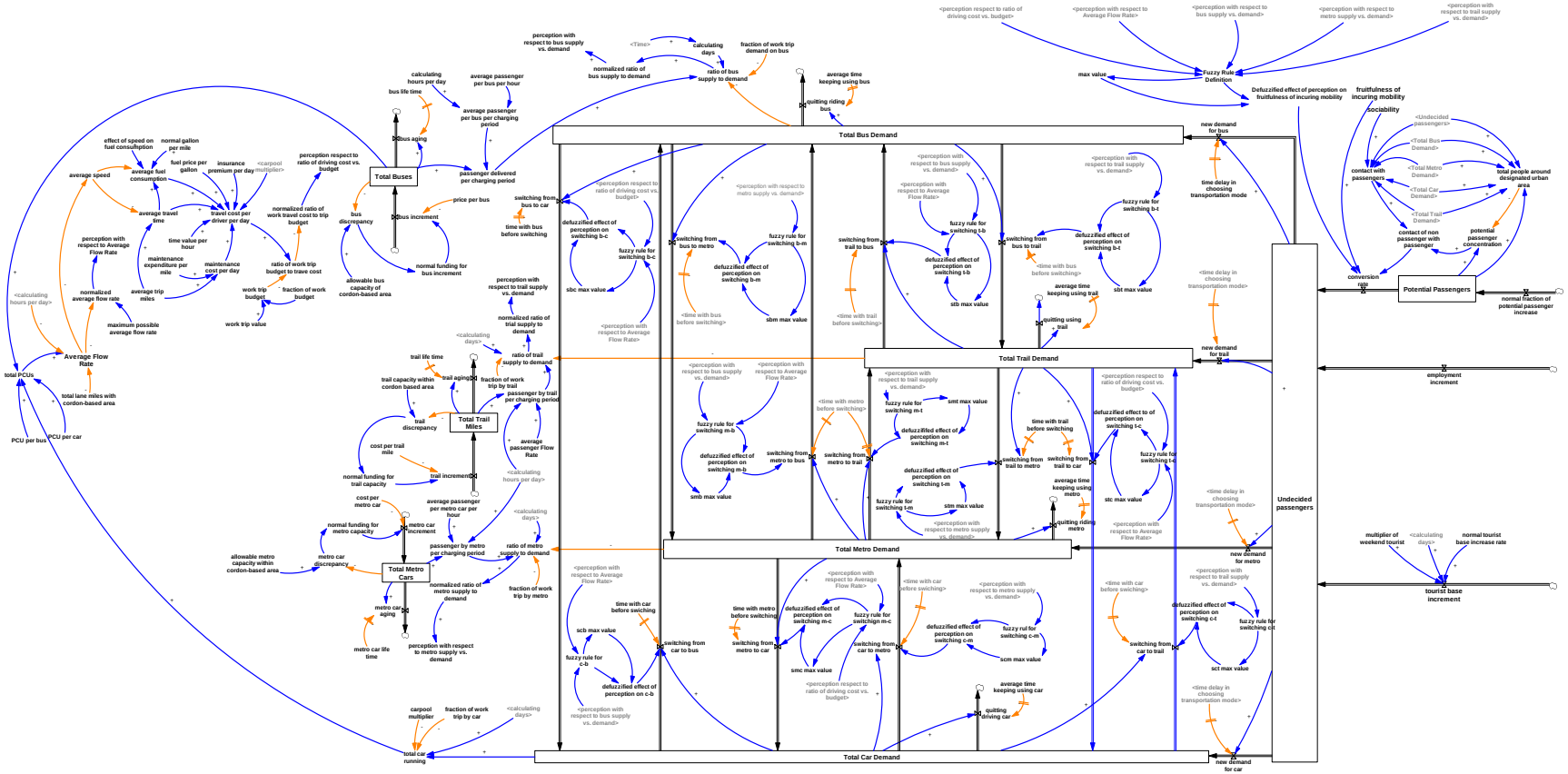


Figure AE.72: Stock and Flow Diagram for Transportation Model without Travel Demand Management Policy

AE7: Formulation for Transportation System Model without Travel Demand Management Policy

1. "allowable bus capacity of cordon-based area"=1500 Units: bus
2. "allowable metro capacity within cordon-based area"=1500 Units: metro car
3. Average Flow Rate=total PCUs/calculating hours per day/"total lane miles with cordon-based area" Units: PCU/hour/mile
4. average fuel consumption=effect of speed on fuel consumption(average speed)*average travel time*average speed*normal gallon per mile Units: gallon/car/day
5. average passenger Flow Rate =30 Units: passenger/hour/mile
6. average passenger per bus per charging period=average passenger per bus per hour*calculating hours per day Units: passenger/bus
7. average passenger per bus per hour=45 Units: passenger/bus/hour
8. average passenger per metro car per hour=68 Units: passenger/hour/metro car
9. average speed=if then else (Average Flow Rate<=10, 55, if then else(Average Flow Rate<=25, 50, if then else (Average Flow Rate<=30, 45, if then else (Average Flow Rate <=40, 40, if then else (Average Flow Rate<=50, 35, if then else (Average Flow Rate<=60, 25, 15)))))) Units: mile/hour
10. average time keeping using bus=1800 Units: day
11. average time keeping using car=3600 Units: day
12. average time keeping using metro=1800 Units: day
13. average time keeping using trail=1080 Units: day
14. average travel time=average trip miles/average speed Units: hour/car/day
15. average trip miles=25 Units: mile/car/day
16. bus aging=Total Buses/bus life time Units: bus/day
17. bus discrepancy="allowable bus capacity of cordon-based area"-Total Buses Units: bus
18. bus increment=normal funding for bus increment/price per bus Units: bus/day
19. bus life time=3600 Units: day
20. Bus S and D: BLow, BMedium, BHigh

21. calculating days=if then else (MODULO(Time, 7)<2, 0,1)
    Units: Dmnl
22. calculating hours per day=12 Units: hour
23. carpool multiplier=1.2 Units: passenger/car
24. contact of non passenger with passenger=contact with passengers*potential passenger concentration Units: contact/day
25. contact with passengers=sociability*(Total Bus Demand+Total Car Demand+Total Metro Demand+Total Trail Demand+Undecided passengers) Units: contact/day
26. conversion rate=contact of non passenger with passenger*Defuzzified effect of perception on fruitfulness of incuring mobility*fruitfulness of incuring mobility
    Units: passenger/day
27. cost per metro car=1e+006 Units: dollar/metro car
28. cost per trail mile=80000 Units: dollar/mile
29. "defuzzified effect of perception on c-b"=if then else ("fuzzy rule for c-b"[cbr2]=scb max value:OR:"fuzzy rule for c-b"[cbr3]=scb max value, 1.5-1.5*scb max value, if then else (("fuzzy rule for c-b"[cbr1]=scb max value:OR:"fuzzy rule for c-b"[cbr4]=scb max value:OR:"fuzzy rule for c-b"[cbr5]=scb max value:OR:"fuzzy rule for c-b"[cbr6]=scb max value:OR:"fuzzy rule for c-b"[cbr9]=scb max value):OR:(("fuzzy rule for c-b"[cbr1]=scb max value:OR:"fuzzy rule for c-b"[cbr4]=scb max value:OR:"fuzzy rule for c-b"[cbr5]=scb max value:OR:"fuzzy rule for c-b"[cbr6]=scb max value:OR:"fuzzy rule for c-b"[cbr9]=scb max value):AND:("fuzzy rule for c-b"[cbr2]=scb max value:OR:"fuzzy rule for c-b"[cbr3]=scb max value)), 3-1.5*scb max value, if then else ("fuzzy rule for c-b"[cbr7]=scb max value:OR:"fuzzy rule for c-b"[cbr8]=scb max value:OR:(("fuzzy rule for c-b"[cbr2]=scb max value:OR:"fuzzy rule for c-b"[cbr3]=scb max value):AND:("fuzzy rule for c-b"[cbr7]=scb max value:OR:"fuzzy rule for c-b"[cbr8]=scb max value)):OR:(("fuzzy rule for c-b"[cbr1]=scb max value:OR:"fuzzy rule for c-b"[cbr4]=scb max value:OR:"fuzzy rule for c-b"[cbr5]=scb max value:OR:"fuzzy rule for c-b"[cbr6]=scb max value:OR:"fuzzy rule for c-b"[cbr9]=scb max value):AND:("fuzzy rule for c-b"[cbr7]=scb max value:OR:"fuzzy rule for c-b"[cbr8]=scb max value)):OR:(("fuzzy rule for c-b"[cbr7]=scb max value:OR:"fuzzy rule for c-b"[cbr8]=scb max value):AND:("fuzzy rule for c-b"[cbr1]=scb max value:OR:"fuzzy rule

for c-b"[cbr4]=scb max value:OR:"fuzzy rule for c-b"[cbr5]=scb max value:OR:"fuzzy rule for c-b"[cbr6]=scb max value:OR:"fuzzy rule for c-b"[cbr9]=scb max value):AND:("fuzzy rule for c-b"[cbr2]=scb max value:OR:"fuzzy rule for c-b"[cbr3]=scb max value)), 3, 1))) Units: Dmnl

30. Defuzzified effect of perception on fruitfulness of incuring mobility=if then else ((Fuzzy Rule Definition[r28]=max value:OR:Fuzzy Rule Definition[r29]=max value:OR:Fuzzy Rule Definition[r31]=max value:OR:Fuzzy Rule Definition[r32]=max value:OR:Fuzzy Rule Definition[r34]=max value:OR:Fuzzy Rule Definition[r37]=max value:OR:Fuzzy Rule Definition[r38]=max value:OR:Fuzzy Rule Definition[r39]=max value:OR:Fuzzy Rule Definition[r40]=max value:OR:Fuzzy Rule Definition[r43]=max value:OR:Fuzzy Rule Definition[r46]=max value:OR:Fuzzy Rule Definition[r55]=max value:OR:Fuzzy Rule Definition[r56]=max value:OR:Fuzzy Rule Definition[r57]=max value:OR:Fuzzy Rule Definition[r58]=max value:OR:Fuzzy Rule Definition[r59]=max value:OR:Fuzzy Rule Definition[r60]=max value:OR:Fuzzy Rule Definition[r61]=max value:OR:Fuzzy Rule Definition[r62]=max value:OR:Fuzzy Rule Definition[r63]=max value:OR:Fuzzy Rule Definition[r64]=max value:OR:Fuzzy Rule Definition[r65]=max value:OR:Fuzzy Rule Definition[r66]=max value:OR:Fuzzy Rule Definition[r67]=max value:OR:Fuzzy Rule Definition[r70]=max value:OR:Fuzzy Rule Definition[r73]=max value:OR:Fuzzy Rule Definition[r74]=max value:OR:Fuzzy Rule Definition[r76]=max value:OR:Fuzzy Rule Definition[r82]=max value:OR:Fuzzy Rule Definition[r83]=max value:OR:Fuzzy Rule Definition[r84]=max value:OR:Fuzzy Rule Definition[r85]=max value:OR:Fuzzy Rule Definition[r86]=max value:OR:Fuzzy Rule Definition[r87]=max value:OR:Fuzzy Rule Definition[r88]=max value:OR:Fuzzy Rule Definition[r89]=max value:OR:Fuzzy Rule Definition[r91]=max value:OR:Fuzzy Rule Definition[r92]=max value:OR:Fuzzy Rule Definition[r94]=max value:OR:Fuzzy Rule Definition[r95]=max value:OR:Fuzzy Rule Definition[r96]=max value:OR:Fuzzy Rule Definition[r97]=max value:OR:Fuzzy Rule Definition[r100]=max value:OR:Fuzzy Rule Definition[r101]=max value:OR:Fuzzy Rule Definition[r103]=max value:OR:Fuzzy Rule Definition[r106]=max value:OR:Fuzzy Rule Definition[r109]=max value:OR:Fuzzy Rule Definition[r110]=max value:OR:Fuzzy Rule Definition[r111]=max value:OR:Fuzzy Rule Definition[r112]=max value:OR:Fuzzy Rule Definition[r113]=max value:OR:Fuzzy Rule Definition[r114]=max value:OR:Fuzzy

Rule Definition[r115]=max value:OR:Fuzzy Rule Definition[r116]=max value:OR:Fuzzy Rule Definition[r117]=max value:OR:Fuzzy Rule Definition[r118]=max value:OR:Fuzzy Rule Definition[r119]=max value:OR:Fuzzy Rule Definition[r120]=max value:OR:Fuzzy Rule Definition[r121]=max value:OR:Fuzzy Rule Definition[r122]=max value:OR:Fuzzy Rule Definition[r124]=max value:OR:Fuzzy Rule Definition[r127]=max value:OR:Fuzzy Rule Definition[r128]=max value:OR:Fuzzy Rule Definition[r129]=max value:OR:Fuzzy Rule Definition[r130]=max value:OR:Fuzzy Rule Definition[r131]=max value:OR:Fuzzy Rule Definition[r136]=max value:OR:Fuzzy Rule Definition[r137]=max value:OR:Fuzzy Rule Definition[r138]=max value:OR:Fuzzy Rule Definition[r139]=max value:OR:Fuzzy Rule Definition[r140]=max value:OR:Fuzzy Rule Definition[r141]=max value:OR:Fuzzy Rule Definition[r142]=max value:OR:Fuzzy Rule Definition[r143]=max value:OR:Fuzzy Rule Definition[r144]=max value:OR:Fuzzy Rule Definition[r145]=max value:OR:Fuzzy Rule Definition[r146]=max value:OR:Fuzzy Rule Definition[r147]=max value:OR:Fuzzy Rule Definition[r148]=max value:OR:Fuzzy Rule Definition[r151]=max value:OR:Fuzzy Rule Definition[r154]=max value:OR:Fuzzy Rule Definition[r155]=max value:OR:Fuzzy Rule Definition[r156]=max value:OR:Fuzzy Rule Definition[r157]=max value:OR:Fuzzy Rule Definition[r160]=max value:OR:Fuzzy Rule Definition[r163]=max value:OR:Fuzzy Rule Definition[r164]=max value:OR:Fuzzy Rule Definition[r165]=max value:OR:Fuzzy Rule Definition[r166]=max value:OR:Fuzzy Rule Definition[r167]=max value:OR:Fuzzy Rule Definition[r168]=max value:OR:Fuzzy Rule Definition[r169]=max value:OR:Fuzzy Rule Definition[r171]=max value:OR:Fuzzy Rule Definition[r172]=max value:OR:Fuzzy Rule Definition[r173]=max value:OR:Fuzzy Rule Definition[r174]=max value:OR:Fuzzy Rule Definition[r175]=max value:OR:Fuzzy Rule Definition[r178]=max value:OR:Fuzzy Rule Definition[r181]=max value:OR:Fuzzy Rule Definition[r182]=max value:OR:Fuzzy Rule Definition[r183]=max value:OR:Fuzzy Rule Definition[r184]=max value:OR:Fuzzy Rule Definition[r187]=max value:OR:Fuzzy Rule Definition[r190]=max value:OR:Fuzzy Rule Definition[r191]=max value:OR:Fuzzy Rule Definition[r192]=max value:OR:Fuzzy Rule Definition[r193]=max value:OR:Fuzzy Rule Definition[r194]=max value:OR:Fuzzy Rule Definition[r195]=max value:OR:Fuzzy Rule Definition[r196]=max value:OR:Fuzzy Rule Definition[r197]=max value:OR:Fuzzy Rule Definition[r199]=max value:OR:Fuzzy Rule Definition[r200]=max value:OR:Fuzzy Rule Definition[r201]=max value:OR:Fuzzy

Rule Definition[r202]=max value:OR:Fuzzy Rule Definition[r205]=max value:OR:Fuzzy Rule Definition[r208]=max value:OR:Fuzzy Rule Definition[r209]=max value:OR:Fuzzy Rule Definition[r211]=max value:OR:Fuzzy Rule Definition[r214]=max value:OR:Fuzzy Rule Definition[r217]=max value:OR:Fuzzy Rule Definition[r218]=max value:OR:Fuzzy Rule Definition[r219]=max value:OR:Fuzzy Rule Definition[r220]=max value:OR:Fuzzy Rule Definition[r221]=max value:OR:Fuzzy Rule Definition[r222]=max value:OR:Fuzzy Rule Definition[r223]=max value:OR:Fuzzy Rule Definition[r224]=max value:OR:Fuzzy Rule Definition[r225]=max value:OR:Fuzzy Rule Definition[r226]=max value:OR:Fuzzy Rule Definition[r227]=max value:OR:Fuzzy Rule Definition[r228]=max value:OR:Fuzzy Rule Definition[r229]=max value:OR:Fuzzy Rule Definition[r230]=max value:OR:Fuzzy Rule Definition[r232]=max value:OR:Fuzzy Rule Definition[r233]=max value:OR:Fuzzy Rule Definition[r235]=max value:OR:Fuzzy Rule Definition[r236]=max value:OR:Fuzzy Rule Definition[r237]=max value:OR:Fuzzy Rule Definition[r238]=max value:OR:Fuzzy Rule Definition[r241]=max value), (1.5-1.5*max value), if then else ((Fuzzy Rule Definition[r1]=max value:OR:Fuzzy Rule Definition[r2]=max value:OR:Fuzzy Rule Definition[r3]=max value:OR:Fuzzy Rule Definition[r4]=max value:OR:Fuzzy Rule Definition[r5]=max value:OR:Fuzzy Rule Definition[r7]=max value:OR:Fuzzy Rule Definition[r8]=max value:OR:Fuzzy Rule Definition[r10]=max value:OR:Fuzzy Rule Definition[r11]=max value:OR:Fuzzy Rule Definition[r13]=max value:OR:Fuzzy Rule Definition[r15]=max value:OR:Fuzzy Rule Definition[r16]=max value:OR:Fuzzy Rule Definition[r17]=max value:OR:Fuzzy Rule Definition[r19]=max value:OR:Fuzzy Rule Definition[r20]=max value:OR:Fuzzy Rule Definition[r22]=max value:OR:Fuzzy Rule Definition[r23]=max value:OR:Fuzzy Rule Definition[r25]=max value:OR:Fuzzy Rule Definition[r30]=max value:OR:Fuzzy Rule Definition[r33]=max value:OR:Fuzzy Rule Definition[r35]=max value:OR:Fuzzy Rule Definition[r36]=max value:OR:Fuzzy Rule Definition[r41]=max value:OR:Fuzzy Rule Definition[r42]=max value:OR:Fuzzy Rule Definition[r44]=max value:OR:Fuzzy Rule Definition[r47]=max value:OR:Fuzzy Rule Definition[r49]=max value:OR:Fuzzy Rule Definition[r50]=max value:OR:Fuzzy Rule Definition[r52]=max value:OR:Fuzzy Rule Definition[r53]=max value:OR:Fuzzy Rule Definition[r68]=max value:OR:Fuzzy Rule Definition[r69]=max value:OR:Fuzzy Rule Definition[r71]=max value:OR:Fuzzy Rule Definition[r72]=max value:OR:Fuzzy Rule

Definition[r75]=max value:OR:Fuzzy Rule Definition[r77]=max value:OR:Fuzzy Rule Definition[r78]=max value:OR:Fuzzy Rule Definition[r79]=max value:OR:Fuzzy Rule Definition[r80]=max value:OR:Fuzzy Rule Definition[r90]=max value:OR:Fuzzy Rule Definition[r93]=max value:OR:Fuzzy Rule Definition[r98]=max value:OR:Fuzzy Rule Definition[r99]=max value:OR:Fuzzy Rule Definition[r102]=max value:OR:Fuzzy Rule Definition[r104]=max value:OR:Fuzzy Rule Definition[r105]=max value:OR:Fuzzy Rule Definition[r107]=max value:OR:Fuzzy Rule Definition[r123]=max value:OR:Fuzzy Rule Definition[r125]=max value:OR:Fuzzy Rule Definition[r126]=max value:OR:Fuzzy Rule Definition[r131]=max value:OR:Fuzzy Rule Definition[r132]=max value:OR:Fuzzy Rule Definition[r134]=max value:OR:Fuzzy Rule Definition[r149]=max value:OR:Fuzzy Rule Definition[r150]=max value:OR:Fuzzy Rule Definition[r152]=max value:OR:Fuzzy Rule Definition[r153]=max value:OR:Fuzzy Rule Definition[r158]=max value:OR:Fuzzy Rule Definition[r159]=max value:OR:Fuzzy Rule Definition[r161]=max value:OR:Fuzzy Rule Definition[r170]=max value:OR:Fuzzy Rule Definition[r176]=max value:OR:Fuzzy Rule Definition[r177]=max value:OR:Fuzzy Rule Definition[r179]=max value:OR:Fuzzy Rule Definition[r180]=max value:OR:Fuzzy Rule Definition[r185]=max value:OR:Fuzzy Rule Definition[r186]=max value:OR:Fuzzy Rule Definition[r188]=max value:OR:Fuzzy Rule Definition[r198]=max value:OR:Fuzzy Rule Definition[r203]=max value:OR:Fuzzy Rule Definition[r204]=max value:OR:Fuzzy Rule Definition[r206]=max value:OR:Fuzzy Rule Definition[r207]=max value:OR:Fuzzy Rule Definition[r210]=max value:OR:Fuzzy Rule Definition[r212]=max value:OR:Fuzzy Rule Definition[r213]=max value:OR:Fuzzy Rule Definition[r215]=max value:OR:Fuzzy Rule Definition[r231]=max value:OR:Fuzzy Rule Definition[r234]=max value:OR:Fuzzy Rule Definition[r239]=max value:OR:Fuzzy Rule Definition[r240]=max value:OR:Fuzzy Rule Definition[r242]=max value) , (3-1.5*max value), if then else ((Fuzzy Rule Definition[r6]=max value:OR:Fuzzy Rule Definition[r9]=max value:OR:Fuzzy Rule Definition[r12]=max value:OR:Fuzzy Rule Definition[r14]=max value:OR:Fuzzy Rule Definition[r18]=max value:OR:Fuzzy Rule Definition[r21]=max value:OR:Fuzzy Rule Definition[r24]=max value:OR:Fuzzy Rule Definition[r26]=max value:OR:Fuzzy Rule Definition[r27]=max value:OR:Fuzzy Rule Definition[r45]=max value:OR:Fuzzy Rule Definition[r48]=max value:OR:Fuzzy Rule Definition[r51]=max value:OR:Fuzzy Rule Definition[r54]=max value:OR:Fuzzy Rule

Definition[r81]=max value:OR:Fuzzy Rule Definition[r108]=max value:OR:Fuzzy Rule Definition[r135]=max value:OR:Fuzzy Rule Definition[r162]=max value:OR:Fuzzy Rule Definition[r189]=max value:OR:Fuzzy Rule Definition[r216]=max value:OR:Fuzzy Rule Definition[r243]=max value), 3, if then else((Fuzzy Rule Definition[r28]=max value:OR:Fuzzy Rule Definition[r29]=max value:OR:Fuzzy Rule Definition[r31]=max value:OR:Fuzzy Rule Definition[r32]=max value:OR:Fuzzy Rule Definition[r34]=max value:OR:Fuzzy Rule Definition[r37]=max value:OR:Fuzzy Rule Definition[r38]=max value:OR:Fuzzy Rule Definition[r39]=max value:OR:Fuzzy Rule Definition[r40]=max value:OR:Fuzzy Rule Definition[r43]=max value:OR:Fuzzy Rule Definition[r46]=max value:OR:Fuzzy Rule Definition[r55]=max value:OR:Fuzzy Rule Definition[r56]=max value:OR:Fuzzy Rule Definition[r57]=max value:OR:Fuzzy Rule Definition[r58]=max value:OR:Fuzzy Rule Definition[r59]=max value:OR:Fuzzy Rule Definition[r60]=max value:OR:Fuzzy Rule Definition[r61]=max value:OR:Fuzzy Rule Definition[r62]=max value:OR:Fuzzy Rule Definition[r63]=max value:OR:Fuzzy Rule Definition[r64]=max value:OR:Fuzzy Rule Definition[r65]=max value:OR:Fuzzy Rule Definition[r66]=max value:OR:Fuzzy Rule Definition[r67]=max value:OR:Fuzzy Rule Definition[r70]=max value:OR:Fuzzy Rule Definition[r73]=max value:OR:Fuzzy Rule Definition[r74]=max value:OR:Fuzzy Rule Definition[r76]=max value:OR:Fuzzy Rule Definition[r82]=max value:OR:Fuzzy Rule Definition[r83]=max value:OR:Fuzzy Rule Definition[r84]=max value:OR:Fuzzy Rule Definition[r85]=max value:OR:Fuzzy Rule Definition[r86]=max value:OR:Fuzzy Rule Definition[r87]=max value:OR:Fuzzy Rule Definition[r88]=max value:OR:Fuzzy Rule Definition[r89]=max value:OR:Fuzzy Rule Definition[r91]=max value:OR:Fuzzy Rule Definition[r92]=max value:OR:Fuzzy Rule Definition[r94]=max value:OR:Fuzzy Rule Definition[r95]=max value:OR:Fuzzy Rule Definition[r96]=max value:OR:Fuzzy Rule Definition[r97]=max value:OR:Fuzzy Rule Definition[r100]=max value:OR:Fuzzy Rule Definition[r101]=max value:OR:Fuzzy Rule Definition[r103]=max value:OR:Fuzzy Rule Definition[r106]=max value:OR:Fuzzy Rule Definition[r109]=max value:OR:Fuzzy Rule Definition[r110]=max value:OR:Fuzzy Rule Definition[r111]=max value:OR:Fuzzy Rule Definition[r112]=max value:OR:Fuzzy Rule Definition[r113]=max value:OR:Fuzzy Rule Definition[r114]=max value:OR:Fuzzy Rule Definition[r115]=max value:OR:Fuzzy Rule Definition[r116]=max value:OR:Fuzzy Rule Definition[r117]=max

value:OR:Fuzzy Rule Definition[r118]=max value:OR:Fuzzy Rule Definition[r119]=max value:OR:Fuzzy Rule Definition[r120]=max value:OR:Fuzzy Rule Definition[r121]=max value:OR:Fuzzy Rule Definition[r122]=max value:OR:Fuzzy Rule Definition[r124]=max value:OR:Fuzzy Rule Definition[r127]=max value:OR:Fuzzy Rule Definition[r128]=max value:OR:Fuzzy Rule Definition[r129]=max value:OR:Fuzzy Rule Definition[r130]=max value:OR:Fuzzy Rule Definition[r131]=max value:OR:Fuzzy Rule Definition[r136]=max value:OR:Fuzzy Rule Definition[r137]=max value:OR:Fuzzy Rule Definition[r138]=max value:OR:Fuzzy Rule Definition[r139]=max value:OR:Fuzzy Rule Definition[r140]=max value:OR:Fuzzy Rule Definition[r141]=max value:OR:Fuzzy Rule Definition[r142]=max value:OR:Fuzzy Rule Definition[r143]=max value:OR:Fuzzy Rule Definition[r144]=max value:OR:Fuzzy Rule Definition[r145]=max value:OR:Fuzzy Rule Definition[r146]=max value:OR:Fuzzy Rule Definition[r147]=max value:OR:Fuzzy Rule Definition[r148]=max value:OR:Fuzzy Rule Definition[r151]=max value:OR:Fuzzy Rule Definition[r154]=max value:OR:Fuzzy Rule Definition[r155]=max value:OR:Fuzzy Rule Definition[r156]=max value:OR:Fuzzy Rule Definition[r157]=max value:OR:Fuzzy Rule Definition[r160]=max value:OR:Fuzzy Rule Definition[r163]=max value:OR:Fuzzy Rule Definition[r164]=max value:OR:Fuzzy Rule Definition[r165]=max value:OR:Fuzzy Rule Definition[r166]=max value:OR:Fuzzy Rule Definition[r167]=max value:OR:Fuzzy Rule Definition[r168]=max value:OR:Fuzzy Rule Definition[r169]=max value:OR:Fuzzy Rule Definition[r171]=max value:OR:Fuzzy Rule Definition[r172]=max value:OR:Fuzzy Rule Definition[r173]=max value:OR:Fuzzy Rule Definition[r174]=max value:OR:Fuzzy Rule Definition[r175]=max value:OR:Fuzzy Rule Definition[r178]=max value:OR:Fuzzy Rule Definition[r181]=max value:OR:Fuzzy Rule Definition[r182]=max value:OR:Fuzzy Rule Definition[r183]=max value:OR:Fuzzy Rule Definition[r184]=max value:OR:Fuzzy Rule Definition[r187]=max value:OR:Fuzzy Rule Definition[r190]=max value:OR:Fuzzy Rule Definition[r191]=max value:OR:Fuzzy Rule Definition[r192]=max value:OR:Fuzzy Rule Definition[r193]=max value:OR:Fuzzy Rule Definition[r194]=max value:OR:Fuzzy Rule Definition[r195]=max value:OR:Fuzzy Rule Definition[r196]=max value:OR:Fuzzy Rule Definition[r197]=max value:OR:Fuzzy Rule Definition[r199]=max value:OR:Fuzzy Rule Definition[r200]=max value:OR:Fuzzy Rule Definition[r201]=max value:OR:Fuzzy Rule Definition[r202]=max value:OR:Fuzzy Rule Definition[r205]=max value:OR:Fuzzy Rule Definition[r208]=max

value:OR:Fuzzy Rule Definition[r209]=max value:OR:Fuzzy Rule Definition[r211]=max value:OR:Fuzzy Rule Definition[r214]=max value:OR:Fuzzy Rule Definition[r217]=max value:OR:Fuzzy Rule Definition[r218]=max value:OR:Fuzzy Rule Definition[r219]=max value:OR:Fuzzy Rule Definition[r220]=max value:OR:Fuzzy Rule Definition[r221]=max value:OR:Fuzzy Rule Definition[r222]=max value:OR:Fuzzy Rule Definition[r223]=max value:OR:Fuzzy Rule Definition[r224]=max value:OR:Fuzzy Rule Definition[r225]=max value:OR:Fuzzy Rule Definition[r226]=max value:OR:Fuzzy Rule Definition[r227]=max value:OR:Fuzzy Rule Definition[r228]=max value:OR:Fuzzy Rule Definition[r229]=max value:OR:Fuzzy Rule Definition[r230]=max value:OR:Fuzzy Rule Definition[r232]=max value:OR:Fuzzy Rule Definition[r233]=max value:OR:Fuzzy Rule Definition[r235]=max value:OR:Fuzzy Rule Definition[r236]=max value:OR:Fuzzy Rule Definition[r237]=max value:OR:Fuzzy Rule Definition[r238]=max value:OR:Fuzzy Rule Definition[r241]=max value):AND: (Fuzzy Rule Definition[r1]=max value:OR:Fuzzy Rule Definition[r2]=max value:OR:Fuzzy Rule Definition[r3]=max value:OR:Fuzzy Rule Definition[r4]=max value:OR:Fuzzy Rule Definition[r5]=max value:OR:Fuzzy Rule Definition[r7]=max value:OR:Fuzzy Rule Definition[r8]=max value:OR:Fuzzy Rule Definition[r10]=max value:OR:Fuzzy Rule Definition[r11]=max value:OR:Fuzzy Rule Definition[r13]=max value:OR:Fuzzy Rule Definition[r15]=max value:OR:Fuzzy Rule Definition[r16]=max value:OR:Fuzzy Rule Definition[r17]=max value:OR:Fuzzy Rule Definition[r19]=max value:OR:Fuzzy Rule Definition[r20]=max value:OR:Fuzzy Rule Definition[r22]=max value:OR:Fuzzy Rule Definition[r23]=max value:OR:Fuzzy Rule Definition[r25]=max value:OR:Fuzzy Rule Definition[r30]=max value:OR:Fuzzy Rule Definition[r33]=max value:OR:Fuzzy Rule Definition[r35]=max value:OR:Fuzzy Rule Definition[r36]=max value:OR:Fuzzy Rule Definition[r41]=max value:OR:Fuzzy Rule Definition[r42]=max value:OR:Fuzzy Rule Definition[r44]=max value:OR:Fuzzy Rule Definition[r47]=max value:OR:Fuzzy Rule Definition[r49]=max value:OR:Fuzzy Rule Definition[r50]=max value:OR:Fuzzy Rule Definition[r52]=max value:OR:Fuzzy Rule Definition[r53]=max value:OR:Fuzzy Rule Definition[r68]=max value:OR:Fuzzy Rule Definition[r69]=max value:OR:Fuzzy Rule Definition[r71]=max value:OR:Fuzzy Rule Definition[r72]=max value:OR:Fuzzy Rule Definition[r75]=max value:OR:Fuzzy Rule Definition[r77]=max value:OR:Fuzzy Rule Definition[r78]=max value:OR:Fuzzy Rule Definition[r79]=max

value:OR:Fuzzy Rule Definition[r80]=max value:OR:Fuzzy Rule Definition[r90]=max value:OR:Fuzzy Rule Definition[r93]=max value:OR:Fuzzy Rule Definition[r98]=max value:OR:Fuzzy Rule Definition[r99]=max value:OR:Fuzzy Rule Definition[r102]=max value:OR:Fuzzy Rule Definition[r104]=max value:OR:Fuzzy Rule Definition[r105]=max value:OR:Fuzzy Rule Definition[r107]=max value:OR:Fuzzy Rule Definition[r123]=max value:OR:Fuzzy Rule Definition[r125]=max value:OR:Fuzzy Rule Definition[r126]=max value:OR:Fuzzy Rule Definition[r131]=max value:OR:Fuzzy Rule Definition[r132]=max value:OR:Fuzzy Rule Definition[r134]=max value:OR:Fuzzy Rule Definition[r149]=max value:OR:Fuzzy Rule Definition[r150]=max value:OR:Fuzzy Rule Definition[r152]=max value:OR:Fuzzy Rule Definition[r153]=max value:OR:Fuzzy Rule Definition[r158]=max value:OR:Fuzzy Rule Definition[r159]=max value:OR:Fuzzy Rule Definition[r161]=max value:OR:Fuzzy Rule Definition[r170]=max value:OR:Fuzzy Rule Definition[r176]=max value:OR:Fuzzy Rule Definition[r177]=max value:OR:Fuzzy Rule Definition[r179]=max value:OR:Fuzzy Rule Definition[r180]=max value:OR:Fuzzy Rule Definition[r185]=max value:OR:Fuzzy Rule Definition[r186]=max value:OR:Fuzzy Rule Definition[r188]=max value:OR:Fuzzy Rule Definition[r198]=max value:OR:Fuzzy Rule Definition[r203]=max value:OR:Fuzzy Rule Definition[r204]=max value:OR:Fuzzy Rule Definition[r206]=max value:OR:Fuzzy Rule Definition[r207]=max value:OR:Fuzzy Rule Definition[r210]=max value:OR:Fuzzy Rule Definition[r212]=max value:OR:Fuzzy Rule Definition[r213]=max value:OR:Fuzzy Rule Definition[r215]=max value:OR:Fuzzy Rule Definition[r231]=max value:OR:Fuzzy Rule Definition[r234]=max value:OR:Fuzzy Rule Definition[r239]=max value:OR:Fuzzy Rule Definition[r240]=max value:OR:Fuzzy Rule Definition[r242]=max value) , (3-1.5*max value), if then else (((Fuzzy Rule Definition[r28]=max value:OR:Fuzzy Rule Definition[r29]=max value:OR:Fuzzy Rule Definition[r31]=max value:OR:Fuzzy Rule Definition[r32]=max value:OR:Fuzzy Rule Definition[r34]=max value:OR:Fuzzy Rule Definition[r37]=max value:OR:Fuzzy Rule Definition[r38]=max value:OR:Fuzzy Rule Definition[r39]=max value:OR:Fuzzy Rule Definition[r40]=max value:OR:Fuzzy Rule Definition[r43]=max value:OR:Fuzzy Rule Definition[r46]=max value:OR:Fuzzy Rule Definition[r55]=max value:OR:Fuzzy Rule Definition[r56]=max value:OR:Fuzzy Rule Definition[r57]=max value:OR:Fuzzy Rule Definition[r58]=max value:OR:Fuzzy Rule Definition[r59]=max value:OR:Fuzzy Rule Definition[r60]=max

value:OR:Fuzzy Rule Definition[r61]=max value:OR:Fuzzy Rule Definition[r62]=max value:OR:Fuzzy Rule Definition[r63]=max value:OR:Fuzzy Rule Definition[r64]=max value:OR:Fuzzy Rule Definition[r65]=max value:OR:Fuzzy Rule Definition[r66]=max value:OR:Fuzzy Rule Definition[r67]=max value:OR:Fuzzy Rule Definition[r70]=max value:OR:Fuzzy Rule Definition[r73]=max value:OR:Fuzzy Rule Definition[r74]=max value:OR:Fuzzy Rule Definition[r76]=max value:OR:Fuzzy Rule Definition[r82]=max value:OR:Fuzzy Rule Definition[r83]=max value:OR:Fuzzy Rule Definition[r84]=max value:OR:Fuzzy Rule Definition[r85]=max value:OR:Fuzzy Rule Definition[r86]=max value:OR:Fuzzy Rule Definition[r87]=max value:OR:Fuzzy Rule Definition[r88]=max value:OR:Fuzzy Rule Definition[r89]=max value:OR:Fuzzy Rule Definition[r91]=max value:OR:Fuzzy Rule Definition[r92]=max value:OR:Fuzzy Rule Definition[r94]=max value:OR:Fuzzy Rule Definition[r95]=max value:OR:Fuzzy Rule Definition[r96]=max value:OR:Fuzzy Rule Definition[r97]=max value:OR:Fuzzy Rule Definition[r100]=max value:OR:Fuzzy Rule Definition[r101]=max value:OR:Fuzzy Rule Definition[r103]=max value:OR:Fuzzy Rule Definition[r106]=max value:OR:Fuzzy Rule Definition[r109]=max value:OR:Fuzzy Rule Definition[r110]=max value:OR:Fuzzy Rule Definition[r111]=max value:OR:Fuzzy Rule Definition[r112]=max value:OR:Fuzzy Rule Definition[r113]=max value:OR:Fuzzy Rule Definition[r114]=max value:OR:Fuzzy Rule Definition[r115]=max value:OR:Fuzzy Rule Definition[r116]=max value:OR:Fuzzy Rule Definition[r117]=max value:OR:Fuzzy Rule Definition[r118]=max value:OR:Fuzzy Rule Definition[r119]=max value:OR:Fuzzy Rule Definition[r120]=max value:OR:Fuzzy Rule Definition[r121]=max value:OR:Fuzzy Rule Definition[r122]=max value:OR:Fuzzy Rule Definition[r124]=max value:OR:Fuzzy Rule Definition[r127]=max value:OR:Fuzzy Rule Definition[r128]=max value:OR:Fuzzy Rule Definition[r129]=max value:OR:Fuzzy Rule Definition[r130]=max value:OR:Fuzzy Rule Definition[r131]=max value:OR:Fuzzy Rule Definition[r136]=max value:OR:Fuzzy Rule Definition[r137]=max value:OR:Fuzzy Rule Definition[r138]=max value:OR:Fuzzy Rule Definition[r139]=max value:OR:Fuzzy Rule Definition[r140]=max value:OR:Fuzzy Rule Definition[r141]=max value:OR:Fuzzy Rule Definition[r142]=max value:OR:Fuzzy Rule Definition[r143]=max value:OR:Fuzzy Rule Definition[r144]=max value:OR:Fuzzy Rule Definition[r145]=max value:OR:Fuzzy Rule Definition[r146]=max value:OR:Fuzzy Rule Definition[r147]=max value:OR:Fuzzy Rule Definition[r148]=max

value:OR:Fuzzy Rule Definition[r151]=max value:OR:Fuzzy Rule Definition[r154]=max value:OR:Fuzzy Rule Definition[r155]=max value:OR:Fuzzy Rule Definition[r156]=max value:OR:Fuzzy Rule Definition[r157]=max value:OR:Fuzzy Rule Definition[r160]=max value:OR:Fuzzy Rule Definition[r163]=max value:OR:Fuzzy Rule Definition[r164]=max value:OR:Fuzzy Rule Definition[r165]=max value:OR:Fuzzy Rule Definition[r166]=max value:OR:Fuzzy Rule Definition[r167]=max value:OR:Fuzzy Rule Definition[r168]=max value:OR:Fuzzy Rule Definition[r169]=max value:OR:Fuzzy Rule Definition[r171]=max value:OR:Fuzzy Rule Definition[r172]=max value:OR:Fuzzy Rule Definition[r173]=max value:OR:Fuzzy Rule Definition[r174]=max value:OR:Fuzzy Rule Definition[r175]=max value:OR:Fuzzy Rule Definition[r178]=max value:OR:Fuzzy Rule Definition[r181]=max value:OR:Fuzzy Rule Definition[r182]=max value:OR:Fuzzy Rule Definition[r183]=max value:OR:Fuzzy Rule Definition[r184]=max value:OR:Fuzzy Rule Definition[r187]=max value:OR:Fuzzy Rule Definition[r190]=max value:OR:Fuzzy Rule Definition[r191]=max value:OR:Fuzzy Rule Definition[r192]=max value:OR:Fuzzy Rule Definition[r193]=max value:OR:Fuzzy Rule Definition[r194]=max value:OR:Fuzzy Rule Definition[r195]=max value:OR:Fuzzy Rule Definition[r196]=max value:OR:Fuzzy Rule Definition[r197]=max value:OR:Fuzzy Rule Definition[r199]=max value:OR:Fuzzy Rule Definition[r200]=max value:OR:Fuzzy Rule Definition[r201]=max value:OR:Fuzzy Rule Definition[r202]=max value:OR:Fuzzy Rule Definition[r205]=max value:OR:Fuzzy Rule Definition[r208]=max value:OR:Fuzzy Rule Definition[r209]=max value:OR:Fuzzy Rule Definition[r211]=max value:OR:Fuzzy Rule Definition[r214]=max value:OR:Fuzzy Rule Definition[r217]=max value:OR:Fuzzy Rule Definition[r218]=max value:OR:Fuzzy Rule Definition[r219]=max value:OR:Fuzzy Rule Definition[r220]=max value:OR:Fuzzy Rule Definition[r221]=max value:OR:Fuzzy Rule Definition[r222]=max value:OR:Fuzzy Rule Definition[r223]=max value:OR:Fuzzy Rule Definition[r224]=max value:OR:Fuzzy Rule Definition[r225]=max value:OR:Fuzzy Rule Definition[r226]=max value:OR:Fuzzy Rule Definition[r227]=max value:OR:Fuzzy Rule Definition[r228]=max value:OR:Fuzzy Rule Definition[r229]=max value:OR:Fuzzy Rule Definition[r230]=max value:OR:Fuzzy Rule Definition[r232]=max value:OR:Fuzzy Rule Definition[r233]=max value:OR:Fuzzy Rule Definition[r235]=max value:OR:Fuzzy Rule Definition[r236]=max value:OR:Fuzzy Rule Definition[r237]=max value:OR:Fuzzy Rule Definition[r238]=max value:OR:Fuzzy Rule Definition[r241]=max

value):AND:(Fuzzy Rule Definition[r6]=max value:OR:Fuzzy Rule Definition[r9]=max value:OR:Fuzzy Rule Definition[r12]=max value:OR:Fuzzy Rule Definition[r14]=max value:OR:Fuzzy Rule Definition[r18]=max value:OR:Fuzzy Rule Definition[r21]=max value:OR:Fuzzy Rule Definition[r24]=max value:OR:Fuzzy Rule Definition[r26]=max value:OR:Fuzzy Rule Definition[r27]=max value:OR:Fuzzy Rule Definition[r45]=max value:OR:Fuzzy Rule Definition[r48]=max value:OR:Fuzzy Rule Definition[r51]=max value:OR:Fuzzy Rule Definition[r54]=max value:OR:Fuzzy Rule Definition[r81]=max value:OR:Fuzzy Rule Definition[r108]=max value:OR:Fuzzy Rule Definition[r135]=max value:OR:Fuzzy Rule Definition[r162]=max value:OR:Fuzzy Rule Definition[r189]=max value:OR:Fuzzy Rule Definition[r216]=max value:OR:Fuzzy Rule Definition[r243]=max value)), 3, 1))))) Units: Dmnl

31. "defuzzified effect of perception on switching b-c"=if then else ("fuzzy rule for switching b-c"[bcr6]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr8]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr9]=sbc max value,1.5-1.5*sbc max value, if then else ("fuzzy rule for switching b-c"[bcr2]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr3]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr4]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr5]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr7]=sbc max value:OR:(("fuzzy rule for switching b-c"[bcr6]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr8]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr9]=sbc max value):AND:("fuzzy rule for switching b-c"[bcr2]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr3]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr4]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr5]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr7]=sbc max value)), 3-1.5*sbc max value, if then else ("fuzzy rule for switching b-c"[bcr1]=sbc max value:OR:(("fuzzy rule for switching b-c"[bcr6]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr8]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr9]=sbc max value):AND:("fuzzy rule for switching b-c"[bcr1]=sbc max value)):OR:(("fuzzy rule for switching b-c"[bcr2]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr3]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr4]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr5]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr7]=sbc max value):AND:("fuzzy rule for switching b-c"[bcr1]=sbc max value)):OR:(("fuzzy rule for switching b-c"[bcr1]=sbc

max value):AND:("fuzzy rule for switching b-c"[bcr6]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr8]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr9]=sbc max value):AND:("fuzzy rule for switching b-c"[bcr2]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr3]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr4]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr5]=sbc max value:OR:"fuzzy rule for switching b-c"[bcr7]=sbc max value)), 3, 1))) Units: Dmnl

32. "defuzzified effect of perception on switching b-m"=if then else ("fuzzy rule for switching b-m"[sbmr1]=sbm max value, 1.5-1.5*sbm max value, if then else ("fuzzy rule for switching b-m"[sbmr2]=sbm max value:OR:(("fuzzy rule for switching b-m"[sbmr2]=sbm max value):AND:("fuzzy rule for switching b-m"[sbmr1]=sbm max value)), 3-1.5*sbm max value, if then else ("fuzzy rule for switching b-m"[sbmr3]=sbm max value:OR:(("fuzzy rule for switching b-m"[sbmr3]=sbm max value):AND:("fuzzy rule for switching b-m"[sbmr3]=sbm max value)), 3, 1))) Units: Dmnl
33. "defuzzified effect of perception on switching b-t"=if then else ("fuzzy rule for switching b-t"[sbtr1]=sbt max value, 1.5-1.5*sbt max value, if then else ("fuzzy rule for switching b-t"[sbtr2]=sbt max value:OR:("fuzzy rule for switching b-t"[sbtr1]=sbt max value:AND:"fuzzy rule for switching b-t"[sbtr2]=sbt max value), 3-1.5*sbt max value, if then else ("fuzzy rule for switching b-t"[sbtr3]=sbt max value:OR:("fuzzy rule for switching b-t"[sbtr2]=sbt max value :AND:"fuzzy rule for switching b-t"[sbtr3]=sbt max value), 3, 1))) Units: Dmnl
34. "defuzzified effect of perception on switching c-m"=if then else ("fuzzy rul for switching c-m"[scmr1]=scm max value, 1.5-1.5*scm max value, if then else ("fuzzy rul for switching c-m"[scmr2]=scm max value:OR:("fuzzy rul for switching c-m"[scmr2]=scm max value:AND:"fuzzy rul for switching c-m"[scmr1]=scm max value), 3-1.5*scm max value, if then else ("fuzzy rul for switching c-m"[scmr3]=scm max value:OR:("fuzzy rul for switching c-m"[scmr2]=scm max value :AND:"fuzzy rul for switching c-m"[scmr3]=scm max value), 3, 1))) Units: Dmnl
35. "defuzzified effect of perception on switching c-t"=if then else ("fuzzy rule for switching c-t"[sctr1]=sct max value, 1.5-1.5*sct max value, if then else ("fuzzy rule for switching c-t"[sctr1]=sct max value :OR: ("fuzzy rule for switching c-t"[sctr1]=sct max value:AND:"fuzzy rule for switchign c-t"[sctr2]=sct max value), 3-1.5*sct max value, if

then else ("fuzzy rule for switchign c-t"[sctr2]=sct max value:OR:("fuzzy rule for switchign c-t"[sctr2]=sct max value:AND:"fuzzy rule for switchign c-t"[sctr3]=sct max value), 3, 1))) Units: Dmnl

36. "defuzzified effect of perception on switching m-b"=if then else ("fuzzy rule for switching m-b"[smbr2]=smb max value:OR:"fuzzy rule for switching m-b"[smbr3]=smb max value, 1.5-1.5*smb max value, if then else (("fuzzy rule for switching m-b"[smbr1]=smb max value:OR:"fuzzy rule for switching m-b"[smbr4]=smb max value :OR:"fuzzy rule for switching m-b"[smbr5]=smb max value:OR:"fuzzy rule for switching m-b"[smbr6]=smb max value:OR:"fuzzy rule for switching m-b"[smbr9]=smb max value):OR:(("fuzzy rule for switching m-b"[smbr1]=smb max value:OR:"fuzzy rule for switching m-b"[smbr2]=smb max value:OR:"fuzzy rule for switching m-b"[smbr3]=smb max value:OR:"fuzzy rule for switching m-b"[smbr4]=smb max value:OR:"fuzzy rule for switching m-b"[smbr9]=smb max value):AND:("fuzzy rule for switching m-b"[smbr5]=smb max value:OR:"fuzzy rule for switching m-b"[smbr6]=smb max value:OR:"fuzzy rule for switching m-b"[smbr8]=smb max value)), 3-1.5*smb max value, if then else ("fuzzy rule for switching m-b"[smbr7]=smb max value:OR:(("fuzzy rule for switching m-b"[smbr1]=smb max value:OR:"fuzzy rule for switching m-b"[smbr2]=smb max value:OR:"fuzzy rule for switching m-b"[smbr3]=smb max value:OR:"fuzzy rule for switching m-b"[smbr4]=smb max value:OR:"fuzzy rule for switching m-b"[smbr9]=smb max value):AND:("fuzzy rule for switching m-b"[smbr7]=smb max value)):OR:(("fuzzy rule for switching m-b"[smbr5]=smb max value:OR:"fuzzy rule for switching m-b"[smbr6]=smb max value:OR:"fuzzy rule for switching m-b"[smbr8]=smb max value):AND:("fuzzy rule for switching m-b"[smbr7]=smb max value)):OR:(("fuzzy rule for switching m-b"[smbr5]=smb max value:OR:"fuzzy rule for switching m-b"[smbr6]=smb max value:OR:"fuzzy rule for switching m-b"[smbr8]=smb max value):AND:("fuzzy rule for switching m-b"[smbr7]=smb max value):AND:("fuzzy rule for switching m-b"[smbr1]=smb max value:OR:"fuzzy rule for switching m-b"[smbr2]=smb max value:OR:"fuzzy rule for switching m-b"[smbr3]=smb max value:OR:"fuzzy rule for switching m-b"[smbr4]=smb max value:OR:"fuzzy rule for switching m-b"[smbr9]=smb max value)), 3, 1))) Units: Dmnl

37. "defuzzified effect of perception on switching m-c"=if then else ("fuzzy rule for switchign m-c"[smcr5]:OR:"fuzzy rule for switchign m-c"[smcr6]:OR:"fuzzy rule for switchign m-c"[smcr8]:OR:"fuzzy rule for switchign m-c"[smcr9], 1.5-1.5*smc max value, if then else (("fuzzy rule for switchign m-c"[smcr3]:OR:"fuzzy rule for switchign m-c"[smcr4]:OR:"fuzzy rule for switchign m-c"[smcr7]):OR:(("fuzzy rule for switchign m-c"[smcr5]:OR:"fuzzy rule for switchign m-c"[smcr6]:OR:"fuzzy rule for switchign m-c"[smcr8]:OR:"fuzzy rule for switchign m-c"[smcr9]):AND:("fuzzy rule for switchign m-c"[smcr3]:OR:"fuzzy rule for switchign m-c"[smcr4]:OR:"fuzzy rule for switchign m-c"[smcr7])), 3-1.5*smc max value, if then else(("fuzzy rule for switchign m-c"[smcr1]:OR:"fuzzy rule for switchign m-c"[smcr2]):OR:(("fuzzy rule for switchign m-c"[smcr1]:OR:"fuzzy rule for switchign m-c"[smcr2]):AND:("fuzzy rule for switchign m-c"[smcr3]:OR:"fuzzy rule for switchign m-c"[smcr4]:OR:"fuzzy rule for switchign m-c"[smcr7])):OR:(("fuzzy rule for switchign m-c"[smcr3]:OR:"fuzzy rule for switchign m-c"[smcr4]:OR:"fuzzy rule for switchign m-c"[smcr7]):AND:("fuzzy rule for switchign m-c"[smcr1]:OR:"fuzzy rule for switchign m-c"[smcr2])):OR:(("fuzzy rule for switchign m-c"[smcr1]:OR:"fuzzy rule for switchign m-c"[smcr2]):AND:("fuzzy rule for switchign m-c"[smcr3]:OR:"fuzzy rule for switchign m-c"[smcr4]:OR:"fuzzy rule for switchign m-c"[smcr7]):AND:("fuzzy rule for switchign m-c"[smcr5]:OR:"fuzzy rule for switchign m-c"[smcr6]:OR:"fuzzy rule for switchign m-c"[smcr8]:OR:"fuzzy rule for switchign m-c"[smcr9])), 3, 1))) Units: Dmnl
38. "defuzzified effect of perception on switching t-b"=if then else("fuzzy rule for switching t-b"[stbr2]=stb max value:OR:"fuzzy rule for switching t-b"[stbr3]=stb max value, 1.5-1.5*stb max value, if then else (("fuzzy rule for switching t-b"[stbr1]=stb max value:OR:"fuzzy rule for switching t-b"[stbr4]=stb max value:OR:"fuzzy rule for switching t-b"[stbr6]=stb max value:OR:"fuzzy rule for switching t-b"[stbr9]=stb max value):OR:(("fuzzy rule for switching t-b"[stbr2]=stb max value:OR:"fuzzy rule for switching t-b"[stbr3]=stb max value):AND:("fuzzy rule for switching t-b"[stbr1]=stb max value:OR:"fuzzy rule for switching t-b"[stbr4]=stb max value:OR:"fuzzy rule for switching t-b"[stbr6]=stb max value:OR:"fuzzy rule for switching t-b"[stbr9]=stb max value)), 3-1.5*stb max value, if then else (("fuzzy rule for switching t-b"[stbr5]=stb max value:OR:"fuzzy rule for switching t-b"[stbr7]=stb max value:OR:"fuzzy rule for

switching t-b"[stbr8]=stb max value):OR:(("fuzzy rule for switching t-b"[stbr2]=stb max value:OR:"fuzzy rule for switching t-b"[stbr3]=stb max value):AND:("fuzzy rule for switching t-b"[stbr5]=stb max value:OR:"fuzzy rule for switching t-b"[stbr7]=stb max value :OR:"fuzzy rule for switching t-b"[stbr8]=stb max value)):OR:(("fuzzy rule for switching t-b"[stbr1]=stb max value:OR:"fuzzy rule for switching t-b"[stbr4]=stb max value :OR:"fuzzy rule for switching t-b"[stbr6]=stb max value:OR:"fuzzy rule for switching t-b"[stbr9]=stb max value):AND:("fuzzy rule for switching t-b"[stbr5]=stb max value:OR:"fuzzy rule for switching t-b"[stbr7]=stb max value:OR:"fuzzy rule for switching t-b"[stbr8]=stb max value)):OR:(("fuzzy rule for switching t-b"[stbr2]=stb max value:OR:"fuzzy rule for switching t-b"[stbr3]=stb max value):AND:("fuzzy rule for switching t-b"[stbr1]=stb max value:OR:"fuzzy rule for switching t-b"[stbr4]=stb max value :OR:"fuzzy rule for switching t-b"[stbr6]=stb max value:OR:"fuzzy rule for switching t-b"[stbr9]=stb max value):AND:("fuzzy rule for switching t-b"[stbr5]=stb max value:OR:"fuzzy rule for switching t-b"[stbr7]=stb max value:OR:"fuzzy rule for switching t-b"[stbr8]=stb max value)), 3, 1))) Units: Dmnl

39. "defuzzified effect of perception on switching t-m"=if then else ("fuzzy rule for switching t-m"[stmr1]=stm max value, 1.5-1.5*stm max value, if then else ("fuzzy rule for switching t-m"[stmr2]=stm max value:OR:("fuzzy rule for switching t-m"[stmr1]=stm max value :AND:"fuzzy rule for switching t-m"[stmr2]=stm max value), 3-1.5*stm max value, if then else ("fuzzy rule for switching t-m"[stmr3]=stm max value:OR:("fuzzy rule for switching t-m"[stmr2]=stm max value:AND:"fuzzy rule for switching t-m"[stmr3]=stm max value), 3, 1))) Units: Dmnl
40. "defuzzified effect to of perception on switching t-c"=if then else ("fuzzy rule for switching t-c"[stcr5]=stc max value:OR:"fuzzy rule for switching t-c"[stcr6]=stc max value:OR:"fuzzy rule for switching t-c"[stcr8]=stc max value:OR:"fuzzy rule for switching t-c"[stcr9]=stc max value, 1.5-1.5*stc max value, if then else (("fuzzy rule for switching t-c"[stcr2]=stc max value:OR:"fuzzy rule for switching t-c"[stcr3]=stc max value:OR:"fuzzy rule for switching t-c"[stcr4]=stc max value:OR:"fuzzy rule for switching t-c"[stcr7]=stc max value):OR:(("fuzzy rule for switching t-c"[stcr5]=stc max value:OR:"fuzzy rule for switching t-c"[stcr6]=stc max value:OR:"fuzzy rule for switching t-c"[stcr8]=stc max value:OR:"fuzzy rule for switching t-c"[stcr9]=stc max

value):AND:("fuzzy rule for switching t-c"[stcr2]=stc max value:OR:"fuzzy rule for switching t-c"[stcr3]=stc max value:OR:"fuzzy rule for switching t-c"[stcr4]=stc max value:OR:"fuzzy rule for switching t-c"[stcr7]=stc max value)), 3-1.5*stc max value, if then else ("fuzzy rule for switching t-c"[stcr1]=stc max value:OR:("fuzzy rule for switching t-c"[stcr1]=stc max value:AND:("fuzzy rule for switching t-c"[stcr5]=stc max value:OR:"fuzzy rule for switching t-c"[stcr6]=stc max value:OR:"fuzzy rule for switching t-c"[stcr8]=stc max value:OR:"fuzzy rule for switching t-c"[stcr9]=stc max value)):OR:("fuzzy rule for switching t-c"[stcr1]=stc max value:AND:("fuzzy rule for switching t-c"[stcr2]=stc max value:OR:"fuzzy rule for switching t-c"[stcr3]=stc max value:OR:"fuzzy rule for switching t-c"[stcr4]=stc max value:OR:"fuzzy rule for switching t-c"[stcr7]=stc max value)):OR:("fuzzy rule for switching t-c"[stcr1]=stc max value :AND:("fuzzy rule for switching t-c"[stcr5]=stc max value:OR:"fuzzy rule for switching t-c"[stcr6]=stc max value:OR:"fuzzy rule for switching t-c"[stcr8]=stc max value:OR:"fuzzy rule for switching t-c"[stcr9]=stc max value):AND:("fuzzy rule for switching t-c"[stcr2]=stc max value:OR:"fuzzy rule for switching t-c"[stcr3]=stc max value:OR:"fuzzy rule for switching t-c"[stcr4]=stc max value:OR:"fuzzy rule for switching t-c"[stcr7]=stc max value)), 3, 1))) Units: Dmnl

41. "defuzzifife d effect of perception on switching m-t"=if then else ("fuzzy rule for switching m-t"[smtr1]=smt max value, 1.5-1.5*smt max value, if then else ("fuzzy rule for switching m-t"[smtr2]=smt max value:OR: ("fuzzy rule for switching m-t"[smtr1]=smt max value:AND:"fuzzy rule for switching m-t"[smtr2]=smt max value), 3-1.5*smt max value, if then else ("fuzzy rule for switching m-t"[smtr3]=smt max value :OR:("fuzzy rule for switching m-t"[smtr2]=smt max value:AND:"fuzzy rule for switching m-t"[smtr3]=smt max value), 3, 1))) Units: Dmnl
42. effect of speed on fuel consumption([(0,0)-(80,2)],(0,0),(15,1.5),(25,1.4), (35,1.2),(45,1), (55,0.9),(60,0.88)) Units: Dmnl
43. employment increment=8.1 Units: passenger/day
44. FINAL TIME = 7200 Units: day
    The final time for the simulation.
45. Flow Rate: FLow, FMedium, FHigh
46. fraction of work budget=0.15 Units: Dmnl

47. fraction of work trip by car=0.6 Units: Dmnl
48. fraction of work trip by metro=0.6 Units: Dmnl
49. fraction of work trip by trail=0.66 Units: Dmnl
50. fraction of work trip demand on bus=0.66 Units: Dmnl
51. fruitfulness of incuring mobility=0.0005 Units: person/contact
52. fuel price per gallon=2.5 Units: dollar/gallon
53. "fuzzy rul for switching c-m"[scmr1]="perception with respect to metro supply vs. demand"[MLow]
54. "fuzzy rul for switching c-m"[scmr2]="perception with respect to metro supply vs. demand"[MMedium]
55. "fuzzy rul for switching c-m"[scmr3]="perception with respect to metro supply vs. demand"[MHigh] Units: Dmnl
56. Fuzzy Rule Definition[r1]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))
57. Fuzzy Rule Definition[r2]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
58. Fuzzy Rule Definition[r3]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
59. Fuzzy Rule Definition[r4]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with

respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

60. Fuzzy Rule Definition[r5]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))
61. Fuzzy Rule Definition[r6]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
62. Fuzzy Rule Definition[r7]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))
63. Fuzzy Rule Definition[r8]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
64. Fuzzy Rule Definition[r9]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
65. Fuzzy Rule Definition[r10]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with

respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

66. Fuzzy Rule Definition[r11]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
67. Fuzzy Rule Definition[r12]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
68. Fuzzy Rule Definition[r13]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))
69. Fuzzy Rule Definition[r14]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))
70. Fuzzy Rule Definition[r15]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
71. Fuzzy Rule Definition[r16]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with

respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

72. Fuzzy Rule Definition[r17]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
73. Fuzzy Rule Definition[r18]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
74. Fuzzy Rule Definition[r19]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))
75. Fuzzy Rule Definition[r20]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
76. Fuzzy Rule Definition[r21]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
77. Fuzzy Rule Definition[r22]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with

respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

78. Fuzzy Rule Definition[r23]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))
79. Fuzzy Rule Definition[r24]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
80. Fuzzy Rule Definition[r25]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))
81. Fuzzy Rule Definition[r26]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
82. Fuzzy Rule Definition[r27]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
83. Fuzzy Rule Definition[r28]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

84. Fuzzy Rule Definition[r29]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
85. Fuzzy Rule Definition[r30]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
86. Fuzzy Rule Definition[r31]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))
87. Fuzzy Rule Definition[r32]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))
88. Fuzzy Rule Definition[r33]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
89. Fuzzy Rule Definition[r34]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh]))))

90. Fuzzy Rule Definition[r35]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
91. Fuzzy Rule Definition[r36]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
92. Fuzzy Rule Definition[r37]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))
93. Fuzzy Rule Definition[r38]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
94. Fuzzy Rule Definition[r39]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
95. Fuzzy Rule Definition[r40]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

96. Fuzzy Rule Definition[r41]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))
97. Fuzzy Rule Definition[r42]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
98. Fuzzy Rule Definition[r43]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))
99. Fuzzy Rule Definition[r44]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
100. Fuzzy Rule Definition[r45]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
101. Fuzzy Rule Definition[r46]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow]))))

102. Fuzzy Rule Definition[r47]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow]))))

103. Fuzzy Rule Definition[r48]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow]))))

104. Fuzzy Rule Definition[r49]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium]))))

105. Fuzzy Rule Definition[r50]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium]))))

106. Fuzzy Rule Definition[r51]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium]))))

107. Fuzzy Rule Definition[r52]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

108. Fuzzy Rule Definition[r53]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

109. Fuzzy Rule Definition[r54]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

110. Fuzzy Rule Definition[r55]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

111. Fuzzy Rule Definition[r56]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

112. Fuzzy Rule Definition[r57]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

113. Fuzzy Rule Definition[r58]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

114. Fuzzy Rule Definition[r59]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

115. Fuzzy Rule Definition[r60]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

116. Fuzzy Rule Definition[r61]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

117. Fuzzy Rule Definition[r62]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

118. Fuzzy Rule Definition[r63]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

119. Fuzzy Rule Definition[r64]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow]))))

120. Fuzzy Rule Definition[r65]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

121. Fuzzy Rule Definition[r66]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

122. Fuzzy Rule Definition[r67]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

123. Fuzzy Rule Definition[r68]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

124. Fuzzy Rule Definition[r69]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

125. Fuzzy Rule Definition[r70]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh]))))

126. Fuzzy Rule Definition[r71]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

127. Fuzzy Rule Definition[r72]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

128. Fuzzy Rule Definition[r73]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

129. Fuzzy Rule Definition[r74]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

130. Fuzzy Rule Definition[r75]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

131. Fuzzy Rule Definition[r76]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

132. Fuzzy Rule Definition[r77]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

133. Fuzzy Rule Definition[r78]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

134. Fuzzy Rule Definition[r79]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

135. Fuzzy Rule Definition[r80]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

136. Fuzzy Rule Definition[r81]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],

137. "perception with respect to trail supply vs. demand"[THigh])))

138. Fuzzy Rule Definition[r82]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

139. Fuzzy Rule Definition[r83]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

140. Fuzzy Rule Definition[r84]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

141. Fuzzy Rule Definition[r85]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

142. Fuzzy Rule Definition[r86]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

143. Fuzzy Rule Definition[r87]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

144. Fuzzy Rule Definition[r88]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh]))))

145. Fuzzy Rule Definition[r89]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

146. Fuzzy Rule Definition[r90]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

147. Fuzzy Rule Definition[r91]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

148. Fuzzy Rule Definition[r92]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

149. Fuzzy Rule Definition[r93]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

150. Fuzzy Rule Definition[r94]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

151. Fuzzy Rule Definition[r95]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

152. Fuzzy Rule Definition[r96]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

153. Fuzzy Rule Definition[r97]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

154. Fuzzy Rule Definition[r98]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

155. Fuzzy Rule Definition[r99]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

156. Fuzzy Rule Definition[r100]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow]))))

157. Fuzzy Rule Definition[r101]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow]))))

158. Fuzzy Rule Definition[r102]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow]))))

159. Fuzzy Rule Definition[r103]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium]))))

160. Fuzzy Rule Definition[r104]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium]))))

161. Fuzzy Rule Definition[r105]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium]))))

162. Fuzzy Rule Definition[r106]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh]))))

163. Fuzzy Rule Definition[r107]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

164. Fuzzy Rule Definition[r108]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

165. Fuzzy Rule Definition[r109]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

166. Fuzzy Rule Definition[r110]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium]

167. ,"perception with respect to trail supply vs. demand"[TLow])))

168. Fuzzy Rule Definition[r111]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand" [TLow])))

169. Fuzzy Rule Definition[r112]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BLow] ,MIN("perception

with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

170. Fuzzy Rule Definition[r113]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium] ,"perception with respect to trail supply vs. demand"[TMedium])))

171. Fuzzy Rule Definition[r114]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"

172. [BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand" [TMedium])))

173. Fuzzy Rule Definition[r115]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

174. Fuzzy Rule Definition[r116]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium] ,"perception with respect to trail supply vs. demand"[THigh])))

175. Fuzzy Rule Definition[r117]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

176. Fuzzy Rule Definition[r118]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow]

,"perception with respect to trail supply vs. demand"[TLow])))

177. Fuzzy Rule Definition[r119]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

178. Fuzzy Rule Definition[r120]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

179. Fuzzy Rule Definition[r121]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow] ,"perception with respect to trail supply vs. demand"[TMedium])))

180. Fuzzy Rule Definition[r122]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

181. Fuzzy Rule Definition[r123]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

182. Fuzzy Rule Definition[r124]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

183. Fuzzy Rule Definition[r125]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

184. Fuzzy Rule Definition[r126]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

185. Fuzzy Rule Definition[r127]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BHigh] ,MIN("perception with respect to metro supply vs demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

186. Fuzzy Rule Definition[r128]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

187. Fuzzy Rule Definition[r129]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh], "perception with respect to trail supply vs. demand"[TLow])))

188. Fuzzy Rule Definition[r130]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand" [TMedium])))

189. Fuzzy Rule Definition[r131]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))) 190. Fuzzy Rule Definition[r132]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average FlowRate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))) 191. Fuzzy Rule Definition[r133]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BHigh] ,MIN("perception with respect to metro supply vs demand"[MLow],"perception with respect to trail supply vs. demand"[THigh]))) 192. Fuzzy Rule Definition[r134]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh]))) 193. Fuzzy Rule Definition[r135]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand" [BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh], "perception with respect to trail supply vs. demand"[THigh]))) 194. Fuzzy Rule Definition[r136]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

195. Fuzzy Rule Definition[r137]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
196. Fuzzy Rule Definition[r138]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
197. Fuzzy Rule Definition[r139]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))
198. Fuzzy Rule Definition[r140]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))
199. Fuzzy Rule Definition[r141]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
200. Fuzzy Rule Definition[r142]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

201. Fuzzy Rule Definition[r143]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
202. Fuzzy Rule Definition[r144]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
203. Fuzzy Rule Definition[r145]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))
204. Fuzzy Rule Definition[r146]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
205. Fuzzy Rule Definition[r147]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
206. Fuzzy Rule Definition[r148]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

207. Fuzzy Rule Definition[r149]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

208. Fuzzy Rule Definition[r150]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

209. Fuzzy Rule Definition[r151]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

210. Fuzzy Rule Definition[r152]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

211. Fuzzy Rule Definition[r153]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

212. Fuzzy Rule Definition[r154]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

213. Fuzzy Rule Definition[r155]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
214. Fuzzy Rule Definition[r156]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
215. Fuzzy Rule Definition[r157]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))
216. Fuzzy Rule Definition[r158]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))
217. Fuzzy Rule Definition[r159]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
218. Fuzzy Rule Definition[r160]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

219. Fuzzy Rule Definition[r161]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
220. Fuzzy Rule Definition[r162]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
221. Fuzzy Rule Definition[r163]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))
222. Fuzzy Rule Definition[r164]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
223. Fuzzy Rule Definition[r165]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
224. Fuzzy Rule Definition[r166]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

225. Fuzzy Rule Definition[r167]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium]))))

226. Fuzzy Rule Definition[r168]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium]))))

227. Fuzzy Rule Definition[r169]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh]))))

228. Fuzzy Rule Definition[r170]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh]))))

229. Fuzzy Rule Definition[r171]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh]))))

230. Fuzzy Rule Definition[r172]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow]))))

231. Fuzzy Rule Definition[r173]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] ,MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow]))))

232. Fuzzy Rule Definition[r174]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] ,MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow]))))

233. Fuzzy Rule Definition[r175]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium]))))

234. Fuzzy Rule Definition[r176]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] ,MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium]))))

235. Fuzzy Rule Definition[r177]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium]))))

236. Fuzzy Rule Definition[r178]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh]))))

237. Fuzzy Rule Definition[r179]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

238. Fuzzy Rule Definition[r180]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))

239. Fuzzy Rule Definition[r181]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

240. Fuzzy Rule Definition[r182]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

241. Fuzzy Rule Definition[r183]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

242. Fuzzy Rule Definition[r184]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

243. Fuzzy Rule Definition[r185]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))
244. Fuzzy Rule Definition[r186]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
245. Fuzzy Rule Definition[r187]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))
246. Fuzzy Rule Definition[r188]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
247. Fuzzy Rule Definition[r189]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FLow] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
248. Fuzzy Rule Definition[r190]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))

249. Fuzzy Rule Definition[r191]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow]))))
250. Fuzzy Rule Definition[r192]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow]))))
251. Fuzzy Rule Definition[r193]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium]))))
252. Fuzzy Rule Definition[r194]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium]))))
253. Fuzzy Rule Definition[r195]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium]))))
254. Fuzzy Rule Definition[r196]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh]))))

255. Fuzzy Rule Definition[r197]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
256. Fuzzy Rule Definition[r198]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
257. Fuzzy Rule Definition[r199]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))
258. Fuzzy Rule Definition[r200]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
259. Fuzzy Rule Definition[r201]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
260. Fuzzy Rule Definition[r202]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

261. Fuzzy Rule Definition[r203]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))))

262. Fuzzy Rule Definition[r204]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))))

263. Fuzzy Rule Definition[r205]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))))

264. Fuzzy Rule Definition[r206]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))))

265. Fuzzy Rule Definition[r207]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))))

266. Fuzzy Rule Definition[r208]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))))

267. Fuzzy Rule Definition[r209]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
268. Fuzzy Rule Definition[r210]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
269. Fuzzy Rule Definition[r211]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))
270. Fuzzy Rule Definition[r212]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))
271. Fuzzy Rule Definition[r213]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))
272. Fuzzy Rule Definition[r214]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

273. Fuzzy Rule Definition[r215]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))
274. Fuzzy Rule Definition[r216]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FMedium] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh])))
275. Fuzzy Rule Definition[r217]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow])))
276. Fuzzy Rule Definition[r218]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))
277. Fuzzy Rule Definition[r219]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))
278. Fuzzy Rule Definition[r220]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

279. Fuzzy Rule Definition[r221]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium]))))
280. Fuzzy Rule Definition[r222]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium]))))
281. Fuzzy Rule Definition[r223]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh]))))
282. Fuzzy Rule Definition[r224]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh]))))
283. Fuzzy Rule Definition[r225]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BLow] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh]))))
284. Fuzzy Rule Definition[r226]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TLow]))))

285. Fuzzy Rule Definition[r227]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow])))

286. Fuzzy Rule Definition[r228]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow])))

287. Fuzzy Rule Definition[r229]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium])))

288. Fuzzy Rule Definition[r230]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

289. Fuzzy Rule Definition[r231]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TMedium])))

290. Fuzzy Rule Definition[r232]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] ,MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

291. Fuzzy Rule Definition[r233]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] ,MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh]))))

292. Fuzzy Rule Definition[r234]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BMedium] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh]))))

293. Fuzzy Rule Definition[r235]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] ,MIN(perception with respect to Average Flow Rate[FHigh] ,MIN("perception with respect to bus supply vs. demand" [BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand" [TLow]))))

294. Fuzzy Rule Definition[r236]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TLow]))))

295. Fuzzy Rule Definition[r237]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] ,MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[TLow]))))

296. Fuzzy Rule Definition[r238]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[TMedium]))))

297. Fuzzy Rule Definition[r239]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] ,MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[TMedium])))

298. Fuzzy Rule Definition[r240]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh], "perception with respect to trail supply vs. demand"[TMedium])))

299. Fuzzy Rule Definition[r241]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MLow],"perception with respect to trail supply vs. demand"[THigh])))

300. Fuzzy Rule Definition[r242]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MMedium],"perception with respect to trail supply vs. demand"[THigh])))

301. Fuzzy Rule Definition[r243]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh] , MIN(perception with respect to Average Flow Rate[FHigh] , MIN("perception with respect to bus supply vs. demand"[BHigh] ,MIN("perception with respect to metro supply vs. demand"[MHigh],"perception with respect to trail supply vs. demand"[THigh]))) Units: Dmnl

302. "fuzzy rule for c-b"[cbr1]=MIN ("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FLow])

303. "fuzzy rule for c-b"[cbr2]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FMedium])

304. "fuzzy rule for c-b"[cbr3]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FHigh])

305. "fuzzy rule for c-b"[cbr4]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FLow])
306. "fuzzy rule for c-b"[cbr5]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FMedium])
307. "fuzzy rule for c-b"[cbr6]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FHigh])
308. "fuzzy rule for c-b"[cbr7]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FLow])
309. "fuzzy rule for c-b"[cbr8]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FMedium])
310. "fuzzy rule for c-b"[cbr9]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FHigh])
Units: Dmnl
311. "fuzzy rule for switching c-t"[sctr1]="perception with respect to trail supply vs. demand"[TLow]
312. "fuzzy rule for switching c-t"[sctr2]="perception with respect to trail supply vs. demand"[TMedium]
313. "fuzzy rule for switching c-t"[sctr3]="perception with respect to trail supply vs. demand"[THigh] Units: Dmnl
314. "fuzzy rule for switching m-c"[smcr1]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FLow])
315. "fuzzy rule for switching m-c"[smcr2]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FMedium])
316. "fuzzy rule for switching m-c"[smcr3]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FHigh])
317. "fuzzy rule for switching m-c"[smcr4]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FLow])
318. "fuzzy rule for switching m-c"[smcr5]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FMedium])
319. "fuzzy rule for switching m-c"[smcr6]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FHigh])

320. "fuzzy rule for switching m-c"[smcr7]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate[FLow])
321. "fuzzy rule for switching m-c"[smcr8]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate[FMedium])
322. "fuzzy rule for switching m-c"[smcr9]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate[FHigh])

Units: Dmnl

323. "fuzzy rule for switching b-c"[bcr1]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow], perception with respect to Average Flow Rate[FLow])
324. "fuzzy rule for switching b-c"[bcr2]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow], perception with respect to Average Flow Rate[FMedium])
325. "fuzzy rule for switching b-c"[bcr3]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow], perception with respect to Average Flow Rate[FHigh])
326. "fuzzy rule for switching b-c"[bcr4]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FLow])
327. "fuzzy rule for switching b-c"[bcr5]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FMedium])
328. "fuzzy rule for switching b-c"[bcr6]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium], perception with respect to Average Flow Rate[FHigh])
329. "fuzzy rule for switching b-c"[bcr7]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], perception with respect to Average Flow Rate[FLow])
330. "fuzzy rule for switching b-c"[bcr8]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], perception with respect to Average Flow Rate[FMedium])
331. "fuzzy rule for switching b-c"[bcr9]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh], perception with respect to Average Flow Rate[FHigh])

Units: Dmnl

332. "fuzzy rule for switching b-m"[sbmr1]="perception with respect to metro supply vs. demand"[MLow]
333. "fuzzy rule for switching b-m"[sbmr2]="perception with respect to metro supply vs. demand"[MMedium]

334. "fuzzy rule for switching b-m"[sbmr3]="perception with respect to metro supply vs. demand"[MHigh] Units: Dmnl

335. "fuzzy rule for switching b-t"[sbtr1]="perception with respect to trail supply vs. demand"[TLow]

336. "fuzzy rule for switching b-t"[sbtr2]="perception with respect to trail supply vs. demand"[TMedium]

337. "fuzzy rule for switching b-t"[sbtr3]="perception with respect to trail supply vs. demand"[THigh] Units: Dmnl

338. "fuzzy rule for switching m-b"[smbr1]=MIN ("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FLow])

339. "fuzzy rule for switching m-b"[smbr2]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FMedium])

340. "fuzzy rule for switching m-b"[smbr3]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FHigh])

341. "fuzzy rule for switching m-b"[smbr4]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FLow])

342. "fuzzy rule for switching m-b"[smbr5]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FMedium])

343. "fuzzy rule for switching m-b"[smbr6]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FHigh]

344. "fuzzy rule for switching m-b"[smbr7]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FLow])

345. "fuzzy rule for switching m-b"[smbr8]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FMedium])

346. "fuzzy rule for switching m-b"[smbr9]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FHigh]) Units: Dmnl

347. "fuzzy rule for switching m-t"[smtr1]="perception with respect to trail supply vs. demand"[TLow]

348. "fuzzy rule for switching m-t"[smtr2]="perception with respect to trail supply vs. demand"[TMedium]

349. "fuzzy rule for switching m-t"[smtr3]="perception with respect to trail supply vs. demand"[THigh] Units: Dmnl

350. "fuzzy rule for switching t-b"[stbr1]=MIN(perception with respect to Average Flow Rate[FLow],"perception with respect to bus supply vs. demand"[BLow])

351. "fuzzy rule for switching t-b"[stbr2]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FMedium])

352. "fuzzy rule for switching t-b"[stbr3]=MIN("perception with respect to bus supply vs. demand"[BLow],perception with respect to Average Flow Rate[FHigh])

353. "fuzzy rule for switching t-b"[stbr4]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FLow])

354. "fuzzy rule for switching t-b"[stbr5]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FMedium])

355. "fuzzy rule for switching t-b"[stbr6]=MIN("perception with respect to bus supply vs. demand"[BMedium],perception with respect to Average Flow Rate[FHigh])

356. "fuzzy rule for switching t-b"[stbr7]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FLow])

357. "fuzzy rule for switching t-b"[stbr8]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FMedium])

358. "fuzzy rule for switching t-b"[stbr9]=MIN("perception with respect to bus supply vs. demand"[BHigh],perception with respect to Average Flow Rate[FHigh])
Units: Dmnl

359. "fuzzy rule for switching t-c"[stcr1]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FLow])

360. "fuzzy rule for switching t-c"[stcr2]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FMedium])

361. "fuzzy rule for switching t-c"[stcr3]=MIN("perception respect to ratio of driving cost vs. budget"[TVCLow],perception with respect to Average Flow Rate[FHigh])

362. "fuzzy rule for switching t-c"[stcr4]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FLow])

363. "fuzzy rule for switching t-c"[stcr5]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FMedium])

364. "fuzzy rule for switching t-c"[stcr6]=MIN("perception respect to ratio of driving cost vs. budget"[TVCMedium],perception with respect to Average Flow Rate[FHigh])
365. "fuzzy rule for switching t-c"[stcr7]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate[FLow])
366. "fuzzy rule for switching t-c"[stcr8]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate[FMedium])
367. "fuzzy rule for switching t-c"[stcr9]=MIN("perception respect to ratio of driving cost vs. budget"[TVCHigh],perception with respect to Average Flow Rate [FHigh])
Units: Dmnl
368. "fuzzy rule for switching t-m"[stmr1]="perception with respect to metro supply vs. demand"[MLow]
369. "fuzzy rule for switching t-m"[stmr2]="perception with respect to metro supply vs. demand"[MMedium]
370. "fuzzy rule for switching t-m"[stmr3]="perception with respect to metro supply vs. demand"[MHigh] Units: Dmnl
371. INITIAL TIME = 0 Units: day
The initial time for the simulation.
372. insurance premium per day=2.5 Units: dollar/car/day
373. maintenance cost per day=average trip miles*maintenance expenditure per mile
Units: dollar/car/day
374. maintenance expenditure per mile=0.029 Units: dollar/mile
375. max value=VMAX(Fuzzy Rule Definition[Range!]) Units: Dmnl
376. maximum possible average flow rate=90 Units: PCU/hour/mile
377. metro car aging=Total Metro Cars/metro car life time Units: metro car/day
378. metro car discrepancy="allowable metro capacity within cordon-based area"-Total Metro Cars Units: metro car
379. metro car increment=normal funding for metro capacity/cost per metro car
Units: metro car/day
380. metro car life time=7200 Units: day
381. Metro S and D: MLow, MMedium, MHigh
382. multiplier of weekend tourist=1.5 Units: Dmnl

383. new demand for bus=Undecided passengers/time delay in choosing transportation mode
Units: passenger/day

384. new demand for car=Undecided passengers/time delay in choosing transportation mode
Units: passenger/day

385. new demand for metro=Undecided passengers/time delay in choosing transportation mode
Units: passenger/day

386. new demand for trail=Undecided passengers/time delay in choosing transportation mode
Units: passenger/day

387. normal fraction of potential passenger increase=0.001/360
Units: passenger/day

388. normal funding for bus increment=if then else (bus discrepancy>=0, 50000, 0)
Units: dollar/day

389. normal funding for metro capacity=if then else (metro car discrepancy>=0, 100000, 0)
Units: dollar/day

390. normal funding for trail capacity=if then else (trail discrepancy>=0, 5000, 0)
Units: dollar/day

391. normal gallon per mile=0.0452 Units: gallon/mile

392. normal tourist base increase rate=97.4 Units: passenger/day

393. normalized average flow rate=MIN(1, Average Flow Rate/maximum possible average flow rate) Units: Dmnl

394. normalized ratio of bus supply to demand=if then else (ratio of bus supply to demand<=0.85, ratio of bus supply to demand, 1) Units: Dmnl

395. normalized ratio of metro supply to demand=if then else (ratio of metro supply to demand<=0.85, ratio of metro supply to demand, 1) Units: Dmnl

396. normalized ratio of trial supply to demand=if then else (ratio of trail supply to demand<=0.6, ratio of trail supply to demand, 1) Units: Dmnl

397. normalized ratio of work travel cost to trip budget=if then else (ratio of work trip budget to trave cost>=0.9, 1, ratio of work trip budget to travel cost)
Units: Dmnl

398. passenger by metro per charging period=Total Metro Cars*average passenger per metro car per hour*calculating hours per day Units: passenger

399. passenger by trail per charging period=Total Trail Miles*calculating hours per day*average passenger Flow Rate Units: passenger

400. passenger delivered per charging period=average passenger per bus per charging period*Total Buses Units: passenger

401. PCU per bus=2.5 Units: PCU/bus

402. PCU per car=1 Units: PCU/car

403. "perception respect to ratio of driving cost vs. budget"[TVCMedium]=if then else (normalized ratio of work travel cost to trip budget>=0 :AND: normalized ratio of work travel cost to trip budget<=0.5, normalized ratio of work travel cost to trip budget/0.5, if then else (normalized ratio of work travel cost to trip budget>=0.5:AND:normalized ratio of work travel cost to trip budget<=1, (1-normalized ratio of work travel cost to trip budget)/0.5, 0))

404. "perception respect to ratio of driving cost vs. budget"[TVCLow]=if then else (normalized ratio of work travel cost to trip budget=0, 1, if then else(normalized ratio of work travel cost to trip budget>=0 :AND: normalized ratio of work travel cost to trip budget<=0.5, (0.5-normalized ratio of work travel cost to trip budget)/0.5, 0))"perception respect to ratio of driving cost vs. budget"[TVCHigh]=if then else (normalized ratio of work travel cost to trip budget>=0.5 :AND: normalized ratio of work travel cost to trip budget<=1, (normalized ratio of work travel cost to trip budget-0.5)/0.5, if then else (normalized ratio of work travel cost to trip budget>=1, 1, 0))
Units: Dmnl

405. perception with respect to Average Flow Rate[FLow]=if then else (normalized average flow rate=0, 1, if then else (normalized average flow rate>=0 :AND: normalized average flow rate<=0.5, (0.5-normalized average flow rate)/0.5, 0))

406. perception with respect to Average Flow Rate[FMedium]=if then else (normalized average flow rate>=0:AND:normalized average flow rate<=0.5, normalized average flow rate/0.5, if then else (normalized average flow rate>=0.5:AND:normalized average flow rate<=1, (1-normalized average flow rate)/0.5, 0))

407. perception with respect to Average Flow Rate[FHigh]=if then else (normalized average flow rate>=0.5:AND:normalized average flow rate<=1, (normalized average flow rate-0.5)/0.5, if then else (normalized average flow rate>=1, 1, 0))

Units: Dmnl

408. "perception with respect to bus supply vs. demand"[BLow]=if then else (normalized ratio of bus supply to demand=0, 1, if then else (normalized ratio of bus supply to demand>=0 :AND:normalized ratio of bus supply to demand<=0.5, (0.5-normalized ratio of bus supply to demand)/0.5, 0))

409. "perception with respect to bus supply vs. demand"[BMedium]=if then else (normalized ratio of bus supply to demand>=0 :AND: normalized ratio of bus supply to demand<=0.5, normalized ratio of bus supply to demand/0.5, if then else (normalized ratio of bus supply to demand>=0.5 :AND: normalized ratio of bus supply to demand<=1, (1-normalized ratio of bus supply to demand)/0.5, 0))

410. "perception with respect to bus supply vs. demand"[BHigh]=if then else (normalized ratio of bus supply to demand>=0.5 :AND: normalized ratio of bus supply to demand <=1, (normalized ratio of bus supply to demand-0.5)/0.5, if then else (normalized ratio of bus supply to demand>=1, 1, 0)) Units: Dmnl

411. "perception with respect to metro supply vs. demand"[MLow]=if then else (normalized ratio of metro supply to demand=0, 1, if then else(normalized ratio of metro supply to demand>=0 :AND: normalized ratio of metro supply to demand<=0.5, (0.5-normalized ratio of metro supply to demand)/0.5, 0))

412. "perception with respect to metro supply vs. demand"[MMedium]=if then else (normalized ratio of metro supply to demand>=0 :AND: normalized ratio of metro supply to demand<=0.5, normalized ratio of metro supply to demand/0.5, if then else (normalized ratio of metro supply to demand>=0.5 :AND: normalized ratio of metro supply to demand<=1, (1-normalized ratio of metro supply to demand)/0.5, 0)) "perception with respect to metro supply vs. demand"[MHigh]=if then else (normalized ratio of metro supply to demand>=0.5 :AND: normalized ratio of metro supply to demand<=1, (normalized ratio of metro supply to demand-0.5)/0.5, if then else (normalized ratio of metro supply to demand>=1, 1, 0))

Units: Dmnl

413. "perception with respect to trail supply vs. demand"[TLow]=if then else (normalized ratio of trial supply to demand=0, 1, if then else(normalized ratio of trial supply to

demand>=0 :AND: normalized ratio of trial supply to demand<=0.5, (0.5-normalized ratio of trial supply to demand)/0.5, 0))

414. "perception with respect to trail supply vs. demand"[TMedium]=if then else (normalized ratio of trial supply to demand>=0 :AND: normalized ratio of trial supply to demand<=0.5, normalized ratio of trial supply to demand/0.5, if then else (normalized ratio of trial supply to demand>=0.5 :AND: normalized ratio of trial supply to demand<=1, (1-normalized ratio of trial supply to demand)/0.5, 0))

415. "perception with respect to trail supply vs. demand"[THigh]=if then else (normalized ratio of trial supply to demand>=0.5 :AND: normalized ratio of trial supply to demand <=1, (normalized ratio of trial supply to demand-0.5)/0.5, if then else (normalized ratio of trial supply to demand>=1, 1, 0)) Units: Dmnl

416. potential passenger concentration=Potential Passengers/total people around designated urban area Units: Dmnl

417. Potential Passengers= INTEG (+normal fraction of potential passenger increase-conversion rate,3e+008) Units: passenger

418. price per bus=300000 Units: dollar/bus

419. quitting driving car=Total Car Demand/average time keeping using car Units: passenger/day

420. quitting riding bus=Total Bus Demand/average time keeping using bus Units: passenger/day

421. quitting riding metro=Total Metro Demand/average time keeping using metro Units: passenger/day

422. quitting using trail=Total Trail Demand/average time keeping using trail Units: passenger/day

423. Range:(r1-r243)

424. ratio of bus supply to demand=if then else (calculating days<>0, passenger delivered per charging period/Total Bus Demand, passenger delivered per charging period/(Total Bus Demand*(1-fraction of work trip demand on bus))) Units: Dmnl

425. ratio of metro supply to demand=if then else (calculating days<>0, passenger by metro per charging period/Total Metro Demand, passenger by metro per charging period/(Total Metro Demand*(1-fraction of work trip by metro))) Units: Dmnl

426. ratio of trail supply to demand=if then else (calculating days<>0, passenger by trail per charging period/Total Trail Demand, passenger by trail per charging period/(Total Trail Demand*(1-fraction of work trip by trail))) Units: Dmnl

427. ratio of work trip budget to travel cost=work trip budget/travel cost per driver per day Units: Dmnl

428. SAVEPER = TIME STEP Units: day [0,?]

The frequency with which output is stored.

429. sbc max value=VMAX("fuzzy rule for switching b-c"[switching bus to car!]) Units: Dmnl

430. sbm max value=VMAX("fuzzy rule for switching b-m"[switching bus to metro!]) Units: Dmnl

431. sbt max value=VMAX("fuzzy rule for switching b-t"[switching bus to trail!]) Units: Dmnl

432. scb max value=VMAX("fuzzy rule for c-b"[switching car to bus!]) Units: Dmnl

433. scm max value=VMAX("fuzzy rul for switching c-m"[switching car to metro!]) Units: Dmnl

434. sct max value=VMAX("fuzzy rule for switchign c-t"[switching car to trail!]) Units: Dmnl

435. smb max value=VMAX("fuzzy rule for switching m-b"[switching metro to bus!]) Units: Dmnl

436. smc max value=VMAX("fuzzy rule for switchign m-c"[switching metro to car!]) Units: Dmnl

437. smt max value=VMAX("fuzzy rule for switching m-t"[switching metro to trail!]) Units: Dmnl

438. sociability=1 Units: contact/passenger/day

439. stb max value=VMAX("fuzzy rule for switching t-b"[switching trail to bus!]) Units: Dmnl

440. stc max value=VMAX("fuzzy rule for switching t-c"[switching trail to car!]) Units: Dmnl

441. stm max value=VMAX("fuzzy rule for switching t-m"[switching trail to metro!])

Units: Dmnl

442. switching bus to car: bcr1, bcr2, bcr3, bcr4, bcr5, bcr6, bcr7, bcr8, bcr9

443. switching bus to metro: sbmr1, sbmr2, sbmr3

444. switching bus to trail: sbtr1, sbtr2, sbtr3

445. switching car to bus: cbr1, cbr2, cbr3, cbr4, cbr5, cbr6, cbr7,cbr8, cbr9

446. switching car to metro: scmr1, scmr2, scmr3

447. switching car to trail: sctr1, sctr2, sctr3

448. switching from bus to car=(Total Bus Demand/time with bus before switching)*"defuzzified effect of perception on switching b-c"

Units: passenger/day

449. switching from bus to metro=(Total Bus Demand/time with bus before switching)*"defuzzified effect of perception on switching b-m"

Units: passenger/day

450. switching from bus to trail=(Total Bus Demand/time with bus before switching)*"defuzzified effect of perception on switching b-t"

Units: passenger/day

451. switching from car to bus=(Total Car Demand/time with car before switching)*"defuzzified effect of perception on c-b" Units: passenger/day

452. switching from car to metro=(Total Car Demand/time with car before switching)*"defuzzified effect of perception on switching c-m"

Units: passenger/day

453. switching from car to trail=(Total Car Demand/time with car before switching)*"defuzzified effect of perception on switching c-t"

Units: passenger/day

454. switching from metro to bus=(Total Metro Demand/time with metro before switching)*"defuzzified effect of perception on switching m-b"

Units: passenger/day

455. switching from metro to car=(Total Metro Demand/time with metro before switching)*"defuzzified effect of perception on switching m-c"

Units: passenger/day

456. switching from metro to trail=(Total Metro Demand/time with metro before switching)*"defuzzifife effect of perception on switching m-t"
Units: passenger/day

457. switching from trail to bus=(Total Trail Demand/time with trail before switching)*"defuzzified effect of perception on switching t-b"
Units: passenger/day

458. switching from trail to car=(Total Trail Demand/time with trail before switching)*"defuzzified effect to of perception on switching t-c"
Units: passenger/day

459. switching from trail to metro=(Total Trail Demand/time with trail before switching)*"defuzzified effect of perception on switching t-m"
Units: passenger/day

460. switching metro to bus: smbr1, smbr2, smbr3, smbr4, smbr5, smbr6, smbr7,smbr8,smbr9

461. switching metro to car: smcr1, smcr2, smcr3, smcr4, smcr5, smcr6, smcr7, smcr8, smcr9

462. switching metro to trail: smtr1, smtr2, smtr3

463. switching trail to bus: stbr1, stbr2, stbr3,stbr4, stbr5, stbr6,stbr7,stbr8,stbr9

464. switching trail to car: stcr1, stcr2, stcr3, stcr4, stcr5, stcr6, stcr7, stcr8, stcr9

465. switching trail to metro:stmr1,stmr2,stmr3

466. time delay in choosing transportation mode=180 Units: day

467. TIME STEP = 0.25 Units: day [0,?]
The time step for the simulation.

468. time value per hour=20 Units: dollar/hour

469. time with bus before switching=720 Units: day

470. time with car before switching=1440 Units: day

471. time with metro before switching=720 Units: day

472. time with trail before switching=1080 Units: day

473. Total Bus Demand= INTEG (new demand for bus+ switching from car to bus+ switching from metro to bus+ switching from trail to bus-quitting riding bus-switching from bus to car-switching from bus to metro-switching from bus to trail, 247770)

Units: passenger

474. Total Buses= INTEG (+bus increment-bus aging, 300) Units: bus

475. Total Car Demand= INTEG (new demand for car+ switching from bus to car+ switching from metro to car+ switching from trail to car-quitting driving car-switching from car to bus-switching from car to metro-switching from car to trail, 401319)
Units: passenger

476. total car running=if then else (calculating days<>0, Total Car Demand/carpool multiplier, (Total Car Demand/(carpool multiplier)*(1-fraction of work trip by car)))
Units: car

477. "total lane miles with cordon-based area"=1500 Units: miles

478. Total Metro Cars= INTEG (+metro car increment-metro car aging, 446)
Units: metro car

479. Total Metro Demand= INTEG (new demand for metro+ switching from bus to metro+ switching from car to metro+ switching from trail to metro-quitting riding metro-switching from metro to bus-switching from metro to car-switching from metro to trail, 143320) Units: passenger

480. total PCUs=total car running*PCU per car+ Total Buses*PCU per bus
Units: PCU

481. total people around designated urban area=Potential Passengers+ Total Bus Demand+ Total Car Demand+ Total Metro Demand+ Total Trail Demand+ Undecided passengers
Units: person

482. Total Trail Demand= INTEG (new demand for trail+ switching from bus to trail+ switching from car to trail+ switching from metro to trail-quitting using trail-switching from trail to bus-switching from trail to car-switching from trail to metro, 42998) Units: passenger

483. Total Trail Miles= INTEG (+trail increment-trail aging, 120)
Units: mile

484. tourist base increment=if then else(calculating days<>0, normal tourist base increase rate, multiplier of weekend tourist*normal tourist base increase rate)
Units: passenger/day

485. trail aging=Total Trail Miles/trail life time Units: mile/day

486. trail capacity within cordon based area=200 Units: mile

487. trail discrepancy=trail capacity within cordon based area-Total Trail Miles
Units: mile

488. trail increment=normal funding for trail capacity/cost per trail mile
Units: mile/day

489. trail life time=5400 Units: day

490. Trail S and D: TLow, TMedium, THigh

491. travel cost per driver per day=(time value per hour*average travel time+ average fuel consumption*fuel price per gallon+ insurance premium per day+ maintenance cost per day)/carpool multiplier Units: dollar/passenger/day

492. Trip Value and Cost: TVCLow, TVCMedium, TVCHigh

493. Undecided passengers= INTEG (conversion rate+ employment increment+ tourist base increment-new demand for bus-new demand for car-new demand for metro-new demand for trail,10000) Units: passenger

494. work trip budget=fraction of work budget*work trip value
Units: dollar/passenger/day

495. work trip value=160 Units: dollar/passenger/day

AE8: Behavior for Variables in Transportation System Model without Travel Demand Management Policy

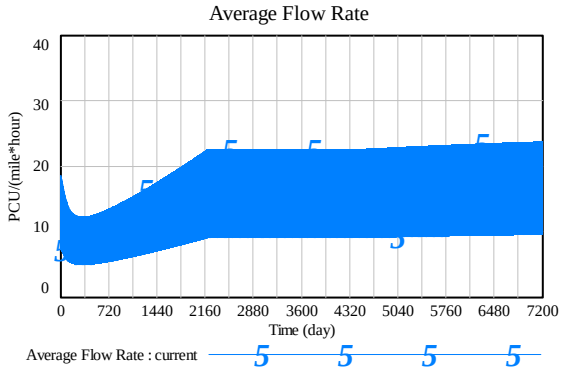


Figure AE.73: Average Traffic Flow Rate_W/O Pricing

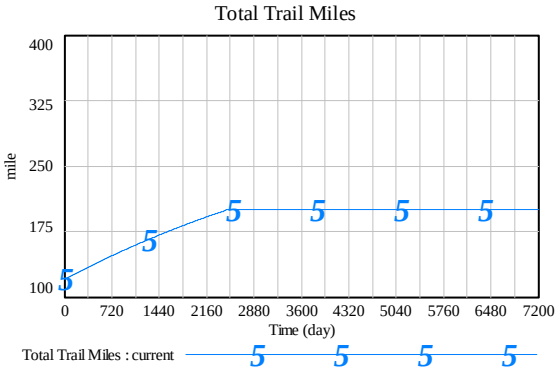


Figure AE.76: Total Trail Miles_W/O Pricing

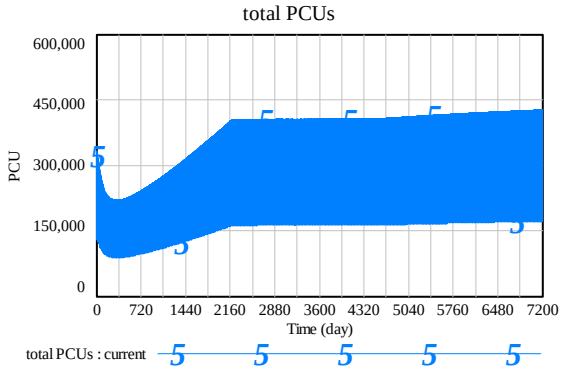


Figure AE.74: Total PCUs_W/O Pricing

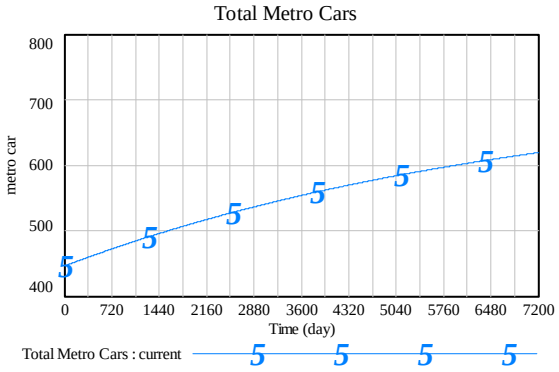


Figure AE.77: Total Metro Rail Cars_W/O Pricing

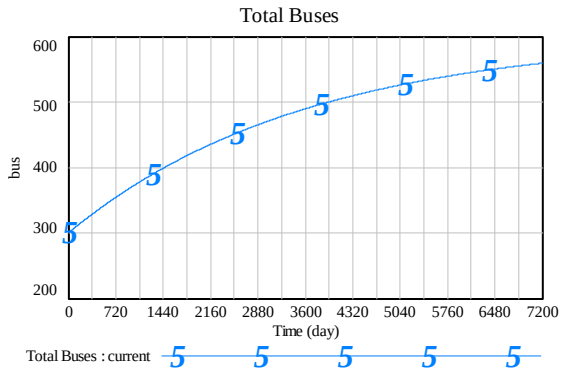


Figure AE.75: Total Buses_W/O Pricing

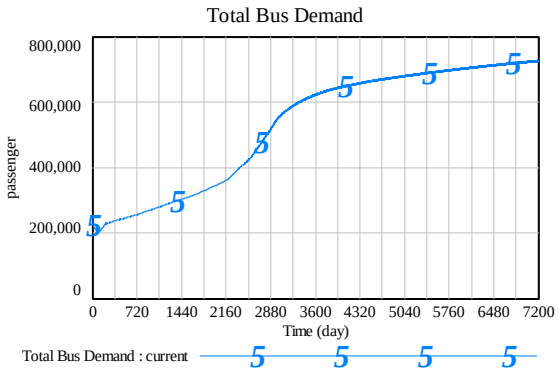


Figure AE.78: Total Bus Demand_W/O Pricing

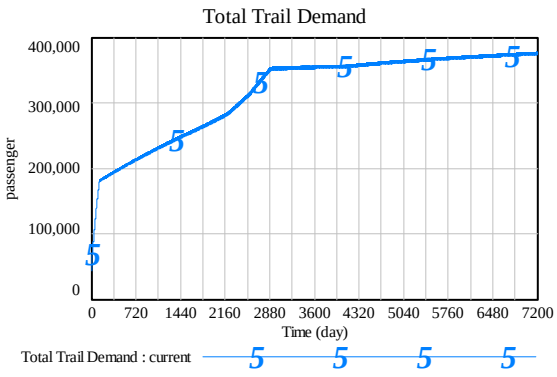


Figure AE.79: Total Metro Demand_W/O Pricing

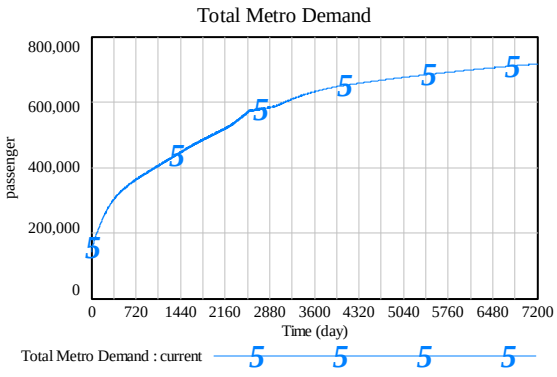


Figure AE.80: Total Metro Demand_W/O Pricing

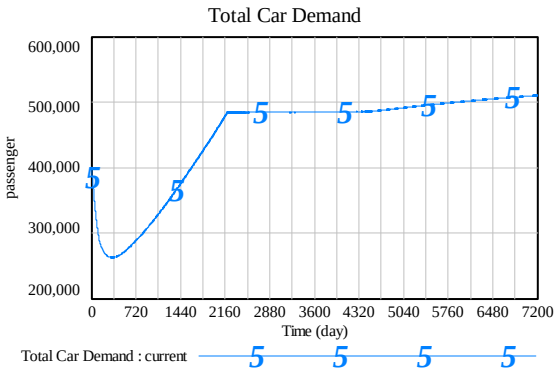


Figure AE.81: Total Car Demand_W/O Pricing

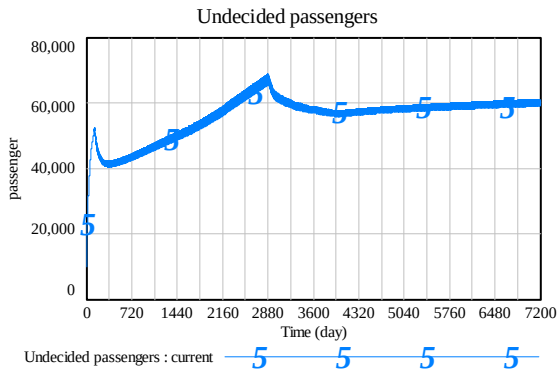


Figure AE.82: Undecided Passengers_W/O Pricing

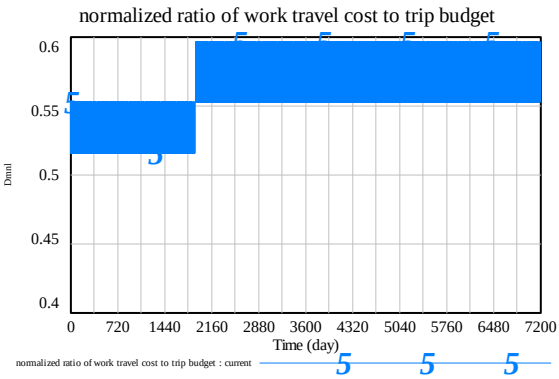


Figure AE.83: Normalized Ratio of Work Travel Cost to Trip Budget_W/O Pricing

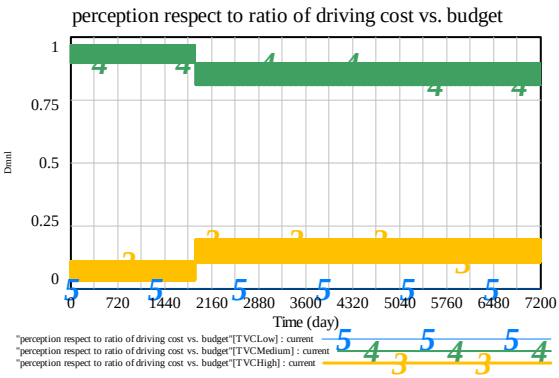


Figure AE.84: Perception with respect Ratio of Driving Cost vs. Budget_W/O Pricing

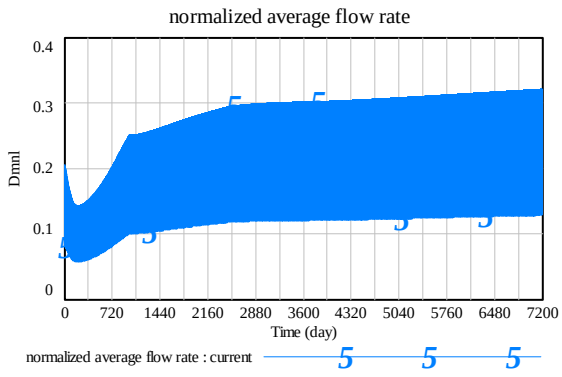


Figure AE.85: Normalized Average Flow Rate_W/O Pricing

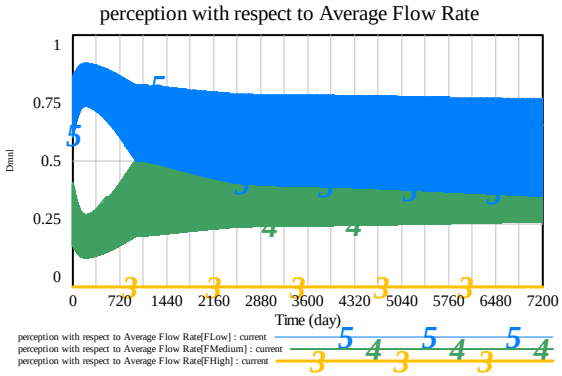


Figure AE.86: Perception with respect to Average Flow Rate_W/O Pricing

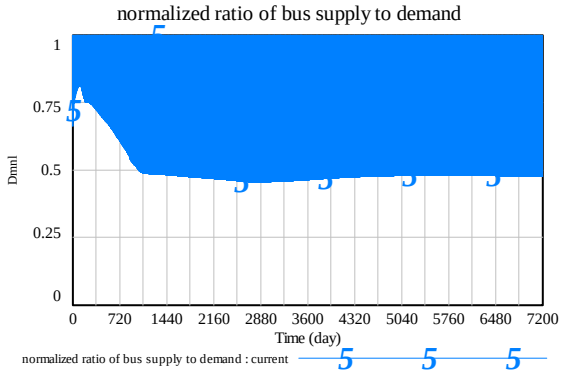


Figure AE.87: Normalized Ratio of Bus Supply to Demand_W/O Pricing

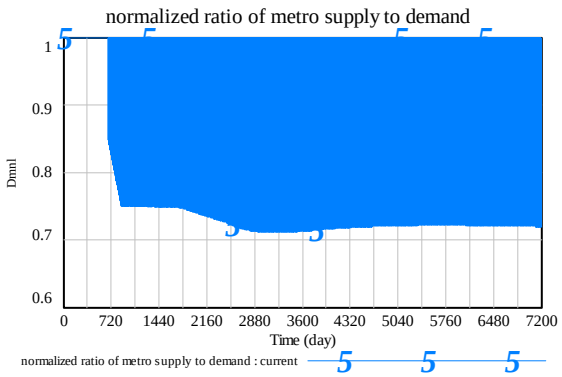


Figure AE.88: Normalized Ratio of Metro Supply to Demand_W/O Pricing

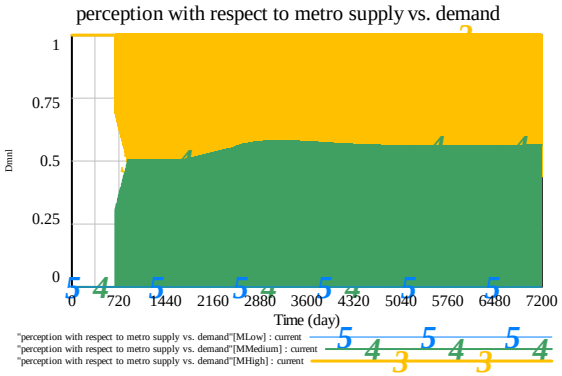


Figure AE.89: Perception with repect to Metro Supply vs. Demand_W/O Pricing

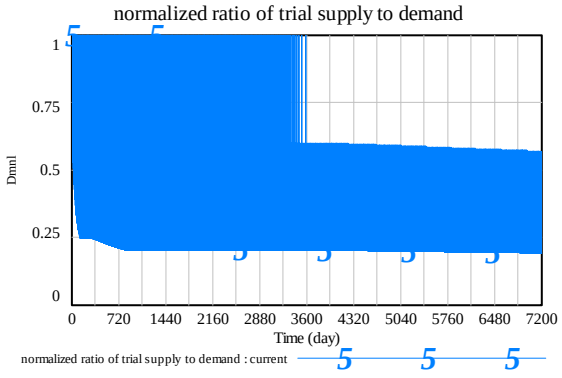


Figure AE.90: Normalized Ratio of Trail Supply to Demand_W/O Pricing

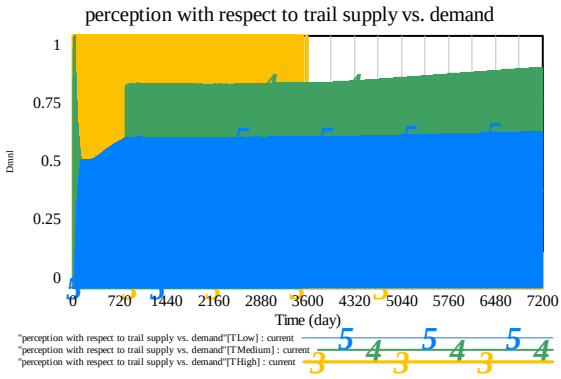


Figure AE.91: Perception with respect to Trail Suplly vs. Demand_W/O Pricing

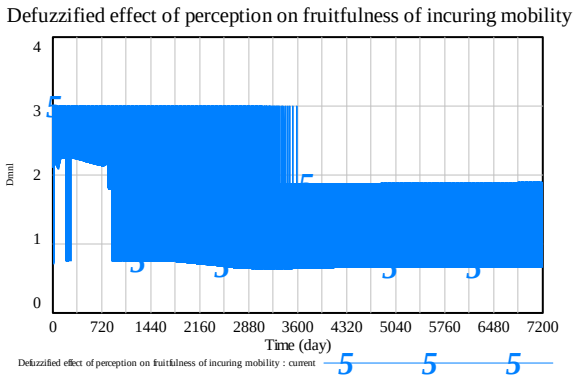


Figure AE.92: Defuzzified Effect of Perception on Fruitfulness of Incrurring Mobility_W/O Pricing

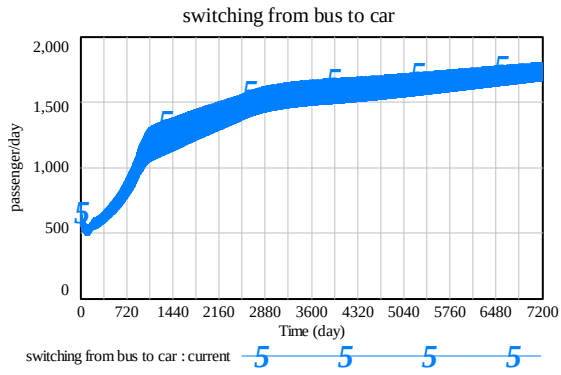


Figure AE.93: Switching from Bus to Car_W/O Pricing

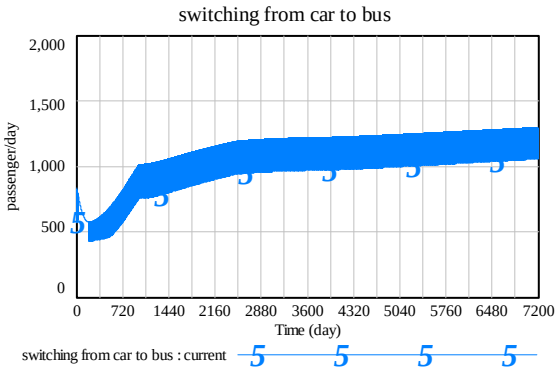


Figure AE.94: Switching from Car to Bus_W/O Pricing

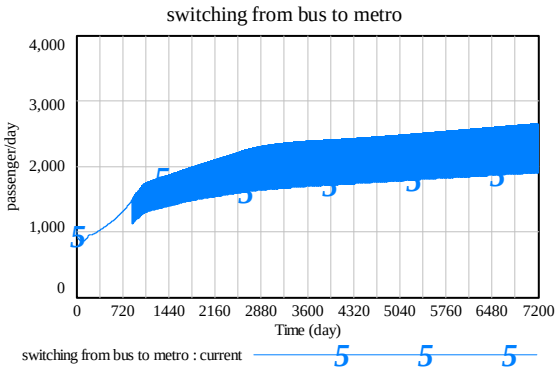


Figure AE.95: Switching from Bus to Metro Rail_W/O Pricing

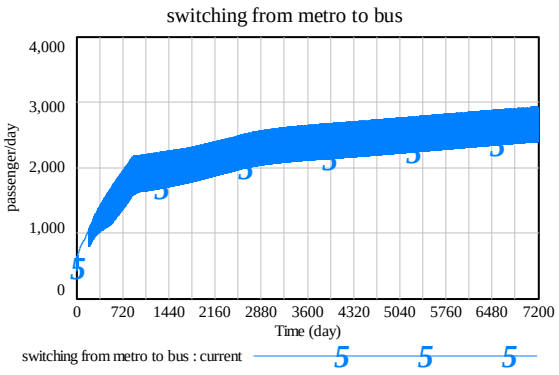


Figure AE.96: Switching from Metro Rail to Bus_W/O Pricing

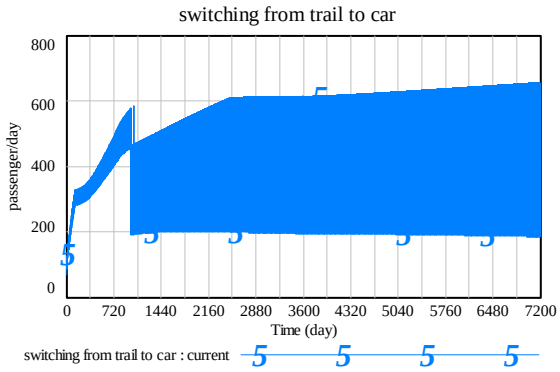


Figure AE.97: Switching from Trail to Car_W/O Pricing

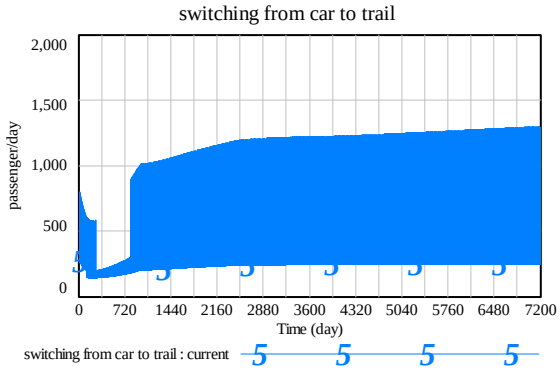


Figure AE.98: Switching from Car to Trail_W/O Pricing

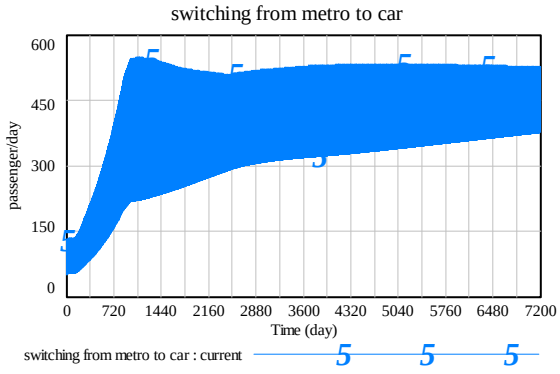


Figure AE.99: Switching from Metro Rail to Car_W/O Pricing

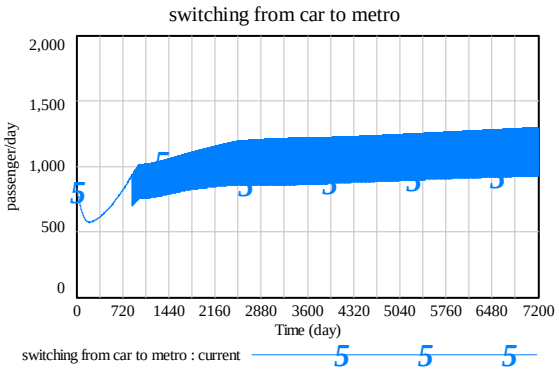


Figure AE.100: Switching from Car to Metro Rail_W/O Pricing

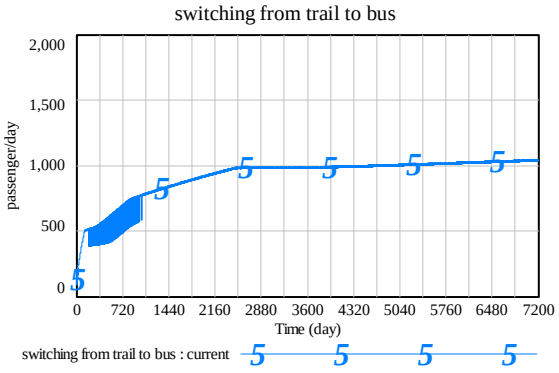


Figure AE.101: Switching from Trail to Bus_W/O Pricing

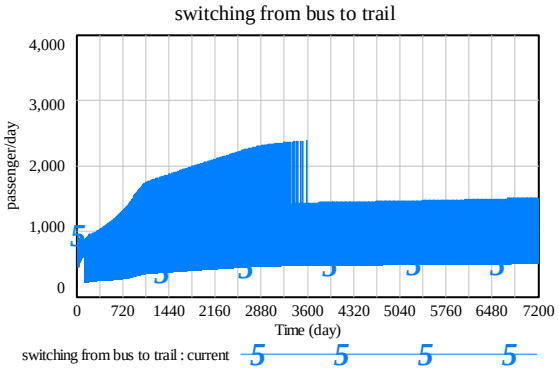


Figure AE.102: Switching from Trail to Bus_W/O Pricing

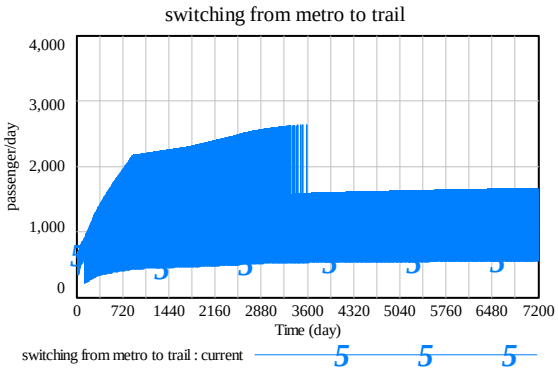


Figure AE.103: Switching from Metro Rail to Trail_W/O Pricing

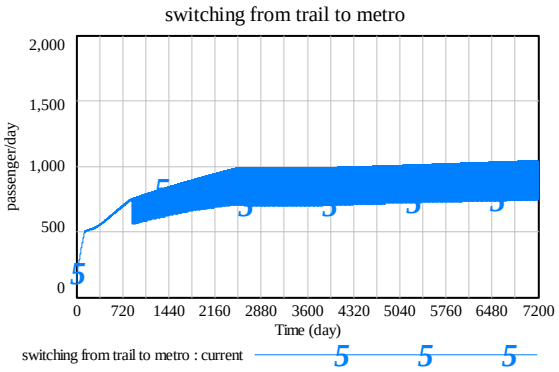


Figure AE.104: Switching from Trail to Metro Rail_W/O Pricing

AE9: Behaviors for Parameter Sensitivity Analysis in Transportation System Model without Travel Demand Management Policy

Number of Simulations: 200

Noise Seed: 1234

Parameter Distribution: Random_Uniform

Table AE.15: Parameter Setting for Sensitivity Analysis

Variable-Parameter Sensitivity without Congestion Pricing	Designated value	Minimum Value	Maximum Value
allowable metro capacity within cordon-based area (metro car)	1500	1200	3000
allowable bus capacity of cordon-based area (bus)	1500	1200	3000
average passenger per bus per hour (passenger/bus/hour)	45	30	55
average passenger per metro car per hour (passenger/metro car/hour)	68	50	98
average time keeping using bus (day)	1800	1440	2160
average time keeping using car (day)	3600	2880	5400
average time keeping using metro (day)	1800	1440	2880
average time keeping using trail (day)	1080	720	1440
average passenger flow rate (passenger/mile/hour)	30	20	40
average trip miles (mile/car/day)	25	20	35
bus life time (day)	3600	2880	4320
carpool multiplier (passenger/car_	1.2	1.1	1.4
cost per metro car (dollar/metro car)	1000000	900000	1200000
cost per trail mile (dollar/mile) note: trail mile	80000	60000	90000
employment increment (passenger/day)	8.1	6	10
fraction of work budget (Dmnl)	0.15	0.12	0.18

fraction of work trip by car (Dmnl)	0.6	0.5	0.7
fraction of work trip by metro (Dmnl)	0.6	0.5	0.7
fraction of work trip by trail (Dmnl)	0.66	0.6	0.75
fraction of work trip demand on bus (Dmnl)	0.66	0.6	0.75
fruitfulness of incurring mobility (Dmnl)	0.0005	0.0002	0.0008
fuel price per gallon (dollar/gallon)	2.5	2	3
insurance premium per day (dollar/car/day)	2.5	2	3
maintenance expenditure per mile (dollar/car/day)	0.029	0.02	0.035
maximum possible average flow rate (PCU//mile/hour)	90	60	95
metro car life time (day)	7200	5400	10800
multiplier of congestion price (Dmnl)	1	1	1.2
multiplier of weekend tourist (passenger/day)	1.5	1.2	1.8
normal gallon per mile (gallon/mile)	0.0452	0.04	0.05
normal money for metro capacity (dollar/day)	100000	80000	120000
normal tourist base increase rate (passenger/day)	97.4	80	110
PCU per bus (PCU/bus)	2.5	2	3
PCU per car (PCU/car)	1	1	1.1
price per bus (dollar/bus)	300000	250000	350000
Sociability (contact/passenger/day)	1	0.8	1.2
time delay in choosing transportation mode (day)	180	90	270
time value per hour (dollar/hour)	20	15	25
time with bus before switching (day)	720	540	1080
time with car before switching (day)	1440	1080	1800

time with metro before switching (day)	720	540	1080
time with trail before switching (day)	1080	720	1440
total lane miles with cordon-based area (mile)	1500	1200	1800
trail capacity within cordon based area (mile)	200	150	250
trail life time (day)	5400	3600	7200
work trip value (dollar/passenger/day)	160	120	200

Following this Table of parameter settings, the following graphs show the behaviors of the sensitivity analysis for different variables.

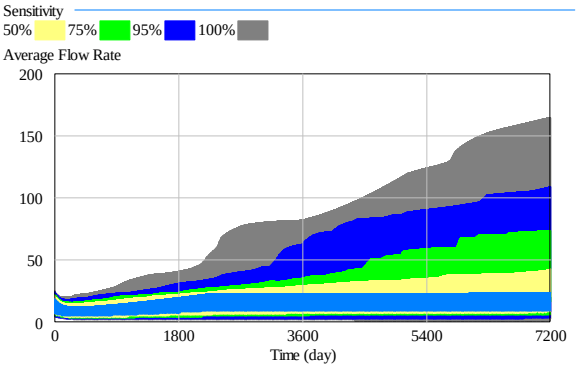


Figure AE.105: Sensitivity Analysis for Average Traffic Flow Rate_W/O Pricing

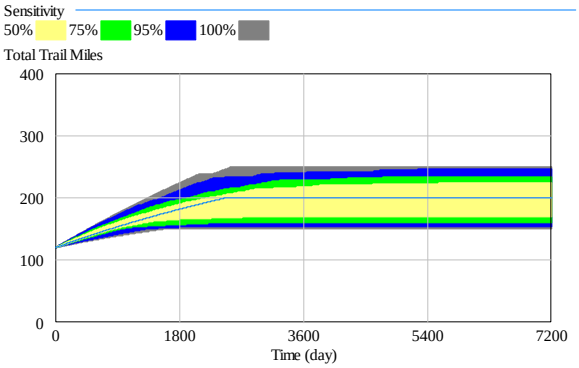


Figure AE.108: Sensitivity Analysis for Total Trail Miles_W/O Pricing

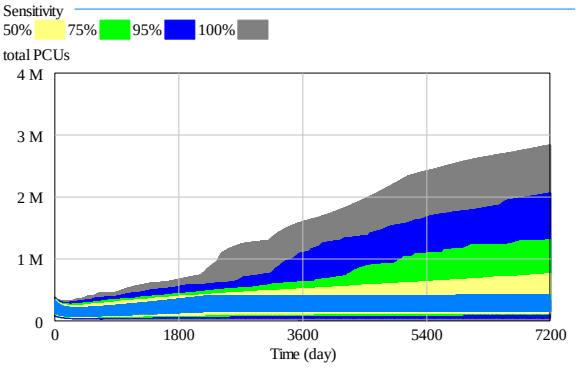


Figure AE.106: Sensitivity Analysis for Total PCUs_W/O Pricing

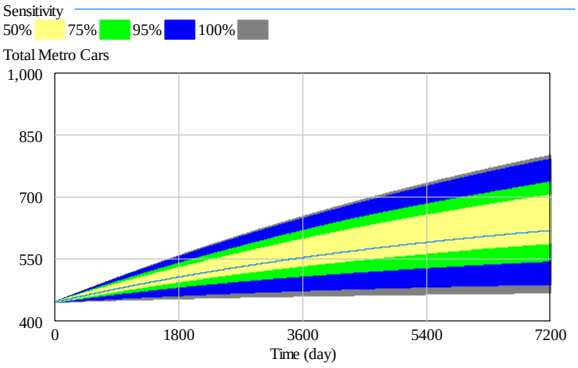


Figure AE.109: Sensitivity Analysis for Total Metro Trail Cars_W/O Pricing

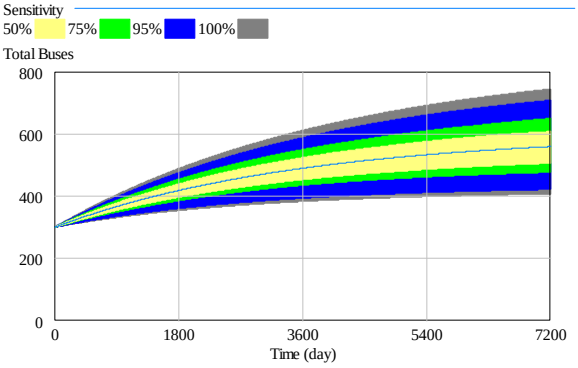


Figure AE.107: Sensitivity Analysis for Total Buses_W/O Pricing

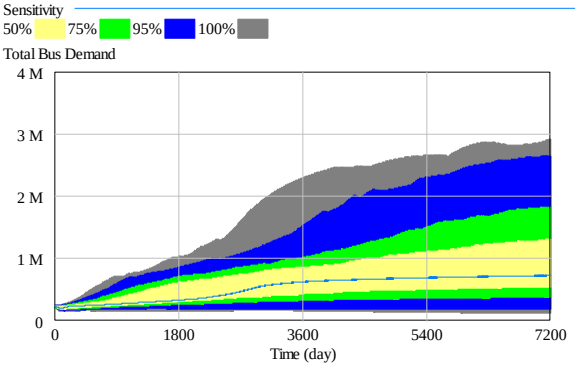


Figure AE.110: Sensitivity Analysis for Total Bus Demand_W/O Pricing

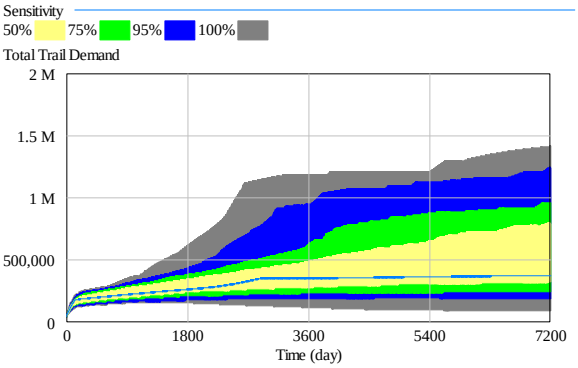


Figure AE.111: Sensitivity Anlaysis for Total Trail Demand_W/O Pricing

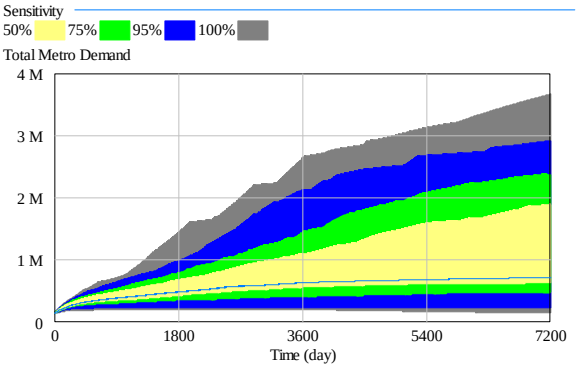


Figure AE.112: Sensitivity Analysis for Total Metro Rail Demand_W/O Pricing

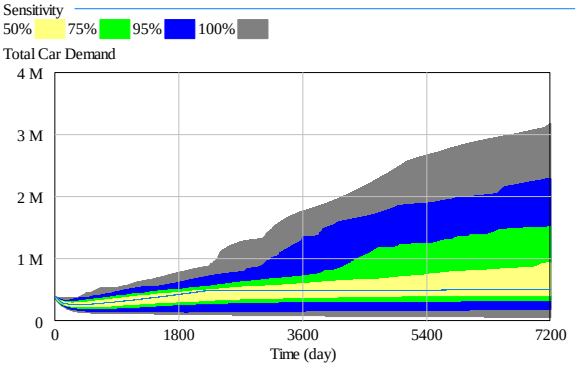


Figure AE.113: Sensitivity Analysis for Total Car Demand_W/O Pricing

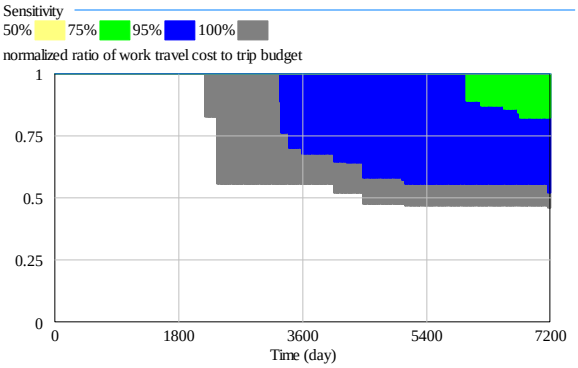


Figure AE.114: Sensitivity Analysis for Normalized Ratio of Work Trip Cost to Budget_W/O Pricing

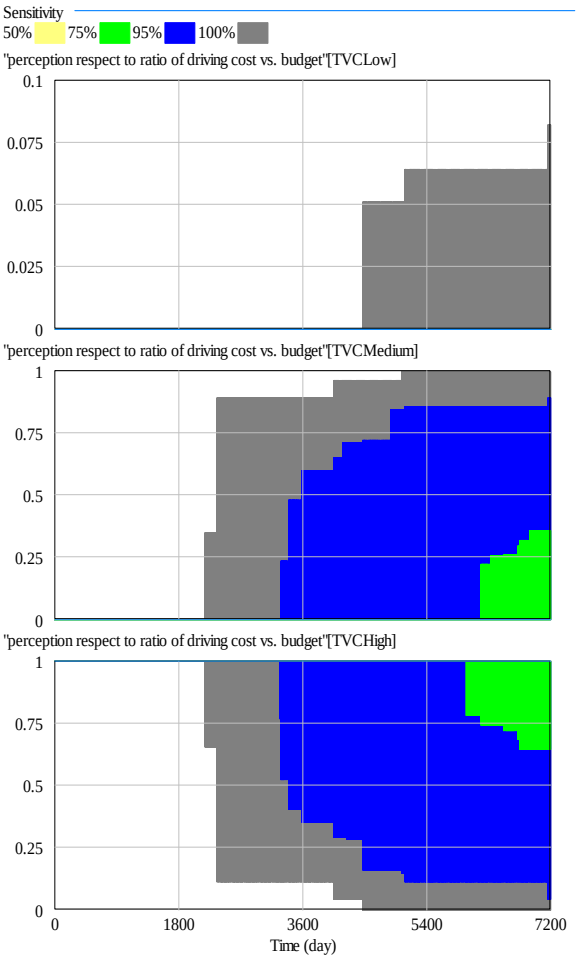


Figure AE.115: Sensitivty Analysis for Perception with respect to Driving Cost vs. Budget_W/O Pricing

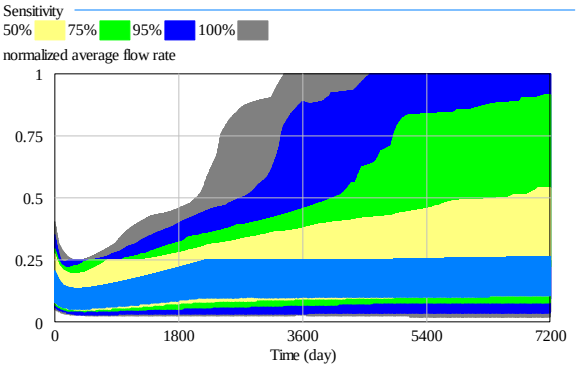


Figure AE.116: Sensitivity Analysis for Normalized Average Traffic Flow Rate_W/O Pricing

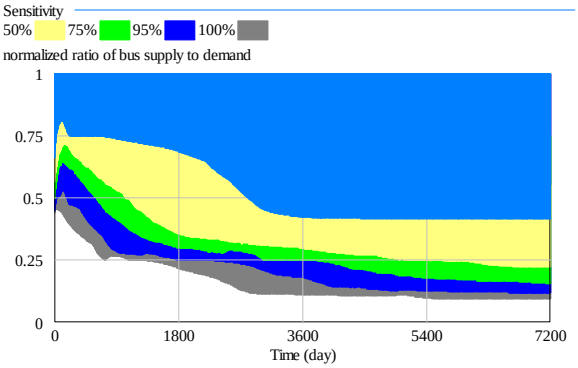


Figure AE.118: Sensitivity Analysis for Normalized Ratio of Bus Supply to Demand_W/O Pricing

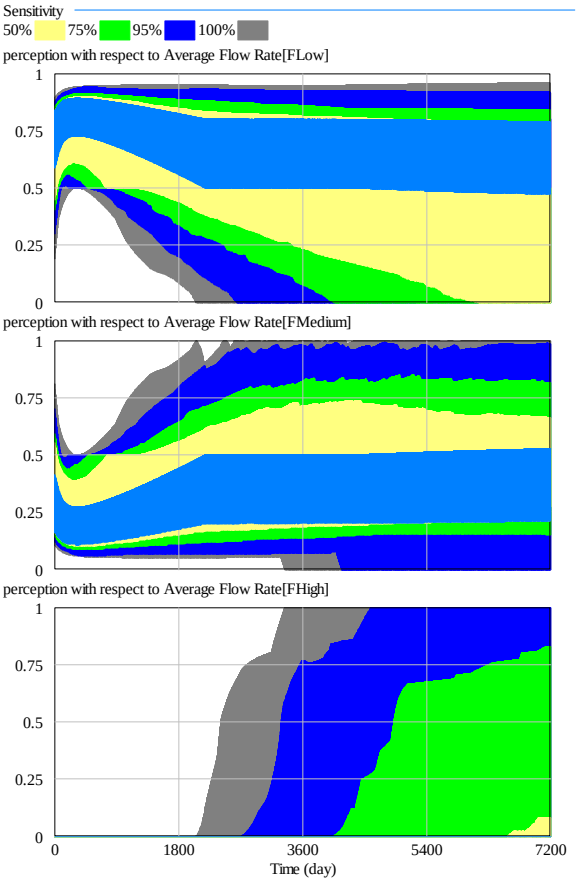


Figure AE.117: Sensitivity Analysis for Perception with respect to Average Traffic Flow Rate_W/O Pricing

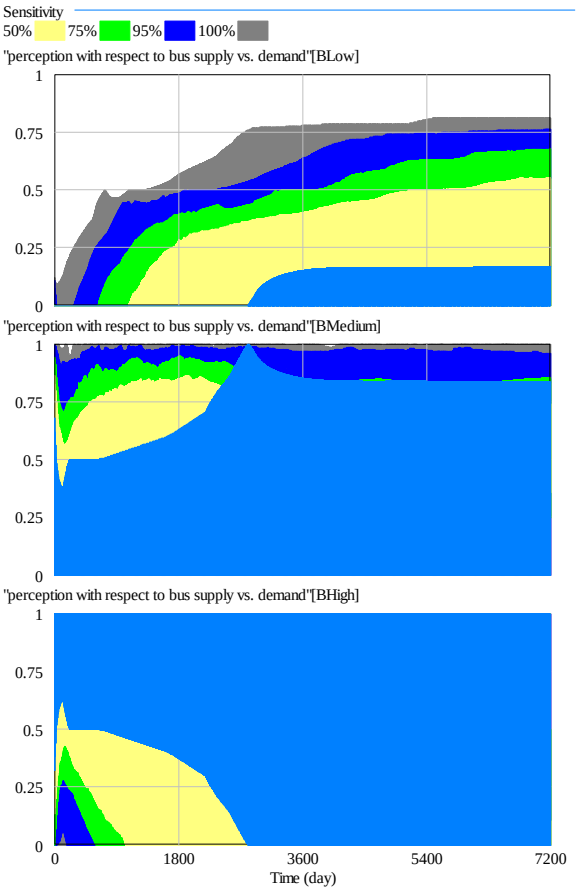


Figure AE.1192: Sensitivity Analysis for Perception with respect to Bus Supply vs. Demand_W/O Pricing

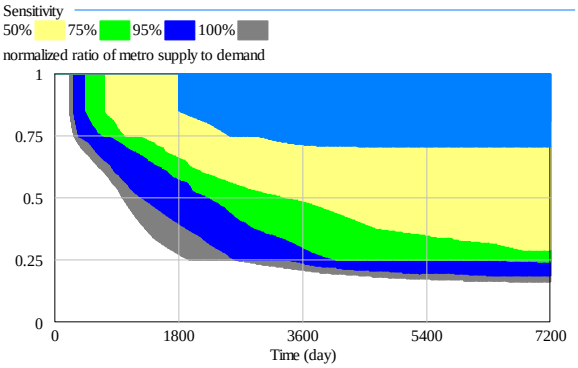


Figure AE.120: Sensitivity Analysis for Normalized Ratio of Metro Rail Car Supply to Demand_W/O Pricing

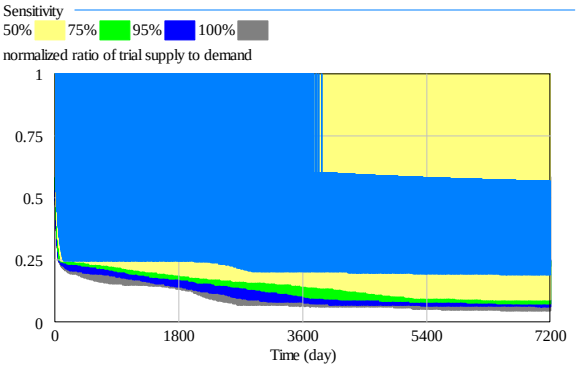


Figure AE.122: Sensitivity Analysis for Normalized Ratio of Trail Supply to Demand_W/O Pricing

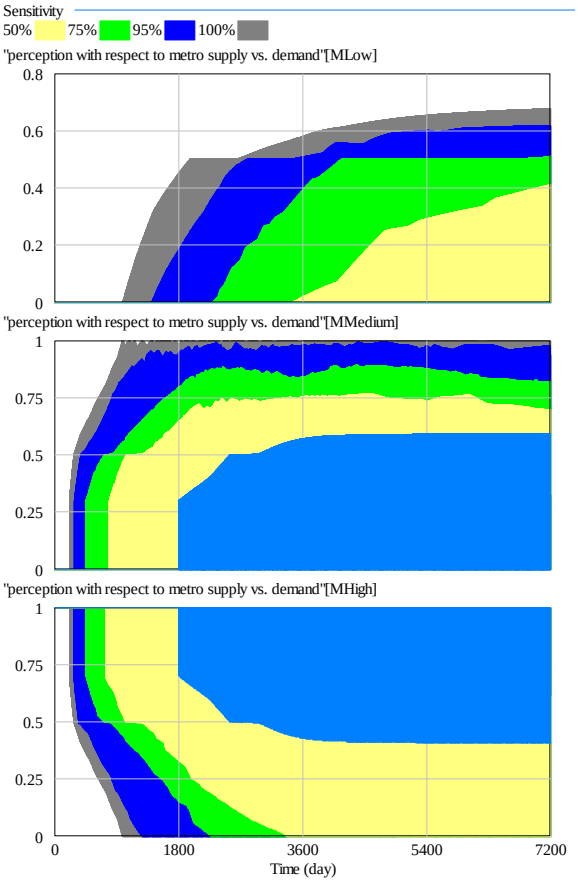


Figure AE.121: Sensitivity Analysis for Perception with respect to Metro Rail Supply vs. Demand_W/O Pricing

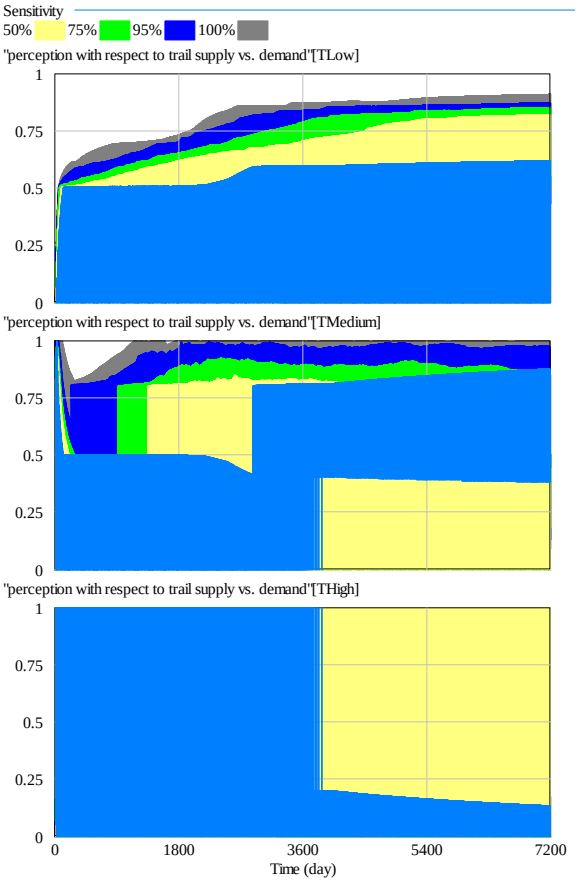


Figure AE.123: Sensitivity Analysis for Perception with respect to Trail Supply vs. Demand_W/O Pricing

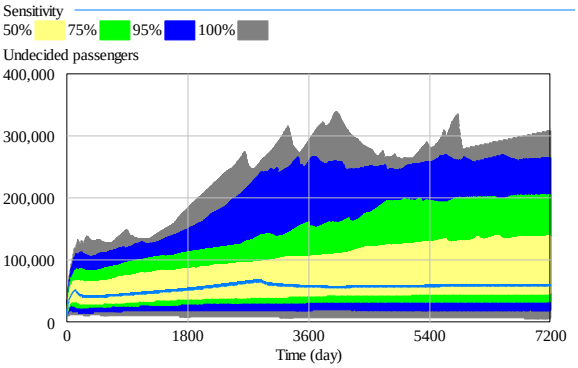


Figure AE.124: Sensitivity Analysis for Undecided Passengers_W/O Pricing

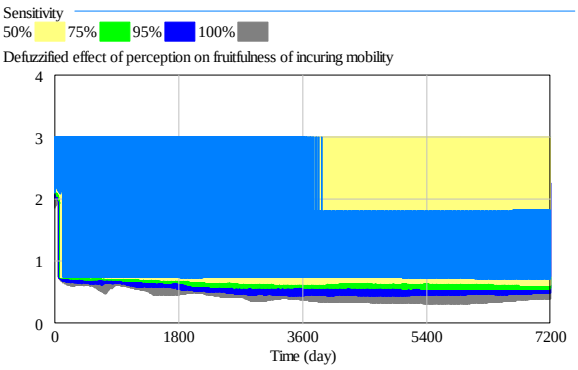


Figure AE.125: Sensitivity Analysis for Defuzzified Effect of Perceptions on Fruitfulness of Incurring Mobility_W/O Pricing

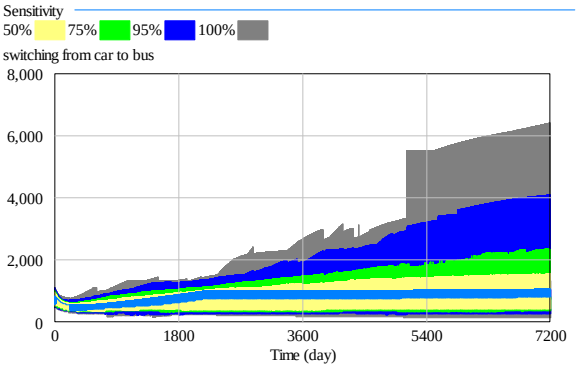


Figure AE.126: Sensitivity Analysis for Switching from Car to Bus_W/O Pricing

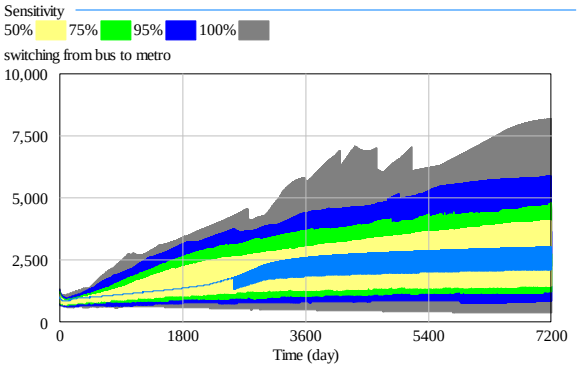


Figure AE.127: Sensitivity Analysis for Switching from Bus to Car_W/O Pricing

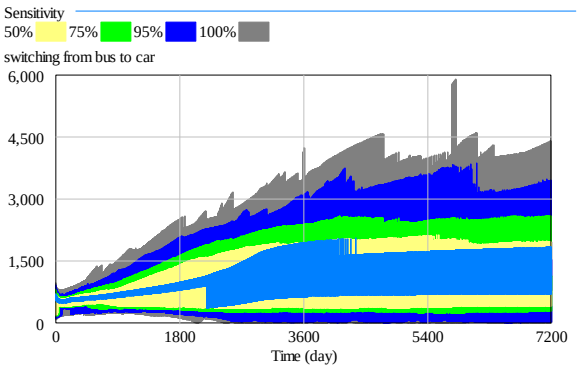


Figure AE.128: Sensitivity Analysis for Switching from Bus to Metro Rail_W/O Pricing

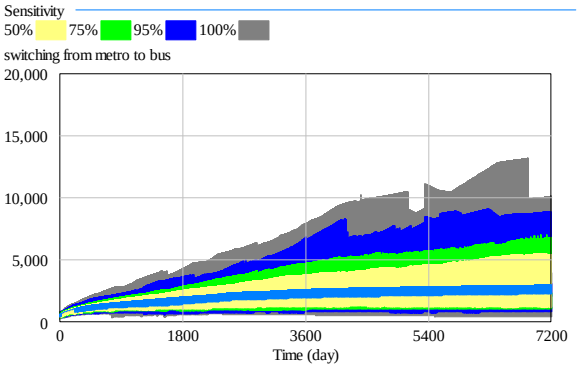


Figure AE.129: Sensitivity Analysis for Switching from Metro Rail to Bus_W/O Pricing

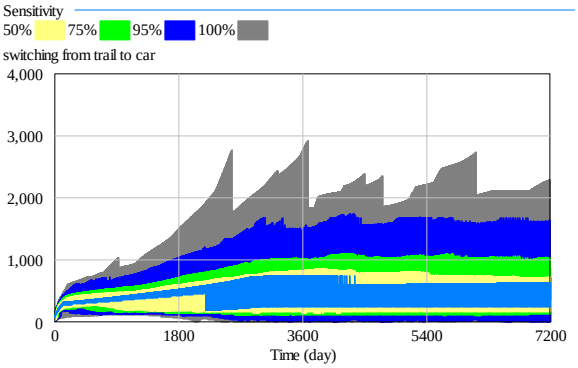


Figure AE.130: Sensitivity Analysis for Switching fromTrail to Car_W/O Pricing

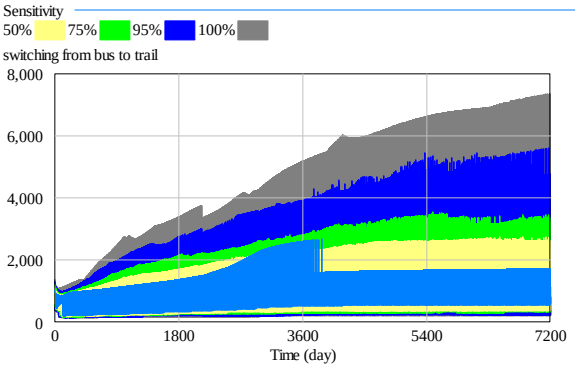


Figure AE.133: Sensitivity Analysis for Switching from Bus to Trail_W/O Pricing

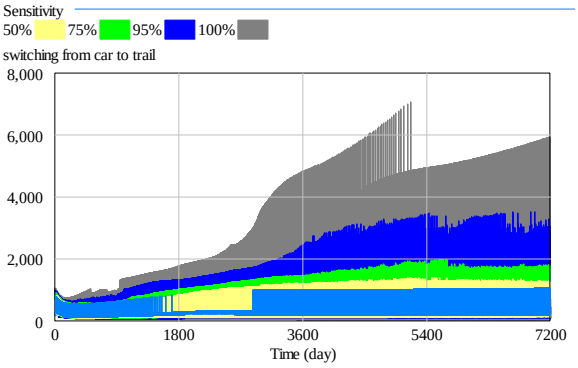


Figure AE.131: Sensitivity Analysis for Switching from Car to Trail_W/O Pricing

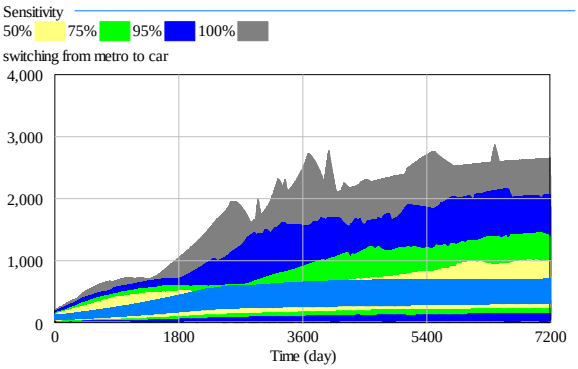


Figure AE.134: Sensitivity Analysis for Switching from Metro Trail to Car_W/O Pricing

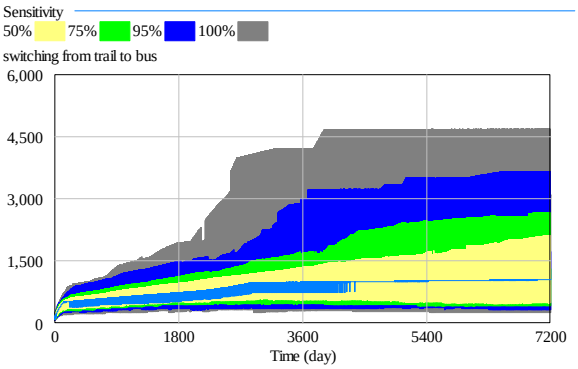


Figure AE.132: Sensitivity Analysis for Switching from Trial to Bus_W/O Pricing

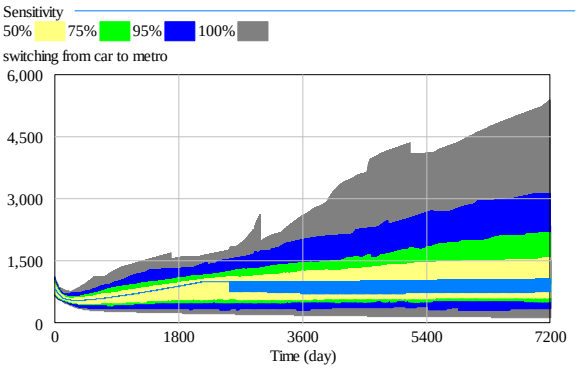


Figure AE.135: Sensitivity Analysis for Switching from Car to Metro Trail_W/O Pricing

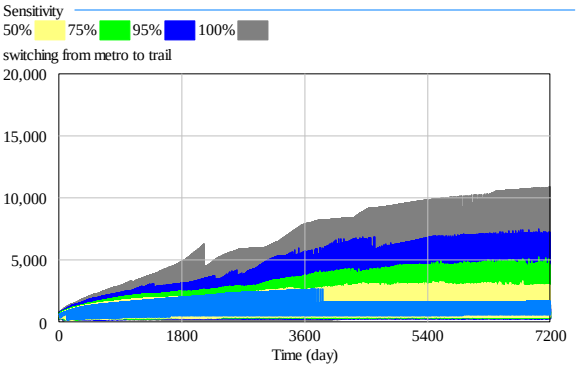


Figure AE.136: Sensitivity Analysis for Switching from Metro Rail to Trail_W/O Pricing

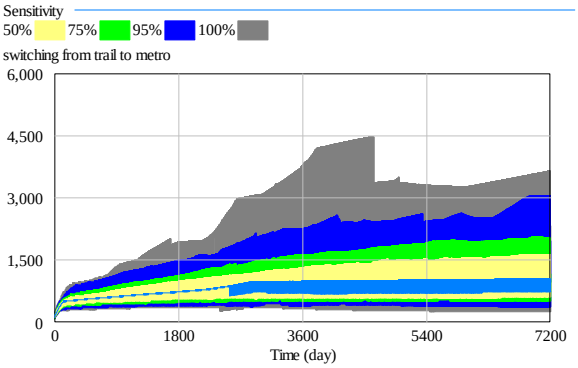


Figure AE.137: Sensitivity Analysis for Switching from Trail to Metro Rail_W/O Pricing

Appendix F: Management Flight Simulator for Transportation System Modeling with Travel Demand Management Policy

AF1: File Related to Management Flight Simulator for Transportation System Modeling with Travel Demand Management Policy

This section provides a file list used for developing Vensim Application Software. They are:

1. *congestion pricing with Triangular Membership function_Backup_April_27-2007.mdl*
   (Providing model structure, model parameter, model variable relationship, and simulation Environment)
2. *congestion pricing with Triangular Membership function_Backup_April_27-2007.vcd*
   (Vensim Custom Definition file used to create a scripted **Venapp** ----Providing interface structure, screen layout, and coding)
3. *congestion pricing with Triangular Membership function_Backup_April_27-2007.vgd*
   (Providing information content for the statement, and guidance, etc)
4. *congestion pricing with Triangular Membership function_Backup_April_27-2007.vsc*
   (Vensim Sensitivity Control file)
5. *Sensitivity.vdf file*
   (Providing sensitivity simulation result file)
6. *Current. vdf*
   (Providing model simulation result file)
7. *congestion pricing with Triangular Membership function_Backup_April_25_2007.lst*
   (Providing the list and relevant order for the sensitivity variables

AF2: Screen Copy for Management Flight Simulator

Welcome Screen

Management Flight Simulator

Travel Demand Management Policy Analysis

System Performance Laboratory

Industrial and Systems Engineering

Virginia Polytechnic Institute and State University

Copyright (C) 2007 Virginia Tech

Exit Screen

Management Flight Simulator

Travel Demand Management Policy Analysis

System Performance Laboratory

Grado Department of Industrial and Systems Engineering

Virginia Polytechnic Institute and State University

Press Any Key to Continue

Copyright (C) 2007 Virginia Tech

Main Menu

Travel Demand Management Policy Analysis

Copyright (C) 2007 Virginia Tech

Guidance for Using Current Management Flight Simulator

Dynamics of Transportation System with Congestion Pricing Policy

Problem Statement of Traffic Congestion

???HELP???

Exit to the Main Menu

Exit Current Application

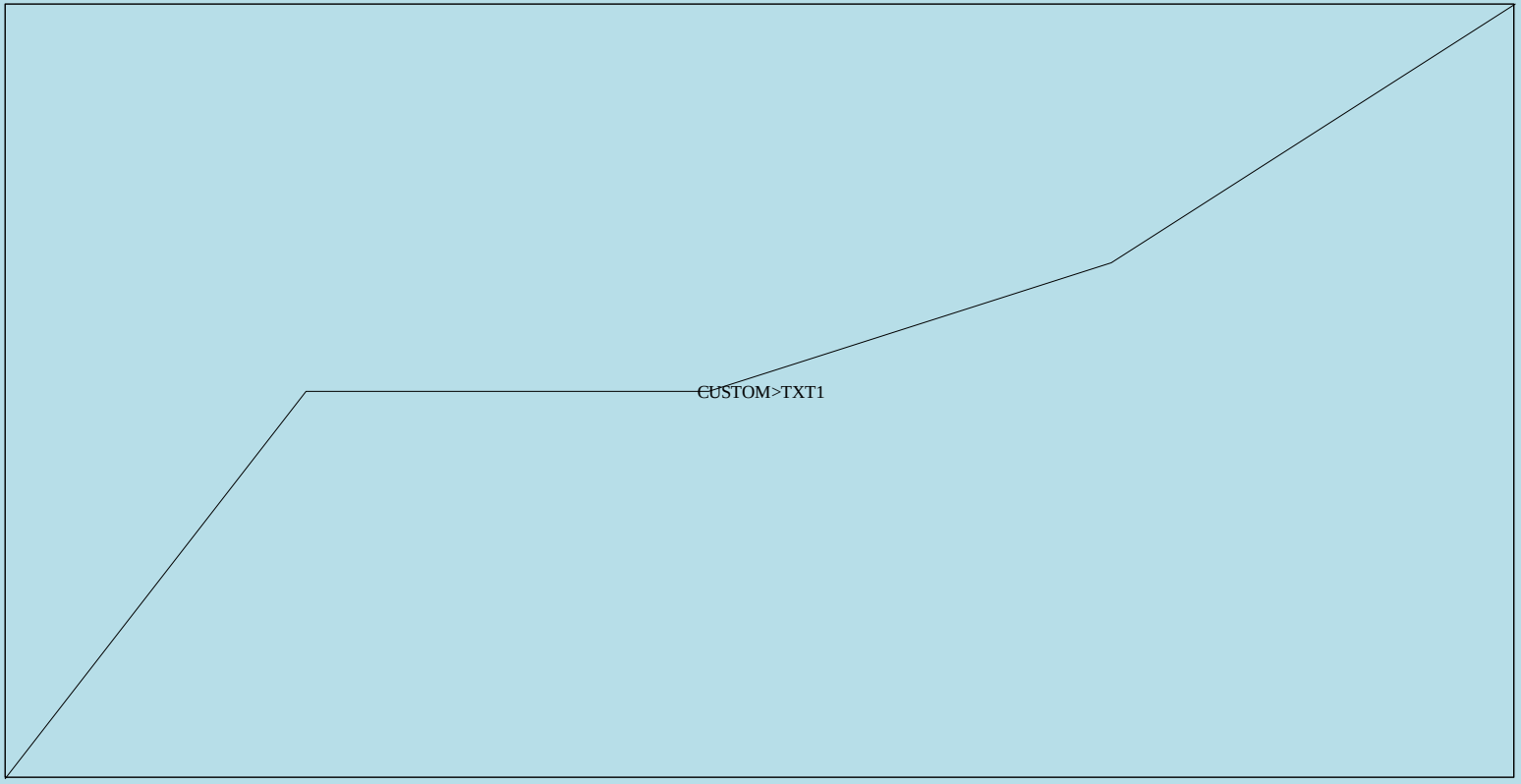
Problem Statement

Travel Demand Management Policy Analysis

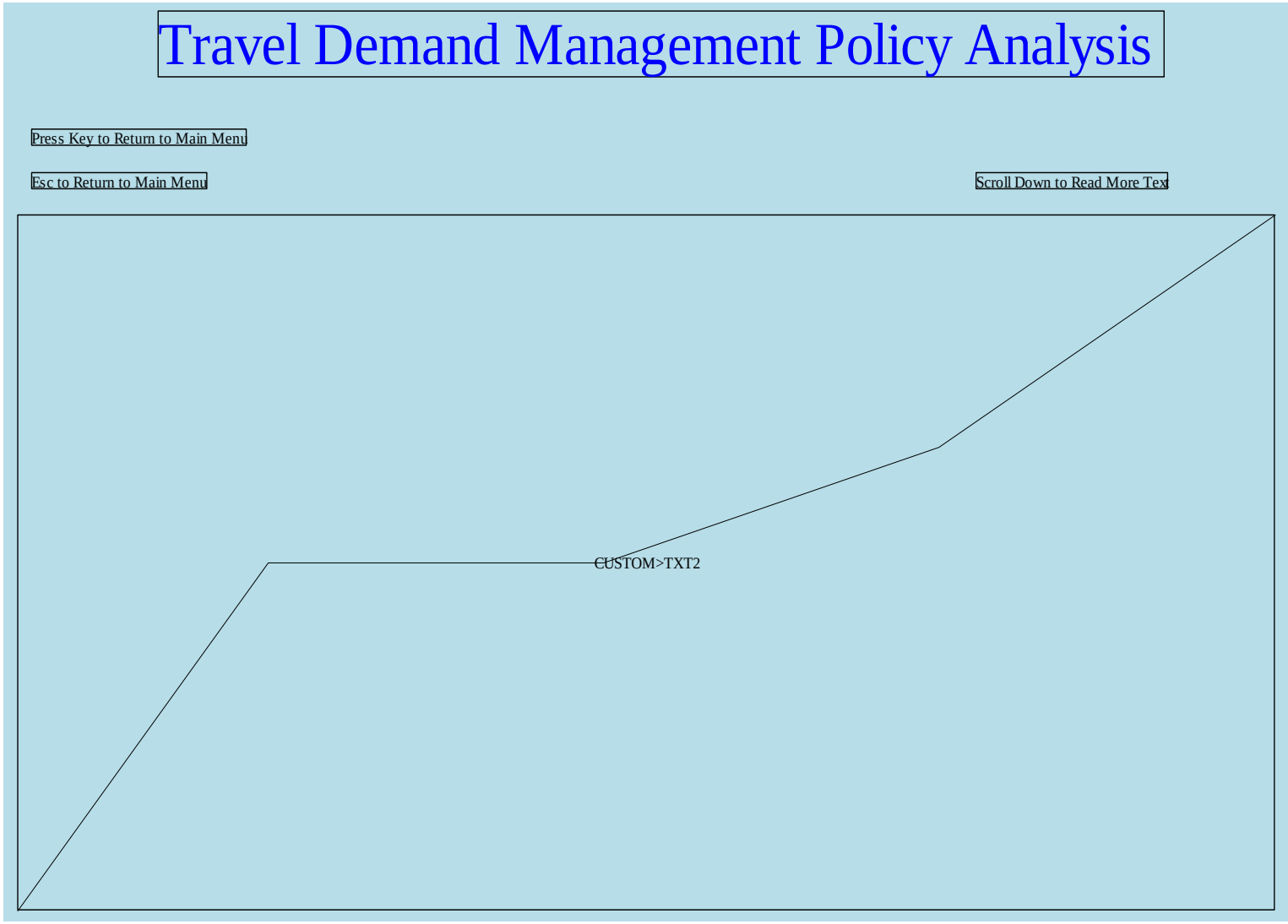
Press Any Key to Continue or

Esc to Return to Main Menu

Scroll Down to Read More Text



Guidance Screen



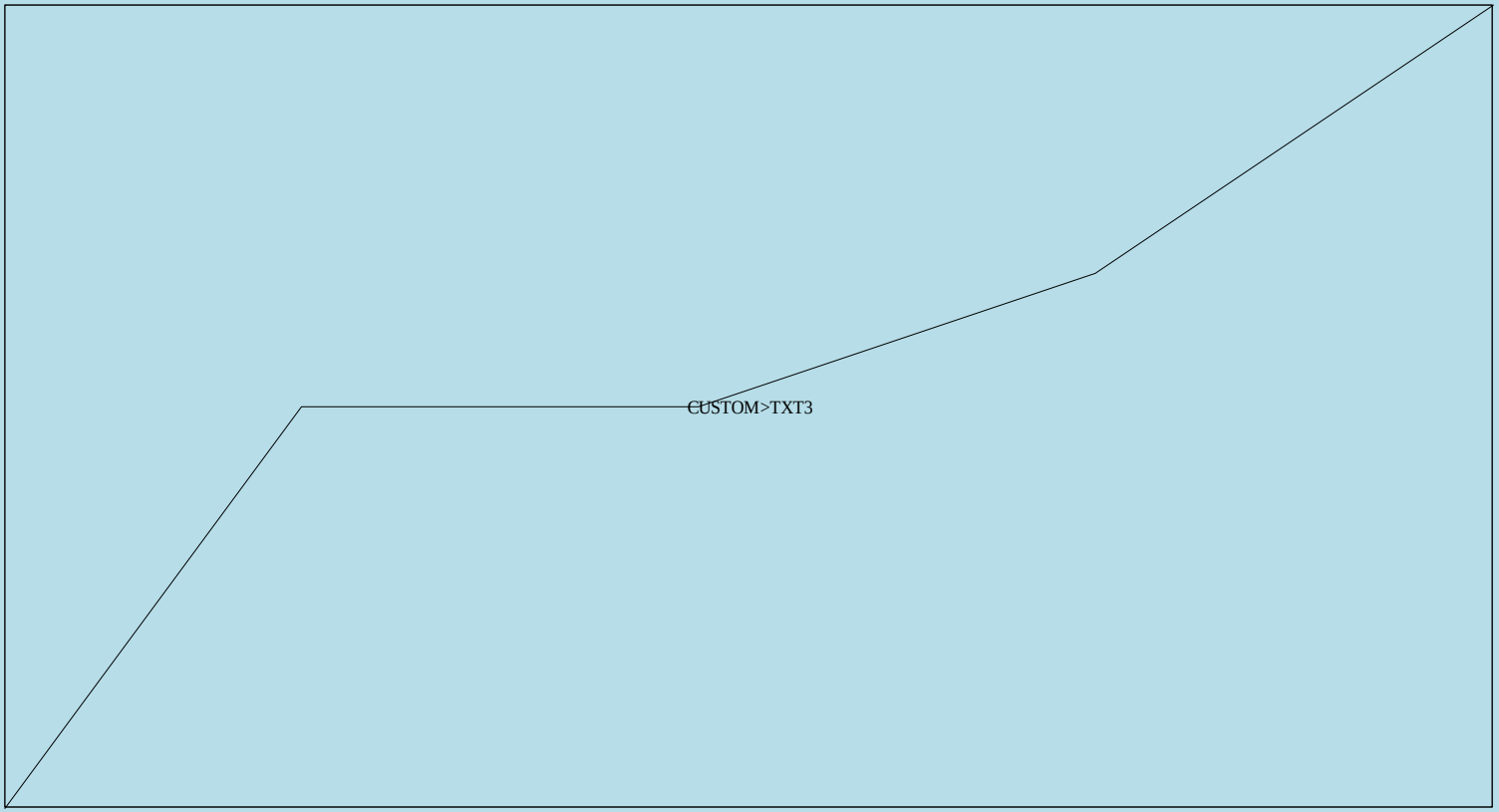
Help Screen

Travel Demand Management Policy Analysis

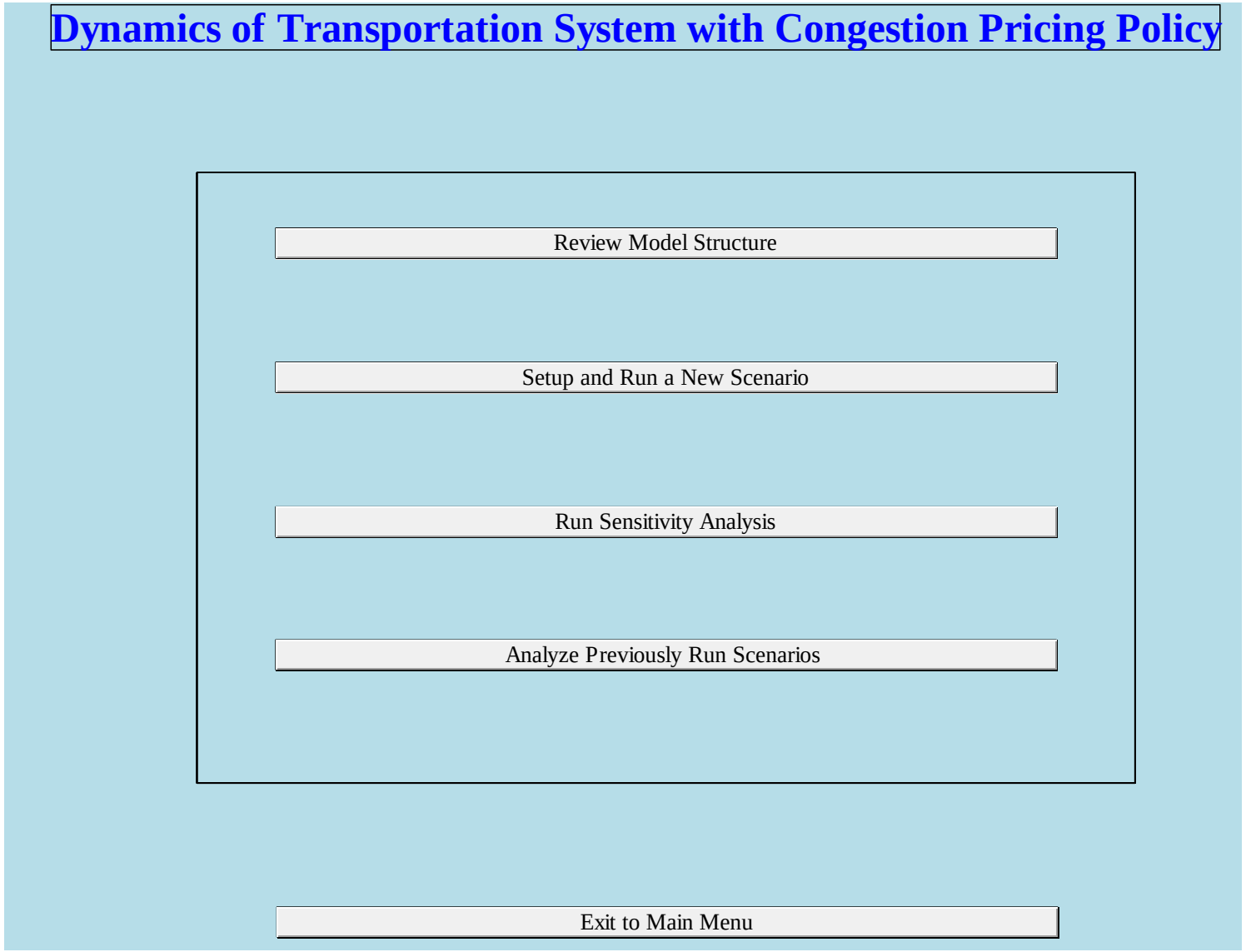
Press Any Key to Return to Main Menu

Esc to Return to Main Menu

Scroll Down to Read More Text



Congestion Pricing Policy First Screen



Major Feature of Application

Major Features of Two Models

Run Scenarios

Run Scenarios Using Different Assumptions and Policy Choices

Sensitivity Analysis

Perform Monte Carlo Multivariate Sensitivity Analysis

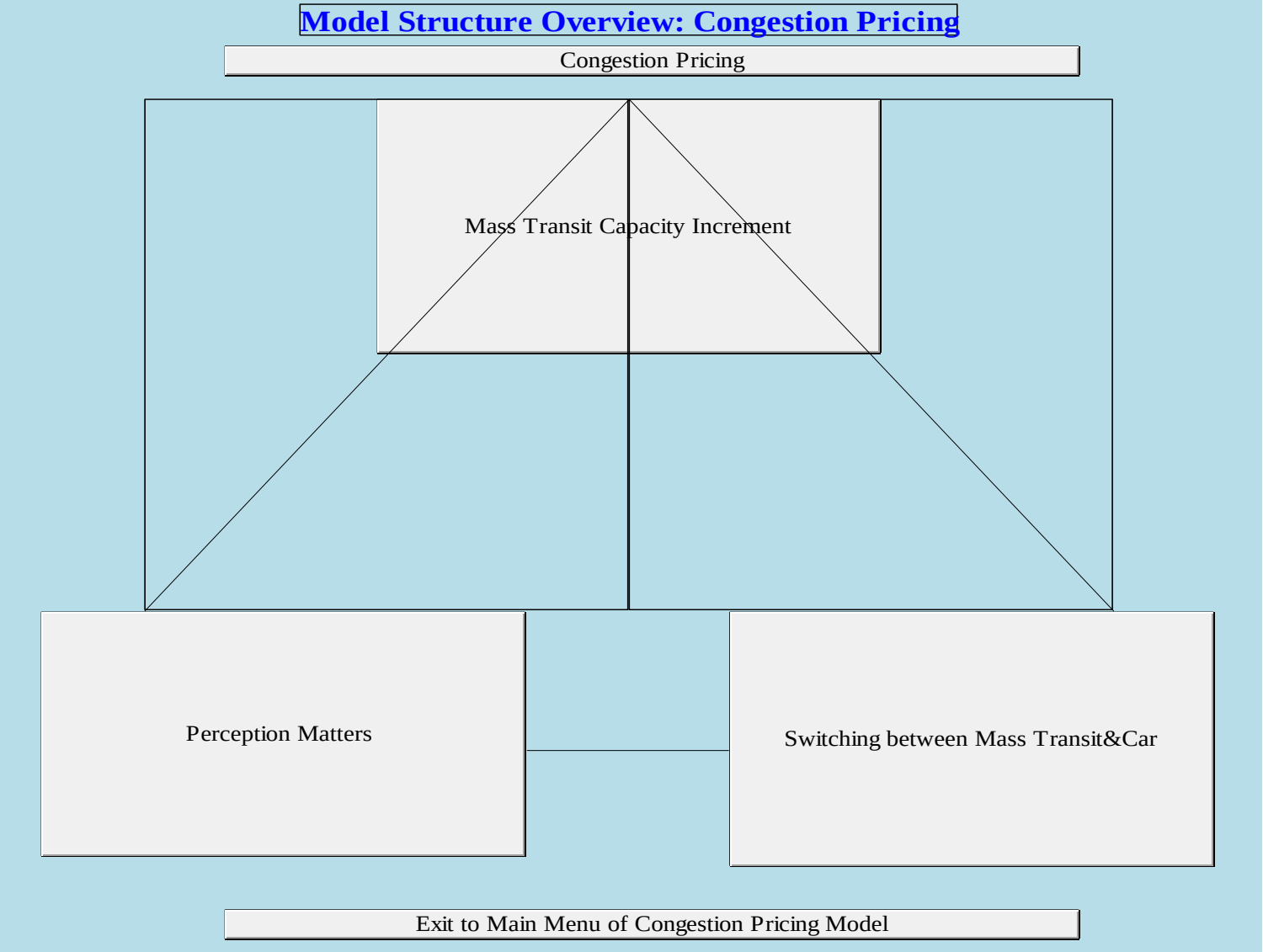
Choose Different Parameter Values

Analysis Scenarios

Use Causal Tracing and Other Analysis Tools

Go To Congestion Pricing Model

Model Structure Screen



Assumption and Policy Screen

Scenairo Assumptions and Policies

Assumptions for Scenario

Policy Setting

Run Scenario

Exit to Main Menu

Assumption 1 Screen

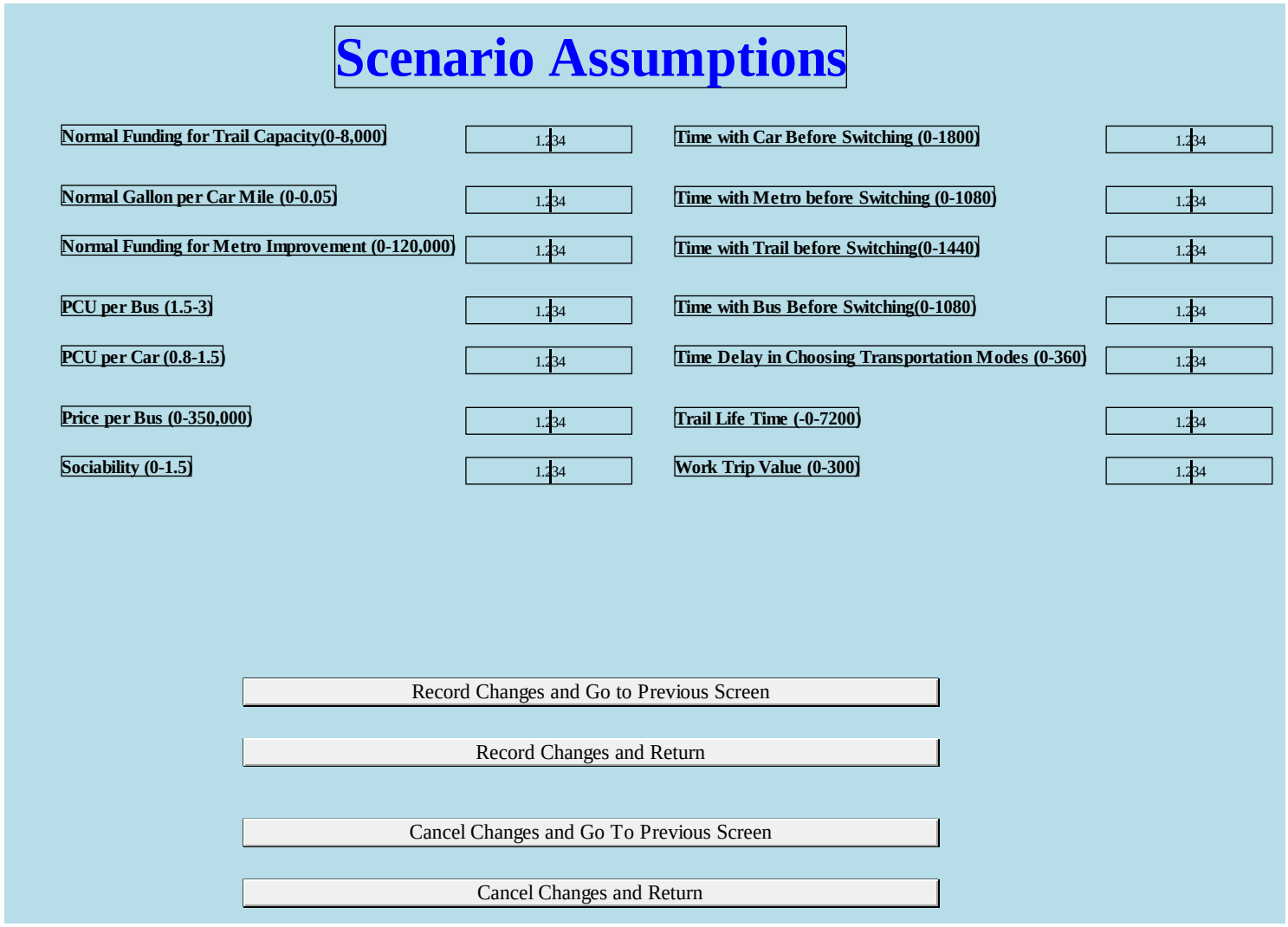
Scenario Assumptions

Average Passenger per Bus per Hour (0-80)	1.234	Fraction of Work Trip by Car (0-0.7)	1.234
Average Passenger per Metro Car per Hour(0-200)	1.234	Fraction of Work Trip by Metro (0-0.7)	1.234
Average Time Keeing Using Bus (0-3,600)	1.234	Fraction of Work Trip by Bus (0-0.75)	1.234
Average Time Keeping Using Car (0-5,400)	1.234	Fraction of Work Trip by Trail (0-0.75)	1.234
Average Time Keeping Using Metro (0-3,600)	1.234	Fraction of Work Trip Budget (0-0.2)	1.234
Average Time Keeping Using Trail (0-1440)	1.234	Fraction of Local Resident(0-0.5)	1.234
Average Passenger Flow Rate for Trail (0-50)	1.234	Fraction of Disabled People (0-0.01)	1.234
Average Trip Miles (0-40)	1.234	Fruitfulness of Incurring Mobility(0-0.0008)	1.234
Bus Life Time (0-5400)	1.234	Fuel Price per Gallon(0-3.5)	1.234
Carpool Mulplier (1-1.5)	1.234	Insurance Premium per Day(0-3)	1.234
Cost per Metro Car (0-1,500,000)	1.234	Maintenance Expenditure per Mile (0-0.04)	1.234
Cost per Trail Mile(0-100,000)	1.234	Metro Car Life Time (0-10800)	1.234
Employment Increment (0-10)	1.234	Normal Funding for Bus Improvment (0-80,000)	1.234

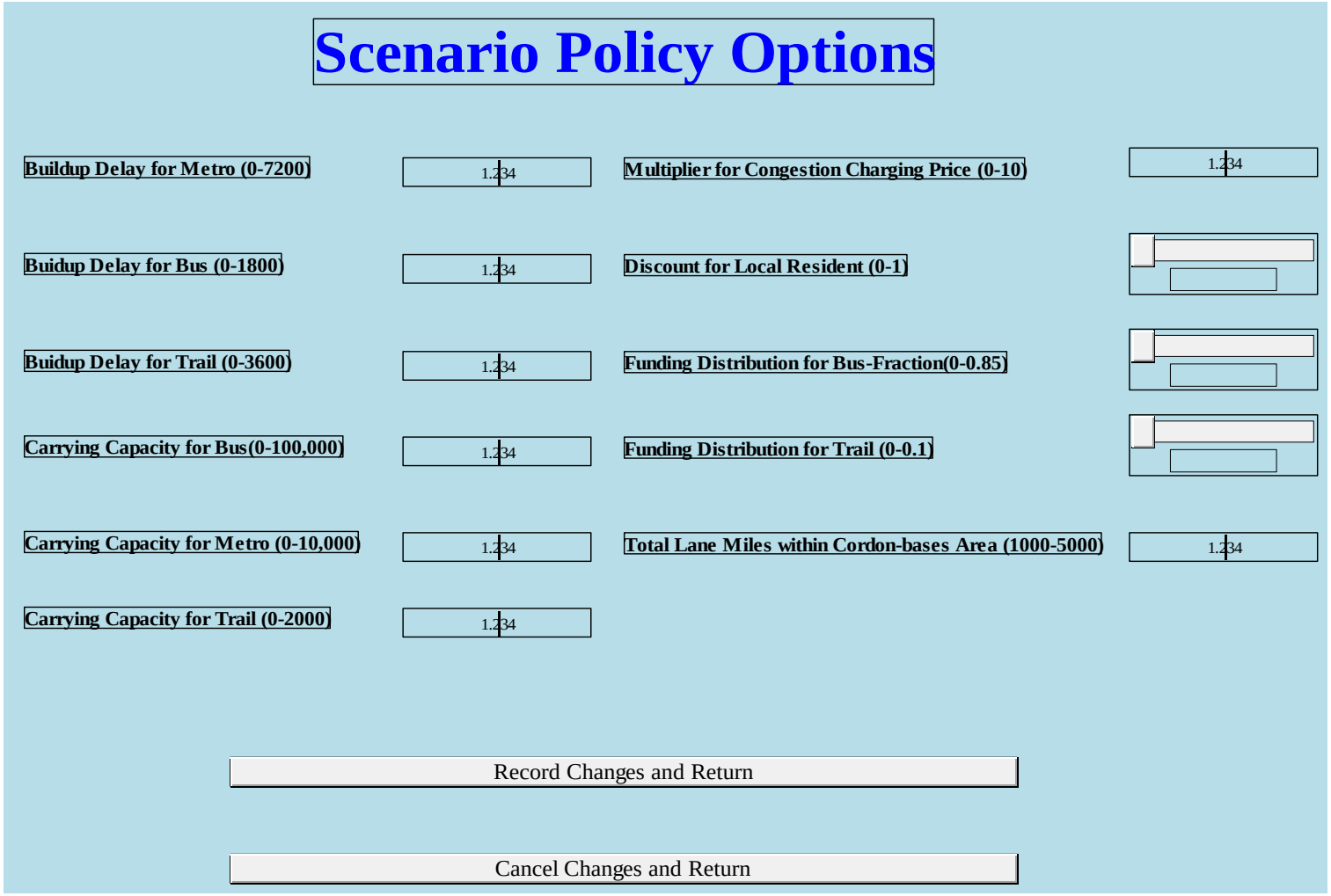
Record Changes and Go to Next Screen

Cancel Changes and Return

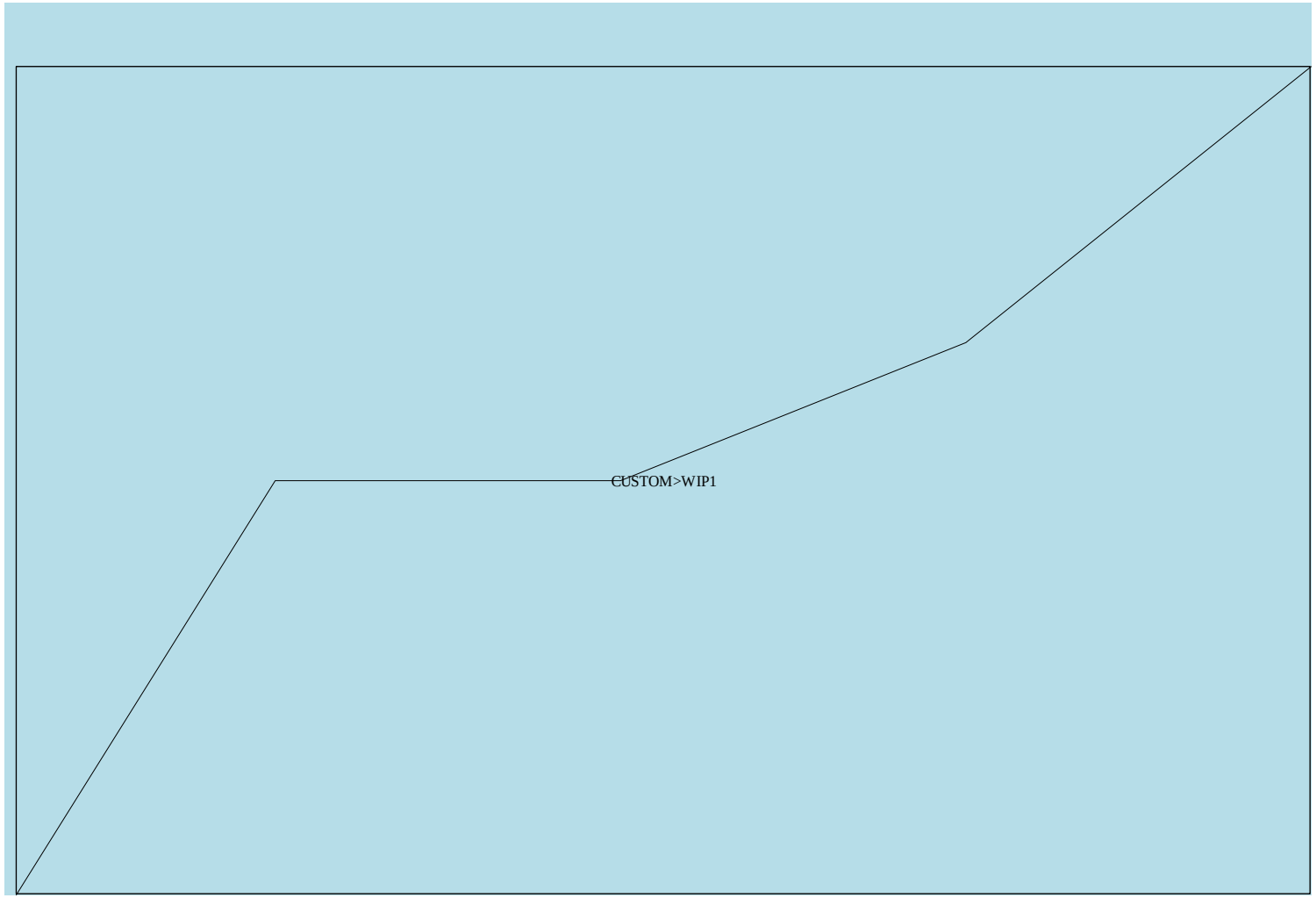
Assumption 1 Screen



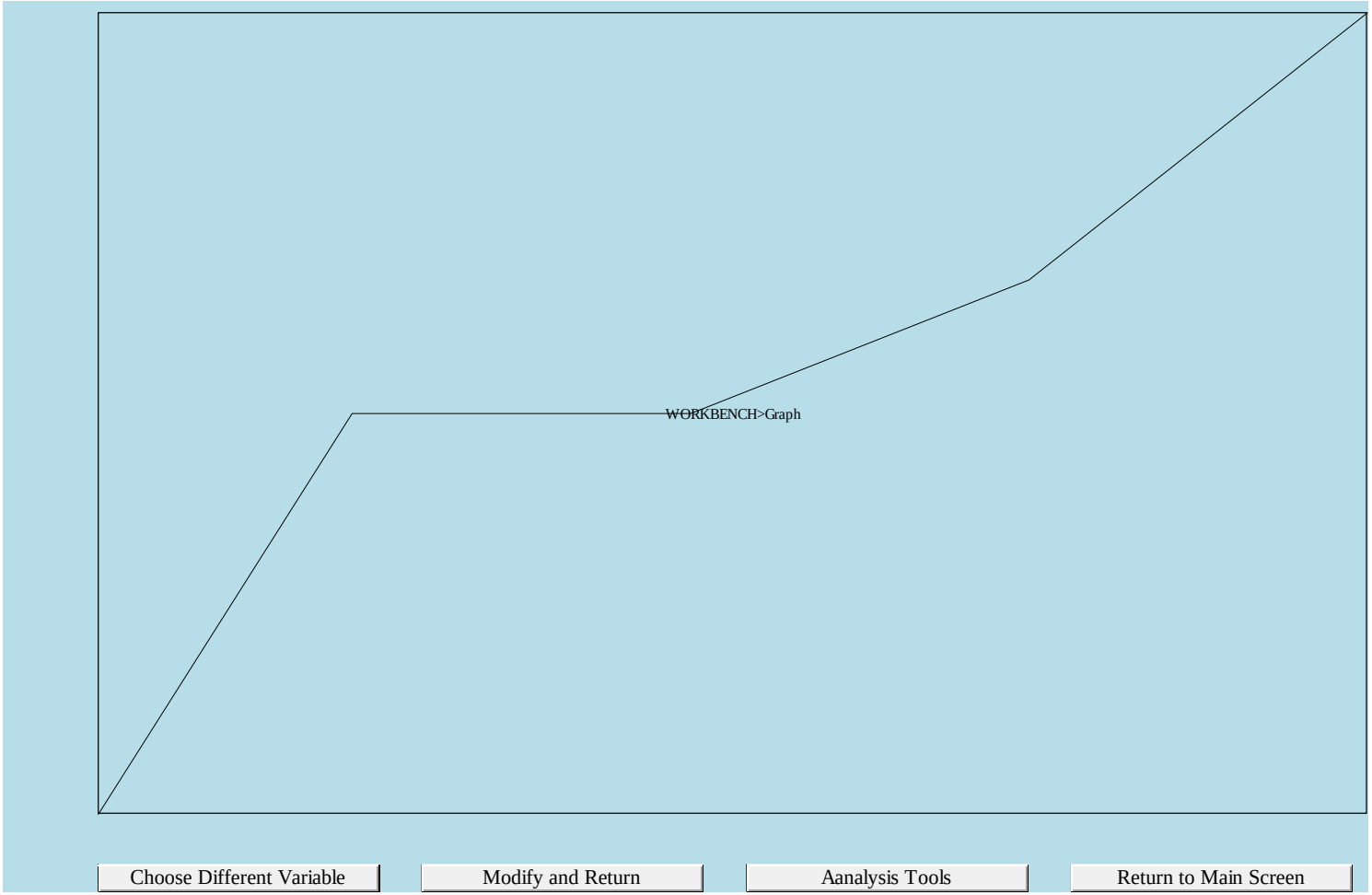
Policy Screen



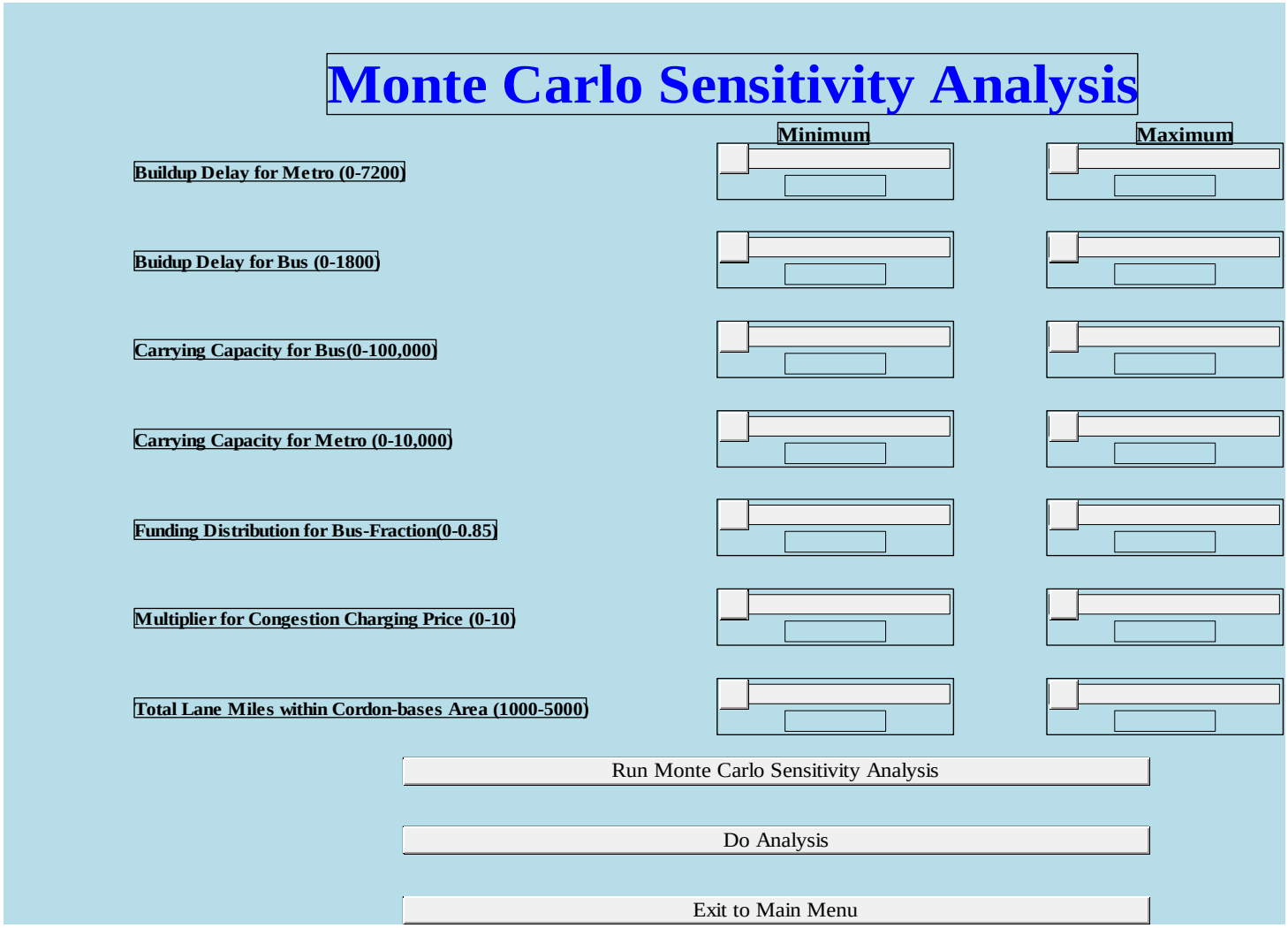
Run Scenario Screen



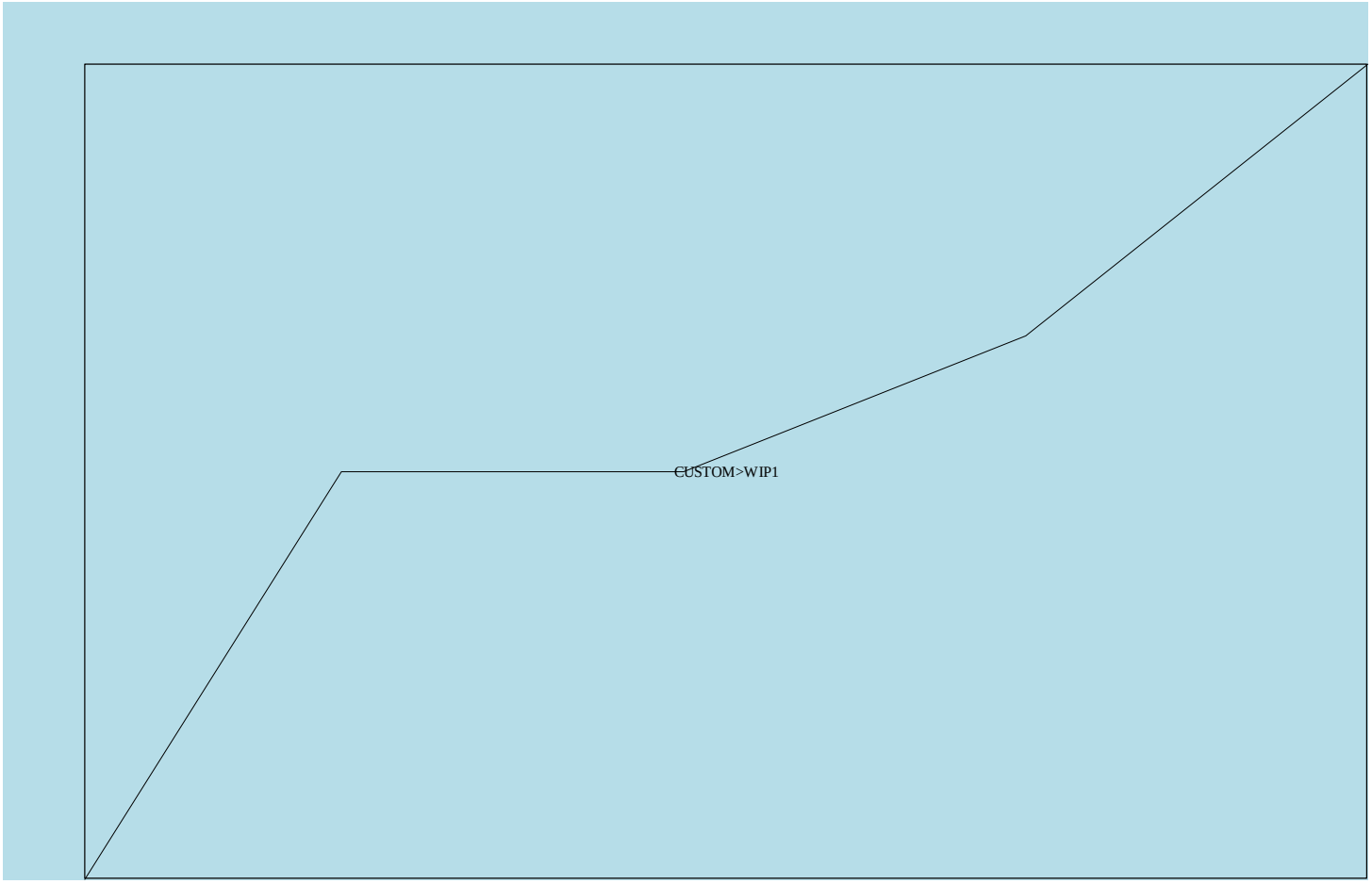
Behavior Display Screen



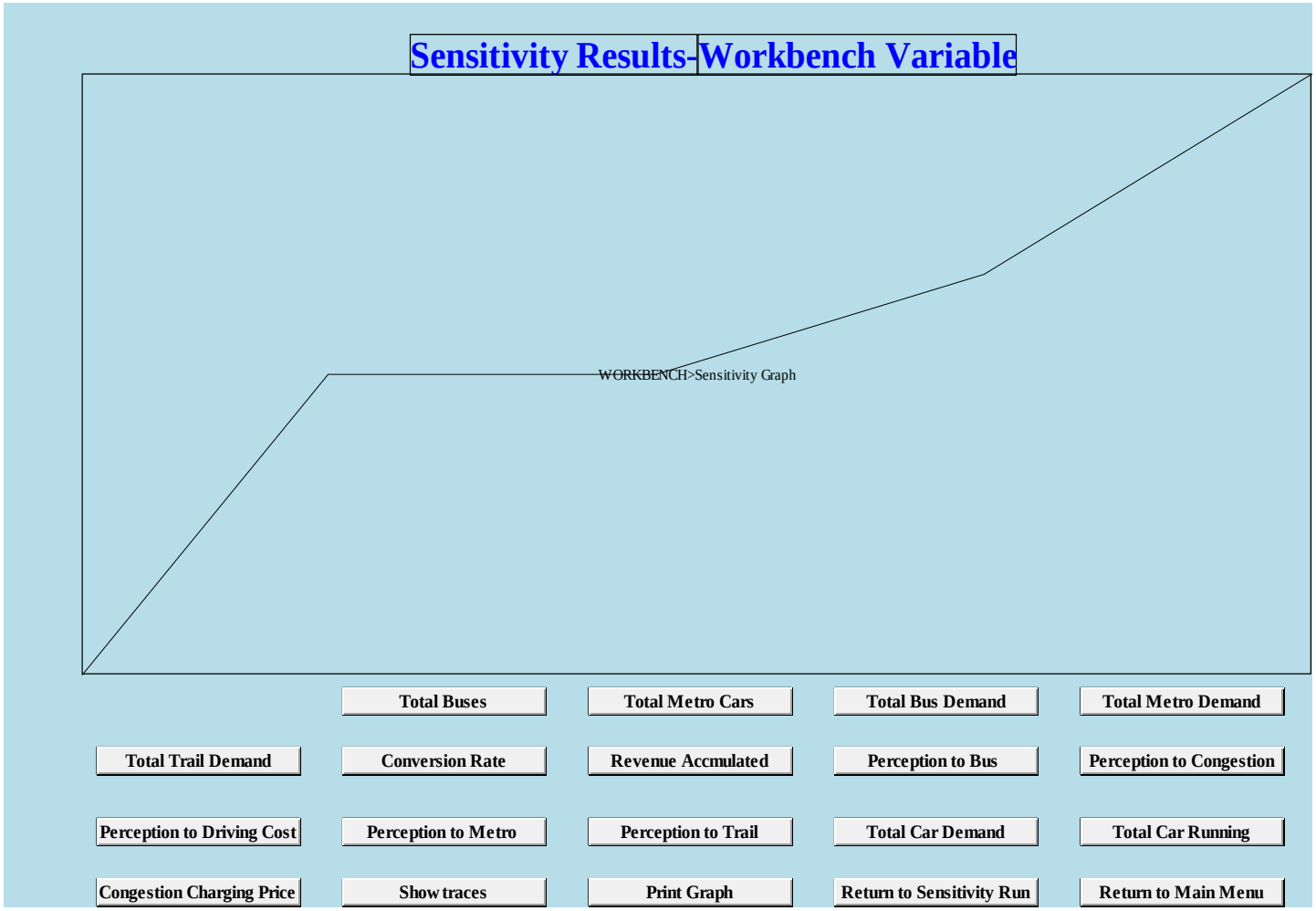
Setup for Sensitivity Analysis Screen



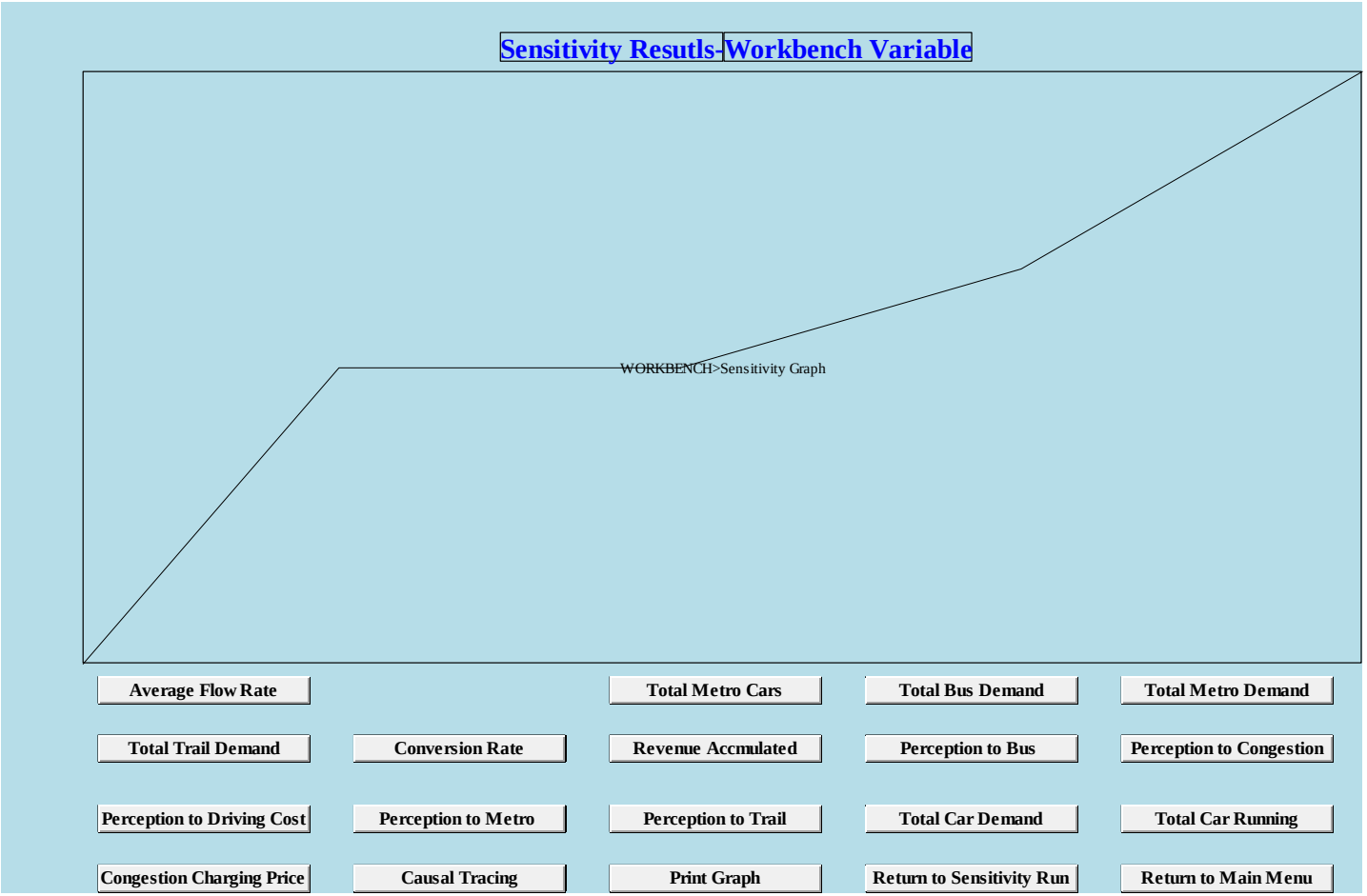
Run Sensitivity Screen



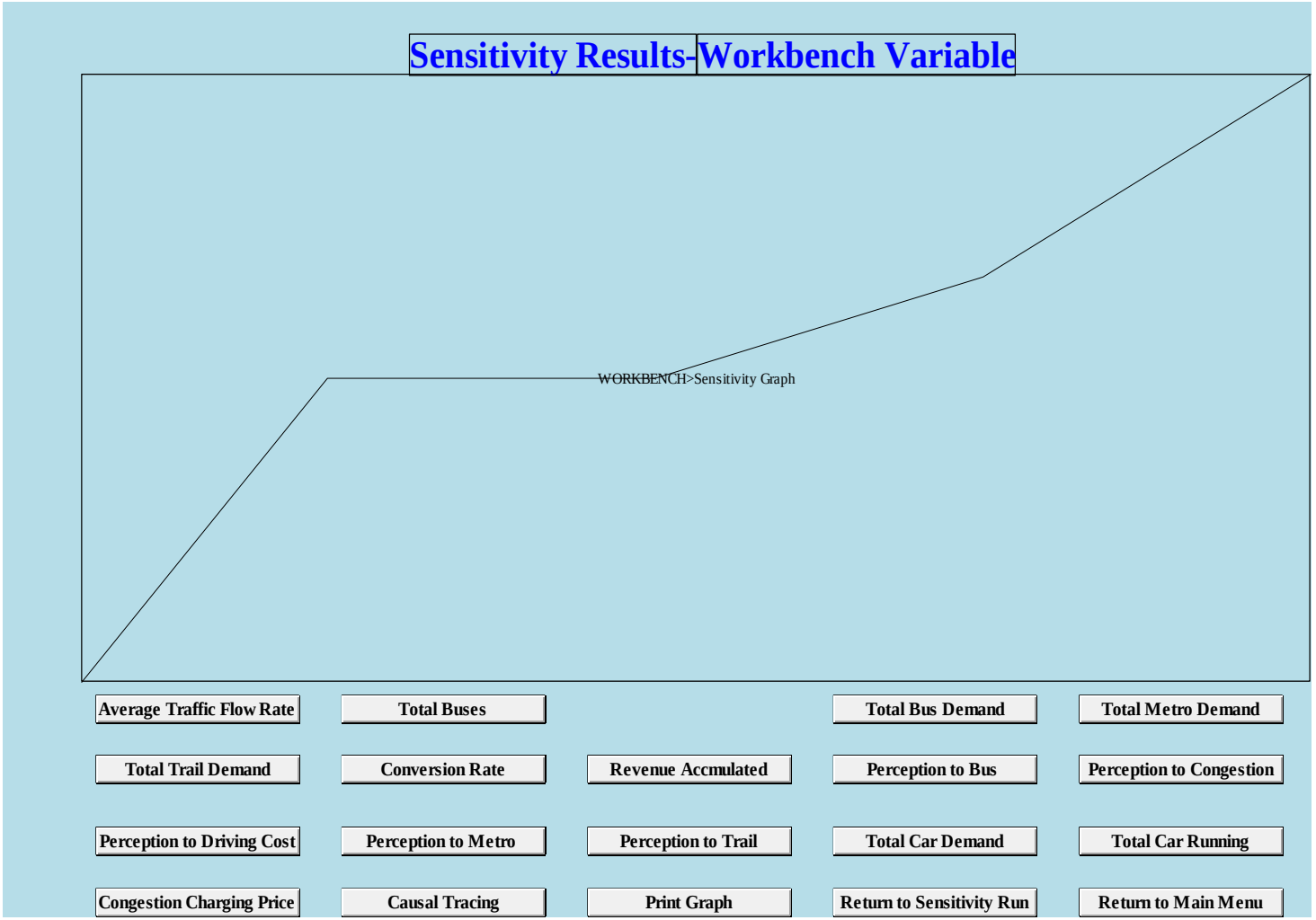
Sensitivity Result 1 Screen



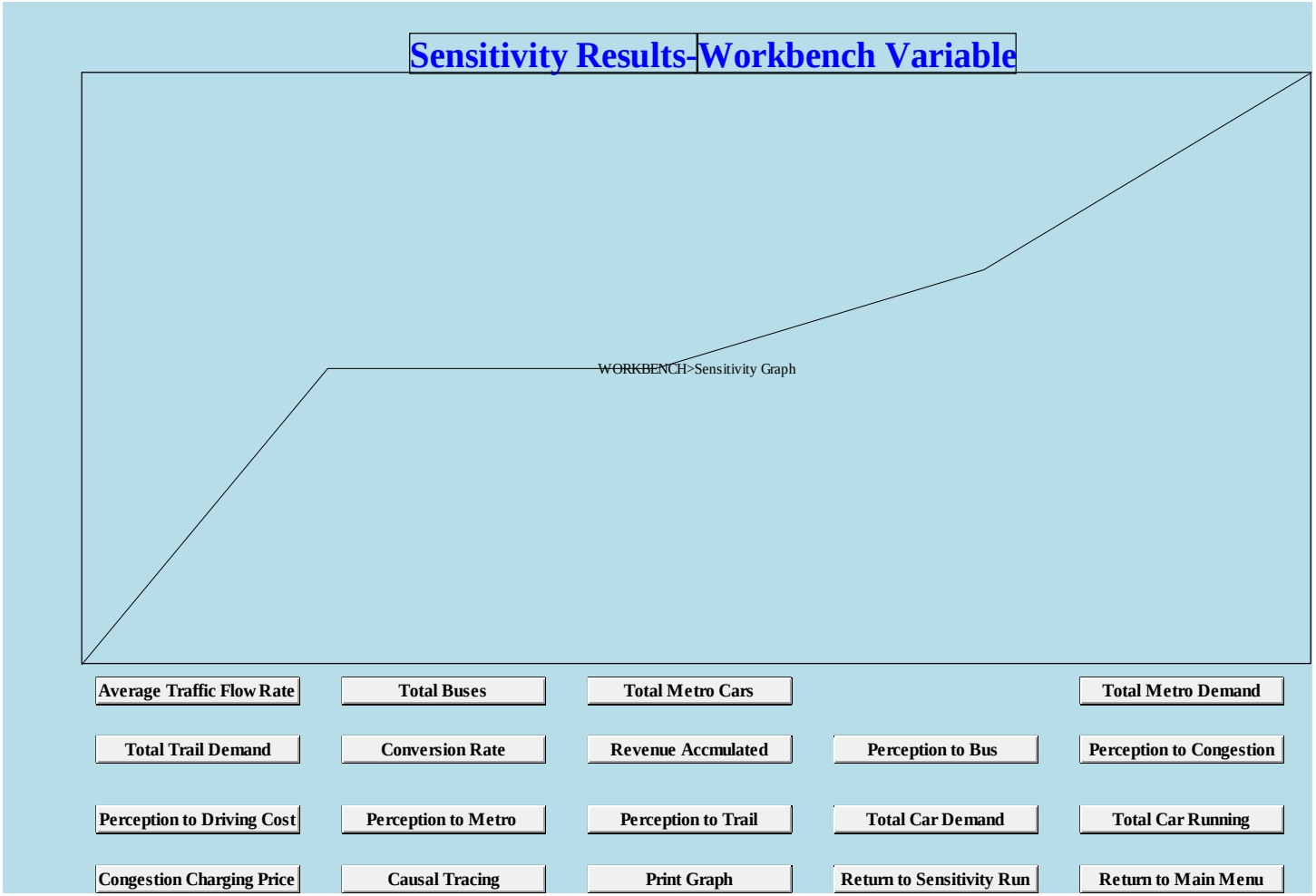
Sensitivity Result 2 Screen



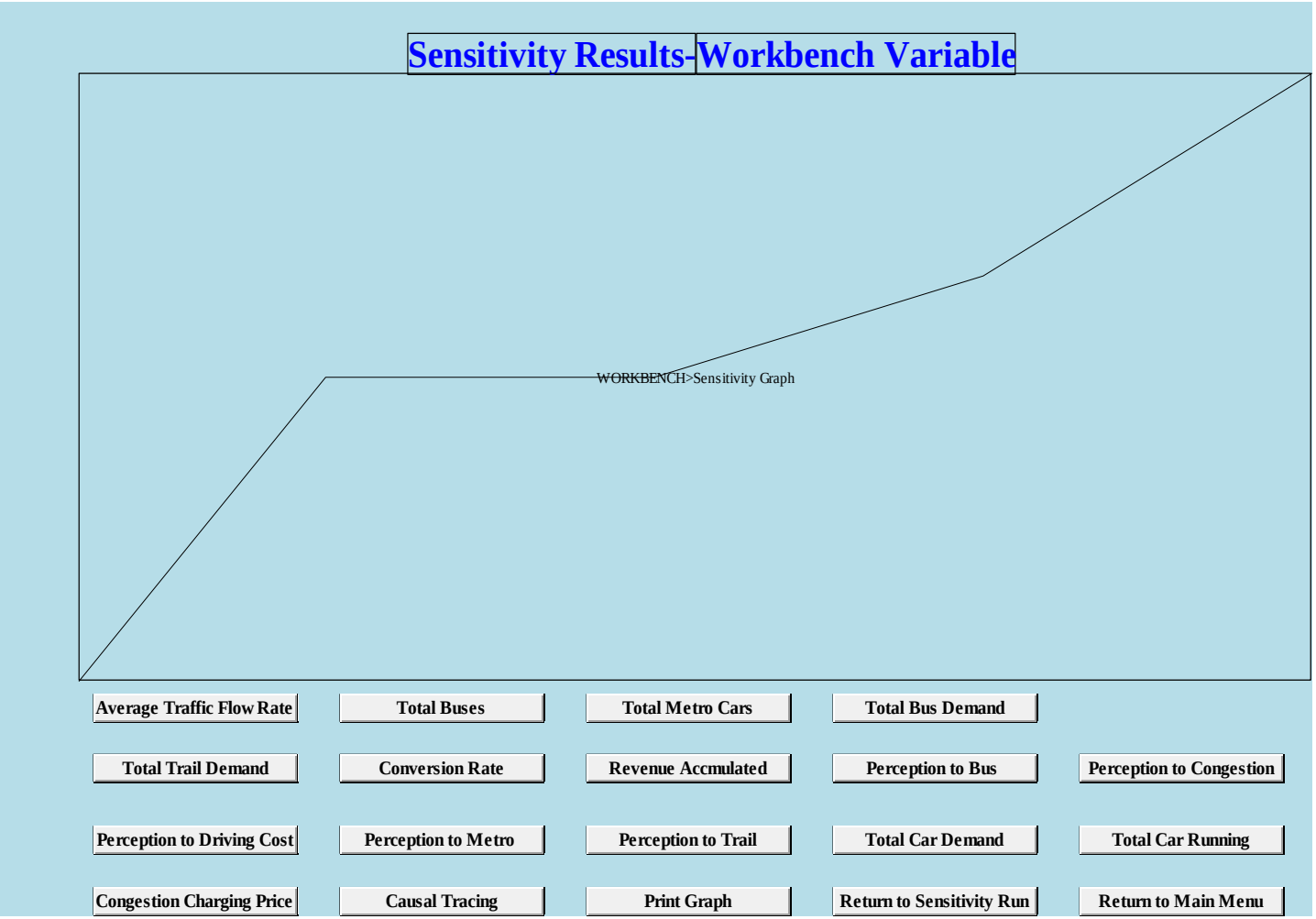
Sensitivity Result 3 Screen



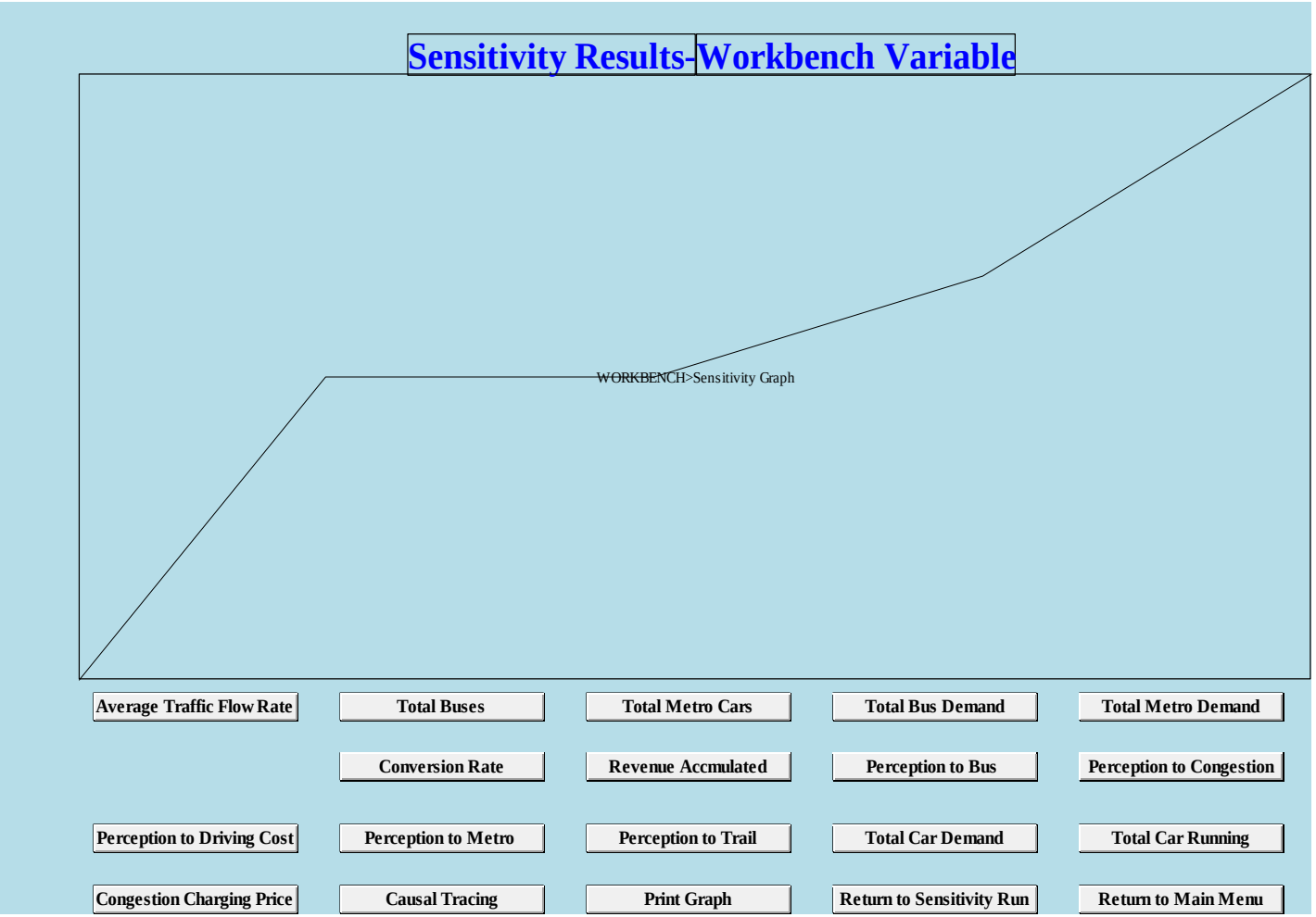
Sensitivity Result 4 Screen



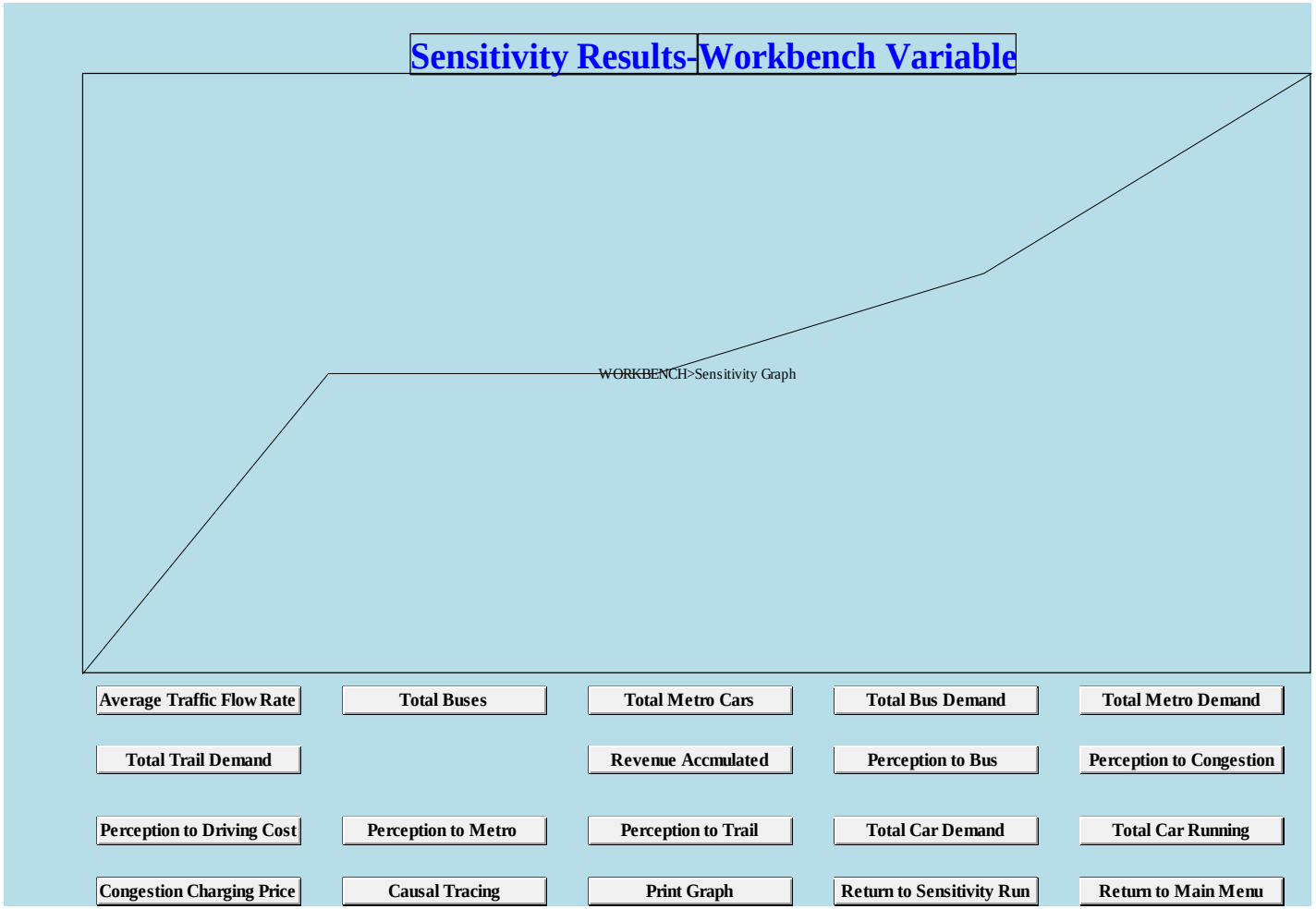
Sensitivity Result 5 Screen



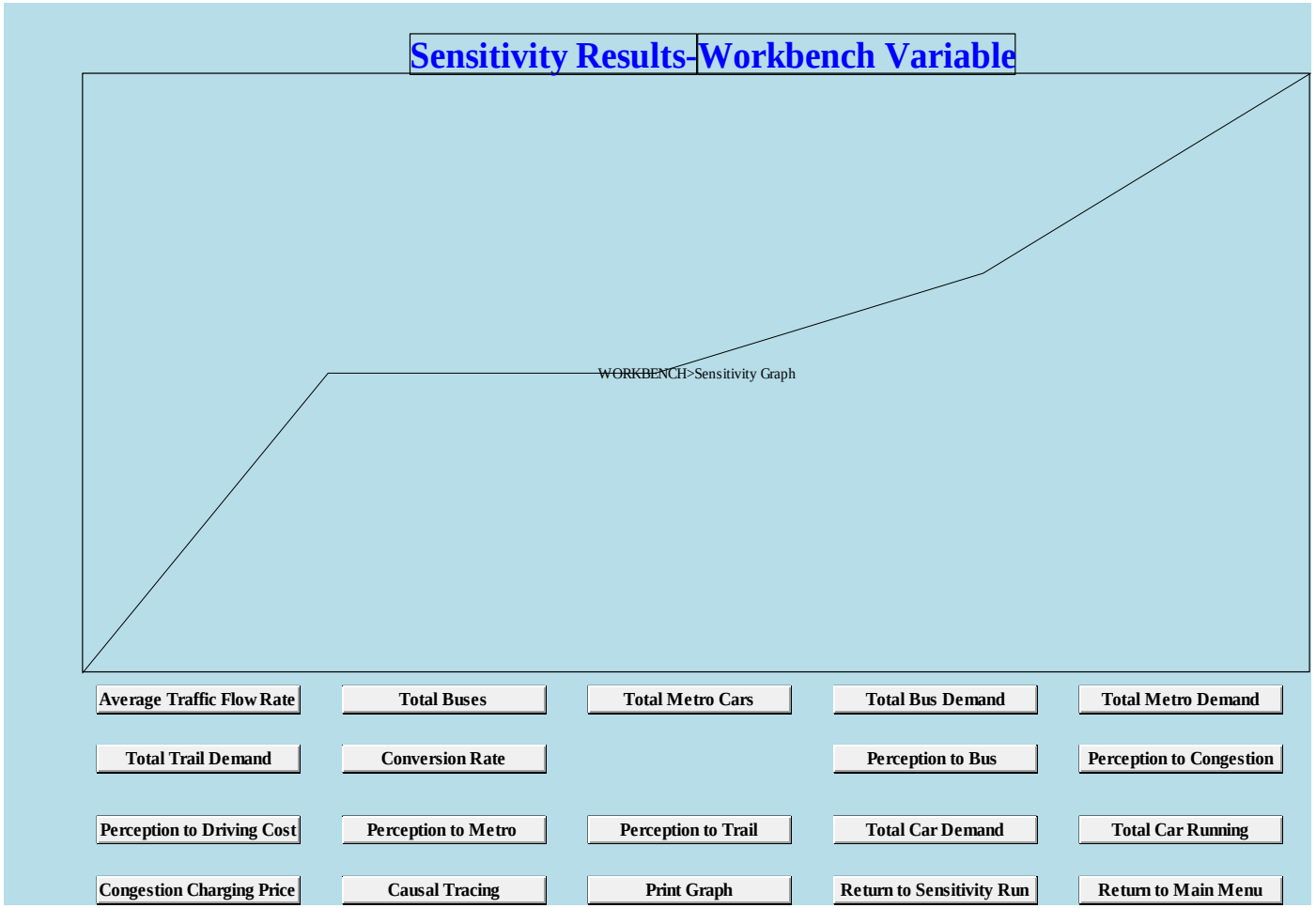
Sensitivity Result 6 Screen



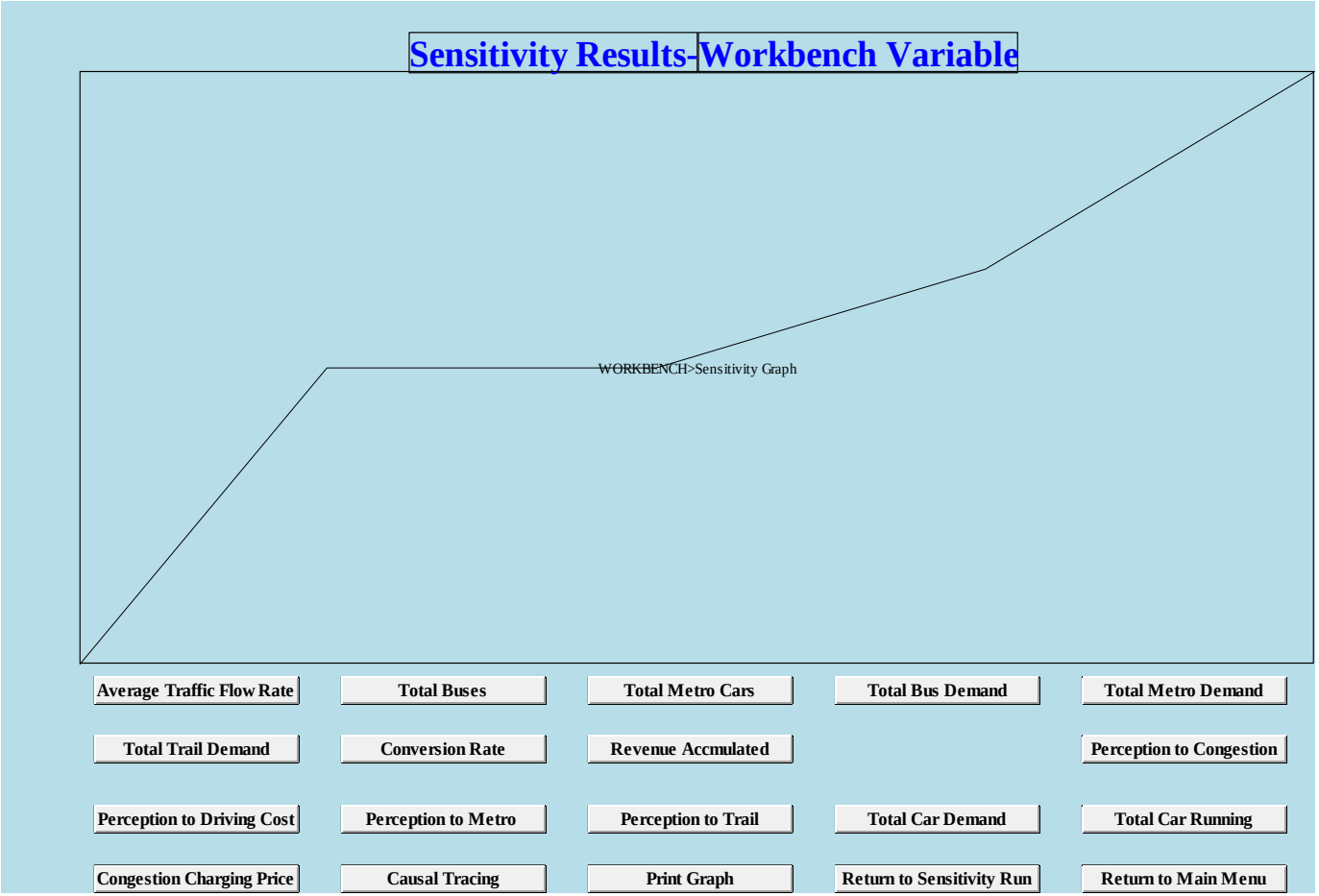
Sensitivity Result 7 Screen



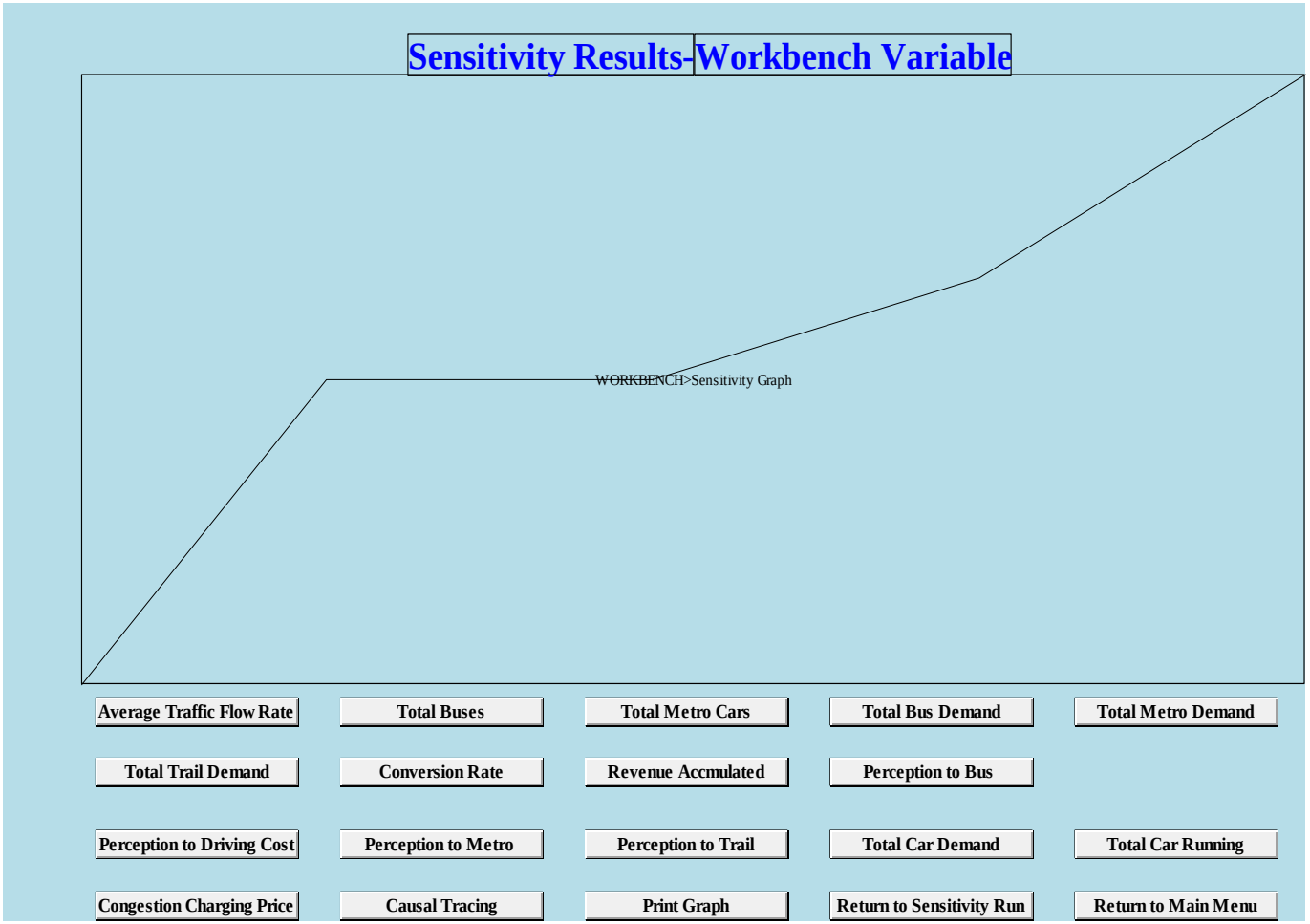
Sensitivity Result 8 Screen



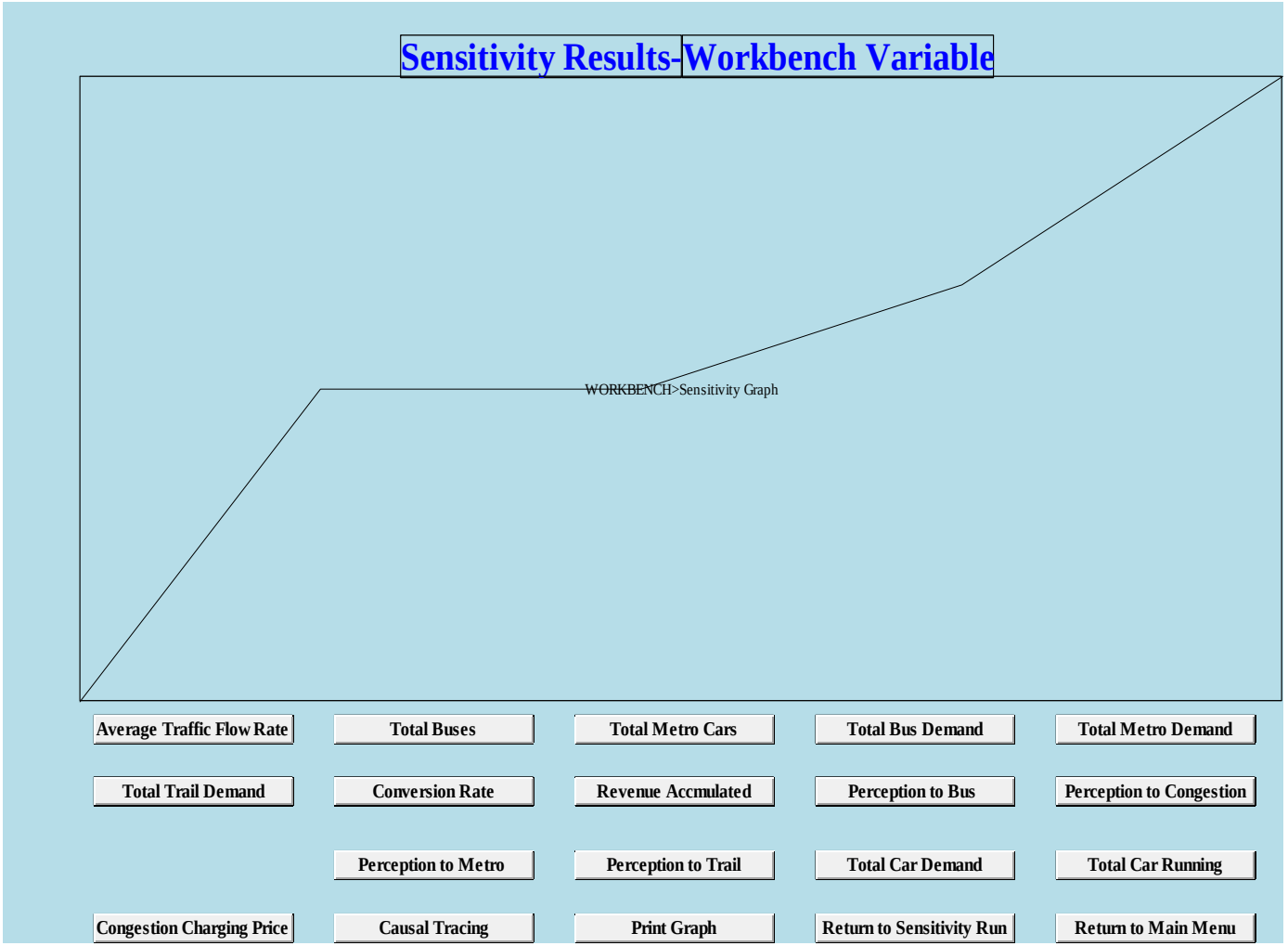
Sensitivity Result 9 Screen



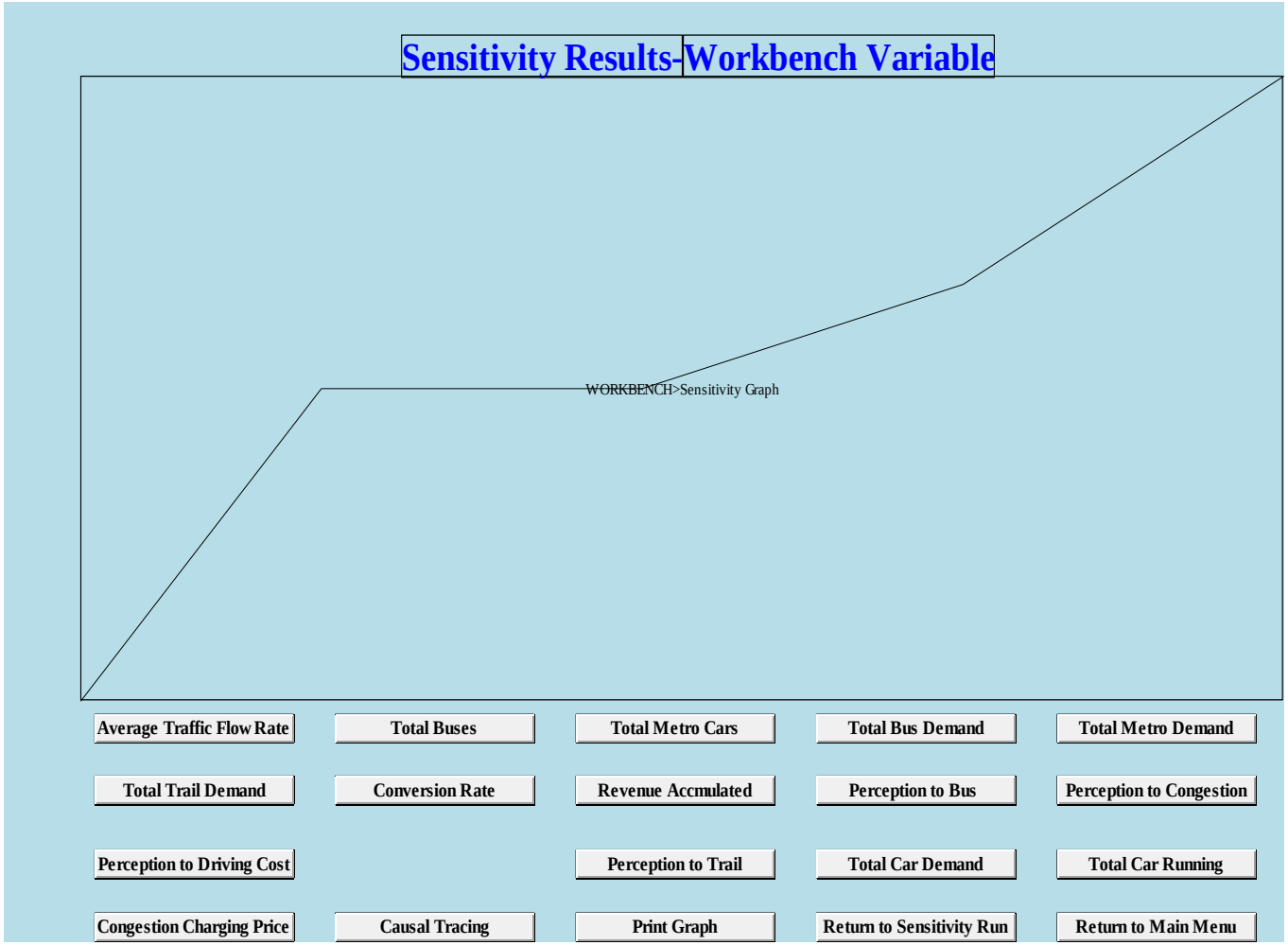
Sensitivity Result 10 Screen



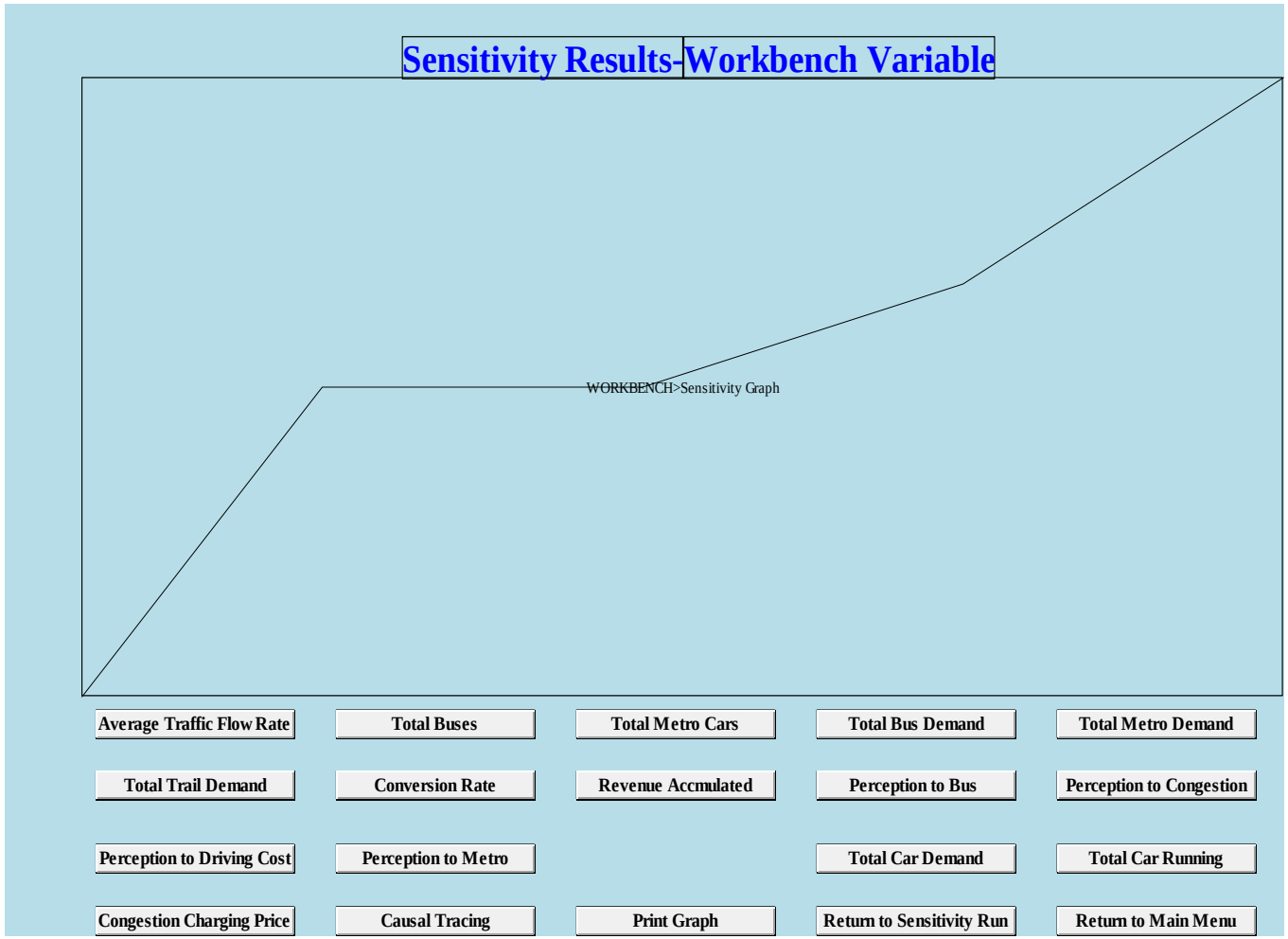
Sensitivity Result 11 Screen



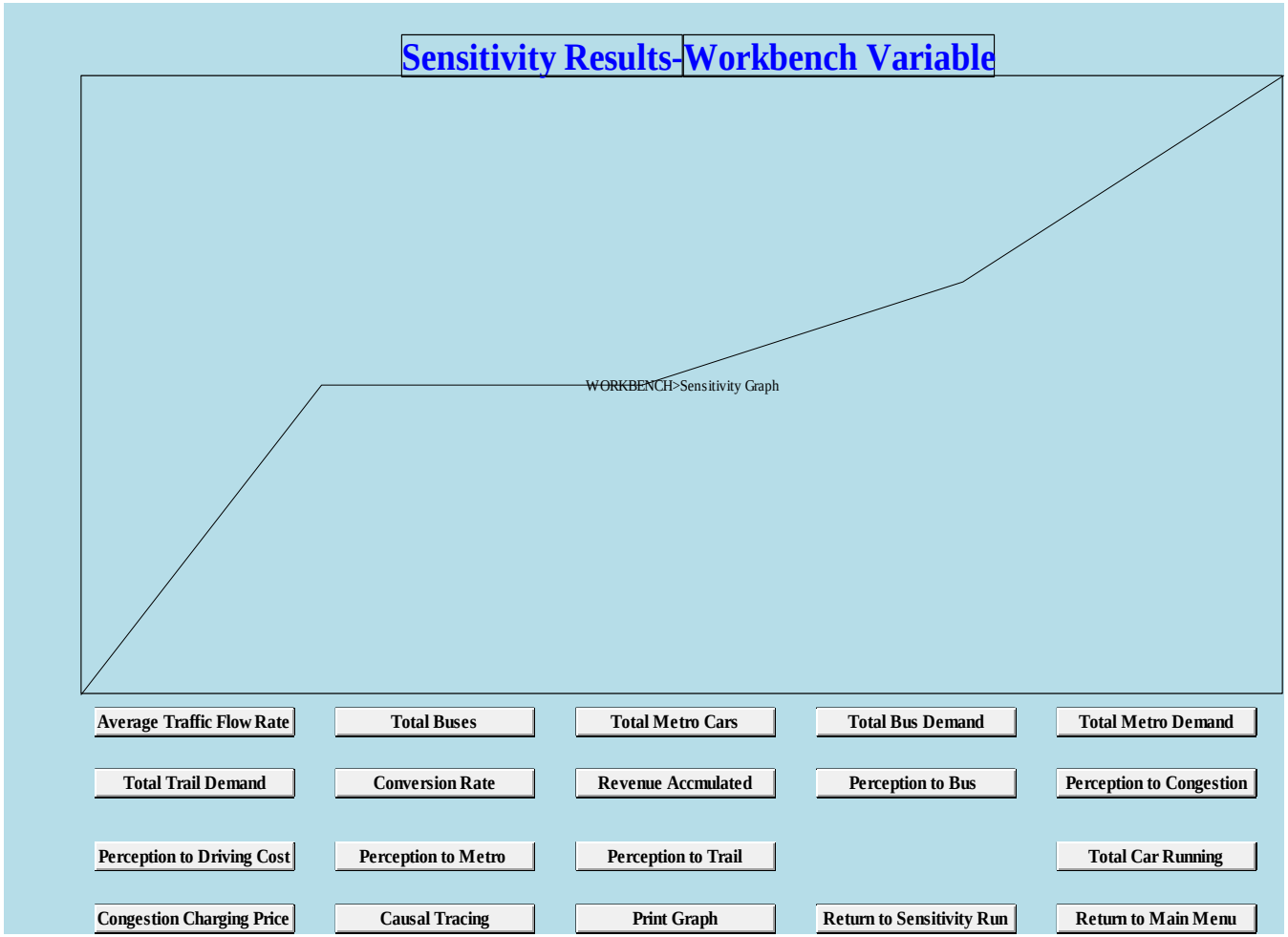
Sensitivity Result 12 Screen



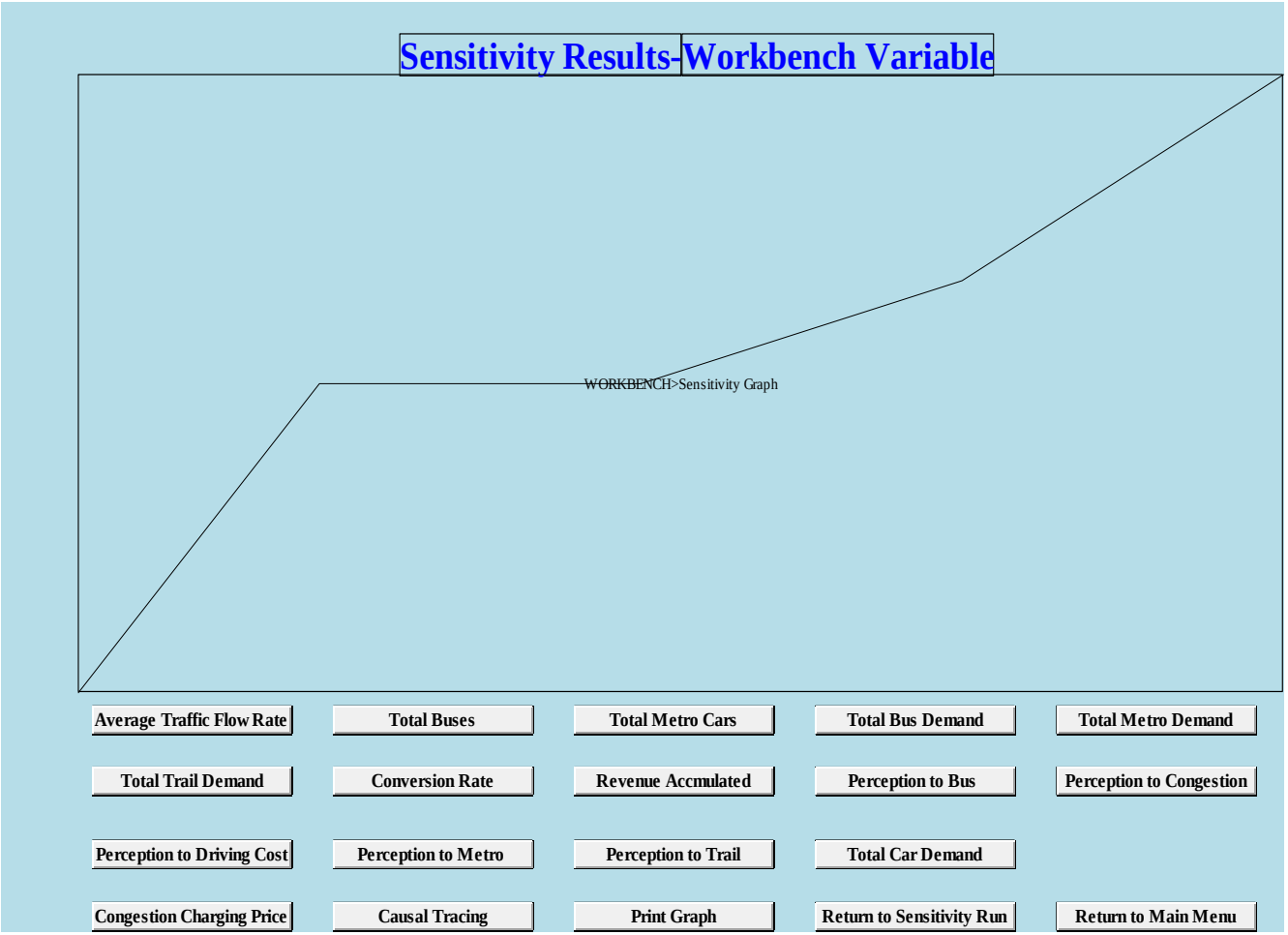
Sensitivity Result 13 Screen



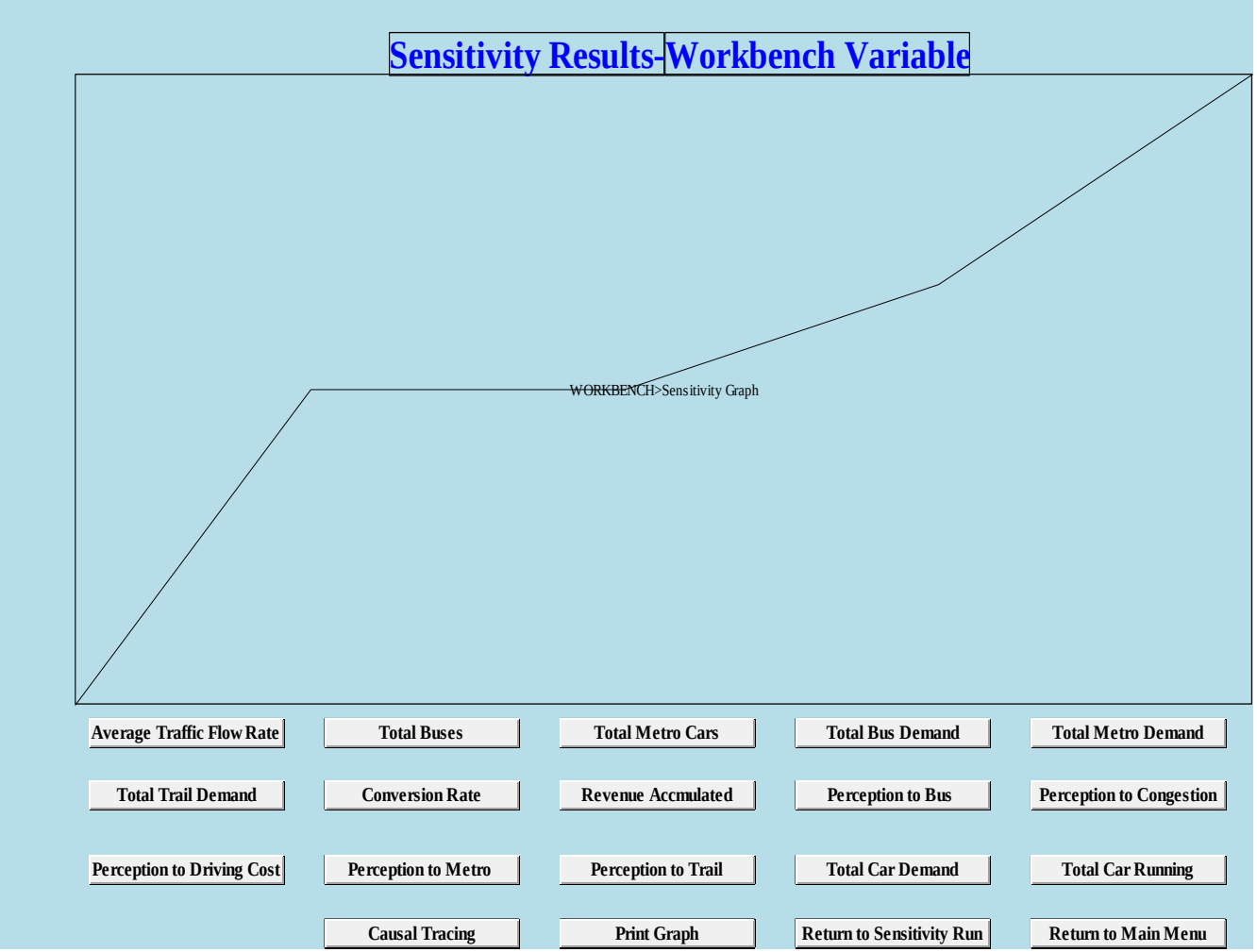
Sensitivity Result 14 Screen



Sensitivity Result 15 Screen



Sensitivity Result 16 Screen



Analysis Control Screen

Analysis Control

Load, Unload and Reorder Previously Run Scenarios

List the Differences between the First Two Loaded Scenarios

Results

Summary for Recently Run Scenario (First Loaded)

Summary for the Comparison of Loaded Scenarios

Causal Tracing

Choose a Variable as a Start Point for Further Analysis

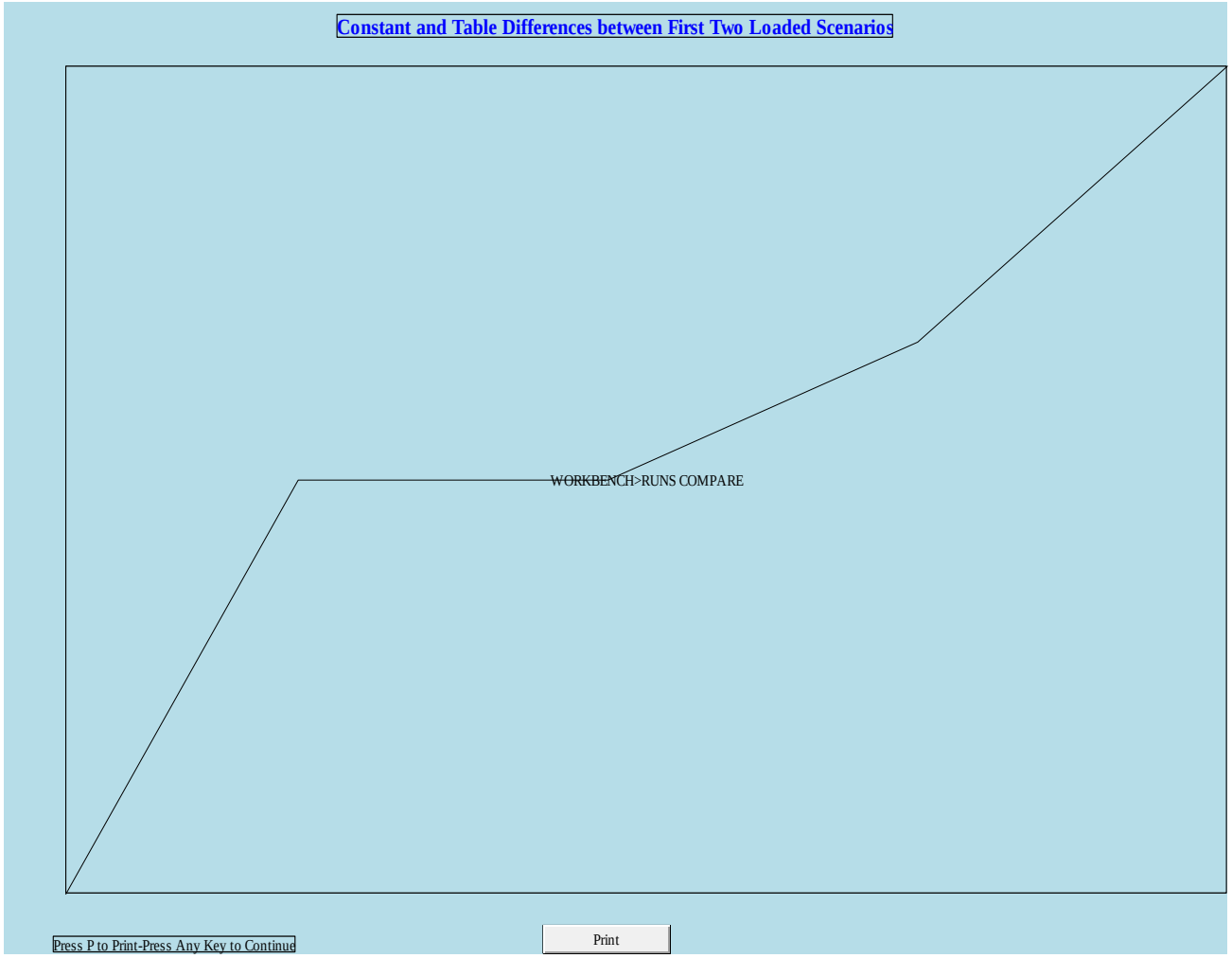
Trace Underlying Causes Using Trees

Trace Underlying Causes Using Graphs

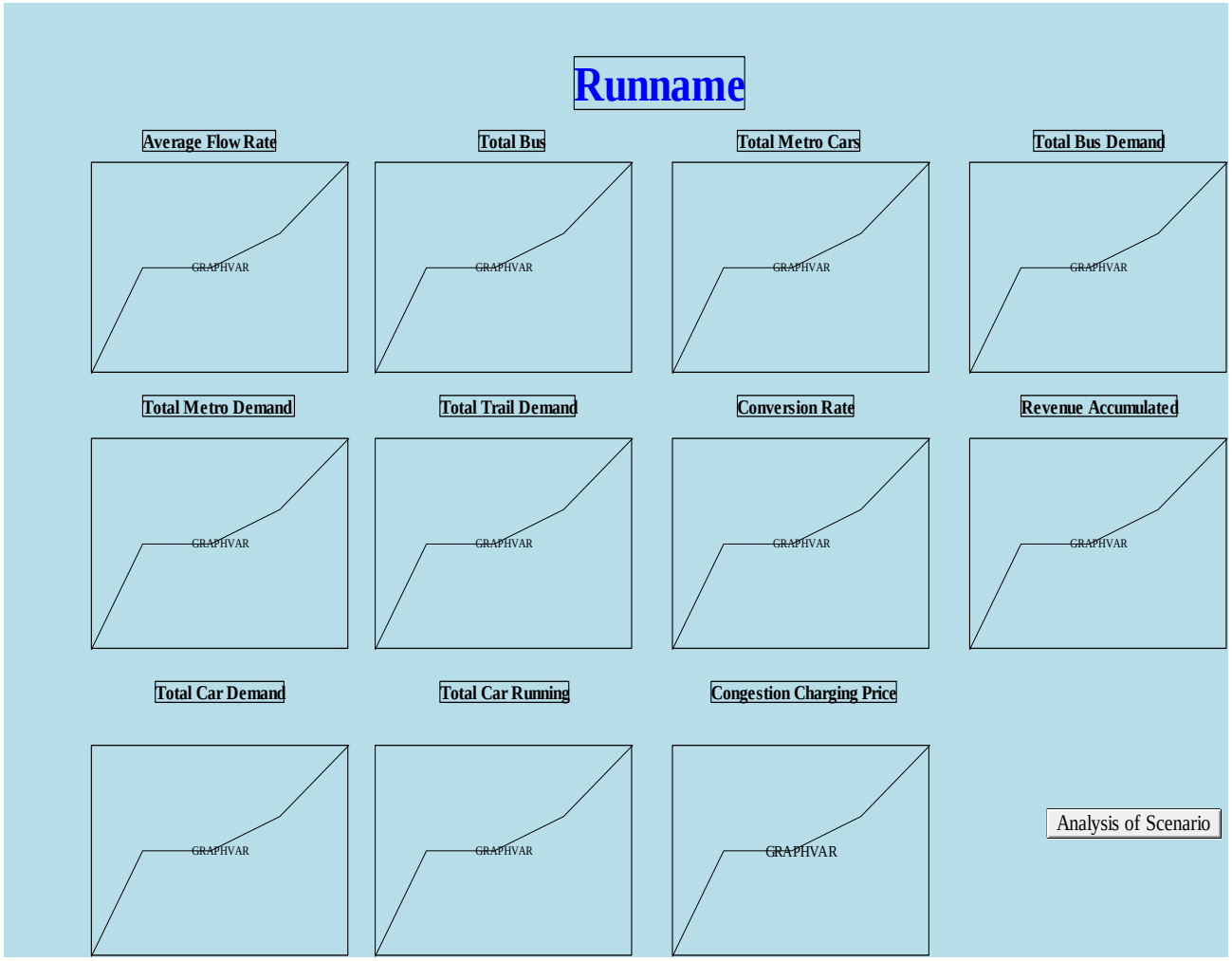
Trace the Use of a Variable

Return to Main Menu

Difference of Two Loaded Scenarios



Simulation Result Screen



Comparison of Parameter Setting Screen1

Assumptions	Runname	Runname	Runname	Runname	Runname
Average Passenger per Bus per Hour (0-80)	1.234	1.234	1.234	1.234	1.234
Average Passenger per Metro Car per Hour(0-200)	1.234	1.234	1.234	1.234	1.234
Average Time Keeing Using Bus (0-3,600)	1.234	1.234	1.234	1.234	1.234
Average Time Keeping Using Car (0-5,400)	1.234	1.234	1.234	1.234	1.234
Average Time Keeping Using Metro (0-3,600)	1.234	1.234	1.234	1.234	1.234
Average Time Keeping Using Trail (0-1440)	1.234	1.234	1.234	1.234	1.234
Average Passenger Flow Rate for Trail (0-50)	1.234	1.234	1.234	1.234	1.234
Average Trip Miles (0-40)	1.234	1.234	1.234	1.234	1.234
Bus Life Time (0-5400)	1.234	1.234	1.234	1.234	1.234
Carpool Mulplier (1-1.5)	1.234	1.234	1.234	1.234	1.234
Cost per Metro Car (0-1,500,000)	1.234	1.234	1.234	1.234	1.234
Cost per Trail Mile(0-100,000)	1.234	1.234	1.234	1.234	1.234
Employment Increment (0-10)	1.234	1.234	1.234	1.234	1.234
Fraction of Work Trip by Car (0-0.7)	1.234	1.234	1.234	1.234	1.234
Fraction of Work Trip by Metro (0-0.7)	1.234	1.234	1.234	1.234	1.234
Fraction of Work Trip by Bus (0-0.75)	1.234	1.234	1.234	1.234	1.234
Fraction of Work Trip by Trail (0-0.75)	1.234	1.234	1.234	1.234	1.234
Fraction of Work Trip Budget (0-0.2)	1.234	1.234	1.234	1.234	1.234
Fraction of Local Resident(0-0.5)	1.234	1.234	1.234	1.234	1.234
Fraction of Disabled People (0-0.01)	1.234	1.234	1.234	1.234	1.234
Fruitfulness of Incurring Mobility(0-0.0008)	1.234	1.234	1.234	1.234	1.234
Fuel Price per Gallon(0-3.5)	1.234	1.234	1.234	1.234	1.234
Insurance Premium per Day(0-3)	1.234	1.234	1.234	1.234	1.234
Maintenance Expenditure per Mile (0-0.04)	1.234	1.234	1.234	1.234	1.234
Metro Car Life Time (0-10800)	1.234	1.234	1.234	1.234	1.234

Press Any Key to Next Screen

Comparison of Parameter Setting Screen2

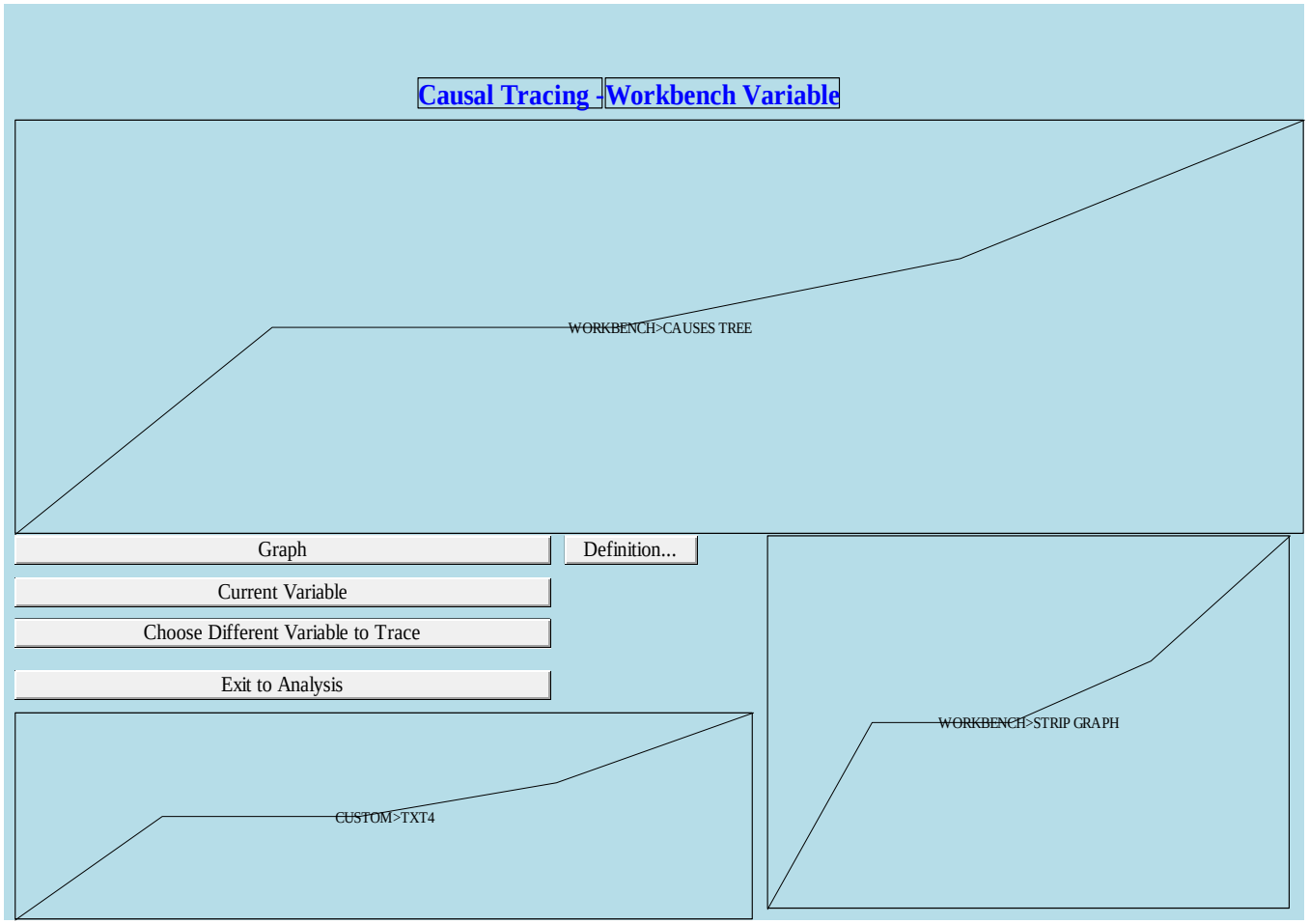
	Runname	Runname	Runname	Runname	Runname
Normal Funding for Bus Improvment (0-80,000)	1.234	1.234	1.234	1.234	1.234
Normal Funding for Trail Capacity(0-8,000)	1.234	1.234	1.234	1.234	1.234
Normal Gallon per Car Mile (0-0.05)	1.234	1.234	1.234	1.234	1.234
Normal Funding for Metro Improvement (0-120,000)	1.234	1.234	1.234	1.234	1.234
PCU per Bus (1.5-3)	1.234	1.234	1.234	1.234	1.234
PCU per Car (0.8-1.5)	1.234	1.234	1.234	1.234	1.234
Price per Bus (0-350,000)	1.234	1.234	1.234	1.234	1.234
Sociability (0-1.5)	1.234	1.234	1.234	1.234	1.234
Time with Car Before Switching (0-1800)	1.234	1.234	1.234	1.234	1.234
Time with Metro before Switching (0-1080)	1.234	1.234	1.234	1.234	1.234
Time with Trail before Switching(0-1440)	1.234	1.234	1.234	1.234	1.234
Time with Bus Before Switching(0-1080)	1.234	1.234	1.234	1.234	1.234
Time Delay in Choosing Transportation Modes (0-360)	1.234	1.234	1.234	1.234	1.234
Trail Life Time (-0-7200)	1.234	1.234	1.234	1.234	1.234
Work Trip Value (0-300)	1.234	1.234	1.234	1.234	1.234
Policies					
Buildup Delay for Metro (0-7200)	1.234	1.234	1.234	1.234	1.234
Buidup Delay for Bus (0-1800)	1.234	1.234	1.234	1.234	1.234
Buidup Delay for Trail (0-3600)	1.234	1.234	1.234	1.234	1.234
Carrying Capacity for Bus(0-100,000)	1.234	1.234	1.234	1.234	1.234
Carrying Capacity for Metro (0-10,000)	1.234	1.234	1.234	1.234	1.234
Carrying Capacity for Trail (0-2000)	1.234	1.234	1.234	1.234	1.234
Multiplier for Congestion Charging Price (0-10)	1.234	1.234	1.234	1.234	1.234
Discount for Local Resident (0-1)	1.234	1.234	1.234	1.234	1.234
Funding Distribution for Bus-Fraction(0-0.85)	1.234	1.234	1.234	1.234	1.234
Funding Distribution for Trail (0-0.1)	1.234	1.234	1.234	1.234	1.234
Total Lane Miles within Cordon-bases Area (1000-5000)	1.234	1.234	1.234	1.234	1.234

Press Any Key to Next Screen

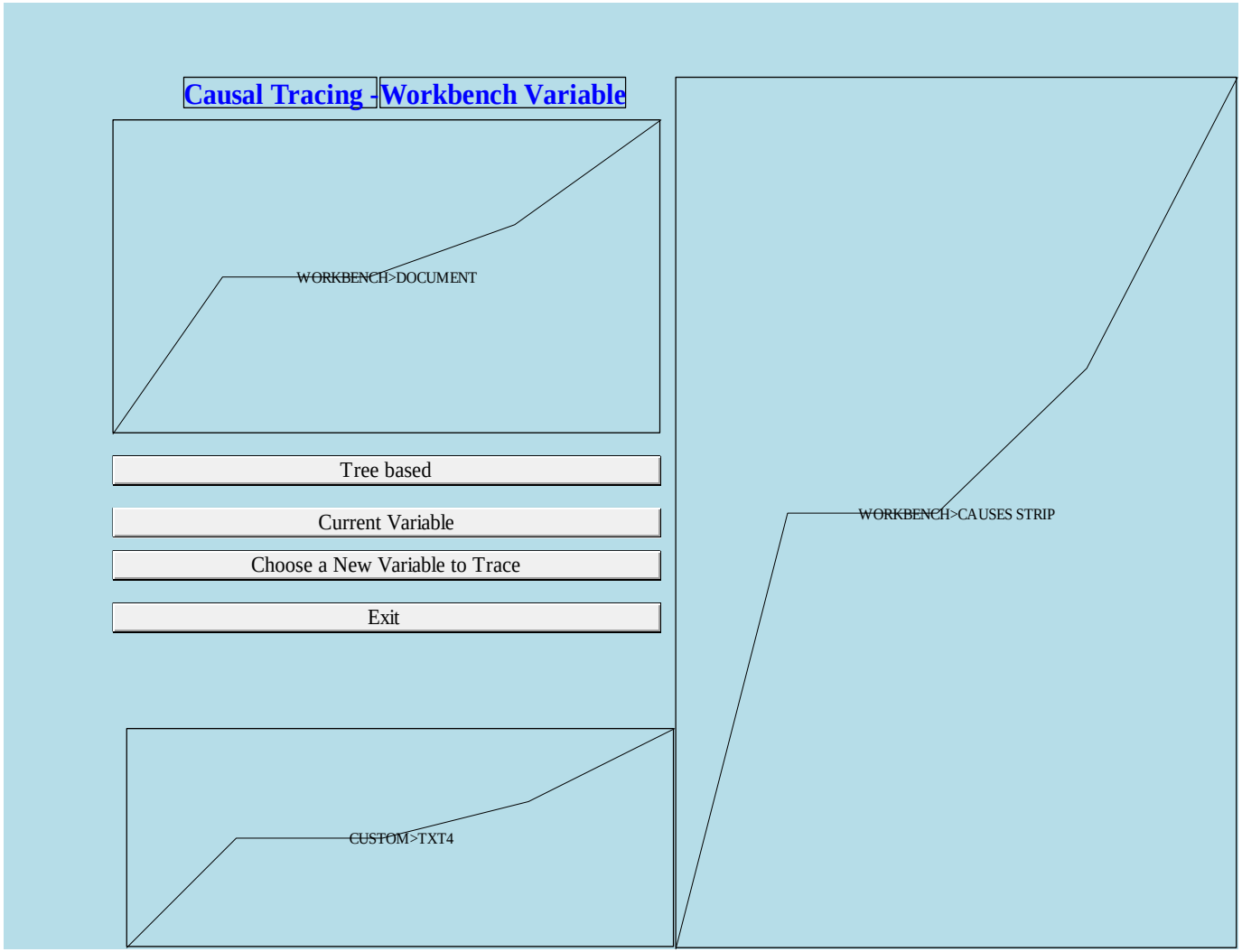
Press Button to Go Back to Previous Screen

Comparison of Behavior for Several Runs

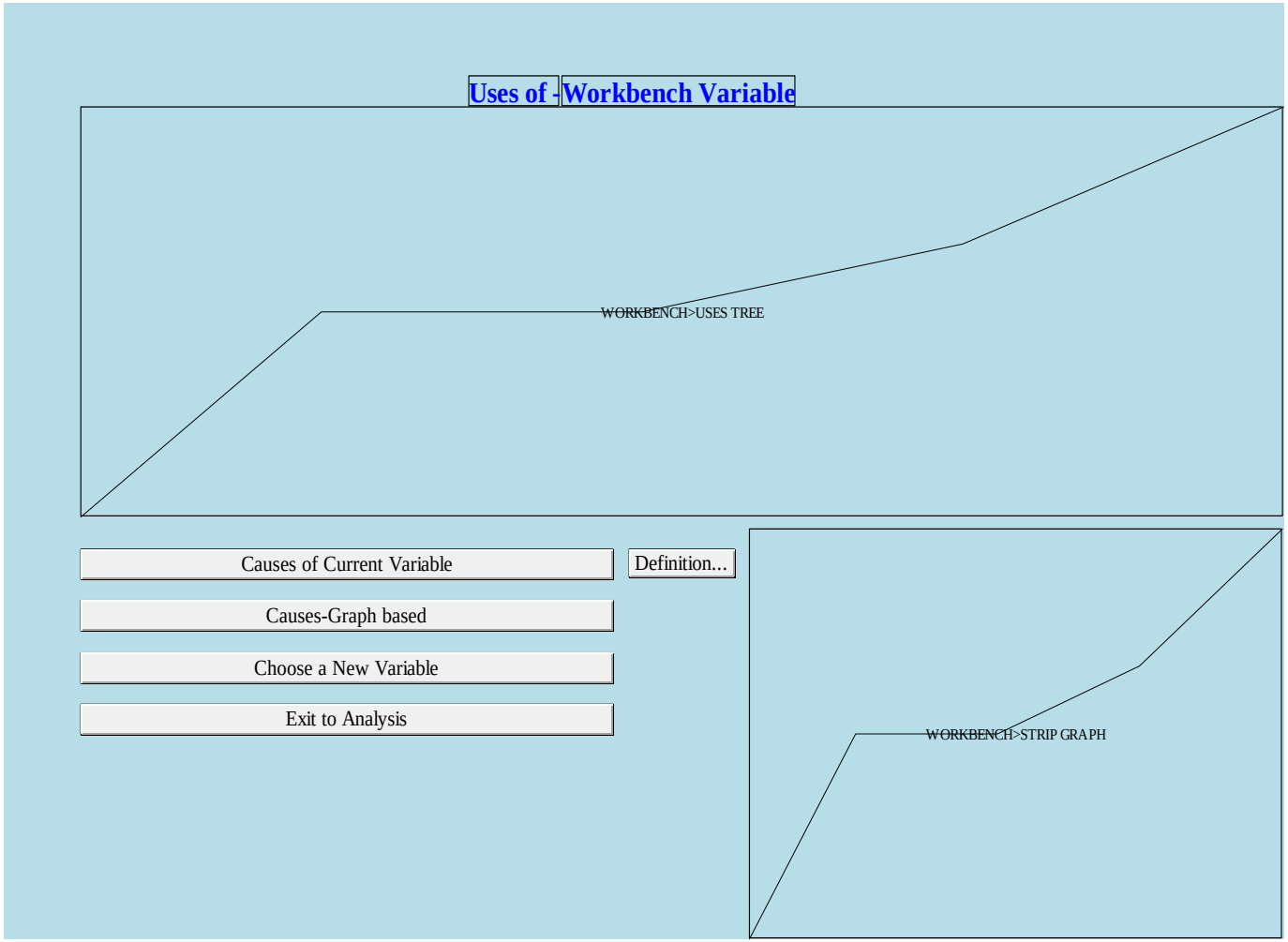
Graph-based Causal Tracing



Tree-based Causal Tracing



Tracing the Use of Different Variable



AF3: Code for Screen Definition of Management Flight Simulator for the Transportation System Modeling with Travel Demand Management Policy

:SCREEN Welcome

1. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
   PIXELPOS,0
2. TEXTONLY,"Travel Demand Management Policy Analysis ",48,19,,,C|Times New Roman|36||0-0-255,,"",
3. TEXTONLY,"Management Flight Simulator",48,8,,,C|Times New Roman|48||0-0-255,,"",
4. TEXTONLY,"System Performance Laboratory",48,50,,,C|Times New Roman|16||0-0-255,,"",
5. TEXTONLY,"Grado Department of Industrial and Systems Engineering",48,54,,,C|Times New Roman|18||0-0-255,,"",
6. TEXTONLY,"Virginia Polytechnic Institute and State University",48,58,0,0,C|Times New Roman|24||0-0-255,,,
7. TEXTONLY,"Copyright (C) 2007 Virginia Tech",48,80,,,C|Times New Roman|18||0-0-0,,"",
8. ANYKEY,"",21,32,,,,←←,"",Menu
9. TEXTONLY,"Press Any Key to Continue ",42,72,,,,,"",Menu
   !
10. COMMAND,"",0,0,,,,,"SPECIAL>LOADMODEL|congestion pricing with Triangular Membership function_Backup_April_25_2007.vmf",
11. COMMAND,"",0,0,,,,,"SPECIAL>READCUSTOM|congestion pricing with Triangular Membership function_Backup_April_25_2007.vgd",
12. COMMAND,"",0,0,,,,,"SPECIAL>CLEARRUNS|",
13. COMMAND,"",0,0,,,,,"SPECIAL>SETTITLE|Management Flight Simulator",
    !

:SCREEN Exit

14. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0

15. TEXTONLY,"Travel Demand Management Policy Analysis ",48,19,,,C|Times New Roman|36||0-0-255,,"",
16. TEXTONLY,"Management Flight Simulator",48,8,,,C|Times New Roman|48||0-0-255,,"",
17. TEXTONLY,"System Performance Laboratory",48,50,,,C|Times New Roman|16||0-0-255,,"",
18. TEXTONLY,"Industrial and Systems Engineering",48,54,,,C|Times New Roman|18||0-0-255,,"",
19. TEXTONLY,"Virginia Polytechnic Institute and State University",48,58,0,0,C|Times New Roman|24||0-0-255,,,
20. TEXTONLY,"Copyright (C) 2007 Virginia Tech",48,80,,,C|Times New Roman|18||0-0-0,,"",
21. ANYKEY,"",21,32,,,,← \027,"",Menu
22. COMMAND,"",19,35,,,L,,"SPECIAL>ASKYESNO|Do you really want to exit?&MENU>EXIT|",
    !

:SCREEN Menu

23. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0!!
24. TEXTONLY,"Travel Demand Management Policy Analysis ",48,11,0,0,C|Times New Roman|36||0-0-255,,,
25. TEXTONLY,"Copyright (C) 2007 Virginia Tech",45,19,0,0,C|Times New Roman|18||0-0-0,,,
26. BUTTON,"Dynamics of Transportation System with Congestion Pricing Policy",48,39,60,3,C|Times New Roman|14||0-0-255,,,MajorF
27. BUTTON,"Problem Statement of Traffic Congestion",48,49,60,3,C|Times New Roman|14||0-0-255,,,Statement
28. BUTTON,"Guidance for Using Current Management Flight Simulator",48,29,60,3,C|Times New Roman|14||0-0-255,,,Guidance
29. BUTTON,"???HELP???",48,59,60,3,C|Times New Roman|14||0-0-255,,,Help
30. BUTTON,"Exit to the Main Menu",48,70,60,3,C|Times New Roman|14||0-0-255,,,Welcome
31. BUTTON,"Exit Current Application",48,80,60,3,C|Times New Roman|14||0-0-255,,,Exit
    !

:SCREEN Statement

32. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0
33. TEXTONLY,"Travel Demand Management Policy Analysis ",48,11,,,C|Times New Roman|36||0-0-255,,"",
34. TEXTONLY,"Press Any Key to Continue or ",3,28,,,,,"",
35. TEXTONLY,"Esc to Return to Main Menu",3,32,,,,,"",
36. TEXTONLY,"Scroll Down to Read More Text",70,32,,,,,"",
37. TOOL,"TXT1",3,35,88,65,,,"CUSTOM>TXT1",
38. ANYKEY,"",32,23,,,,← ,"",Menu
    !

:SCREEN Guidance

39. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0!!
40. TEXTONLY,"Travel Demand Management Policy Analysis ",48,11,,,C|Times New Roman|36||0-0-255,,"",
41. TEXTONLY,"Press Key to Return to Main Menu",4,22,,,,← ,"",Menu
42. ANYKEY,"",36,36,,,,← \027,"",Menu
    !
43. TEXTONLY,"Esc to Return to Main Menu",4,26,0,0,,,,
44. TEXTONLY,"Scroll Down to Read More Text",70,26,0,0,,,,
45. TOOL,"TXT2",3,30,88,65,,,"CUSTOM>TXT2",
    !

:SCREEN Help

46. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0!!
47. TEXTONLY,"Travel Demand Management Policy Analysis ",48,11,,,C|Times New Roman|36||0-0-255,,"",
48. TEXTONLY,"Press Any Key to Return to Main Menu",15,23,0,0,C,← ,,
49. ANYKEY,"Press Any Key to Return to Main Menu",41,53,,,,\027,"",Menu

!

50. TEXTONLY,"Esc to Return to Main Menu",6,26,0,0,,,,
51. TEXTONLY,"Scroll Down to Read More Text",70,26,0,0,,,,
52. TOOL,"TXT3",3,31,88,65,,,"CUSTOM>TXT3",
    !

:SCREEN Pricing

53. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0!!
54. TEXTONLY,"Dynamics of Transportation System with Congestion Pricing
    Policy",48,11,,,C|Times New Roman|24|B|0-0-255,,"",
55. RECTANGLE,"",20,26,60,55,C|Times New Roman|12||0-0-255,,,
56. BUTTON,"Exit to Main Menu",50,92,50,3,C|Times New Roman|14||0-0-0,,"",Menu
57. RECTANGLE,"",20,26,60,55,C|Times New Roman|12||0-0-255,,"",
58. RECTANGLE,"",20,26,60,55,C|Times New Roman|12||0-0-255,,"",
59. RECTANGLE,"",20,26,60,55,C|Times New Roman|12||0-0-255,,"",
60. BUTTON,"Analyze Previously Run Scenarios ",25,68,50,3,|Times New Roman|14||0-0-
    0,Aa,"",DOANALYSIS
61. BUTTON,"Run Sensitivity Analysis",25,56,50,3,|Times New Roman|14||0-0-0,,,SETSENS
62. BUTTON,"Setup and Run a New Scenario",25,43,50,3,|Times New Roman|14||0-0-
    0,Ss,SIMULATE>RUNNAME|?Name for the New Scenario|0,Setup
63. BUTTON,"Review Model Structure",25,31,50,3,|Times New Roman|14||0-0-0,,"",Pricing-
    OV
64. BRANCH,"OK",,,,,,,"",DISPLAYS1
65. BRANCH,"NOTOK",,,,,,,"",RUNSENS
    !

:SCREEN MajorF

66. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0!!

67. TEXTONLY,"Major Features of Two Models ",0,5,100,,C|Times New Roman|24|B|0-0-255,,"",
68. TEXTONLY,"Run Scenarios",10,18,0,0,L|Times New Roman|18|B|0-0-255,,,
69. TEXTONLY,"Run Scenarios Using Different Assumptions and Policy Choices",15,28,0,0,L|Times New Roman|12|B|0-0-255,,,
70. TEXTONLY,"Sensitivity Analysis",10,37,0,0,L|Times New Roman|18|B|0-0-255,,,
71. TEXTONLY,"Perform Monte Carlo Multivariate Sensitivity Analysis",15,47,0,0,L|Times New Roman|12|B|0-0-255,,,
72. TEXTONLY,"Choose Different Parameter Values",15,57,0,0,L|Times New Roman|12|B|0-0-255,,,
73. TEXTONLY,"Analysis Scenarios ",10,69,0,0,L|Times New Roman|18|B|0-0-255,,,
74. TEXTONLY,"Use Causal Tracing and Othe
75. TEXTONLY,"Use Causal Tracing and Other Analysis Tools",15,81,,,L|Times New Roman|12|B|0-0-255,,"",
76. BUTTON,"Go To Congestion Pricing Model",41,88,0,0,|Times New Roman|14||0-0-0,,,Pricing
    !
77. ANYKEY,"",,,,,,,"",Pricing
    !

:SCREEN Pricing-OV

78. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0
    !!
79. TEXTONLY,"Model Structure Overview: Congestion Pricing",0,5,100,,C|Times New Roman|18|B|0-0-255,,"",
80. BUTTON,"Mass Transit Capacity Increment",50,14,30,24,C|Times New Roman|14||0-0-0,Ww,"",MCapacityP
81. BUTTON,"Switching between Mass Transit&Car",56,62,29,24,|Times New Roman|14||0-0-0,Ww,"",SwitchingP

82. BUTTON,"Perception Matters ",15,62,29,23,|Times New Roman|14||0-0-0,Ww,"",
    PerceptionP
83. BUTTON,"Exit to Main Menu of Congestion Pricing Model",26,90,51,3,L|Times New
    Roman|14||0-0-0,,"",Pricing
84. LINE,"",44,75,12,,C||||0-0-255,,"",
85. LINE,"",50,14,29,48,C||||0-0-255,,"",
86. LINE,"",50,14,-29,48,C||||0-0-255,,"",
87. BUTTON,"Congestion Pricing",26,9,51,3,|Times New Roman|14||0-0-0,,"",Aggregateleve
    !

:SCREEN MCapacityP

88. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0
89. SKETCH,"SK1",0,0,100,90,,,"5",
90. TEXTONLY,"Press Any Key to Return to Overview",1,97,,,L|Times New Roman|10|B|0-0-
    255,,"",
    !
91. ANYKEY,"",0,0,,,0,,"",Pricing-OV
    !

:SCREEN PerceptionP

92. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0
    !!
93. SKETCH,"SK1",0,0,100,90,,,"4",
94. TEXTONLY,"Press Any Key to Return to Overview",1,97,,,L|Times New Roman|10|B|0-0-
    255,,"",
    !
95. ANYKEY,"",0,0,,,0,,"",Pricing-OV
    !

:SCREEN SwitchingP

96. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0
    !!
97. SKETCH,"SK1",0,0,100,90,,,"3",
98. TEXTONLY,"Press Any Key to Return to Overview",1,97,,,L|Times New Roman|10|B|0-0-255,,"",
    !
99. ANYKEY,"",0,0,,,0,,"",Pricing-OV
    !
100. :SCREEN Aggregateleve
101. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
102. PIXELPOS,0
    !!
    !!
103. SKETCH,"SK1",0,0,100,90,,,"1",
104. TEXTONLY,"Press Any Key to Return to Overview",1,97,,,L|Times New Roman|10|B|0-0-255,,"",
    !
105. ANYKEY,"",0,0,,,0,,"",Pricing-OV
    !

:SCREEN Setup

106. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0
107. TEXTONLY,"Scenairo Assumptions and Policies",0,6,100,,C|Times New Roman|36|B|0-0-255,,"",
108. BUTTON,"Assumptions for Scenario ",25,21,50,3,L|Times New Roman|14||0-0-0,,"",Scenarioasspt
109. BUTTON,"Policy Setting",25,33,50,3,L|Times New Roman|14||0-0-0,,"",PolicyAsptn
110. BUTTON,"Run Scenario",25,46,50,3,L|Times New Roman|14||0-0-0,Mm,"",Runscenario

111. BUTTON,"Exit to Main Menu",50,73,50,3,C|Times New Roman|14||0-0-0,,"",Menu
!

:SCREEN Scenarioasspt

112. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
113. TEXTONLY,"Scenario Assumptions",48,4,,,C|Times New Roman|36|B|0-0-255,,"",
114. TEXTONLY,"Average Passenger per Bus per Hour (0-80)",10,14,0,3,L|Times New Roman|12|B|0-0-0,,,
115. TEXTONLY,"Average Passenger per Metro Car per Hour(0-200)",10,19,0,3,L|Times New Roman|12|B|0-0-0,,,
116. TEXTONLY,"Average Time Keeping Using Trail (0-1440)",10,41,0,3,L|Times New Roman|12|B|0-0-0,,,
117. TEXTONLY,"Average Time Keeing Using Bus (0-3,600)",10,25,0,3,L|Times New Roman|12|B|0-0-0,,,
118. TEXTONLY,"Average Time Keeping Using Car (0-5,400)",10,30,0,3,L|Times New Roman|12|B|0-0-0,,,
119. TEXTONLY,"Average Passenger Flow Rate for Trail (0-50)",10,47,0,3,L|Times New Roman|12|B|0-0-0,,,
120. TEXTONLY,"Average Time Keeping Using Metro (0-3,600)",10,36,0,3,L|Times New Roman|12|B|0-0-0,,,
121. TEXTONLY,"Average Trip Miles (0-40)",10,52,0,3,L|Times New Roman|12|B|0-0-0,,,
122. TEXTONLY,"Bus Life Time (0-5400)",10,56,0,3,L|Times New Roman|12|B|0-0-0,,,
123. TEXTONLY,"Carpool Mulplier (1-1.5)",10,61,0,3,L|Times New Roman|12|B|0-0-0,,,
124. TEXTONLY,"Cost per Metro Car (0-1,500,000)",10,66,0,3,L|Times New Roman|12|B|0-0-0,,,
125. BUTTON,"Record Changes and Go to Next Screen",48,83,50,3,C|Times New Roman|14||0-0-0,Rr,"",Scenarioassp2
126. TEXTONLY,"Employment Increment (0-10)",10,77,0,3,L|Times New Roman|12|B|0-0-0,,,
127. TEXTONLY,"Fraction of Work Trip by Car (0-0.7)",53,14,0,3,L|Times New

Roman|12|B|0-0-0,,,

128. TEXTONLY,"Fraction of Local Resident(0-0.5)",53,41,0,3,L|Times New Roman|12|B|0-0-0,,,
129. TEXTONLY,"Fraction of Work Trip by Metro (0-0.7)",53,19,0,3,L|Times New Roman|12|B|0-0-0,,,
130. TEXTONLY,"Fraction of Work Trip by Trail (0-0.75)",53,30,0,3,L|Times New Roman|12|B|0-0-0,,,
131. TEXTONLY,"Fraction of Work Trip by Bus (0-0.75)",53,25,0,0,L|Times New Roman|12|B|0-0-0,,,
132. TEXTONLY,"Fraction of Disabled People (0-0.01)",53,47,0,3,L|Times New Roman|12|B|0-0-0,,,
133. TEXTONLY,"Fraction of Work Trip Budget (0-0.2)",53,36,0,3,L|Times New Roman|12|B|0-0-0,,,
134. TEXTONLY,"Fruitfulness of Incurring Mobility(0-0.0008)",53,52,0,3,L|Times New Roman|12|B|0-0-0,,,
135. TEXTONLY,"Fuel Price per Gallon(0-3.5)",53,56,0,3,L|Times New Roman|12|B|0-0-0,,,
136. TEXTONLY,"Insurance Premium per Day(0-3)",53,61,0,3,L|Times New Roman|12|B|0-0-0,,,
137. TEXTONLY,"Maintenance Expenditure per Mile (0-0.04)",53,66,0,3,L|Times New Roman|12|B|0-0-0,,,
138. MODVAR,"average passenger per bus per hour",39,14,12,3,L,|[0|80],,
139. MODVAR,"average time keeping using bus",39,25,12,3,L,|[0|3600],,
140. MODVAR,"average passenger per metro car per hour",39,19,12,3,L,|[0|200],,
141. MODVAR,"average time keeping using car",39,30,12,3,L,|[0|5400],,
142. MODVAR,"average time keeping using metro",39,36,12,3,L,|[0|3600],,
143. MODVAR,"average time keeping using trail",39,41,12,3,L,|[0|1440],,
144. MODVAR,"average passenger Flow Rate",39,47,12,3,L,|[0|50],,
145. MODVAR,"average trip miles",39,52,12,3,L,|[0|40],,
146. MODVAR,"bus life time",39,56,12,3,L,|[0|5400],,
147. MODVAR,"carpool multiplier",39,61,12,3,L,|[0|1.5],,
148. MODVAR,"cost per trail mile",39,72,12,3,L,|[0|100000],,

149. MODVAR,"cost per metro car",39,66,12,3,L,|[0|1500000],,
150. MODVAR,"employment increment",39,77,12,3,L,|[0|10],,
151. MODVAR,"fraction of work trip by metro",80,19,12,3,L,|[0|0.7],,
152. MODVAR,"fraction of work trip by car",80,14,12,3,L,|[0|0.7],,
153. MODVAR,"fraction of work trip demand on bus",80,25,12,3,L,|[0|0.75],,
154. MODVAR,"fraction of work trip by trail",80,30,12,3,L,|[0|0.75],,
155. MODVAR,"fraction of work budget",80,36,12,3,L,|[0|0.2],,
156. MODVAR,"fraction of local resident",80,41,12,3,L,|[0|0.5],,
157. MODVAR,"fraction of disable people",80,47,12,3,L,|[0|0.01],,
158. MODVAR,"fruitfulness of incuring mobility",80,52,12,3,L,|[0|0.0008],,
159. MODVAR,"fuel price per gallon",80,56,12,3,L,|[0|3.5],,
160. MODVAR,"average passenger per bus per hour",80,66,12,3,L,|[0|0.04],,
161. MODVAR,"insurance premium per day",80,61,12,3,L,|[0|3],,
162. TEXTONLY,"Cost per Trail Mile(0-100,000)",10,72,0,2,L|Times New Roman|12|B|0-0-0,,,
163. BUTTON,"Cancel Changes and Return",48,90,50,3,C|Times New Roman|14||0-0-0,EeXx,"CANCEL",Setup
164. MODVAR,"metro car life time",80,72,12,3,L,|[0|10800],"",
165. TEXTONLY,"Metro Car Life Time (0-10800)",53,72,0,2,L|Times New Roman|12|B|0-0-0,,,
166. TEXTONLY,"Normal Funding for Bus Improvment (0-80,000)",53,77,0,2,L|Times New Roman|12|B|0-0-0,,,
167. MODVAR,"normal funding for bus increment",80,77,12,3,L,|[0|80000],,

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:SCREEN Scenarioassp2

168. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
169. TEXTONLY,"Scenario Assumptions",48,4,,,C|Times New Roman|36|B|0-0-255,,"",
170. TEXTONLY,"PCU per Car (0.8-1.5)",10,36,0,2,L|Times New Roman|12|B|0-0-0,,,
171. TEXTONLY,"Normal Funding for Trail Capacity(0-8,000)",10,14,0,2,L|Times New

Roman|12|B|0-0-0,,,

172. TEXTONLY,"Normal Funding for Metro Improvement (0-120,000)",10,25,0,2,L|Times New Roman|12|B|0-0-0,,,
173. TEXTONLY,"Normal Gallon per Car Mile (0-0.05)",10,20,0,2,L|Times New Roman|12|B|0-0-0,,,
174. TEXTONLY,"Price per Bus (0-350,000)",10,42,0,2,L|Times New Roman|12|B|0-0-0,,,
175. TEXTONLY,"PCU per Bus (1.5-3)",10,31,0,2,L|Times New Roman|12|B|0-0-0,,,
176. TEXTONLY,"Sociability (0-1.5)",10,47,,2,L|Times New Roman|12|B|0-0-0,,"",
177. TEXTONLY,"Time Delay in Choosing Transportation Modes (0-360)",54,36,0,2,L|Times New Roman|12|B|0-0-0,,,
178. TEXTONLY,"Work Trip Value (0-300)",54,47,0,2,L|Times New Roman|12|B|0-0-0,,,
179. TEXTONLY,"Time with Bus Before Switching(0-1080)",54,31,0,2,L|Times New Roman|12|B|0-0-0,,,
180. BUTTON,"Record Changes and Return",48,75,50,3,C|Times New Roman|14||0-0-0,Rr,"",Setup
181. TEXTONLY,"Time with Car Before Switching (0-1800)",54,14,0,0,L|Times New Roman|12|B|0-0-0,,,
182. TEXTONLY,"Time with Metro before Switching (0-1080)",54,20,0,0,L|Times New Roman|12|B|0-0-0,,,
183. TEXTONLY,"Time with Trail before Switching(0-1440)",54,25,0,0,L|Times New Roman|12|B|0-0-0,,,
184. TEXTONLY,"Trail Life Time (-0-7200)",54,42,0,0,L|Times New Roman|12|B|0-0-0,,,
185. BUTTON,"Cancel Changes and Return",48,89,50,3,C|Times New Roman|14||0-0-0,EeXx,"CANCEL",Setup
186. BUTTON,"Record Changes and Go to Previous Screen",48,69,50,3,C|Times New Roman|14||0-0-0,Rr,"",Scenarioasspt

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187. MODVAR,"normal funding for trail capacity",39,14,12,3,L,|[0|8000],,
188. MODVAR,"normal gallon per mile",39,20,12,3,L,|[0|8000],,
189. MODVAR,"normal money for metro capacity",39,25,12,3,L,|[0|120000],,
190. MODVAR,"PCU per bus",39,31,12,3,L,|[1.5|3],,

191. MODVAR,"PCU per car",39,36,12,3,L,|[0.8|1.5],,
192. MODVAR,"price per bus",39,42,12,3,L,|[0|350000],,
193. MODVAR,"sociability",39,47,12,3,L,|[0|1.5],,
194. MODVAR,"time with car before swiching",85,14,12,3,L,|[0|1800],,
195. MODVAR,"time with trail before switching",85,25,12,3,L,|[0|1440],,
196. MODVAR,"time with metro before switching",85,20,12,3,L,|[0|1080],,
197. MODVAR,"time with bus before switching",85,31,12,3,L,|[0|1080],,
198. MODVAR,"work trip value",85,47,12,3,L,|[0|300],,
199. MODVAR,"time delay in choosing transportation mode",85,36,12,3,L,|[0|360],"",
200. MODVAR,"trail life time",85,42,12,3,L,|[0|7200],,
201. BUTTON,"Cancel Changes and Go To Previous Screen",48,83,50,3,C|Times New Roman|14||0-0-0,EeXx,"CANCEL",Scenarioasspt
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    !

:SCREEN PolicyAsptn

202. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0
    !!
203. TEXTONLY,"Scenario Policy Options",48,4,,,C|Times New Roman|36|B|0-0-255,,"",
204. TEXTONLY,"Carrying Capacity for Metro (0-10,000)",10,52,0,2,L|Times New Roman|12|B|0-0-0,,,
205. TEXTONLY,"Carrying Capacity for Trail (0-2000)",10,59,0,2,L|Times New Roman|12|B|0-0-0,,,
206. TEXTONLY,"Carrying Capacity for Bus(0-100,000)",10,43,0,2,L|Times New Roman|12|B|0-0-0,,,
207. TEXTONLY,"Buildup Delay for Metro (0-7200)",10,17,0,2,L|Times New Roman|12|B|0-0-0,,,
208. TEXTONLY,"Buidup Delay for Bus (0-1800)",10,26,0,2,L|Times New Roman|12|B|0-0-0,,,
209. TEXTONLY,"Discount for Local Resident (0-1)",48,26,0,0,L|Times New Roman|12|B|0-

0-0,,,

210. TEXTONLY,"Funding Distribution for Bus-Fraction(0-0.85)",48,35,0,0,L|Times New Roman|12|B|0-0-0,,,
211. SLIDEVAR,"fraction for bus",80,33,12,6,L,[0|0.85|0.001]],,
212. TEXTONLY,"Funding Distribution for Trail (0-0.1)",48,43,0,0,L|Times New Roman|12|B|0-0-0,,,
213. SLIDEVAR,"fraction for trail",80,41,12,6,L,[0|0.1|0.001],,
214. MODVAR,"Carrying Capacity for Bus",34,43,12,3,L,|[0|100000],"",
215. MODVAR,"Carrying Capacity for Metro",34,52,12,3,L,|[0|10000],"",
216. MODVAR,"Carrying Capacity for Trail",34,59,12,3,L,|[0|2000],"",
217. MODVAR,"Buildup Delay for Metro",34,17,12,3,L,|[0|7200],"",
218. MODVAR,"Buildup Delay for Bus",34,26,12,3,L,|[0|1800],"",
219. TEXTONLY,"Buidup Delay for Trail (0-3600)",10,35,0,2,L|Times New Roman|12|B|0-0-0,,,
220. MODVAR,"Buildup Delay for Trail",34,35,12,3,L,|[0|1800],"",
221. TEXTONLY,"Multiplier for Congestion Charging Price (0-10)",48,17,,,L|Times New Roman|12|B|0-0-0,,"",
222. MODVAR,"multiplier for congestion price",80,16,12,3,L,[0|10|0.001],"",
223. BUTTON,"Record Changes and Return",48,73,50,3,C|Times New Roman|14||0-0-0,Rr,,Setup
224. BUTTON,"Cancel Changes and Return",48,82,50,3,C|Times New Roman|14||0-0-0,EeXx,CANCEL,Setup
225. SLIDEVAR,"discount for local resident",80,24,12,6,L,[0|1.00|0.001]],"",
226. TEXTONLY,"Total Lane Miles within Cordon-bases Area (1000-5000)",48,52,0,0,L|Times New Roman|12|B|0-0-0,,,
227. MODVAR,"Total Lane Miles",80,52,12,3,L,|[1000|3000],"",

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:SCREEN Runscenario

228. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0

229. WIPTOOL,"GR1",0,5,90,80,L,,"CUSTOM>WIP1",
230. COMMAND,"",0,0,,,,,"MENU>RUN1|O",
231. COMMAND,"",0,0,,,,,"SPECIAL>SETWBITEM|Average Flow Rate",
232. CLOSESCREEN,"",0,0,,,,,"",DisplayS
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:SCREEN DisplayS

233. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
234. TOOL,"GR1",6,0,90,80,,,"WORKBENCH>Graph",
235. BUTTON,"Choose Different Variable",6,85,20,3,L|Times New Roman|14||0-0-0,Ss,"SPECIAL>VARSELECT|Different Variable to Use",DisplayS
!
236. BUTTON,"Return to Main Screen",75,85,20,3,L|Times New Roman|14||0-0-0,Ss,"",Pricing
237. BUTTON,"Aanalysis Tools",52,85,20,3,L|Times New Roman|14||0-0-0,Ss,"",DOANALYSIS
238. BUTTON,"Modify and Return",29,85,20,3,L|Times New Roman|14||0-0-0,Ss,"",Setup
!

:SCREEN SETSENS

239. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
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240. TEXTONLY,"Monte Carlo Sensitivity Analysis",48,4,,,C|Times New Roman|36|B|0-0-255,,"",
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241. TEXTONLY,"Carrying Capacity for Metro (0-10,000)",8,42,0,2,L|Times New Roman|12|B|0-0-0,,,
242. TEXTONLY,"Carrying Capacity for Bus(0-100,000)",8,33,0,2,L|Times New Roman|12|B|0-0-0,,,

243. TEXTONLY,"Buildup Delay for Metro (0-7200)",8,15,0,2,L|Times New Roman|12|B|0-0-0,,,
244. TEXTONLY,"Buidup Delay for Bus (0-1800)",8,24,0,2,L|Times New Roman|12|B|0-0-0,,,
245. TEXTONLY,"Funding Distribution for Bus-Fraction(0-0.85)",8,51,0,0,L|Times New Roman|12|B|0-0-0,,,
246. TEXTONLY,"Multiplier for Congestion Charging Price (0-10)",8,60,0,0,L|Times New Roman|12|B|0-0-0,,,
247. TEXTONLY,"Total Lane Miles within Cordon-bases Area (1000-5000)",8,69,0,0,L|Times New Roman|12|B|0-0-0,,,
248. TEXTONLY,"Minimum",51,11,0,0,|Times New Roman|14|B|0-0-0,,,
249. TEXTONLY,"Maximum",75,11,0,0,|Times New Roman|14|B|0-0-0,,,
!
250. SLIDEVAR,"BUILDUP DELAY FOR METRO MIN",47,13,16,6,,[0|1800|0.1],"",
251. SLIDEVAR,"BUILDUP DELAY FOR METRO MAX",69,13,16,6,,[1800|7200|0.1],"",
252. SLIDEVAR,"MULTIPLIER FOR CONGESTION PRICE MAX",69,58,16,6,,[1|10|0.1],"",
253. SLIDEVAR,"FRACTION FOR BUS MAX",69,49,16,6,,[0.1|0.85|0.01],"",
254. SLIDEVAR,"FRACTION FOR BUS MIN",47,49,16,6,,[0|0.1|0.01],"",
255. SLIDEVAR,"CARRYING CAPACITY FOR METRO MAX",69,40,16,6,,[700|10000|0.1],"",
256. SLIDEVAR,"CARRYING CAPACITY FOR METRO MIN",47,40,16,6,,[0|700|0.1],"",
257. SLIDEVAR,"BUILDUP DELAY FOR BUS MIN",47,22,16,6,,[0|360|0.1],"",
258. SLIDEVAR,"BUILDUP DELAY FOR BUS MAX",69,22,16,6,,[360|1800|0.1},"",
259. SLIDEVAR,"MULTIPLIER FOR CONGESTION PRICE MIN",47,58,16,6,,[0|1|0.1],"",
260. SLIDEVAR,"CARRYING CAPACITY FOR BUS MAX",69,31,16,6,,[1000|100000|0.1],"",
261. SLIDEVAR,"CARRYING CAPACITY FOR BUS MIN",47,31,16,6,,[0|1000|0.1],"",
262. SLIDEVAR,"TOTAL LANE MILES MAX",69,67,16,6,,[1000|5000|0.1],"",
263. SLIDEVAR,"TOTAL LANE MILES MIN",47,67,16,6,,[0|1000|0.1],"",
264. BUTTON,"Run Monte Carlo Sensitivity Analysis",26,75,50,3,|Times New Roman|14||0-

0-0,Ss,"",RUNSENS

265. BUTTON,"Exit to Main Menu",26,89,50,3,L|Times New Roman|14||0-0-0,,"",Pricing
266. BUTTON,"Do Analysis",26,82,50,3,L|Times New Roman|14||0-0-0,,"",DOANALYSIS

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:SCREEN RUNSENS

267. SCREENFONT,Times New Roman|10||0-0-0|192-255-255

PIXELPOS,0

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268. WIPTOOL,"GR1",5,5,90,80,,,"CUSTOM>WIP1",
269. COMMAND,"",0,0,,,,,"SPECIAL>CLEARRUNS|",
270. COMMAND,"",0,0,,,,,"SIMULATE>RUNNAME|sensitivity.vdf",
271. COMMAND,"",0,0,,,,,"SIMULATE>SENSITIVITY|congestion pricing with Triangular Membership function_Backup_April_25_2007.vsc",
272. COMMAND,"",0,0,,,,,"SIMULATE>SENSSAVELIST|congestion pricing with Triangular Membership function_Backup_April_25_2007.lst",
273. COMMAND,"",0,0,,,,,"MENU>RUN_SENSITIVITY|O",
274. CLOSESCREEN,"",0,0,,,,,"",DISPLAYS1

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:SCREEN DISPLAYS1

275. SCREENFONT,Times New Roman|10||0-0-0|192-255-255

PIXELPOS,0

276. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|Average Flow Rate"
277. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",
278. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
279. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
280. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
281. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS3
282. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-

0,,"",DISPLAYS4

283. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY5
284. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,,DISPLAYSNY11
285. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,,DISPLAYSNY10
286. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,,DISPLAYSNY9
287. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY8
288. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY6
289. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY7
290. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,"PRINT>GR1",
291. BUTTON,"Show traces",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
292. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,,DISPLAYSNY13
293. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,,DISPLAYSNY12
294. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
295. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
296. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,,DISPLAYSNY14
297. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,,DISPLAYSNY15
298. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY16

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:SCREEN DISPLAYS2

299. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
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300. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|Total Buses"
301. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS3
302. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4
303. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5
304. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10
305. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9
306. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8
307. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6
308. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
309. BUTTON,"Average Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
310. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS11
311. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
312. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
313. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13

314. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
315. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
316. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
317. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
318. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14
319. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16
320. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
321. TEXTONLY,"Sensitivity Resutls-",50,2,,,R|Times New Roman|18|B|0-0-255,,"",
322. WBVAR,"",50,2,,,L|Times New Roman|18|B|0-0-255,,"",
!

:SCREEN DISPLAYS3

323. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
!!
324. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|Total Metro Cars"
325. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",
326. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
327. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
328. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
329. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5
330. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10
331. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9

332. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8
333. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6
334. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
!
335. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
336. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS11
337. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
338. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
339. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
340. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
341. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
342. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
343. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
344. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14
345. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16
346. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4
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:SCREEN DISPLAYS4

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347. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
     PIXELPOS,0
     !!
348. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|Total Bus Demand"
349. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",
350. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
351. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
352. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-
     0,,"",DISPLAYSNY3
353. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
354. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-
     0,,"",DISPLAYS5
355. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-
     0,,"",DISPLAYS10
356. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-
     0,,"",DISPLAYS9
357. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-
     0,,"",DISPLAYS8
358. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-
     0,,"",DISPLAYS6
359. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
360. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-
     0,,"",DISPLAYS1
361. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-
     0,,"",DISPLAYS11
362. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
363. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-
     0,,"WORKBENCH>Sensitivity Traces",
364. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-
     0,,"",DISPLAYS13
365. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-
```

0,,"",DISPLAYS12

366. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
367. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
368. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
369. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14
370. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16

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:SCREEN DISPLAYS5

371. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0

!!

372. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|Total Metro Demand"
373. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",
374. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
375. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
376. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3
377. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
378. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10
379. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9
380. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8
381. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6

382. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
383. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
384. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS11
385. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
386. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
387. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
388. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
389. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
390. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
391. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
392. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14
393. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16
394. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4
    !

:SCREEN DISPLAYS6

395. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
    PIXELPOS,0
    !!
396. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|Total Trail Demand"
397. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",

398. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
399. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
400. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3
401. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
402. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5
403. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10
404. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9
405. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8
406. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
407. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
408. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS11
409. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
410. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
411. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
412. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
413. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
414. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
415. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
416. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-

0,,"",DISPLAYS14

417. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16

418. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4

!

:SCREEN DISPLAYS7

419. SCREENFONT,Times New Roman|10||0-0-0|192-255-255

PIXELPOS,0

!!

420. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|conversion rate"

421. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",

422. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",

423. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",

424. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3

425. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2

426. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5

427. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10

428. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9

429. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8

430. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6

431. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1

432. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-

0,,"",DISPLAYS11

433. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
434. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
435. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
436. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
437. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
438. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
439. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
440. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14
441. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16
442. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4

    !

:SCREEN DISPLAYS8

443. SCREENFONT,Times New Roman|10||0-0-0|192-255-255

    PIXELPOS,0

    !!
444. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|Revenue from Pricing Scheme"
445. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",
446. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
447. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
448. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3

449. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
450. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5
451. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10
452. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9
453. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6
454. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
455. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
456. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS11
457. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
458. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
459. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
460. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
461. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
462. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
463. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
464. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14
465. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16
466. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-

0,,"",DISPLAYS4

!

:SCREEN DISPLAYS9

467. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
!!
468. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|"perception with respect to bus supply vs. demand""
469. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",
470. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
471. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
472. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3
473. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
474. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5
475. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10
476. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8
477. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6
478. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
479. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
480. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS11
481. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
482. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",

483. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
484. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
485. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
486. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
487. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
488. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14
489. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16
490. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4
!

:SCREEN DISPLAYS10

491. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
!!
492. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|perception with respect to Average Flow Rate"
493. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",
494. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
495. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
496. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3
497. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
498. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5

499. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9
500. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8
501. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6
502. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
503. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
504. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS11
505. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
506. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
507. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
508. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
509. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
510. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
511. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
512. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14
513. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16
514. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4
!

:SCREEN DISPLAYS11

515. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
!!
516. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|"perception respect to ratio of driving cost vs. budget""
517. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",
518. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
519. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
520. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3
521. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
522. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5
523. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10
524. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9
525. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8
526. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6
527. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
528. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
529. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
530. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
531. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
532. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-

0,,"",DISPLAYS12

533. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
534. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
535. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
536. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14
537. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16
538. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4

!

:SCREEN DISPLAYS12

539. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
!!
540. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|"perception with respect to metro supply vs. demand""
541. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",
542. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
543. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
544. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3
545. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
546. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5
547. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10
548. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-

0,,"",DISPLAYS9

549. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8
550. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6
551. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
552. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
553. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS11
554. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
555. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
556. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
557. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
558. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
559. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
560. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14
561. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16
562. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4

!

:SCREEN DISPLAYS13

563. SCREENFONT,Times New Roman|10||0-0-0|192-255-255

PIXELPOS,0

!!

564. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|"perception with respect to trail supply vs. demand""
565. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",
566. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",
567. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
568. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3
569. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
570. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5
571. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10
572. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9
573. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8
574. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6
575. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
576. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
577. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,,DISPLAYS11
578. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
579. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
580. BUTTON,"Perception to Metro",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
581. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
582. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-

0,,"",SETSENS

583. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15

584. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14

585. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16

586. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4

!

:SCREEN DISPLAYS14

587. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
!!

588. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|Total Car Demand"

589. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",

590. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",

591. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",

592. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3

593. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2

594. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5

595. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10

596. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9

597. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8

598. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-

0,,"",DISPLAYS6

599. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
600. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
601. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS11
602. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
603. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
604. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
605. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
606. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
607. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
608. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
609. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16
610. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4

    !

:SCREEN DISPLAYS15

611. SCREENFONT,Times New Roman|10||0-0-0|192-255-255

    PIXELPOS,0

    !!

612. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|total car running"
613. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",
614. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",

615. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",
616. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3
617. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2
618. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5
619. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10
620. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9
621. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8
622. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6
623. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7
624. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1
625. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS11
626. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
627. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
628. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
629. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
630. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,,Pricing
631. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
632. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14

633. BUTTON,"Congestion Charging Price",6,86,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS16

634. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4

!

:SCREEN DISPLAYS16

635. SCREENFONT,Times New Roman|10||0-0-0|192-255-255

PIXELPOS,0

!!

636. COMMAND,,,,,,,,"SPECIAL>SETWBITEM|congestion charging price"

637. TEXTONLY,"Sensitivity Results-",50,2,,,R|Times New Roman|24|B|0-0-255,,"",

638. TOOL,"GR1",5,6,90,60,,,"WORKBENCH>Sensitivity Graph",

639. WBVAR,"",50,2,,,L|Times New Roman|24|B|0-0-255,,"",

640. BUTTON,"Total Metro Cars",42,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYSNY3

641. BUTTON,"Total Buses",24,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS2

642. BUTTON,"Total Metro Demand",78,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS5

643. BUTTON,"Perception to Congestion",78,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS10

644. BUTTON,"Perception to Bus ",60,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS9

645. BUTTON,"Revenue Accmulated",42,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS8

646. BUTTON,"Total Trail Demand",6,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS6

647. BUTTON,"Conversion Rate",24,73,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS7

648. BUTTON,"Average Traffic Flow Rate",6,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS1

649. BUTTON,"Perception to Driving Cost",6,80,15,3,|Times New Roman|12|B|0-0-

0,,"",DISPLAYS11

650. BUTTON,"Print Graph",42,86,15,3,|Times New Roman|12|B|0-0-0,,PRINT>GR1,
651. BUTTON,"Causal Tracing",24,86,15,3,|Times New Roman|12|B|0-0-0,,"WORKBENCH>Sensitivity Traces",
652. BUTTON,"Perception to Trail",42,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS13
653. BUTTON,"Perception to Metro ",24,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS12
654. BUTTON,"Return to Main Menu",78,86,15,3,|Times New Roman|12|B|0-0-0,,"",Pricing
655. BUTTON,"Return to Sensitivity Run",60,86,15,3,|Times New Roman|12|B|0-0-0,,"",SETSENS
656. BUTTON,"Total Car Running",78,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS15
657. BUTTON,"Total Car Demand",60,80,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS14
658. BUTTON,"Total Bus Demand",60,67,15,3,|Times New Roman|12|B|0-0-0,,"",DISPLAYS4

!

:SCREEN DOANALYSIS

659. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0

!!

660. TEXTONLY,"Analysis Control",22,4,50,0,C|Times New Roman|36|B|0-0-255,,,
661. BUTTON,"Load, Unload and Reorder Previously Run Scenarios",23,13,50,3,L|Times New Roman|14||0-0-0,1,"MENU>LOAD_RUN|",
662. BUTTON,"List the Differences between the First Two Loaded Scenarios",23,18,50,3,L|Times New Roman|14||0-0-0,8,"",Difference
663. BUTTON,"Summary for Recently Run Scenario (First Loaded)",23,32,50,3,L|Times New Roman|14||0-0-0,2,"",Results
664. BUTTON,"Summary for the Comparison of Loaded Scenarios",23,37,50,3,L|Times New

Roman|14||0-0-0,3,"",Compare

665. BUTTON,"Trace the Use of a Variable ",23,72,50,3,L|Times New Roman|14||0-0-0,7,"",USE
666. BUTTON,"Trace Underlying Causes Using Graphs",23,65,50,3,L|Times New Roman|14||0-0-0,6,"",CausalB
667. BUTTON,"Trace Underlying Causes Using Trees",23,58,50,3,L|Times New Roman|14||0-0-0,5,"",CausalA
668. BUTTON,"Choose a Variable as a Start Point for Further Analysis",23,52,50,3,L|Times New Roman|14||0-0-0,4,"\
669. SPECIAL>SETWBITEM|Average Flow Rate&SPECIAL>VARSELECT|New Variable to Choose",
670. BUTTON,"Return to Main Menu",63,78,30,3,R|Times New Roman|14||0-0-0,1,"",Pricing
!
671. TEXTONLY,"Results",41,22,0,0,|Times New Roman|36|B|0-0-255,,,
672. TEXTONLY,"Causal Tracing",34,44,0,0,|Times New Roman|36|B|0-0-255,,,
!

:SCREEN Difference

673. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
!!
674. TEXTONLY,"Constant and Table Differences between First Two Loaded Scenarios",25,0,0,0,L|Times New Roman|14|B|0-0-255,,,
675. TOOL,"GR2",4,5,90,80,,,"WORKBENCH>RUNS COMPARE",
676. TEXTONLY,"Press P to Print-Press Any Key to Continue",3,89,0,0,,,,
677. BUTTON,"Print",41,88,10,3,,Pp,"PRINT>GR2",
678. ANYKEY,"",,,,,,,"",DOANALYSIS
!

:SCREEN Results

679. SCREENFONT,Times New Roman|10||0-0-0|192-255-255

PIXELPOS,0

!!"",10,2,0,0,,,,

680. COMMAND,,,,,,,,"SPECIAL>SUBSCRIPT|Bus S and D|"
681. RUNNAME,"*1",50,4,,,C|Times New Roman|30|B|0-0-255,,"",
682. TEXTONLY,"Average Flow Rate",10,11,0,0,|Times New Roman|12|B|0-0-0,,,
683. TEXTONLY,"Total Bus",36,11,0,0,|Times New Roman|12|B|0-0-0,,,
684. TEXTONLY,"Total Metro Cars",56,11,0,0,|Times New Roman|12|B|0-0-0,,,
685. TEXTONLY,"Total Bus Demand",79,11,0,0,|Times New Roman|12|B|0-0-0,,,
686. TEXTONLY,"Total Metro Demand ",10,36,0,0,|Times New Roman|12|B|0-0-0,,,
687. TEXTONLY,"Total Trail Demand",33,36,0,0,|Times New Roman|12|B|0-0-0,,,
688. TEXTONLY,"Conversion Rate",56,36,0,0,|Times New Roman|12|B|0-0-0,,,
689. TEXTONLY,"Revenue Accumulated",78,36,0,0,|Times New Roman|12|B|0-0-0,,,
690. TEXTONLY,"Total Car Demand",11,63,0,0,|Times New Roman|12|B|0-0-0,,,
691. TEXTONLY,"Total Car Running",33,63,0,0,|Times New Roman|12|B|0-0-0,,,
692. TEXTONLY,"Congestion Charging Price",54,63,0,0,|Times New Roman|12|B|0-0-0,,,
693. BUTTON,"Analysis of Scenario",80,75,0,3,|Times New Roman|14||0-0-0,,,DOANALYSIS
694. GRAPHVAR,"Average Flow Rate",6,14,20,20,L|Times New Roman|8||0-0-0,x%lyl[0|1e2],,
695. GRAPHVAR,"Total Buses",28,14,20,20,L|Times New Roman|8||0-0-0,x%lyl[0|2e3],,
696. GRAPHVAR,"Total Metro Cars",51,14,20,20,L|Times New Roman|8||0-0-0,x%lyl[0|20000],,
697. GRAPHVAR,"Total Bus Demand",74,14,20,20,L|Times New Roman|8||0-0-0,x%lyl[0|2e6],,
698. GRAPHVAR,"Total Metro Demand",6,40,20,20,L|Times New Roman|8||0-0-0,x%lyl[0|2e6],,
699. GRAPHVAR,"Total Trail Demand",28,40,20,20,L|Times New Roman|8||0-0-0,x%lyl[0|2e6],,
700. GRAPHVAR,"conversion rate",51,40,20,20,L|Times New Roman|8||0-0-0,x%lyl[0|10000],,
701. GRAPHVAR,"Revenue from Pricing Scheme",74,40,20,20,L|Times New Roman|8||0-0-

0,x%lyl[0|1e10],,

702. GRAPHVAR,"Total Car Demand",6,69,20,20,L|Times New Roman|8||0-0-0,x%lyl[0|1e6],,
703. GRAPHVAR,"total car running",28,69,20,20,L|Times New Roman|8||0-0-0,x%lyl[0|1e6],,
704. GRAPHVAR,"congestion charging price",51,69,20,20,L,x%lyl[0|100],,
!

:SCREEN Compare

705. SCREENFONT,Times New Roman|10||0-0-0|192-255-255
PIXELPOS,0
706. TEXTONLY,"Assumptions",12,2,,,|Times New Roman|18|B|0-0-255,,"",
707. RUNNAME,"*1",37,2,,,L|@Arial Unicode MS|12|B|0-0-0,,"",
708. RUNNAME,"*2",50,2,,,L|@Arial Unicode MS|12|B|0-0-0,,"",
709. RUNNAME,"*3",62,2,,,L|@Arial Unicode MS|12|B|0-0-0,,"",
710. RUNNAME,"*4",73,2,,,L|@Arial Unicode MS|12|B|0-0-0,,"",
711. RUNNAME,"*5",86,2,,,L|@Arial Unicode MS|12|B|0-0-0,,"",
712. LINE,"",34,6,60,0,,,,
713. LINE,"",46,6,0,80,,,,
714. LINE,"",58,6,0,80,,,,
715. LINE,"",70,6,0,80,,,,
716. LINE,"",82,6,0,80,,,,
717. LINE,"",94,6,0,80,,,,
718. LINE,"",34,86,60,0,,,,
719. LINE,"",34,6,0,80,,,,
720. TEXTONLY,"Average Passenger per Bus per Hour (0-80)",5,6,0,3,L|Times New Roman|12|B|0-0-0,,,
721. TEXTONLY,"Average Passenger per Metro Car per Hour(0-200)",5,9,0,3,L|Times New Roman|12|B|0-0-0,,,
722. TEXTONLY,"Average Time Keeping Using Trail (0-1440)",5,22,0,3,L|Times New Roman|12|B|0-0-0,,,
723. TEXTONLY,"Average Time Keeing Using Bus (0-3,600)",5,12,0,3,L|Times New

Roman|12|B|0-0-0,,,

724. TEXTONLY,"Average Time Keeping Using Car (0-5,400)",5,15,0,3,L|Times New Roman|12|B|0-0-0,,,
725. TEXTONLY,"Average Passenger Flow Rate for Trail (0-50)",5,25,0,3,L|Times New Roman|12|B|0-0-0,,,
726. TEXTONLY,"Average Time Keeping Using Metro (0-3,600)",5,19,0,3,L|Times New Roman|12|B|0-0-0,,,
727. TEXTONLY,"Average Trip Miles (0-40)",5,28,0,3,L|Times New Roman|12|B|0-0-0,,,
728. TEXTONLY,"Bus Life Time (0-5400)",5,31,0,3,L|Times New Roman|12|B|0-0-0,,,
729. TEXTONLY,"Carpool Mulplier (1-1.5)",5,34,0,3,L|Times New Roman|12|B|0-0-0,,,
730. TEXTONLY,"Cost per Metro Car (0-1,500,000)",5,37,0,3,L|Times New Roman|12|B|0-0-0,,,
731. TEXTONLY,"Employment Increment (0-10)",5,44,0,3,L|Times New Roman|12|B|0-0-0,,,
732. TEXTONLY,"Cost per Trail Mile(0-100,000)",5,41,0,2,L|Times New Roman|12|B|0-0-0,,,
733. TEXTONLY,"Fraction of Work Trip by Car (0-0.7)",5,47,0,3,L|Times New Roman|12|B|0-0-0,,,
734. TEXTONLY,"Fraction of Local Resident(0-0.5)",5,62,0,3,L|Times New Roman|12|B|0-0-0,,,
735. TEXTONLY,"Fraction of Work Trip by Metro (0-0.7)",5,50,0,3,L|Times New Roman|12|B|0-0-0,,,
736. TEXTONLY,"Fraction of Work Trip by Trail (0-0.75)",5,56,0,3,L|Times New Roman|12|B|0-0-0,,,
737. TEXTONLY,"Fraction of Work Trip by Bus (0-0.75)",5,53,0,0,L|Times New Roman|12|B|0-0-0,,,
738. TEXTONLY,"Fraction of Disabled People (0-0.01)",5,65,0,3,L|Times New Roman|12|B|0-0-0,,,
739. TEXTONLY,"Fraction of Work Trip Budget (0-0.2)",5,59,0,3,L|Times New Roman|12|B|0-0-0,,,
740. TEXTONLY,"Fruitfulness of Incurring Mobility(0-0.0008)",5,69,0,3,L|Times New

Roman|12|B|0-0-0,,,

741. TEXTONLY,"Fuel Price per Gallon(0-3.5)",5,72,0,3,L|Times New Roman|12|B|0-0-0,,,
742. TEXTONLY,"Insurance Premium per Day(0-3)",5,75,0,3,L|Times New Roman|12|B|0-0-0,,,
743. TEXTONLY,"Maintenance Expenditure per Mile (0-0.04)",5,79,0,3,L|Times New Roman|12|B|0-0-0,,,
744. TEXTONLY,"Metro Car Life Time (0-10800)",5,83,0,2,L|Times New Roman|12|B|0-0-0,,,
745. ANYKEY,"Press Any Key to Next Screen",20,10,,,,EeXx,"",Compare2
746. TEXTONLY,"Press Any Key to Next Screen",34,88,0,0,,,,
747. SHOWVAR,"average passenger per bus per hour&*1",37,7,0,0,L,,,
748. SHOWVAR,"average passenger per bus per hour&*2",50,7,0,0,,,,
749. SHOWVAR,"average passenger per bus per hour&*3",62,7,0,0,,,,
750. SHOWVAR,"average passenger per bus per hour&*4",75,7,0,0,,,,
751. SHOWVAR,"average passenger per bus per hour&*5",88,7,0,0,,,,
752. SHOWVAR,"average passenger per metro car per hour&*1",37,10,,,,,"",
753. SHOWVAR,"average passenger per metro car per hour&*2",50,10,,,,,"",
754. SHOWVAR,"average passenger per metro car per hour&*3",62,10,,,,,"",
755. SHOWVAR,"average passenger per metro car per hour&*4",75,10,,,,,"",
756. SHOWVAR,"average passenger per metro car per hour&*5",88,10,,,,,"",
757. SHOWVAR,"average time keeping using bus&*1",37,13,,,,,"",
758. SHOWVAR,"average time keeping using bus&*2",50,13,,,,,"",
759. SHOWVAR,"average time keeping using bus&*3",62,13,,,,,"",
760. SHOWVAR,"average time keeping using bus&*4",75,13,,,,,"",
761. SHOWVAR,"average time keeping using bus&*5",88,13,,,,,"",
762. SHOWVAR,"average time keeping using car&*1",37,16,,,,,"",
763. SHOWVAR,"average time keeping using car&*2",50,16,,,,,"",
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:SCREEN Compare3

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An increasing number of U.S. highways and roads experience overwhelming traffic congestion problems, even though most Interstate physical and safety conditions have improved. According to the GAO Report rush hour travel time on urban Interstates increased 12 percent from 1990 through 2000. State officials in nearly half of the states reported that urban congestion is already high,and officials from 41 states predicted that it will be high 10 years from now.State officials reported high rural congestion in only one state now, but expected it in 18 states within 10 years(GAO Report, 2002, p.27). The Federal Highway Administration echoes these findings in their report. Congestion extends to more time of the day, more roads, affects more travel, and creates more extra travel time than in the past. Congestion levels have risen in all cities of all sizes since 1982, indicating than even the smaller areas are not able to keep pace with rising demand (FHWA Report, 2004 p.1).Government estimates show that people living in the U.S. spend approximately 8 billion hours per year in traffic, and estimates of lost productivity due to traffic congestion range from $43 billion to $168 billion per year (see Sterman, 2000, p.178). According to a report from the Texas Transportation Institute (TTI) which measures traffic congestion trends from 1982 through 2003, traffic congestion is costing Americans, in selected 85 urban areas, $78 billion in wasted time and fuel annually, among which $63.1 billion is in extra fuel consumption. Specifically, drivers in Los Angeles, on the average, spent 136 hours a year in congested traffic, the worst in the nation. With 92 hours per driver, the Francisco metropolitan area was the second worst, followed by Washington, D.C. at 82 hours, and Houston, at 75.

Traffic congestion creates a number of costs:

1. there are the time costs such as increased average travel time and unexpected delays.
2. one can identify physical costs such as, extra fuel costs and faster depreciation of vehicles.
3. there are environmental costs associated with noise and air pollution.
4. Last but not least, one of the unintended consequences of traffic congestion is that it is very detrimental for community life. In round numbers, the evidence suggests that each additional ten minutes in daily commuting time cuts involvement in community affairs by ten percent (Putnam, 2000, p.213).

Since traffic flows continue to outpace the current resources available to improve the infrastructure and facilities, researchers and policy makers have begun to consider strategies that focus on travel demand management (TDM) to encourage travel that use the existing transportation system in ways that are less likely to generate congestion. This has the advantage that it does not require costly new road-building. TDM (Travel Demand Management) strategies use a variety of mechanisms to change travel patterns, including facility design, improved transport options, pricing, and land use changes.These affect travel behavior in various ways, including changes in trip scheduling, route, mode, destination, and frequency, plus traffic speed, mode choice and land use patterns.

One of the most important demand management strategies is congestion pricing.

Congestion pricing introduces different fees for road usage. The different fees or tolls may vary with the location, the time of a day and/or the level of traffic congestion. Drivers should pay to use a specific road, corridor, bridge, or to enter a particular area such as central business district (CBD) during some high volume time period. In the past, most of the work on congestion pricing has been of a static nature-the toll is not allowed to vary dynamically, with time of day and level of traffic on the highway, though the peak period tolls are still different from the off-peak tolls.

This research will study the dynamics of the transportation system when the dynamic congestion pricing policyis implemented for a cordon based metropolitan area.In doing so this research will address how congestion pricing for a cordon based metropolitan area can potentially affect:

1. The overall congestion level;
2. Investments in mass transit;
3. The environmental quality;
4. The residential quality of life;
5. Social equity;
6. Economic performance of local business.

Furthermore, it is important to understand the structure of the transportation system in conjunction with the social, environmental, economic systems with regard to the aspects of:

1. Physical
2. Decision Making
3. Organizational

It is also necessary to incorporate the notion of linguistic representation of key variables since precise and detailed data are not available or are not quantifiable. For example:

1. Perception of people to congestion level
2. Perception of people to supply &demand of alternative modes other than private cars.
3. Perception of people to environmental quality

:END-OF-REPORT

:REPORT TXT2

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This Management Flight Simulator for Congestion Pricing Policy is a Vensim Simulation Environment-based software application which employs the Venapp function to develop an esay-to-use interactive simulation software.

This application provides a series of buttons and other commands in multiple screens that lead the users or practitioner to go to the desired screen by which the specific simulation can be executed and analyzed.

Basically, this application software has five functions which consist of:

1. Structure display
2. Simulation and result analysis under different parameter assumptions and policy scenarios
3. Sensitivity simulation and result analysis
4. Variable causal tracing which has two kinds of display format i.e. tree-based and graph-based
5. Comparison of different loads

Among which, structure display is show the causal loop diagram of major feedback loops.

This software allows users to change the settings for some parameters and policies. After setting the parameters and policies, the software will internally load the model and exhibit the behavior of different variables on the screen. One can choose different variables to display on the screen. This application system also allows users to do sensitivity analysis by changing the minimum and maximum values. One can choose different variables to show.

Having done the model simulation and sensitivity, in the variable behavior screen, one button allows users to do analysis which leads to the screen in which the causal tracing function buttons are listed. One can choose to use tree- or graph-based causal tracing methods which shows the causal relationship of relevant variables. The application also provides the mechanism of comparing several different loads under different parameter settings and policies.
It is necessary to notice that this application system is an easy-to-operate software by
Which one can easily do the simulation and analysis.
:END-OF-REPORT

:REPORT TXT3

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THIS IS A MANAGMENT FLIGHT SIMULATOR
http://www.vensim.com/resource.html
For the development of this application, please refer to Vensim 5 DSS Reference Supplement for the Venapp Editing Function and document. It is also helpful to look at the example in the Vensim files.

1. By clicking the welcome screen, it leads you to the screen which displays the major features of this software.
2. Press any key, the appeared screen allows you to have a basic understanding upon the problem definition, application domain, and some guidance on how to use this application software. It provides the guidance for using current application software, problem statement for traffic congestion problem, and help functions.
3. When you select the guidance, problem statement or help buttons, it returns to the text files that provides specific illustration. As one selects the dynamics of transportation with congestion pricing policy. It returns to the screen that provides the major features of this simulator.
4. By press any key or the "Go to congestion pricing model" button, it returns pivotal screen that renders user do all kinds of analysis.
5. As one chooses the "Review Model Structure" button, it returns to the screen which allows users to view different causal loop diagrams and overall system structure.

6. Once user chooses the "Setup and Run a New Scenario" button, it returns to the screen of scenario assumptions and policies setting. In this screen, it lets user choose assumptions setting button or policy setting button. By pressing either of these two buttons, one can change the value setting for parameter assumptions and polices. And then, by clicking the "Run Scenario" button, one can have the behaviors of different variables. One can also choose any desired variable to display. As one chooses the "Run Sensitivity Analysis" button, it returns to the screen of Monte Carlo sensitivity analysis. This screen allows users to change the value settings of different constant variables. After pressing the "Run Monte Carlo Sensitivity Analysis" button, one can observe the behaviors for the sensitivity of different variables. By clicking the button with different variable name, sensitivity behaviors for other variables are showed.
7. In the pivotal screen, it returns to the analysis screen if one chooses the "Analyze Previously run Scenarios" button. In the analysis control screen, one load, unload, and reorder previous run scenarios. One can also observe the differences for the first two loaded scenarios. This screen leads users to the summary of recently run scenarios and comparison of loaded scenarios, too.

8. In the screen, it also allows users to choose one of the two causal tracing methods i.e. tree-based and graph-based. It also provides the tracing for the use of a specific variable.

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The cause and tracing screens display different variables. This application let you compare the result of different scenarios. The causal trees are to investigate the causal relationship among different variables as well as the structure of this model. You can double click any variable name in the graphs, trees or documentation to go to the analysis view for that variable. You can also choose a new variable to start the analysis. You can print the graphs and tracing trees using the P command or print button. In causal tracing structure, you can switch between the causal tree and graph representation of causes.

:END-OF-REPORT

Glossary

Alternative Modes: Alternative Modes here indicate the mass transit, walking, and bicycling.

Economic System: economic system involves various industries such as retail, and tourism

Horizontal Equity: horizontal equity is concerned with fairness between individuals and classes with comparable needs and resources. It assumes that “like should be treated alike”.

Induced Travel Demand: Induced travel demand is a term that has been widely used to describe the observed increase in traffic volume that occurs soon after a new highway is opened or a previously congested highway is widened.

Mental Models: mental models are the result of internal psychological representations of peoples' interactions with the world.

Political System: political system considers the government agencies and policies related to transportation.

Predict and Provide: predict and provide is based on the assumption that the predicted traffic growth must be provided for at all costs, inevitably results in promoting further congestion.

Public Security: public security here only denotes the security problems related to the mass transit and walking /bicycling.

Resident Bearing Capacity: resident bearing capacity is the maximum population can dwell in the cordon-based pricing area.

Social Network: a social network is a social structure between actors, mostly individuals or organizations. It indicates the ways in which they are connected through various social familiarities ranging from causal acquaintance to close familial bonds. The term was first coined in 1954 by J. A. Barnes (in: Class and Committees in a Norwegian Island Parish, “Human Relations”).

Social System: Social system is composed of the equity issues, social activities, travel and generic social behavior, and social connections.

TEA-LU: TEA-LU represents Transportation Equity Act: A Legacy for Users.

Traffic Congestion: traffic congestion occurs when the volume of traffic on a roadway is high enough to become detrimental to its performance. In congested conditions, vehicle speeds are reduced, increasing drive times. These conditions are also more frustrating for drivers (see road

rage), and automobile accidents may be more frequent. Furthermore, vehicles burn unnecessary fuel when stuck at idle. A period of extreme traffic congestion is known as a traffic jam. Congestion can be measured in various ways, including roadway Level of Service (LOS), average traffic speed, and average congestion delay compared with free-flowing traffic ("Congestion Costs," Litman, 2004a). The capacity of a road depends on various design factors such as lane widths and intersection configurations.

Transportation-socioeconomic System: transportation-socioeconomic system denotes the system constructed by the subsystems, namely, economic subsystem, political subsystem, environmental subsystem, transportation subsystem, and social system, and their interactions. That is to say that the transportation socioeconomic system not only considers transportation system but also the feedback linkages between transportation system and other systems, by which the large system concepts can examine the impacts of transportation system change on it environment as well as the impacts of the environment change on the transportation system.

Transportation System: transportation system includes the road subsystem, vehicles, passengers, demand and supply of transportation capacity, and transportation-related policies.

Travel Demand Management (TDM): travel demand management is the strategy that uses a variety of mechanisms to change travel patterns, including facility design, improved transport options, pricing, and land use changes. These affect travel behavior in various ways, including changes in trip scheduling, route, mode, destination, and frequency, plus traffic speed, mode choice and land use patterns.

Vertical Equity: vertical equity is concerned with the treatment of individuals and classes that are unlike. By this principle, the distribution of costs and benefits should reflect people's needs and abilities.

Visual Intrusion: visual intrusion is the undesirable aesthetic feeling caused by the visual impact of congested roads.

Curriculum Vitae

The author Shiyong Liu was born in Wuqiao County, Hebei Province, People's Republic of China. His father was an orphan. Therefore, his father was illiterate due to the lack of education. In this poor but warm family, his childhood was tough and rememberable. Without instruction in education, he struggled to step out of that helpless predicament. He enrolled at Daqing Petroleum Institute in 1994. In 1998, he graduated with a bachelor degree in Engineering and got opportunity to work in an American Company in China. During that period of time, he also enrolled Guangdong University of Technology. In 2002, he got his master degree in Management Science and Engineering. He thought he should go outside to see the broad world. In 2002, he got an offer from ISE department of Virginia Tech. He started his first job in US in Oct, 2007,