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Analysis of Input Variables for a Pre-Feasibility Evaluation Model for Toll Highways

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Center for Transportation Research
University of Texas at Austin
3208 Red River, Suite 200
Austin, Texas 78705-2650

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16. Abstract:

In recent years, private industry has been more involved in highway financing and operation. Many countries have started to apply new or improved strategies to promote the development of highway projects using sources other than the State. The most widely used concept is the scheme known as Build-Operate-Transfer (T-O-T). The major problem related to private highway participation is the high financial risk involved. This is caused mainly by the difficulty to forecast future revenue because the toll traffic usage, which is the major souci of income, is hard to predict accurately. This report analyzes the main variables affecting a toll highway project, and develops mathematical models that describe their behavior. These models can serve as a tool in the decision-making process during the planning and operation of the facility. This study focuses on the development of a toll traffic estimation model based on the attributes of the highway and the elasticity of the demand. The goal is to estimate the amount of traffic that could be diverted to the toll facility in an existing corridor with a free access road as an alternate route. Some possible methods to estimate the toll price are discussed as well as an analysis to determine the optimum toll. The Mexican experience is used as a case study to develop empirical models.

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ANALYSIS OF INPUT VARIABLES FOR A PRE-FEASIBILITY EVALUATION MODEL FOR TOLL HIGHWAYS

by

Juan J. Orozco

B. Frank McCullough

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Southwest Region University Transportation Center
Center for Transportation Research
The University of Texas at Austin
Austin, Texas 78712

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ABSTRACT

In recent years, private industry has been more involved in highway financing and operation. Many countries have started to apply new or improved strategies to promote the development of highway projects using sources other than the State. The most widely used concept is the scheme known as Build-Operate-Transfer (B-O-T). The major problem related to private highway participation is the high financial risk involved. This is caused mainly by the difficulty to forecast future revenue because the toll traffic usage, which is the major source of income, is hard to predict accurately. This report analyzes the main variables affecting a toll highway project, and develops mathematical models that describe their behavior. These models can serve as a tool in the decision-making process during the planning and operation of the facility. This study focuses on the development of a toll traffic estimation model based on the attributes of the highway and the elasticity of the demand. The goal is to estimate the amount of traffic that could be diverted to the toll facility in an existing corridor with a free access road as an alternate route. Some possible methods to estimate the toll price are discussed as well as an analysis to determine the optimum toll. The Mexican experience is used as a case study to develop empirical models.

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EXECUTIVE SUMMARY

In recent years, the private participation has become a widely used solution for highway financing. From the transportation point of view, highway systems are not viewed solely as government responsibility. The private sector can serve in all the phases including the planning, developing, financing, constructing, operating and owning the facility. Some countries have used concepts based on this to promote the development of highway projects using sources other than the State. Some of these countries are currently using a concept known as Build-Operate-Transfer (B-O-T) that involves private sector participation during some or all of the stages of a highway project. In almost all the cases, a private firm takes care of financing, constructing, operating and maintaining the system during a certain pre-established period and is entitled to make a profit.

The major problem for private sector highway participation is the high financial risk involved. This is attributed primarily to the difficulty of forecasting future revenues, which come from the vehicles that use the facility and the user willingness to pay for its use, two tasks which are hard to predict. The accurate forecasting of the expenses, yielded mainly by the maintenance of the pavement, is also hard to estimate.

In the last eight years, a large number of highways have been built in Mexico under the "Concession Scheme," which is based on Build-Operate-Transfer (B-O-T) concepts. The Mexican highway construction program was very ambitious, requiring the equivalent of $6.5 billion US dollars to be provided by the private sector for 5,400 km of new toll roads and eight bridges. [20] Since the concession program was first launched in 1989, some problems have been identified. Besides the political issues, in many cases the primary flaw was an excessive overestimation of the initial ADT. In addition, the actual demand was significantly less than the projected demand because of the high toll prices.

This points out the importance that a reliable estimation of the traffic (ADT) and an optimum selection of the toll price have in a highway project. This study is mainly focused towards the analysis of these topics and how they interact with each other. In order to do this, the Mexican case was analyzed as a test case by taking advantage of their recent experience and the availability of the necessary data. In Mexico, there are currently more than fifty toll highways operating under the Concession Scheme. For the purpose of this study, only twenty-nine cases were analyzed due to the complete data availability. These cases were selected to provide highways representing the different conditions that affect highway projects, such as geographic location, kind of terrain, or type of pavement.

The aim of this study is to quantify the variables that affect a toll highway project by developing mathematical models that describe their behavior. By achieving this primary objective, the following subobjectives were also attained:

1. Development of a mathematical model that can be part of a feasibility evaluation model to be used as a tool by planners.
2. Development of a traffic forecast model based on the physical characteristics of the facility and the elasticity of the demand analyzed in terms of the toll price.
3. A discussion of several possible methods to estimate the amount of the toll price.
4. An analysis to find the optimum toll that yields the maximum gross income.

To achieve the primary objective, an analysis to develop empirical models using the data from the case study was carried out. To develop these models, the interrelationship between traffic and toll price was analyzed. The models were based on the physical characteristics of the highway, i.e. the distance to be covered, the time needed to cover that distance, and the cost incurred by the user of the roadway.

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CHAPTER 1. INTRODUCTION

BACKGROUND

In recent years, the private participation has become a widely used solution for highway financing. From the transportation point of view, highway systems are not viewed solely as government responsibility; the private sector can serve in all the phases including the planning, developing, financing, constructing, operating and owning the facility. Some countries have used concepts based on this to promote the development of highway projects using sources other than the State. Some of these countries are currently using a concept known as Build-Operate-Transfer (B-O-T) that involves private sector participation during some or all of the stages of a highway project. In almost all the cases, a private firm takes care of financing, constructing, operating and maintaining the system. During a certain pre-established period, the private company is entitled to make a profit out of the system. When this period is finished, the firm has to transfer the facility to the state. There are some variants of the B-O-T concept including B-O-O-T (Build-Own-Operate-Transfer) and B-T-O (Build-Transfer-Operate).

Although the quality of the work force in private industry is not necessarily better than the public sector, there are many advantages to the inclusion of the private sector in the financing, constructing and operation of highway facilities. [20] Experience has demonstrated that projects involving private participation have some clear advantages such as enhanced performance, less concern with politics, lower costs, better information, and competition.

The major problem for private sector highway participation is the high financial risk involved. This is attributed primarily to the difficulty of forecasting future revenues, which come from the vehicles that use the facility and the user willingness to pay for its use, two tasks hard to predict. The accurate forecasting of the expenses, yielded mainly by the maintenance of the pavement, is also hard to estimate.

OBJECTIVE

The objective of this study is to quantify the variables that affect a toll highway project by developing mathematical models that describe their behavior. By achieving this primary objective, the following subobjectives may be attained.

1. Develop a mathematical model that can be part of a feasibility evaluation model to be used as a tool by planners.

2. Develop a traffic forecast model based on the physical characteristics of the facility and the elasticity of the demand analyzed in terms of the toll price.
3. Discuss several possible methods to estimate the amount of the toll price.
4. Perform an analysis to find the optimum toll that yields the maximum gross income.

ANALYSIS CONCEPTS

To achieve the primary objective, an analysis to develop empirical models using data from a specific case study is carried out. To develop this models, the interrelationship between traffic and toll price is analyzed. The models are based on the physical characteristics of the highway, i.e. the distance to be covered, the time needed to cover that distance, and the cost incurred by the user of the roadway.

Throughout the study, a comparison is made between the physical characteristics or attributes of the toll highway and those of a free access road going from the same origin to the same destination. The free access road is also referred to as "alternative route" since the user always has the opportunity to choose between the two options. This study describes the user response to use the toll facility as a function of the advantages offered in distance, time and cost.

METHODOLOGY AND SCOPE

The overall methodology of the study is illustrated in Figure 1.1 in terms of a step by step procedure. The process is organized into five sections with each being covered by one chapter.

The first step of the process is to obtain the physical characteristics of both highways between the same origin and destination, as well as the total Average Daily Traffic (ADT) along the route. The required characteristics are the lengths of both highways and the travel time or speed, since one is dependent of the other. These items are covered in Chapter 2.

The next task is to develop the traffic forecasting model based on the attributes of both highways. This attributes are travel distance, travel time and user cost. In order to achieve this, each highway is related to a Level of Service based on the travel speed, which is then used to estimate the user cost associated with both alternatives. The predicted traffic potentially diverted to the toll road is represented as a percentage of the total ADT in the route. These items are covered in Chapter 3.

The following step, covered in Chapter 4, is to determine the relationship between traffic and toll price, using an elasticity study. Once a mathematical function describing the user response to toll changes is determined, the traffic predicted by the model previously developed can be adjusted.

Next are briefly discussed some different methods to estimate the toll price, based on different bases or criteria. Developing a model to determine the amount of the toll could be the objective of an entire study. The purpose here however, is just to present the main issues that should be considered by the analyst. This is covered in Chapter 5.

Finally, using the models developed in the previous chapters, an analysis of the income versus the toll price is made in Chapter 6 to determine the optimum toll. The optimum toll is that which would yield the maximum gross income.

Chapter 7 presents the conclusions and recommendations of the study. Some highlights for the use of the models are pointed out and some comments for further research are presented.

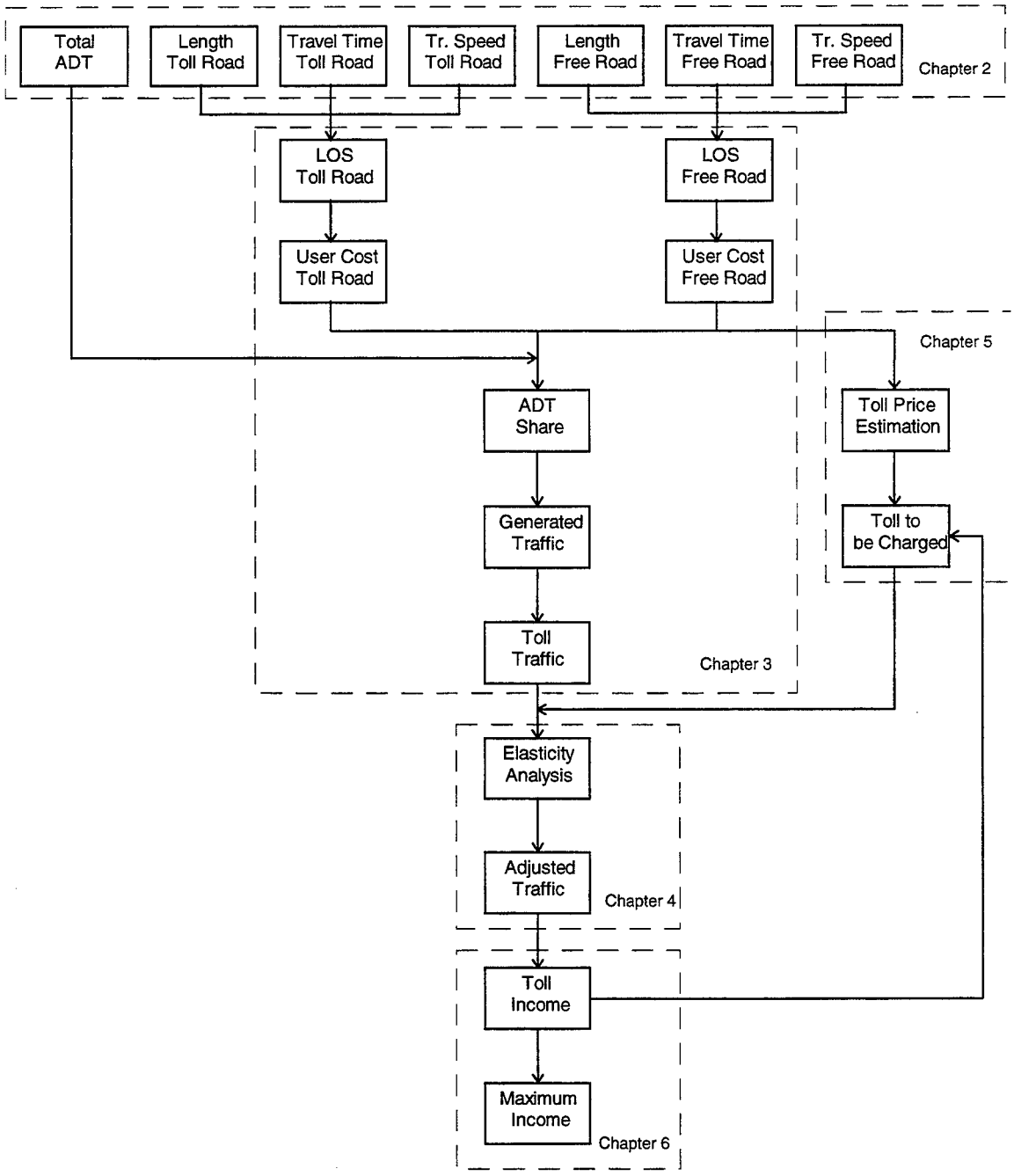


Figure 1.1 Methodology used in the study for the analysis

CHAPTER 2. CASE STUDY

This chapter gives an overview of the case study used for the analysis. The reasons for selecting the Mexican case are indicated and some basic concepts of private participation schemes are described.

OVERVIEW

Mexico has recently explored new financing strategies which involve the private sector in the highway development. In the last eight years, a large number of highways have been built in Mexico under the "Concession Scheme," which is based on Build-Operate-Transfer (B-O-T) concepts. In the B-O-T projects, a private company finances, constructs, and operates the system for a pre-established period, after which, the facility is transferred to the government. When this scheme was first implemented in Mexico, the Ministry of Communications and Transportation (SCT) acting as the governing agency, guaranteed the minimum Average Daily Traffic (ADT) for the concession period to the bidding companies. The project was awarded to the company offering the minimum construction cost and the minimum concession period. The longer the concession period, the more time the concessionaire has to recover the investment and pay back the loan. So for a longer period, the toll to be charged to the users would be less than the toll required for a short concession period. Thus, the short concession period criterion used by the SCT to award the project implied the maximum toll price, because the investor has less time to recover the investment.

The Mexican highway construction program was very ambitious, requiring the equivalent of $6.5 billion US Dollars to be provided by the private sector for 5,400 km of new toll roads and eight bridges. [20] Since the concession program was first launched in 1989, some problems have been identified. Besides the political issues, the primary flaw was by an excessive overestimation of the initial ADT in many cases In addition, the actual demand was significantly less than the projected demand because of the high toll prices. Most of the projects experienced financial problems early in their life, thus they had to be restructured by the SCT on two occasions. The first time the agency granted the concessionaire funds to assist in paying the interest to the financial institutions; and in the second case the toll rates were reduced, and the concession period was extended for selected projects. The problem was also aggravated by the adverse economic crisis that the country has experienced since the beginning of 1995. This adverse

economic situation was caused by the political instability that Mexico experienced immediately after the presidential succession.

Even though the Concession Scheme has experienced some problems in Mexico, it might be an excellent solution to the highway financing issue, once the initial problems are solved. The generation of a model that reliably predicts the behavior of the demand and the tolls, and estimates the optimum toll price for each project, can alleviate many of these problems.

The recent experience in Mexico points out the importance that a reliable estimation of the traffic (ADT) and an optimum selection of the toll price have in a highway project. This study is mainly focused towards the analysis of these topics and how they interact with each other. In order to do this, the Mexican case is analyzed as a test case by taking advantage of their recent experience and the availability of the necessary data.

DEFINITION OF THE CASE STUDY

In Mexico, there are currently more than fifty toll highways operating under the Concession Scheme. For the purpose of this study, only twenty-nine cases are analyzed due to the complete data availability. These cases were selected to provide highways representing the different conditions that affect highway projects, such as geographic location, kind of terrain, or type of pavement.

PRIMARY DATA

The information to be analyzed comes from the records kept for the SCT [10, 16] and the Mexican Association of Concessioned Infrastructure (AMICO). [13] In Table 2.1, the toll highway data to be analyzed are shown. The table contains the highway name (origin and destination), length, construction cost, travel time, Average Daily Traffic (ADT), concession period, ADT distribution for cars, buses and trucks, and the toll price.

In all the cases, there is an alternate route referred to as the free access road, which connects the same origin to the same destination as the toll road. This is the path the user always has the opportunity to choose. In Chapter 4, a comparison of these two options is made in terms of time, distance, and costs to the user.

Table 2.2 shows data for the parallel free access roads for each of the toll roads in Table 2.1. This table contains the name of the toll facility with its length, travel time, ADT, and ADT distribution that would be the alternate route for the free access highway.

Appendices A and B contain more detailed data used for the computations in this study.

TABLE 2.1 PRIMARY DATA FOR TOLL ROADS USED IN THE ANALYSIS

No.	TOLL ROAD	LENGTH	CONST.	TRAVEL	ADT	CONSC.	ADT DISTRIBUTION (%)			TOLL PRICE ($)*		
		(km)	COST* ($x10^6$)	TIME (hr)	(YR 1996)	PERIOD	CAR	BUS	TRUCK	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	47	61.7	0.43	2388	14	84	6	10	3.72	9.23	15.26
2	ATLACOMULCO-MARAVATIO	64	88.5	0.58	4073	20	78	9	14	3.21	4.74	9.49
3	CADEREYTA-REYNOSA	175	230.1	1.59	2458	12	88	7	5	12.05	12.69	23.85
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	157	-	1.43	2095	17	63	15	22	3.85	23.08	46.15
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	34	29.2	0.31	4467	20	49	6	45	2.56	5.00	11.28
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	21	108.8	0.19	3129	25	87	10	3	4.10	12.05	24.10
7	CORDOBA-VERACRUZ	108	203.2	0.98	4147	30	77	16	7	9.87	15.90	29.49
8	CUERNAVACA-ACAPULCO	263	1652.1	2.39	4199	15	84	12	3	32.44	56.41	97.31
9	CHAMAPA-LECHERIA	30	208.6	0.27	18927	18	92	0	8	2.82	4.62	11.28
10	DELICIAS-CAMARGO	65	39.4	0.59	2208	20	71	13	16	3.08	7.69	15.38
11	DURANGO-YERBANIS	105	109.2	0.95	650	30	82	10	8	7.82	13.21	25.13
12	ECATEPEC-PIRAMIDES	22	30.6	0.20	12727	19	78	13	9	1.67	5.26	10.13
13	GUADALAJARA-COLIMA	148	305.0	1.35	4478	20	79	6	16	9.23	11.41	22.95
14	GUADALAJARA-ZAPOTLANEJO	26	32.2	0.24	14096	20	81	11	8	1.92	3.08	6.79
15	LA TINAJA-COSOLEACAQUE	228	535.9	2.07	1676	16	69	19	12	21.15	31.41	61.54
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	116	229.4	1.05	2755	30	81	7	12	9.87	14.62	30.64
17	LIBRAMIENTO DE FRESNILLO	33	25.0	0.30	3742	14	56	8	36	1.41	2.31	3.97
18	LIBRAMIENTO NORESTE DE QUERETARO	37	90.3	0.34	4030	30	55	10	35	2.56	4.23	4.62
19	LIBRAMIENTO ORIENTE DE SALTILLO	22	17.9	0.20	3329	20	47	6	47	1.54	2.18	0.00
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	34	45.3	0.31	1932	30	31	5	64	2.56	4.49	4.49
21	LIBRAMIENTO PONIENTE DE TAMPICO	14	26.2	0.13	2601	12	34	0	66	2.18	3.08	5.90
22	MAZATLAN-CULIACAN	182	403.3	1.65	1860	14	73	16	11	14.10	22.44	47.82
23	MERIDA-CANCUN	240	144.6	2.18	1216	18	74	17	9	15.26	29.23	63.59
24	MONTERREY-NUEVO LAREDO	146	168.6	1.33	3040	23	85	8	7	12.05	19.74	37.44
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	26	25.4	0.24	3079	30	74	19	8	2.18	4.23	7.56
26	TEPIC-ENTRONQUE SAN BLAS	25	33.6	0.23	4196	20	73	14	13	2.18	3.33	6.41
27	TIJUANA-TECATE-LIB. TECATE	35	65.4	0.32	3696	30	85	8	7	3.21	4.74	8.85
28	TORREON-CUENCAME-YERBANIS	119	128.2	1.08	1406	30	70	17	13	9.87	16.41	31.54
29	ZAPOTLANEJO-LAGOS DE MORENO	152	218.2	1.38	3931	14	80	10	10	11.28	15.38	31.41

*US Dollars (1996), 1 Dollar = 7.8 Pesos

TABLE 2.2 PRIMARY DATA FOR PARALLEL FREE ACCESS ROADS USED IN THE ANALYSIS

No.	FREE ACCESS ROAD	LENGTH	TRAVEL TIME	ADT	ADT DISTRIBUTION (%)		
		(km)	(hr)	(YR 1996)	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	47	0.52	2726	79	8	13
2	ATLACOMULCO-MARAVATIO	79	0.94	2497	74	5	21
3	CADEREYTA-REYNOSA	192	2.34	5780	75	6	20
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	151	1.38	1927	67	7	26
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	54	0.66	2000	-	-	-
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	20	0.26	14512	79	4	17
7	CORDOBA-VERACRUZ	126	1.59	6640	73	9	19
8	CUERNAVACA-ACAPULCO	356	4.36	2165	72	8	20
9	CHAMAPA-LECHERIA	67	0.78	7936	-	-	-
10	DELICIAS-CAMARGO	75	0.68	1335	77	4	19
11	DURANGO-YERBANIS	121	1.40	2202	75	4	20
12	ECATEPEC-PIRAMIDES	47	0.59	4350	81	3	16
13	GUADALAJARA-COLIMA	210	2.66	2822	74	4	22
14	GUADALAJARA-ZAPOTLANEJO	30	0.37	12357	67	6	27
15	LA TINAJA-COSOLEACAQUE	241	2.97	5242	70	7	23
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	129	1.59	5385	72	6	22
17	LIBRAMIENTO DE FRESNILLO	41	0.47	5706	-	-	-
18	LIBRAMIENTO NORESTE DE QUERETARO	40	0.39	9890	66	7	27
19	LIBRAMIENTO ORIENTE DE SALTILLO	55	0.66	7203	60	5	35
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	94	0.86	6940	73	6	21
21	LIBRAMIENTO PONIENTE DE TAMPICO	28	0.38	9870	61	7	32
22	MAZATLAN-CULIACAN	216	2.56	4090	62	7	31
23	MERIDA-CANCUN	322	3.59	1820	80	5	15
24	MONTERREY-NUEVO LAREDO	231	2.54	4575	77	5	18
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	35	0.41	3111	79	6	15
26	TEPIC-ENTRONQUE SAN BLAS	34	0.58	3525	65	7	28
27	TIJUANA-TECATE-LIB. TECATE	81	1.06	4953	68	5	27
28	TORREON-CUENCAME-YERBANIS	133	1.61	2780	73	6	21
29	ZAPOTLANEJO-LAGOS DE MORENO	201	2.81	7025	73	6	21

CHAPTER 3. TOLL TRAFFIC ESTIMATION

For the toll road developers and operators, the revenue generation and corresponding profitability of toll facilities are critical. The success of a toll highway project depends to a large extent on traffic prediction reliability, as was demonstrated by the recent experience in Mexico. The revenue generated by a toll road is directly proportional to the traffic volume using the facility and the toll prices levied on the various vehicle categories. Generally, the financial feasibility of a toll highway project depends on both the toll price and the demand level. In this chapter, various toll traffic estimation methods are examined, and an analysis of the data for the case study is performed.

Despite the importance of toll traffic demand prediction, previous research projects [6] found that there is no efficient procedure for such an estimation so far, nor is there available literature on comprehensive treatments of toll usage forecasting. For estimation of traffic on toll facilities, it is a common practice for many analysts to first estimate the traffic that would be diverted to the new facility if it were a free access road going from the same origin and destination, and then reduce the estimated traffic volume considering the toll restraint. In the case of Mexico, there is a free access road in all the routes that acts as an alternate path to the toll highway. Therefore, the amount of traffic attracted to the toll facility can be analyzed as a percentage of the total traffic with the same origin and destination.

REVIEW OF DIFFERENT METHODS

To better describe the toll traffic estimating methods, a brief historic review is presented. Most of the methods analyzed are not current, but they are still applicable. However it has to be recognized that the actual conditions are not the same and some values need to be updated with current data.

The following procedures are summarized in "Highway Traffic Estimation" (1956): [17]

1. Estimate the traffic that would be attracted to the facility if it were a free access road, using origin and destination surveys together with time-delay studies, if possible, and using diversion curves to estimate diversion.
2. Sixty-five to seventy-five percent of this total free demand would be allocated as potential toll trips. Values of about forty percent for equal travel time and ninety percent for equal travel distance are suggested by the Bureau of Public Roads. (1954)

3. About twenty-five percent of the anticipated normal traffic in the immediate corridor would be added as induced traffic.

"Toll Roads and Free Roads" (1939) states:

> No more than about one-third of the vehicles that might use a typical free road could be considered as potential traffic if it were operated as a toll facility. It is also estimated three years after completion of a route this traffic would increase the total diverted traffic by twenty percent. Factors ranging from 0.167 to 0.4 were used to estimate the traffic converted to a toll facility. [18]

In "Traffic and Financial Studies for Toll Turnpikes" (1953), the author says that:

> If the toll charge in a specific instance would be less than the value of time that would be saved, we allocate an appropriate portion of the traffic to the proposed toll road. The maximum allocation –usually about eighty-five percent— is made when the value of time saved would be equal to at least twice the toll charge. [19]

Practically speaking , the estimation of the toll traffic volume depends on the traveler's decision of whether to choose the toll facility or the alternate route. Thus, it results relevant to analyze the process that the traveler follows during the decision-making process before choosing one of the alternatives. [6]

From the review, it was found that the amount of traffic diverted to the toll highway would depend mainly on the advantages that it represents to the user, such as savings in time, operation cost or distance, the increase in safety and comfort, and of course the selected toll price.

The time-saving issue is very important for many users, but it is also sometimes difficult to estimate the value of time for different types of users because not all the people value their time the same way. In this study, one decision criteria to evaluate the willingness to use the toll highway is the savings in terms of user cost, which also considers travel time and distance. The elements considered in this cost are explained in Chapter 4.

When a toll road is incorporated on a network, the users may or may not divert to the toll facility. Some of the users may even increase trip frequency as a result of the new trip choice. The new route may be attractive to the user if it represents advantages in terms of improved level of service, travel time, and reduced travel distance.

In a recent study, [6] the authors discuss two approaches to estimate toll road usage, a traditional aggregate approach, and techniques based on discrete choice models.

The traditional aggregate approach is based on some of the principles outlined at the beginning of this review. To estimate the toll traffic demand, the following steps are used:

1. Code a computer network with the generalized cost of travel and identify the present link flows by this computer method.
2. Incorporate the toll facility as a link in the network.
3. Estimate the equivalent time penalty of the toll price by an average value of the travel time, and allocate this additional time penalty to the toll road link.
4. Using a selected assignment algorithm, assign an origin-destination table to the network.

This approach has several shortcomings. The time penalty in toll links is just a rough approximation, dependent on the user perception of the value of travel time and its relationship with the toll price. Also, the model produces extremely sensitive assignment patterns. Based on this approach, any toll route could change from the shortest to the "second best" alternative, and vice versa due to toll price or travel time changes. The use of this model is not recommended as a method to analyze complex route choice phenomena. Another possible alternative is the use of discrete choice models based on consumer choice theory.

During the same study, the authors discuss the usage of the typical discrete choice models, Logit and Probit, and analyze the difficulty of using them in modeling the route assignment step. Following, these two methods are briefly explained and their advantages and disadvantages are discussed.

a) Logit Model.

This is a random utility model widely used to predict mode choice in both urban and intercity applications. This model is based on the assumption that the choice of the user of whether or not use the facility can be represented by a utility function. The utility of an alternative depends on the attributes of the alternative and characteristics of the user who is assumed to choose the alternative that represents the highest utility.

The multinominal Logit model, which is the simplest and more frequently used random utility model, assumes an independent and identical distributed (IID) pattern with the Gumbel distribution. It has been recognized that the multinominal Logit model is inappropriate for use with components of utility that are not IID across alternatives and

observations of choices. For example, this model is not applicable when alternatives have common unobserved attributes that influence choice.

b) Probit Model.

A more flexible way to deal with the IID assumption of multinominal Logit model is to assume that the random components of utility have a multivariate normal distribution, which leads to the multinominal Probit model.

Unfortunately, this model has some problems as well. There is no closed analytic form for the integrals of the multivariate normal density function, and they must be evaluated numerically. When there are more than three alternatives, this model presents severe computational difficulties. For this reason, this model is not used frequently. This could change when more powerful computational tools are developed in the future.

When the availability of the data allows the analysis of the travel demand elasticity, it could be a convenient method of estimating toll traffic because it is quick and inexpensive. This issue will be discussed in the next chapter.

Whenever possible, it is a good practice to analyze the available data to determine the actual behavior of the toll traffic as a percentage of a total vehicle volume going from the same origin to the same destination.

DATA ANALYSIS FOR THE CASE STUDY

In this part of the study, an analysis of the actual data for the Mexican case is presented. As mentioned in the last chapter, twenty-nine toll highways were analyzed and compared with their alternate routes. In Table 3.1, the total traffic volume for the highways under study is presented, as well as the distribution on the toll and free roads. Table 3.2 shows the ADT diverted to the toll facilities as a percentage of the total traffic in each corridor. Figure 3.1 shows the cumulative distribution of the traffic from the free access road to the toll road in terms of ADT and vehicle type for the twenty-nine cases. Note that the diversion is the greatest for buses and the lowest for trucks. Obviously the time value of the bus passengers makes the toll road alternative an attractive one.

In order to find the relationship between the percentage of traffic diverted to the toll facility as a function of the advantage for the user, three approaches were used in this study. They are travel distance, travel time, and user cost. In the following subsections, each of these parameters

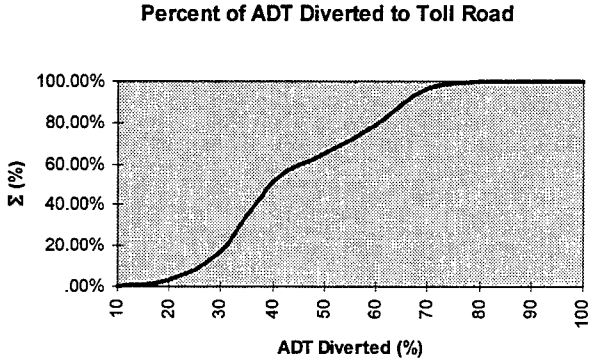
are evaluated individually, i.e. component, and then the total relationship is derived by multi-regression analysis.

TABLE 3.1 ADT SHARE FOR TOLL AND FREE ACCESS ROADS

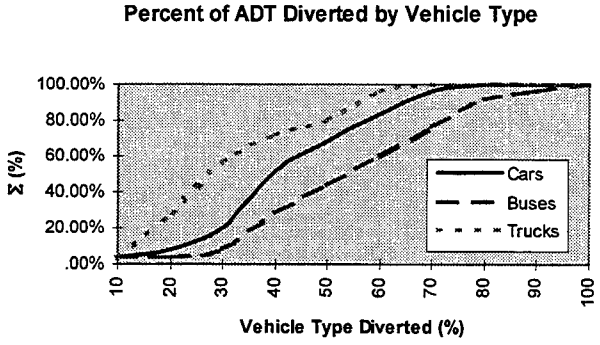
No.	ROUTE	TOTAL ADT (YR 1996)	TOLL ROAD		FREE ACCESS ROAD	
			ADT	ADT (%)	ADT	ADT (%)
1	ARMERIA-MANZANILLO	5114	2388	47	2726	53
2	ATLACOMULCO-MARAVATIO	6570	4073	62	2497	38
3	CADEREYTA-REYNOSA	8238	2458	30	5780	70
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	4022	2095	52	1927	48
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	6467	4467	69	2000	31
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	33439	18927	57	14512	43
7	CORDOBA-VERACRUZ	9769	3129	32	6640	68
8	CUERNAVACA-ACAPULCO	6312	4147	66	2165	34
9	CHAMAPA-LECHERIA	12135	4199	35	7936	65
10	DELICIAS-CAMARGO	3543	2208	62	1335	38
11	DURANGO-YERBANIS	2852	650	23	2202	77
12	ECATEPEC-PIRAMIDES	17077	12727	75	4350	25
13	GUADALAJARA-COLIMA	7300	4478	61	2822	39
14	GUADALAJARA-ZAPOTLANEJO	26453	14096	53	12357	47
15	LA TINAJA-COSOLEACAQUE	6918	1676	24	5242	76
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	8140	2755	34	5385	66
17	LIBRAMIENTO DE FRESNILLO	8307	2601	31	5706	69
18	LIBRAMIENTO NORESTE DE QUERETARO	13632	3742	27	9890	73
19	LIBRAMIENTO ORIENTE DE SALTILLO	11233	4030	36	7203	64
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	10269	3329	32	6940	68
21	LIBRAMIENTO PONIENTE DE TAMPICO	11802	1932	16	9870	84
22	MAZATLAN-CULIACAN	5950	1860	31	4090	69
23	MERIDA-CANCUN	3036	1216	40	1820	60
24	MONTERREY-NUEVO LAREDO	7615	3040	40	4575	60
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	6190	3079	50	3111	50
26	TEPIC-ENTRONQUE SAN BLAS	7721	4196	54	3525	46
27	TIJUANA-TECATE-LIB. TECATE	8649	3696	43	4953	57
28	TORREON-CUENCAME-YERBANIS	4186	1406	34	2780	66
29	ZAPOTLANEJO-LAGOS DE MORENO	10956	3931	36	7025	64
	Sum=	273895	122531		151364	
	Average=			43		57
	Standard Deviation=			15.32		15.32

TABLE 3.2 PERCENTAGE OF ADT DIVERTED TO TOLL HIGHWAYS FOR CARS, BUSES AND TRUCKS

No.	ROUTE	ADT DIVERTED TOLL ROAD		
		CAR (%)	BUS (%)	TRUCK (%)
1	ARMERIA-MANZANILLO	48	39	40
2	ATLACOMULCO-MARAVATIO	63	73	52
3	CADEREYTA-REYNOSA	33	35	10
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	51	70	48
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	-	-	-
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	59	75	20
7	CORDOBA-VERACRUZ	33	47	15
8	CUERNAVACA-ACAPULCO	69	75	24
9	CHAMAPA-LECHERIA	-	-	-
10	DELICIAS-CAMARGO	60	84	58
11	DURANGO-YERBANIS	24	40	10
12	ECATEPEC-PIRAMIDES	74	93	63
13	GUADALAJARA-COLIMA	63	68	53
14	GUADALAJARA-ZAPOTLANEJO	58	68	26
15	LA TINAJA-COSOLEACAQUE	24	46	14
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	37	38	22
17	LIBRAMIENTO DE FRESNILLO	-	-	-
18	LIBRAMIENTO NORESTE DE QUERETARO	24	35	33
19	LIBRAMIENTO ORIENTE DE SALTILLO	30	41	43
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	17	28	59
21	LIBRAMIENTO PONIENTE DE TAMPICO	10	1	29
22	MAZATLAN-CULIACAN	35	51	14
23	MERIDA-CANCUN	38	69	29
24	MONTERREY-NUEVO LAREDO	42	51	20
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	48	75	33
26	TEPIC-ENTRONQUE SAN BLAS	57	70	36
27	TIJUANA-TECATE-LIB. TECATE	48	55	17
28	TORREON-CUENCAME-YERBANIS	33	58	24
29	ZAPOTLANEJO-LAGOS DE MORENO	38	49	21
	Average=	43	55	31
	Standard Deviation=	16.74	20.37	16.06



3.1a Percent of ADT Diverted to Toll Roads



3.1b Percent of ADT Diverted by Vehicle Type

Figure 3.1 Traffic diversion to toll roads from free access roads for the case study

COMPONENT ANALYSIS

The model used by the SCT [22] was taken as a base for the analysis. This model is an "S" curve represented in Figure 3.2. The objective here was to fit the available data into this model considering the maximum values analyzed in the first part of this chapter performing a regression analysis. Various mathematical models were analyzed, but the best result was obtained by considering the central part of the model as a straight line. The limiting values for this line were determined following the SCT procedures and are presented for each case later in this chapter.

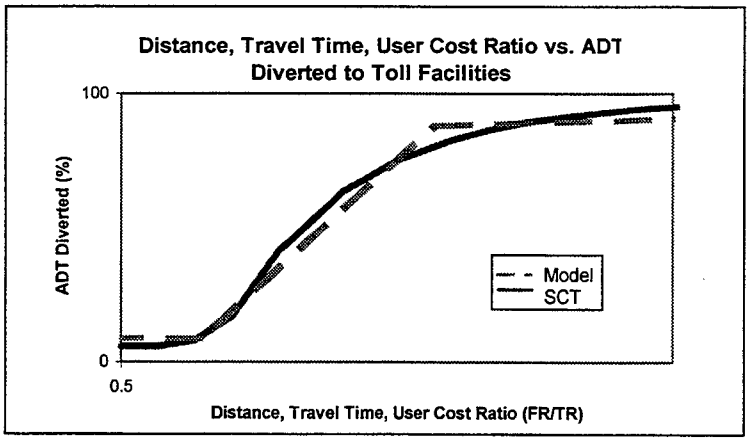


Figure 3.2 Model for ADT diversion

The regression equation considered is of the form:

$$ADT_D = ax + b$$

where:

ADT_D =	ADT diverted to the toll facility in percentage
x =	travel distance, time or user cost ratio (FR/TR)
a, b =	regression constants (slope and intercept, respectively)

The regression constant values "a" and "b" are shown in the following figures, as well as the correlation for each case.

In the case of travel distance and user cost, the best correlation was obtained when the cases under analysis were separated in two groups, one where free access roads are shorter than 100 km, and the other composed of those longer than 100 km. It was found that the behavior of these two groups is quite different.

For the case of travel time, the routes were separated also in two groups, whether the travel time in the free access road is more or less than one hour. It is important to note that during the analysis some routes were not taken into account, because they had a completely different behavior, due to the fact that they function as bypasses or are used for urban traffic.

Travel Distance

Figures 3.3, and 3.4 show the regression relationship between the toll traffic for passenger cars, and the travel distance as a ratio of that for the free access road and toll highway

for the case studied. Figures 3.5 and 3.6 show the same for the case of buses, and figures 3.7 and 3.8 for the case of trucks.

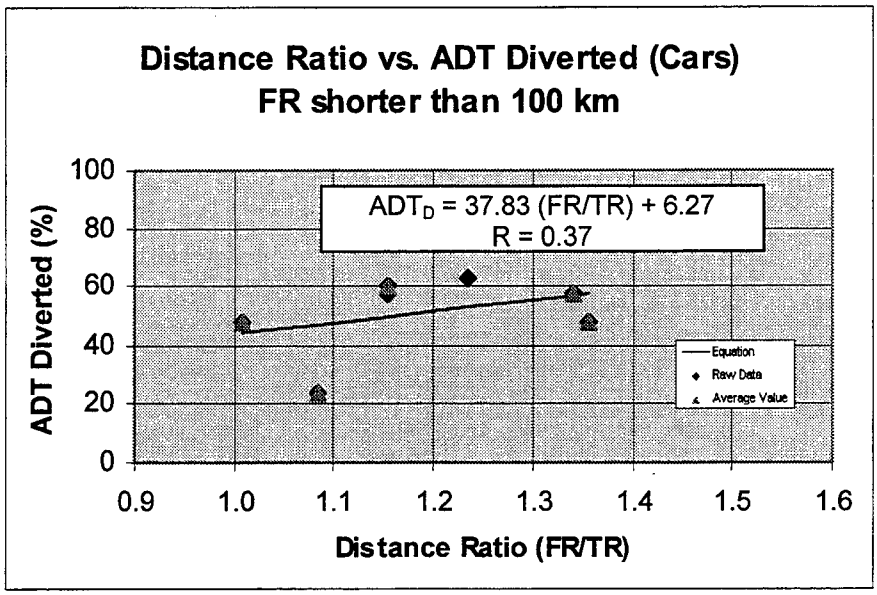


Figure 3.3 Distance ratio vs. ADT diverted for cars in routes with a free road shorter than 100 km

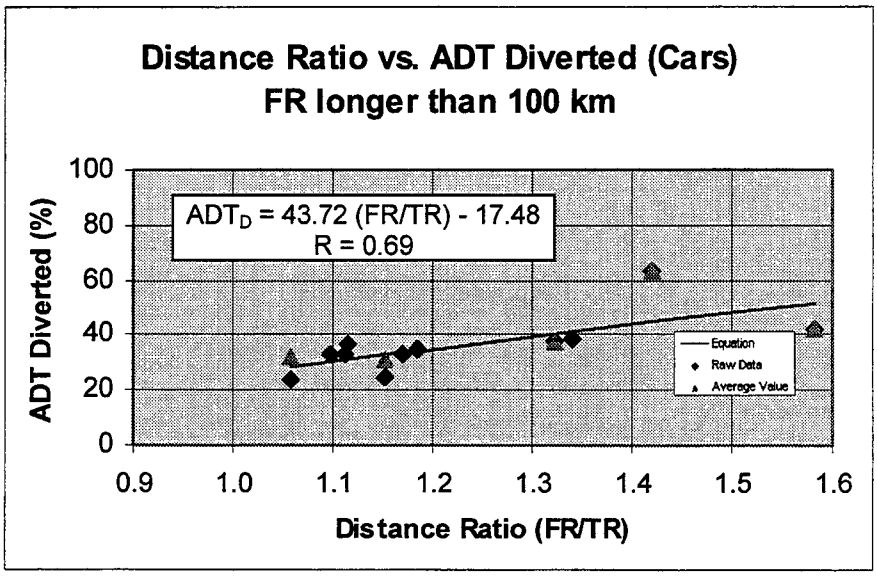


Figure 3.4 Distance ratio vs. ADT diverted for cars in routes with a free road longer than 100 km

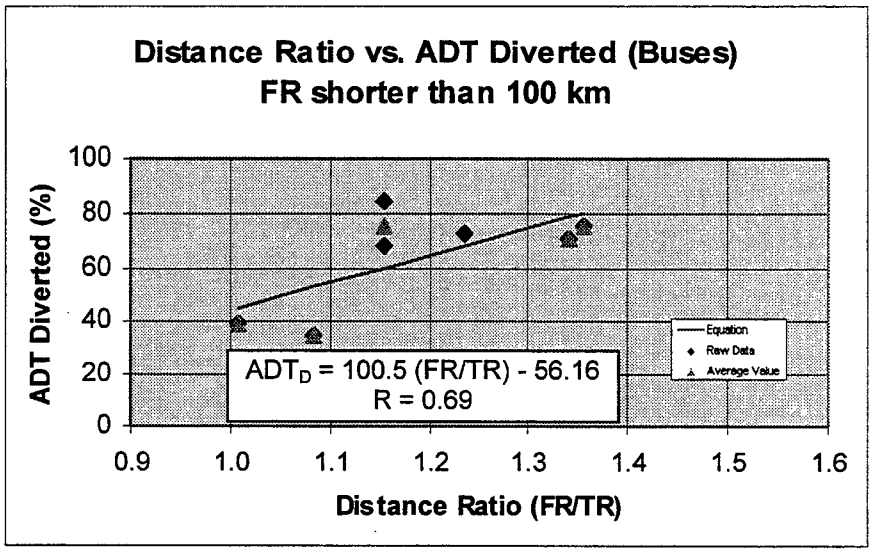


Figure 3.5 Distance ratio vs. ADT diverted for buses in routes with a free road shorter than 100 km

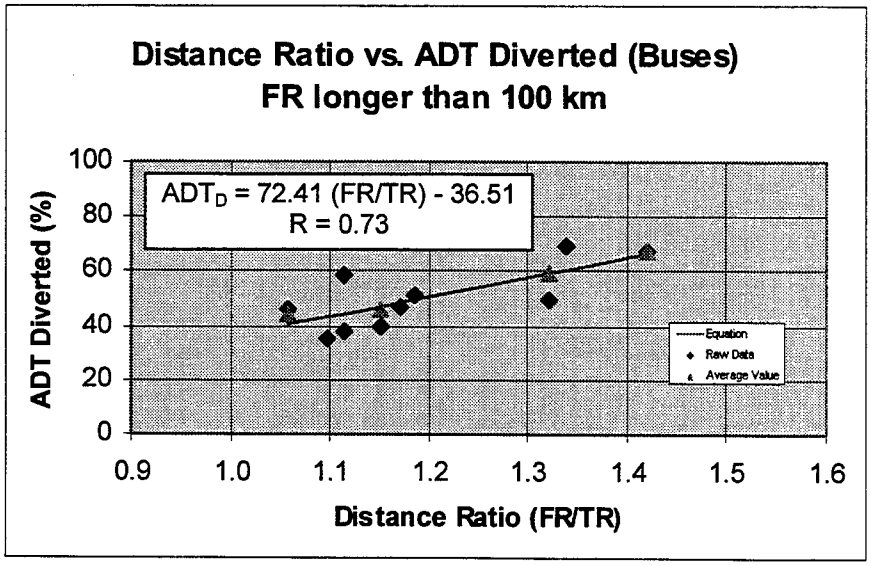


Figure 3.6 Distance ratio vs. ADT diverted for buses in routes with a free road longer than 100 km

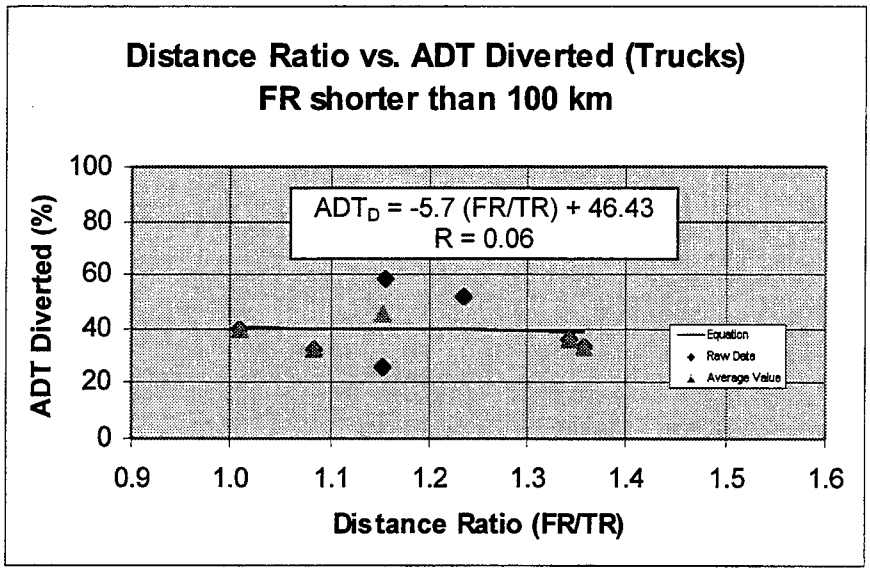


Figure 3.7 Distance ratio vs. ADT diverted for trucks in routes with a free road shorter than 100 km

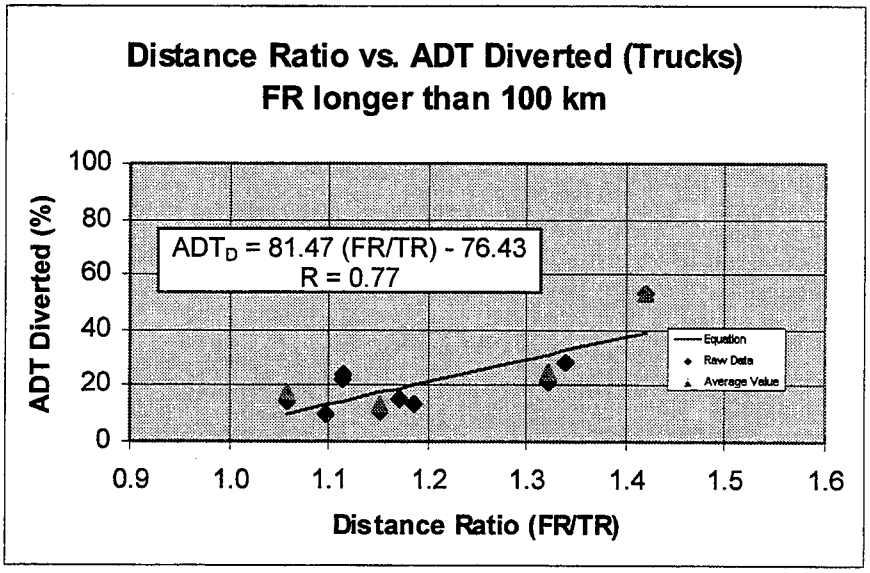


Figure 3.8 Distance ratio vs. ADT diverted for trucks in routes with a free road longer than 100 km

From the figures, several conclusions can be drawn. For the case of passenger cars, the response to use the toll facility is very similar for both groups. However, in the case where the alternate route (free access road) is longer than 100 km, a more defined behavior is shown since there is a better correlation between the variables. The same response applies to the case of

buses. For the case of trucks, the difference between the two groups is evident. For routes with a free access road shorter than 100 km, the users do not have a good response to the toll alternative. Even when the distance ratio increases, the ADT diversion barely changes. The opposite can be noted in the second group, where it can be seen that the ADT diversion increases substantially when the distance ratio increases.

Travel Time

Figures 3.9 and 3.10 show the relationship between the toll traffic for passenger cars in terms of a travel time ratio of free access road to the toll highway for the case study. Figures 3.11 and 3.12 show the same for the bus cases of and figures 3.13 and 3.14 for the truck cases.

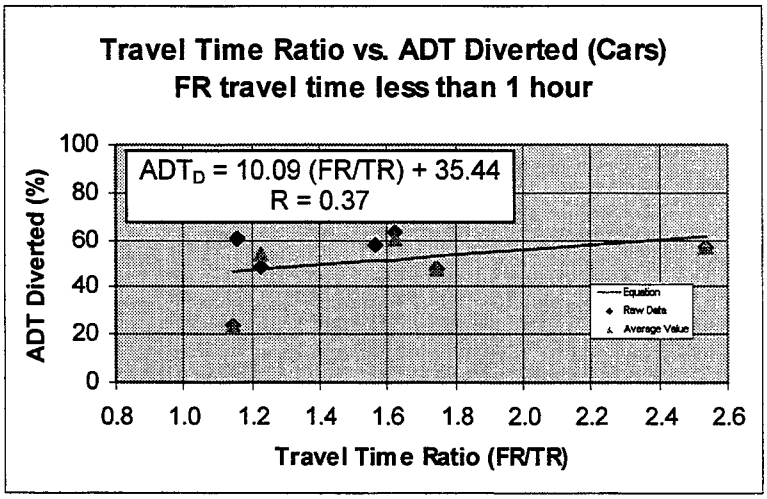


Figure 3.9 Travel time ratio vs. ADT diverted for cars in routes with a free road travel time less than 1 hour

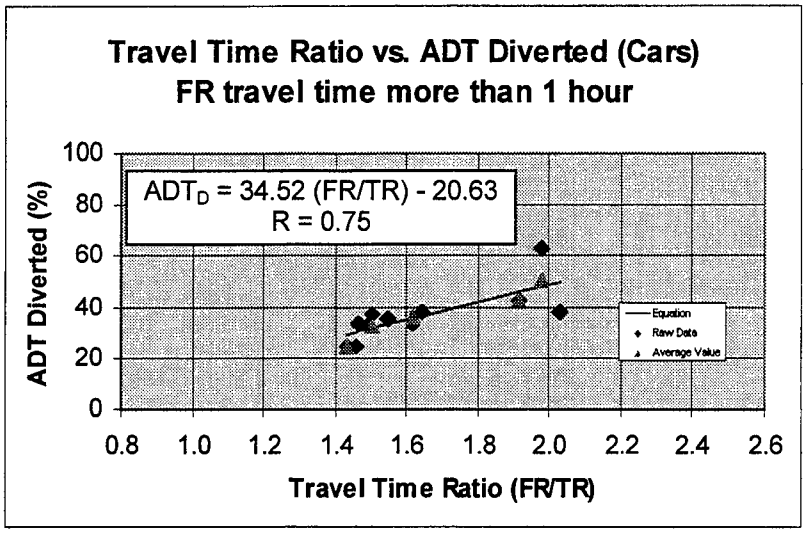


Figure 3.10 Travel time ratio vs. ADT diverted for cars in routes with a free road travel time more than 1 hour

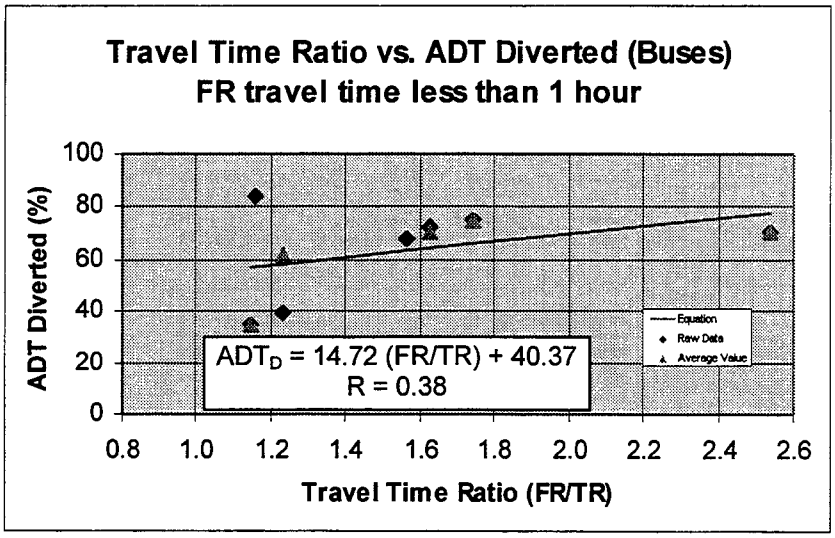


Figure 3.11 Travel time ratio vs. ADT diverted for buses in routes with a free road travel time less than 1 hour

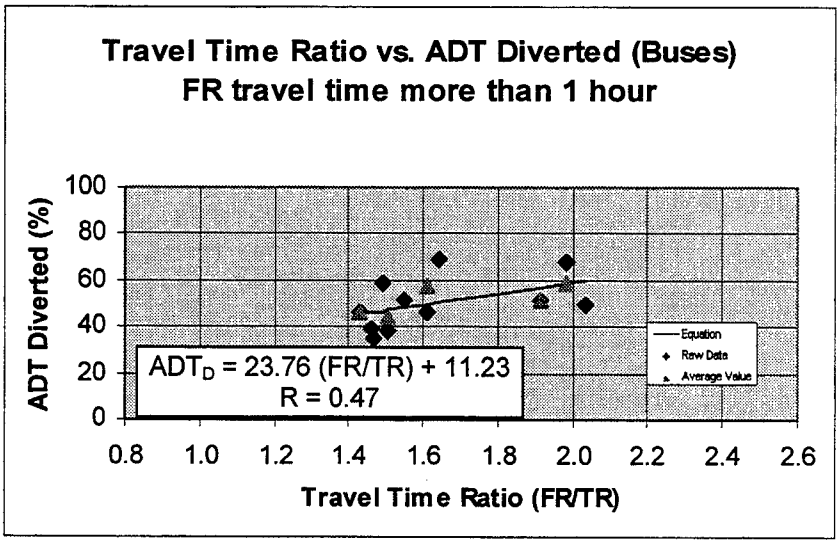


Figure 3.12 Travel time ratio vs. ADT diverted for buses in routes with a free road travel time more than 1 hour

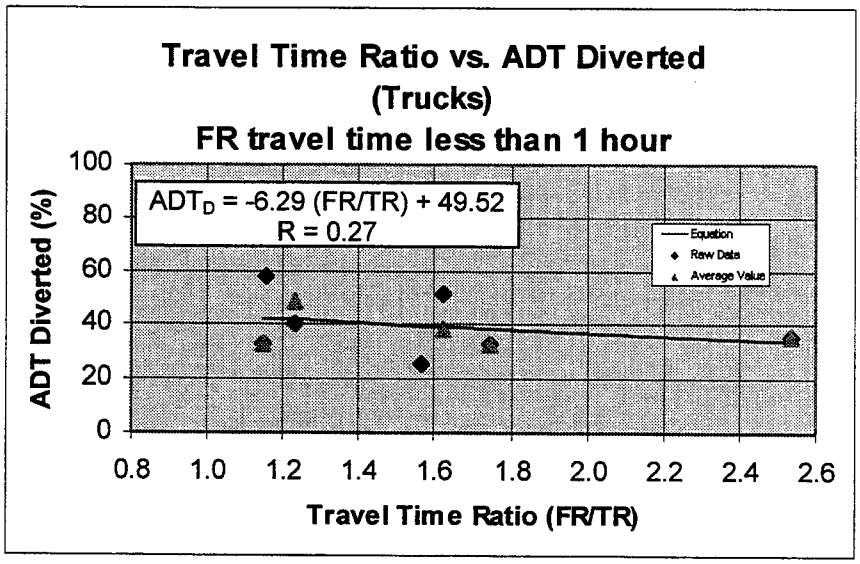


Figure 3.13 Travel time ratio vs. ADT diverted for trucks in routes with a free road travel time less than 1 hour

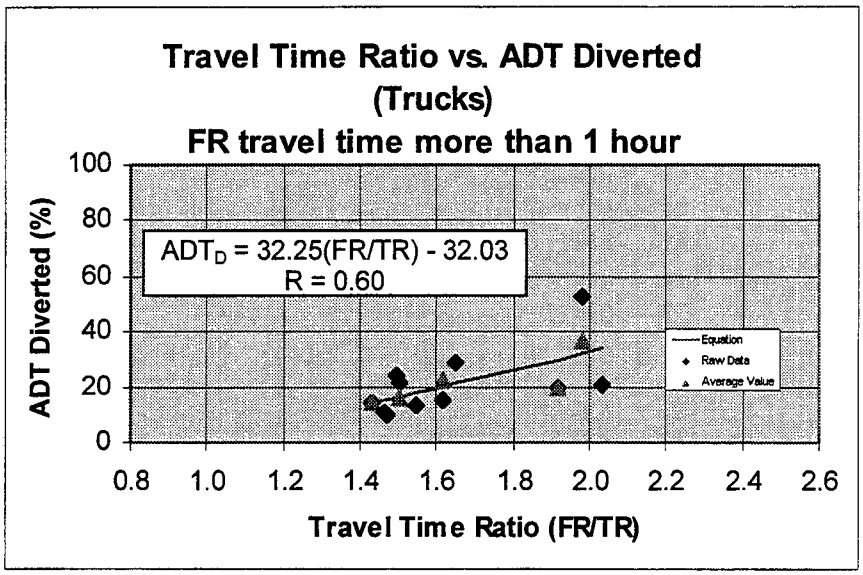


Figure 3.14 Travel time ratio vs. ADT diverted for trucks in routes with a free road travel time more than 1 hour

From the figures, it can be observed that the users follow a behavior very similar to that shown when the distance ratio vs. ADT diversion was analyzed. The two groups have different responses, that is, for trips longer than one hour the users are more aware of the benefits of using the toll road. Again, this is very clear for the case of trucks, where for trips shorter than one hour the ADT diversion barely changes, but it does increase in the case of trips longer than one hour as the travel time ratio increases.

User Cost

Finally, the response of the users to choose the toll alternative is studied analyzing the ADT diversion against the user cost ratio between the free access road and the toll highway.

The user cost for this study is composed of all the costs paid by the user during the operation of a vehicle on a highway. Figure 3.15 shows the components considered with the user cost. These costs were calculated using concepts analyzed in previous research projects [3] and studies [11], and then compared with the average values in Mexico. [4]

The cost for the user to operate on a highway are highly sensitive to the speed at which the vehicle travels. Each speed has a related Level of Service (LOS) so it is possible to find a relationship between the user cost and the LOS. This relationship is shown in Table 3.3.

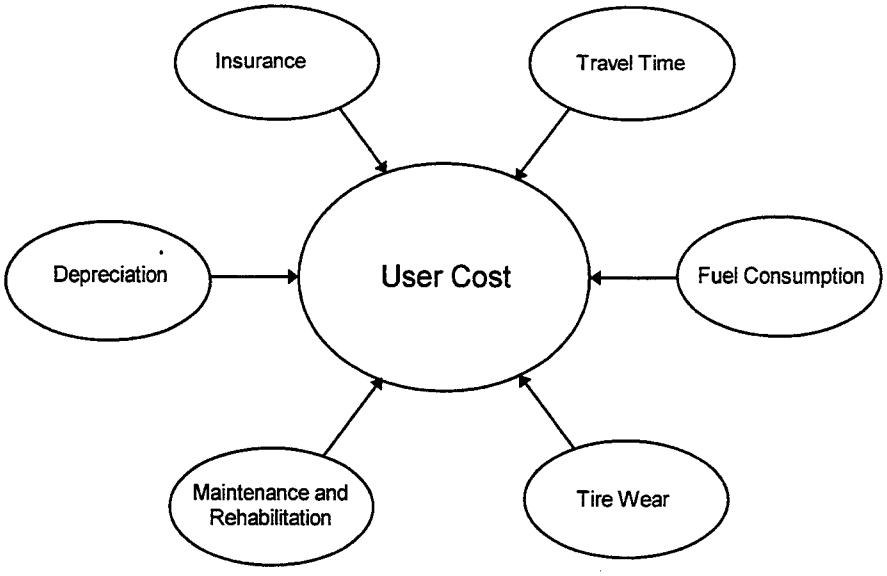


Figure 3.15 Elements of the user cost

TABLE 3.3 SPEEDS RELATED TO LEVEL OF SERVICE

Level of Service	Travel Speed (km/h)
A	105
B	95
C	90
D	85
E	70
F	50

Table 3.4 shows the values used to calculate the total user cost in each one of the highways under study. [3, 4, 11]

TABLE 3.4 USER COST FOR DIFFERENT LOS (COST IN 1996 US DOLLARS)

Type of Vehicle	User Cost ($/km)					
	LOS A	LOS B	LOS C	LOS D	LOSE	LOS F
Car	0.277	0.291	0.303	0.312	0.412	0.771
Bus	0.510	0.519	0.528	0.536	0.835	1.494
Truck	0.586	0.597	0.607	0.616	0.960	1.718

All the highways under study were related to a LOS. Then the user cost was assigned to each one of them and the total cost of operating the facility was estimated. Table 3.5 summarizes the total user cost for both toll and free access highways.

Figures 3.16 and 3.17 show the relationship between the toll traffic for passenger cars and the user cost as ratio of free access road and toll highway for the case study. Figures 3.18 and 3.19 illustrate the same for the case of buses, and figures 3.20 and 3.21 for the case of trucks.

TABLE 3.5 USER COST RATIO SUMMARY FOR TOLL AND FREE ACCESS HIGHWAYS

No.	ROUTE	TOLL ROAD					FREE ACCESS ROAD				
		LENGTH (km)	LOS	USER COST ($)*			LENGTH (km)	LOS	USER COST ($)*		
				CAR	BUS	TRUCK			CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	47	A	13.02	23.97	27.54	47	C	14.36	25.03	28.77
2	ATLACOMULCO-MARAVATIO	64	A	17.73	32.64	37.50	79	D	24.65	42.34	48.66
3	CADEREYTA-REYNOSA	175	A	48.48	89.25	102.55	192	D	59.90	102.91	118.27
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	157	A	43.49	80.07	92.00	151	A	41.92	77.18	88.68
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	34	A	9.42	17.34	19.92	54	C	16.36	28.51	32.78
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	21	A	5.82	10.71	12.31	20	E	8.40	17.02	19.56
7	CORDOBA-VERACRUZ	108	A	29.92	55.08	63.29	126	E	52.11	105.61	121.42
8	CUERNAVACA-ACAPULCO	263	A	72.85	134.13	154.12	356	D	111.19	191.01	219.52
9	CHAMAPA-LECHERIA	30	A	8.31	15.30	17.58	67	C	20.29	35.35	40.64
10	DELICIAS-CAMARGO	65	A	18.01	33.15	38.09	75	A	20.80	38.30	44.01
11	DURANGO-YERBANIS	105	A	29.09	53.55	61.53	121	D	37.72	64.80	74.47
12	ECATEPEC-PIRAMIDES	22	A	6.09	11.22	12.89	47	D	14.61	25.10	28.85
13	GUADALAJARA-COLIMA	148	A	41.00	75.48	86.73	210	D	65.61	112.71	129.53
14	GUADALAJARA-ZAPOTLANEJO	26	A	7.20	13.26	15.24	30	D	9.36	16.08	18.48
15	LA TINAJA-COSOLEACAQUE	228	A	63.16	116.28	133.61	241	D	75.31	129.37	148.68
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	116	A	32.13	59.16	67.98	129	D	40.37	69.35	79.70
17	LIBRAMIENTO DE FRESNILLO	33	A	9.14	16.83	19.34	41	D	12.68	21.79	25.04
18	LIBRAMIENTO NORESTE DE QUERETARO	37	A	10.25	18.87	21.68	40	A	11.12	20.47	23.52
19	LIBRAMIENTO ORIENTE DE SALTILLO	22	A	6.09	11.22	12.89	55	C	16.51	28.78	33.08
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	34	A	9.42	17.34	19.92	94	A	26.12	48.10	55.27
21	LIBRAMIENTO PONIENTE DE TAMPICO	14	A	3.88	7.14	8.20	28	E	11.61	23.54	27.06
22	MAZATLAN-CULIACAN	182	A	50.41	92.82	106.65	216	D	67.30	115.62	132.87
23	MERIDA-CANCUN	240	A	66.48	122.40	140.64	322	C	97.41	169.75	195.15
24	MONTERREY-NUEVO LAREDO	146	A	40.44	74.46	85.56	231	C	69.99	121.97	140.22
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	26	A	7.20	13.26	15.24	35	C	10.68	18.62	21.40
26	TEPIC-ENTRONQUE SAN BLAS	25	A	6.93	12.75	14.65	34	F	25.86	50.11	57.62
27	TIJUANA-TECATE-LIB. TECATE	35	A	9.70	17.85	20.51	81	E	33.21	67.30	77.38
28	TORREON-CUENCAME-YERBANIS	119	A	32.96	60.69	69.73	133	D	41.34	71.02	81.62
29	ZAPOTLANEJO-LAGOS DE MORENO	152	A	42.10	77.52	89.07	201	E	82.81	167.84	192.96

*Cost in US Dollars (1996), 1 Dollar = 7.8 Pesos

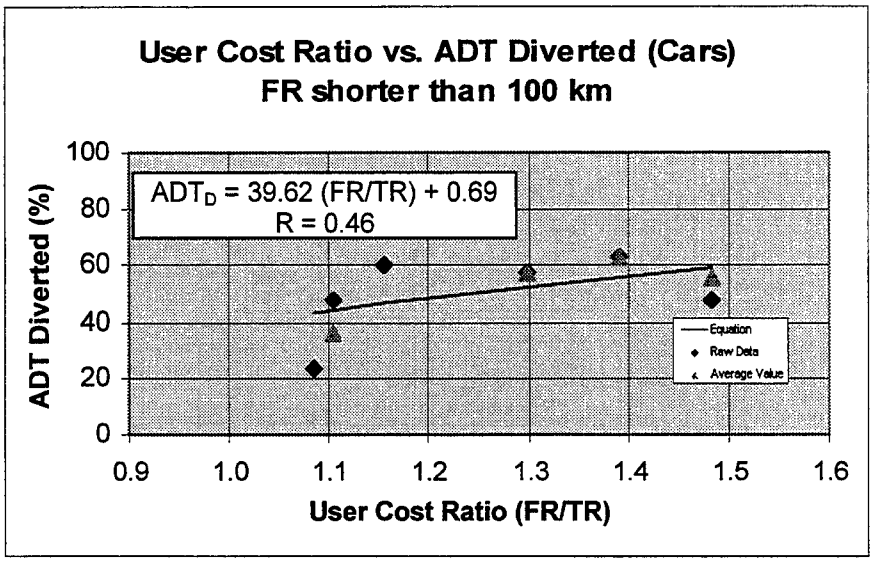


Figure 3.16 User cost ratio vs. ADT diverted for cars in routes with a free road length shorter than 100 km

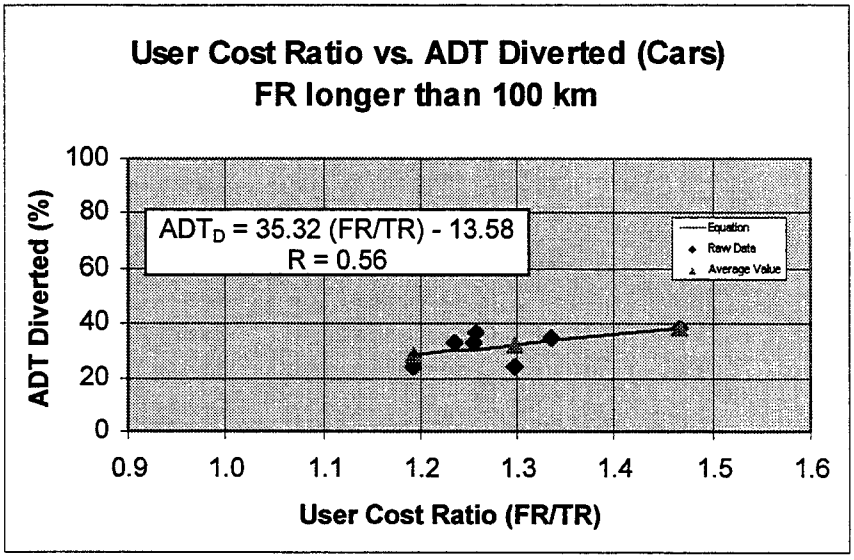


Figure 3.17 User cost ratio vs. ADT diverted for cars in routes with a free road length longer than 100 km

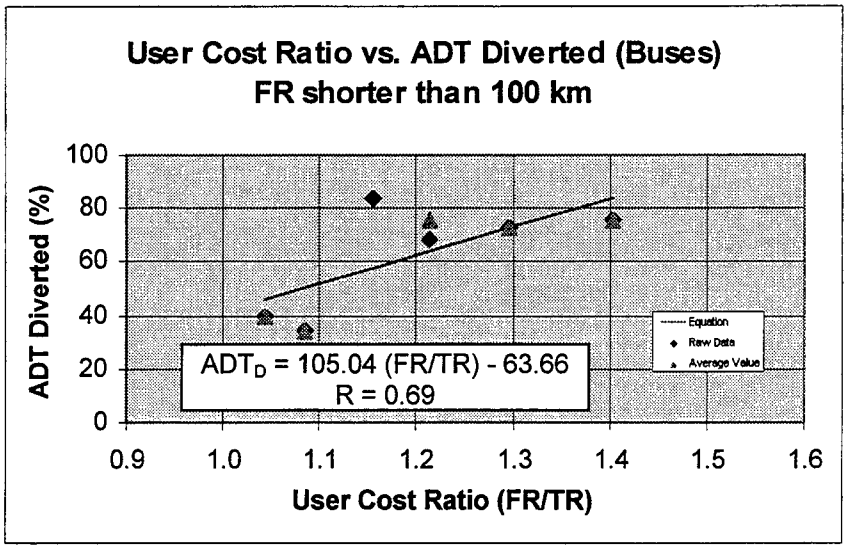


Figure 3.18 User cost ratio vs. ADT diverted for buses in routes with a free road length shorter than 100 km

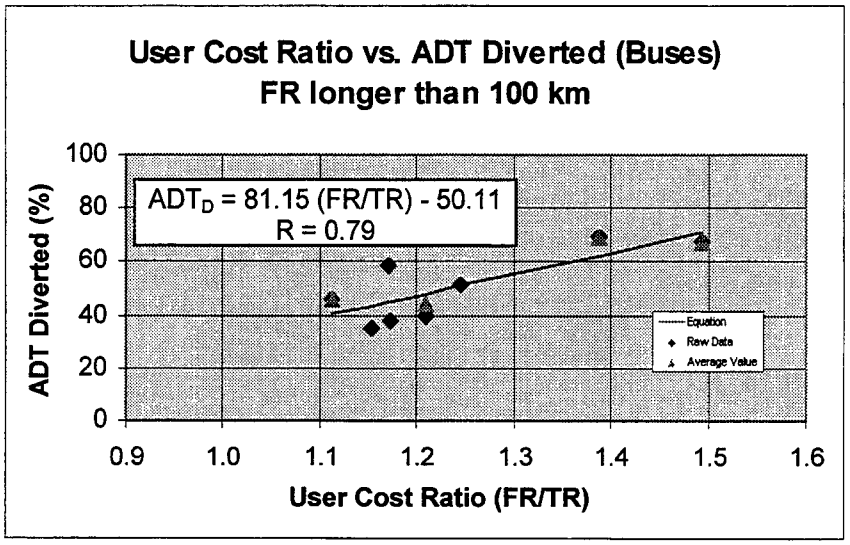


Figure 3.19 User cost ratio vs. ADT diverted for buses in routes with a free road length longer than 100 km

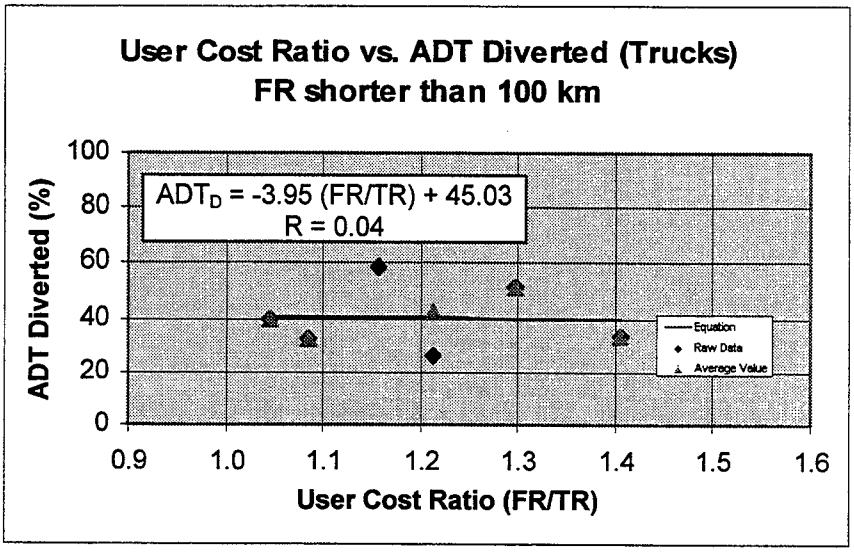


Figure 3.20 User cost ratio vs. ADT diverted for trucks in routes with a free road length shorter than 100 km

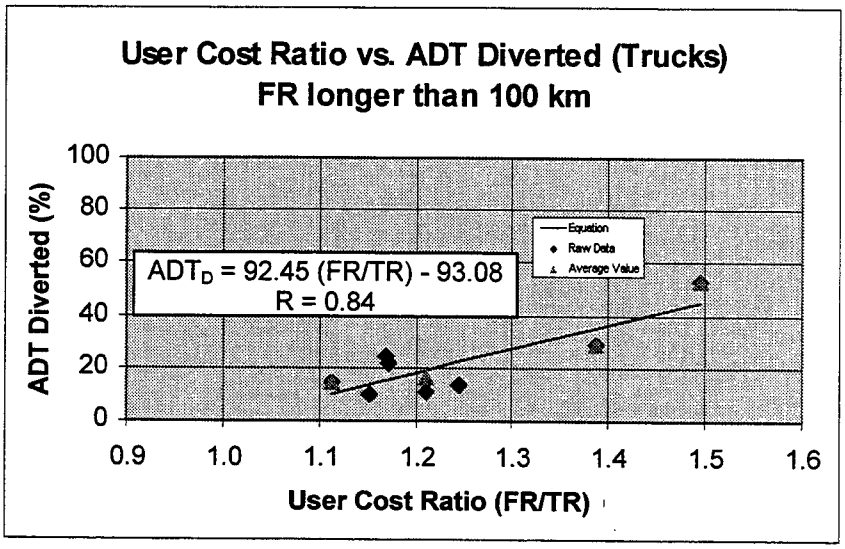


Figure 3.21 User cost ratio vs. ADT diverted for trucks in routes with a free road length longer than 100 km

The conclusions are, once again, very similar to the cases where the travel distance and time were the independent variable. For routes where the distance is longer than one hundred km, the user seems to consider the toll alternative as a better option, especially in the case of trucks.

When trips are shorter than one hundred km the behavior of the users is very inconsistent. It is logical to consider that the longer the trip is, the more importance the user gives to the cost savings issue.

Using these models it is possible to estimate the expected traffic using a toll facility, based solely on the physical characteristics of the free access and toll highways. In the next chapter, an analysis is performed to estimate the traffic considering the toll amount, another important factor to take into account. At the end of the next chapter, a comparison of the results of the models against the actual values is performed.

MULTI-REGRESSION ANALYSIS

Once all the relationships between travel distance, time and user cost were determined, the next step was to build a single model for each group and each type of vehicle. The objective was to create one equation for each case combining the three different variables, i.e. travel distance, travel time and user cost. Table 3.6 shows all the possible combinations according to the grouping made for the analysis earlier in this chapter.

Table 3.6 is a summary of all the coefficients for each group and each variable for the three types of vehicle under study. From this table, it is possible to state that the users present a better response to the toll for routes involving trips longer than 100 km or one hour, since the correlation coefficients are much bigger than the other groups.

TABLE 3.6 COEFFICIENT SUMMARY FOR EACH COMPONENT

		FR < 100 km or < 1 hr			FR > 100 km or > 1 hr			
		CAR	BUS	TRUCK		CAR	BUS	TRUCK
TRAVEL DISTANCE	R=	0.366	0.685	0.064	R=	0.688	0.734	0.774
	a=	37.827	100.498	-5.701	a=	43.723	72.410	81.465
	b=	6.265	-56.159	46.430	b=	6.265	-36.511	-76.426
TRAVEL TIME	R=	0.371	0.382	0.269	R=	0.745	0.469	0.596
	a=	10.096	14.717	-6.288	a=	34.516	23.758	32.245
	b=	35.436	40.369	49.523	b=	-20.359	11.234	-32.029
USER COST	R=	0.455	0.695	0.043	R=	0.560	0.789	0.848
	a=	39.617	105.042	-3.953	a=	35.321	81.150	92.452
	b=	0.691	-63.664	45.035	b=	-13.581	-50.114	-93.080

A multi-regression analysis was performed combining the three variables, i.e. distance, time and user cost. The variables were analyzed as a toll road to free access road ratio. One equation was developed for each vehicle type, i.e. passenger car, bus and truck.

The resulting prediction model would be:

$$ADT_D\ (\%) = K_0 + K_1 R_d + K_2 R_t + K_3 R_c$$

where:

ADT_D = Percentage of ADT diverted to toll road (cars, buses or trucks)

R_d, R_t, R_c = travel distance, travel time and user cost ratios

K_0, K_1, K_2, K_3 = equation constants

Table 3.7 is a summary of the coefficients and the correlation for the traffic prediction model for each of the three vehicle type.

TABLE 3.7 COEFFICIENT SUMMARY FOR THE TRAFFIC PREDICTION MODEL

Coefficient	Vehicle Type		
	Car	Bus	Truck
K_o =	29.00	47.46	34.48
K_1 =	28.38	37.72	23.07
K_2 =	-25.33	-34.01	-28.89
K_3 =	13.01	11.97	8.59
R =	0.34	0.30	0.22

Table 3.8 is a summary of the calculations of the ADT diversion using the prediction model developed. Note that these values represent the traffic volume that can be expected when the toll charged is \$0.75 / km, which is the average toll of the cases used to developed the model. These values will change when they are affected by the elasticity model developed in Chapter 4. In Chapter 4, the final values are presented and compared to the actual ADT diversion.

TABLE 3.8 SUMMARY OF RESULTS OF ADT DIVERSION MODEL

No.	ROUTE	DIST. RATIO FR/TR (R_d)	TIME RATIO FR/TR (R_t)	USER COST RATIO FR/TR (R_c)			PREDICTED ADT (%) ADT_D		
				CAR	BUS	TRUCK	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	1.0	1.2	1.1	1.0	1.0	41	56	31
2	ATLACOMULCO-MARAVATIO	1.2	1.6	1.4	1.3	1.3	41	54	27
3	CADEREYTA-REYNOSA	1.1	1.5	1.2	1.2	1.2	39	53	27
7	CORDOBA-VERACRUZ	1.2	1.6	1.7	1.9	1.9	44	60	31
10	DELICIAS-CAMARGO	1.2	1.2	1.2	1.2	1.2	48	66	38
11	DURANGO-YERBANIS	1.2	1.5	1.3	1.2	1.2	42	56	29
13	GUADALAJARA-COLIMA	1.4	2.0	1.6	1.5	1.5	40	52	23
14	GUADALAJARA-ZAPOTLANEJO	1.2	1.6	1.3	1.2	1.2	39	52	26
15	LA TINAJA-COSOLEACAQUE	1.1	1.4	1.2	1.1	1.1	38	52	27
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	1.1	1.5	1.3	1.2	1.2	39	52	27
22	MAZATLAN-CULIACAN	1.2	1.5	1.3	1.2	1.2	41	54	28
23	MERIDA-CANCUN	1.3	1.6	1.5	1.4	1.4	44	59	30
24	MONTERREY-NUEVO LAREDO	1.6	1.9	1.7	1.6	1.6	48	62	30
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	1.4	1.7	1.5	1.4	1.4	43	56	28
26	TEPIC-ENTRONQUE SAN BLAS	1.3	2.5	3.7	3.9	3.9	51	59	26
27	TIJUANA-TECATE-LIB. TECATE	2.3	3.3	3.4	3.8	3.8	54	66	24
28	TORREON-CUENCAME-YERBANIS	1.1	1.5	1.3	1.2	1.2	39	53	27
29	ZAPOTLANEJO-LAGOS DE MORENO	1.3	2.0	2.0	2.2	2.2	41	54	25

CHAPTER 4. TOLL ELASTICITY

This chapter presents the basic demand and toll elasticity concepts used in this report. Then, the close relationship between the toll highway usage and the toll price elasticity is explained. Finally, an analysis of the data for the case study is presented to describe the relationship between the toll price and the traffic volume using the toll facility.

DEMAND ELASTICITY CONCEPTS

Travel demand elasticity is defined as the percent of change in traffic volume that results from a one percent change in a given variable, such as travel time or cost. Figure 4.1 shows graphically the concept of *point elasticity* and is defined by the following relationship:

$$\varepsilon_o = \frac{\delta D}{\delta V} * \frac{V_o}{D_o}$$

where:

V_o = the prevailing variable condition

D_o = the prevailing travel demand corresponding to V_o

$\frac{\delta D}{\delta V}$ = the partial derivative of the demand function with respect to variable V

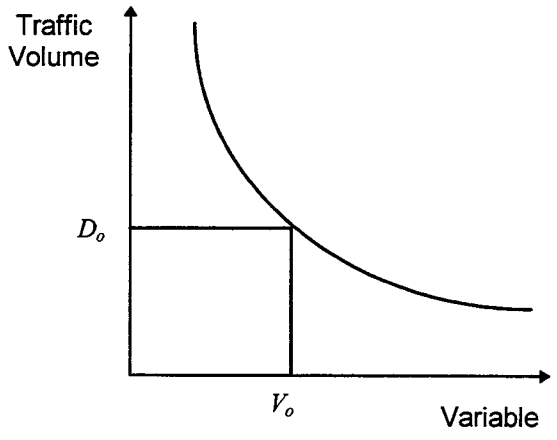


Figure 4.1 Graphical representation of point elasticity

Generally, the demand function is unknown, but if data on travel demand before and after the change is made in the independent variable are available, it is possible to calculate arc elasticity as follows:

$$\varepsilon_{arc} = \frac{\frac{\Delta D}{D_o}}{\frac{\Delta V}{V_o}}$$

where:

ΔD = the change in travel demand due to the change in variable V

ΔV = the change in the variable V

D_o = the prevailing travel demand corresponding to V_o

V_o = the prevailing variable condition

This is:

$$\varepsilon_{arc} = \frac{\%\ Change\ in\ Travel\ Demand}{\%\ Change\ in\ Variable}$$

The graphical representation of arc elasticity is shown in Figure 4.2.

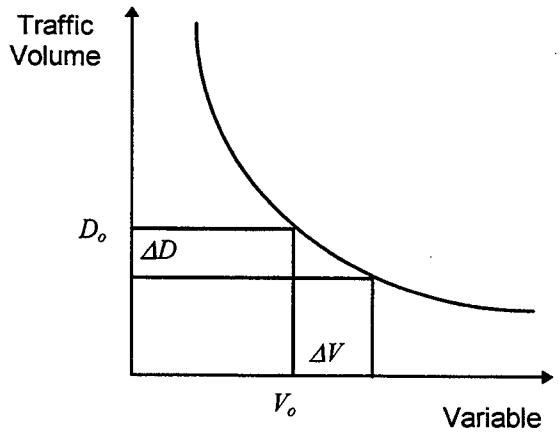


Figure 4.2 Graphical representation of arc elasticity

TOLL TRAFFIC ESTIMATION AND TOLL ELASTICITY

Once demand elasticity studies have been performed, the results of this analysis can be used to estimate the first-order approximations to travel-demand relations. These approximations can also be used to predict user response to changes in the system, e.g. toll price. Thus, analyzing the sensitivity to toll price changes is an important factor in a toll traffic prediction model. In the previous chapter, several theoretical methods were mentioned, and an analysis of actual data for the case study was also discussed.

The two methods to estimate the elasticity are:

1. *Calibrated elasticity*. This kind of elasticity does not take into account historical observations, and is derived from a theoretical demand model. The elasticity can be estimated from the coefficients of variables in the utility function in the Logit model.
2. *Empirical elasticity*. It involves observations of actual changes over time, that is, it considers historical data analyzing the traffic before and after a change in the system is made. This elasticity is a direct measure of the actual conditions of the object under study.

Empirical elasticity is a more appropriate and desirable basis to predict the consequences of changes made to the system than the calibrated elasticity, because empirical elasticity is based on actual observations and responses of the system over time. For this report, the empirical approach is used in a network level instead of a project level.

DATA ANALYSIS FOR THE CASE STUDY

An analysis of the data for the case study is presented here using empirical elasticity concepts applied at a network level. The objective of this analysis was to determine the relationship between the toll price and the traffic using the toll facility as a percentage of the total traffic going from the same origin to the same destination.

Unfortunately, not enough origin-destination (O-D) studies were available for the analysis, so the ADT measured in certain points in the highway network was used, once it was found that both values, ADT and O-D traffic, are fairly similar if taken as a percentage of the total traffic. In other words, the percentage of total ADT using the toll highway is close enough to the percentage of the total O-D traffic in the same facility. [24] It is pointed out that for further research, it would be

better to perform complete O-D studies prior to the analysis in order to increase the reliability of the results.

The objective here is to fit the available data to an elasticity model of the form:

$$ADT_D\ (\%) = m\ Ln\ C_T + n$$

where:

ADT_D =	percentage of ADT diverted to the toll road
C_T =	toll cost per km ($/km)
m, n =	regression constants

All the routes involving bypasses or highways with urban traffic were not taken into account in this analysis, so just eighteen routes out of the twenty-nine were used.

Again, as in Chapter 3, two different groups were identified based in its different behavior. One group was composed of all the routes having a 60% or more savings in travel time by using the toll alternative, and another group integrated by the routes having less than 60%. This grouping yielded the best fit to the mathematical model.

Figures 4.3 and 4.4 show the relationship between the ADT diversion for passenger cars and the toll per km (in US Dollars) for the case study. Figures 4.5 and 4.6 show the same for the case of buses, and figures 4.7 and 4.8 for the case of trucks.

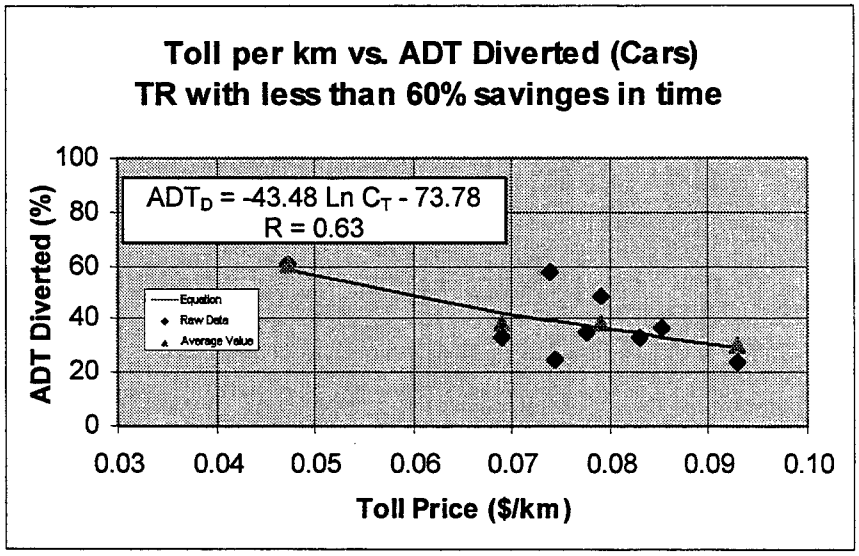


Figure 4.3 ADT diverted vs. toll per km for cars in routes with less than 60% in time savings using the toll alternative

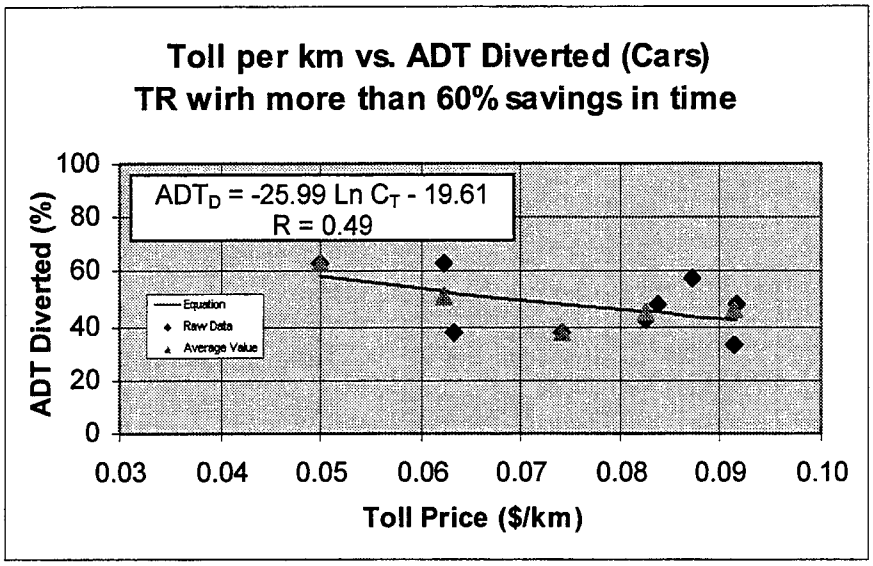


Figure 4.4 ADT diverted vs. toll per km for cars in routes with more than 60% in time savings using the toll alternative

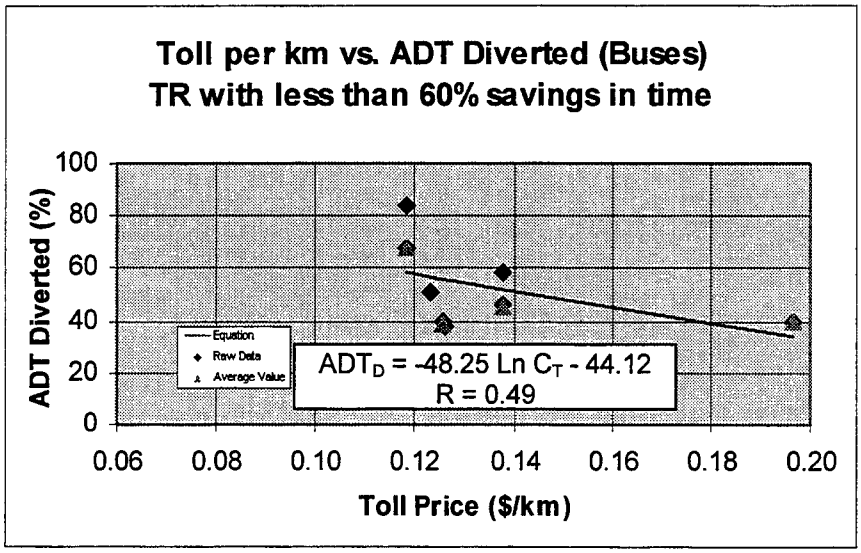


Figure 4.5 ADT diverted vs. toll per km for buses in routes with Less than 60% in time savings using the toll alternative

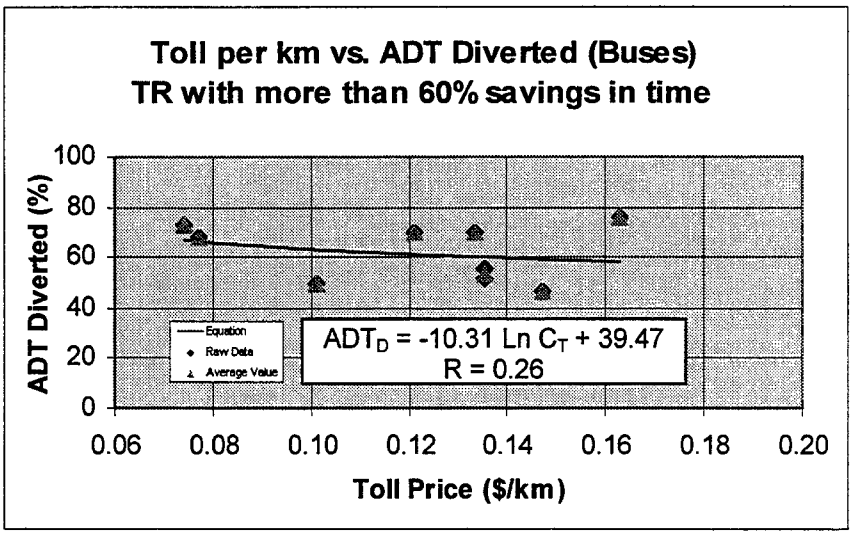


Figure 4.6 ADT diverted vs. toll per km for buses in routes with more than 60% in time savings using the toll alternative

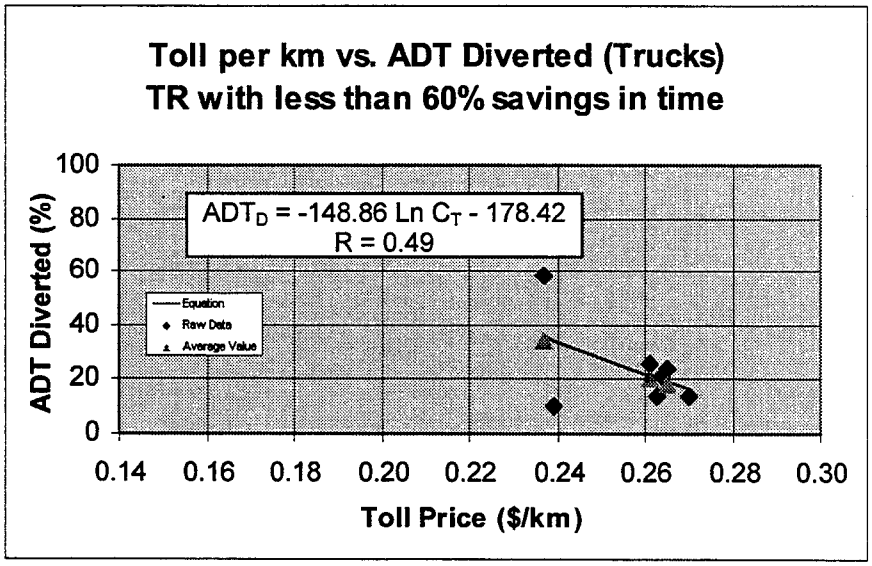


Figure 4.7 ADT diverted vs. toll per km for trucks in routes with less than 60% in time savings using the toll alternative

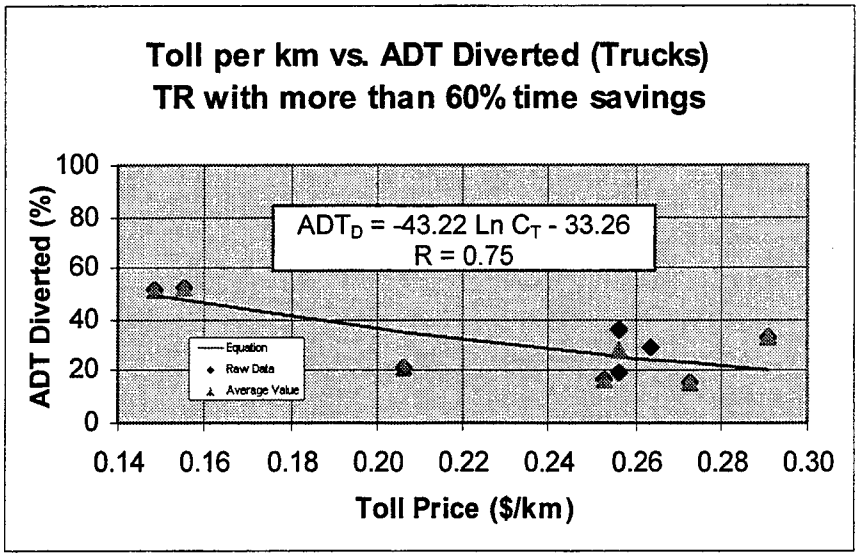


Figure 4.8 ADT diverted vs. toll per km for trucks in routes with more than 60% time savings using the toll alternative

From the figures, several conclusions can be drawn. It is clear that the group of routes that have a toll highway alternative that yields a 60% or more savings in travel time is less elastic to the changes in the toll, the ADT diversion does not change considerably while the toll per km increases. On the other hand, when the savings by using the toll alternative are less than 60%, the response of the users is highly sensitive or elastic to the toll price.

Table 4.1 summarizes the values of ADT diversion estimated in Chapter 3, and the new values affected by the elasticity model, as well as a comparison with the actual values.

TABLE 4.1 SUMMARY OF PREDICTED ADT DIVERSION

No.	ROUTE	PREDICTED ADT (%)			AFTER ELASTICITY ADT (%)			ACTUAL ADT (%)			DIFFERENCE ADT (%)		
		CAR	BUS	TRUCK	CAR	BUS	TRUCK	CAR	BUS	TRUCK	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	41	56	31	39	56	31	48	39	40	(9)	17	(9)
2	ATLACOMULCO-MARAVATIO	41	54	27	59	54	27	63	73	52	(4)	(18)	(25)
3	CADEREYTA-REYNOSA	39	53	27	43	53	27	33	35	10	10	18	18
7	CORDOBA-VERACRUZ	44	60	31	36	60	31	33	47	15	2	13	16
10	DELICIAS-CAMARGO	48	66	38	68	66	38	60	84	58	7	(18)	(20)
11	DURANGO-YERBANIS	42	56	29	42	56	29	24	40	10	18	16	19
13	GUADALAJARA-COLIMA	40	52	23	48	52	23	63	68	53	(15)	(16)	(30)
14	GUADALAJARA-ZAPOTLANEJO	39	52	26	40	52	26	58	68	26	(18)	(16)	0
15	LA TINAJA-COSOLEACAQUE	38	52	27	29	52	27	24	46	14	5	6	13
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	39	52	27	34	52	27	24	35	33	10	18	(6)
22	MAZATLAN-CULIACAN	41	54	28	40	54	28	35	51	14	5	3	14
23	MERIDA-CANCUN	44	59	30	52	59	30	38	69	29	14	(11)	1
24	MONTERREY-NUEVO LAREDO	48	62	30	44	62	30	42	51	20	2	10	10
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	43	56	28	38	56	28	48	75	33	(10)	(19)	(6)
26	TEPIC-ENTRONQUE SAN BLAS	51	59	26	45	59	26	57	70	36	(12)	(12)	(10)
27	TIJUANA-TECATE-LIB. TECATE	54	66	24	46	66	24	48	55	17	(2)	11	7
28	TORREON-CUENCAME-YERBANIS	39	53	27	35	53	27	33	58	24	2	(6)	3
29	ZAPOTLANEJO-LAGOS DE MORENO	41	54	25	41	54	25	38	49	21	3	5	4
										AVERAGE =	0.45	(0.66)	(0.90)
										STANDARD DEVIATION=	10.03	14.33	14.62

Figures 4.9, 4.10 and 4.11 shows a graphical comparison between the ADT diversion predicted by the model and the actual values for cars, buses and trucks respectively.

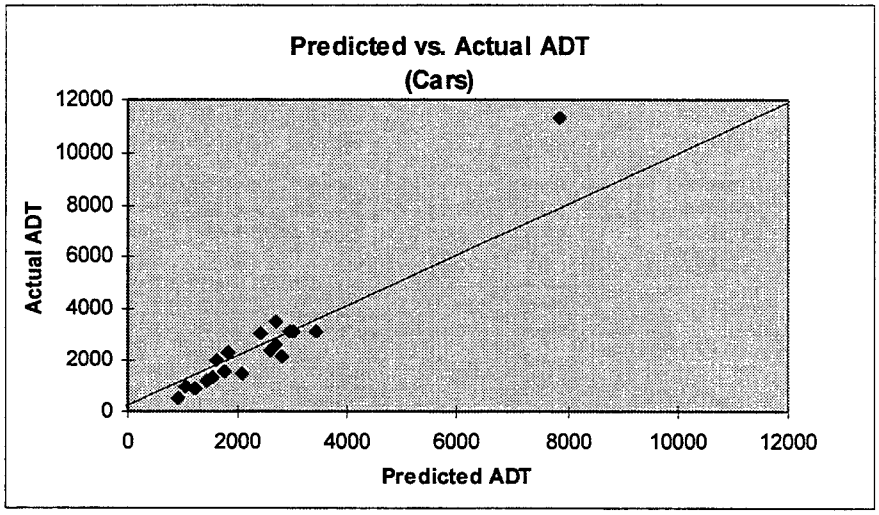


Figure 4.9 Comparison between predicted and actual ADT for cars

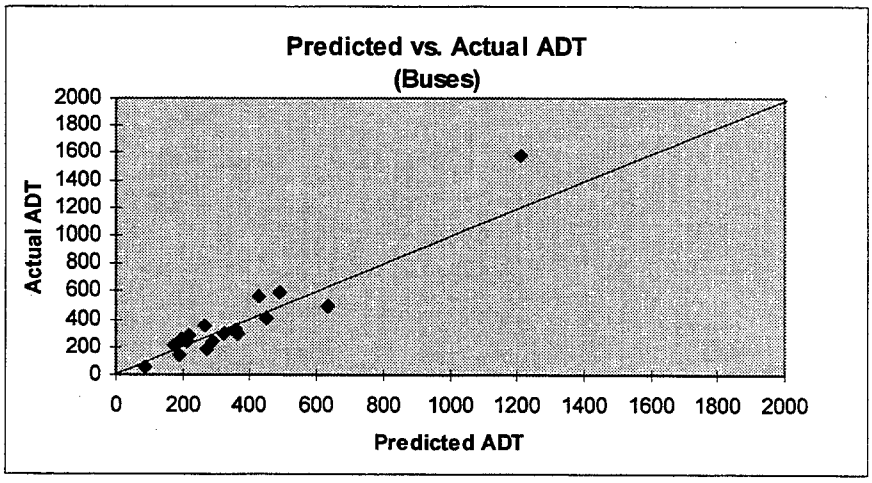


Figure 4.10 Comparison between predicted and actual ADT for buses

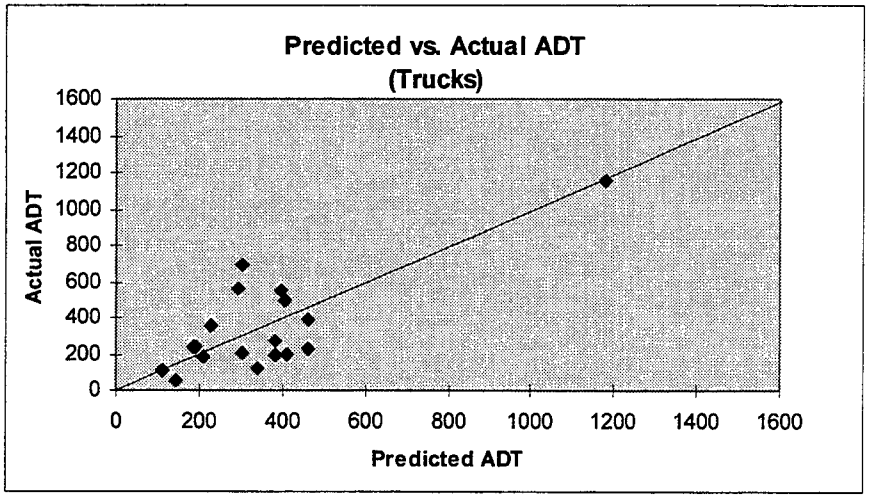


Figure 4.11 Comparison between predicted and actual ADT for trucks

From the figures, it can be seen that the prediction models give reliable values for the case of passenger cars and buses. In the case of trucks, it appears that there is not a very defined response to the use of toll highways, maybe due to very high prices compared to other countries. Nevertheless, the most important type of vehicle to predict its behavior for a financial analysis, is the passenger car, since 67% of the income in the concessioned highways comes from that source, while buses contribute 15% and the remaining 18% comes from trucks.[13]

CHAPTER 5. TOLL PRICE ESTIMATION

In this chapter, four methods to estimate the toll price are discussed. The objective is to review the attributes and expose the different shortcomings that these methods have in a broad sense. The intention here is not to actually develop a model to estimate tolls, but to present the principal variables that should be considered by the analyst during the feasibility analysis of a toll highway project when setting a toll.

First, a method based on user cost savings by using the toll alternative is presented. The second method is based on the minimum rate of return to make the project profitable. Then, a procedure based on the damage consumption that different categories of vehicles cause to the pavement is outlined. Finally a method based on the elasticity analysis is presented.

The data for the case study is used to give an approximate idea of the values that could be developed by each of these methods.

USER COST METHOD

This method is based on the cost savings the user experiences by using the toll highway alternative. First, the user cost on the free access highway was calculated based on the values presented in Chapter 3, taking into account the level of service that the facility offers. Then, the user cost is estimated by the same method for the toll highway. The resulting toll is the difference between the user cost on the free access road and the toll facility, adjusted by a factor estimated by the analyst. For the computations in this analysis an adjustment factor of one was used. Even when the user has savings by using the toll option, he may not have a personal knowledge of the amount, since user cost savings are not readily apparent when compared to a toll payment.

The equation expressing the toll based on the user cost savings is as follows:

$$T_s = A\,(C_f - C_t)$$

where:

- T_s = estimated toll for a facility from user cost savings.
- A = adjustment factor based on experience
- C_f = estimated user cost resulting from utilizing the free access highway
- C_t = estimated user cost resulting from utilizing the toll highway

The actual tolls and the results of this procedure are shown in Table 5.1. Figures 5.1, 5.2 and 5.3 present a comparison between these values and the actual toll in graphical form for passenger cars, buses, and trucks respectively.

TABLE 5.1 SUMMARY OF RESULTS OF USER COST METHOD

No.	ROUTE	TOLL ROAD USER COST (C_t) ($)*			FREE ROAD USER COST (C_f) ($)*			SAVINGS BY USING TR (T_s) ($)*			ACTUAL TOLL ($)*		
		CAR	BUS	TRUCK	CAR	BUS	TRUCK	CAR	BUS	TRUCK	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	13.02	23.97	27.54	14.36	25.03	28.77	1.34	1.06	1.23	3.72	9.23	15.26
2	ATLACOMULCO-MARAVATIO	17.73	32.64	37.50	24.65	42.34	48.66	6.92	9.70	11.16	3.21	4.74	9.49
3	CADEREYTA-REYNOSA	48.48	89.25	102.55	59.90	102.91	118.27	11.43	13.66	15.72	12.05	12.69	23.85
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	9.42	17.34	19.92	16.36	28.51	32.78	6.94	11.17	12.85	2.56	5.00	11.28
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	5.82	10.71	12.31	8.40	17.02	19.56	2.58	6.31	7.26	4.10	12.05	24.10
7	CORDOBA-VERACRUZ	29.92	55.08	63.29	52.11	105.61	121.42	22.19	50.53	58.13	9.87	15.90	29.49
8	CUERNAVACA-ACAPULCO	72.85	134.13	154.12	111.19	191.01	219.52	38.34	56.88	65.41	32.44	56.41	97.31
9	CHAMAPA-LECHERIA	8.31	15.30	17.58	20.29	35.35	40.64	11.98	20.05	23.06	2.82	4.62	11.28
10	DELICIAS-CAMARGO	18.01	33.15	38.09	20.80	38.30	44.01	2.80	5.15	5.92	3.08	7.69	15.38
11	DURANGO-YERBANIS	29.09	53.55	61.53	37.72	64.80	74.47	8.64	11.25	12.94	7.82	13.21	25.13
12	ECATEPEC-PIRAMIDES	6.09	11.22	12.89	14.61	25.10	28.85	8.52	13.88	15.96	1.67	5.26	10.13
13	GUADALAJARA-COLIMA	41.00	75.48	86.73	65.61	112.71	129.53	24.61	37.23	42.80	9.23	11.41	22.95
14	GUADALAJARA-ZAPOTLANEJO	7.20	13.26	15.24	9.36	16.08	18.48	2.16	2.82	3.24	1.92	3.08	6.79
15	LA TINAJA-COSOLEACAQUE	63.16	116.28	133.61	75.31	129.37	148.68	12.15	13.09	15.08	21.15	31.41	61.54
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	32.13	59.16	67.98	40.37	69.35	79.70	8.23	10.19	11.72	9.87	14.62	30.64
17	LIBRAMIENTO DE FRESNILLO	9.14	16.83	19.34	12.68	21.79	25.04	3.54	4.96	5.70	1.41	2.31	3.97
18	LIBRAMIENTO NORESTE DE QUERETARO	10.25	18.87	21.68	11.12	20.47	23.52	0.87	1.60	1.83	2.56	4.23	4.62
19	LIBRAMIENTO ORIENTE DE SALTILLO	6.09	11.22	12.89	16.51	28.78	33.08	10.42	17.56	20.19	1.54	2.18	0.00
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	9.42	17.34	19.92	26.12	48.10	55.27	16.71	30.76	35.34	2.56	4.49	4.49
21	LIBRAMIENTO PONIENTE DE TAMPICO	3.88	7.14	8.20	11.61	23.54	27.06	7.74	16.40	18.86	2.18	3.08	5.90
22	MAZATLAN-CULIACAN	50.41	92.82	106.65	67.30	115.62	132.87	16.88	22.80	26.22	14.10	22.44	47.82
23	MERIDA-CANCUN	66.48	122.40	140.64	97.41	169.75	195.15	30.93	47.35	54.51	15.26	29.23	63.59
24	MONTERREY-NUEVO LAREDO	40.44	74.46	85.56	69.99	121.97	140.22	29.55	47.51	54.66	12.05	19.74	37.44
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	7.20	13.26	15.24	10.68	18.62	21.40	3.48	5.36	6.17	2.18	4.23	7.56
26	TEPIC-ENTRONQUE SAN BLAS	6.93	12.75	14.65	25.86	50.11	57.62	18.93	37.36	42.97	2.18	3.33	6.41
27	TIJUANA-TECATE-LIB. TECATE	9.70	17.85	20.51	33.21	67.30	77.38	23.51	49.45	56.87	3.21	4.74	8.85
28	TORREON-CUENCAME-YERBANIS	32.96	60.69	69.73	41.34	71.02	81.62	8.38	10.33	11.89	9.87	16.41	31.54
29	ZAPOTLANEJO-LAGOS DE MORENO	42.10	77.52	89.07	82.81	167.84	192.96	40.71	90.32	103.89	11.28	15.38	31.41

*US Dollars 1996

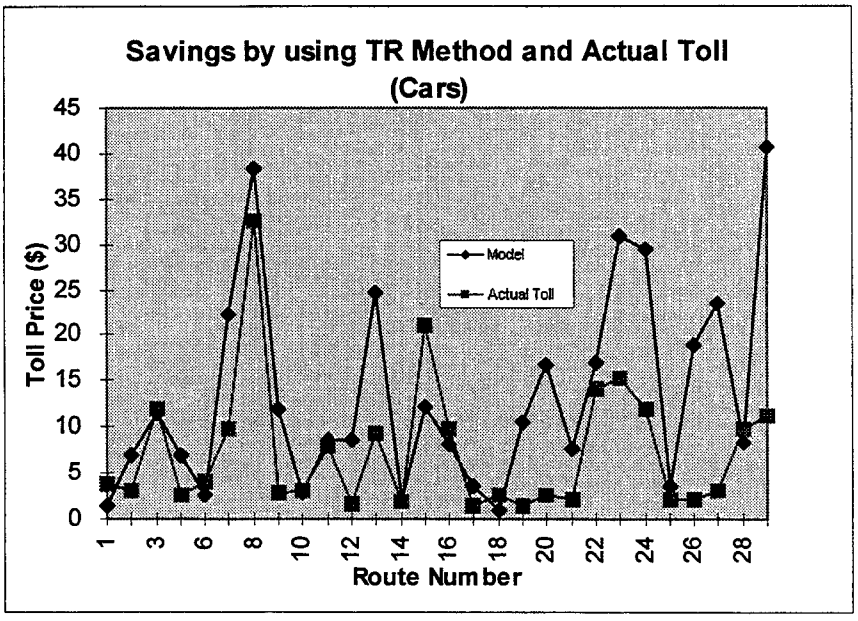


Figure 5.1 User cost method values and actual tolls for passenger cars

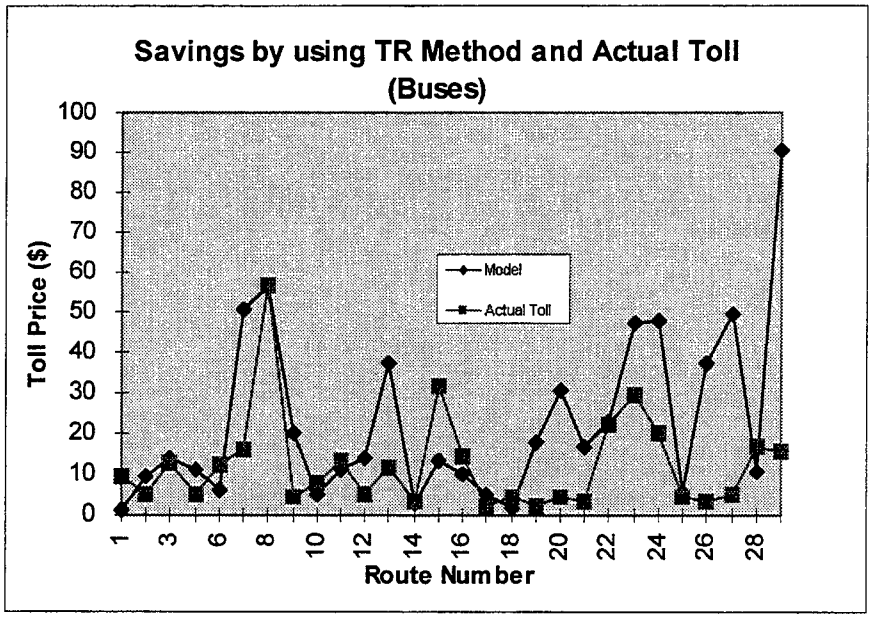


Figure 5.2 User cost method values and actual tolls for buses

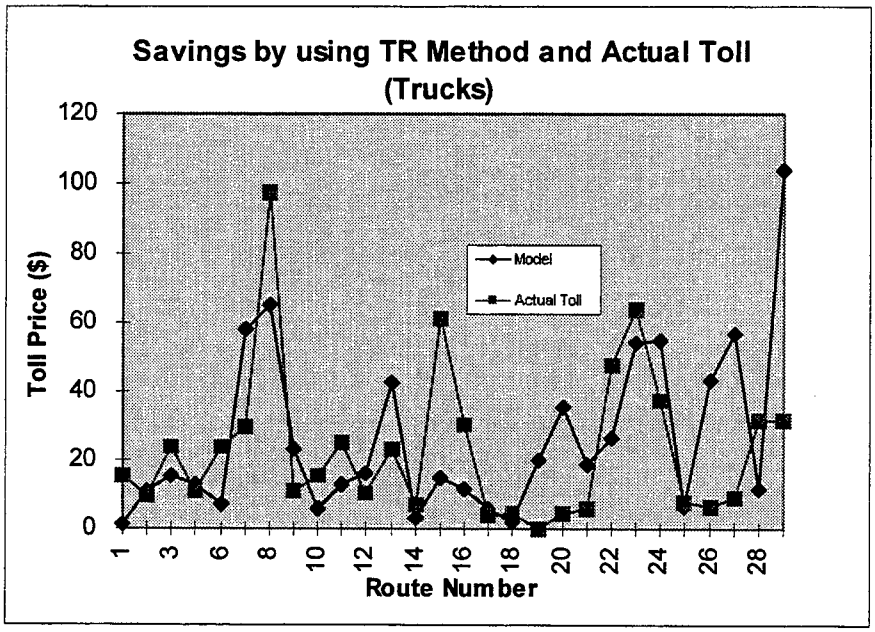


Figure 5.3 User cost method values and actual tolls for trucks

From the figures, it can be seen that in most of the cases the savings are actually greater than the charged toll to the user, especially for passenger cars. This is because, as mentioned previously, in most cases the user has no knowledge of the concept of the full cost of the use of a vehicle, and therefore, may not be willing to pay a toll equal to this value. Here is where the analyst assigns the adjustment factor to the model based on some kind of indicator, such the economic area the highway is located in, or the importance that the connected origin-destination points may have.

MINIMUM REQUIRED RATE OF RETURN METHOD

This method is based on the minimum rate of return required to make the project profitable. First, the analyst needs to make an estimation of all the expenses yielded by the project, including construction, maintenance and interest costs as well as all the costs of operating the facility, such as toll collection equipment and salaries.

Next, it is necessary to estimate the number of vehicles (cars, buses, and trucks) that would use the facility during the entire concession period. A model such as the one developed in Chapter 3 could then be used to forecast the initial ADT. A reliable estimation of the growth rate to forecast the total traffic experienced during the study period is also an important need.

In a simplistic approach, the model for this method would be:

$$T_r = \frac{PC}{100\,V}$$

where:

- T_r = estimated toll for a vehicle type using minimum internal rate of return method
- P = percentage of the total cost that will be covered for the type of vehicle (car, bus or truck)
- C = total cost of the facility during the concession period
- V = number of vehicles during the concession period (cars, buses or trucks)

The factor P is assigned by the analyst. It represents the amount of the cost that will be covered for each vehicle category. For the analysis presented here, the factors are 67% for passenger cars, 15% for buses and 18% for trucks which are the average values in Mexico. [13]

Table 5.2 presents the total traffic using the toll facility during the concession period. These computations are presented in Appendix C in more detail. Table 5.3 is a summary of the

resulting toll prices using this method. Note that the cost variable was taken solely as the construction cost, since the required data was not available.

Figures 5.4, 5.5 and 5.6 present these values in graphical form for passenger cars, buses and trucks respectively.

TABLE 5.2 TOTAL TRAFFIC DURING CONCESSION PERIOD FOR THE CASE STUDY

No.	HIGHWAY	TRAFFIC DURING CONCESSION PERIOD			
		TOTAL	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	13,932,740	11,762,314	787,655	1,382,772
2	ATLACOMULCO-MARAVATIO	44,299,753	34,347,808	3,839,384	6,112,561
3	CADEREYTA-REYNOSA	13,489,935	11,832,506	993,360	664,069
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	48,585,072	23,645,388	3,132,416	21,807,269
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	47,595,745	41,487,536	4,556,638	1,551,570
7	CORDOBA-VERACRUZ	84,951,393	65,322,164	13,439,099	6,190,130
8	CUERNAVACA-ACAPULCO	30,709,871	25,903,817	3,813,741	992,313
9	CHAMAPA-LECHERIA	194,481,616	179,243,594	0	15,238,021
10	DELICIAS-CAMARGO	24,015,187	17,119,522	3,056,281	3,839,384
11	DURANGO-YERBANIS	13,315,265	10,979,973	1,270,071	1,065,221
12	ECATEPEC-PIRAMIDES	128,630,727	100,361,681	16,534,915	11,734,130
13	GUADALAJARA-COLIMA	48,704,713	38,317,709	2,806,122	7,580,881
14	GUADALAJARA-ZAPOTLANEJO	153,314,343	123,556,395	17,173,904	12,584,045
15	LA TINAJA-COSOLEACAQUE	13,360,083	9,270,750	2,526,937	1,562,396
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	56,436,240	45,681,602	4,015,065	6,739,573
17	LIBRAMIENTO DE FRESNILLO	23,352,998	13,162,436	1,786,715	8,403,847
18	LIBRAMIENTO NORESTE DE QUERETARO	82,554,645	45,799,958	8,052,497	28,702,189
19	LIBRAMIENTO ORIENTE DE SALTILLO	36,207,679	16,917,881	2,237,149	17,052,649
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	39,577,065	12,364,118	1,961,615	25,251,333
21	LIBRAMIENTO PONIENTE DE TAMPICO	14,274,744	4,817,357	59,109	9,398,279
22	MAZATLAN-CULIACAN	12,426,884	9,079,643	2,017,698	1,329,543
23	MERIDA-CANCUN	11,390,256	8,420,921	1,938,966	1,030,369
24	MONTERREY-NUEVO LAREDO	32,028,293	27,350,477	2,549,621	2,128,196
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	63,073,387	46,582,943	11,676,463	4,813,981
26	TEPIC-ENTRONQUE SAN BLAS	45,637,556	33,292,793	6,373,596	5,971,167
27	TIJUANA-TECATE-LIB. TECATE	75,712,647	64,077,154	6,165,992	5,469,501
28	TORREON-CUENCAME-YERBANIS	28,801,943	20,198,233	4,813,981	3,789,729
29	ZAPOTLANEJO-LAGOS DE MORENO	25,380,577	20,215,362	2,640,716	2,524,499

TABLE 5.3 SUMMARY OF RESULTS FOR THE MINIMUM RATE OF RETURN METHOD

No.	ROUTE	CONST. COST* $1x10^6$	CONC. PERIOD (Years)	PRICE TO CHARGE DURING CONCESSION ($)*			ACTUAL TOLL ($)*		
				CAR	BUS	TRUCK	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	61.67	14	3.51	11.74	8.03	3.72	9.23	15.26
2	ATLACOMULCO-MARAVATIO	88.46	20	1.73	3.46	2.60	3.21	4.74	9.49
3	CADEREYTA-REYNOSA	230.13	12	13.03	34.75	62.38	12.05	12.69	23.85
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	29.23	20	0.83	1.40	0.24	2.56	5.00	11.28
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	108.85	25	1.76	3.58	12.63	4.10	12.05	24.10
7	CORDOBA-VERACRUZ	203.21	30	2.08	2.27	5.91	9.87	15.90	29.49
8	CUERNAVACA-ACAPULCO	1652.05	15	42.73	64.98	299.67	32.44	56.41	97.31
9	CHAMAPA-LECHERIA	208.59	18	0.78	-	2.46	2.82	4.62	11.28
10	DELICIAS-CAMARGO	39.36	20	1.54	1.93	1.85	3.08	7.69	15.38
11	DURANGO-YERBANIS	109.23	30	6.67	12.90	18.46	7.82	13.21	25.13
12	ECATEPEC-PIRAMIDES	30.64	19	0.20	0.28	0.47	1.67	5.26	10.13
13	GUADALAJARA-COLIMA	305.00	20	5.33	16.30	7.24	9.23	11.41	22.95
14	GUADALAJARA-ZAPOTLANEJO	32.18	20	0.17	0.28	0.46	1.92	3.08	6.79
15	LA TINAJA-COSOLEACAQUE	535.90	16	38.73	31.81	61.74	21.15	31.41	61.54
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	229.36	30	3.36	8.57	6.13	9.87	14.62	30.64
17	LIBRAMIENTO DE FRESNILLO	25.00	14	1.27	2.10	0.54	1.41	2.31	3.97
18	LIBRAMIENTO NORESTE DE QUERETARO	90.26	30	1.32	1.68	0.57	2.56	4.23	4.62
19	LIBRAMIENTO ORIENTE DE SALTILLO	17.95	20	0.71	1.20	0.19	1.54	2.18	0.00
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	45.26	30	2.45	3.46	0.32	2.56	4.49	4.49
21	LIBRAMIENTO PONIENTE DE TAMPICO	26.15	12	4.45	66.37	0.50	2.18	3.08	5.90
22	MAZATLAN-CULIACAN	403.33	14	29.76	29.98	54.61	14.10	22.44	47.82
23	MERIDA-CANCUN	144.62	18	11.51	11.19	25.26	15.26	29.23	63.59
24	MONTERREY-NUEVO LAREDO	168.59	23	4.13	9.92	14.26	12.05	19.74	37.44
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	25.38	30	0.37	0.33	0.95	2.18	4.23	7.56
26	TEPIC-ENTRONQUE SAN BLAS	33.59	20	0.68	0.79	1.01	2.18	3.33	6.41
27	TIJUANA-TECATE-LIB. TECATE	65.38	30	0.68	1.59	2.15	3.21	4.74	8.85
28	TORREON-CUENCAME-YERBANIS	128.21	30	4.25	3.99	6.09	9.87	16.41	31.54
29	ZAPOTLANEJO-LAGOS DE MORENO	218.21	14	7.23	12.39	15.56	11.28	15.38	31.41

*US Dollars 1996

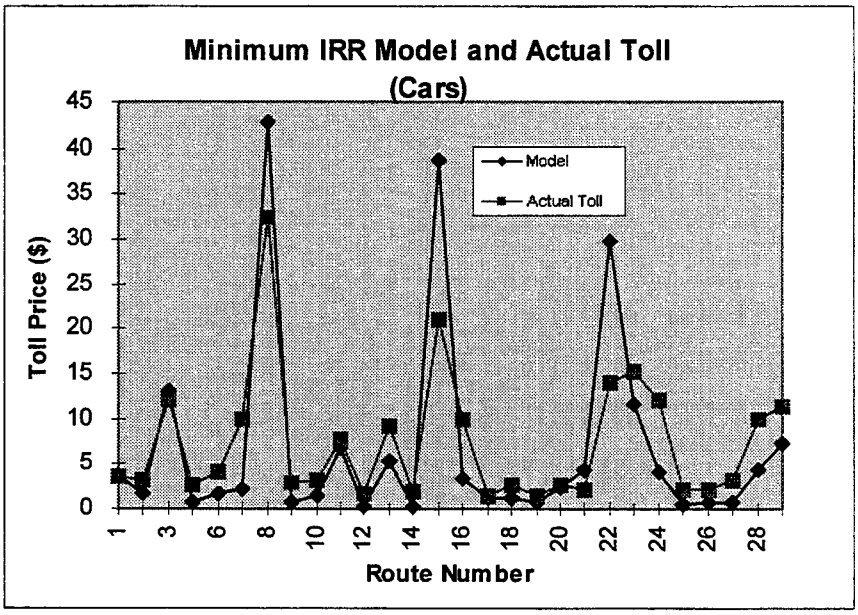


Figure 5.4 Minimum rate of return method values and actual tolls for cars

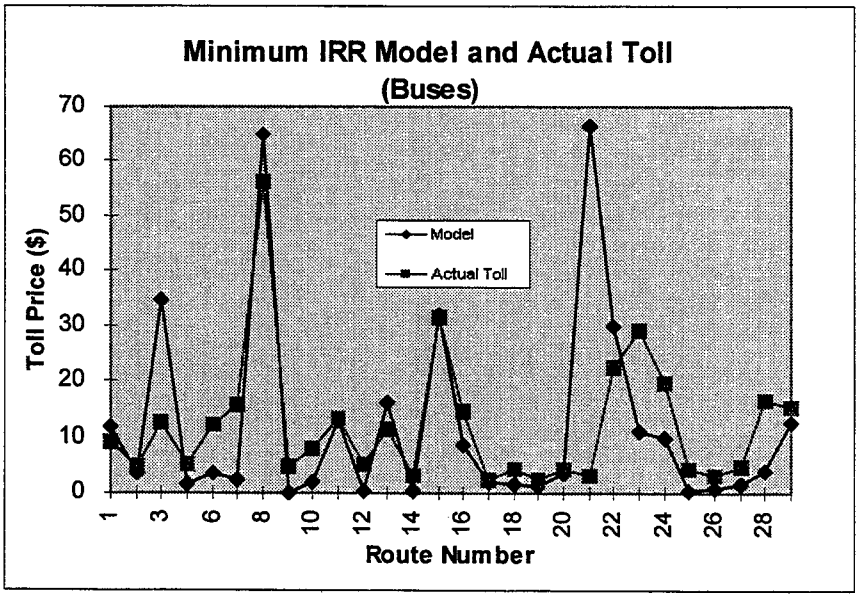


Figure 5.5 Minimum rate of return method values and actual tolls for buses

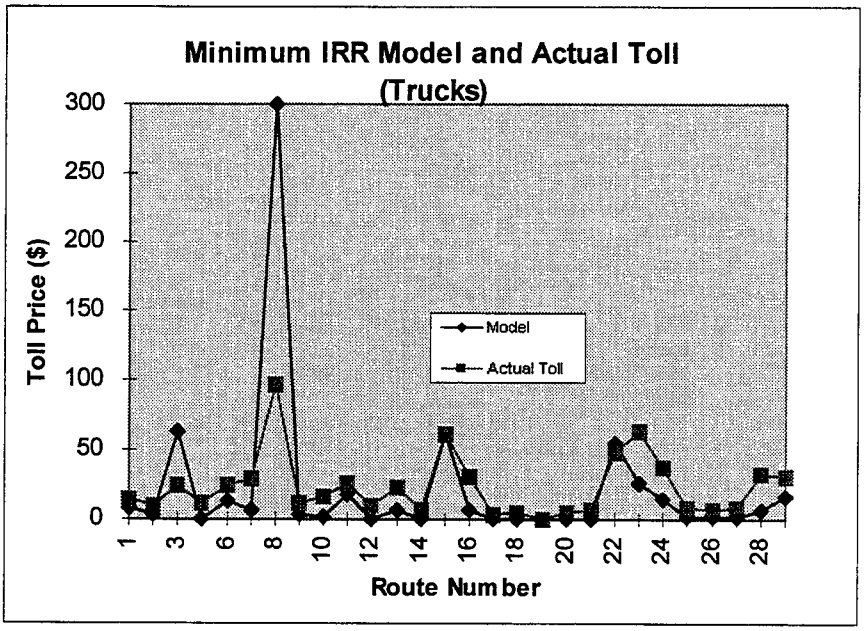


Figure 5.6 Minimum rate of return method values and actual tolls for trucks

From the figures, it can be seen that the values calculated by this method are fairly close to the actual toll price, although the actual toll is slightly higher. This is because the total cost used for the computations corresponds to just the construction cost. However, the graphs show some estimated values that differ from the actual toll. One reason for the differences could be that for the purposes of this study, average values of the variable "P" were used instead of the actual values.

CONSUMPTION METHOD

For the estimation of the toll, this method considers the actual damage caused to the pavement structure by the vehicles using the facility. The essence of this procedure is to charge the actual service life consumption by each vehicle type while utilizing the pavement. In order to do this, it is necessary to know the number of Equivalent Standard Axle Loads (ESAL) that can operate on the pavement structure during its service life, and the total traffic for the different vehicle categories for the same period. Next, the equivalent number of 18 kips (1 ESAL) is determined for each category.

The resulting model is:

$$T_{d\text{-}i} = \frac{e_i \, C_T}{W_{T\text{-}D}}$$

where:

$T_{d\text{-}i}$ = estimated toll using per damage method

e_i = EASLs for a vehicle type (car, bus or truck)

C_T = total cost to be covered during the pavement service life

$W_{T\text{-}D}$ = estimated facility life in terms of total 18 kips ESALs repetitions used in designing the pavement structure

Unfortunately, the necessary data to use this method were not available, although several basic comments can be made. The passenger car does practically no damage to the pavement structure compared to the heavy vehicles such as buses and trucks. For this reason, the estimated toll for buses and especially for heavy trucks will be quite high, and for passenger cars quite small. Thus, the resulting toll for the heavy categories will not be attractive for the users.

Table 5.4 shows equivalency values for the three vehicle types used in this study. These values correspond to a two single-axle passenger car, a one single one-tandem axle bus, and one single two-tandem axle truck, on a 7 inch slab concrete pavement and a p_t value of 2.0. [23]

TABLE 5.4 EQUIVALENT 18 KIPS EASL APPLICATIONS

Vehicle Category	Equivalent EASL Application
Car	0.0004
Bus	0.0360
Truck	3.9800

Using these values, it can be seen that just one single application of a heavy truck is equivalent to 9950 passenger car repetitions. Based solely on this characteristic, the toll price for trucks will be too high compared to passenger cars or even buses. This problem could be alleviated if the method not only takes into account the actual damage to the pavement, but also considers charging the users for the highway area or space that they use during a trip. The main

vehicle category using a highway is passenger car, and it is also the principal source of congestion or decreases in the level of service of the facility. Thus, charging passenger cars for the space they use would balance the toll structure, and the prices for buses and trucks would be lowered. This method also has an additional advantage for the empty trucks, since they would pay a lower toll than a loaded truck.

The detailed study of a method to determine the toll price could be the objective of a full study, thus, it goes beyond the scope of this report.

ELASTICITY BASED METHOD

Probably, a better way to determine the toll to be charged would be using a method based on the elasticity of the demand. In Chapter 4 the behavior of the traffic demand and the toll price was studied. From the resulting model, it is possible for the analyst to choose a toll as a function of the expected traffic that would use the facility, and start to evaluate the project from there.

In Chapter 6, an analysis of the toll prices as a function of the traffic usage is presented, and the optimum toll is determined based on the elasticity model developed in Chapter 4. The optimum toll is that which yields the maximum gross income.

SUMMARY

In order to estimate a fair toll price, the analyst may explore all four methods presented in this chapter. After estimating different toll prices using these methods, the analyst can assign a toll based on a tangible basis.

CHAPTER 6. TOLL INCOME

This chapter analyzes how the toll income varies when the toll price is modified as it affects the traffic demand. This chapter also presents a function that describes the relationship between the toll price and the toll income, and explains how they are strongly related to the elasticity of demand.

Finally, an analysis of the data for the case study is performed and the results are presented to illustrate the behavior of the concepts discussed before.

TOLL INCOME AND TOLL PRICE

In order to increase the gross income in a toll highway project, it is a common practice to raise the toll price. Nevertheless, this action may not be the solution, as a matter of fact, it might even produce a decrease in the total income. This is because the users of the highway may decide to use the toll facility or the free access road option. This is the situation in the case of Mexico, where the use of a toll highway is voluntary, and there is always a free access road as an alternate route. The user will pay the toll if he feels the benefits received in terms of time, distance, safety and cost, are worth the price. The user's willingness to pay the toll can vary from country to country, [12] and even from region to region, so this makes the selection of the optimum toll a difficult task.

The optimum toll for the society is that which yields the demand that minimizes the consumption of social, economical and political resources. From the user point of view, the optimum toll is zero because he does not have to pay extra money to get the benefits of the highway. This of course, yields the maximum traffic demand. On the other side, if the toll is too high, then the demand will decrease and the income will trend to zero. So, somewhere in the middle there is a price that yields the maximum income, when the function of the product of the demand multiplied by the toll price reaches its top.

This income function is defined by:

$$I = y\,x$$

where:

I = income function

y = demand function ($y = m \text{ Ln } x + n$)

x = toll to be charged per km

n, m = constants

The demand function is the model developed in Chapter 4, and it represents the percentage of ADT diverted to the toll highway.

So, the resulting model is:

$$I = (m \text{ Ln } x + n)\,x$$

DATA ANALYSIS FOR THE CASE STUDY

Now, using the data for the cases considered in the development of the models in chapters 3 and 4, an analysis is performed. Note that the data correspond to a group of different highways and the analysis made is at a network level. The results presented here are just an example of how to run the model, and they can give a relative idea of the values that can be expected in a particular case studied at a project level.

The following graphs come from the elasticity model described in Chapter 4, and the regression constants "m" and "n" were estimated taking into account just three groups, passenger cars, buses and trucks.

Figures 6.1, 6.2 and 6.3 show the income function for the case of passenger cars, buses and trucks, respectively. The regression constants used for the demand function are also shown below each figure.

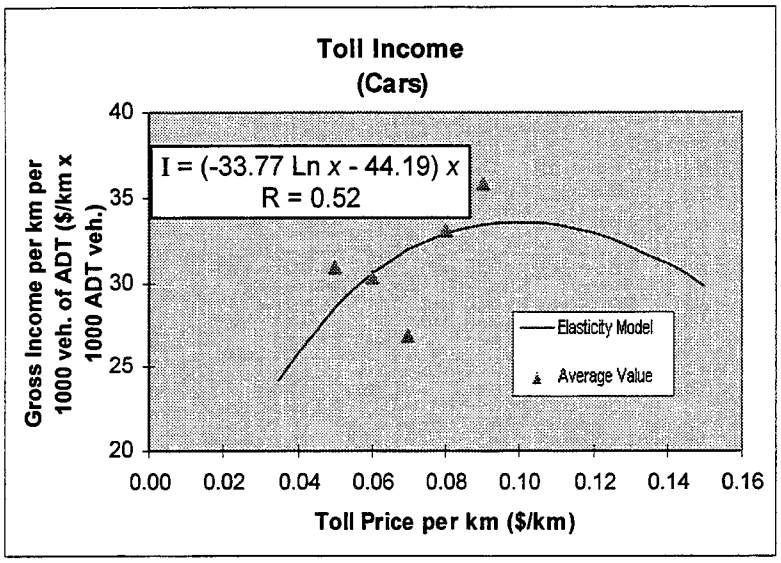


Figure 6.1 Income function for passenger cars

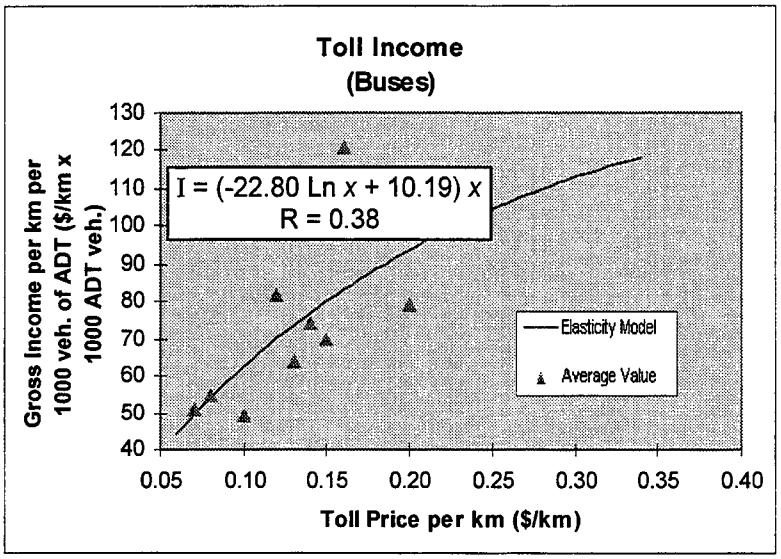


Figure 6.2 Income function for buses

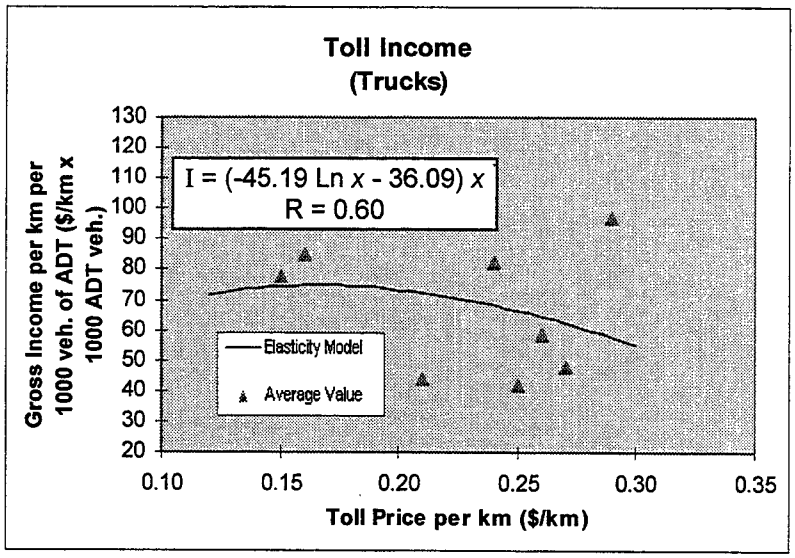


Figure 6.3 Income function for trucks

The optimum tolls according to the income functions presented above are $0.10/km for passenger cars and $0.17/km for trucks. Since the behavior of buses is almost inelastic, the demand practically does not change when the toll price varies. Figure 6.2 indicates the toll yielding the maximum income would be much higher than the actual prices. However, these values would be beyond the range considered in the elasticity model so extrapolation is not recommended. With further research, updating the models with more data, and studying every project separately, the models can be made more accurate.

It is important to note that the level of convenience of the toll prices depends on the user criteria, so they can vary widely in time or from region to region. As mentioned before, toll price determination is not an easy task, and it could be the objective of an entire study, going well beyond the scope of this report.

CHAPTER 7. CONCLUSIONS AND RECOMMENDATIONS

During the evaluation of the economic feasibility of a toll highway project, the main factor to address is the behavior of the traffic demand that would use the facility. This, in addition to the toll price, is the most sensitive variable for the success of the project as pointed out by the recent Mexican experience.

The models developed in this study give a fair estimation of the ADT that could be expected for a certain toll highway, depending on its attributes and toll price. These models do not pretend to be a general solution for all the cases, although the concepts described in this report can be used to adapt the models to an specific project. The user willingness to pay a toll could change with time, and vary from country to country, so these models would need to be calibrated before they are used.

The study proposes to show the convenience of performing rational models of analysis to improve the decision-making process during the planning stage. The analysis was performed on a network level. More reliable results can be reached when the models are calibrated at a project level.

The analysis was performed at a network level due to the lack of availability of data for most of the highways. This is because the Mexican experience with concessioned highways is short. For further research it would be recommendable to have a complete data base.

The behavior of the toll income when the toll changes is also described in this report, and the fact that it is possible to increase the gross income when the toll is reduced is exposed.

By following a rational process to estimate the toll traffic and determine the toll price, such as the methodology described in Chapter 1, the planner would have a reliable input for a feasibility evaluation model.

The models were developed for a certain range of values. It is not recommended to extrapolate the results beyond that range, especially in the elasticity model, where extrapolation could result in an overestimation of the toll price.

APPENDIX A. FREE ACCESS ROAD DATA

ROUTE: ARMERIA-MANZANILLO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	5.67	90	0.06
2	32.87	91	0.36
3	8.86	88	0.10
	ΣL= 47.40	Avg= 90	ΣT= 0.52

ROUTE: ATLACOMULCO-MARAVATIO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	16.40	85	0.19
2	13.60	86	0.16
3	4.50	78	0.06
4	44.50	83	0.54
	ΣL= 79.00	Avg= 84	ΣT= 0.94

ROUTE: CADEREYTA-REYNOSA

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	13.80	81	0.17
2	5.00	81	0.06
3	16.98	85	0.20
4	17.62	86	0.20
5	10.98	85	0.13
6	12.47	85	0.15
7	3.15	85	0.04
8	12.00	86	0.14
9	13.10	79	0.17
10	48.30	79	0.61
11	5.60	84	0.07
12	33.00	82	0.40
	ΣL= 192.00	Avg= 82	ΣT= 2.34

ROUTE: CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	65.00	110	0.59
2	2.70	110	0.02
3	83.63	110	0.76
	ΣL= 151.33	Avg= 110	ΣT= 1.38

ROUTE: CARBONERA-PUERTO MEXICO "LOS CHORROS"

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	19.00	56	0.34
2	35.00	110	0.32
	ΣL= 54.00	Avg= 91	ΣT= 0.66

ROUTE: CONSTITUYENTES-LA VENTA-LA MARQUESA

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	6.96	75	0.09
2	3.40	75	0.05
3	9.48	80	0.12
4	0.54	80	0.01
	ΣL= 20.38	Avg= 77	ΣT= 0.26

ROUTE: CORDOBA-VERACRUZ

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	7.49	64	0.12
2	6.01	80	0.08
3	12.6	80	0.16
4	33.7	65	0.52
5	8.02	74	0.11
6	9.26	74	0.13
7	32.81	80	0.41
8	9.03	80	0.11
9	7.56	80	0.09
	ΣL= 126.48	Avg= 74	ΣT= 1.72

ROUTE: CUERNAVACA-ACAPULCO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	9.80	110	0.09
2	2.63	56	0.05
3	7.49	56	0.13
4	4.85	72	0.07
5	14.22	80	0.18
6	5.14	70	0.07
7	2.80	81	0.03
8	9.62	81	0.12
9	6.92	87	0.08
10	26.33	90	0.29
11	15.80	85	0.19
12	14.03	77	0.18
13	4.35	85	0.05
14	30.97	85	0.36
15	8.61	85	0.10
16	26.33	64	0.41
17	20.39	80	0.25
18	10.70	60	0.18
19	2.72	60	0.05
20	12.01	110	0.11
21	8.28	86	0.10
22	30.39	87	0.35
23	12.46	86	0.14
24	45.64	83	0.55
25	23.89	110	0.22
	ΣL= 356.37	Avg= 84	ΣT= 4.36

ROUTE: CHAMAPA-LECHERIA

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	13.60	60	0.23
2	6.96	75	0.09
3	3.40	75	0.05
4	11.30	90	0.13
3	31.70	110	0.29
	ΣL= 66.96	Avg= 91	ΣT= 0.78

ROUTE: DELICIAS-CAMARGO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	72.80	110	0.66
2	2.30	110	0.02
	ΣL= 75.10	Avg= 110	ΣT= 0.68

ROUTE: DURANGO-YERBANIS

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	7.70	86	0.09
2	19.40	87	0.22
3	29.19	87	0.34
4	20.86	89	0.23
5	11.65	86	0.14
6	32.10	85	0.38
	ΣL= 120.90	Avg= 87	ΣT= 1.40

ROUTE: ECATEPEC-PIRAMIDES

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	16.54	72	0.23
2	6.18	80	0.08
3	5.94	87	0.07
4	4.15	88	0.05
5	14.02	85	0.16
	ΣL= 46.83	Avg= 80	ΣT= 0.59

ROUTE: GUADALAJARA-COLIMA

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	9.80	110	0.09
2	2.63	56	0.05
3	7.49	56	0.13
4	4.85	72	0.07
5	14.22	80	0.18
6	5.14	70	0.07
7	2.80	81	0.03
8	9.62	81	0.12
9	6.92	87	0.08
10	26.33	90	0.29
11	15.80	85	0.19
12	14.03	77	0.18
13	4.35	85	0.05
14	30.97	85	0.36
15	8.61	85	0.10
16	26.33	64	0.41
17	20.39	80	0.25
	ΣL= 210.28	Avg= 81	ΣT= 2.66

ROUTE: GUADALAJARA-ZAPOTLANEJO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	30.00	81	0.37
	ΣL= 30.00	Avg= 81	ΣT= 0.37

ROUTE: LA TINAJA-COSOLEACAQUE

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	14.35	83	0.17
2	11.61	83	0.14
3	10.04	83	0.12
4	13.40	82	0.16
5	29.60	82	0.36
6	1.80	82	0.02
7	34.90	82	0.43
8	6.49	82	0.08
9	23.68	81	0.29
10	25.00	81	0.31
11	29.00	81	0.36
12	11.50	79	0.15
13	21.00	78	0.27
14	9.00	84	0.11
	ΣL= 241.37	Avg= 81	ΣT= 2.97

ROUTE: LEON-LAGOS DE MORENO-AGUASCALIENTES

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	16.70	80	0.21
2	27.48	79	0.35
3	42.50	78	0.54
4	17.50	74	0.24
5	5.97	82	0.07
6	0.85	110	0.01
7	7.40	110	0.07
8	10.98	110	0.10
	ΣL= 129.38	Avg= 83	ΣT= 1.59

ROUTE: LIBRAMIENTO DE FRESNILLO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	24.15	86	0.28
2	16.50	86	0.19
	ΣL= 40.65	Avg= 86	ΣT= 0.47

ROUTE: LIBRAMIENTO NORESTE DE QUERETARO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	4.60	73	0.06
2	35.53	110	0.32
	ΣL= 40.13	Avg= 106	ΣT= 0.39

ROUTE: LIBRAMIENTO ORIENTE DE SALTILLO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	19.00	56	0.34
2	35.50	110	0.32
	ΣL= 54.50	Avg= 91	ΣT= 0.66

ROUTE: LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	48.37	110	0.44
2	45.94	110	0.42
	ΣL= 94.31	Avg= 110	ΣT= 0.86

ROUTE: LIBRAMIENTO PONIENTE DE TAMPICO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	4.19	83	0.05
2	24.00	73	0.33
	ΣL= 28.19	Avg= 74	ΣT= 0.38

ROUTE: MAZATLAN-CULIACAN

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	6.40	82	0.08
2	4.47	86	0.05
3	11.84	83	0.14
4	10.29	83	0.12
5	33.77	83	0.41
6	7.19	87	0.08
7	17.96	87	0.21
8	15.01	87	0.17
9	68.31	85	0.80
10	18.14	80	0.23
11	22.32	85	0.26
	ΣL= 215.70	Avg= 84	ΣT= 2.56

ROUTE: MERIDA-CANCUN

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	28.79	87	0.33
2	17.86	90	0.20
3	1.97	90	0.02
4	44.29	92	0.48
5	23.11	92	0.25
6	44.66	92	0.49
7	10.32	91	0.11
8	11.00	91	0.12
9	48.44	91	0.53
10	0.56	90	0.01
11	13.00	90	0.14
12	10.50	90	0.12
13	6.50	91	0.07
14	14.50	91	0.16
15	13.60	87	0.16
16	28.50	81	0.35
17	3.90	80	0.05
	ΣL= 321.50	Avg= 90	ΣT= 3.59

ROUTE: MONTERREY-NUEVO LAREDO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	28.79	87	0.33
2	17.86	90	0.20
3	1.97	90	0.02
4	44.29	92	0.48
5	23.11	92	0.25
6	44.66	92	0.49
7	10.32	91	0.11
8	11.00	91	0.12
9	48.44	91	0.53
10	0.56	90	0.01
	ΣL= 231.00	Avg= 91	ΣT= 2.54

ROUTE: SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	6.90	82	0.08
2	3.55	82	0.04
3	1.65	82	0.02
4	1.19	89	0.01
5	0.61	90	0.01
6	3.28	88	0.04
7	5.12	87	0.06
8	9.53	110	0.09
9	3.43	56	0.06
	ΣL= 35.26	Avg= 89	ΣT= 0.41

ROUTE: TEPIC-ENTRONQUE SAN BLAS

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	2.56	110	0.02
2	30.98	56	0.55
	ΣL= 33.54	Avg= 60	ΣT= 0.58

ROUTE: TIJUANA-TECATE-LIB. TECATE

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	30.00	79	0.38
2	20.00	63	0.32
3	13.00	82	0.16
4	17.60	86	0.20
	ΣL= 80.60	Avg= 77	ΣT= 1.06

ROUTE: TORREON-CUENCAME-YERBANIS

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	23.40	85	0.28
2	27.31	76	0.36
3	15.88	79	0.20
4	40.81	84	0.49
5	22.00	83	0.27
6	3.10	110	0.03
	ΣL= 132.50	Avg= 82	ΣT= 1.61

ROUTE: ZAPOTLANEJO-LAGOS DE MORENO

Link No.	Length (km)	Travel Velocity (Km/h)	Travel Time (hr)
1	2.70	83	0.03
2	41.66	77	0.54
3	19.14	79	0.24
4	137.50	69	1.99
	ΣL= 201.00	Avg= 72	ΣT= 2.81

APPENDIX B. DATA USED IN THE ANALYSIS

TABLE B.1 LENGTH COMPARISON BETWEEN TOLL AND FREE ACCESS HIGHWAYS

No.	ROUTE	TOLL ROAD LENGTH (km)	FREE ROAD LENGTH (km)	DEVIATION FROM TR (%)
1	ARMERIA-MANZANILLO	47	47	1
2	ATLACOMULCO-MARAVATIO	64	79	23
3	CADEREYTA-REYNOSA	175	192	10
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	157	151	(4)
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	34	54	59
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	21	20	(3)
7	CORDOBA-VERACRUZ	108	126	17
8	CUERNAVACA-ACAPULCO	263	356	36
9	CHAMAPA-LECHERIA	30	67	123
10	DELICIAS-CAMARGO	65	75	16
11	DURANGO-YERBANIS	105	121	15
12	ECATEPEC-PIRAMIDES	22	47	113
13	GUADALAJARA-COLIMA	148	210	42
14	GUADALAJARA-ZAPOTLANEJO	26	30	15
15	LA TINAJA-COSOLEACAQUE	228	241	6
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	116	129	12
17	LIBRAMIENTO DE FRESNILLO	33	41	23
18	LIBRAMIENTO NORESTE DE QUERETARO	37	40	8
19	LIBRAMIENTO ORIENTE DE SALTILLO	22	55	148
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	34	94	177
21	LIBRAMIENTO PONIENTE DE TAMPICO	14	28	101
22	MAZATLAN-CULIACAN	182	216	19
23	MERIDA-CANCUN	240	322	34
24	MONTERREY-NUEVO LAREDO	146	231	58
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	26	35	36
26	TEPIC-ENTRONQUE SAN BLAS	25	34	34
27	TIJUANA-TECATE-LIB. TECATE	35	81	130
28	TORREON-CUENCAME-YERBANIS	119	133	11
29	ZAPOTLANEJO-LAGOS DE MORENO	152	201	32
		ΣL_T= 2674	ΣL_F= 3457	Avg D= 37

TABLE B.2 TRAVEL TIME COMPARISON BETWEEN TOLL AND FREE ACCESS HIGHWAYS

No.	ROUTE	TOLL ROAD TRAVEL TIME (hr)	FREE ROAD TRAVEL TIME (hr)	DEVIATION FROM TR (%)
1	ARMERIA-MANZANILLO	0.43	0.52	23
2	ATLACOMULCO-MARAVATIO	0.58	0.94	62
3	CADEREYTA-REYNOSA	1.59	2.34	47
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	1.43	1.38	(4)
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	0.31	0.66	113
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	0.19	0.26	38
7	CORDOBA-VERACRUZ	0.98	1.59	61
8	CUERNAVACA-ACAPULCO	2.39	4.36	82
9	CHAMAPA-LECHERIA	0.27	0.78	185
10	DELICIAS-CAMARGO	0.59	0.68	16
11	DURANGO-YERBANIS	0.95	1.40	46
12	ECATEPEC-PIRAMIDES	0.20	0.59	194
13	GUADALAJARA-COLIMA	1.35	2.66	98
14	GUADALAJARA-ZAPOTLANEJO	0.24	0.37	57
15	LA TINAJA-COSOLEACAQUE	2.07	2.97	43
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	1.05	1.59	50
17	LIBRAMIENTO DE FRESNILLO	0.30	0.47	58
18	LIBRAMIENTO NORESTE DE QUERETARO	0.34	0.39	15
19	LIBRAMIENTO ORIENTE DE SALTILLO	0.20	0.66	231
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	0.31	0.86	177
21	LIBRAMIENTO PONIENTE DE TAMPICO	0.13	0.38	198
22	MAZATLAN-CULIACAN	1.65	2.56	55
23	MERIDA-CANCUN	2.18	3.59	65
24	MONTERREY-NUEVO LAREDO	1.33	2.54	92
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	0.24	0.41	74
26	TEPIC-ENTRONQUE SAN BLAS	0.23	0.58	154
27	TIJUANA-TECATE-LIB. TECATE	0.32	1.06	233
28	TORREON-CUENCAME-YERBANIS	1.08	1.61	49
29	ZAPOTLANEJO-LAGOS DE MORENO	1.38	2.81	103
			W. AVERAGE=	80

TABLE B.3 TRAVEL SPEED COMPARISON BETWEEN TOLL AND FREE ACCESS HIGHWAYS

No.	ROUTE	TOLL ROAD TRAVEL SPEED (Km/hr)	FREE ROAD TRAVEL SPEED (Km/hr)	DEVIATION FROM TR (%)
1	ARMERIA-MANZANILLO	110	90	(18)
2	ATLACOMULCO-MARAVATIO	110	84	(24)
3	CADEREYTA-REYNOSA	110	82	(25)
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	110	110	0
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	110	91	(17)
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	110	77	(30)
7	CORDOBA-VERACRUZ	110	74	(33)
8	CUERNAVACA-ACAPULCO	110	84	(24)
9	CHAMAPA-LECHERIA	110	91	(17)
10	DELICIAS-CAMARGO	110	110	0
11	DURANGO-YERBANIS	110	87	(21)
12	ECATEPEC-PIRAMIDES	110	80	(27)
13	GUADALAJARA-COLIMA	110	81	(27)
14	GUADALAJARA-ZAPOTLANEJO	110	81	(26)
15	LA TINAJA-COSOLEACAQUE	110	81	(26)
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	110	83	(25)
17	LIBRAMIENTO DE FRESNILLO	110	86	(22)
18	LIBRAMIENTO NORESTE DE QUERETARO	110	106	(4)
19	LIBRAMIENTO ORIENTE DE SALTILLO	110	91	(17)
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	110	110	(0)
21	LIBRAMIENTO PONIENTE DE TAMPICO	110	74	(32)
22	MAZATLAN-CULIACAN	110	84	(23)
23	MERIDA-CANCUN	110	90	(18)
24	MONTERREY-NUEVO LAREDO	110	91	(17)
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	110	89	(19)
26	TEPIC-ENTRONQUE SAN BLAS	110	60	(45)
27	TIJUANA-TECATE-LIB. TECATE	110	77	(30)
28	TORREON-CUENCAME-YERBANIS	110	82	(25)
29	ZAPOTLANEJO-LAGOS DE MORENO	110	72	(35)
	AVERAGE=	110	86	(20)

TABLE B.4 USER COST IN TOLL HIGHWAYS

No.	ROUTE	TOLL ROAD							
		LENGTH (km)	LOS	USER COST (S/Km)			USER COST (S)		
				CAR	BUS	TRUCK	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	47	A	0.28	0.51	0.59	13.02	23.97	27.54
2	ATLACOMULCO-MARAVATIO	64	A	0.28	0.51	0.59	17.73	32.64	37.50
3	CADEREYTA-REYNOSA	175	A	0.28	0.51	0.59	48.48	89.25	102.55
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	157	A	0.28	0.51	0.59	43.49	80.07	92.00
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	34	A	0.28	0.51	0.59	9.42	17.34	19.92
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	21	A	0.28	0.51	0.59	5.82	10.71	12.31
7	CORDOBA-VERACRUZ	108	A	0.28	0.51	0.59	29.92	55.08	63.29
8	CUERNAVACA-ACAPULCO	263	A	0.28	0.51	0.59	72.85	134.13	154.12
9	CHAMAPA-LECHERIA	30	A	0.28	0.51	0.59	8.31	15.30	17.58
10	DELICIAS-CAMARGO	65	A	0.28	0.51	0.59	18.01	33.15	38.09
11	DURANGO-YERBANIS	105	A	0.28	0.51	0.59	29.09	53.55	61.53
12	ECATEPEC-PIRAMIDES	22	A	0.28	0.51	0.59	6.09	11.22	12.89
13	GUADALAJARA-COLIMA	148	A	0.28	0.51	0.59	41.00	75.48	86.73
14	GUADALAJARA-ZAPOTLANEJO	26	A	0.28	0.51	0.59	7.20	13.26	15.24
15	LA TINAJA-COSOLEACAQUE	228	A	0.28	0.51	0.59	63.16	116.28	133.61
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	116	A	0.28	0.51	0.59	32.13	59.16	67.98
17	LIBRAMIENTO DE FRESNILLO	33	A	0.28	0.51	0.59	9.14	16.83	19.34
18	LIBRAMIENTO NORESTE DE QUERETARO	37	A	0.28	0.51	0.59	10.25	18.87	21.68
19	LIBRAMIENTO ORIENTE DE SALTILLO	22	A	0.28	0.51	0.59	6.09	11.22	12.89
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	34	A	0.28	0.51	0.59	9.42	17.34	19.92
21	LIBRAMIENTO PONIENTE DE TAMPICO	14	A	0.28	0.51	0.59	3.88	7.14	8.20
22	MAZATLAN-CULIACAN	182	A	0.28	0.51	0.59	50.41	92.82	106.65
23	MERIDA-CANCUN	240	A	0.28	0.51	0.59	66.48	122.40	140.64
24	MONTERREY-NUEVO LAREDO	146	A	0.28	0.51	0.59	40.44	74.46	85.56
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	26	A	0.28	0.51	0.59	7.20	13.26	15.24
26	TEPIC-ENTRONQUE SAN BLAS	25	A	0.28	0.51	0.59	6.93	12.75	14.65
27	TIJUANA-TECATE-LIB. TECATE	35	A	0.28	0.51	0.59	9.70	17.85	20.51
28	TORREON-CUENCAME-YERBANIS	119	A	0.28	0.51	0.59	32.96	60.69	69.73
29	ZAPOTLANEJO-LAGOS DE MORENO	152	A	0.28	0.51	0.59	42.10	77.52	89.07

TABLE B.5 USER COST IN FREE ACCESS HIGHWAYS

No.	ROUTE	FREE ROAD							
		LENGTH (km)	LOS	USER COST ($/Km)			USER COST ($)		
				CAR	BUS	TRUCK	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	47	C	0.30	0.53	0.61	14.36	25.03	28.77
2	ATLACOMULCO-MARAVATIO	79	D	0.31	0.54	0.62	24.65	42.34	48.66
3	CADEREYTA-REYNOSA	192	D	0.31	0.54	0.62	59.90	102.91	118.27
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	151	A	0.28	0.51	0.59	41.92	77.18	88.68
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	54	C	0.30	0.53	0.61	16.36	28.51	32.78
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	20	E	0.41	0.84	0.96	8.40	17.02	19.56
7	CORDOBA-VERACRUZ	126	E	0.41	0.84	0.96	52.11	105.61	121.42
8	CUERNAVACA-ACAPULCO	356	D	0.31	0.54	0.62	111.19	191.01	219.52
9	CHAMAPA-LECHERIA	67	C	0.30	0.53	0.61	20.29	35.35	40.64
10	DELICIAS-CAMARGO	75	A	0.28	0.51	0.59	20.80	38.30	44.01
11	DURANGO-YERBANIS	121	D	0.31	0.54	0.62	37.72	64.80	74.47
12	ECATEPEC-PIRAMIDES	47	D	0.31	0.54	0.62	14.61	25.10	28.85
13	GUADALAJARA-COLIMA	210	D	0.31	0.54	0.62	65.61	112.71	129.53
14	GUADALAJARA-ZAPOTLANEJO	30	D	0.31	0.54	0.62	9.36	16.08	18.48
15	LA TINAJA-COSOLEACAQUE	241	D	0.31	0.54	0.62	75.31	129.37	148.68
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	129	D	0.31	0.54	0.62	40.37	69.35	79.70
17	LIBRAMIENTO DE FRESNILLO	41	D	0.31	0.54	0.62	12.68	21.79	25.04
18	LIBRAMIENTO NORESTE DE QUERETARO	40	A	0.28	0.51	0.59	11.12	20.47	23.52
19	LIBRAMIENTO ORIENTE DE SALTILLO	55	C	0.30	0.53	0.61	16.51	28.78	33.08
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	94	A	0.28	0.51	0.59	26.12	48.10	55.27
21	LIBRAMIENTO PONIENTE DE TAMPICO	28	E	0.41	0.84	0.96	11.61	23.54	27.06
22	MAZATLAN-CULIACAN	216	D	0.31	0.54	0.62	67.30	115.62	132.87
23	MERIDA-CANCUN	322	C	0.30	0.53	0.61	97.41	169.75	195.15
24	MONTERREY-NUEVO LAREDO	231	C	0.30	0.53	0.61	69.99	121.97	140.22
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	35	C	0.30	0.53	0.61	10.68	18.62	21.40
26	TEPIC-ENTRONQUE SAN BLAS	34	F	0.77	1.49	1.72	25.86	50.11	57.62
27	TIJUANA-TECATE-LIB. TECATE	81	E	0.41	0.84	0.96	33.21	67.30	77.38
28	TORREON-CUENCAME-YERBANIS	133	D	0.31	0.54	0.62	41.34	71.02	81.62
29	ZAPOTLANEJO-LAGOS DE MORENO	201	E	0.41	0.84	0.96	82.81	167.84	192.96

TABLE B.6 TOTAL ADT AND ADT DISTRIBUTION IN THE CORRIDOR

No.	ROUTE	TOTAL (YR 1996)			
		ADT	CAR*	BUS*	TRUCK*
1	ARMERIA-MANZANILLO	5114	4180	342	590
2	ATLACOMULCO-MARAVATIO	6570	4998	485	1086
3	CADEREYTA-REYNOSA	8238	6468	516	1254
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	4022	2604	444	973
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	6467	-	-	-
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	33439	28006	2422	3011
7	CORDOBA-VERACRUZ	9769	7240	1059	1469
8	CUERNAVACA-ACAPULCO	6312	5063	690	559
9	CHAMAPA-LECHERIA	12135	-	-	-
10	DELICIAS-CAMARGO	3543	2602	334	606
11	DURANGO-YERBANIS	2852	2196	157	499
12	ECATEPEC-PIRAMIDES	17077	13454	1767	1856
13	GUADALAJARA-COLIMA	7300	5603	379	1318
14	GUADALAJARA-ZAPOTLANEJO	26453	19639	2320	4494
15	LA TINAJA-COSOLEACAQUE	6918	4832	684	1402
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	8140	6107	519	1514
17	LIBRAMIENTO DE FRESNILLO	8307	-	-	-
18	LIBRAMIENTO NORESTE DE QUERETARO	13632	8603	1057	3971
19	LIBRAMIENTO ORIENTE DE SALTILLO	11233	6205	609	4419
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	10269	6106	581	3581
21	LIBRAMIENTO PONIENTE DE TAMPICO	11802	6673	699	4429
22	MAZATLAN-CULIACAN	5950	3895	588	1467
23	MERIDA-CANCUN	3036	2355	298	383
24	MONTERREY-NUEVO LAREDO	7615	6119	471	1027
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	6190	4732	757	701
26	TEPIC-ENTRONQUE SAN BLAS	7721	5352	833	1536
27	TIJUANA-TECATE-LIB. TECATE	8649	6496	549	1604
28	TORREON-CUENCAME-YERBANIS	4186	3015	402	768
29	ZAPOTLANEJO-LAGOS DE MORENO	10956	8259	831	1865

*NOTE: Sum may not match due to approximations.

TABLE B.7 ADT DIVERSION AND ADT DISTRIBUTION IN TOLL HIGHWAY

No.	ROUTE	TOLL ROAD							
		ADT	ADT (%)	CAR (%)	BUS (%)	TRUCK (%)	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	2388	47	84	6	10	2016	135	236
2	ATLACOMULCO-MARAVATIO	4073	62	78	9	14	3158	353	562
3	CADEREYTA-REYNOSA	2458	30	88	7	5	2156	181	121
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	2095	52	63	15	22	1321	309	464
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	4467	69	49	6	45	2174	288	2006
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	18927	57	87	10	3	16498	1812	617
7	CORDOBA-VERACRUZ	3129	32	77	16	7	2406	495	227
8	CUERNAVACA-ACAPULCO	4147	66	84	12	3	3498	515	135
9	CHAMAPA-LECHERIA	4199	35	92	0	8	3870	0	329
10	DELICIAS-CAMARGO	2208	62	71	13	16	1574	281	352
11	DURANGO-YERBANIS	650	23	82	10	8	536	62	52
12	ECATEPEC-PIRAMIDES	12727	75	78	13	9	9930	1636	1160
13	GUADALAJARA-COLIMA	4478	61	79	6	16	3523	258	697
14	GUADALAJARA-ZAPOTLANEJO	14096	53	81	11	8	11360	1579	1158
15	LA TINAJA-COSOLEACAQUE	1676	24	69	19	12	1163	317	196
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	2755	34	81	7	12	2230	196	329
17	LIBRAMIENTO DE FRESNILLO	2601	31	56	8	36	1466	199	937
18	LIBRAMIENTO NORESTE DE QUERETARO	3742	27	55	10	35	2076	365	1301
19	LIBRAMIENTO ORIENTE DE SALTILLO	4030	36	47	6	47	1883	249	1898
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	3329	32	31	5	64	1040	165	2124
21	LIBRAMIENTO PONIENTE DE TAMPICO	1932	16	34	0	66	652	8	1271
22	MAZATLAN-CULIACAN	,1860	31	73	16	11	1359	302	199
23	MERIDA-CANCUN	1216	40	74	17	9	899	207	110
24	MONTERREY-NUEVO LAREDO	3040	40	85	8	7	2596	242	203
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	3079	50	74	19	8	2274	570	234
26	TEPIC-ENTRONQUE SAN BLAS	4196	54	73	14	13	3061	586	549
27	TIJUANA-TECATE-LIB. TECATE	3696	43	85	8	7	3128	301	267
28	TORREON-CUENCAME-YERBANIS	1406	34	70	17	13	986	235	184
29	ZAPOTLANEJO-LAGOS DE MORENO	3931	36	80	10	10	3131	409	390

TABLE B.8 ADT DIVERSION AND ADT DISTRIBUTION IN FREE ACCESS HIGHWAY

No.	ROUTE	FREE ACCESS ROAD							
		ADT	ADT (%)	CAR (%)	BUS (%)	TRUCK (%)	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	2726	53	79	8	13	2164	207	354
2	ATLACOMULCO-MARAVATIO	2497	38	74	5	21	1840	132	524
3	CADEREYTA-REYNOSA	5780	70	75	6	20	4312	335	1133
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	1927	48	67	7	26	1283	135	509
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	2000	31	-	-	-	-	-	-
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	14512	43	79	4	17	11508	610	2394
7	CORDOBA-VERACRUZ	6640	68	73	9	19	4834	564	1242
8	CUERNAVACA-ACAPULCO	2165	34	72	8	20	1565	175	424
9	CHAMAPA-LECHERIA	7936	65	-	-	-	-	-	-
10	DELICIAS-CAMARGO	1335	38	77	4	19	1028	53	254
11	DURANGO-YERBANIS	2202	77	75	4	20	1660	95	447
12	ECATEPEC-PIRAMIDES	4350	25	81	3	16	3524	131	696
13	GUADALAJARA-COLIMA	2822	39	74	4	22	2080	121	621
14	GUADALAJARA-ZAPOTLANEJO	12357	47	67	6	27	8279	741	3336
15	LA TINAJA-COSOLEACAQUE	5242	76	70	7	23	3669	367	1206
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	5385	66	72	6	22	3877	323	1185
17	LIBRAMIENTO DE FRESNILLO	5706	69	-	-	-	-	-	-
18	LIBRAMIENTO NORESTE DE QUERETARO	9890	73	66	7	27	6527	692	2670
19	LIBRAMIENTO ORIENTE DE SALTILLO	7203	64	60	5	35	4322	360	2521
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	6940	68	73	6	21	5066	416	1457
21	LIBRAMIENTO PONIENTE DE TAMPICO	9870	84	61	7	32	6021	691	3158
22	MAZATLAN-CULIACAN	4090	69	62	7	31	2536	286	1268
23	MERIDA-CANCUN	1820	60	80	5	15	1456	91	273
24	MONTERREY-NUEVO LAREDO	4575	60	77	5	18	3523	229	824
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	3111	50	79	6	15	2458	187	467
26	TEPIC-ENTRONQUE SAN BLAS	3525	46	65	7	28	2291	247	987
27	TIJUANA-TECATE-LIB. TECATE	4953	57	68	5	27	3368	248	1337
28	TORREON-CUENCAME-YERBANIS	2780	66	73	6	21	2029	167	584
29	ZAPOTLANEJO-LAGOS DE MORENO	7025	64	73	6	21	5128	422	1475

TABLE B.9 TOLL PRICES AND TOLL PER KM

No.	TOLL ROAD	TOLL PRICE ($)*			TOLL PRICE ($/km)*		
		CAR	BUS	TRUCK	CAR	BUS	TRUCK
1	ARMERIA-MANZANILLO	3.72	9.23	15.26	0.079	0.196	0.325
2	ATLACOMULCO-MARAVATIO	3.21	4.74	9.49	0.050	0.074	0.148
3	CADEREYTA-REYNOSA	12.05	12.69	23.85	0.069	0.073	0.136
4	CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA	3.85	23.08	46.15	0.024	0.147	0.294
5	CARBONERA-PUERTO MEXICO "LOS CHORROS"	2.56	5.00	11.28	0.075	0.147	0.332
6	CONSTITUYENTES-LA VENTA-LA MARQUESA	4.10	12.05	24.10	0.195	0.574	1.148
7	CORDOBA-VERACRUZ	9.87	15.90	29.49	0.091	0.147	0.273
8	CUERNAVACA-ACAPULCO	32.44	56.41	97.31	0.123	0.214	0.370
9	CHAMAPA-LECHERIA	2.82	4.62	11.28	0.094	0.154	0.376
10	DELICIAS-CAMARGO	3.08	7.69	15.38	0.047	0.118	0.237
11	DURANGO-YERBANIS	7.82	13.21	25.13	0.074	0.126	0.239
12	ECATEPEC-PIRAMIDES	1.67	5.26	10.13	0.076	0.239	0.460
13	GUADALAJARA-COLIMA	9.23	11.41	22.95	0.062	0.077	0.155
14	GUADALAJARA-ZAPOTLANEJO	1.92	3.08	6.79	0.074	0.118	0.261
15	LA TINAJA-COSOLEACAQUE	21.15	31.41	61.54	0.093	0.138	0.270
16	LEON-LAGOS DE MORENO-AGUASCALIENTES	9.87	14.62	30.64	0.085	0.126	0.264
17	LIBRAMIENTO DE FRESNILLO	1.41	2.31	3.97	0.043	0.070	0.120
18	LIBRAMIENTO NORESTE DE QUERETARO	2.56	4.23	4.62	0.069	0.114	0.125
19	LIBRAMIENTO ORIENTE DE SALTILLO	1.54	2.18	0.00	0.070	0.099	0.000
20	LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI	2.56	4.49	4.49	0.075	0.132	0.132
21	LIBRAMIENTO PONIENTE DE TAMPICO	2.18	3.08	5.90	0.156	0.220	0.421
22	MAZATLAN-CULIACAN	14.10	22.44	47.82	0.077	0.123	0.263
23	MERIDA-CANCUN	15.26	29.23	63.59	0.064	0.122	0.265
24	MONTERREY-NUEVO LAREDO	12.05	19.74	37.44	0.083	0.135	0.256
25	SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO	2.18	4.23	7.56	0.084	0.163	0.291
26	TEPIC-ENTRONQUE SAN BLAS	2.18	3.33	6.41	0.087	0.133	0.256
27	TIJUANA-TECATE-LIB. TECATE	3.21	4.74	8.85	0.092	0.136	0.253
28	TORREON-CUENCAME-YERBANIS	9.87	16.41	31.54	0.083	0.138	0.265
29	ZAPOTLANEJO-LAGOS DE MORENO	11.28	15.38	31.41	0.074	0.101	0.207

*US Dollars (1996), 1 Dollar = 7.8 Pesos

APPENDIX C. TRAFFIC COMPUTATIONS FOR TOLL ROADS

HIGHWAY: ARMERIA-MANZANILLO GROWTH RATE: 2%
ADT DISTRIBUTION: CARS: 84% BUSES: 6% TRUCKS: 10%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL CAR	TOTAL BUS	TOTAL TRUCK
1	2388	872217	872217	736344	49309	86564
2	2436	889661	1761878	1487415	99604	174860
3	2484	907455	2669333	2253507	150904	264921
4	2534	925604	3594937	3034921	203231	356784
5	2585	944116	4539052	3831964	256605	450484
6	2637	962998	5502050	4644947	311046	546058
7	2689	982258	6484308	5474190	366575	643543
8	2743	1001903	7486212	6320018	423215	742978
9	2798	1021941	8508153	7182762	480989	844402
10	2854	1042380	9550533	8062761	539917	947854
11	2911	1063228	10613760	8960361	600024	1053376
12	2969	1084492	11698253	9875912	661333	1161007
13	3029	1106182	12804435	10809774	723869	1270792
14	3089	1128306	13932740	11762314	787655	1382772
15	3151	1150872	15083612	12733904	852717	1496992
16	3214	1173889	16257501	13724926	919080	1613496
17	3278	1197367	17454868	14735768	986770	1732330
18	3344	1221314	18676183	15766828	1055814	1853541
19	3411	1245741	19921924	16818508	1126239	1977176
20	3479	1270655	21192579	17891222	1198073	2103284
21	3548	1296069	22488648	18985391	1271343	2231914
22	3619	1321990	23810638	20101443	1346079	2363116
23	3692	1348430	25159067	21239816	1422309	2496943
24	3766	1375398	26534466	22400956	1500064	2633446
25	3841	1402906	27937372	23585319	1579374	2772679
26	3918	1430964	29368336	24793369	1660270	2914697
27	3996	1459584	30827920	26025581	1742784	3059555
28	4076	1488775	32316696	27282436	1826949	3207310
29	4158	1518551	33835246	28564429	1912797	3358021
30	4241	1548922	35384168	29872062	2000361	3511745

HIGHWAY: ATLACOMULCO-MARAVATIO GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 78% BUSES: 9% TRUCKS: 14%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL CAR	TOTAL BUS	TOTAL TRUCK
1	4073	1487663	1487663	1153460	128933	205271
2	4236	1547170	3034833	2353057	263024	418752
3	4405	1609057	4643890	3600639	402478	640772
4	4582	1673419	6317308	4898124	547510	871674
5	4765	1740356	8057664	6247509	698344	1111811
6	4955	1809970	9867634	7650869	855211	1361554
7	5154	1882369	11750002	9110363	1018353	1621287
8	5360	1957663	13707666	10628237	1188020	1891409
9	5574	2035970	15743636	12206826	1364474	2172336
10	5797	2117409	17861044	13848558	1547986	2464500
11	6029	2202105	20063149	15555960	1738839	2768350
12	6270	2290189	22353339	17331658	1937326	3084355
13	6521	2381797	24735135	19178384	2143752	3412999
14	6782	2477069	27212204	21098979	2358436	3754790
15	7053	2576151	29788355	23096397	2581706	4110252
16	7335	2679197	32467553	25173713	2813908	4479932
17	7629	2786365	35253918	27334121	3055397	4864400
18	7934	2897820	38151738	29580945	3306546	5264247
19	8251	3013733	41165471	31917642	3567742	5680087
20	8581	3134282	44299753	34347808	3839384	6112561
21	8924	3259653	47559407	36875179	4121893	6562334
22	9281	3390040	50949446	39503646	4415702	7030098
23	9653	3525641	54475087	42237251	4721263	7516572
24	10039	3666667	58141754	45080201	5039047	8022506
25	10440	3813333	61955087	48036869	5369542	8548676
26	10858	3965867	65920954	51111803	5713257	9095894
27	11292	4124501	70045455	54309734	6070721	9665000
28	11744	4289481	74334937	57635583	6442483	10256871
29	12214	4461061	78795998	61094466	6829115	10872416
30	12702	4639503	83435501	64691704	7231213	11512583

HIGHWAY: CADEREYTA-REYNOSA GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 88% BUSES: 7% TRUCKS: 5%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	2458	897785	897785	787479	66110	44195
2	2556	933696	1831480	1606457	134865	90158
3	2659	971044	2802524	2458194	206370	137960
4	2765	1009885	3812410	3344001	280735	187674
5	2876	1050281	4862690	4265240	358074	239376
6	2991	1092292	5954983	5223329	438508	293146
7	3110	1135984	7090966	6219741	522158	349067
8	3235	1181423	8272390	7256010	609155	407225
9	3364	1228680	9501070	8333729	699631	467709
10	3499	1277827	10778897	9454557	793727	530613
11	3638	1328940	12107837	10620219	891586	596033
12	3784	1382098	13489935	11832506	993360	664069
13	3935	1437382	14927317	13093286	1099204	734827
14	4093	1494877	16422194	14404496	1209283	808416
15	4256	1554672	17976867	15768155	1323764	884947
16	4427	1616859	19593726	17186360	1442825	964541
17	4604	1681534	21275259	18661293	1566648	1047317
18	4788	1748795	23024054	20195224	1695425	1133405
19	4979	1818747	24842801	21790512	1829352	1222937
20	5179	1891497	26734297	23449612	1968636	1316050
21	5386	1967156	28701454	25175075	2113492	1412887
22	5601	2045843	30747296	26969557	2264142	1513598
23	5825	2127676	32874973	28835818	2420818	1618337
24	6058	2212783	35087756	30776730	2583761	1727265
25	6301	2301295	37389051	32795278	2753221	1840551
26	6553	2393347	39782397	34894568	2929461	1958369
27	6815	2489080	42271478	37077830	3112749	2080899
28	7087	2588644	44860122	39348422	3303369	2208330
29	7371	2692189	47552311	41709838	3501614	2340858
30	7666	2799877	50352188	44165711	3707789	2478688

HIGHWAY: CAMARGO-JIMENEZ Y EL SUECO VILLA AHUMADA GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 63% BUSES: 15% TRUCKS: 22%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	2095	765199	765199	482495	112862	169841
2	2179	795807	1561005	984290	230239	346476
3	2266	827639	2388644	1506157	352311	530176
4	2357	860745	3249389	2048899	479265	721225
5	2451	895174	4144563	2613350	611298	919915
6	2549	930981	5075545	3200379	748613	1126553
7	2651	968221	6043765	3810890	891419	1341456
8	2757	1006949	7050714	4445820	1039938	1564956
9	2867	1047227	8097942	5106148	1194398	1797395
10	2982	1089116	9187058	5792890	1355036	2039132
11	3101	1132681	10319739	6507100	1522100	2290539
12	3225	1177988	11497728	7249880	1695846	2552002
13	3354	1225108	12722835	8022370	1876542	2823923
14	3488	1274112	13996948	8825760	2064466	3106721
15	3628	1325077	15322024	9661286	2259907	3400831
16	3773	1378080	16700104	10530233	2463166	3706706
17	3924	1433203	18133307	11433937	2674555	4024815
18	4081	1490531	19623838	12373790	2894399	4355649
19	4244	1550152	21173990	13351237	3123037	4699716
20	4414	1612158	22786149	14367781	3360821	5057546
21	4590	1676645	24462793	15424988	3608116	5429689
22	4774	1743710	26206504	16524483	3865303	5816718
23	4965	1813459	28019963	17667957	4132777	6219228
24	5164	1885997	29905960	18857171	4410951	6637838
25	5370	1961437	31867397	20093953	4700251	7073193
26	5585	2039895	33907292	21380206	5001123	7525962
27	5808	2121490	36028782	22717910	5314030	7996842
28	6041	2206350	38235132	24109121	5639454	8486557
29	6282	2294604	40529736	25555982	5977894	8995860
30	6534	2386388	42916124	27060716	6329872	9525536

HIGHWAY: CARBONERA-PUERTO MEXICO "LOS CHORROS" GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 49% BUSES: 6% TRUCKS: 45%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	4467	1631572	1631572	794054	105192	732326
2	4646	1696835	3328406	1619869	214592	1493946
3	4832	1764708	5093114	2478717	328367	2286030
4	5025	1835296	6928411	3371920	446694	3109797
5	5226	1908708	8837119	4300850	569754	3966515
6	5435	1985057	10822175	5266937	697736	4857502
7	5652	2064459	12886634	6271668	830837	5784128
8	5878	2147037	15033671	7316589	969263	6747820
9	6113	2232919	17266590	8403306	1113225	7750059
10	6358	2322235	19588825	9533491	1262946	8792387
11	6612	2415125	22003950	10708885	1418656	9876409
12	6877	2511730	24515680	11931293	1580595	11003792
13	7152	2612199	27127879	13202599	1749010	12176270
14	7438	2716687	29844566	14524756	1924163	13395647
15	7735	2825354	32669920	15899800	2106321	14663799
16	8045	2938369	35608288	17329845	2295766	15982677
17	8367	3055903	38664192	18817093	2492789	17354310
18	8701	3178139	41842331	20363830	2697692	18780809
19	9049	3305265	45147596	21972437	2910792	20264368
20	9411	3437476	48585072	23645388	3132416	21807269
21	9788	3574975	52160046	25385257	3362904	23411886
22	10179	3717974	55878020	27194720	3602612	25080687
23	10586	3866693	59744713	29076563	3851909	26816241
24	11010	4021360	63766073	31033679	4111177	28621217
25	11450	4182215	67948287	33069079	4380816	30498392
26	11908	4349503	72297791	35185896	4661241	32450654
27	12385	4523483	76821274	37387385	4952883	34481006
28	12880	4704423	81525697	39676934	5256190	36592573
29	13395	4892600	86418296	42058065	5571630	38788602
30	13931	5088304	91506600	44534441	5899687	41072472

HIGHWAY: CONSTITUYENTES-LA VENTA-LA MARQUESA GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 87% BUSES: 10% TRUCKS: 3%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	3129	1142867	1142867	996197	109414	37256
2	3254	1188582	2331449	2032242	223204	76003
3	3384	1236125	3567574	3109729	341546	116299
4	3520	1285570	4853145	4230315	464622	158207
5	3660	1336993	6190138	5395725	592621	201792
6	3807	1390473	7580610	6607751	725739	247120
7	3959	1446092	9026702	7868259	864183	294261
8	4118	1503935	10530637	9179186	1008164	343288
9	4282	1564093	12094730	10542551	1157904	394275
10	4454	1626656	13721387	11960450	1313634	447303
11	4632	1691723	15413109	13435065	1475593	502451
12	4817	1759392	17172501	14968665	1644031	559805
13	5010	1829767	19002268	16563609	1819206	619454
14	5210	1902958	20905226	18222350	2001388	681488
15	5418	1979076	22884303	19947441	2190857	746004
16	5635	2058239	24942542	21741536	2387905	813100
17	5861	2140569	27083111	23607395	2592835	882881
18	6095	2226192	29309302	25547888	2805963	955452
19	6339	2315239	31624542	27566000	3027615	1030926
20	6592	2407849	34032391	29664838	3258133	1109420
21	6856	2504163	36536554	31847628	3497873	1191053
22	7130	2604329	39140883	34117731	3747201	1275951
23	7415	2708503	41849386	36478637	4006503	1364245
24	7712	2816843	44666228	38933980	4276177	1456071
25	8021	2929516	47595745	41487536	4556638	1551570
26	8341	3046697	50642442	44143235	4848317	1650890
27	8675	3168565	53811007	46905161	5151664	1754181
28	9022	3295308	57106314	49777565	5467144	1861605
29	9383	3427120	60533434	52764865	5795244	1973325
30	9758	3564205	64097639	55871656	6136468	2089515

HIGHWAY: CORDOBA-VERACRUZ GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 77% BUSES: 16% TRUCKS: 7%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	4147	1514692	1514692	1164701	239620	110371
2	4313	1575279	3089971	2375989	488826	225156
3	4485	1638291	4728262	3635730	747999	344533
4	4665	1703822	6432084	4945859	1017540	468685
5	4851	1771975	8204059	6308394	1297862	597803
6	5045	1842854	10046913	7725431	1589397	732086
7	5247	1916568	11963481	9199149	1892593	871740
8	5457	1993231	13956712	10731815	2207917	1016980
9	5675	2072960	16029673	12325789	2535854	1168030
10	5902	2155879	18185551	13983521	2876909	1325122
11	6139	2242114	20427665	15707562	3231606	1488497
12	6384	2331798	22759464	17500565	3600490	1658408
13	6639	2425070	25184534	19365289	3984130	1835115
14	6905	2522073	27706607	21304601	4383116	2018890
15	7181	2622956	30329563	23321486	4798061	2210016
16	7469	2727874	33057437	25419046	5229604	2408787
17	7767	2836989	35894427	27600508	5678409	2615510
18	8078	2950469	38844895	29869229	6145166	2830501
19	8401	3068488	41913383	32228699	6630593	3054091
20	8737	3191227	45104610	34682548	7135437	3286625
21	9087	3318876	48423486	37234550	7660475	3528461
22	9450	3451631	51875117	39888633	8206514	3779970
23	9828	3589696	55464814	42648879	8774395	4041540
24	10221	3733284	59198098	45519535	9364992	4313572
25	10630	3882616	63080714	48505017	9979212	4596485
26	11055	4037920	67118634	51609918	10618001	4890715
27	11497	4199437	71318071	54839015	11282341	5196715
28	11957	4367415	75685486	58197277	11973255	5514954
29	12436	4542111	80227597	61689868	12691806	5845923
30	12933	4723796	84951393	65322164	13439099	6190130

HIGHWAY: CUERNAVACA-ACAPULCO GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 84% BUSES: 12% TRUCKS: 3%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	4199	1533685	1533685	1293665	190462	49557
2	4367	1595032	3128717	2639077	388543	101097
3	4542	1658833	4787550	4038305	594547	154698
4	4723	1725187	6512737	5493502	808792	210443
5	4912	1794194	8306931	7006908	1031606	268418
6	5109	1865962	10172893	8580849	1263333	328712
7	5313	1940600	12113494	10217748	1504328	391417
8	5526	2018225	14131718	11920123	1754964	456631
9	5747	2098953	16230672	13690593	2015625	524454
10	5976	2182912	18413583	15531882	2286712	594989
11	6216	2270228	20683811	17446822	2568643	668346
12	6464	2361037	23044849	19438360	2861851	744637
13	6723	2455479	25500327	21509560	3166788	823980
14	6992	2553698	28054025	23663607	3483922	906496
15	7271	2655846	30709871	25903817	3813741	992313
16	7562	2762080	33471951	28233635	4156753	1081563
17	7865	2872563	36344513	30656645	4513486	1174383
18	8179	2987465	39331979	33176576	4884487	1270915
19	8506	3106964	42438943	35797304	5270329	1371309
20	8847	3231242	45670185	38522862	5671605	1475719
21	9201	3360492	49030677	41357441	6088931	1584304
22	9569	3494912	52525589	44305404	6522951	1697234
23	9951	3634708	56160297	47371285	6974332	1814680
24	10349	3780097	59940394	50559802	7443767	1936825
25	10763	3931301	63871694	53875859	7931980	2063855
26	11194	4088553	67960247	57324558	8439722	2195967
27	11642	4252095	72212342	60911206	8967773	2333362
28	12107	4422178	76634520	64641319	9516947	2476254
29	12592	4599066	81233586	68520637	10088087	2624861
30	13095	4783028	86016614	72555128	10682073	2779413

HIGHWAY: CHAMAPA-LECHERIA GROWTH RATE: 5%
ADT DISTRIBUTION: CARS: 92% BUSES: 0% TRUCKS: 8%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	18927	6913087	6913087	6371433	00000	541654
2	19873	7258741	14171828	13061437	00000	1110391
3	20867	7621678	21793506	20085941	00000	1707565
4	21910	8002762	29796268	27461671	00000	2334597
5	23006	8402900	38199168	35206187	00000	2992981
6	24156	8823045	47022213	43337929	00000	3684284
7	25364	9264197	56286411	51876259	00000	4410152
8	26632	9727407	66013818	60841504	00000	5172314
9	27964	10213778	76227596	70255012	00000	5972584
10	29362	10724467	86952062	80139195	00000	6812867
11	30830	11260690	98212752	90517588	00000	7695164
12	32372	11823724	110036476	101414900	00000	8621577
13	33990	12414911	122451387	112857077	00000	9594310
14	35690	13035656	135487043	124871364	00000	10615679
15	37474	13687439	149174482	137486365	00000	11688117
16	39348	14371811	163546293	150732116	00000	12814177
17	41315	15090401	178636694	164640154	00000	13996540
18	43381	15844921	194481616	179243594	00000	15238021
19	45550	16637168	211118783	194577207	00000	16541576
20	47828	17469026	228587809	210677500	00000	17910309
21	50219	18342477	246930286	227582807	00000	19347479
22	52730	19259601	266189887	245333380	00000	20856507
23	55366	20222581	286412469	263971482	00000	22440986
24	58135	21233710	307646179	283541489	00000	24104690
25	61041	22295396	329941574	304089996	00000	25851578
26	64094	23410165	353351740	325665928	00000	27685811
27	67298	24580674	377932414	348320658	00000	29611756
28	70663	25809707	403742121	372108123	00000	31633998
29	74196	27100193	430842314	397084962	00000	33757352
30	77906	28455202	459297516	423310643	00000	35986874

HIGHWAY: DELICIAS-CAMARGO GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 71% BUSES: 13% TRUCKS: 16%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	2208	806472	806472	574904	102635	128933
2	2296	838731	1645203	1172803	209376	263024
3	2388	872280	2517483	1794619	320386	402478
4	2484	907171	3424654	2441307	435837	547510
5	2583	943458	4368112	3113863	555906	698344
6	2686	981196	5349309	3813321	680777	855211
7	2794	1020444	6369753	4540757	810643	1018353
8	2906	1061262	7431015	5297291	945704	1188020
9	3022	1103713	8534728	6084086	1086168	1364474
10	3143	1147861	9682589	6902353	1232250	1547986
11	3268	1193776	10876365	7753351	1384175	1738839
12	3399	1241527	12117891	8638388	1542177	1937326
13	3535	1291188	13409079	9558827	1706500	2143752
14	3676	1342835	14751914	10516084	1877395	2358436
15	3824	1396549	16148463	11511631	2055126	2581706
16	3976	1452411	17600873	12546999	2239966	2813908
17	4136	1510507	19111380	13623783	2432200	3055397
18	4301	1570927	20682307	14743638	2632123	3306546
19	4473	1633764	22316072	15908287	2840044	3567742
20	4652	1699115	24015187	17119522	3056281	3839384
21	4838	1767079	25782266	18379206	3281167	4121893
22	5032	1837763	27620029	19689278	3515049	4415702
23	5233	1911273	29531302	21051752	3758286	4721263
24	5442	1987724	31519026	22468726	4011253	5039047
25	5660	2067233	33586259	23942378	4274338	5369542
26	5886	2149922	35736181	25474977	4547947	5713257
27	6122	2235919	37972101	27068880	4832500	6070721
28	6366	2325356	40297457	28726538	5128435	6442483
29	6621	2418370	42715827	30450503	5436208	6829115
30	6886	2515105	45230932	32243427	5756292	7231213

HIGHWAY: DURANGO-YERBANIS GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 82% BUSES: 10% TRUCKS: 8%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	650	237413	237413	195774	22646	18993
2	676	246909	484322	399379	46197	38746
3	703	256785	741107	611128	70690	59289
4	731	267057	1008164	831347	96163	80653
5	760	277739	1285903	1060375	122655	102872
6	791	288849	1574751	1298564	150207	125980
7	822	300403	1875154	1546281	178861	150012
8	855	312419	2187572	1803906	208661	175006
9	890	324915	2512488	2071836	239653	200999
10	925	337912	2850400	2350484	271884	228032
11	962	351428	3201828	2640277	305405	256146
12	1001	365486	3567314	2941662	340267	285385
13	1041	380105	3947419	3255103	376523	315794
14	1082	395309	4342728	3581081	414229	347418
15	1126	411122	4753850	3920098	453444	380308
16	1171	427567	5181417	4272676	494227	414513
17	1217	444669	5626086	4639357	536642	450087
18	1266	462456	6088542	5020705	580753	487083
19	1317	480954	6569496	5417307	626629	525560
20	1369	500192	7069688	5829774	674339	565575
21	1424	520200	7589888	6258738	723959	607191
22	1481	541008	8130896	6704862	775562	650472
23	1540	562648	8693544	7168831	829230	695484
24	1602	585154	9278699	7651358	885045	742296
25	1666	608560	9887259	8153186	943092	790981
26	1733	632903	10520162	8675087	1003462	841613
27	1802	658219	11178381	9217865	1066246	894270
28	1874	684548	11862929	9782354	1131541	949034
29	1949	711930	12574858	10369422	1199448	1005989
30	2027	740407	13315265	10979973	1270071	1065221

HIGHWAY: ECATEPEC-PIRAMIDES GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 78% BUSES: 13% TRUCKS: 9%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	12727	4648537	4648537	3626933	597549	424055
2	13236	4834478	9483015	7398942	1219000	865073
3	13766	5027857	14510872	11321832	1865309	1323731
4	14316	5228972	19739844	15401638	2537470	1800735
5	14889	5438131	25177974	19644636	3236518	2296820
6	15484	5655656	30833630	24057354	3963528	2812748
7	16104	5881882	36715512	28646581	4719618	3349313
8	16748	6117157	42832669	33419377	5505952	3907341
9	17418	6361844	49194513	38383084	6323739	4487690
10	18114	6616317	55810830	43545340	7174237	5091253
11	18839	6880970	62691800	48914086	8058756	5718958
12	19593	7156209	69848009	54497582	8978655	6371772
13	20376	7442457	77290466	60304418	9935350	7050698
14	21191	7740155	85030621	66343527	10930313	7756781
15	22039	8049762	93080383	72624201	11965075	8491107
16	22921	8371752	101452135	79156101	13041227	9254807
17	23837	8706622	110158757	85949278	14160425	10049055
18	24791	9054887	119213644	93014181	15324391	10875072
19	25783	9417083	128630727	100361681	16534915	11734130
20	26814	9793766	138424493	108003081	17793861	12627551
21	27886	10185516	148610009	115950137	19103165	13556708
22	29002	10592937	159202946	124215075	20464840	14523031
23	30162	11016655	170219601	132810610	21880983	15528008
24	31368	11457321	181676922	141749967	23353771	16573183
25	32623	11915614	193592535	151046898	24885471	17660166
26	33928	12392238	205984773	160715707	26478439	18790628
27	35285	12887928	218872701	170771267	28135125	19966308
28	36697	13403445	232276146	181229051	29858079	21189016
29	38164	13939583	246215728	192105145	31649951	22460632
30	39691	14497166	260712894	203416283	33513498	23783112

HIGHWAY: GUADALAJARA-COLIMA GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 79% BUSES: 6% TRUCKS: 16%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL CAR	TOTAL BUS	TOTAL TRUCK
1	4478	1635590	1635590	1286776	94235	254579
2	4657	1701013	3336603	2625023	192238	519342
3	4843	1769054	5105656	4016799	294162	794695
4	5037	1839816	6945472	5464247	400163	1081062
5	5239	1913408	8858880	6969593	510404	1378883
6	5448	1989945	10848825	8535152	625055	1688618
7	5666	2069543	12918368	10163334	744292	2010742
8	5893	2152324	15070692	11856643	868298	2345751
9	6128	2238417	17309109	13617684	997264	2694160
10	6374	2327954	19637063	15449167	1131390	3056506
11	6629	2421072	22058135	17353910	1270880	3433345
12	6894	2517915	24576050	19334842	1415949	3825258
13	7169	2618631	27194681	21395012	1566822	4232848
14	7456	2723377	29918058	23537588	1723729	4656741
15	7754	2832312	32750370	25765867	1886913	5097590
16	8065	2945604	35695974	28083277	2056624	5556073
17	8387	3063428	38759402	30493384	2233123	6032895
18	8723	3185966	41945368	32999895	2416683	6528790
19	9072	3313404	45258772	35606667	2607584	7044521
20	9434	3445940	48704713	38317709	2806122	7580881
21	9812	3583778	52288491	41137194	3012602	8138695
22	10204	3727129	56015620	44069457	3227340	8718822
23	10612	3876214	59891834	47119011	3450668	9322155
24	11037	4031263	63923097	50290547	3682930	9949620
25	11478	4192513	68115610	53588945	3924481	10602184
26	11938	4360214	72475824	57019278	4175695	11280851
27	12415	4534622	77010447	60586825	4436957	11986664
28	12912	4716007	81726454	64297074	4708670	12720710
29	13428	4904648	86631102	68155733	4991252	13484117
30	13965	5100834	91731935	72168738	5285136	14278061

HIGHWAY: GUADALAJARA-ZAPOTLANEJO GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 81% BUSES: 11% TRUCKS: 8%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL CAR	TOTAL BUS	TOTAL TRUCK
1	14096	5148564	5148564	4149240	576730	422594
2	14660	5354507	10503071	8464450	1176529	862092
3	15246	5568687	16071757	12952268	1800320	1319170
4	15856	5791434	21863192	17619598	2449062	1794531
5	16490	6023092	27886283	22473622	3123754	2288907
6	17150	6264015	34150299	27521807	3825434	2803057
7	17836	6514576	40664875	32771919	4555181	3337774
8	18549	6775159	47440034	38232036	5314118	3893879
9	19291	7046165	54486199	43910558	6103413	4472228
10	20063	7328012	61814211	49816220	6924279	5073712
11	20866	7621132	69435343	55958109	7777980	5699255
12	21700	7925978	77361321	62345673	8665829	6349819
13	22568	8243017	85604338	68988740	9589192	7026406
14	23471	8572738	94177075	75897530	10549489	7730056
15	24410	8915647	103092722	83082671	11548199	8461853
16	25386	9272273	112364995	90555218	12586856	9222921
17	26402	9643164	122008159	98326666	13667060	10014432
18	27458	10028890	132037050	106408973	14790473	10837604
19	28556	10430046	142467096	114814572	15958821	11693702
20	29698	10847248	153314343	123556395	17173904	12584045
21	30886	11281138	164595481	132647891	18437590	13510001
22	32122	11732383	176327864	142103046	19751823	14472995
23	33406	12201679	188529543	151936408	21118626	15474509
24	34743	12689746	201219289	162163104	22540101	16516084
25	36132	13197336	214416624	172798869	24018434	17599321
26	37578	13725229	228141853	183860063	25555901	18725888
27	39081	14274238	242416091	195363706	27154867	19897518
28	40644	14845208	257261299	207327494	28817792	21116013
29	42270	15439016	272700315	219769834	30547233	22383248
30	43961	16056577	288756891	232709867	32345852	23701172

HIGHWAY: LA TINAJA-COSOLEACAQUE GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 69% BUSES: 19% TRUCKS: 12%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	1676	612159	612159	424786	115784	71589
2	1743	636645	1248804	866563	236200	146042
3	1813	662111	1910916	1326011	361432	223472
4	1885	688596	2599511	1803837	491674	304000
5	1961	716139	3315651	2300777	627125	387749
6	2039	744785	4060436	2817593	767994	474848
7	2121	774576	4835012	3355083	914498	565431
8	2206	805559	5640572	3914072	1066862	659637
9	2294	837782	6478353	4495421	1225321	757612
10	2385	871293	7349647	5100023	1390118	859505
11	2481	906145	8255791	5728810	1561507	965474
12	2580	942391	9198182	6382748	1739752	1075682
13	2683	980086	10178268	7062844	1925126	1190299
14	2791	1019290	11197558	7770143	2117915	1309500
15	2902	1060061	12257619	8505735	2318416	1433469
16	3018	1102464	13360083	9270750	2526937	1562396
17	3139	1146562	14506645	10066366	2743799	1696481
18	3265	1192425	15699070	10893806	2969335	1835929
19	3395	1240122	16939192	11754344	3203893	1980956
20	3531	1289727	18228919	12649303	3447832	2131783
21	3672	1341316	19570235	13580061	3701530	2288643
22	3819	1394968	20965203	14548050	3965375	2451778
23	3972	1450767	22415970	15554757	4239775	2621438
24	4131	1508798	23924768	16601733	4525150	2797885
25	4296	1569150	25493918	17690588	4821940	2981389
26	4468	1631916	27125833	18822998	5130602	3172233
27	4647	1697192	28823026	20000703	5451610	3370712
28	4833	1765080	30588106	21225517	5785459	3577129
29	5026	1835683	32423789	22499324	6132662	3791803
30	5227	1909111	34332899	23824082	6493752	4015065

HIGHWAY: LEON-LAGOS DE MORENO-AGUASCALIENTES GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 81% BUSES: 7% TRUCKS: 12%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	2755	1006264	1006264	814508	71589	120167
2	2865	1046514	2052778	1661595	146042	245141
3	2980	1088375	3141153	2542567	223472	375114
4	3099	1131910	4273063	3458777	304000	510286
5	3223	1177186	5450249	4411635	387749	650865
6	3352	1224274	6674523	5402608	474848	797066
7	3486	1273245	7947767	6433220	565431	949116
8	3625	1324174	9271942	7505056	659637	1107248
9	3770	1377141	10649083	8619766	757612	1271705
10	3921	1432227	12081310	9779064	859505	1442741
11	4078	1489516	13570827	10984734	965474	1620618
12	4241	1549097	15119923	12238631	1075682	1805610
13	4411	1611061	16730984	13542684	1190299	1998001
14	4587	1675503	18406487	14898899	1309500	2198089
15	4771	1742523	20149010	16309362	1433469	2406179
16	4962	1812224	21961235	17776244	1562396	2622594
17	5160	1884713	23845948	19301802	1696481	2847665
18	5366	1960102	25806049	20888381	1835929	3081739
19	5581	2038506	27844555	22538424	1980956	3325176
20	5804	2120046	29964601	24254468	2131783	3578350
21	6037	2204848	32169449	26039155	2288643	3841651
22	6278	2293042	34462491	27895228	2451778	4115484
23	6529	2384763	36847254	29825545	2621438	4400271
24	6790	2480154	39327408	31833074	2797885	4696449
25	7062	2579360	41906768	33920905	2981389	5004474
26	7344	2682534	44589302	36092248	3172233	5324820
27	7638	2789836	47379138	38350446	3370712	5657981
28	7944	2901429	50280567	40698971	3577129	6004467
29	8261	3017486	53298054	43141437	3791803	6364813
30	8592	3138186	56436240	45681602	4015065	6739573

HIGHWAY: LIBRAMIENTO DE FRESNILLO GROWTH RATE: 3%
ADT DISTRIBUTION: CARS: 56% BUSES: 8% TRUCKS: 36%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	3742	1366766	1366766	770349	104570	491846
2	3854	1407768	2774534	1563809	212277	998448
3	3970	1450002	4224535	2381072	323215	1520248
4	4089	1493502	5718037	3222854	437481	2057702
5	4212	1538307	7256344	4089888	555176	2611279
6	4338	1584456	8840799	4982934	676401	3181464
7	4468	1631989	10472789	5902771	801263	3768755
8	4602	1680949	12153738	6850204	929871	4373664
9	4740	1731378	13885116	7826059	1062337	4996720
10	4882	1783319	15668435	8831190	1198777	5638468
11	5029	1836819	17505253	9866475	1339310	6299468
12	5180	1891923	19397176	10932818	1484059	6980299
13	5335	1948681	21345857	12031152	1633151	7681554
14	5495	2007141	23352998	13162436	1786715	8403847
15	5660	2067355	25420354	14327658	1944887	9147809
16	5830	2129376	27549730	15527837	2107803	9914090
17	6005	2193257	29742987	16764021	2275607	10703359
18	6185	2259055	32002042	18037291	2448445	11516306
19	6371	2326827	34328869	19348759	2626469	12353642
20	6562	2396632	36725501	20699571	2809833	13216097
21	6758	2468531	39194031	22090907	2998698	14104427
22	6961	2542586	41736618	23523984	3193228	15019406
23	7170	2618864	44355482	25000052	3393595	15961834
24	7385	2697430	47052912	26520403	3599973	16932536
25	7607	2778353	49831265	28086364	3812542	17932358
26	7835	2861703	52692968	29699305	4031488	18962175
27	8070	2947555	55640523	31360633	4257003	20022887
28	8312	3035981	58676504	33071801	4489283	21115420
29	8561	3127061	61803564	34834304	4728531	22240729
30	8818	3220872	65024437	36649683	4974957	23399797

HIGHWAY: LIBRAMIENTO NORESTE DE QUERETARO GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 55% BUSES: 10% TRUCKS: 35%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	4030	1471958	1471958	816618	143577	511763
2	4191	1530836	3002793	1665900	292897	1043996
3	4359	1592069	4594863	2549154	448189	1597519
4	4533	1655752	6250615	3467738	609694	2173183
5	4715	1721982	7972597	4423065	777658	2771873
6	4903	1790861	9763458	5416606	952342	3394511
7	5099	1862496	11625954	6449888	1134012	4042054
8	5303	1936996	13562949	7524501	1322949	4715499
9	5515	2014475	15577425	8642099	1519444	5415882
10	5736	2095054	17672479	9804401	1723799	6144280
11	5965	2178857	19851336	11013194	1936328	6901814
12	6204	2266011	22117347	12270340	2157357	7689650
13	6452	2356651	24473998	13577771	2387229	8508998
14	6710	2450917	26924916	14937500	2626295	9361121
15	6979	2548954	29473870	16351618	2874923	10247329
16	7258	2650912	32124782	17822300	3133497	11168985
17	7548	2756949	34881731	19351810	3402414	12127507
18	7850	2867227	37748958	20942500	3682087	13124370
19	8164	2981916	40730874	22596818	3972947	14161108
20	8491	3101192	43832066	24317309	4275442	15239315
21	8830	3225240	47057306	26106619	4590037	16360651
22	9183	3354250	50411556	27967501	4917215	17526840
23	9551	3488420	53899976	29902819	5257480	18739676
24	9933	3627957	57527932	31915550	5611356	20001026
25	10330	3773075	61301007	34008790	5979387	21312830
26	10743	3923998	65225005	36185759	6362140	22677106
27	11173	4080958	69305963	38449807	6760202	24095953
28	11620	4244196	73550159	40804417	7174187	25571554
29	12085	4413964	77964122	43253212	7604731	27106179
30	12568	4590522	82554645	45799958	8052497	28702189

HIGHWAY: LIBRAMIENTO ORIENTE DE SALTILLO GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 47% BUSES: 6% TRUCKS: 47%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	3329	1215917	1215917	568132	75127	572658
2	3462	1264554	2480471	1158989	153260	1168222
3	3601	1315136	3795607	1773481	234518	1787609
4	3745	1367742	5163349	2412552	319026	2431771
5	3894	1422451	6585800	3077186	406914	3101699
6	4050	1479349	8065149	3768406	498318	3798425
7	4212	1538523	9603673	4487274	593378	4523020
8	4381	1600064	11203737	5234897	692241	5276599
9	4556	1664067	12867803	6012425	795058	6060320
10	4738	1730629	14598433	6821054	901988	6875391
11	4928	1799855	16398287	7662029	1013194	7723064
12	5125	1871849	18270136	8536642	1128850	8604645
13	5330	1946723	20216859	9446239	1249131	9521488
14	5543	2024592	22241450	10392221	1374224	10475006
15	5765	2105575	24347026	11376042	1504320	11466664
16	5995	2189798	26536824	12399216	1639620	12497988
17	6235	2277390	28814214	13463316	1780332	13570565
18	6485	2368486	31182700	14569981	1926673	14686046
19	6744	2463225	33645925	15720912	2078867	15846145
20	7014	2561754	36207679	16917881	2237149	17052649
21	7294	2664224	38871904	18162728	2401763	18307413
22	7586	2770793	41642697	19457369	2572961	19612367
23	7889	2881625	44524322	20803796	2751007	20969520
24	8205	2996890	47521213	22204080	2936174	22380958
25	8533	3116766	50637978	23660375	3128749	23848854
26	8875	3241436	53879415	25174923	3329026	25375466
27	9230	3371094	57250508	26750051	3537314	26963143
28	9599	3505938	60756446	28388186	3753934	28614326
29	9983	3646175	64402621	30091845	3979219	30331557
30	10382	3792022	68194643	31863651	4213515	32117477

HIGHWAY: LIBRAMIENTO ORIENTE DE SAN LUIS POTOSI GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 31% BUSES: 5% TRUCKS: 64%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	1932	705663	705663	220453	34976	450234
2	2009	733890	1439553	449725	71351	918477
3	2090	763245	2202798	688167	109180	1405450
4	2173	793775	2996573	936148	148523	1911901
5	2260	825526	3822098	1194047	189440	2438611
6	2351	858547	4680645	1462262	231994	2986390
7	2445	892889	5573534	1741206	276249	3556079
8	2542	928604	6502139	2031308	322275	4148556
9	2644	965749	7467887	2333014	370142	4764732
10	2750	1004378	8472266	2646788	419923	5405555
11	2860	1044554	9516819	2973113	471696	6072011
12	2974	1086336	10603155	3312491	525539	6765125
13	3093	1129789	11732944	3665444	581537	7485964
14	3217	1174981	12907925	4032515	639774	8235636
15	3346	1221980	14129905	4414269	700341	9015295
16	3479	1270859	15400764	4811293	763330	9826141
17	3619	1321694	16722458	5224198	828839	10669420
18	3763	1374561	18097019	5653620	896968	11546431
19	3914	1429544	19526563	6100218	967823	12458522
20	4070	1486726	21013288	6564680	1041512	13407097
21	4233	1546195	22559483	7047721	1118148	14393614
22	4403	1608042	24167525	7550083	1197850	15419592
23	4579	1672364	25839889	8072540	1280739	16486610
24	4762	1739259	27579148	8615895	1366945	17596308
25	4952	1808829	29387977	9180984	1456598	18750394
26	5150	1881182	31269159	9768677	1549838	19950644
27	5356	1956429	33225588	10379877	1646807	21198903
28	5571	2034687	35260275	11015526	1747656	22497093
29	5793	2116074	37376348	11676600	1852538	23847211
30	6025	2200717	39577065	12364118	1961615	25251333

HIGHWAY: LIBRAMIENTO PONIENTE DE TAMPICO GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 34% BUSES: 0% TRUCKS: 66%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL CAR	TOTAL BUS	TOTAL TRUCK
1	2601	950015	950015	320606	03934	625476
2	2705	988016	1938031	654035	08025	1275971
3	2813	1027536	2965568	1000802	12280	1952486
4	2926	1068638	4034206	1361440	16705	2656061
5	3043	1111383	5145589	1736503	21307	3387779
6	3165	1155839	6301428	2126569	26093	4148766
7	3291	1202072	7503500	2532237	31070	4940193
8	3423	1250155	8753655	2954132	36247	5763276
9	3560	1300161	10053817	3392903	41631	6619283
10	3702	1352168	11405985	3849225	47230	7509530
11	3850	1406255	12812240	4323799	53053	8435387
12	4004	1462505	14274744	4817357	59109	9398279
13	4164	1521005	15795749	5330657	65407	10399686
14	4331	1581845	17377595	5864488	71957	11441149
15	4504	1645119	19022714	6419674	78769	12524271
16	4684	1710924	20733637	6997066	85854	13650718
17	4872	1779361	22512998	7597554	93222	14822222
18	5066	1850535	24363533	8222062	100884	16040587
19	5269	1924557	26288090	8871550	108853	17307687
20	5480	2001539	28289629	9547018	117141	18625470
21	5699	2081600	30371229	10249504	125761	19995965
22	5927	2164864	32536094	10980090	134725	21421279
23	6164	2251459	34787553	11739899	144048	22903606
24	6411	2341517	37129070	12530100	153744	24445226
25	6667	2435178	39564248	13351910	163827	26048511
26	6934	2532585	42096833	14206592	174314	27715927
27	7211	2633889	44730722	15095461	185220	29450040
28	7500	2739244	47469966	16019885	196563	31253518
29	7800	2848814	50318780	16981286	208359	33129134
30	8112	2962766	53281546	17981143	220628	35079776

HIGHWAY: MAZATLAN-CULIACAN GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 73% BUSES: 16% TRUCKS: 11%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL CAR	TOTAL BUS	TOTAL TRUCK
1	1860	679365	679365	496375	110306	72685
2	1934	706540	1385905	1012604	225023	148277
3	2012	734801	2120706	1549483	344330	226893
4	2092	764193	2884899	2107838	468408	308653
5	2176	794761	3679660	2688526	597450	393684
6	2263	826551	4506211	3292442	731654	482116
7	2353	859613	5365825	3920514	871225	574086
8	2448	893998	6259823	4573709	1016380	669734
9	2546	929758	7189581	5253032	1167341	769208
10	2647	966948	8156529	5959528	1324340	872661
11	2753	1005626	9162155	6694284	1487619	980252
12	2863	1045851	10208006	7458430	1657429	1092147
13	2978	1087685	11295692	8253142	1834032	1208518
14	3097	1131193	12426884	9079643	2017698	1329543
15	3221	1176440	13603325	9939203	2208712	1455409
16	3350	1223498	14826823	10833146	2407366	1586311
17	3484	1272438	16099261	11762847	2613966	1722448
18	3623	1323335	17422596	12729735	2828830	1864030
19	3768	1376269	18798865	13735300	3052289	2011276
20	3919	1431320	20230184	14781086	3284686	2164412
21	4075	1488572	21718757	15868705	3526379	2323673
22	4239	1548115	23266872	16999827	3777739	2489305
23	4408	1610040	24876912	18176195	4039155	2661562
24	4584	1674441	26551353	19399618	4311026	2840709
25	4768	1741419	28292772	20671977	4593773	3027022
26	4958	1811076	30103848	21995231	4887829	3220788
27	5157	1883519	31987367	23371415	5193648	3422304
28	5363	1958860	33946227	24802647	5511699	3631881
29	5578	2037214	35983441	26291127	5842473	3849841
30	5801	2118703	38102144	27839147	6186477	4076520

HIGHWAY: MERIDA-CANCUN GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 74% BUSES: 17% TRUCKS: 9%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	1216	444144	444144	328360	75607	40178
2	1265	461910	906054	669854	154238	81962
3	1315	480386	1386440	1025008	236014	125418
4	1368	499602	1886042	1394368	321061	170612
5	1423	519586	2405627	1778502	409511	217614
6	1479	540369	2945996	2178002	501498	266496
7	1539	561984	3507980	2593482	597164	317334
8	1600	584463	4092443	3025581	696658	370205
9	1664	607842	4700285	3474964	800131	425190
10	1731	632155	5332440	3942322	907743	482375
11	1800	657442	5989882	4428375	1019659	541848
12	1872	683739	6673621	4933870	1136052	603699
13	1947	711089	7384710	5459584	1257101	668025
14	2025	739532	8124243	6006327	1382992	734923
15	2106	769114	8893356	6574940	1513918	804498
16	2190	799878	9693235	7166298	1650082	876855
17	2278	831873	10525108	7781309	1791692	952107
18	2369	865148	11390256	8420921	1938966	1030369
19	2463	899754	12290011	9086118	2092132	1111761
20	2562	935744	13225755	9777922	2251424	1196409
21	2664	973174	14198929	10497399	2417087	1284443
22	2771	1012101	15211030	11245655	2589378	1375998
23	2882	1052585	16263616	12023841	2768560	1471215
24	2997	1094689	17358304	12833154	2954909	1570241
25	3117	1138476	18496780	13674840	3148712	1673228
26	3242	1184015	19680796	14550193	3350267	1780335
27	3371	1231376	20912171	15460561	3559884	1891726
28	3506	1280631	22192802	16407343	3777887	2007573
29	3646	1331856	23524658	17391997	4004609	2128053
30	3792	1385130	24909789	18416036	4240400	2253353

HIGHWAY: MONTERREY-NUEVO LAREDO GROWTH RATE: 2%
ADT DISTRIBUTION: CARS: 85% BUSES: 8% TRUCKS: 7%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	3040	1110360	1110360	948189	88391	73781
2	3101	1132567	2242927	1915342	178549	149037
3	3163	1155219	3398146	2901838	270510	225798
4	3226	1178323	4576469	3908063	364311	304094
5	3291	1201889	5778358	4934414	459988	383957
6	3356	1225927	7004285	5981291	557578	465416
7	3424	1250446	8254731	7049106	657120	548505
8	3492	1275455	9530186	8138277	758653	633256
9	3562	1300964	10831149	9249231	862216	719701
10	3633	1326983	12158132	10382405	967851	807876
11	3706	1353523	13511655	11538242	1075599	897814
12	3780	1380593	14892248	12717196	1185501	989551
13	3855	1408205	16300453	13919729	1297602	1083122
14	3933	1436369	17736822	15146312	1411944	1178565
15	4011	1465096	19201918	16397428	1528574	1275917
16	4091	1494398	20696317	17673565	1647536	1375216
17	4173	1524286	22220603	18975226	1768877	1476501
18	4257	1554772	23775375	20302919	1892645	1579811
19	4342	1585868	25361243	21657166	2018888	1685188
20	4429	1617585	26978828	23038499	2147657	1792672
21	4517	1649937	28628764	24447458	2279000	1902306
22	4608	1682935	30311699	25884596	2412971	2014133
23	4700	1716594	32028293	27350477	2549621	2128196
24	4794	1750926	33779219	28845675	2689004	2244540
25	4890	1785944	35565164	30370778	2831174	2363212
26	4987	1821663	37386827	31926382	2976188	2484256
27	5087	1858097	39244923	33513099	3124102	2607722
28	5189	1895258	41140182	35131550	3274975	2733657
29	5293	1933164	43073346	36782370	3428865	2862110
30	5399	1971827	45045172	38466206	3585833	2993133

HIGHWAY: SAN MARTIN TEXMELUCAN-TLAXCALA-EL MOLINITO GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 74% BUSES: 19% TRUCKS: 8%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL CAR	TOTAL BUS	TOTAL TRUCK
1	3079	1124605	1124605	830579	208193	85834
2	3202	1169589	2294194	1694380	424713	175101
3	3330	1216372	3510566	2592734	649894	267939
4	3463	1265027	4775594	3527022	884082	364490
5	3602	1315628	6091222	4498681	1127638	464903
6	3746	1368254	7459476	5509207	1380936	569333
7	3896	1422984	8882459	6560154	1644366	677940
8	4052	1479903	10362363	7653138	1918333	790892
9	4214	1539099	11901462	8789842	2203259	908361
10	4382	1600663	13502125	9972014	2499581	1030529
11	4558	1664690	15166815	11201474	2807757	1157584
12	4740	1731277	16898092	12480111	3128260	1289721
13	4930	1800528	18698621	13809894	3461583	1427144
14	5127	1872550	20571170	15192868	3808239	1570063
15	5332	1947452	22518622	16631161	4168761	1718700
16	5545	2025350	24543971	18126986	4543704	1873281
17	5767	2106364	26650335	19682644	4933644	2034046
18	5998	2190618	28840953	21300529	5339183	2201242
19	6237	2278243	31119196	22983128	5760942	2375125
20	6487	2369373	33488569	24733032	6199573	2555964
21	6746	2464147	35952716	26552932	6655748	2744036
22	7016	2562713	38515430	28445627	7130170	2939632
23	7297	2665222	41180651	30414031	7623570	3143051
24	7589	2771831	43952482	32461171	8136705	3354606
25	7892	2882704	46835186	34590196	8670366	3574624
26	8208	2998012	49833198	36804382	9225373	3803443
27	8536	3117933	52951131	39107136	9802580	4041415
28	8878	3242650	56193781	41502000	10402876	4288905
29	9233	3372356	59566137	43992659	11027184	4546295
30	9602	3507250	63073387	46582943	11676463	4813981

HIGHWAY: TEPIC-ENTRONQUE SAN BLAS GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 73% BUSES: 14% TRUCKS: 13%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL CAR	TOTAL BUS	TOTAL TRUCK
1	4196	1532589	1532589	1118030	214037	200522
2	4364	1593893	3126482	2280782	436634	409065
3	4538	1657648	4784130	3490043	668136	625950
4	4720	1723954	6508084	4747675	908898	851511
5	4909	1792912	8300996	6055612	1159291	1086093
6	5105	1864629	10165625	7415867	1419699	1330059
7	5309	1939214	12104839	8830532	1690523	1583784
8	5522	2016783	14121622	10301784	1972181	1847657
9	5743	2097454	16219076	11831885	2265104	2122086
10	5972	2181352	18400428	13423191	2569745	2407492
11	6211	2268606	20669034	15078149	2886571	2704314
12	6460	2359350	23028384	16799305	3216071	3013008
13	6718	2453724	25482109	18589307	3558750	3334051
14	6987	2551873	28033982	20450910	3915137	3667935
15	7266	2653948	30687930	22386977	4285779	4015175
16	7557	2760106	33448036	24400486	4671246	4376304
17	7859	2870510	36318547	26494536	5072133	4751879
18	8173	2985331	39303878	28672347	5489054	5142476
19	8500	3104744	42408622	30937272	5922653	5548697
20	8840	3228934	45637556	33292793	6373596	5971167
21	9194	3358091	48995647	35742535	6842576	6410536
22	9562	3492415	52488062	38290266	7330316	6867480
23	9944	3632111	56120173	40939907	7837565	7342701
24	10342	3777396	59897569	43695534	8365104	7836932
25	10756	3928492	63826061	46561385	8913744	8350931
26	11186	4085631	67911692	49541871	9484331	8885491
27	11633	4249057	72160749	52641576	10077740	9441433
28	12099	4419019	76579768	55865269	10694887	10019612
29	12583	4595780	81175548	59217910	11336719	10620919
30	13086	4779611	85955159	62704657	12004224	11246278

HIGHWAY: TIJUANA-TECATE-LIB. TECATE GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 85% BUSES: 8% TRUCKS: 7%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL CAR	TOTAL BUS	TOTAL TRUCK
1	3696	1349964	1349964	1142502	109940	97522
2	3844	1403963	2753927	2330704	224278	198944
3	3998	1460121	4214048	3566434	343189	304424
4	4157	1518526	5732574	4851594	466857	414123
5	4324	1579267	7311840	6188159	595472	528209
6	4497	1642438	8954278	7578188	729231	646859
7	4677	1708135	10662413	9023817	868340	770255
8	4864	1776461	12438874	10527272	1013014	898587
9	5058	1847519	14286393	12090865	1163475	1032053
10	5261	1921420	16207812	13717001	1319954	1170857
11	5471	1998276	18206089	15408183	1482693	1315213
12	5690	2078208	20284296	17167013	1651941	1465343
13	5917	2161336	22445632	18996195	1827959	1621478
14	6154	2247789	24693422	20898545	2011017	1783859
15	6400	2337701	27031122	22876989	2201398	1952735
16	6656	2431209	29462331	24934570	2399394	2128366
17	6923	2528457	31990789	27074455	2605310	2311023
18	7199	2629596	34620384	29299936	2819463	2500986
19	7487	2734779	37355164	31614435	3042182	2698547
20	7787	2844171	40199334	34021514	3273809	2904010
21	8098	2957937	43157271	36524877	3514702	3117692
22	8422	3076255	46233526	39128374	3765230	3339922
23	8759	3199305	49432831	41836011	4025780	3571041
24	9110	3327277	52760109	44651953	4296751	3811404
25	9474	3460368	56220477	47580534	4578562	4061382
26	9853	3598783	59819260	50626257	4871644	4321359
27	10247	3742734	63561994	53793809	5176450	4591735
28	10657	3892444	67454438	57088063	5493449	4872926
29	11083	4048142	71502580	60514088	5823127	5165365
30	11527	4210067	75712647	64077154	6165992	5469501

HIGHWAY: TORREON-CUENCAME-YERBANIS GROWTH RATE: 4%
ADT DISTRIBUTION: CARS: 70% BUSES: 17% TRUCKS: 13%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL CAR	TOTAL BUS	TOTAL TRUCK
1	1406	513542	513542	360137	85834	67571
2	1462	534083	1047625	734678	175101	137845
3	1521	555446	1603071	1124202	267939	210930
4	1582	577664	2180735	1529307	364490	286939
5	1645	600771	2781506	1950615	464903	365988
6	1711	624802	3406308	2388777	569333	448198
7	1779	649794	4056102	2844464	677940	533698
8	1850	675786	4731888	3318379	790892	622617
9	1924	702817	5434705	3811251	908361	715093
10	2001	730930	6165634	4323837	1030529	811268
11	2081	760167	6925801	4856927	1157584	911290
12	2164	790574	7716375	5411341	1289721	1015312
13	2251	822196	8538571	5987931	1427144	1123496
14	2341	855084	9393656	6587585	1570063	1236007
15	2435	889288	10282943	7211225	1718700	1353019
16	2532	924859	11207802	7859810	1873281	1474711
17	2633	961854	12169656	8534339	2034046	1601271
18	2739	1000328	13169984	9235849	2201242	1732893
19	2848	1040341	14210325	9965420	2375125	1869780
20	2962	1081954	15292279	10724173	2555964	2012142
21	3081	1125233	16417512	11513276	2744036	2160199
22	3204	1170242	17587754	12333944	2939632	2314178
23	3332	1217052	18804805	13187438	3143051	2474317
24	3465	1265734	20070539	14075072	3354606	2640860
25	3604	1316363	21386902	14998212	3574624	2814066
26	3748	1369018	22755920	15958277	3803443	2994200
27	3898	1423778	24179698	16956744	4041415	3181539
28	4054	1480729	25660428	17995150	4288905	3376372
29	4216	1539959	27200386	19075093	4546295	3578998
30	4385	1601557	28801943	20198233	4813981	3789729

HIGHWAY: ZAPOTLANEJO-LAGOS DE MORENO GROWTH RATE: 4%

ADT DISTRIBUTION: CARS: 80% BUSES: 10% TRUCKS: 10%

YEAR	ADT	TOTAL YEAR	TOTAL CUMULATIVE	TOTAL		
				CAR	BUS	TRUCK
1	3931	1435798	1435798	1143598	149387	142813
2	4069	1486051	2921848	2327221	304003	290624
3	4211	1538062	4459911	3552272	464030	443609
4	4358	1591895	6051805	4820199	629659	601948
5	4511	1647611	7699416	6132504	801084	765828
6	4669	1705277	9404694	7490739	978509	935445
7	4832	1764962	11169656	8896513	1162144	1110999
8	5001	1826736	12996391	10351489	1352207	1292696
9	5176	1890671	14887063	11857388	1548921	1480753
10	5358	1956845	16843908	13415995	1752521	1675393
11	5545	2025335	18869242	15029152	1963246	1876844
12	5739	2096221	20965464	16698770	2181347	2085346
13	5940	2169589	23135053	18426825	2407081	2301146
14	6148	2245525	25380577	20215362	2640716	2524499
15	6363	2324118	27704695	22066497	2882529	2755669
16	6586	2405462	30110157	23982422	3132804	2994930
17	6816	2489653	32599811	25965405	3391840	3242566
18	7055	2576791	35176602	28017792	3659942	3498868
19	7302	2666979	37843580	30142012	3937427	3764141
20	7557	2760323	40603904	32340580	4224624	4038699
21	7822	2856934	43460838	34616099	4521873	4322866
22	8096	2956927	46417765	36971260	4829526	4616979
23	8379	3060420	49478184	39408852	5147946	4921386
24	8672	3167534	52645719	41931759	5477512	5236448
25	8976	3278398	55924117	44542968	5818612	5562536
26	9290	3393142	59317258	47245570	6171651	5900038
27	9615	3511902	62829160	50042763	6537046	6249352
28	9952	3634818	66463979	52937857	6915230	6610892
29	10300	3762037	70226016	55934280	7306650	6985086
30	10660	3893708	74119724	59035578	7711770	7372377

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