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Electronic Toll Collection System (ETC) User Survey

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EXECUTIVE SUMMARY
ELECTRONIC TOLL COLLECTION SYSTEM (ETC)
USER SURVEY

This is a summary of several surveys concerning the use of an electronic toll collection system (ETC) among Bay Area motorists. The objective of these surveys was to determine the level of interest in subscribing to an electronic toll collection service for Bay Area toll bridges. The issues addressed in the surveys were: 1) interest in the ETC service, 2) preferred types of automated vehicle identification (AVI) tags, 3) preferred location or placement of AVI tags on the vehicle, 4) desired method of payment for the ETC service, and 5) perceived benefits of ETC.

A. Definitions

For consistency in the meanings of the words used throughout this executive summary, the following definitions were adopted:

Motorists - automobile drivers

Commercial users - companies using vehicles with three or more axles and trailers

Respondents - users of toll bridges who responded to mail or telephone surveys

Patrons or users - everyone who uses toll bridges

B. Mail and Telephone Surveys

The study was divided into three parts: 1) a mail survey of toll bridge users among Bay Area motorists, 2) a follow-up telephone survey of the mail survey respondents, and 3) a telephone survey of commercial users.

In October 1990, 30,000 mail surveys were distributed to bridge users at toll plazas. The toll bridges surveyed were San Francisco/Oakland, Golden Gate, Richmond/San Rafael, San Mateo/Hayward, Dumbarton, Carquinez, and Benicia/Martinez. Antioch Bridge was excluded from the survey because of low traffic volume. Car-pool, vanpool and commercial users were also excluded from the survey because of technical difficulties in distributing questionnaires at toll gates. (According to the Metropolitan Transportation Commission, 23 percent of the person trips on the San Francisco/Oakland Bay Bridge last year were generated by carpools and vanpools.) Of the 30,000 survey forms distributed, 17 percent or 5,095 usable surveys had been received by the cutoff date.

In December 1990, a telephone survey of motorists was conducted to follow up on the mail survey. A random sampling of motorists was selected from a pool of mail survey respondents who had expressed interest in the electronic toll collection service. One

thousand telephone interviews were completed for the follow-up survey and over 90 percent responded.

In December 1990, 200 telephone interviews were completed with the owners or managers of commercial firms. The purpose of the survey was to estimate the level of interest in ETC among the current commercial patrons. A random sampling of commercial users was selected from a list of firms having accounts with Caltrans. The response rate of the commercial users was nearly 90 percent, almost as high as the motorist telephone survey.

To correct for response biases, the mail survey responses were weighted by traffic volume and payment method data for each bridge. The data used in weighting were prepared by Caltrans and the Golden Gate Bridge District in 1990. Telephone survey data were not weighted because they represented a unique subset of motorists who expressed an interest in ETC and comparable population-based data were not available. ETC demand projections were based primarily on the weighted mail survey results. The telephone survey results were used in evaluating ETC interest based on tag types and operational issues of an electronic toll collection system.

C. Survey Methods and Confidence Level of Data

The basic issue of these surveys is whether or not our samples are truly representative. Even though the mail survey questionnaires were distributed randomly at toll gates, the questionnaires were probably more likely to be returned by those who had a favorable response to this technology. There are no techniques which could guarantee truly non-biased returns nor are there any magic numbers which could completely mitigate biased responses. There were ways, however, in which statistical analysis could be made more rigorous in order to give a better control over biases.

At the outset of the study, we realized that there were at least three ways in which non-random samples could be generated: a) distribution of questionnaires, b) scheduling of distribution, and c) non-response. To assess and minimize the impact of these biases, several methods were employed.

1) The results of our study were compared with historical data and with other studies of similar situations, i.e., Port of New York and New Jersey (1990), and State of Florida (1990).

2) To control for non-response biases, the mail survey data were weighted according to the actual traffic volume and payment methods of individual bridges.

3) For the follow-up surveys, a telephone survey method was chosen over a mail survey method to provide better control over non-response biases. The Council of American Survey Research Organizations (CASRO) offers a standard for an acceptable response rate

based on the upper bound calculation formula. The formula is the ratio of completed interviews to the sum of completed interviews plus incompleted interviews plus refused interviews. CASRO considers at least a 60 percent upper bound response rate to be acceptable for most opinion research applications. The response rate to our telephone surveys was over 90 percent.

4) The sample size was made large enough to meet accepted standards for statistical precision. For example, assuming that we have obtained an unbiased sample of mail survey responses, 5,095 survey responses will give us an acceptable error of no more than ± 1.4 percent at the 95 percent level of confidence. This level of precision exceeds commonly accepted standards in public opinion research.

D. Summary of Results of Motorist Surveys

A summary of the findings and conclusions from the two surveys of motorists is as follows:

Interest in ETC

1) The number of potential patrons of ETC on the eight Bay Area bridges is estimated to be approximately 290,000, with transferable tags. These estimates were based on the survey results and a 1990 Caltrans report on the average daily traffic volume on these bridges. In 1990, the annual average daily traffic transaction was 375,250. For estimating ETC demand in the Bay Area, two methods were used. The first method was an extrapolation of the weighted mail survey results according to the daily traffic volume. The second method was based on the relationships between ETC interest and the frequency of bridge use among the mail survey respondents. The ETC demand estimates were derived from averaging the outcomes of these two methods. Using the first method, the demand was to be 288,000 and using the second method, the demand was to be 291,000 if tags were transferable. The average of these two estimates was approximately 290,000 patrons. The telephone survey suggested that if tags were permanently affixed, demand would drop about 12 percent, to an estimated 255,000 ETC patrons.

2) The survey showed that commute tickets were used more frequently by the respondents using the bridges on a regular basis than the respondents using the bridges once or twice a week. Commute tickets were coupons that could be purchased at a discount rate at toll agencies. Discount amounts were about 15 percent, although they varied slightly from bridge to bridge. (The Golden Gate Bridge discount rate was 16.7 percent.)

3) According to the telephone survey, respondents travelling on the San Francisco/Oakland and Golden Gate bridges showed slightly higher interest in subscribing to ETC than the respondents travelling on the San Mateo, Dumbarton, and Benicia bridges.

Tag Type and Mounting

1) From the mail survey, it was estimated that 85 percent of bridge users interested in ETC would prefer transferable tags to permanently affixed tags. For these transferable tags only one choice of tag placement was considered -- inside the windshield.

2) For permanently affixed tags, three placement locations were considered: outside the windshield, on the license plate, and on the underside of the vehicle. If tags were to be permanently affixed, 57.4 percent of telephone survey respondents said that they would prefer to have the tags mounted on the undersides of their cars. Among the reasons were aesthetics and potential vandalism if tags were placed visibly, such as on license plates or the outsides of windshields.

Tag Deposits

To use an AVI tag, subscribers would be required to pay the toll agency a one-time refundable deposit. These results showed that imposing a tag deposit would not be a major deterrent to subscribing to an ETC service. Nearly 9 out of 10 respondents (88.5%) said they would be interested in ETC even if the deposit were $30. If the cost of the deposit were reduced to $15, there would be an increase of 5.3 percentage points in interest to 93.8 percent. If the cost of the deposit were dropped from $15 to $5, an additional 1.7 percent of the respondents would be interested in ETC to 95.5 percent.

Minimum Amount for ETC Account

1) To use ETC it would be necessary to open an account with the toll agency. The minimum amount necessary to open an account could be as much as $40, which was acceptable to 90 percent of the telephone survey respondents.

2) Reducing the minimum amount to $20 would increase interest in ETC to 95 percent. However, if earnings from the "float" were an important ETC cost recovery consideration, the revenue lost from changing the minimum amount from $40 to $20 would far outweigh the revenue gained from an increase in the use of ETC by a ratio of nearly 2 to 1, as only 5 percent more people would be interested in subscribing.

Method of Payment

Nearly two thirds of the telephone survey respondents (63.9%) said cash was their first choice as a method of payment. The second choice was by credit card and the least desired was an electronic transfer of funds from bank accounts.

Transaction Logs

Seventy two percent of the telephone survey respondents said they would be interested

in receiving a monthly log of their bridge crossings because the log would be helpful for accounting purposes. However, if a $1.00 monthly fee were charged for the service, there would be a 26 percent drop in interest to 46 percent.

Perceived Benefits of ETC

1) Nearly 90 percent of the telephone survey respondents believed that there would be less traffic congestion at toll plazas if ETC were implemented.

2) Of the telephone survey respondents, 77.5 percent believed that vandalism would be a problem if the electronic tags could be seen.

3) Conversely, only 7 percent of the respondents showed a strong concern that electronic tags would permit the police to track or trace their vehicle.

4) The general perception of the telephone survey respondents was that ETC would help improve air quality because there would be less carbon monoxide produced by vehicles decelerating and idling at toll gates (71%).

5) Telephone survey respondents generally disagreed (75.2%) with the idea that ETC might encourage people to use their cars more often because it would be easier to cross the bridges.

Commuter Discounts

1) Only one half (48.9%) of the telephone survey respondents said they would still be interested in ETC if the commuter discounts on toll charges were discontinued. Respondents might have inferred that commuter discounts would still be offered to those not subscribing to ETC. In fact, if the commuter discount were discontinued, all motorists would be affected.

2) The respondents travelling on the San Francisco/Oakland Bridge were more receptive to ETC without the commuter discounts than were the respondents of the Golden Gate, Carquinez, and Benicia bridges. One reason for this response could be that the commuter discounts for the Golden Gate, Carguinez, and Benicia bridges are more than for other bridges. The Golden Gate Bridge discount is 33 cents for a $2 toll charge and the discount on the Carquinez and Benicia Bridges is 25 cents for a $1 toll whereas the discounts on other state-owned bridges are 15 cents for $1 tolls. There was a higher proportion of commute ticket users among the respondents on Golden Gate (78.1%), Dumbarton (59.8%), and Carquinez (52.3%) bridges than on other bridges.

Operational Issues

1) The Golden Gate Bridge and the seven other Bay Area toll bridges are run by two separate agencies. Therefore, patrons may need to open two separate ETC accounts if

they were to use ETC on the Golden Gate Bridge as well as on the seven other Bay Area toll bridges. Of the 205 respondents using the Golden Gate Bridge as well as the other Bay Area toll bridges, 68.3 percent said they would not be interested in opening two ETC accounts.

2) While nearly one half (45.6%) of Golden Gate bridge respondents said they used other toll bridges at least once a month, only 15.1 percent of other bridge respondents said they used the Golden Gate Bridge once a month or more.

So&o-Economic Profile of Users Interested in ETC

1) The telephone survey respondents using Bay Area toll bridges were in the upper middle or high income group, had a family income of over $30,000 a year, and had two or more cars in the family. According to the telephone survey, it was estimated that the primary users of the Bay Area bridges interested in ETC would be in the age group 30-50.

2) On the Golden Gate Bridge, 31 percent of the sample population had an income of more than $100,000 last year, a greater proportion than for any other bridge.

3) The San Francisco/Oakland, Richmond, Dumbarton, and Carquinez bridges had their highest proportion of respondents among the age groups 30-39 and 40-49.

E. Telephone Survey of Commercial Users

A random sampling of 200 commercial users was selected from approximately 1,200 firms having accounts with Caltrans. The firms were classified according to the size of their accounts. More than 75 percent of the firms interviewed had an account size of less than $1,000 a month. Approximately 20 percent of the firms interviewed had an account size between $1,000 and $4,999 and 2 percent had an account size of $5,000 or more. Three percent of the firms interviewed did not respond. This distribution matches the actual distribution among all commercial accounts with Caltrans.

Interest in ETC among Commercial Users

1) Among commercial users, 76.5 percent of the firms surveyed said they were interested in subscribing to ETC and their interest remained about the same when considering permanently affixed tags.

2) If a deposit were required to obtain a tag, 41 percent of the respondents said they would still be interested in ETC but 32 percent said it would depend on the cost of the tag deposit.

Tag Deposits

The survey showed that commercial users' interest in ETC was highly price-sensitive. If the cost of the tag deposit were $30, only 54.5 percent said they would be interested in ETC. If the tag deposit price were decreased to $15, there would be an increase of 10.5 percent to 65 percent. If the tag deposit were reduced to $5, there would be an increase of 17.5 percent to 71.5 percent. Therefore it is highly desirable to keep the cost of the tag as low as possible for commercial users to be attracted to ETC.

Method of Payment

1) Between the two types of accounts, more than 65 percent preferred billed accounts and less than 24 percent preferred prepaid accounts. Ten percent of the respondents were uncommitted.

2) For either prepaid or billed accounts, cash payments were preferred. The second choice was an electronic transfer of funds from bank accounts.

3) The survey showed that 55 percent of trailers would not be tagged. This could possibly create operational problems for toll agencies.

PREFACE

This is the final report on a three-phase market survey for an electronic toll collection (ETC) system. The purpose of the market survey was to evaluate public interest in the use of an ETC system for toll bridges in the Bay Area. This report documents the results of a mail survey of toll bridge users among Bay Area motorists and two telephone surveys, one for motorists and one for commercial users. There was a Phase I report issued in October 1990 which discussed the mail survey in greater detail. This project was undertaken in conjunction with the California Department of Transportation (Caltrans), Golden Gate Bridge, Highway, and Transportation District, and Metropolitan Transportation Commission (MTC).

The toll bridges surveyed were San Francisco/Oakland, Golden Gate, Richmond/ San Rafael, San Mateo/Hayward, Dumbarton, Carquinez, and Benicia/Martinez. The Phase I mail survey was conducted from October 16-23, 1990, the Phase II telephone survey of motorists was conducted December 3-14, 1990, and the Phase III telephone survey of commercial users was completed December 4-16, 1990. The mail survey was completed in association with GLS Research and CSD Traffic Survey and the telephone surveys were conducted by GLS Research.

1. INTRODUCTION

This is a market feasibility study of an electronic toll collection (ETC) system for toll bridges in the Bay area. To improve toll collection, Caltrans and the Golden Gate Bridge, Highway and Transportation District are considering an electronic toll collection system for the Bay Area toll bridges. The benefits of ETC are potentially significant in operational efficiency, environmental quality and congestion relief at toll gates (Hensher, 1990). To assess likely consumer response to an electronic toll collection system, several surveys were conducted among Bay Area motorists who use the toll bridges. The primary objective of the present study was to determine the levels of interest in an electronic toll collection (ETC) service. The issues addressed in the surveys were: 1) interest in subscriptions to the ETC service, 2) preferred types of transponders or automated vehicle identification (AVI) tags, 3) preferred location or placement of transponders on the vehicle, 4) desired method of payment for the ETC service, and 5) perceived benefits of ETC.

To determine the levels of interest in ETC, the following surveys were completed: 1) a mail survey of the toll bridge users among Bay Area motorists, 2) a telephone survey of mail survey respondents interested in ETC, and 3) a telephone survey of commercial users. The mail survey determined the overall interest in subscriptions to an ETC service among motorists who use the toll bridges. The follow-up telephone survey determined the levels of interest in ETC when operational information was provided. A separate telephone survey of companies having commercial accounts with Caltrans was also conducted to assess interest in ETC and sensitivity to operational details of ETC.

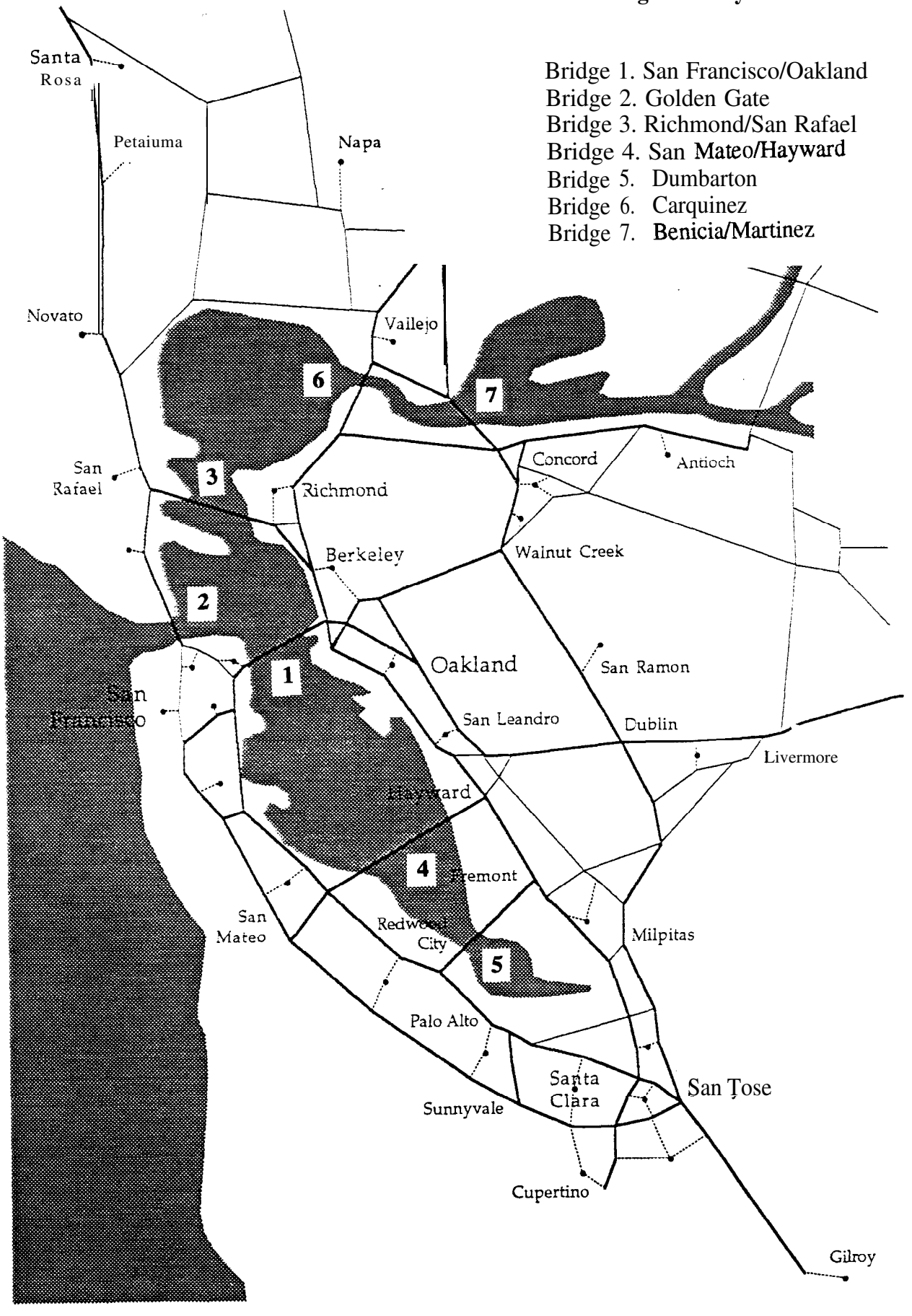
In October 1990, 30,000 survey forms were handed out at toll plazas during peak and off-peak hours according to traffic volume on each bridge. Of the eight toll bridges serving the Bay Area, San Francisco/Oakland, Golden Gate, Richmond/San Rafael, San Mateo/Hayward, Dumbarton, Carquinez, and Benicia/Martinez were surveyed (Figure 1.1). Antioch Bridge was excluded because of its low volume of daily traffic.

In December 1990, two telephone surveys were conducted, one for the mail respondents and one for commercial users. One thousand telephone interviews were completed with the mail survey respondents and 200 interviews were completed with commercial firms which have accounts with Caltrans. The following sections review ETC technology, previous studies, the scope of work, and the survey methodology.

1.1. ETC Technology

To use an electronic toll collection system, a subscriber would need to open an account with the toll agency and obtain an automated vehicle identification (AVI) tag or

Figure 1.1.
Toll Bridges Surveyed



transponder for the vehicle. Every time a motorist would pass through a toll plaza, sensors would read the tag and the toll would be automatically deducted from the balance in the motorist's account.

AVI technologies are presently being utilized in the toll collection industry and are composed of three basic elements: a vehicle mounted transponder or tag, an adjacent reader antenna, and a computer system for the processing and storage of data. The transponder and the reader antenna are used for detection while the computer system is used for management and accounting.

AVI technology originated in the railway industry, first in order to improve scheduling efficiency and later to keep track of cargo. The first system used was an optical/bar system which presented many difficulties in adverse weather conditions such as rain, snow, or sleet. Today's technology, with its use of radio, telemetry, microwaves, magnetic induction, and acoustic crystal technologies, has resulted in more versatile uses of AVI equipment.

The AVI process is straightforward. A tag attached to the vehicle is encoded with information identifying the account. As the vehicle passes a reader site, the coded data is read by the reader antenna and then passed to the roadside reader. The data is then checked for integrity and transmitted to a computer system for processing and storage.

There are several AVI technologies in use today and advances in data processing and vehicle detection continue.

a) Optical and Infrared

Most early AVI systems were based on optical scanner techniques. Optical systems utilize tags in which each contains information in the form of a coded label consisting of a series of lines of varying widths or colors. A scanner using a laser beam extracts data from the bar coded label. The laser beam is deflected in a fan shaped pattern across the label. The reflected energy of the laser beam, representing the unique lines of the coded label, is collected, processed, and converted to a digital signal. The scanning process is completed in less than one quarter of a second. The problems from this system arise from the necessity for clear visibility and controlled lighting. This system is also particularly sensitive to tag misalignment, depth perception, and focusing.

Infrared systems operate much like the optical technology but use an infrared frequency which penetrates slightly more. This technology is like the optical systems in that it is highly sensitive to extremes of weather. However, readings can occur at high traffic speeds (55 miles per hour).

b) Inductive Loop

This technology uses inductive coupling for data transmission, with conventional loops in the pavement acting as antennae for relaying signals to or from vehicles. This technology is primarily used in transit and bus applications, where toll plazas are not necessary for the monitoring of vehicle locations and headway. In pavement, loops typically cover a lateral span of up to 6 feet and readings can occur at speeds up to 100 miles per hour.

There are three types of inductive systems: active, semi-active and passive. Active systems use transponders that acquire their power from the vehicle on which they are mounted. Semi-active systems use an internal battery to provide power to transmit an identification signal when triggered by the inductive loop. Passive systems use transponders that are energized by power transmitted by the inductive loop embedded in the pavement.

c) Radio Frequency (RF) and Microwave

Radio frequency and microwaves can transmit greater amounts of data at much faster rates than inductive loop systems. The transponder contains a small internal receiving antenna, an internal transmitter, or modulator which may contain solid-state electronic circuitry. RF and microwave transponders also tend to be smaller in size than inductive loop transponders.

d) Surface Acoustical Wave (SAW)

SAW operates at much the same frequency range as the RF and microwave system, however the SAW transponder can not be programmed in the field. With SAW technology, a low power radio frequency signal from the AVI reader is captured by the transponder antenna and energizes a lithium crystal, setting up an acoustical wave along its surface. This acoustical wave travels along the surface of the crystal so that etched metal tapes can be used to send back a series of timed reflections of the original signal that uniquely identify a transponder. SAW technology may be more problematic in high speed reading.

e) "Smart" Transponder

"Smart" transponders are two-way devices that contain both microprocessors and memory elements. Therefore, this technology would perform calculations and manipulate data independently of any inboard vehicular device to which a transponder might be connected. This would allow the transponder to maintain toll account records and to automatically debit the account each time the vehicle passed through a toll plaza.

f) Administration

In general, most AVI installations have been retrofitted to existing toll facilities as agencies have not felt that the demand warranted a dedicated AVI lane. Thus, AVI traffic often operates in mixed lanes with non-AVI traffic. There are now several new toll roads under design or construction which have fully integrated AVI technologies.

Payment systems need to consider three factors: price of toll (premium tolls vs. discount tolls), timing of payment (pre-payment system vs. post-payment system), and actual method of payment (cash, check, credit card).

1.2. Existing Electronic Toll Collection Systems

There are a number of ETC systems in operation at the present time, with various locations in Texas, Louisiana, Florida, and New York. A brief description of the AVI systems will illustrate some of the technologies in use.

The Dallas North Tollway, operated by the Texas Turnpike Authority, has an ETC system covering the entire 14 miles of the Tollway with another 3 miles under construction. One major advantage has been the increase in the processing capacity of the toll booths. Prior to implementation of the system, toll booths were processing 350 to 400 vehicles per hour per lane (Center for Urban Transportation Research, 1990). After implementation, some toll booths were processing 700 to 750, with over 40 percent of peak traffic motorists using AVI. The Texas Authority estimates that dedicating a lane strictly to AVI would result in a processing rate of 1200 to 1500 vehicles per hour.

The system utilizes Amtech Corporation's TollTag which makes use of a radio frequency (RF) technology. TollTags are actually small transponders that reflect and modify continuous radio wave signals. Readers receive the signals from the antenna and RF module and transmit the data to a computer or some other logging device. To guard against lane runners and the possibility of AVI tags not being read, a camera system is used.

The system, operating since 1989, includes 62 toll stations equipped with coin counting and AVI equipment. Amtech Corporation was contracted for the installation and operation of an electronic toll collection system (ETCS). This contract has shifted the entire risk from the Authority to the private sector. Use of the system has grown and in April 1990, AVI represented 13 percent of transactions on the Tollway on a weekly basis. During peak periods, the figure was 20 percent.

The San Diego-Coronado Bridge ETCS was the first in California. It was initiated in October 1988 as a test of AVI and was discontinued in 1990. The Coronado system employed AVI technology developed by X-CYTE Corporation and is based on acoustical wave technology tags which can be remotely read by radio frequency (RF) readers. Each

(McRaniel, et. al., 1986). Each RF tag is assigned a unique number identifying the vehicle. The electronic tag is the size of a credit card and is attached to the windshield.

The Grosse Ile Bridge in southwest Detroit also uses AVI surface acoustical wave (SAW) technology by X-CYTE Inc. On a typical day approximately 3,900 (65%) of the 6,000 daily transactions on this bridge are through AVI.

The Delaware River Port Authority uses AVI systems on its four toll bridges in the greater Philadelphia area. The technology is produced by LazerData Corporation and uses an optical laser scanner designed for bar-code reading where a wide scan angle or long reading range is required. A bar coded sticker is attached to the driver's side window. AVI patronage on these four bridges during April 1990 accounted for approximately 30 percent of the total traffic.

1.3. Methodology

Several survey methods were considered for this study. Among them were: 1) using mail surveys only, 2) using telephone surveys only, and 3) using both mail and telephone surveys. The sampling techniques considered included: 1) license plate survey, 2) telephone directory survey, 3) random digit dialing, and 4) on-site solicitation method.

Based on the criteria of time, budget, reliability of survey results, economy of sampling techniques, and representative samples of the bridge-user population, a three phase survey method was chosen. The first phase of the survey was a mail survey of 30,000 randomly selected toll bridge users in the Bay Area using on-site solicitation techniques. The second phase of the study was a follow-up telephone survey of mail survey respondents who expressed an initial interest in the ETC technology. The third phase was a telephone survey of commercial users.

As in any market research survey, the basic issue was whether or not the samples obtained were truly representative. Although questionnaires were distributed randomly at toll gates, it is likely that people who favored the ETC technology were more likely to respond to our survey. In the present study we realized that we could have obtained non-random samples from the following: a) the way questionnaires were distributed, b) the way dates and times were selected for distributing questionnaires and conducting interviews, or c) the likelihood of respondents contributing to non-response biases.

In order to control and assess possible biases from the above conditions, the following methods were employed in the present study:

1) The results of our surveys were compared with historical data and with similar studies recently conducted in New York, Florida, and New Jersey (The Port Authority of New York and New Jersey, 1990; AT/Comm, 1990).

2) The mail survey data were weighted to reflect the travel characteristics of Bay Area

bridge users and the current payment methods used by the bridges.
3) A telephone survey method was chosen over a mail survey method for the follow-up survey to provide a better control over non-response bias. The Council of American Survey Research Organizations (CASRO) offers a standard for acceptable response rate based on the upper bound calculation formula. The formula is the ratio of completed interviews to the sum of completed interviews plus incompleted interviews plus refused interviews. CASTRO considers at least a 60 percent upper bound response rate to be acceptable for most opinion research applications. The survey response rate to the telephone survey was over 90 percent.
4) The sample size was made large enough to meet accepted standards for statistical precision. Assuming that we obtained an unbiased sample of mail survey responses, 5,095 survey responses would give us an acceptable error of no more than $\pm$ 1.4 percent at the 95 percent level of confidence. One thousand telephone survey responses gave an acceptable error of no more than $\pm$3.2 at the 95 percent level of confidence. In public opinion research, the commonly accepted standard is an acceptable error of $\pm$5.0 at the 95 percent level of confidence. The level of precision in both the mail and telephone surveys of motorists exceeded the commonly accepted standard.

The sample size of 200 commercial users, given a population of 1,200, would give an acceptable error of no more than $\pm$6.3 at the 95 percent level of confidence (Appendix 1-1). Although this acceptable error is higher than that for the survey of motorists, it gives a general notion as to what the attitudes of commercial users are toward the ETC technology.

1.4. Scope of Work

As mentioned in the previous section, there were three parts in this study: 1) a mail survey of toll bridge users among Bay Area motorists, 2) a follow-up telephone survey of ETC interested motorists, and 3) a telephone survey of commercial users. Each phase consisted of a set of tasks to be carried out for a specific result.

The Phase I tasks included conducting a focus group meeting, designing a mail survey questionnaire, selecting a sample population, distributing questionnaires at toll bridges, and coding, editing, and analyzing the returned surveys.

In Phase II, telephone interviews were conducted with the mail survey respondents who expressed an interest in ETC, to ask additional questions regarding the operational aspects of ETC. The Phase II tasks included selecting a sample population from the mail survey respondents, designing a telephone interview format, conducting telephone interviews, and cross tabulating interview results. One thousand interviews were completed in Phase II.

In Phase III, telephone interviews were conducted with commercial users in order to assess their interest in ETC and their sensitivity to ETC operations. The concern was how receptivity to ETC technology by commercial users would differ from that of motorists and if commercial users would desire services different from those for motorists. Therefore, commercial users were interviewed with a set of questions slightly different from the questions used in Phase II for motorists. The tasks in this phase of the study included selecting a sample population from the current commercial accounts, designing a telephone survey format, conducting telephone interviews, and coding and analyzing data. Two hundred interviews were completed in this phase.

2. MAIL SURVEY

As mentioned earlier, the purpose of the mail survey was to evaluate interest in subscriptions to an electronic toll collection service. A mail survey was conducted among Bay Area motorists and 30,000 survey forms were distributed to toll bridge patrons at the San Francisco/Oakland, Golden Gate, Richmond/San Rafael, San Mateo/Hayward, Dumbarton, Carquinez, and Benicia/Martinez bridges. The Antioch bridge was excluded from the survey because of low traffic volume.

2.1. Methodology - Mail Survey

To increase the response rate, the mail survey questionnaire was designed to be short and concise, and fit in a one page format. The self-administered questionnaire consisted of a short introduction to ETC and six closed-ended questions. Names and telephone numbers of respondents were solicited to follow-up on the mail survey with telephone interviews (Appendix 2- 1). The questions addressed three main issues: a) general interest in subscriptions to an electronic toll collection (ETC) service, b) preference in automated vehicle identification (AVI) tag types and placing or mounting locations of tags on the vehicle, and c) payment methods of current bridge-users, the frequencies of bridge use, and the purposes for primary trips.

The sample size of 30,000 was determined based on an expected rate of return of 15 to 20 percent. Even with a 15 percent return, the sample size would be sufficiently large to obtain statistically precise data for each bridge.

A one-page mail questionnaire was handed out at the toll plazas of seven bridges on October 16, 17, 18, and 23, 1990, during morning and evening peak hours and also off-peak hours. The number of survey forms distributed was proportional to the annual average daily peak and off-peak hour traffic volume. To differentiate returned questionnaires from bridge to bridge, each bridge was assigned its own specific color of paper for the questionnaire.

Among the 30,000 survey forms distributed, approximately 6,000 forms, or 20 percent, were returned over a two month period. An overwhelmingly large number of respondents (85% of the responses) expressed their willingness to participate in a follow-up telephone survey. Forms received after November 2, 1990, were not processed. The number of forms processed was 5,095. A sample size of 5,000 is generally large enough to provide statistically significant results. Adding another 1,000 would not have significantly changed the results or conclusions. (A sample of 5,000 gave an error no more than ± 1.4 and a sample of 6,000 would have given an error no more than $\pm$ 1.35

at 95% confidence level.) In order to reduce the sampling error by one half, it will be necessary to quadruple the size of the sample.

The returned questionnaires were edited and manually coded into categorized variables representing the six questions asked. A special matrix format was prepared using the StatView statistical packages. This matrix consists of 5,095 cases representing the responses received. A numerical case number was assigned to each survey form after checking for errors. The quality of data entry was also checked after the completion of the entire matrix.

The mail survey data were analyzed using both descriptive and inferential statistics tests with the SPSSPC program. For frequency distribution tests, the data were analyzed at three levels: 1) frequency distribution count per question per bridge by time period (AM, PM, and off-peak hours), 2) frequency distribution count per question per bridge, and 3) frequency distribution count per question on all bridges. For inferential statistical analyses, Chi-square and T tests were used.

To estimate the overall receptivity of all bridge users to ETC technology, the sample responses were weighted by the actual traffic flows at each bridge. The percentage of traffic volume on each bridge was computed based on the Caltrans' 1990 traffic transaction data.

After the sample responses were weighted according to the traffic volume on each bridge, the weighted results of the sample respondents were weighted again according to the actual distribution of commute ticket users and cash users. This was to control possible non-response biases because commute ticket users were probably more likely to respond favorably to ETC technology than cash users. The commute ticket information used in the analysis was the 1990 data prepared by Caltrans and the Golden Gate Bridge, Highway, and Transportation District. The weighted frequency distribution counts for the overall results on each question are discussed in the subsequent section and the method used for weighting is discussed in Appendix 2-2.

2.2. Mail Survey of Motorists

The mail survey results are reported in two parts: the overall survey results for all seven bridges and the survey results for each bridge. In our study the response rates varied somewhat from bridge to bridge and ranged from 10 percent to 30 percent. The Dumbarton bridge had the highest response rate which suggests that either there was a higher proportion of commuters on this bridge or a higher percent of commuters responded to our questionnaire than on other bridges. Perhaps the users of the Dumbarton Bridge were more receptive to advanced technology since the bridge serves a population in the Silicon Valley. The Benicia Bridge had the lowest response rate. This could mean that

the number of commuters on that bridge was proportionally lower than on other bridges (Figures 2.1 and 2.2).

2.3. **Mail Survey Results on All Bridges**

Following is a summary of the responses in percentage distribution for all seven bridges. The weighted results shown below were based on the 1990 traffic volume and payment method data furnished by Caltrans and the Golden Gate Bridge, Highway, and Transportation District. The actual and weighted distribution counts are presented in Table 1 and Figures 2.3 through 2.8.

Table 1. Percentage Distribution on All Bridges - Mail Survey

Question 1. Would you be interested in subscribing to an electronic toll collection service?

	Actual	Weighted
Yes	86.1%	82.4%
No	13.9	17.6

Question 2. The AVI tag could be permanently affixed to your car or it could be transferable from car to car. Which would you prefer?

	Actual	Weighted
Permanently affixed	15.1%	15.0%
Transferable	84.6	85.0

Question 3. The AVI tag will be flat and about the size of a candy bar. Where would you be most willing to mount the tag on your vehicle?

	Actual	Weighted
On the license plate	6.1%	6.3%
On the underbody of the vehicle	10.0	10.0
Outside the car on the windshield	1.8	1.7
Inside the car on the windshield	82.1	82.0

Question 4. How do you usually pay your toll?

	Actual	Weighted
Commute ticket	49.5%	24.9%
Cash	50.0	74.2
Other	0.5	0.9

Question 5. How often do you pass through the toll plaza of this bridge?

	Actual	Weighted
5 or more times a week	58.6%	46.5%
3-4 times a week	16.3	16.9
1-2 times a week	13.2	18.0
Less than once a week	11.9	18.6

Question 6. What is the primary purpose of your trip today?

	Actual	Weighted
To or from work	75.9%	67.1%
School/college	2.2	2.4
Personal business	7.7	10.3
Medical/dental visit	2.3	3.0
Social/recreation/vacation	4.3	6.5
Shopping trip	0.8	1.0
Other	6.8	9.7

The mail survey suggested that the number of potential subscribers to ETC could be as high as 82.4 percent of the current bridge users (Figure 2.3). This figure was adjusted later when we estimated ETC demand for Bay Area motorists. The methods used in computing demand estimates are explained in Section 3.4. The mail survey also suggested that an overwhelmingly high proportion of Bay Area toll bridge users (85%) would favor a transferable tag over an affixed tag (Figure 2.4). For the transferable tags, there was only one option given in the survey - inside the windshield. For the permanently affixed tags, three options were given - 1) on the license plate, 2) on the underside of the vehicle, and 3) on the outside of the windshield. The most favored tag location was, consequently, on the windshield inside the vehicle. The second most preferred location was the underside of the vehicle, followed by the license plate. Mounting the tag on the outside of the vehicle on the windshield was the least desired mainly for vandalism and aesthetic reasons (Figure 2.5).

Most of the respondents said they paid tolls either with cash or with commute tickets. Among the respondents the cash users and commute ticket users were evenly divided. Only a fraction of respondents (0.5%) used methods other than cash or commute tickets. However, Caltrans' records show that more people use cash than commute tickets. This suggests that Commute ticket users may have been over-represented in our sample data. The actual and weighted distribution of commute ticket users and cash users are shown in Figure 2.6.

There were more frequent users (commuters) than infrequent users in our sample data, but after weighting the survey data according to the payment methods it was found that commuters were greatly less than what was shown in the sample data (Figure 2.7). The weighted results of the mail survey suggested that 46.5 percent of the patrons used toll bridges on a daily basis (live or more times a week) and 16.9 percent used the bridges 3-4 times a week, and 36.6 percent used the bridges less than twice a week.

The survey also suggested that 67 percent of the trips were to or from work, 10.3 percent of the trips were for personal business, 9.7 percent were for the category designated "other trips," 6.5 percent were for social and recreational trips, 3 percent for medical/dental, 2.4 percent for school and the least were for shopping trips, 1 percent (Figure 2.8).

2.4. Mail Survey Results on Individual Bridges

The highest response was obtained from the Dumbarton Bridge, an almost 30 percent return rate, and the lowest response was from the Benicia/Martinez Bridge, a less than 10 percent return rate. The response rate at other bridges ranged from 15 to 19 percent. Interest of respondents in ETC varied little among bridges. The highest interest was obtained from the Dumbarton Bridge, 93.5 percent. The lowest interest was from the Benicia/Martinez bridge, 79.7 percent.

The preferred tag type and tag location results were fairly consistent on all bridges. The majority of respondents on all bridges said they preferred a transferable tag placed inside the windshield. However, the highest response for transferable tags was from the Dumbarton Bridge, 88.8 percent, and the lowest was from the Golden Gate Bridge, 80.1 percent.

The payment methods varied slightly among bridges. On the San Francisco/ Oakland Bridge, there were more respondents who used cash than commute tickets. On the Golden Gate Bridge, the pattern was reversed - far more respondents used commute tickets than cash. On other bridges, cash and commute ticket users were almost evenly divided.

On all bridges, the largest number of trips were made for work. The distribution of work trips ranged from 60 to 94 percent, except on the Benicia/Martinez Bridge, where the majority of the respondents were daily commuters who used the bridges 5 or more times a week.

The table below is a summary of the sample survey results on each bridge. These results are unweighted.

Table 2. Percent Distribution on Individual Bridges - Mail Survey

Question 1. Would you be interested in subscribing to an electronic toll collection service?

	Yes	No
San Francisco/Oakland	86.5%	13.5%
Golden Gate	85.2	14.8
Richmond/San Rafael	86.6	13.4
San Mateo/Hayward	87.2	12.8
Dumbarton	93.5	6.5
Carquinez	81.0	19.0
Benicia/Martinez	79.7	20.3

Question 2. The AVI tag could be permanently affixed to your car or it could be transferable from car to car. Which would you prefer?

	Permanent	Transferable
San Francisco/Oakland	15.9%	84.1%
Golden Gate	19.9	80.1
Richmond/San Rafael	14.7	85.3
San Mateo/Hayward	12.9	87.1
Dumbarton	11.2	88.8
Carquinez	13.8	86.2
Benicia/Martinez	14.4	85.6

Question 3. The AVI tag will be flat and about the size of a candy bar. Where would you be most willing to mount the tag on your vehicle?

	License plate	Underside of car	Outside windshield	Inside windshield
San Francisco/Oakland	6.1%	10.2%	2.0%	81.6%
Golden Gate	6.6	15.8	1.4	76.1
Richmond/San Rafael	5.3	9.9	2.5	82.3
San Mateo/Hayward	6.3	7.9	0.8	85.1
Dumbarton	4.3	7.8	2.1	85.8
Carquinez	7.3	6.4	2.1	84.3
Benicia/Martinez	7.0	7.7	1.8	83.4

Question 4. How do you usually pay your toll?

	Commute ticket	Cash	Other
San Francisco/Oakland	29.7%	69.2%	1.1%
Golden Gate	78.1	21.6	0.3
Richmond/San Rafael	45.5	53.7	0.8
San Mateo/Hayward	46.1	53.7	0.2
Dumbarton	59.8	40.1	0.1
Carquinez	52.3	47.4	0.3
Benicia/Martinez	42.6	56.8	0.6

Question 5. About how often do you pass through the toll plaza of this bridge?

	>5/week	3-4/week	1-2/week	<l/week
San Francisco/Oakland	50.3%	20.1%	17.3%	12.3%
Golden Gate	59.7	16.9	13.8	9.6
Richmond/San Rafael	58.2	17.6	11.1	13.2
San Mateo/Hayward	64.6	16.5	9.8	9.1
Dumbarton	79.3	12.9	5.6	2.2
Carquinez	57.0	11.3	13.4	18.3
Benicia/Martinez	46.1	12.4	15.1	26.4

Question 6. What is the primary purpose of your trip today?

	Work	Sch	Bus	Med	Soc	Shop	Other
San Francisco/Oakland	73.0%	2.5%	10.2%	3.1%	4.1%	0.9%	6.2%
Golden Gate	76.2	3.4	7.2	2.9	4.4	0.5	5.4
Richmond/San Rafael	76.1	1.9	7.0	2.4	5.4	0.8	6.4
San Mateo/Hayward	83.9	1.6	4.5	0.5	1.1	0.2	8.2
Dumbarton	93.8	1.4	1.7	0.6	0.6	0.0	1.9
Carquinez	67.7	1.4	11.2	2.3	6.9	1.2	9.3
Benicia/Martinez	60.4	2.1	6.8	3.0	10.0	2.0	15.7

2.5. Cross Tabulation Results of Mail Survey

To evaluate whether or not the frequencies obtained from our surveys differed significantly from the expected frequencies under a set of theoretical assumptions, the variables considered in the surveys were cross-tabulated. Interest in subscribing to ETC was strongly associated with the payment method and the trip purpose. A weak associa-

tion was found between ETC subscription interest and tag placement issues. Cross tabulation showed that:

1) Respondents crossing bridges to and from work were more interested in ETC than respondents crossing bridges for social, recreational, shopping, or medical/dental services.

2) Relating to the above statement, respondents who use the bridges frequently were more interested in ETC than the respondents who use the bridges infrequently.

3) Respondents using commute tickets were more interested in subscribing to ETC than respondents using cash.

4) Of the respondents, commute tickets were used mostly by frequent bridge users. There were no significant differences between frequent and infrequent users among respondents using cash.

The cross-tabulation results are as follows. Additional information about the cross-tabulation results of the mail survey is discussed in Appendix 2-3.

1) Question 1, ETC interest, by trip purpose: of those respondents in each trip category, how many were interested in ETC?

by trip mu-nose	N	ETC interest
To or from work	3,776	91.3%
School/college	108	84.3
Personal business	377	77.2
Medical/dental	114	62.3
Social/recreational	212	53.8
Shopping	37	56.8
Other	330	73.0

2) Question 1, ETC interest, by trip frequency: of all those respondents who frequently use bridges, how many were interested in ETC?

by trip frequency	N	ETC interest
5 or more times a week	2,946	92.6%
3-4 times a week	821	91.6
1-2 times a week	663	79.9
Less than once a week	596	54.0

3) Question 1, interest in ETC, by payment: of all those respondents who use commute tickets, how many were interested in ETC? Of all those respondents who use cash, how many were interested in ETC?

By payment	N	ETC interest
Commute ticket	2,464	91.8%
Cash	2,014	80.8
Other	26	80.8

2) Question 5, trip frequency, by payment: of all those respondents using commute tickets how many were frequent users and how many were infrequent users?

By payment	N	>5 times a week	3-4 times a week	l-2 times a week	< once a week
Commute ticket	2,472	80.0%	14.4%	4.3%	1.4%
Cash	2,500	37.1	18.3	22.1	22.5
Other	29	69.0	13.8	10.3	6.9

2.6. Conclusions - Mail Survey of Motorists

The initial response of the mail survey indicated that ETC was highly favored. The respondents preferred transferable tags to permanently affixed tags. The preferred tag location was on the windshields inside the vehicles. The sample data were weighted according to the daily traffic volume and payment methods. The weighted results suggested that as high as 82.4 percent of the current Bay Area bridge patrons could be interested in ETC and 85 percent of the potential patrons would favor transferable tags over permanently affixed tags. The survey also suggested that approximately one half of the bridge patrons were commuters. These suggestions were considered in computing demand estimates for ETC in the Bay Area. Section 3.4. explains the method of calculating demand estimates. The survey also suggested that approximately half of the bridge patrons were commuters and over 70 percent of the trips were either to or from work.

Figure 2.1.
Mail Survey Response Rate by Bridge

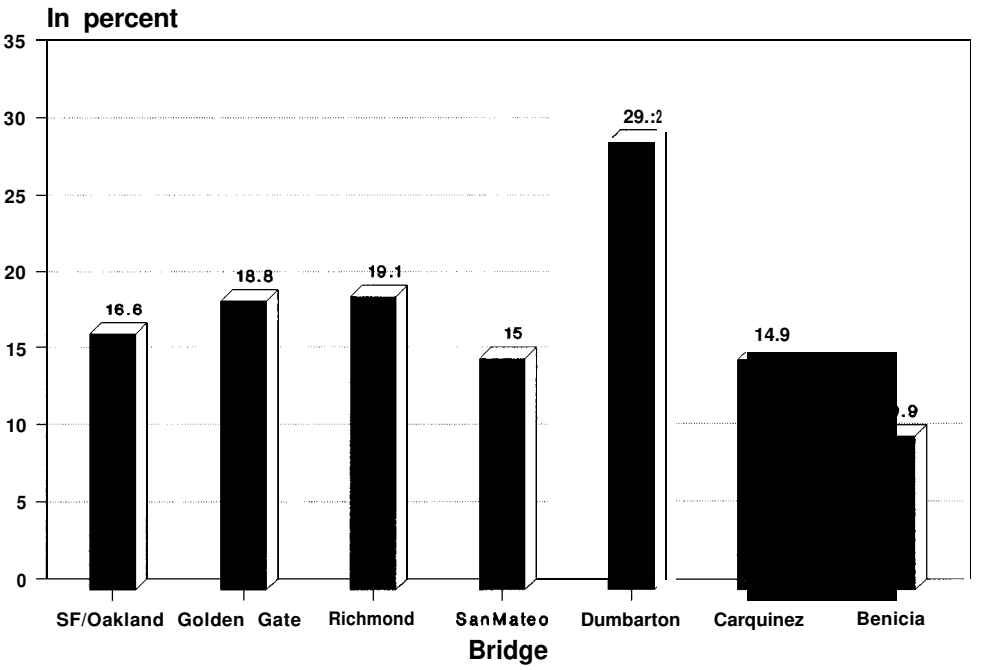


Figure 2.2.
Mail Survey Response Rate by Time Period
(peak and off-peak hours)

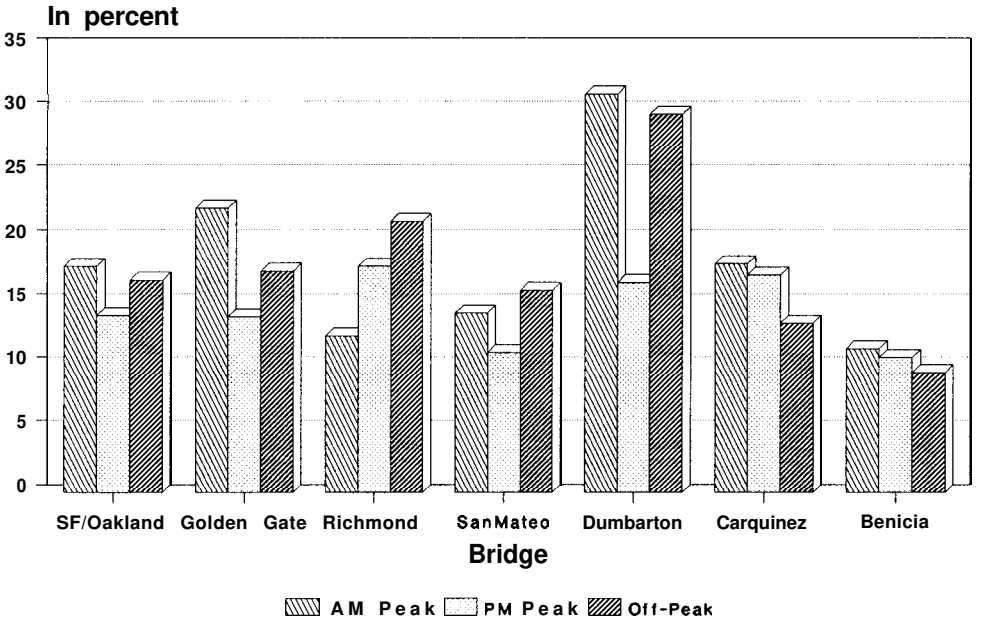


Figure 2.3. ETC Subscription interest
(all bridges)

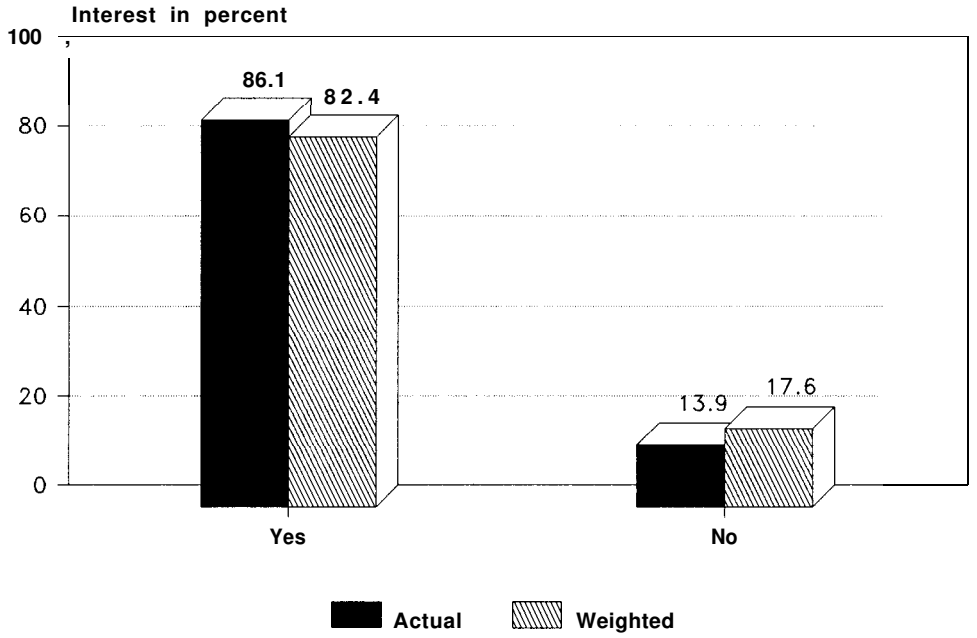


Figure 2.4. Tag Type
(all bridges)

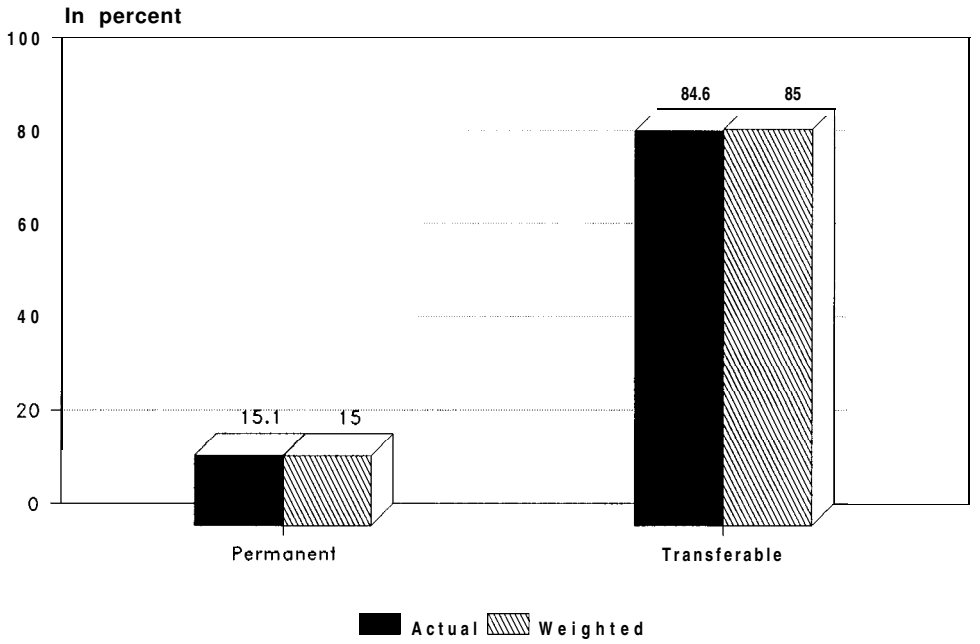


Figure 2.5. Tag Mounting Location
(all bridges)

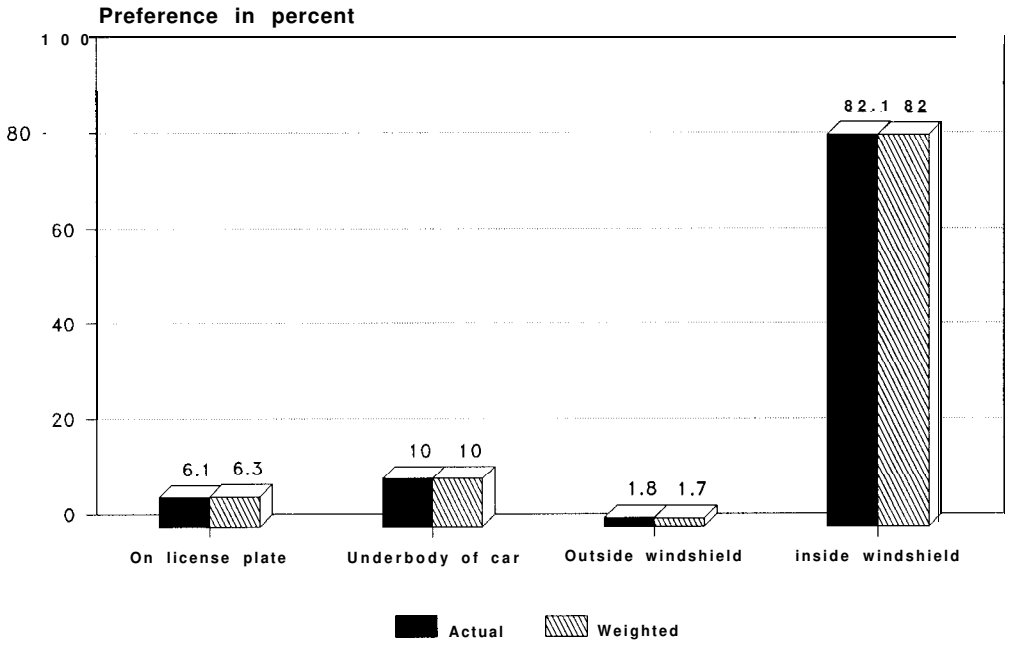


Figure 2.6. Method of Payment
(all bridges)

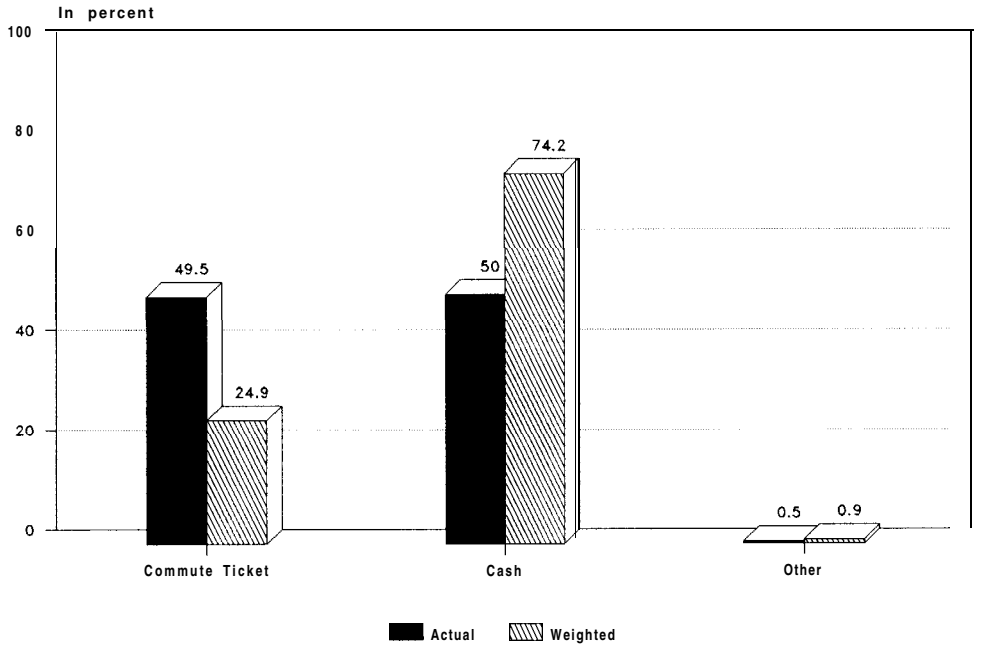


Figure 2.7. Frequency of Bridge Use
(all bridges)

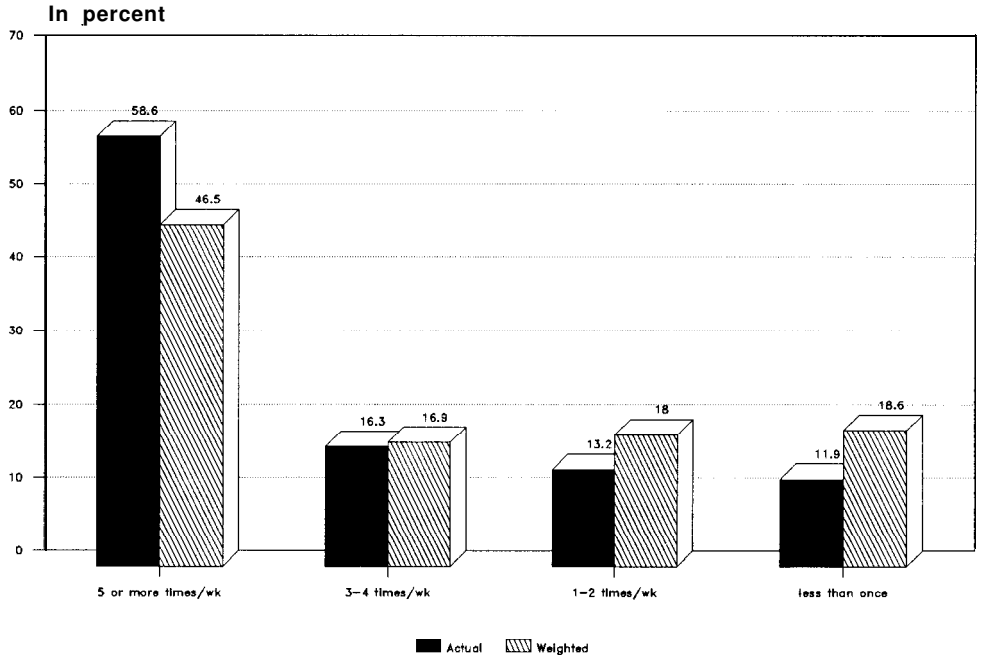
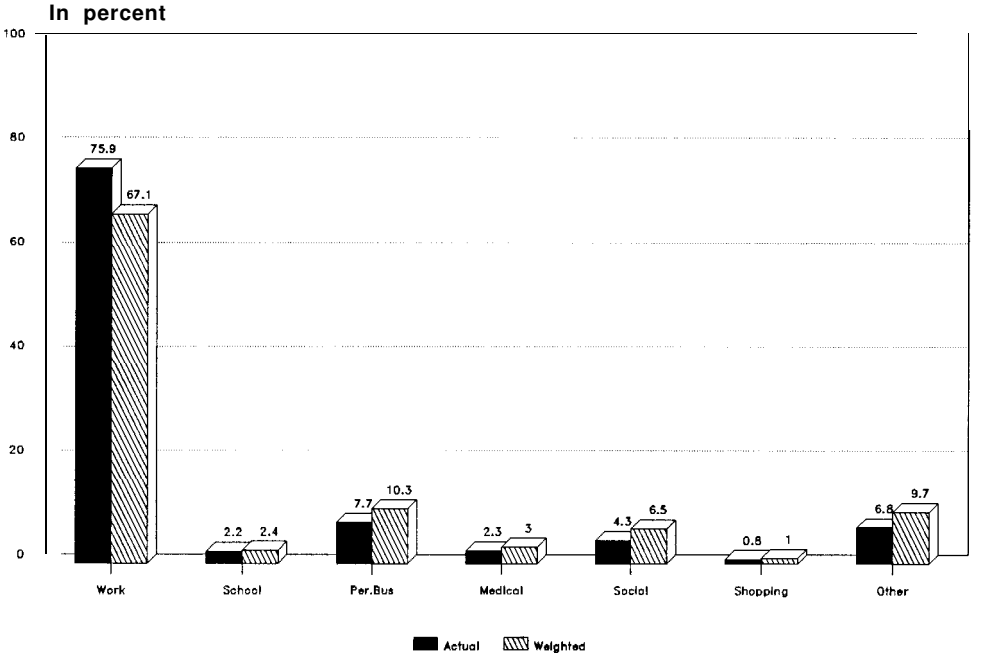


Figure 2.8. Primary Trip Purpose
(all bridges)



3. MOTORISTS TELEPHONE SURVEY

This section reports on the findings of the telephone survey of motorists who expressed an interest in ETC. "Motorists" refers to those who had previously responded to our mail survey. This term distinguishes the respondents as the general users of the toll bridges rather than commercial users. The purpose of the telephone survey was to ask specific questions regarding limitations of hardware, acceptable cost of tag deposit, desirable method of payment, perceived benefits of ETC, and other related issues that could not be covered in the mail survey. The telephone survey was conducted during December 1990. This section discusses the methodology and findings of the survey.

3.1. Methodology - Telephone Survey of Motorists

A telephone survey sample was chosen from a pool of the mail survey respondents who expressed an interest in ETC and indicated a willingness to participate in the follow-up telephone survey. Approximately 4,500, or 85 percent, of the mail survey respondents gave their names and telephone numbers for participation in the telephone survey. One thousand interviews were completed. The number of the mail survey respondents interviewed at each bridge was as follows: 300 from San Francisco/Oakland, 175 from Golden Gate, 78 from Richmond/San Rafael, 91 from San Mateo/Hayward, 151 from Dumbarton, 125 from Carquinez, and 67 from Benicia/Martinez.

The telephone interviews consisted of 27 questions. These questions were designed to determine: 1) level of interest in ETC if tags were permanently affixed, 2) preferred tag mounting location for permanently affixed tags, 3) acceptable tag deposit cost, 4) desirable method of payment, 5) perceived benefits of ETC, 6) usage of toll bridges, 7) mode of travel, and 8) socio-economic profile of interested toll bridge users.

The telephone interviews were conducted December 3-14, 1990. Each interviewer filled out a form containing 27 questions as the answers were given. The telephone survey instrument used during the interview is shown in Appendix 3- 1. The median interview time was approximately 10 minutes.

As in the case of the mail survey, the survey responses were analyzed using "descriptive" and "inferential" testing methods. "Descriptive" meant the number of occurrences of survey responses were shown in frequency distribution and "inferential" meant that chi-square tests were used to identify the relationships between variables considered. The results of interviews in frequency distribution and in cross-tabulation are reported in the following sections.

3.2. Telephone Survey Results of Motorists

The responses obtained from the telephone interviews are reported under the heading of each question below. The reported results are frequency distributions of responses and are given in percentages.

The telephone response rate was over 90 percent. Of the 1,000 respondents, 69.4 percent were male and 30.6 percent were female.

Question 1: Are you still interested in ETC?

This question was to screen the sample prior to proceeding with other questions. If the response was negative, no further questions were asked.

Question 2: If the tag had to be permanently affixed to your car and could not be moved, would you still be interested in ETC?

This question was to determine the extent to which people would subscribe to ETC if tags were permanently affixed. It was asked only of those who said, in Question 1 that they were interested in ETC. "N" is the number of responses.

N = 1,000	ETC interest
Yes	66.0%
No	17.6
Depends	12.3
Not sure	4.1

Question 3: The ETC tag would be permanently affixed either to your front license plate or to the underside of your car, behind the front bumper. Knowing that, do you think you would be interested in ETC?

This question was asked only of those who answered "no," "depends," or "not sure" to Question 2. Of the 1,000 respondents, 340 respondents answered in one of the three ways mentioned above.

N = 340	ETC interest
Yes	55.6%
No	32.4
Depends	8.2
Not sure	3.8

From Questions 2 and 3, the cumulative number of respondents favoring ETC with

permanently affixed tags was 849 or 84.9 percent.

Questions 4 and 5: Which tag location would you prefer: 1) on the front license plate, 2) on the underside of the car, or 3) behind the front bumper?

Question 4 was asked only of those respondents who answered positively to Question 3. Question 5 was asked only of those who answered positively to Question 2. As mentioned earlier, the total number of respondents to Questions 4 and 5 was 849.

N = 849	
Underside of the car	57.4%
License plate	20.3
Not sure	19.4
No answer	2.9

Question 6: To use an AVI tag, subscribers would be required to give the toll agency a one-time, refundable deposit. The deposit would be refunded at any time the tags were returned to the toll agency. Knowing there would be a tag deposit, would you still be interested in ETC?

N = 1,000	ETC interest
Yes	52.0%
Depends on cost	44.2
No	3.0
Not sure	0.8

Question 7: Would you still be interested in ETC if you knew the one-time refundable deposit was... (interviewers asked each dollar amount until respondents says "yes" or until all three dollar amounts have been asked) . . . $30, $15, or $5.

This question was asked only of those respondents who said they were still interested in ETC or who said "depends" to Question 6.

Tag deposit	N	Yes	No
$30.00	962	92.0%	8.0%
$15.00	962	97.5	2.5
$ 5.00	962	99.3	0.7

The survey showed that if the fee were dropped to $15, there would be an increase of 5.5 percent in interest to 97.5 percent. If the fee were dropped to $5, there would be an increase of 7.3 percent to 99.3 percent. These responses suggest that the cost of the deposit might not be a major factor influencing motorists' decisions to use ETC.

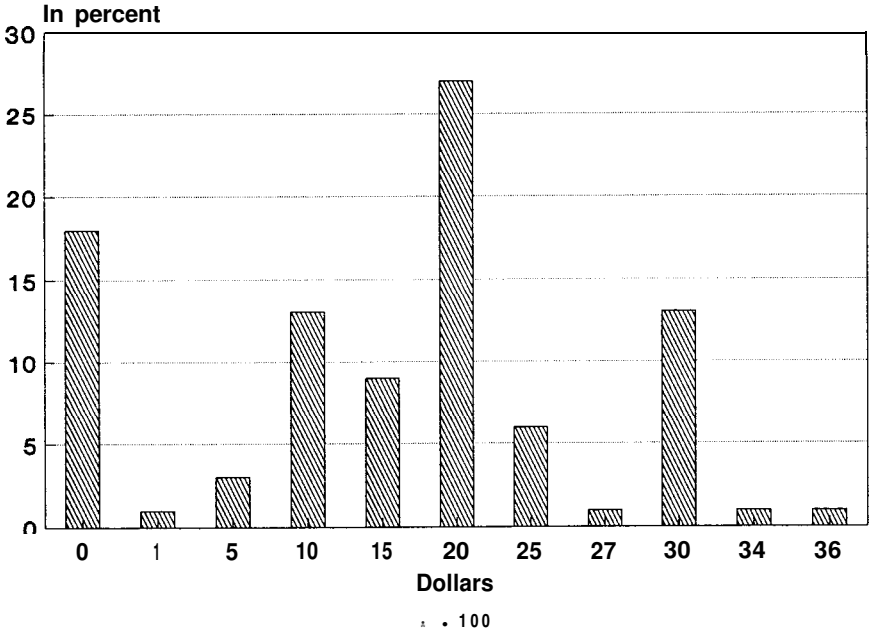
Question 8: In order to use ETC, you would need to open an account with the toll agency. The minimum amount necessary to open an account may be as much as $40.00. Knowing that, would you still be interested in ETC?

N = 1,000	ETC interest
Yes	90.0%
No	7.0
Not sure	3.0

Question 9: What minimum amount would you be willing to spend to open an ETC account with the toll agency? Amount must be less than $40.00.

If dollars and cents were given, they were rounded to the next highest dollar amount. This question was directed to those who said "no" or "not sure" in Question 8. These were 100 respondents or 10 percent of the total sample. The median minimum amount was $20 and the desired amount ranged from 0 to $36 (Figure 3.1).

Figure 3.1. Desired Minimum ETC Account among respondents who would not pay $40



Question 10: You would open an ETC account with an initial payment. Every time you passed through the toll plaza, your toll would be deducted from your account. You would replenish your account by making payments directly to the toll agency and NOT to the toll collector at the toll plaza. The toll agencies are thinking of accepting three possible forms of payment: a major credit card, electronic transfer of funds from your bank account, or a check, cash, or money order. Which form of payment would you most prefer? What would your second choice be?

N = 1,000	First Choice	Second Choice
Major credit card	19.7%	43.4%
Electronic funds transfer	14.2	23.5
Check, cash, or money order	63.9	24.5
None of these (volunteered)	0.6	5.6
Not sure	1.6	2.3
No answer	0.0	0.7

The first choice was payment by cash and the second choice was by credit card.

Question 11: Some people have suggested that the toll agency should provide ETC users with a log of their bridge crossings. The log could be used for income tax or other personal business purposes. If you decided to use the ETC system, would you be interested in receiving a log of your bridge crossings?

N = 1,000	Log interest
Yes	72.1%
No	26.2
Not sure	1.5
No answer	0.2

Question 12: A log of your bridge crossings could be provided every time you replenish your ETC account, at the cost of $1.00 per log. Would you be willing to pay $1.00 for such a log? This question was asked of those respondents who said, in answer to Question 11, that they would be interested in a transaction log service.

	N = 721	N = 1,000
	Log interest	Log interest
Yes	63.8%	46.0%
No	31.1	22.4
Not sure	5.0	3.6
No answer	0.1	0.1
Missing	--	27.9

The survey indicated that 46 percent of the 1,000 respondents were interested in receiving a log service even if a $1 fee were charged.

Question 13 was about the perceived benefits of ETC. This question was divided into five parts: a) traffic congestion, b) vandalism, c) privacy, d) air quality, and e) automobile use. The questions asked whether the respondents agreed or disagreed with the following statements.

a) There will be less traffic congestion at the toll plazas once the ETC system is implemented (Figure 3.2).

N = 1,000	
Strongly agree	65.8%
Somewhat agree	22.4
Somewhat disagree	4.0
Strongly disagree	2.5
Not sure	5.2
No answer	0.1

b) If the electronic tag is affixed to your car where anyone can see it, people will try to steal it.

N = 1,000	
Strongly agree	46.8%
Somewhat agree	30.7
Somewhat disagree	11.8
Strongly disagree	6.2
Not sure	4.3
No answer	0.2

c) The ETC electronic tag will allow the police to always know where your car is, and that's not good (Figure 3.3).

N = 1,000	
Strongly agree	7.2%
Somewhat agree	6.6
Somewhat disagree	25.2
Strongly disagree	52.0
Not sure	8.7
No answer	0.3

d) ETC would help improve air quality because there would be less carbon monoxide produced by vehicles decelerating and idling (Figure 3.4).

N = 1,000	
Strongly agree	34.9%
Somewhat agree	36.1
Somewhat disagree	14.0
Strongly disagree	7.5
Not sure	7.2
No answer	0.3

e) ETC might encourage people to use their cars more because it would be easier to cross the bridges, and that's not good.

N = 1,000	
Strongly agree	7.2%
Somewhat agree	13.8
Somewhat disagree	28.0
Strongly disagree	47.2
Not sure	3.4
No answer	0.4

Question 14: Now you have heard a little more about ETC, do you think you would be interested in subscribing to the ETC service?

N = 1,000	ETC interest
Yes	89.9%
No	2.7
Not sure	7.3
No answer	0.1

Questions 15 Currently, people who buy monthly commuter tickets receive a small discount, approximately 15 percent, on toll charges. Would you still be interested in ETC if you knew it would NOT include this commuter discount on toll charges? This question was asked only of those who said "yes" in Question 14.

N = 899	ETC interest
Yes	54.4%
No	36.3
No sure	9.2

Question 16: Currently, people who buy monthly commuter tickets receive a small discount, approximately 15 percent, on toll charges. Do you think you would be interested in subscribing to the ETC service if you knew you would receive the commuter discount on toll charges? This question was asked only of those who said "no," "not sure," or did not respond on Question 14.

N = 101	ETC interest
Yes	73.3%
No	15.8
Not sure	10.9

Question 17: Which of the Bay Area's toll bridges do you use most often? Only one answer was accepted.

N = 1,000	Bridge usage
Golden Gate	18.2%
San Francisco/Oakland Bay	33.3
Carquinez	9.6
Benicia/Martinez	6.9
Richmond/San Rafael	6.6
San Mateo/Hayward	9.3
Dumbarton	15.0
Antioch	0.1
No answer	1.0

Question 18: Do you use any of the other Bay Area toll bridges more than once a month? This question was asked only of those who said Golden Gate Bridge most frequently in Question 17.

N= 182	Bridge usage
Yes	45.6%
No	53.8
Not sure	0.5

Question 19: Do you use the Golden Gate Bridge more than once a month? This question was asked only of those who said they use Caltrans operated bridges most frequently in Question 17.

N = 808	Bridge usage
Yes	15.1%
No	84.8
Not sure	0.1

Question 20: One ETC tag could be used on any of the Bay Area's eight toll bridges. However, the Golden Gate Bridge and the seven other Bay Area toll bridges are run by two separate agencies. Therefore, you would need to open two separate ETC accounts if you wanted to use ETC on the Golden Gate Bridge as well as on the seven other Bay Area toll bridges. Would you be interested in opening two ETC accounts -- one for the Golden Gate Bridge and one for the 7 other Bay Area toll bridges? This question was asked only of those who said "yes" to Questions 18 or 19.

N = 205	Two accounts
Yes	24.4%
No	68.3
Not sure	6.8
No answer	0.5

Question 21: Thinking of the toll bridge you use most often, do you ever carp001 or vanpool when crossing the bridge?

N = 1,000	Carpool/vanpool
Yes	23.0%
No	76.9
No answer	0.1

Question 22: About how often do you carp001 or vanpool? This question was asked only of those who said "yes" to Question 2 1.

N = 230	Carpool/vanpool
5 times a week	21.3%
2 to 3 times a week	22.6
1 to 2 times a week	13.0
Less than once a week	42.2
Not sure	0.9

Question 23: How many licensed drivers are there in your household?

N = 1,000	
Number of Drivers	
1	15.3%
2	68.4
3	9.6
4	5.1
5 or more	1.5
No answer	0.1

Question 24: How many operating cars and trucks are there in your household?

N = 1,000	
Number of cars	
0	0.2%
1	14.0
2	53.9
3	21.1
4 or more	10.6
No answer	0.2

Question 25: What is your employment situation?

N = 1,000	
Employed full time	78.2%
Employed part time	3.6
Self-employed	10.9
Not employed for pay	1.2
Retired	3.9
Student	1.9
No answer	0.3

Question 26: What is your age? If respondent refuses to state age, it was asked which of the categories shown in Figure 3.5 does their age fall into? Frequency distribution of age groups showed that the median was between 30-39 (30.4 %). The second largest age group was 40-49 (29.5 %), the third was 50-59 (15.6 %), and the fourth was 22-29 (12.8%). The age group 60 and over was 9.1 percent and between 18-21 was only 1.2 percent.

Question 27: Which one of the income categories (shown in Figure 3.6) includes your total family income before taxes last year? Family income included their own income and that of any member of their immediate family who was living with them. Of the respondents (N=1,000), 39.7 percent had a family income between $30,000-$60,000, 24.5 percent had an income between $60,000-100,000 and 16.8 percent had an income over $100,000. Only 9 percent of the respondents had an income of less than $30,000 last year.

3.3. Cross Tabulation of Motorist Telephone Survey

To determine whether or not systematic relationships existed between combinations of two variables, Chi-square and T tests were performed. Each question was cross tabulated by bridge, by frequency of bridge use, by payment methods and by trip purpose. Among the relationships evaluated by cross tabulation, the following relationships showed statistical significance. The data used in this analysis are based on the situation that tags were assumed to be permanently affixed.

1) Question 3, interest in ETC if tags were permanently affixed, by bridge (meaning cross tabulation of Question 3 by bridge):
The interest in subscribing to ETC was associated with the bridge. According to the T-

test, respondents using the Golden Gate Bridge showed a slightly greater interest in ETC than respondents using other bridges.

by bridge	N	ETC interest
San Francisco/Oakland	300	87.7%
Golden Gate	175	91.4
Richmond/San Rafael	78	84.6
San Mateo/Hayward	91	81.3
Dumbarton	151	82.1
Carquinez	125	86.4
Benicia/Martinez	67	80.6

2) Question 3, interest in ETC if tags were permanently affixed, by trip purpose:
The cross tabulation showed that respondents using bridges for work, school, and personal trips indicated a slightly higher receptivity to ETC than those using bridges for other trip purposes.

by trip mu-nose	N	ETC interest
To or from work	789	85.3%
School/college	29	96.6
Personal business	65	96.9
Other	89	79.8

3) Question 7, $30 tag deposit, by trip frequency:
Willingness to purchase a tag was closely associated with the frequency of bridge use. A greater proportion of the respondents who use bridges frequently showed a higher receptivity to the tag deposit than the respondents who use bridges infrequently.

by trip freauencv	N	ETC interest
5 or more times a week	644	89.9%
3-4 times a week	170	88.2
l-2 times a week	118	86.4
less than once a week	63	77.8

4) Question 7, if tag deposit were $30, interest in ETC by payment:
The cross tabulation showed that respondents using commute tickets indicated a greater receptivity to the tag deposit requirement than respondents using cash.

by payment	N	ETC interest
Commute ticket	544	90.6%
Cash	443	85.8

5) Question 7, if tag deposit were $30, interest in ETC by trip purpose:
Respondents using bridges for work, personal business, and other purposes showed a greater receptivity to a tag deposit than respondents using bridges for school trips.

by trip mu-pose	N	ETC interest
To or from work	800	90.1%
School/college	30	63.3
Personal business	66	83.3
Other	89	86.5

6) Question 8, if an ETC account were required, interest in ETC by trip frequency:
Willingness to open an ETC account was closely associated with the frequency of bridge use. Respondents using bridges frequently showed a greater receptivity to opening an account than respondents using bridges infrequently.

by trip frequency	N	ETC interest
5 or more times a week	644	92.2%
3-4 times a week	170	90.6
1-2 times a week	118	86.4
less than once a week	63	73.0

7) Question 8, if an ETC account were required, interest in ETC by payment method: Willingness to open an ETC account was also closely associated with the way respondents pay their tolls. Again respondents who use commute tickets showed a greater willingness to open an ETC account than respondents who use cash.

by payment	N	ETC interest
Commute ticket	544	92.6%
Cash	443	86.7

8) Question 8, if an ETC account were required, interest in ETC by trip purpose: Respondents using bridges for work and school trips showed a greater willingness to open an account than respondents using bridges for personal business or other purposes.

by trip purpose	N	ETC interest
To or from work	800	91.6%
School/college	30	96.7
Personal business	66	86.4
Other	89	77.5

9) Question 10, payment method, by bridge:
Respondents on the San Mateo, Carquinez, and Benicia bridges preferred cash more than respondents on other bridges. Respondents on Dumbarton Bridge showed a slightly higher receptivity to the electronic funds transfer method than respondents on other bridges.

by bridge	N	Cash	Credit Card	Electronic Funds
San Francisco/Oakland	304	65.5%	19.7%	14.8%
Golden Gate	175	59.2	28.2	12.6
Richmond/San Rafael	77	61.0	24.7	14.3
San Mateo/Hayward	89	73.0	14.6	12.4
Dumbarton	144	61.1	17.4	21.5
Carquinez	125	72.0	15.2	12.8
Benicia/Martinez	65	72.3	18.5	9.2

10) Question 10, payment method, by trip frequency:
Respondents who use bridges on a daily basis showed a slightly greater interest in using cash than respondents who use bridges infrequently or occasionally.

by trip frequency	N	Cash	Credit Card	Electronic Funds
5 or more times a week	632	67.9%	16.0%	16.1%
3-4 times a week	169	60.4	24.3	15.4
1-2 times a week	113	59.3	32.7	8.0
less than once a week	60	63.3	28.3	8.3

11) Question 10, payment method, by payment:
Cash payments were favored slightly more among respondents using cash than among respondents using commute tickets.

by payment	N	Cash	Credit Card	Electronic Funds
Commute ticket	533	63.4%	19.3%	17.3%
Cash	433	67.2	21.2	11.5

12) Question 10, payment method, by trip purpose:
Cash was still the preferred method of toll payment regardless of trip purpose. However, those respondents who used bridges for commuting to work or for making personal trips favored cash slightly more than those respondents who used bridges for school or other trip purposes.

by trip purpose	N	Cash	Credit Card	Electronic Funds
To or from work	788	65.9%	18.1%	16.0%
School/college	30	60.0	23.3	16.7
Personal business	63	68.3	22.2	9.5
Other	84	60.7	36.9	2.4

13) Question 12, logging charges, by payment:
Respondents using commute tickets were less interested in the logging service for bridge crossings than respondents using cash.

by payment	N	Logging Interest	Logging Disinterest	Not Sure
Commute ticket	543	40.0%	54.9%	5.2%
Cash	443	54.0	44.2	1.8

14) Question 13A, traffic congestion, by bridge:
The perception of respondents regarding the impact of ETC on traffic congestion appeared to be associated with the bridge. A greater expectation of reduced traffic congestion was shown among the respondents of Golden Gate (97.1%), San Mateo/Hayward (95.4%), Dumbarton, and Carquinez than respondents of other bridges (San Francisco/Oakland, 89.7%; Richmond/San Rafael, 90.6%; Benicia, 90.7%). The percentages shown are cumulative responses of those who strongly and somewhat agreed with the statement in Question 13A by bridge.

by bridge	N	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
San Francisco	291	60.1%	29.6%	5.8%	4.5%
Golden Gate	170	76.5	20.6	1.8	1.2
Richmond	74	59.5	31.1	5.4	4.1
San Mateo	87	71.3	24.1	4.6	0.0
Dumbarton	140	81.4	12.9	3.6	2.1
Carquinez	121	73.6	22.3	3.3	0.8
Benicia	64	68.8	21.9	4.7	4.7

15) Question 13C, privacy, by payment:

The cross tabulation showed that 404 respondents who used commute tickets, or 16.2 percent, felt negatively or somewhat negatively about their vehicles being traced if AVI tags were used. Respondents using commute tickets showed slightly more concern for protecting their privacy than respondents using cash (13.6%). The percentages shown are cumulative responses of those who strongly and somewhat agreed with the statement in Question 13C by payment method.

by payment	N	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
Commute ticket	493	9.3%	6.9%	31.0%	52.7%
Cash	404	5.9	7.7	24.3	62.1

16) Question 13C, by trip purpose:

There seemed to be a strong correlation between trip purpose and concern for privacy. Respondents who used the bridges for school trips (30%) showed more concern for privacy than those on other trips (work trips, 14.8%; personal trips, 13.6%; other trips, 14.3%). The percentages shown are cumulative responses of those who strongly and somewhat agreed with the statement in Question 13C by trip purpose.

by mu-nose	N	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
To or from work	729	7.4%	7.4%	29.5%	55.7%
School/college	30	13.3	16.7	6.7	63.3
Personal business	59	8.5	5.1	15.3	71.2
Other	77	9.1	5.2	26.0	59.7

17) Question 13D, air quality, by bridge:

Respondents of the San Mateo/Hayward (86.1%) and Carquinez (8 1.2%) bridges felt more strongly that ETC would improve air quality than the respondents from the other bridges (San Francisco/Oakland, 75.4%; Golden Gate, 72.7%; Richmond/San Rafael, 75.0%; Dumbarton, 78.1%; Benicia 70.4%). The percentages shown are cumulative responses of those who strongly and somewhat agreed with the statement from Question 13D.

by bridge	N	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
San Francisco	277	35.0%	40.4%	14.8%	9.7%
Golden Gate	165	29.1	43.6	17.0	10.3
Richmond	72	25.0	50.0	15.3	9.7
San Mateo	86	51.2	34.9	9.3	4.7
Dumbarton	142	41.5	36.6	15.5	6.3
Carquinez	122	48.4	32.8	12.3	6.6
Benicia	61	39.3	31.1	24.6	4.9

18) Question 13E, automobile use, by payment:

The perception of increased use of automobiles because of ETC seemed to be associated with the way respondents paid tolls. Respondents who used cash (26.5%) agreed more with the perception of increased automobile use than respondents who used commute tickets (18.0%). The percentages shown are cumulative responses of those who strongly and somewhat agreed with the statement in Question 13E.

by payment	N	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
Commute ticket	516	6.6%	11.4%	29.8%	52.1%
Cash	434	8.8	17.7	28.6	44.9

19) Question 15, commuter discount, by bridge:

Respondents of the San Francisco/Oakland, Richmond/San Rafael, San Mateo/Hayward, and Dumbarton bridges showed a greater willingness to give up commute ticket discounts than respondents of the Golden Gate, Carquinez, and Benicia bridges. The reason could be that discount rates on the Golden Gate, Carquinez, and Benicia bridges are higher than other bridges. The discount rate on the Golden Gate Bridge is 16.7 percent, or 33 cents for every $2 toll and on the Carquinez and Benicia bridges the discount rate is 25 percent for every $1 toll. Other bridges have a 15 percent discount for a $1 toll charge.

by bridge	N	Yes	No	Not Sure
San Francisco/Oakland	275	66.9%	26.2%	6.9%
Golden Gate	159	34.6	54.7	10.7
Richmond/San Rafael	71	60.6	29.6	9.9
San Mateo/Hayward	81	60.5	27.2	12.3
Dumbarton	139	59.0	30.2	10.8
Carquinez	112	42.0	50.9	7.1
Benicia/Martinez	62	46.8	7.1	11.3

20) Question 15, commuter discount, by trip frequency:

The commuter discount issue seemed to be closely associated with the frequency of bridge use. Those respondents who used the bridges infrequently responded more favorably to ETC without a commuter discount than those respondents who used the bridges frequently. The low rate of favoring ETC without commuter discounts among the respondents using bridges on a daily basis may be due to the thought that people may be able to continue to receive a commuter discount if they do not subscribe to ETC.

by trip freauencv	N	Yes	No	Not Sure
5 or more times a week	582	49.0%	41.2%	9.8%
3-4 times a week	157	55.4	33.8	10.8
1-2 times a week	103	69.9	25.2	4.9
less than once a week	52	78.8	13.5	7.7

21) Question 15, commuter discount, by payment:

The cross tabulation showed that interest in ETC without a commuter discount was

associated with the way respondents paid tolls. Without a commuter discount, respondents who used commute tickets were less interested in ETC than those who used cash.

by payment	N	Yes	No	Not Sure
Commute Ticket	489	35.4%	52.4%	12.3%
Cash	398	77.6	16.6	5.8

22) Question 15, commuter discount, by trip purpose:
Without a commuter discount, respondents using bridges for work or school were less interested in ETC than respondents using bridges for personal business or other purposes.

by trip purpose	N	Yes	No	Not Sure
To or from work	726	51.5%	39.1%	9.4%
School/college	29	58.6	34.5	6.9
Personal business	57	70.2	17.5	12.3
Other	74	64.9	28.4	6.8

23) Question 26, age of respondents, by bridge (Figure 3.7):
San Francisco/Oakland, Richmond/San Rafael, Dumbarton, and Carquinez showed a greater proportion of respondents among the age group between 30-49 than those using other bridges. Respondents travelling on the Golden Gate Bridge were generally older than on other bridges. Over 70 percent of the respondents from the Golden Gate Bridge were in the age groups over 40. On Dumbarton Bridge, respondents were younger than on other bridges. Sixty percent of the respondents travelling on Dumbarton Bridge were in the age group between 18-39.

		Age group				
by bridge	N	18-29	30-39	40-49	50-59	60 & over
San Francisco/Oakland	300	17.0%	32.7%	27.7%	14.7%	8.0%
Golden Gate	177	7.9	21.5	31.1	24.3	15.3
Richmond/San Rafael	78	15.4	35.9	26.9	16.7	5.1
San Mateo/Hayward	90	18.9	26.7	32.2	14.4	7.8
Dumbarton	150	17.3	39.3	27.3	10.7	5.3
Carquinez	124	7.3	33.1	34.7	12.1	12.9
Benicia/Martinez	67	16.4	23.9	34.3	17.9	7.5

24) Question 26, age of respondents, by frequency:
Frequency of bridge use seemed to be associated with the age of the respondent. Those respondents in the age group between 18-50 were more frequent users than those respondents in the age group over 50.

		Age Group				
by trip frequency	N	18-29	30-39	40-49	50-59	60 & over
5 or more times a week	638	15.4%	32.1%	31.5%	14.9%	6.1%
3-4 times a week	167	10.8	32.3	28.7	16.2	12.0
1-2 times a week	115	17.4	23.5	23.5	18.3	17.4
less than once a week	61	4.9	26.2	27.9	21.3	19.7

25) Question 26, age of respondents, by payment:
Among the respondents in the age group between 40-59, commute tickets were used slightly more than cash. Age groups between 18-29, 30-39, and 60 and over used cash more than commute tickets.

		Age Group				
by payment	N	18-29	30-39	40-49	50-59	60 & over
Commute ticket	535	9.9%	30.1%	32.7%	18.3%	9.0%
Cash	438	19.4	31.3	26.3	13.2	9.8

26) Question 26, age of respondents, by trip purpose:
One third of the respondents among the age group between 30-49 travelled to and from work. Over half of the respondents among the age group between 18-29 used the bridges for school. A high proportion of respondents among the age group 60 or older used the bridges for personal business.

		Age Group				
by trip purpose	N	18-29	30-39	40-49	50-59	60 & over
To or from work	792	14.1%	33.6%	30.9%	15.7%	5.7%
School/college	29	55.2	17.2	10.3	13.8	3.4
Personal business	65	6.2	21.5	24.6	16.9	30.8
Other	85	5.9	17.6	29.4	20.0	27.1

27) Question 27, household income, by bridge (Figure 3.8):
On all bridges, a high proportion of respondents were in those income groups between $40,000-$60,000. However, household incomes of respondents appeared to be associated with the bridge. The respondents of the Golden Gate Bridge had generally higher household incomes than other bridges. Over 30 percent of the respondents on the Golden Gate Bridge had incomes over $100,000 last year. Respondents travelling on the Carquinez and Benicia Bridges had lower household incomes than on other bridges. These bridges also showed a higher proportion of respondents whose household income was $30,000 or less, than other bridges.

28) Question 27, household income, by payment (Figure 3.9):
A higher proportion of the respondents whose household incomes were less than $50,000 or between $70,000-80,000 preferred cash to commute tickets. A higher proportion of the respondents whose household incomes were between $50,000-70,000 and above $80,000 preferred commute tickets to cash.

29) Question 27, household income, by trip purpose (Figure 3.10):
The cross tabulation showed that nearly 45 percent of those income groups between $30,000-$60,000 used toll bridges primarily for commuting. Thirty-seven percent of the respondents among the income groups earning less than $30,000 made trips for school. Nearly 50 percent of the respondents among the income groups earning over $100,000 used the bridges for personal business or other trip purposes. Only 18 percent of the respondents among the income groups over $100,000 travelled to or from work.

3.4. ETC Demand Estimates for Motorists

Our surveys and the surveys done in other states indicated that ETC was received most favorably by those who used the toll facilities frequently. Therefore, we suggest that ETC be targeted at people who commute to work and at commercial users who frequently use toll facilities. In this regard, demand among motorists for the ETC service can be described as a function of trip frequency. Trip frequency depends on trip purpose, as frequent users are likely to be commuters who use tickets. The survey also indicated that interest in ETC would be elastic with respect to the types of tags that would be offered. If the tags were permanently affixed, the interest in ETC would drop by 12 percent.

On the basis of Caltrans' 1990 data on traffic volume at each bridge, demand for the ETC service in the Bay Area was estimated to be between 255,000 and 290,000 patrons, depending on whether tags were transferable or permanently affixed. If tags were permanently affixed, as mentioned earlier, there would be less market penetration for the ETC service.

Several assumptions were used in the demand analysis:

1) Work trips represent commuters or frequent users.
2) Trips other than work trips represent infrequent users.
3) The number of commuters using the Bay Area toll bridges remains constant.
4) The numbers and make-up of non-commuters using the bridges are also constant, although they may vary by week, month, and by season. Forecasts based on individual bridge patrons among non-commuters would yield a higher number of potential ETC users than estimates based on our assumptions. Since the information on daily individual bridge patrons was not available, ETC demand was estimated based on the assumption that the same motorists used the bridges throughout the year.

Two methods were used to estimate ETC demand, extrapolation of the weighted mail survey results and the relationships between ETC interest and the trip frequency of bridge use among the mail survey respondents.

Method 1: Extrapolation of the weighted mail survey results

This method estimates demand based on the weighted results of the mail survey. The steps used in arriving at these demand estimates were as follows:

1) The daily average number of motorists using the Bay Area toll bridges was estimated by trip purpose. The Caltrans' traffic data was compared with the MTC data on traffic and toll revenues.
2) The demand for the ETC service was estimated for each trip purpose based on the weighted results of the mail survey.

3) The total demand was estimated by multiplying the survey demand estimate by the number of motorists for each trip purpose.

In 1990, the annual average daily traffic transaction (AADTT) including weekends was 375,250. According to the MTC estimates, approximately 50 percent of these transactions were generated by work trips. Our survey suggested that 67 percent of the patrons would have used the bridges to or from work on weekdays. Since the AADTT includes the weekend trips, the MTC estimate was used for the demand analysis. In the analysis, non-work trips were adjusted according to the MTC work-trip figures.

From our surveys, we estimated demand levels for ETC by trip purpose as follows:

Table 3.
Estimated Demand for ETC using Method 1

Trip Purpose	Trips MTC	Traffic Volume MTC	ETC Interest/ Weighted	Demand Transfer Tags	Demand Affixed Tags
Work	50.0%	187,625	87.2%	163,560	143,933
School/college	3.6	13,641	80.5	10,979	9,662
Personal business	15.6	58,543	73.7	43,153	37,974
Medical/dental	4.5	17,05 1	59.5	10,143	8,925
Social/recreat	9.9	36,945	51.4	18,978	16,700
Shopping trip	1.5	5,684	54.2	3,082	2,712
Other	14.7	55,133	69.7	38,428	33,816
Total				288,325	253,725

Using the above method, demand for ETC among commuters was calculated at approximately 160,000 if transferable tags were offered. Demand was calculated as approximately 140,000 if tags were permanently affixed. Using the same principle, demand for the ETC service among patrons not travelling to and from work was estimated to be 130,000 if tags were transferable. Demand would be about 111,000 if tags were permanently affixed.

Method 2: Proportional Method

This method estimates demand for ETC based on the relationships between ETC interest and the frequency of bridge use among the mail survey respondents. The relationship between the level of ETC interest and trip frequency can be shown as follows:

$D_{tf} = \alpha_1$ (tf) — D_{tf} = Demand for ETC among frequent users (3 or more bridge crossings per week)
tf = Traffic volume of frequent users or commuters

$D_{ti} = \alpha_2$ (ti) — D_{ti} = Demand for ETC among infrequent users (l-2 bridge crossings per week)
ti = Traffic volume of infrequent users or non-commuters

$D_{to} = \alpha_3$ (to) — D_{to} = Demand for ETC among occasional users (less than one bridge crossing per week)
to = Traffic volume of occasional users

a, is the mean of the level of ETC interest among frequent users, α_2 is the mean of the level of interest among infrequent users, and α_3 is the mean of the level of interest among occasional users at the seven bridges shown in percentages. The a values were computed as follows:

Table 4.
ETC Interest among Frequent, Infrequent, and Occasional Users by Bridge

Bridge	Freauent	Infreauent	Occasional
San Francisco/Oakland	93.2%	82.1%	50.7%
Golden Gate	90.5	73.9	49.1
Richmond/San Rafael	87.8	84.5	61.7
San Mateo/Hayward	91.5	84.8	58.5
Dumbarton	94.3	78.1	81.3
Carquinez	89.5	75.3	56.1
Benicia/Marinez	94.6	80.3	47.1
Mean	91.6%	79.9%	57.8%
Standard Deviation	2.55	4.29	11.64

Therefore, a, is 0.9 and α_2 is 0.8 in rounded numbers. In the case of occasional users, the standard deviation is approximately 20 percent of the mean, which is relatively high, and thus the α_3 value is rounded to 0.5. The a values were computed from the weighted values of ETC interest among the mail survey respondents. Where the average daily frequent traffic volume, tf, is 187,625 (50% of 375,250), demand for ETC among frequent users is estimated to be:

$$D_{tf} = 0.9 \text{ (tf)} = 169{,}000$$

Similarly, D_{ti} and D_{to} can be computed as:

$$D_{ti} = 0.8\ (ti) = 75{,}000$$

where the average daily infrequent traffic volume, ti, is 93,812 (25% of 375,250). According to the mail survey, the number of infrequent users was similar to the number of occasional users. Therefore,

$$D_{to} = 0.5\ (to) = 47{,}000$$

where, to is also 93,812 (25% of 375,250).

Using this method, the total demand for ETC among all bridge users is estimated to be 291,000 if tags are transferable. If tags are permanently affixed, demand is 12 percent less. Therefore, demand for ETC with permanently affixed tags is estimated to be 256,000.

Demand for ETC among motorists is computed by averaging the demands estimated using methods 1 and 2. If tags are transferable, demand is estimated to be approximately 290,000. This figure is derived from (288,000 + 291,000)/2. If tags are permanently affixed, demand is expected to be 12 percent less, approximately 255,000 potential patrons.

Forecasting techniques for new technology demands are not readily available, especially in transportation. Recent studies in electronic toll collection systems, such as at the University of South Florida in 1990, suggest that demand for ETC can be estimated based on the results of opinion surveys, such as with the demand models used in this study. Although these models were somewhat limited in accuracy and predictability, we used these models because they were readily applied in market survey research. Motorists' intentions to use the ETC service do not always coincide with the actual number of subscriptions to the service. The proportions between those who actually subscribe to the service and those who intended to subscribe are not known. The demand projections in this study may be used as the basis for estimating the level of interest in ETC. For the final decisions to implement ETC, further research is needed to accurately project ETC demand among Bay Area motorists and commercial users.

3.5. Conclusions - Telephone Survey of Motorists

A telephone survey was conducted among the respondents of the mail survey to evaluate the ETC interest if AVI tags were permanently affixed. The telephone survey suggested that even if tags were permanently affixed a large number of the Bay Area motorists would still be interested in ETC. If tags were permanently affixed, 70.4 percent of the respondents said they would be interested in subscribing to the ETC service.

The telephone survey also showed that interest in ETC varied somewhat from bridge to bridge. Respondents travelling on the San Francisco/Oakland and Golden Gate bridges showed a slightly greater interest in ETC than respondents travelling on other bridges. As expected, respondents using bridges on a daily basis showed a higher receptivity to ETC than respondents using bridges infrequently. Respondents using commute tickets were also more receptive to ETC than those using cash.

If tags were to be permanently affixed, the most favored location of tag placement would be the underside of the car. There was a strong willingness to support the operational requirements of the ETC service. Over 90 percent of the respondents said they would not mind paying $30 for a one-time refundable tag deposit and would keep the $40 minimum balance for an ETC account. Among the three possible payment methods, cash, credit cards, and an electronic transfer of funds, the first choice was cash and the second choice was credit cards. Reasons for consumer skepticism toward the electronic funds transfer method are discussed in Appendix 3.2.

Over 70 percent of the respondents said they would like to receive a log of their bridge crossings. However, when a monthly $1.00 fee was to be charged, interest in receiving the service dropped as much as 26 percentage points, from 72 to 46 percent.

Perceived benefits of ETC include reduced traffic congestion and improved air quality at toll plazas. The respondents were concerned with the location of the tag. If tags were visible, vandalism could result. Only seven percent of the respondents showed a concern for the privacy of drivers if vehicles were traceable. The convenience of ETC was not perceived to result in an increased use of automobiles.

Ten percent of the 1,000 respondents said they carp001 or vanpool on a regular or semi-regular basis (3 or more times a week). Approximately 13 percent of the 1,000 respondents said they carp001 or vanpool less than twice a week. (Note that these respondents were not on the high occupancy vehicle (HOV) lanes at the time when they received the mail survey questionnaires.) The majority of the respondents had two or more drivers (84.7 % of 1,000) and also had two or more cars (93.2% of 1,000) per household.

Of the 1,000 respondents, 78.2 percent were employed full-time, and 3.6 percent were part-time employees, and 10.9 percent were self-employed. The median age of the

respondents was 40'and the median household income was between $40,000-50,000. The household income varied from bridge to bridge. The respondents travelling on the Golden Gate Bridge showed the highest proportion, 31 percent, of family income over $100,000. However, the respondents travelling on the Dumbarton Bridge had higher family incomes overall than other bridge respondents. The findings of surveys in other states compared to this survey are shown in Appendix 3.3.

Figure 3.2. Perception about Traffic Congestion
There will be less traffic congestion at the toll plazas once the ETC system is implemented.

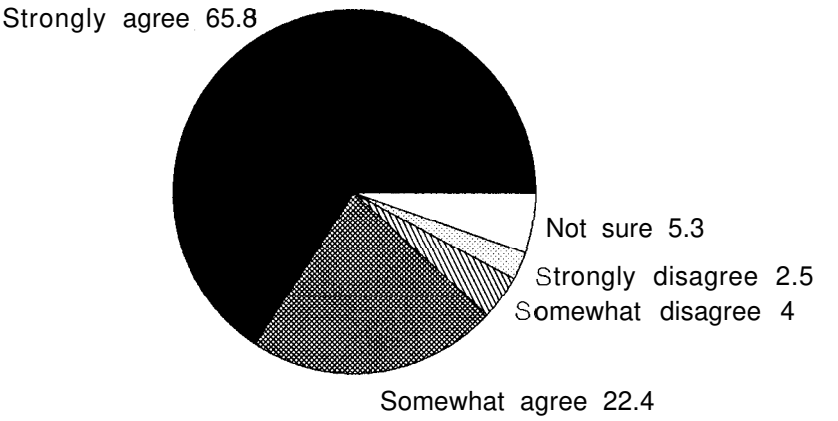


Figure 3.3. Perception about Privacy
The ETC electronic tag will allow the police to always know where your car is, and that's not good.

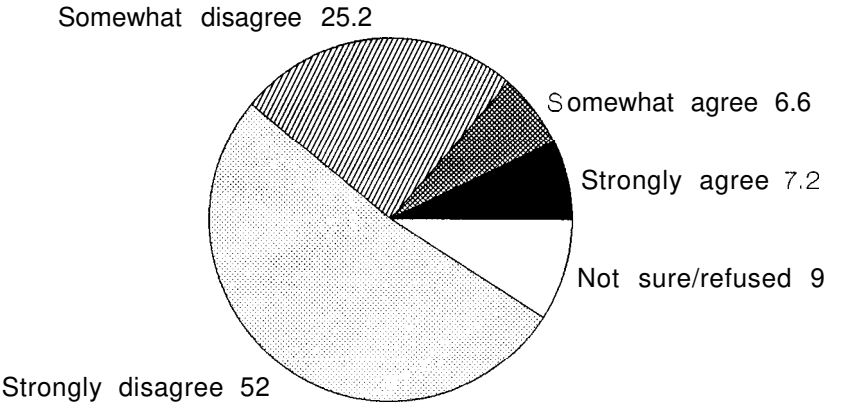
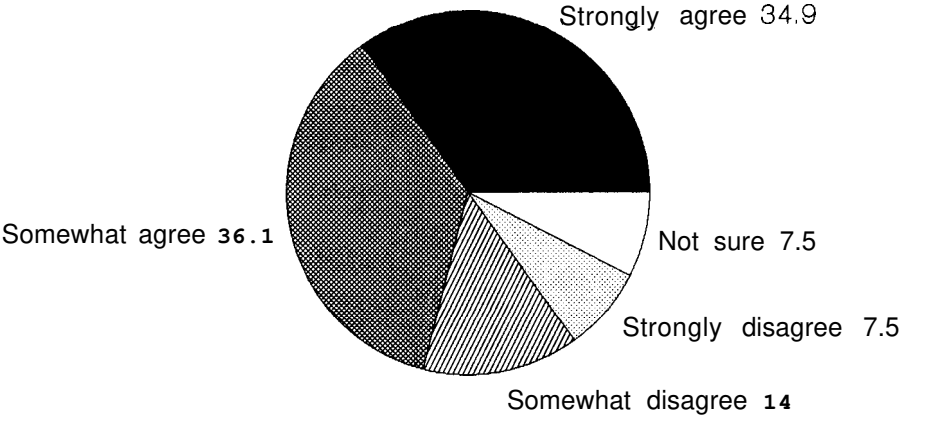


Figure 3.4. Perception about Air Quality
ETC would help improve air quality because there would be less carbon monoxide produced by vehicles decelerating and idling at the toll plazas.



Note: Values shown are percentages.

Figure 3.5.
Age Distribution

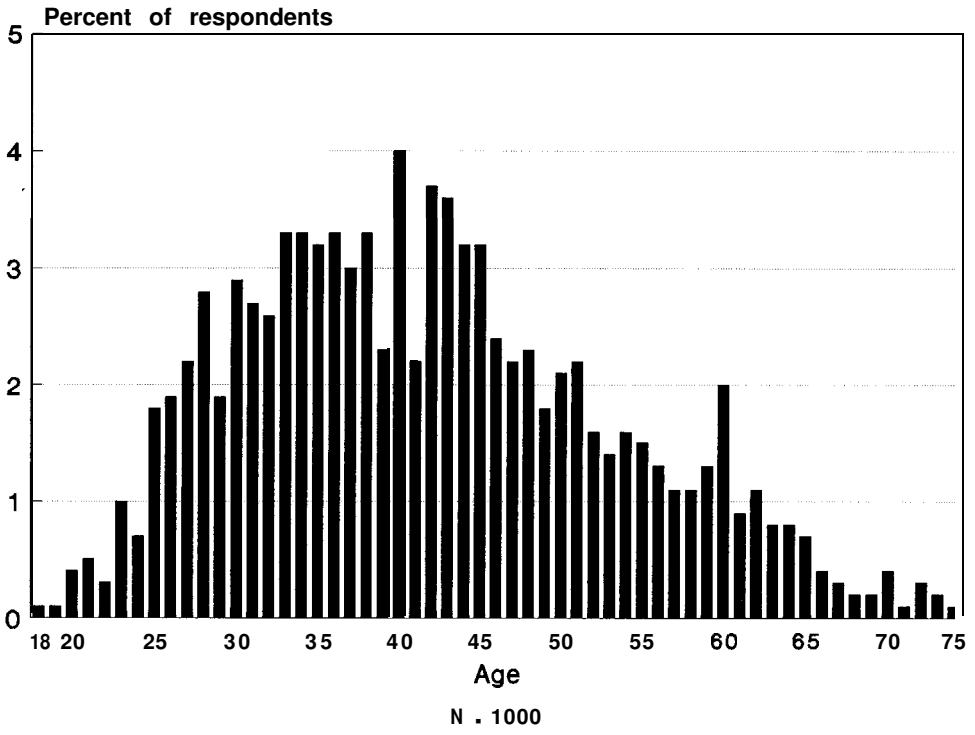


Figure 3.6.
Household Income

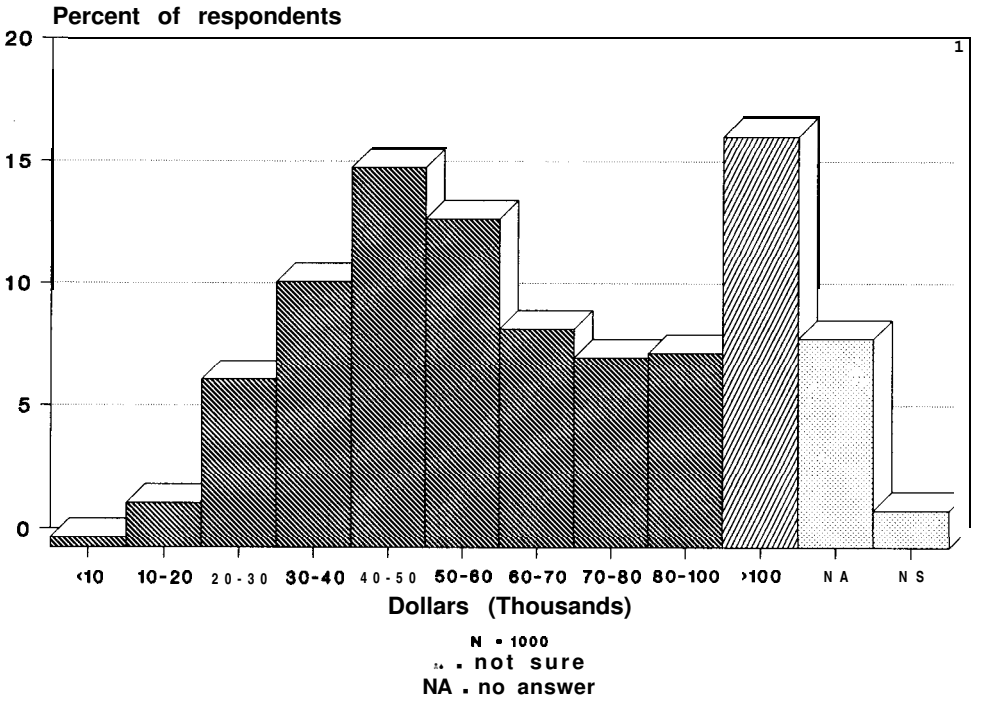


Figure 3.7.
Age of Respondents by Bridge

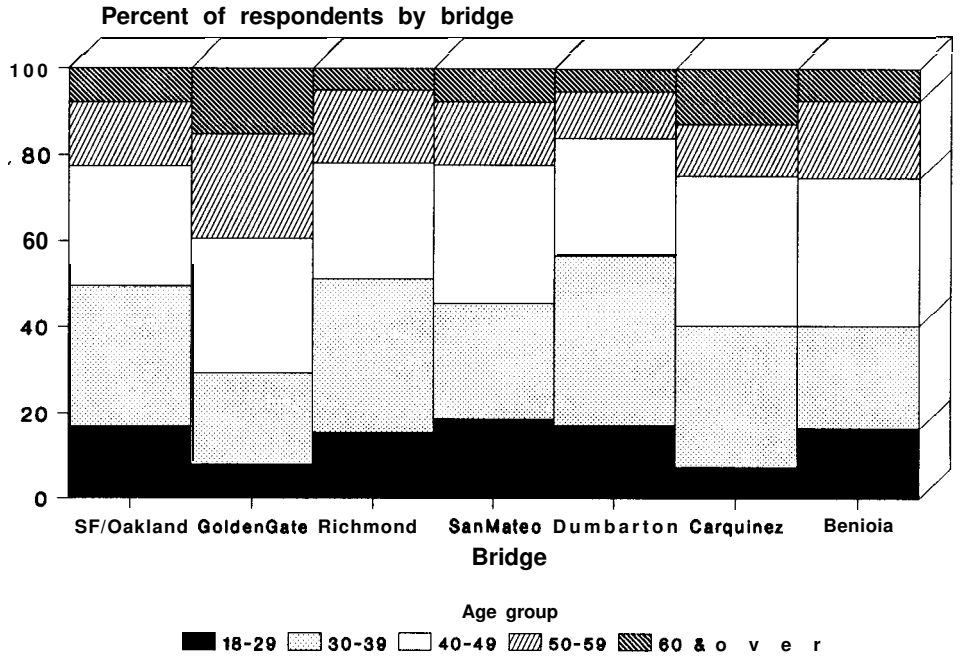


Figure 3.8.
Household Income by Bridge

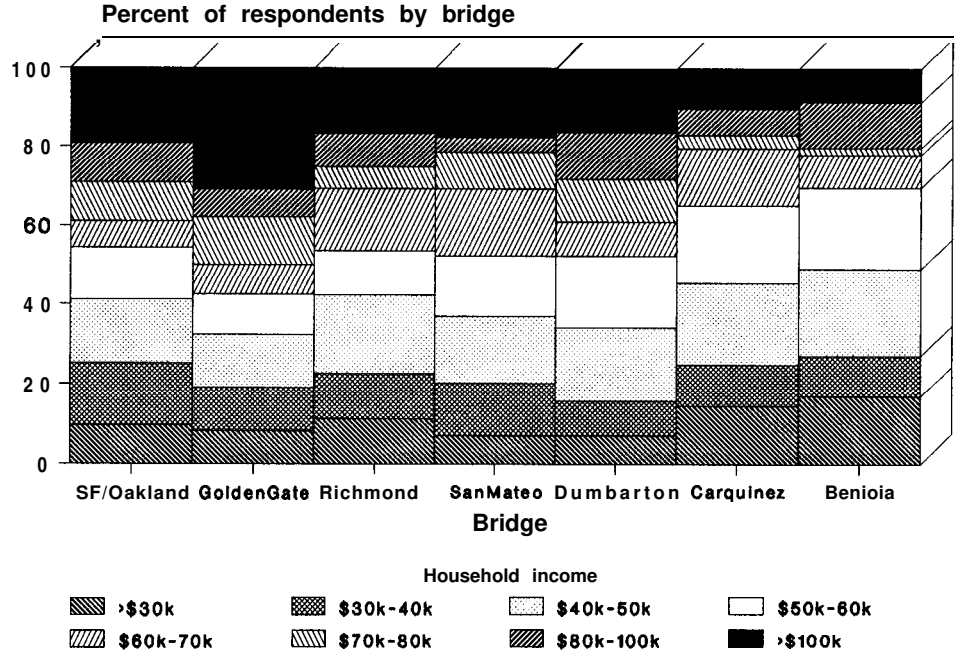


Figure 3.9.
Household Income by Payment

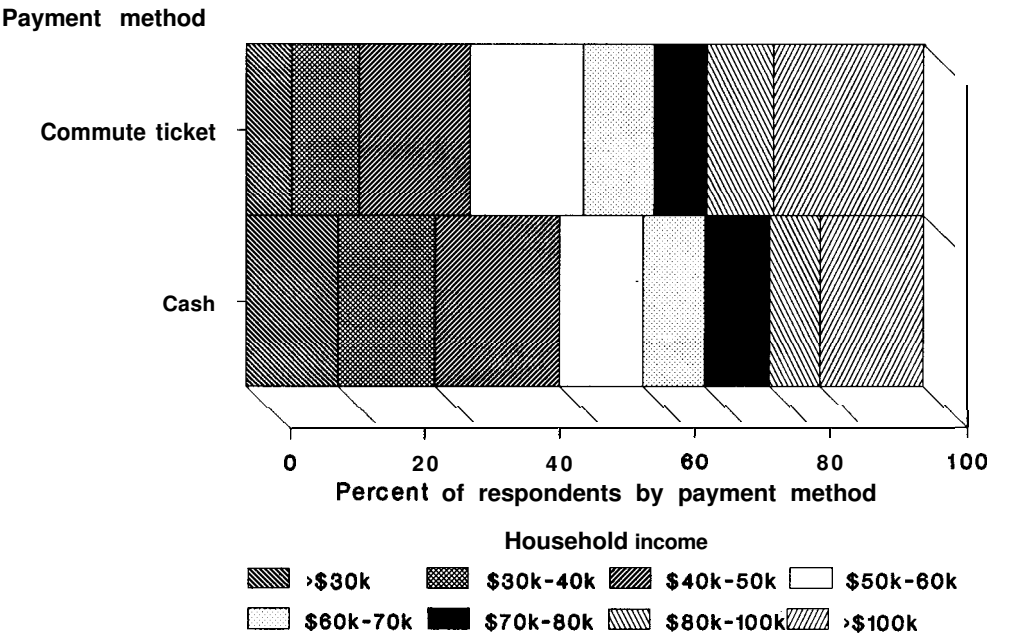
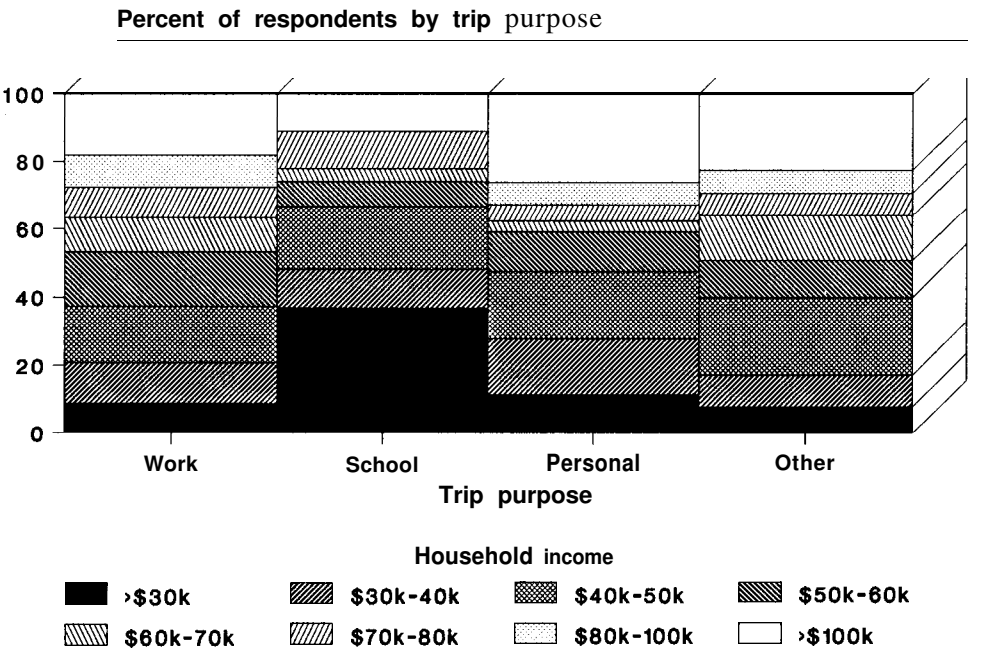


Figure 3.10.
Household Income by Trip Purpose



4. COMMERCIAL USERS TELEPHONE SURVEY

This section reports on the telephone survey of commercial users. The purpose of the survey was to determine the level of interest in subscribing to ETC among commercial users. Twenty-two questions addressed the following issues: 1) interest in subscription to ETC, 2) method of payment, and 3) tag deposit amount.

4.1. Methodology - Telephone Survey of Commercial Users

A sample of commercial users was chosen from the list of approximately 1,200 commercial users who have existing accounts with Caltrans. Telephone interviews were conducted during the first and second week of December 1990. Two hundred telephone interviews were completed. The median length of the interview was seven minutes. The survey instrument used during the interview is shown in Appendix 4-1.

Of the firms interviewed, 77.5 percent had an account of less than $1,000 per month, 20.5 percent had $l,OOO-4,999 per month, and 2 percent had $5,000 or more per month. This distribution matches exactly the account size distribution among the 1,200 Caltrans commercial accounts.

4.2. Telephone Survey Results of Commercial Users

Under the heading of each question, the responses obtained from the telephone interviews of commercial users are reported below. The following results are frequency distributions of responses and are shown in percentages.

Question 1: Do you think your company would be interested in subscribing to the ETC service? This question was designed to estimate the level of interest in ETC among commercial users.

N = 200	ETC interest
Yes	76.5%
No	14.5
Not Sure	9.0

Ouestion 2: Your company would have to permanently attach an ETC electronic sensor tag to each tractor or hauling unit using ETC in your fleet. Attaching the tag would be no more complicated than attaching a license plate. Knowing this, are you still interested in ETC? This question was asked only of those who answered “yes” or “not sure” in Question 1.

N = 171	ETC interest
Yes	90.1%
No	6.4
Not Sure	3.5

Question 3: To receive ETC tags, there would be a one-time refundable tag deposit. Knowing there could be a tag deposit, would you still be interested in ETC? This question was asked only of those who said "yes" and "not sure" in Question 2.

N= 160	ETC interest
Yes	51.3%
Depends on Cost	40.0
No	4.4
Not Sure	4.4

Question 4: Would you still be interested in ETC if you knew the one-time refundable deposit was $30? This question was asked only of those who said "yes," "depends on cost," and "not sure" in Question 3.

N = 153	Yes	No
$30 per tag	71.2%	28.8%
$15 per tag	85.0	15.0
$ 5 per tag	94.1	5.9

Question 5: The State could offer you two types of accounts: PREPAID and BILLED. With a PREPAID account, your company would be required to prepay an amount equal to your average monthly toll bridge bill. As your company's vehicles used the bridges, tolls would be automatically deducted from the balance in your account. You would replenish your account approximately once a month, or when your account reached some predetermined minimum.

If you preferred a BILLED account, your company would be required to post a bond equal to twice your average monthly toll fees. The bond would be refunded to you if your company ever left the ETC system. Your company would be billed monthly for its toll bridge usage and payment would be expected within 30 days. Which type of account would your company prefer-- a PREPAID account or a BILLED account?

N= 160	
Prepaid	23.8%
Billed	66.3
Not sure	8.8
No answer	1.3

Ouestion 6: A prepaid account could be paid in one of three ways: 1) automatic monthly electronic funds transfer from a company's bank account, 2) automatic monthly charge to a Visa or MasterCard account, or 3) a check, cash, or money order. If tolls were paid by check, cash or money order there would be a monthly service charge of $7. If they were paid by electronic funds transfer or by credit card, there would be no service charge. Which payment method do you think your company would most prefer? What would your second choice be?

N = 106	First choice	Second choice
Electronic funds	18.4%	31.6%
Visa/Master Card	7.9	21.1
Check/cash/money order	68.4	21.1
None of these	5.3	23.7
Not sure	--	2.6

Ouestion 7: A billed account could be paid in one of three ways: 1) automatic monthly electronic funds transfer from a company's bank account, 2) automatic monthly charge to a Visa or Master-Card account, or 3) a check, cash, or money order. If tolls were paid by check, cash or money order there would be a monthly service charge of $7. If they were paid by electronic funds transfer or by credit card, there would be no service charge. Which payment method do you think your company would most prefer? What would your second choice be?

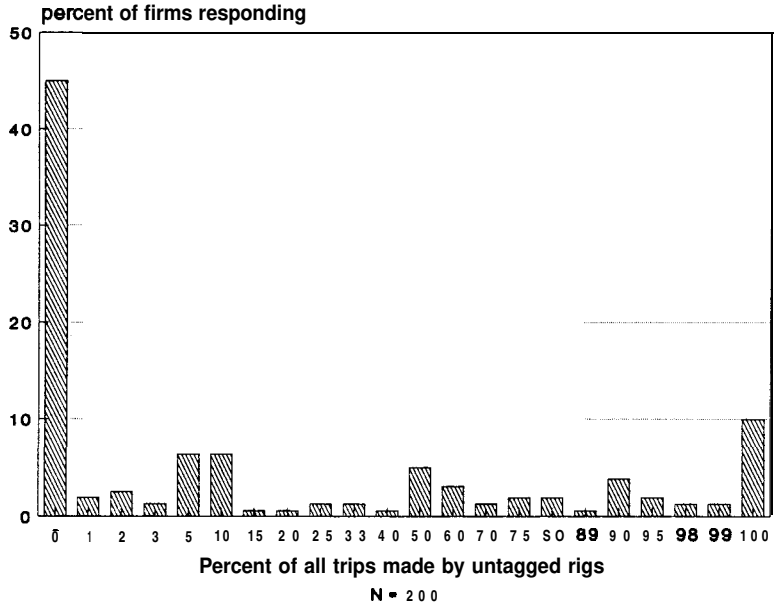
N = 106	First choice	Second choice
Electronic funds	10.4%	25.5%
Visa/Master Card	5.7	15.1
Check/cash/money order	72.6	13.2
None of these	4.7	33.0
Not sure	5.7	11.3
No answer	0.9	1.9

Question 8: Every unit in your fleet that has its own Vehicle Identification Number could have its own ETC tag. For instance, a typical tractor/trailer rig is made up of two units -- the tractor or hauling unit and the trailer. If both units had tags, then the sensors at the toll plaza could read both tags and automatically calculate the total toll charge. Since the toll collector would not have to manually enter the total axles for the rig, your drivers would get through the toll plaza faster. However, some companies frequently haul trailers which arrive from outside the Bay Area or out-of-state. These trailers probably would not have ETC tags.

Suppose you decided to use the ETC system. All your hauling or tractor units would need an AVI tag. Tags for your own trailer units would be optional, and many trailer units you haul from outside the Bay Area probably would not have tags. Think now of all the TRIPS your rigs make across Bay Area bridges. If you were using ETC, about what percentage of all TRIPS would be made by rigs which were NOT completely tagged -- that is, where the tractor or hauling unit had a tag but the trailer unit (or any other unit being hauled) did NOT have a tag?

Of the 160 respondents, 45 percent said the trailers would be completely tagged. Ten percent said trailers would not be tagged most of the times (Figure 4.1).

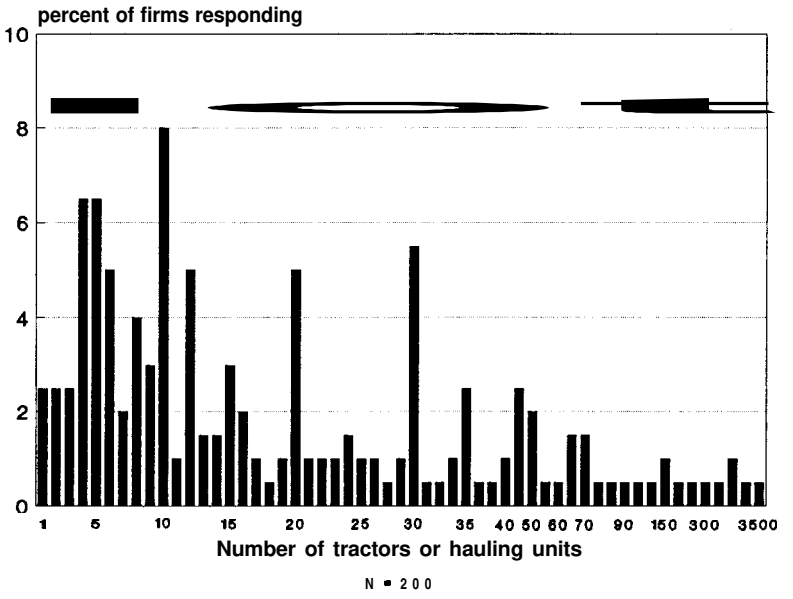
Figure 4.1. Untagged Trailers



Question 9: What is the total number of tractor or hauling units in your company's fleet?

The number of respondents or valid cases was 200. Although the frequency distribution was spread out between 1 and 3500, the median number of tractors and hauling units operated by the respondents was 10. The frequency distribution showed that companies having 4 to 6, 10, 12, 20, and 30 trailers were the most common (Figure 4.2).

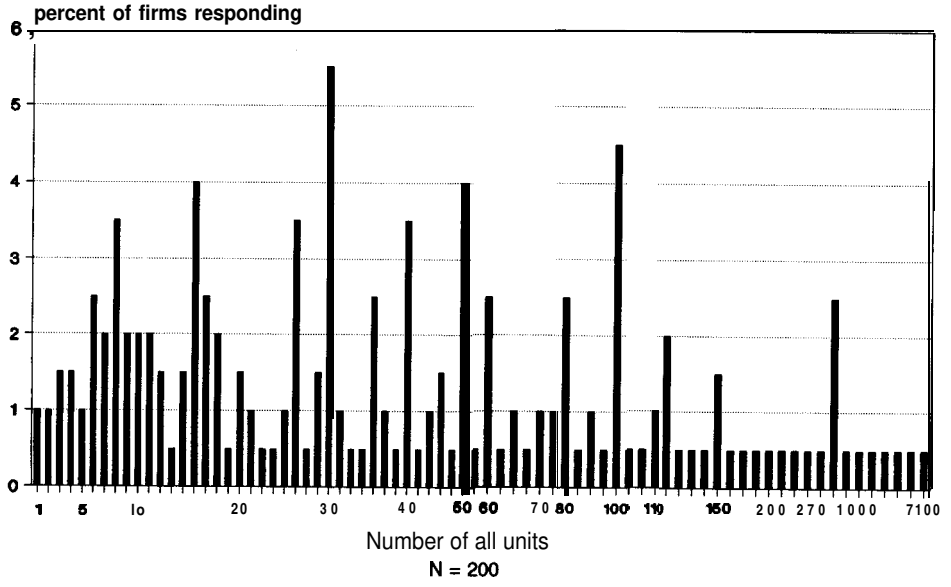
Figure 4.2. Distribution of Size of Trucking Firms



Question 10: What was the total number of all units in your company's fleet including any unit that has its own Vehicle Identification Number?

There were 200 valid cases. The frequency distribution of all units operated by the respondents was also fairly spread out. However, the median number of all units operated by the respondents was 30 (Figures 4.3).

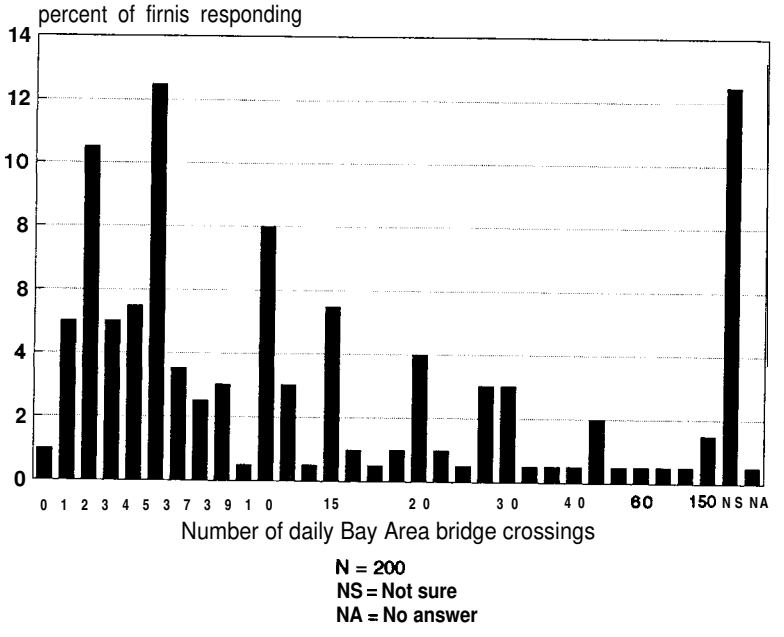
Figure 4.3. Number of All Units in Company's Fleet



Question 11: What is the approximate number of daily Bay Area bridge crossings by your company's vehicles?

The median number was five crossings a day. There was, however, a cluster of frequent crossings between twice a day and five times a day. Approximately 12.5 percent of the respondents said they were "not sure" (Figure 4.4).

Figure 4.4. Bridge Crossings



Question 12: Which of the following methods (state charge card, cash, or scrip) do your drivers currently use to pay tolls?

Payment method	**Yes**	**No**
State charge card	**96.5%**	3.5%
Cash	19.5	80.5
Scrip	6.5	93.5

4.3. Conclusions - Telephone Survey of Commercial Users

Those commercial users who were interviewed responded positively to ETC. Of the respondents, 76.5 percent said they would be interested in ETC. However, the survey suggested that commercial users were more price sensitive to the operating cost of ETC than motorists. With a tag deposit of $30, interest dropped 22 percent to 54.5 percent. If the tag deposit price were decreased to $15, there would be an increase of 10.5 percent, from 54.5 percent to 65 percent. If the cost of the deposit were decreased from $30 to $5, there would be an increase of 17.5 percentage points in interest, from 54.5 percent to 7 1.5 percent.

Between the prepaid and billed accounting method, the respondents preferred the billed. Among the three ways of payment, cash, credit cards, and electronic funds transfer, cash was the most preferred method.

The frequency distribution of the number of tractors or hauling units owned by the respondents was fairly spread out between 1 and 3,500. However, the median number of all tractors or hauling units was 10. The frequency distribution of the number of all units, including any unit with a Vehicle Identification Number, owned by the respondents was also spread out between 1 and 7,500, but the median number of all units was 30.

Over 40 percent of the respondents made bridge crossings between twice a day and 5 times a day. One quarter of the respondents did not know how many crossings they made per day. Of the 160 respondents, only 45 percent of the respondents said their trailers would be completely tagged. Income percentages of commercial users compared to non-commercial users are shown in Appendix 4.2.

5. SUMMARY AND CONCLUSIONS

Caltrans and the Golden Gate Bridge, Highway, and Transportation District are considering an electronic toll collection system for the Bay Area toll bridges. The objective of the study was to determine the level of interest among Bay Area motorists in subscribing to an electronic toll collection service. To gauge public opinion, the study utilized various survey techniques including mail-back questionnaires, telephone interviews, and focus group meetings. The questionnaires consisted mainly of self-contained questions.

The study was divided into three parts: 1) a mail-back survey of motorists, 2) a telephone survey of the ETC interested mail survey respondents, and 3) a telephone survey of commercial users. Seven of the eight Bay Area bridges were surveyed including San Francisco/Oakland, Richmond/San Rafael, San Mateo/Hayward, Dumbarton, Carquinez, and Benicia/Martinez. Antioch Bridge was not included in the survey because the daily traffic volume was low.

a) Mail survey of motorists:

In October 1990, 30,000 survey forms were distributed at toll gates proportional to the annual average daily traffic volume. Of the 30,000 survey forms distributed, approximately 6,000 surveys, or 20 percent, were returned by the end of December. However, 5,095 forms were analyzed. Forms received after November 2 were not processed.

The mail survey suggested that over 80 percent of the toll bridge patrons would be interested in subscribing to ETC. The number of potential patrons of ETC on the eight Bay Area bridges is estimated to be approximately 290,000, with transferable tags. This figure is based on the recent annual average traffic transactions on these bridges.

The mail survey also suggested that people would prefer transferable AVI tags, placed inside the windshield, to permanently affixed tags. As expected, cross tabulation analyses of the mail survey showed that commute tickets were used more frequently by the respondents using bridges on a regular basis than the respondents using bridges once or twice a week.

b) Telephone survey of motorists:

In December 1990, a telephone survey of motorists was conducted as a follow-up to the mail survey. A random sampling of motorists was selected from a pool of mail survey respondents who expressed interest in the electronic toll collection service. One thousand telephone interviews were completed and over 90 percent responded. Of the

1,000 respondents, ‘69.4 percent were male and 30.6 percent were female.

For safety, enforcement, and technical reasons, tags may need to be permanently affixed. The telephone survey suggested that if tags were permanently affixed, interest in ETC would drop by 12 percent from the initial 82.4 percent shown in the mail survey to 70 percent.

For placement of permanently affixed tags, the location most preferable was the underside of the car. The second most preferable location was the license plate and the least preferred was the outside of the windshield. Among the concerns were vandalism and aesthetics of transponders if visible. The telephone survey results showed that imposing a tag deposit of $30 would not be a major deterrent to subscribing to an ETC service.

To use ETC it would be necessary to open an account with the toll agency. Over 90 percent of the telephone survey respondents said a minimum amount of $40 would be acceptable. Reducing the minimum amount to $20 would increase interest in ETC by another 5 percent. However, if earnings from the “float” were an important ETC cost recovery consideration, the revenue loss by changing the minimum amount to $20 from $40 would far outweigh the increased interest in ETC.

Of the telephone survey respondents, cash was clearly the first choice as a method of payment. The second choice was payment by credit card. The least desired was the electronic transfer of funds from bank accounts.

A log of bridge crossings was seen as helpful for accounting purposes. Over 70 percent of the respondents said that they would be interested in receiving such a log. But if a $1.00 monthly fee were charged for the service, there was a substantial drop in interest, from 72 percent to 46 percent.

ETC was perceived as beneficial in at least two ways: nearly 90 percent of the telephone survey respondents believed that there would be less traffic congestion at toll plazas and consequently there would be an improvement of air quality if ETC were implemented. Of the telephone survey respondents, over 75 percent believed that vandalism would be a problem if the electronic tags could be seen. Conversely only 7 percent of the respondents showed a strong concern that electronic tags would permit the police to track or trace their vehicles. The telephone respondents generally disagreed with the idea that ETC might encourage people to use their cars more often because of the bridges being easier to cross.

If commuter discounts were not offered with ETC, only one half of the telephone respondents would still be interested in subscribing. This low rate of response in favor of ETC may have been due to the respondents thinking that commute ticket discounts would be continued even if ETC were implemented. The respondents travelling on the

San Francisco/Oakland Bridge were slightly more receptive to ETC without the commuter discounts than were the respondents on the Golden Gate, Carquinez, and Benicia bridges. One reason for this difference could be that the commuter discount for these bridges was more than for other Bay Area toll bridges. The Golden Gate Bridge discount rate was 16.7 percent for a $2 toll charge, and the discount rate on the Carquinez and Benicia Bridges was 25 percent for a $1 toll, whereas other bridges were 15 percent for a $1 toll charge. There was also a higher proportion of commute ticket users on these bridges than on other bridges.

Two separate agencies, Caltrans and the Golden Gate Bridge, Highway, and Transportation District, are responsible for toll operations. If people want to use the Golden Gate Bridge as well as other bridges, they may need to open two separate ETC accounts. Nearly 70 percent of the telephone respondents said they would not be interested in having two ETC accounts. About one half of the Golden Gate bridge respondents said they used other toll bridges at least once a month while only 15 percent of the state bridge respondents said they used the Golden Gate Bridge once a month or more.

The majority (59.9%) of the telephone respondents were in the age group between 30-49. The San Francisco/Oakland, Richmond, Dumbarton, and Carquinez bridges showed a higher proportion of respondents among this age group. The telephone survey respondents were in the upper middle or high income group, with a family income of over $30,000 a year, and with two or more cars in the family. The telephone respondents travelling on the Golden Gate and Dumbarton bridges showed proportionally higher income than any other bridge. On the Golden Gate Bridge, over 30 percent of the sample population had an income of more than $100,000 last year. On the Dumbarton Bridge, nearly 25 percent of the respondents had an income between $70,000-100,000.

c) Telephone survey of commercial users:

In December 1990, 200 telephone interviews were completed with the owners or managers of commercial firms. A random sampling of commercial users was selected from approximately 1,200 firms having accounts with Caltrans. The purpose of the survey was to estimate the level of interest in ETC among the current commercial patrons. The response rate of the commercial users was similar to that of the motorist telephone survey.

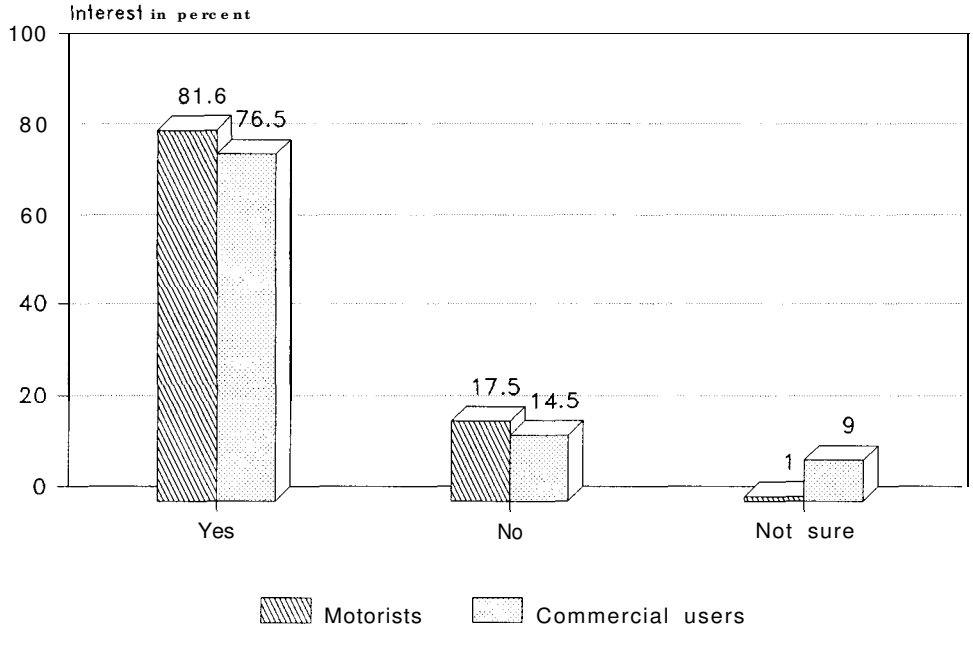
Over 75 percent of the firms participating in the survey had an account size of less than $1,000 a month. Twenty percent of the firms interviewed had accounts between $1,000 and $5,000 and only 2 percent had accounts of $5,000 or more. The sample distribution was proportional to the actual distribution among all commercial accounts with Caltrans.

More than 75 percent of the firms surveyed indicated that they were interested in subscribing to ETC. Their interest in ETC was not dependent on the tag type. When the respondents were asked about the permanently affixed tags, interest remained the same. ETC subscription interest between respondents among motorists and among commercial users is shown in Figure 5.1.

The survey showed that the commercial users' interest in ETC was highly price-sensitive. If the cost of the tag deposit were $30, only 54.5 percent said they would be interested in ETC. If the tag deposit price were decreased to $15, there would be an increase of 10.5 percent (to 65 percent). If the tag deposit were reduced to $5, there would be an increase of 17.5 percent (to 72 percent). Therefore, it is highly desirable to keep the cost of the tag as low as possible if commercial users are to be attracted to ETC. Among the commercial respondents, billed accounts were preferred to prepaid accounts, 66.3 percent to 23.8 percent. The preferred payment method for either prepaid or billed accounts was with cash. The second choice was by an electronic transfer of funds. The survey showed that there is a probability that over 50 percent of trailers would not be tagged. This could be a potential problem for ETC operation.

Figure 5.1. ETC Subscription Interest

Motorists vs Commercial Users



Appendices

Appendix l-l. Commercial Users - Sampling Error Calculation

Sampling error calculation for commercial users telephone survey:

$$d = \sqrt{\frac{N-n}{Nn}\ (z^2_{pq})}$$

$$d = .0632587$$

d = sampling error
z = z-score for 95% confidence level (1.96)
p = assumed population proportion (.5)
q = l-p (.5)
n = sample size (200)
N = population size (1,200)

Appendix 2-1
Mail Survey Questionnaire

Electronic Toll Collection Survey

Caltrans and the Golden Gate Bridge Highway and Transportation District are considering an Electronic Toll Collection (ETC) service for toll bridges in the Bay Area. To evaluate interest in this service among Bay Area motorists, we are conducting this survey of toll bridge users.

To use ETC, you would open an account with the toll bridge agency and obtain an electronic device, called a "tag," for your vehicle. Every time you pass through a toll plaza, sensors would read the tag and the toll would automatically be recorded in your account. By using ETC you would be able to pass through the toll plaza without stopping at a toll booth. Motorists would still be able to pay by cash or commute ticket if necessary.

1. Would you be interested in subscribing to an electronic toll collection (ETC) service like the one described above? (please check only one.)

   1-☐ Yes (please continue with Question 2)
   2-☐ No (please skip to Question 4) (6)

2. The ETC "tag" could be permanently affixed to your car or it could be transferable from car to car. Which would you prefer? (please check only one.)

   1-☐ Permanently affixed 2-☐ Transferable (7)

3. The ETC "tag" will be flat and about the size of a candy bar. Where would you be most willing to mount the tag on your vehicle? (please check only one.1

   1-☐ On your license plate (permanent)
   2-☐ On the underbody of your vehicle (permanent)
   3-☐ Outside your car on the windshield (permanent)
   4-☐ Inside your car on the windshield (transferable) (8)

PLEASE ANSWER THE FOLLOWING QUESTIONS FOR THE BRIDGE YOU WERE CROSSING WHEN YOU RECEIVED THIS QUESTIONNAIRE.

4. How do you usually pay your toll? (please check only one.)

   1-☐ Commute ticket 2-☐ Cash 3-☐ Other (9)

5. About how often do you pass through the toll plaza of this bridge? (please check only one.1

   1-☐ 5 or more times a week 3-☐ 1-2 times a week
   2-☐ 3-4 times a week 4-☐ Less than once a week (10)

6. What is the primary purpose of your trip today? (please check only one.)

   1-☐ From or to work 5-☐ Social/ recreation/ vacation
   2-☐ School/ college 6-☐ Shopping trip
   3-☐ Personal business 7-☐ Other
   4-☐ Medical/ dental visit (11)

We would like to contact some of you soon to ask a few more questions about the Electronic Toll Collection service. By participating in this follow-up survey, you will help us decide the best way of providing this service. Please supply the telephone contact information requested on the other side of this form. YOUR HELP IS GREATLY APPRECIATED.

Appendix 2-2. Method of Weighting Survey Results

To estimate the frequency distribution of all user populations for each question, the sample responses were weighted by the actual traffic flow and payment method used at each bridge. The survey results were weighted in two steps: the first step was to weight the results based on traffic data and the second was to weight these results according to the payment method. The data used in this study were the 1990 data furnished by Caltrans and the Golden Gate Bridge, Highway, and Transportation and Highway District.

The weighted frequency distributions for the overall results on each question based on average daily traffic volume were obtained by the following:

$$w_{1a} = (\frac{v_a}{V})/(\frac{n_{1a}}{N_1})$$

$$r_{1a} = w_{1a}(n_{1a}) \qquad \text{for each answer to Question 1, etc.}$$

$$R_{1a} = \sum_{i=1}^{7} r_{1i} \qquad \text{for each answer to Question 1, etc.}$$

w_{1a} = weighing factor for Question 1 at Bridge "a"
v_a = annual average daily traffic volume on Bridge "a"
V = total annual average daily traffic volume on all bridges
n_{1a} = number of sample respondents to Question 1 at Bridge "a"
N_1 = total number of sample respondents to Question 1 at all bridges
r_{1a} = weighted number of responses to Question 1 at Bridge "a"
R_{1a} = total weighted number of responses to Question 1 at all bridges
i = number of bridges surveyed

TRAFFIC TRANSACTIONS, SAMPLE POPULATION AND RESPONSES

ANNUAL AVERAGE TRAFFIC TRANSACTIONS

Bridge	Hours	Counts	Samples	Response	Resp/Dist	Resp/Vol
SanFran/Oakland	24hours	118400	9500	1579	0.166	0.013
Golden Gate	24hours	61850	5000	933	0.188	0.015
Richmond/SanRafael	24hours	25400	2000	382	0.191	0.015
SanMateo/Hayward	24hours	37400	3000	449	0.150	0.012
Dumbarton	24hours	29350	2500	730	0.292	0.025
Carquinez	24hours	53200	4500	670	0.149	0.013
Benicia/Martinez	24hours	43600	3500	347	0.099	0.008

AM PEAK HOURS

Bridge	Hours	Counts	Samples	Response	Resp/Dist	
SanFran/Oakland	6AM- 9AM	23300	1900	339	0.178	0.015
Golden Gate	6AM-10AM	22300	1800	402	0.223	0.018
Richmond/SanRafael	6AM-9AM*	3810	300	37	0.123	0.010
SanMateo/Hayward	6AM- 9AM	8100	700	99	0.141	0.012
Dumbarton	6AM- 9AM	11350	1000	312	0.312	0.027
Carquinez	6AM-9AM*	5910	500	90	0.180	0.015
Benicia/Martinez	6AM-9AM*	4980	400	45	0.113	0.009

PM PEAK HOURS

Bridge	Hours	Counts	Samples	Response	Resp/Dist	
SanFran/Oakland	4PM-6PM*	12460	1000	139	0.139	0.011
Golden Gate	4PM-6PM*	7000	600	83	0.138	0.012
Richmond/SanRafael	3PM-6PM	6100	500	89	0.178	0.015
SanMateo/Hayward	4PM-6PM*	3740	300	33	0.110	0.009
Dumbarton	4PM-6PM*	2350	200	33	0.165	0.014
Carquinez	3PM-6PM	14500	1300	222	0.171	0.015
Benicia/Martinez	3PM-6PM	10100	800	85	0.106	0.008

OFF-PEAK HOURS

Bridge	Hours	counts	Samples	Response	Resp/Dist	
SanFran/Oakland	9AM-4PM	82640	6600	1101	0.167	0.013
Golden Gate	10AM-4PM	32550	2600	453	0.174	0.014
Richmond/SanRafael	9AM-3PM	15490	1200	256	0.213	0.017
SanMateo/Hayward	9AM-4PM	25560	2000	317	0.159	0.012
Dumbarton	9AM-4PM	15650	1300	385	0.296	0.025
Carquinez	9AM-3PM	32790	2700	358	0.133	0.011
Benicia/Martinez	9AM-3PM	28520	2300	217	0.094	0.008

Appendix 2-3
Cross Tabulation
Mail Survey of Motorists

Appendix 2-3. Cross Tabulation - Mail Survey of Motorists

In addition to the results discussed in Section 2.5, the following relationships. showed statistical significance.

1) Question 4, payment method, by ETC interest: of all those respondents who said "yes" in Question 1 (interest in subscriptions to ETC), what proportion were commute ticket users and what proportion were cash users?

by ETC interest	N	Commute ticket	Cash	Other
Yes	4,296	52.6%	46.9%	0.5%
No	687	29.5	69.7	0.7

2) Question 5, trip frequency, by ETC interest: of those respondents who said they were interested in ETC, how many were frequent bridge users and how many were infrequent bridge users?

by ETC interest	N	>5 times a week	3-4 times a week	l-2 times a week	< once a week
Yes	4,331	63.0%	17.4%	12.2%	7.4%
No	695	31.5	9.9	19.1	39.4

3) Question 6, trip purpose, by ETC interest: of all those respondents who said "yes" in Question 1 (interest in subscription to ETC), what was the proportional distribution among trip purposes?

by payment	N	Work	School	Personal	Medical	Social	Shop	Other
Yes	4,275	80.6%	2.1%	6.8%	1.7%	2.7%	0.5%	5.6%
No	679	48.6	2.5	12.7	6.3	14.4	2.4	13.1

4) Question 6, trip purpose, by payment: of all those respondents using commute tickets, what was the proportional distribution among trip purposes?

by payment	N	Work	School	Personal	Medical	Social	Shop	Other
Commute ticket	2,446	90.9%	1.8%	2.6%	1.1%	1.0%	0.4%	2.3%
Cash	2,463	61.6	2.7	12.6	3.6	7.6	1.1	10.8
Other	29	65.5	--	--	3.4	3.4	--	27.6

Appendix 3-l
Telephone Survey Instrument for Motorists

Appendix 3-1. Telephone Survey Instrument for Motorists

GLS RESEARCH — CALTRANS/GOLDEN GATE BRIDGE DISTRICT "ETC" MOTORISTS SURVEY — PROJECT #90513

FINAL QUESTIONNAIRE — DECEMBER 1990

Card #1 (1)

Respondent ID# _ _ _ _ (2-5)

Time Started _____

Time Ended _____

interview Length _ _ (6-7)

Interviewer _____

Date _____

Page # _____

GENDER (BY OBSERVATION)

MALE 1 (8)

FEMALE 2

INTERVIEWER: RECORD THE FOLLOWING ITEMS FROM THE INFORMATION YOU WILL FIND ON THE SAMPLE.

"BRG" [BRIDGE] (CIRCLE NUMBER)

1 2 3 4 5 6 7 (9)

"FRQ" [FREQUENCY] (CIRCLE NUMBER)

1 2 3 4 (10)

"PAY" [PAYMENT METHOD] (CIRCLE NUMBER)

1 2 3 (11)

"PUR" [PURPOSE] (CIRCLE NUMBER)

1 2 3 4 5 6 7 (12)

Hello. My name is _____, and I'm calling on behalf of Caltrans and the Golden Gate Bridge District. A few weeks ago you filled out a brief survey about Electronic Toll Collection, also known as E-T-C. It was the survey you were given when you were waiting to pay your toll at one of the Bay Area's toll bridges. When you filled out the survey, you indicated that we could call you back and ask you a few more questions about the E-T-C system. May I have a few moments of your time now? Our survey is very short, and all your answers will be kept strictly confidential. (IF RESPONDENT IS UNABLE TO COMPLETE THE SURVEY IMMEDIATELY BUT WILLING TO DO SO LATER, SCHEDULE A TIME FOR A CALLBACK.)

As you may recall, E-T-C is an automatic bridge toll payment system. To use E-T-C, you would open an account with the toll agency and obtain an electronic device, called a "tag," for your vehicle. Then every time you passed through a toll plaza, sensors would read the "tag" and the toll would be automatically deducted from the balance in your account.

1. When you completed our first survey, you said you would be interested in subscribing to the E-T-C service? Are you still interested in E-T-C?

YES	CONTINUE
NO	TERMINATE

2. As you may remember from our first survey, we told you that the E-T-C "tag" could be permanently affixed to your car *OR* it could be moveable from car to car.

However -- safety, enforcement, and technical reasons may make it necessary to permanently affix the E-T-C "tag" to your car. If the "tag" had to be permanently affixed to your car and could not be moveable, would you still be interested in E-T-C?

YES	1 SKIP TO Q5
NO	2
DEPENDS (VOL.) ...	3 ASK Q3
NOT SURE/DK	8 (13)
REFUSED/NA	9

3. The E-T-C "tag" would be permanently affixed either to your Front license plate or to the underside of your car, behind the Front bumper. Knowing that, do you think you would be interested in E-T-C?

YES..... 1 ASK Q4
NO..... 2
DEPENDS (VOL.).... 3 SKIP TO Q6
NOT SURE/OK..... 8 (14)
REFUSED/NA..... 9

4. (ASK ONLY IF "YES" IN Q3.) Which "tag" location would you prefer -- on your Front license plate or the underside of your car, behind the Front bumper?

LICENSE PLATE..... 1
UNDERSIDE OF CAR.. 2 (15)
NOT SURE/OK..... 8
REFUSED/NA..... 9

SKIP TO Q6

5. (ASK ONLY IF "YES" IN Q2.) The E-T-C "tag" could be permanently affixed either to your front license plate or to the underside of your car, behind the front bumper. Which location would you prefer?

LICENSE PLATE.'.... 1
UNDERSIDE OF CAR.. 2 (15)
NOT SURE/OK..... 8
REFUSED/NA..... 9

KEYPUNCHER:
PLEASE NOTE THAT Q4 & Q5 ARE BOTH PUNCHED IN COLUMN 15.

6. In order to receive your E-T-C electronic "tag," you would be required to give the toll agency a one-time, refundable deposit. The deposit would be refunded to you at any time you quit using E-T-C and returned the "tag" to the toll agency.

Knowing there would be a "tag" deposit, would you still be interested in E-T-C?

YES ..... 1 ASK Q7
DEPENDS ON COST .. 2
NO 3 (16)
NOT SURE/DK ..... E1 SKIP TO Q8
REFUSED/NA 9

7. Would you still be interested in E-T-C if you knew the one-time refundable deposit was... (ASK EACH DOLLAR AMOUNT UNTIL RESPONOENT SAYS "YES" OR UNTIL ALL THRCE DOLLAR AMOUNTS HAVE BEEN ASKED.)

	YES	NO	
$30.00	1	2	(17)
$15.00	1	2	(18)
$ 5.00	1	2	(19)

8. As I mentioned earlier, in order to use E-T-C, you would need to open an account with the toll agency. The minimum amount necessary to open an account may be as much as $40.00. Knowing that, would you still be interested in E-T-C?

YES ..... 1 SKIP TO Q10
NO 2 (20) 1
NOT SURE/DK ... 8 ASK Q9
REFUSED/NA 9

9. What minimum amount would you be willing to spend to open an E-T-C account with the toll agency? (IF DOLLARS AND CENTS, ROUND TO NEXT HIGHEST DOLLAR AMOUNT. AMOUNT *MUST BE LESS THAN $40.)*

$ __ __ (21-22)

NOTHING = 00
NOT SURE/DK = 98
REFUSED/NA = 99

10. As I mentioned, you would open an E-T-C account with an initial payment. Every time you passed through the toll plaza, your toll would be deducted from your account.

You would replenish your account by making payments directly to the toll agency and NOT to the toll collector at the toll plaza. The toll agencies are thinking of accepting three possible forms of payment: *a major credit card, electronic transfer of funds from your bank* account, or a *check, cash, or money order.* Which form of payment would you *most* prefer? (PROBE:) What would your second choice be? (REPEAT FIRST THREE ITEMS BELOW IF RESPONDENT ASKS.)

	FIRST CHOICE	SECOND CHOICE
Major credit card.....	1	1
Electronic funds transfer....	2	2
Check, cash, or money order....	3(23)	3 (24)
NONE OF THESE (VOLUNTEERED).....	4	4
NOT SURE/DK.....	8	8
REFUSED/NA.....	9	9

11. Some people have suggested that the toll agency should provide E-T-C users with a log of their bridge crossings. The log could be used for income tax or other personal business purposes. If you decided to use the E-T-C system, would you be interested in receiving a log of your bridge crossings?

YES	1 ASK 912
NO	2 (25)
NOT SURE/DK...	8 SKIP TO Q13
REFUSED/NA	9

12. A log of your bridge crossings could be provided every time you replenish your E-T-C account, at the cost of $1.00 per log. Would you be willing to pay $1.00 for such a log?

YES	1
NO	2
NOT SURE/OK	8(26)
REFUSED/NA	9

13. I'm going to read you some statements people have made about the E-T-C system, and I'd like YOU to tell me if you agree or disagree with each. Is that [agree/disagree] strongly or somewhat?

START:

	STRONGLY AGREE	SOMEWHAT AGREE	SOMEWHAT DISAGREE	STRONGLY DISAGREE	NS/DK	REF/NA	
[I a. There will be less traffic congestion at the toll plazas once the E-T-C system is implemented.	1	2	3	4	a	9	(27)
[1 b. If the electronic "tag" is affixed to your car where anyone can see it, people will try to steal it.	1	2	3	4	a	9	(28)
[1 c. The E-T-C electronic "tag" will allow the police to always know where your car is, and that's not good.	1	2	3	4	a	9	(29)
[1 d. E-T-C would help improve air quality because there would be less carbon monoxide produced by vehicles decelerating and idling.	1	2	3	4	a	9	(30)
[1 e. E-T-C might encourage people to use their cars more because it would be easier to cross the bridges, and that's not good.	1	2	3	4	a	9	(31)

14. Now that you've heard a little more about E-T-C, do you think you would be interested in subscribing to the E-T-C service?

YES..... 1 ASK Q15

NO..... 2 (32)

NOT SURE/DK.... 8 SKIP TO Q16

REFUSED/NA..... 9

15. (ASK ONLY OF THOSE WHO SAID "YES" IN Q14)
Currently, people who buy a monthly commuter ticket receive a small discount on toll charges. Would you still be interested in E-T-C if you knew it would NOT include this commuter discount on toll charges?

YES..... 1

NO.. ..... 2 (33)

NOT SURE/DK.... a

REFUSED/NA..... 9

SKIP TO Q17

16. (ASK ONLY OF THOSE WHO SAID "NO," "NOT SURE/DK," OR "REFUSED/NA" IN Q14)
Currently, people who buy a monthly commuter ticket receive a small discount on toll charges. Do you think you would be interested in subscribing to the E-T-C service if you knew you would receive the commuter discount on toll charges?

YES 1

NO 2 (34)

NOT SURE/DK 8

REFUSED/NA 9

17. Which of the Bay Area's toll bridges do you use *most* often. (ACCEPT ONLY *ONE* RESPONSE.)

GOLDEN GATE.....	1 ASK Q18
SAN FRANCISCO/ OAKLANO BAY....	2
CARQUINEZ.....	3
BENICIA- MARTINEZ.....	4 (35)
RICHMOND SAN KAFAEL.....	5 SKIP TO Q19
SAN MATEO- HAYWARD.....	6
DUMBARTON.....	7
ANTIOCH.....	8
REFUSED/NA.....	9 SKIP TO Q21

18. (ASK ONLY OF THOSE WHO SAID "GOLDEN GATE" IN 417.) 00 you use any of the other Bay Area toll bridges more than once a month?

YES.....	! ASK Q20
NO.....	*2* (36)
NOT SURE/OK....	8 SKIP TO Q21
REFUSED/NA.....	9

19. (ASK ONLY OF THOSE WHO GAVE RESPONSES 2-8 IN Q17.) Do you use the Golden Gate Bridge more than once a month?

YES	1 ASK 420
NO	2 (37)
NOT SURE/DK ...	8 SKIP TO Q21
REFUSED/NA	9

20. One E-T-C "tag" could be used on any of the Bay Area's eight toll bridges. However, the Golden Gate Bridge and the seven other Bay Area toll bridges are run by two separate agencies. Therefore,, you would need to open two separate E-T-C accounts if you wanted to use E-T-C on the Golden Gate Bridge as well as on the seven other Bay Area toll bridges. Would you be interested in opening two E-T-C accounts -- one for the Golden Gate Bridge and one for the 7 other Bay Area toll bridges?

YES	1
NO	2 (38)
NOT SURE/DK	8
REFUSED/NA	9

* * * * * * * * * * * * * * *

Now I'd like to ask you some questions just for classification purposes. As I mentioned before, all your answers will be kept strictly confidential.

21. Thinking of the toll bridge you use most often, do you ever "carpool" or "vanpool" when crossing the bridge?

YES.....	1 ASK Q22
NO.....	2 (39)
NOT SURE/DK....	8 SKIP TO Q23
REFUSED/NA....	9

(RECORD EXACT NUMBER. INCLUDE MOTORCYCLES.)

22. About how often do you "carpool" or "vanpool"? Is it... (READ LIST)

5 times a week	1
2 to 4 times a week	2
1 to 2 times a week	3 (40)
Less than once a week	4
NOT SURE/DK	8
REFUSED/NA	9

23. How many licensed drivers are there in your household? (RECORD EXACT NUMBER.)

__ __ (41-42)

NOT SURE/DK = 98
REFUSED/NA = 99

And how many operating cars and trucks are there in your household?

D O N O T

_ _ (43-44)

NOT SURE/DK = 98
REFUSED/NA = 99

25. What is your employment situation? Are you... (READ LIST.)

Employed full time.....1
Employed part time.....2
Self-employed.....3
Not employed for pay....4 (45)
Retired.....5
Student.....6
REFUSED/NA.....9

26. What is your age, please? (RECORD IT EXACTLY *AND CIRCLE APPROPRIATE CATEGORY BELOW.*)

AGE: _ _ (46-47)

REFUSED/NA = 99

(IF RESPONDENT REFUSES TO STATE AGE, ASK:)

Which of the following categories does your age fail into? (READ LIST.)

18 to 21..... 1
22 to 29..... 2
30 to 39..... 3
40 to 49..... 4 (48)
50 to 59..... 5
60 to 64..... 6
65 and older.... 7
REFUSED/NA..... 9

27. Please tell me which one of the following categories includes your total family income before taxes last year. Include your own income and that of any member of your immediate family who is living with you. Was it... (READ LIST.)

Less than $10,000 01
$10,000 to $19,999 02
$20,000 to $29,999 03
$30,000 to $39,999 04
$40,000 to $49,999 05
$50,000 to $59.999 . . . . . 06 (49-50)
$60,000 to $69,999 07
$70,000 to $79,999 08
$80,000 to $99,999 09
$100,000 or more 10
NOT SURE/OK..... 98
REFUSED/NA 99

END CARD #1

* * * * * * * * * * * * * * *

My supervisor may be calling you to confirm that this interview took place. May I have your first name and telephone number so she can call and ask for you?

Name _____ Telephone # _____

That's all the questions I have. Thank you very much for participating in the survey.

CALCULATE AND RECORD INTERVIEW LENGTH. RECORD GENDER ON THE FIRST PAGE. RECORD "BRIDGE," "FREQUENCY," "PAYMENT METHOD," AND "PURPOSE" FROM SAMPLE.

I AFFIRM THAT THE ABOVE INFORMATION IS ACCURATELY RECORDED FROM THE RESPONDENT'S STATEMENTS.

Interviewer's Signature _____ Date _____

Appendix 3.2
Electronic Funds Transfer Systems and ETC Operations

Appendix 3.2. Electronic Funds Transfer Systems and ETC Operations

The electronic funds transfer system (EFTS) was considered a potentially viable payment method in this market research. The telephone survey, however, showed that the EFTS was not perceived favorably by Bay Area motorists. This section examines the benefits and disadvantages of the electronic funds transfer systems, with particular emphasis placed on its application to an electronic toll collection (ETC) system. To implement the ETC system, it will be necessary to understand the emerging trends of the advanced monetary transaction technology and how the EFTS could increase operational efficiency of the electronic toll collection tasks. Specific issues addressed in this section include the credibility of electronic billing and the extent to which users are willing to accept the EFTS in the current market.

1. Background - Payment Methods and Transactions

Over the past two decades there has been widespread interest in the use of EFTS, especially among people in the financial community. Martin (1978) defines EFTS as "a system for the exchange of value via electronic entry without processing paper." In the historical context, the idea of EFIS came mainly from financial institutions and government regulators. Consumers have had little to do with either the development or the implementation of EFTS. It has been difficult to gauge the level of interest in using the EFTS because consumers have not been actively involved in the process.

It was cited in several studies that the EFTS was precipitated principally by the economic necessity of the financial systems. Financial institutions and regulators were concerned with the increasing number of breakdowns of the paper-based system, as the transaction volume was growing at the rate of approximately 7 percent annually. There was also a strong conviction in the financial community that the paper-based system had reached the economies of scale.

In the 1970s, approximately 80% of all transactions were cash payments, although the amount of each transaction was less than a dollar. While cash was used for 80% of all transactions, checks were used for 90% of the total transaction volume. The average cost-per-transaction was 1% or 1.5% of the transaction. This was to be the optimum level of efficiency in the non-electronic banking system.

Other reasons EFTS was favored among the financial community were that it provided opportunities to increase market shares and it relaxed restrictions on competition among the traditional structures of financial institutions.

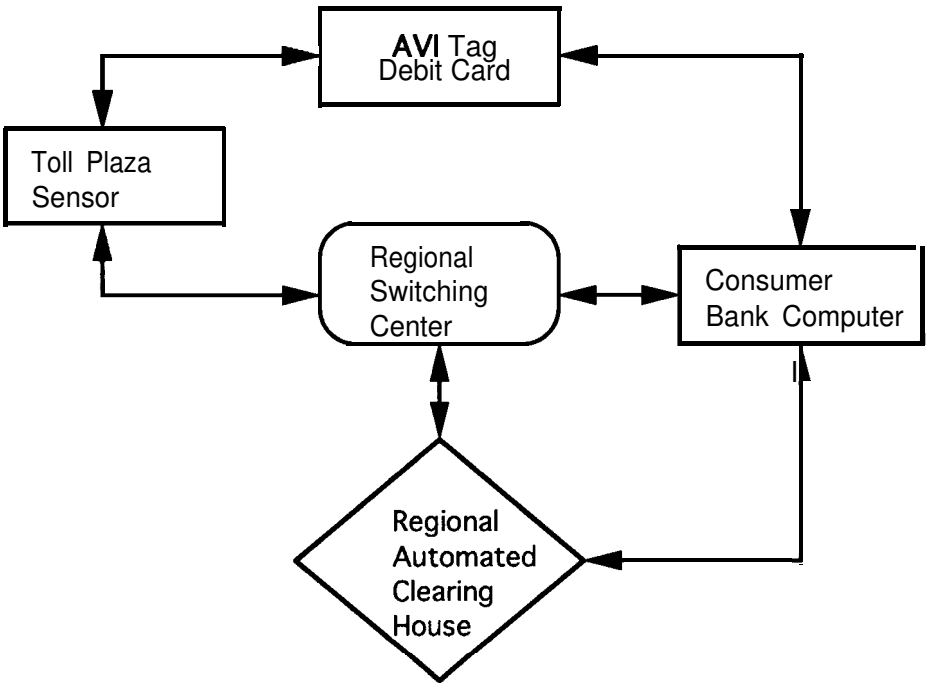
Today there are nine payment methods being used in the U.S. The non-electronic

methods consist of cash, checks, credit cards, money orders, and travelers' checks. Among the electronic methods are automated clearing houses (ACH), automated teller machines (ATM), point-of-sale (POS) payments, and wire transfers. Currently over 99% of the payments transactions are made in non-electornic payments. Cash and check transactions account for 95% of the total. Cash transactions alone comprise 70% of the transactions. Less than 1% of the total transactions use electronic payment methods and wire transfers. However, when the total dollar values of payment transactions are concerned, 78% of the total dollar value is transferred by the electronic payment methods. This means that at least 85% of the dollar values of payment transactions made by checks ten years ago have now been replaced with the electronic method.

b) Electronic Funds Transfer System for Toll Collection

The EFTS for toll collection could function with five basic components: 1) the consumer's AVI tag transponder in the vehicle, 2) the sensor at the toll plaza, 3) a regional switching center, 4) a regional automated clearing house, and 5) a consumer bank computer. The diagram below shows conceptual relationships, as we envision, among the various elements of the electronic toll collection system using the EFTS.

Conceptual Relationships between ETC and EFTS



The EFTS communication links between these system components will be connected primarily by either regular or leased telephone lines. The automated clearing house will be the place where financial institutions interface with other financial institutions, at which point in the process they will exchange credits and debits electronically without the paper work. The AVI tag and the sensor at the toll gates will be the devices used for system data entry. The sensor at the toll plaza will be connected to the regional switching center where the data will be sent to a regional automated clearing house (RACH). The interface between the RACH and the individual bank computer will be an electronic transfer of funds from the customer's bank account to the toll facility operators.

2. Benefits and Disadvantages of EFTS

The credibility of electronic billing is closely associated with the factual and perceptual elements of the system characteristics of EFT. The factual elements refer to the quality of performances inherent in the system. The perceptual elements are the qualitative judgements about the system based on the individual's previous experience. In this study we have attempted to identify the credibility of electronic billing by identifying benefits and disadvantages of the electronic fund transfer systems.

The benefits and disadvantages of the EFTS will have to be measured from two perspectives, the provider's point of view and the user's point of view. Although the provider's interest is intrinsic to the user's needs, the consumer's objective may differ from that of the provider. The financial institutions'objectives would include maximizing profit by reducing the costs of operation. The financial institutions will benefit from the EFTS by reducing paper work and speeding transactions. However, the high initial investment and operating costs require a significantly high transaction volume to make the system economically viable.

The most visible advantages that the EFTS offers are the convenience in making payments without paper work, and cost savings in postage, stationery, and telephone calls. Less visible advantages are the preventions of theft and loss of payments in the mail when cash or checks are used (Kirkman, 1987).

Visible disadvantages of EFTS to consumers include the loss of "float" time, the inability to stop payments, and the lack of financial privacy. The disadvantages unapparent to consumers are the costs of risks associated with fraud, bad credit, and system malfunctions. The costs of these risks are ultimately transferred to consumers and the general public (Martin, 1978). More specifically, possible disadvantages are:

Forgery

The EFTS would encourage computer-related criminal activates. Although the scale or

magnitude of the crime is not well defined, there exists a high risk of computer theft in using and operating the EFIS. It is difficult to prevent computer theft, particularly in the POS environment, unless proper cryptographic protocol is used (Solomon, 1987). The POS environment in the POS is extremely vulnerable to forgery. Today there is no such protocol to safely use the EFT systems for on-line or off-line operations.

Electronic system risk

Another risk expected in a computer-aided system is the possibility of errors created by electronic system malfunctions. Errors or inconveniences caused previously by computer-based systems have generated consumer skepticism.

Loss of float time

One of the adversities of EFTS is the loss of float time. 'Float time" means the duration of time, typically two or three days, between the point when consumers write a check and the time when the check is cleared. Consumers Union strongly suggested that consumers "will not willingly, and could not rationally, relinquish such an advantage in the interests of the system as a whole, at least not unless they receive equivalent benefits in return" (Solomon, 1987).

Stop payment

A related disadvantage is that the EFTS would take away the privilege of stopping a payment. To consumers, this is the ultimate leverage in making transactions with the providers of goods and services.

Lack of privacy

Since the EFIS has far more capacity in surveillance, data storage, and data processing than the non-electronic system, it has the ability to trace financial activities of individual accounts. Although the increasing awareness of this privacy issue in recent years has resulted in public and congressional attention, the issue of protecting privacy has not been fully resolved. While many are concerned with the disclosure of their financial data, others argue that record keeping is an integral part of contemporary living. Checking accounts basically provide the similar effect. It may be desirable to think that privacy has certain values like other goods. Thus the record of individual accounts should be sold and bought. The value of the record depends on who wants it and for what purpose. "It is not a homogeneous good; both the demand and the cost will depend on the exact type of information in question, precisely who is being given access to it and for what purpose.

The kinds of information involved, the extent of privacy different people desire and the costs of achieving it all will vary greatly. One underlying factor in the present wave of concern, that is common to all these contexts, and that is the capacity of the computer to lower search and analysis costs for a large volume of records. The degree of privacy to which we have been accustomed in the recent past has been in part a function of the cost of compiling and accessing data files; as the computer reduces that cost, a lowered level of privacy across a variety of contexts results" (Baxter, 1977).

Financial privacy of toll payments may not be an issue critical to the electronic toll collection activities. Skepticism of the EFTS, however, may have caused a disfavoring of electronic billing.

Credit risks

If post-payment systems are used, banks would have to take standard credit risks on a daily basis. The pre-payment systems could include direct billing to the customers or the use of their credit cards. When allowing customers to use uncollected or credited balances prior to settlements, credit risks exist. If funds are not received to cover the credit balances by the end of the day, it becomes an overnight loan to customers. The costs of the credit risks are presently shifted to the public.

Even though financial institutions might claim that the EFTS would help reduce the service costs it is unlikely that consumers could expect the reduced service charges since the cost of the EFTS is substantially higher than the non-electronic system. From the consumer point of view, disadvantages of the EFTS seem to outweigh the benefits. The system characteristics opposed by consumers may result in a slow rate of technology diffusion.

3. Consumer Attitudes Toward ETFS

This study addresses the level of interest among Bay Area motorists in using electronic billing and consumer attitudes toward an electronic funds transfer system. Given that the financial institutions can no longer effectively operate their banking systems without the electronics technology, the issue is how soon consumers will adapt to cashless banking. The hypothesis is that when consumers are willing to accept the EFTS, motorists would also be highly receptive to electronic billing.

What is the current status of consumer attitudes toward eletronic funds transfer system? Recent studies indicated that consumers were still hesitant to use the electronic banking although evidence indicated that there were a gradual change to direct debit payments in recent years (Kirkman, 1987).

The market penetration of the EFTS is important to our interest in electronic billing

for the services provided in transportation systems. As we consider many options regarding pricing schemes for alleviating congestion problems and the equaitable distribution of transportation resources, electronic payments may become inevitable in the future.

The recent study by the University of South Florida (USF) indicated that the cost of collecting tolls is closely associated with the method of collection. For post-payment, direct billing would be more costly than using credit cards. But for pre-payment, direct prepayments are cheaper than credit cards. In all cases, direct prepay was least costly to the toll collection agencies. From the toll operator's viewpoint, electronic billing for prepayment is most advantageous as far as the cost is concerned. However, our survey suggested that the least desired method was electronic transfer of funds.

The cost of service also has a scale effect. As a general rule, the processing cost per transaction decreases as the number of transactions increases, until economies of scale are reached. The study of the USF showed that the effects of scale are almost identical among all payment methods being considered.

The USF study also indicated that all of the selected toll operators decided to use the prepayment method paid by cash or check, with the exception to the San Diego Coronado Bridge. The Coronado Bridge also offered a post-payment plan in addition to a pre-payment plan. The experiment on the Coronado Bridge was completed in 1990. Four agencies, the Maryland Transportation Authority and toll agencies of the Dallas North Tollway, New Orleans, and Gross Ile, accepted credit cards in addition to cash or checks. The toll agencies' preference for a prepayment plan is primarily to avoid collecting payments and handling delinquent accounts.

The previous studies did not provide conclusive evidence with regard to the extent to which consumers are willing to accept the EFTS or how receptive toll users are to electronic payments. The surveys, nonetheless, indicated certain segments of the population are more receptive to the EFTS than others.

The studies suggested that demand for the EFTS can be estimated based on the socioeconomic characteristics of the population. Younger and more affluent consumers showed a greater propensity to the electronic banking services (Battle Creek and Canton Center data). For the EFTS to be fully utilized among Bay Area motorists, there must be a greater readiness for change than has been exhibited in the current trends.

4. Further Research

There are several issues regarding the electronic funds transfer methods that warrant further research. These include the benefits and cost of the EFTS from the toll agency and the user's point of view, the regulatory aspects of the utilization and implementation

of the EFTS, and the effects of the EFTS on society at a broader level.

Little attention has been paid to the effects of the EFTS on the institutions and retailers affected by the system. The available literature and studies mainly focused on the effects of the system on financial institutions. Further research is needed to attain a deeper understanding of the effects of the payment methods and the EFTS on transportation systems. More specifically, the efficiency of toll facility operations, among other factors, bears on the method of toll collection, and payment methods are the integral part of the system operation. As the road or congestion pricing schemes become more realistic, the payment collection method would play an important role in the operational aspects of the transportation system.

Another issue that needs to be analyzed is the effects of federal and state regulations on the use and implementation of the EFTS. The federal regulators attitude is to wait and see. Their opinion is that regulations will have to follow the technology. State regulators, on the other hand, view that the new system may result in the loss of their control over financial institutions. The concern is that the new electronic systems may abolish the dual regulatory system which presently exists at the state and national levels. The state regulators' interest is in regulating prior to the full implementation of the system. While the debate continues, it will be worth investgating the probable effects of the federal and state regulations.

Little or no research has been done on the broader context of this electronic technology, on how the EFTS would affect the society as a whole. The need for a complete assessment of this technology has been suggested by many. As noted by P.M. Pratt (Martin, 1978), "The cybernetic view of man and society is that we move ahead by a steering process, individually and collectively. We must continually look ahead to see which direction we are going in and how it needs to be changed, and what we must do to change."

Many questions need to be answered in a social context. Could there be socially significant benefits gained from the EFTS; who should be responsible for the security of the information; and what are the regulatory mechanisms needed to enforce certain obligations to protect consumers and providers? Presently, there is no overall demand of the EFTS. But as the technology takes off, the answers to these questions will help shape the development and implementation of the EFT systems on electronic toll collection.

Appendix 3-3
Comparison of Caltran's Survey with Other Surveys

Appendix 3.3. Comparison of Caltrans' Survey with Other Surveys

During the past year, several surveys were conducted by various agencies to learn about consumer attitudes toward the ETC technology .in other states. These surveys included the Dulles Fastoll project by the Virginia Department of Transportation (VDOT), the state toll facilities user study by Illinois State Toll Highway Autority (ITHA), the study of turnpike patrons by the Oklahoma Turnpike Authority (OTA), the Florida Turnpike patrons study by the Florida Department of Transportation(FDOT), and the study of three toll crossings, Lincoln Tunnel, Goethals bridge, George Washington bridge, by AT/Comm with the Port Authority of New York and New Jersey(PNY/NJ). Between October 1989 and May 1990, AT/Comm (1990) also surveyed 54 U.S. and two European agencies to determine system desing, market potentials, and pricing structures of ETC.

General contents of the survey questions were similar among those surveys and to those of our surveys. Many similarities were also found among the findings of those surveys although the survey instrument varied from survey to survey. The sample sizes of the surveys conducted by the authorities mentioned above varied significantly from 50 to 2,688 respondents and the return rates ranged from 10% to 25%. In the previous studies, more men responded to the surveys than women. The majority of the respondents had two cars or more, were generally in the age groups between 30-39 and 40-49, and fell into the annual household income group between $25,000 and $75,000.

The previous surveys showed that the majority of the respondents among the toll facility users favored ETC and preferred payment of the ETC service by cash or checks. An electronic transfer of funds from a bank account was least desired. The previous surveys also suggested that respondents expected to have a minimum balance over $20 required to open an ETC account. Approximately one half of the respondents expected to pay $20 to $25 for the AVI tag deposit. The findings of the previous surveys are reported below and shown in Tables 1 through 8.

Legend:

CDOT = California Department of Transportation (Caltrans)
VDOT = Virginia Department of Transportation
FDOT = Florida Department of Transportation
ITHA = Illinois State Toll Highway Authority
OTA = Oklahoma Turnpike Authority
PNY/NJ = Port Authority of New York and New Jersey
AT/Comm = AT/Comm, Incorporated

Table 1. Sample Size

	CDOT	VDOT	FDOT	ITHA	OTA	PNY/NJ
Distribution	30000	10050	10400	--	30000	12000
Return rate	20%	25%	20%	--	10%	16%
Sample size	5095	--	--	1119	2688	900
Year surveyed	1990	1989*	1990	1989*	1989*	1990

*, estimated year surveys were conducted.

Table 2. Gender of Respondents

	CDOT	FDOT	PNY/NJ
Men	69.4%	56.7%	77.0%
Women	30.6	42.4	23.0

Table 3. Interest in ETC

	CDOT	VDOT	FDOT	ITHA	OTA
Positive	82.4%	65.0%	67.4%	69.0%	56.0%
Negative	17.6	10.0	32.4%	30.0*	--
Not sure	--	25.0	0.2	--	--

* combined both negative and not sure.

Table 4. Method of Payment

	CDOT	VDOT	FDOT	PNY/NJ
Cash or check	63.9%	60.0%	59.6%	53.0%
Credit card	19.7	--	33.4	23.0
Eletronic transfer	14.2	--	7.0	--
Not sure	1.6	--	0.0	--

Table 5. Minimum Balance for ETC Account

	CDOT*	PNY/NJ
0	1.7	--
$10	1.3	34.1%
$20	2.7	42.0
$30	1.3	13.7
$40	90.0	--
$50	--	10.3

* percentages of respondents desiring minimum balance between 0-$9, $11-$19, $21-$29, and $30-$39 are not indicated above.

Table 6. Tag Price

	CDOT	ITHA	PNY/NJ
$50-65	--	4.0%	--
$35-50	--	28.0	47.0% ($30-50 with discount toll)
$20-35	($30) 92%	50.0	--
0	--	--	48.0 (agency pays for the tag)

Table 7. Trip Purpose

	CDOT	FDOT	VDOT	AT/Comm
To or from work	67.1%	82.7%	75.0%	83.0%
Business	10.3	10.1	--	--
School	2.4	1.2	--	--
Medical/dental	3.0	0.7	--	--
Social/recreation	6.5	3.9	--	--
Shopping	1.0	0.7	--	--
Other	9.7	0.7	--	--

Table 8. Trip Frequency

	CDOT	FDOT	PNY/NJ
>5 times/week	46.5%	79.9%	74%
3-4 times/week	16.9	9.6	--
1-2 times/week	18.0	5.6	--
<once/week	18.6	4.9	--

Table 9. Number of Drivers per Household

	CDOT	FDOT
0	0.2%	
1	14.1	19.5%
2	53.9	57.5
3 or more	31.7	23.0

Table 10. Age Distribution

	CDOT
≤ 18	1.2%
19-29	14.0
30-39	30.4
40-49	29.5
50-59	15.6
≥60	9.1

Table 11. Annual Household Income

	CDOT
<$10K	0.4%
$10K - 30K	8.6
$30K - 50K	33.0
$50K - 80K	30.0
$80K - 100K	7.9
>$100K	16.8

	FDOT
≤20	0.4%
20-24	6.6
25-34	31.0%
35-44	30.4
45-54	19.1
55-59	5.5
60-64	3.8
≥65	3.1

	FDOT	PNY/NJ
<$10K	2.5%	1.5% (<$15K)
$10K - 25K	11.9	3.4 ($15K-25K)
$25K - 50K	39.6	22.7
$50K - 75K	28.0	23.7
$75K - 100K	10.7	17.3
>$100K	7.2	31.3

Appendix 4-l
Telephone Survey Instrument for Commercial Users

Appendix 4-1. Telephone Survey Instrument for Commercial Users

GLS RESEARCH | CALTRANS "ETC" COMMERCIAL USERS SURVEY | PROJECT #90514

FINAL QUESTIONNAIRE | DECEMBER 1990

Card #1 (1)

Respondent ID# _ _ _ (2-4)

Time Started _____

Time Ended _____

Interview Length _ _ (5-6)

Interviewer _____

Date _____

Page # _____

INTERVIEWER! SEE YOUR SUPERVISOR ABOUT QUOTAS ACCORDING TO ACCOUNT SIZE.

ACCOUNT SIZE (FROM SAMPLE)

LESS THAN $1,000 . . 1

$1,000-$4,999 . . . . . 2 (7)

$5,000 OR MORE.... 3

Hello. My name is _____ , and I'm calling on behalf of Caltrans.

(IF THERE IS A NAME ON THE SAMPLE SHEET, SAY:) May I please speak to [NAME ON SAMPLE]?

(IF SAMPLE DOES NOT CONTAIN A NAME, SAY:) May I please speak to the person who would make decisions concerning your company's toll bridge and toll road agreement with the State of California?

(IF FURTHER EXPLANATION IS NECESSARY, SAY:) Your company maintains an account with the State of California to pay for your company's use of toll bridges and roads in the State. Could I speak to the person who would make decisions with regard to that account?

(INTERVIEWER: WE ARE INTERESTED IN SPEAKING TO A PERSON IN A DECISION-MAKING CAPACITY, NOT A BOOKKEEPER OR ACCOUNT PAYABLES CLERK WHO MERELY PAYS THE BILLS. IF A RECEPTIONIST GIVES YOUR CALL TO SUCH A PERSON, ASK HIM/HER WHO WOULD MAKE DECISIONS REGARDING THE COMPANY'S TOLL BRIDGE AND TOLL ROAD ACCOUNT WITH THE STATE OF CALIFORNIA, AND THEN ASK TO SPEAK TO THAT PERSON. IF THE BOOKKEEPER OR ACCOUNTS PAYABLE CLERK DOESN'T KNOW, ASK TO SPEAK TO HIS/HER SUPEKVISOR.)

(WHEN YOU HAVE THE RIGHT PERSON, READ THE FOLLOWING:)
Caltrans is considering implementing an Electronic Toll Collection (E-T-C) system that would replace existing charge accounts on all Caltrans toll bridges. To evaluate interest in this system among Bay Area companies who use the toll bridges, Caltrans is conducting this survey of commercial toll bridge users.

To use E-T-C, your company would open an account with Caltrans and obtain an electronic device, called a "tag," for each hauling or tractor unit in your fleet that would use E-T-C.

Every time a vehicle with a "tag" passed through a toll plaza, sensors would read the "tag" and this would allow the Loll collector to access your account by computer inside the toll booth. The toll collector would then calculate the total toll based on the number of axels and charge the total toll to your account. The C-T-C "tag" would eliminate the need for any interaction between the toll collector and the driver.

1. Do you think your company would be interested in subscribing to the E-T-C service?

YES..... 1	ASK Q2
NO..... 2	SKIP TO Q9 ON PAGE 4
NOT SURE/DK..... 8	ASK C12 (8)
REFUSED/NA..... 9	SKIP TO Q9 ON PAGE 4

2. Your company would have to permanently-attach an E-T-C electronic sensor "tag" to each tractor or hauling unit using E-T-C in your fleet. Attaching the "tag" would be no more complicated than attaching a license plate. Knowing this, are you still interested in E-T-C?

YES..... 1	ASK Q3
NO..... 2	SKIP TO Q9 ON PAGE 4
NOT SURE/DK..... 8	ASK Q3 (9)
REFUSED/NA..... 9	SKIP TO Q9 ON PAGE 4

3. In order to receive your E-T-C electronic "tags," you could be required to give the toll agency a one-time, refundable deposit for each "tag." The deposit would be refunded to you at any time you quit using E-T-C and returned the "tags" to the toll agency.

Knowing there could be a "tag" deposit, would you still be interested in E-T-C?

YES..... 1 DEPENDS ON COST... 2	ASK Q4
NO..... 3	SKIP TO Q.5
NOT SURE/DK..... 8	ASK Q4 (10)
REFUSED/NA..... 9	SKIP TO Q5

4. Would you still be interested in E-T-C if you knew the one-time refundable deposit was... (ASK EACH DOLLAR AMOUNT UNTIL RESPONDENT SAYS "YES" OR UNTIL ALL THREE DOLLAR AMOUNTS HAVE BEEN ASKED.)

	YES	NO
$30.00 per tag.....	1	2 (11)
$15.00 per tag.....	1	2 (12)
$ 5.00 per tag.....	1	2 (13)

EDITORS!
IF "YES" TO $30.00, SHOULD ALSO BE "YES" TO $15.00 AND $5.00.
IF "NO" TO $30.00 BUT "YES" TO $15.00, SHOULD ALSO BE "YES" TO $5.00.

5. The State could offer you two types of accounts: PREPAID and BILLED.

With a PREPAID account, your company would be required to prepay an amount equal to your average monthly toll bridge bill. As your company's vehicles used the bridges, tolls would be automatically deducted from the balance in your account. You would replenish your account approximately once a month, or when your account reached some predetermined minimum.

If you preferred a BILLED account, your company would be required to post a bond equal to twice your average monthly toll fees. The bond would be refunded to you if your company ever left the E-T-C system. Your company would be billed monthly for its toll bridge usage and payment would be expected within 30 days.

Which type of account would your company prefer -- a PREPAID account or a BILLED account.

PREPAID..... 1	ASK Q6
BILLED..... 2	SKIP TO Q7 ON PAGE 3
NOT SURE/DK ... 8 REFUSED/NA 9	(14) SKIP TO Q8 ON PAGE 3

6. A PREPAID account could be paid in one of three ways:

1) automatic monthly electronic funds transfer from your company's bank account,

2) automatic monthly charge to a Visa or Mastercard account, or

3) a check; cash, or money order.

If you paid by check, cash, or money order there would be a monthly service charge of $7.

If you paid by electronic funds transfer or by credit card, there would be no service charge.

Which payment method do you think your company would most prefer? (PROBE:) What would your second choice be? (REPEAT FIRST THREE ITEMS BELOW IF RESPONDENT ASKS.)

	FIRST CHOICE	SECOND CHOICE
Electronic funds transfer....	1	1
Visa or Mastercard.....	2	2
Check, cash, or money order....	3 (15)	3 (16)
NONE OF THESE (VOLUNTEERED).....	4	4
NOT SURE/DK.....	8	a
REFUSED/NA.....	9	9

7. A BILLED account could be paid in one of three ways:

1) automatic monthly electronic funds transfer from your company's bank account,

2) automatic monthly charge to a Visa or Mastercard account, or

3) a check, cash, or money order.

If you paid by check, cash, or money order there would be a transaction fee and a monthly service charge. Currently the transaction fee is 10 cents per toll and the monthly service charge is $7.

If you paid by electronic funds transfer or by credit card, there would be no transaction fee but there would be a service charge.

Q7 CONTINUED IN NEXT COLUMN

Which payment method do you think your company would *most* prefer? (PROBE:) What would your second choice be? (REPEAT FIRST THREE ITEMS BELOW IF RESPONDENT ASKS.)

	FIRST CHOICE	SECOND CHOICE
Electronic funds transfer...	1	1
Visa or Mastercard	2	2
Check, cash, or money order...	3 (17)	3 (18)
NONE OF THESE (VOLUNTEERED)	4	4
NOT SURE/DK	8	8
REFUSED/NA	9	9

8. Every unit in your fleet that has its own Vehicle Identification Number *could* have its own E-T-C "tag." For instance, a typical tractor/trailer rig is made up of two units -- the tractor or hauling unit and the trailor. If both units had tags, then the sensors at the toll plaza could read both tags and automatically calculate the total toll charge. Since the toll collector would not have to manually enter the total axels for the rig, your drivers would get through the toll plaza faster.

However, some companies frequently haul trailors which arrive from outside the Bay Area or out-of-state. These trailors probably would not have E-T-C tags.

Suppose you decided to use the E-T-C system. All your hauling or tractor units would need an E-T-C "tag." "Tags" for your own trailor units would be optional, and any trailor units you haul from outside the Bay Area probably would not have "tags."

Think now of all the TRIPS your rigs make across Bay Area bridges. If you were using E-T-C, about what percentage of all TRIPS would be made by rigs which were NOT completely "tagged" -- that is, where the tractor or hauling unit had a "tag" but the trailor unit (or any other unit being hauled) did NOT have a "tag"? (NUMBER CANNOT EXCEED 100 PERCENT.)

NOT SURE/DK = 998
REFUSED/NA = 999

PERCENT OF ALL TRIPS:

_ _ _ % (19-21)

* * * * * * * * * * * * * *

Now I'd like to ask you some questions just for classification purposes. As I mentioned before, all your answers will be kept strictly confidential.

9. What is the total number of tractor or hauling units in your company's fleet? (RECORD NUMBER BELOW. IF RESPONDENT CANNOT GIVE THE EXACT NUMBER. ASK THEM TO GIVE YOU THE "aooroximate total number.")

NOT SURE/DK = 9998
REFUSED/NA = 9999

___ ___ ___ ___ (22-25)

10. What is the total number of a77 units in your company's fleet? Please include any unit that has its own Vehicle Identification Number. (RECORD NUMBER BELOW. IF RESPONDENT CANNOT GIVE THE EXACT NUMBER, ASK THEM TO GIVE YOU THE "aooroximate total number.")

NOT SURE/DK = 9998
REFUSED/NA = 9999

- - - - (26-29)

11. What is the approximate number of daily Bay Area bridge crossings by your company's vehicles. (RECORD NUMBER BELOW.)

NOT SURE/DK = 9998
REFUSED/NA = 9999

___ ___ ___ ___ (30-33)

12. Which of the following methods do your drivers currently use to pay tolls? (READ LIST.)

	YES	NO	DK/NA
State Charge Card	1	2	9 (34)
Cash	1	2	9 (35)
Scrip	1	2	9 (36)

* * * * * * * * * * * * * * *

My supervisor may be calling you to confirm that this interview took place. May 1 have your first name and telephone number so she can call and ask for you?

Name _____ Telephone # _____

That's all the questions I have. Thank you very much for participating in the survey.

CALCULATE AND RECORO INTERVIEW LENGTH ON THE FIRST PAGE. RECORD ACCOUNT SIZE FROM THE SAMPLE ON THE FIRST PAGE.

I AFFIRM THAT THE ABOVE INFORMATION IS ACCURATELY RECORDED FROM THE RESPONDENT'S STATEMENTS.

Interviewer's Signature _____ Date _____

Appendix 4-2
Income Percentages of Non-commercial and Commercial Users

Appendix 4.2. Income Percentages of Non-commercial and Commercial Users

Volume and income percentages of non-commercial and commercial users of the Bay Area Bridges in 1990 are shown below. As expected, the income-volume ratio of commercial users is much higher than non-commercial users.

Volume percentage

ADT/Auto	ADT/Truck	ADT/Other
95.99%	3.98%	0.03%

Income percentage

Auto	Truck	Other
86.51%	13.4%	0.09%

Volume and Income percentages for All Bay Area bridges

VOLUME PERCENTAGES OF NON-COMMERCIAL & COMMERCIAL USERS OF THE BAY AREA BRIDGES

Bridge	Autos	Trucks	Other	ADT	ADT/Auto	ADT/Trk	ADT/Other	
SF/Oakland	95.42	2.6	1.78	118400	112977.2	3163.363	56.30787	
SanMateo/Hayward	94.93	4.88	0.19	37400	35503.82	1732.586	3.291914	
Dumbarton	96.66	3.07	0.27	29350	28369.71	870.9500	2.351565	
Richmond/SanRafael	94.72	4.8	0.46	25400	24058.88	1154.626	5.543165	
Carquinez	93.64	5.39	0.77	53200	49922.88	2690.843	20.71949	
Benecia/Martinez	94.14	5.41	0.45	43600	41045.04	2220.536	9.992414	
Antioch	90.25	9.14	0.61	6050	5460.125	499.0554	3.044238	
GoldenGate				61850				
Total					297337.7	12332.16	101.2506	309771.1
					0.959862	0.039810	0.000326	
Percent of ADT					95.99	3.98	0.03	

ADT = Average Daily Transactions

INCOME PERCENTAGES OF NON-COMMERCIAL & COMMERCIAL USERS OF THE BAY AREA BRIDGES

Bridge	Autos	Trucks	Other	AOT	RevAuto	RevTruck	RevOther	
SF/Oakland	88.31	10.45	1.24	118400	104559.0	10926.41	135.4876	
SanMateo/Hayward	86.65	12.51	0.64	37400	32407.1	4054.128	34.05467	
Dumbarton	92.55	7.27	0.18	29350	27163.42	1974.760	3.554605	
Richmond/SanRafael	79.23	20.55	0.22	25400	20124.42	4135.568	9.098250	
Carquinez	74.5	24.87	0.63	53200	39634	9856.975	62.09894	
Benecia/Martinez	75.41	24.57	0.02	43600	32878.76	8078.311	1.615662	
Antioch	64.29	34.9	0.61	6050	3889.545	1357.451	10.99535	
GoldenGate				61850				
Total					260656.2	40383.63	256.9051	301296.8
					0.665114	0.134032	0.000852	
Percent of INCOME					86.51	13.4	0.09	

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