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16. Abstract

The principal goal of this study is to provide TxDOT engineers and officials with information and approaches that would assist in: 1) determining the potential of road pricing for urban congestion control, air quality enhancement, and revenue generation in Texas; and 2) developing a strategy for possible implementation of road pricing in Texas.

Previous experience with congestion pricing in the U.S. and overseas is reviewed, revealing successful aspects as well as areas of concern. An integrated methodology for the evaluation of the networkwide traffic and air quality impacts of particular pricing schemes is developed. It is based on the DYNASMART dynamic simulation-assignment framework, expanded to incorporate specific user responses to pricing. An extensive stated preference survey of residents of Dallas, Houston, El Paso, and San Antonio is also conducted, indicating generally negative public attitudes towards pricing.

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ASSESSMENT OF CONGESTION PRICING FOR REDUCING URBAN CONGESTION AND IMPROVING AIR QUALITY

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RESEARCH REPORT 1321-1F

Research Study 0-1321
Use of Congestion Pricing for Reducing Urban Congestion as a Revenue Source and Compliance With the Clean Air Act

conducted for the

Texas Department of Transportation

in cooperation with the

U.S. Department of Transportation
Federal Highway Administration

by the

CENTER FOR TRANSPORTATION RESEARCH
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APRIL 1995

IMPLEMENTATION STATEMENT

The findings of this study can be used by traffic engineers, Texas Department of Transportation officials, and by cities in Texas to evaluate the use of congestion pricing for reducing urban congestion as a revenue source and in compliance with the Clean Air Act.

Prepared in cooperation with the Texas Department of Transportation and the
U.S. Department of Transportation, Federal Highway Administration

DISCLAIMERS

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views of policies of the Federal Highway Administration or the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation.

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SUMMARY

The principal goal of this study is to compile a comprehensive report for Texas Department of Transportation engineers and officials on the feasibility and effectiveness of road pricing as a measure to reduce congestion and bring non-attainment areas into compliance with the provisions of the Clean Air Act of 1990. The objectives of the study include reviewing previous congestion pricing projects and proposals, examining the technologies and policies of implementing road pricing in Texas, developing a procedure to determining optimal prices (taking into account time-of-day variations in demand as well as network effects), and identifying selected candidate locations for possible implementation of congestion pricing strategies in Texas.

An integrated methodology has been developed to evaluate the travel behavior impacts of particular congestion pricing schemes in a network, along with the associated impacts on network flow patterns, travel time, and air quality. The methodology is based on the DYNASMART dynamic simulation-assignment framework initially developed for ITS applications.

An extensive mail survey of residents in four Texas cities has been conducted to gauge attitudes towards congestion pricing and to predict likely user responses to specific pricing schemes. The four cities include Dallas, El Paso, and Houston (all three of which are non-attainment of air quality standards), and San Antonio.

While residents concede that congestion and air quality are problems affecting their respective cities and quality of life, little interest is shown in alleviating those concerns by changing their own behavior. They blame someone else for the problem. They also feel that the problem is not so important as to require radical measures; after all, congestion levels are still acceptable. Most respondents feel that the automobile is the only way they can travel, since no real alternatives are provided. Additionally, it is believed that building additional lanes onto freeways and new facilities is a viable solution to alleviate congestion regardless of the financial costs. Any measure that considers restrictions on the use of the automobile is not acceptable.

Therefore, given current public attitudes, attaining a level of acceptability for congestion pricing will be a difficult task. A strong influence is needed to catalyze a transformation in the public's transportation thinking, and it is unclear what the influence should be. Nonetheless, it is important to establish a framework and current understanding of pricing so that when the political climate is more favorable, a scheme can be pilot tested.

CHAPTER 1. INTRODUCTION

MOTIVATION

With continuing increase in automobile use, induced in part by economic and population growth, traffic congestion looms as a major problem common in urban environments. Several problems are associated with traffic congestion, including travel delays, energy waste, increases in pollution levels and noise and, consequently, reduction in the quality of life, etc. Although some economists, such as Button and Pearman (Ref. 1) believe that congestion may be an effective way to allocate scarce resources, congested situations can be accepted only up to a point where the value of the service received by using the road is higher than the value of the waiting time in queue to receive that service and of all the other associated costs. Traffic congestion, and particularly its associated environmental costs, is a serious concern that is certain that traffic congestion requires major attention and concerted action towards its solution.

Two kinds of measures can be proposed when dealing with problems of traffic congestion. On the supply side, measures such as new construction, upgrading of existing facilities to increase road network capacity and implementation of better traffic controls, are typically proposed. Demand management constitutes the other category of measures, which include flexible work schedules, increasing parking fees, high occupancy vehicle lanes and congestion pricing.

In order to have a significant impact, supply side measures require high levels of investment. The construction of new roads with higher standards, additional lanes, overpasses and other forms of physical capacity addition are financially demanding and are often politically unacceptable. It is well accepted that any contemplated increase in the capacity of the road networks generally falls short of the anticipated increases in the demand, and that sooner than later the roads become congested again. On the other hand, demand side measures are cheaper to implement than the supply side measures. Their application could reduce the number of cars on the road network, so as to reduce congestion severity.

Among demand side measures, congestion pricing has received renewed attention from policy-makers in recent years, particularly because of its potential environmental advantages. Congestion pricing involves charging for the use of a facility only during congested periods. This encourages motorists to use the tolled facility when costs are lower, use other modes such as transit, or to forego the trip completely. Congestion pricing could also be used as a significant source of new revenue, since the congestion charges would be in addition to current fuel taxes. The use of congestion pricing will also be compatible with the provisions of the 1990 Clean Air

Act Amendment, because it would assist cities classified as non-attainment areas to comply with the requirements of the law.

Some of the potential benefits attributed to congestion pricing include (1) it acts as a rationing mechanism for a scarce resource, whereby only those users who value their time more than the imposed toll will make use of a facility or enter a restricted zone in a city; (2) it provides a better reflection of the true cost of driving because it allows charging users the full social cost that their travel is causing; (3) it improves travel times and operating costs; (4) it reduces non-essential travel and energy consumption; (5) it improves air quality because of the reduced number of trips; (6) it improves transit productivity since demand may be shifted to these systems; (7) it reduces demand for new roads; (8) it is applied only when needed without affecting non-peak hour traffic; and finally, and (9) it is a source of much needed new revenues.

STUDY OBJECTIVES

The principal intent of this study is to provide TxDOT engineers and officials with information and approaches that would assist in: (1) determining the potential of road pricing for urban congestion control, air quality enhancement and revenue generation in Texas, and (2) developing a strategy, if appropriate, for possible implementation of road pricing, in a manner that would be well integrated with contemplated traffic management systems and ITS (Intelligent Transportation Systems) in Texas.

The principal objectives of this study are as follows:

1. Examine the feasibility and effectiveness of road pricing as a measure to reduce congestion and bring non-attainment areas into compliance with the provisions of the 1990 Clean Air Act.
2. Review experience to date with congestion pricing, as well as proposed projects, especially in the US, and asses their applicability and relevance to Texas conditions.
3. Examine the technologies and policies that can be most effective in implementing road pricing in Texas.
4. Develop a procedure for the determination of "optimal" prices, taking time-of-day variation in demand as well as network effects into account.
5. Provide guidelines to identify selected candidate locations for possible implementation of congestion pricing strategies in Texas.

STRUCTURE OF THE REPORT

This report is organized as follows. After the presentation of the motivation for the work, the problem statement and the study objectives in this chapter, the second chapter of the report describes the economic background for the application of congestion pricing. The same chapter also includes the determination of optimal prices from an economic theory perspective, a description of the technology for the application of congestion pricing and summary of experiences in the area in the US and overseas. The third chapter describes the instruments and methodology used in the development of this project to determine the effect of congestion pricing on air quality and on traffic networks. Chapter four presents the description and the results of the attitude survey made as part of this project, Chapter five provides conclusions regarding the feasibility of congestion pricing in Texas, along with recommended guidelines for the identification of candidate locations for the possible introduction of congestion pricing.

CHAPTER 2. CONGESTION PRICING

ECONOMIC JUSTIFICATION

This chapter first describes the theoretical basis for the economic justification of congestion pricing. It then discusses the considerations underlying the determination of "optimal" prices for the use of transport facilities. Technologies available and contemplated for the application of congestion pricing are reviewed in the third section, followed by an extensive review of experience to date, in the US and overseas, in the application of congestion pricing.

Vickrey (Ref. 2) provides the first important analysis of congestion pricing, as an alternative to continued investment in the construction of new roads as a means to improve congestion. One would be pricing the use of roads during peak hours in such a way that drivers who price their time lower would not travel until traffic becomes lighter, or even possibly forego travel altogether. If the price for using the road could be set in such a way that the demand is shifted to a non-congested level, and any new vehicle using the facility is priced according to its effect on the rest of the vehicles, the problem of congestion would be "solved". Those drivers not willing to pay the price for using the facility would take alternative routes or would wait until the price is lower.

The approach described by Vickrey can be graphically formulated as follows. Let us consider two groups of drivers that are trying to traverse a single lane bridge. The drivers are classified depending on how much they are willing to pay for the use of the bridge (i.e., how they value their time). Their demand curves are represented on Figure 1 as ADx for group one, and BDy for group two. In Figure 1, OC represents the capacity of the bridge. The demand of group one is measured from left to right, and from right to left for group two.

In the initial condition, when no fee for the use of the bridge is charged, the two groups compete for a fixed capacity (number of cars that the facility can handle per unit time). If the total number of cars trying to use the bridge is lower than the capacity, all the vehicles can pass (non-peak condition). However, for a peak hour situation, the demand for use of the bridge would be ODx plus CDy, which is in excess of the capacity OC, resulting in the formation of a queue. Vehicles from both groups will have to experience congestion and, consequently, delays up to the time when the demand is reduced and the queue dissipates.

If no price is set the queue would build up to the point at which the value of the waiting time reaches OP1. At this point, the number of vehicles entering the bridge would be the same as that of those leaving it. The users would be paying a waiting cost of value OP1 rather than cash. The

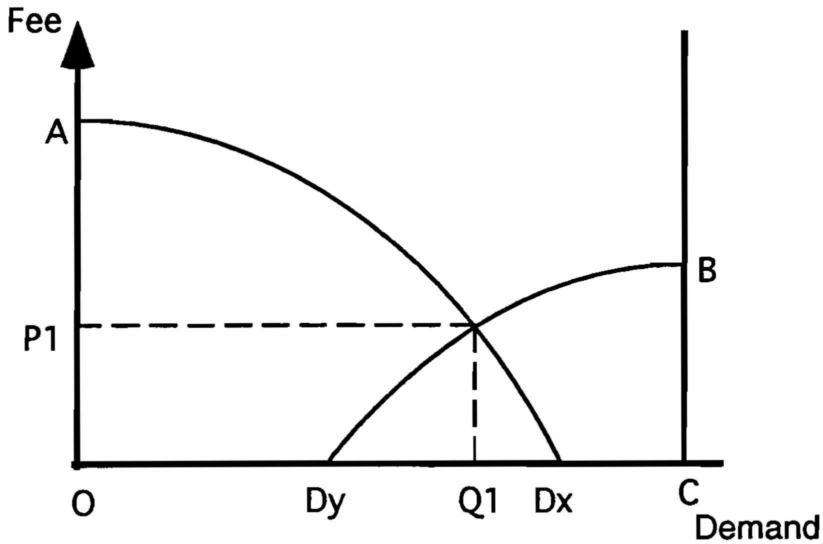


Figure 2.1 Demand curves for two groups of drivers using a single lane bridge

drivers that value their time higher than OP1 would not join the queue, they will prefer to stay away until the queue dissipates, select a different route if available or even forego the trip.

However, if during the peak period, a fee is introduced such that the use of the bridge would cost OP1, the demand from group one would be reduced from ODx to OQ1. At the same time the demand from group two would be reduced from CDy to CQ1. Congestion would only be due to possible random fluctuations in the demand.

If the price for the use of the bridge is set a little higher than OP1, the impact of the random fluctuations would also be eliminated, and there would in principle not be congestion. If the price is set a little lower than OP1, the queue would still form but the number of affected vehicles would be reduced. The equilibrium point reached with and without toll solutions would be the same but, with no fee, a revenue of OP1 x OC would be lost. If a fee is set, those using the bridge would generate that revenue.

The ethical concern would be the fairness of the toll system. Only those who price their time higher than the price set for the use of the bridge would be willing to pay, some of them would not be able to do so because of their inability to pay. Those with lower purchasing power would be forced to wait until the end of the peak period. However, they will still have the options of carpooling or using transit. They could also be compensated in some other way, since the additional revenue generated by the toll system could be spent in improvements to the transit system, new road construction or even in subsidies to low income driver groups.

DETERMINATION OF OPTIMAL PRICES.

In the case of driving, an optimal price should reflect the total costs incurred and/or imposed by the road user. These costs should include not only the costs directly paid by the single user, but also the costs that his/her driving imposes on other motorists by increasing their travel time, and on society as a whole. Costs not paid for by the road user but incurred by others are known in economics as externalities. To correctly evaluate and allocate the externalities of road driving is a very difficult task. For instance, how should the correct cost of the travel time be evaluated? How should the cost of health problems caused by air or noise pollution be calculated? The assessment and evaluation of such costs could be performed in an approximate manner. One part of these costs that, in an approximate form, can be relatively easily calculated is the increment in travel time that an additional motorist entering a road causes to those traveling behind him/her. This increment is known as marginal travel time and can be calculated from the link performance functions.

For a particular link, the travel time is known to depend on the level of congestion that the driver encounters upon entering the link. If the motorist is alone on that link, he/she can travel at his/her own desired speed without being affected by other motorists. The speed at which he/she travels is known as free travel speed and is only limited by posted speed limits or the vehicle's performance. However, most drivers find themselves affected by other vehicular traffic. The higher the number of vehicles the more time would typically be required to traverse the link.

A link performance function can be expressed in mathematical form as follows:

$$t = C + f(\text{Congestion})$$

where t is the travel time for the link, C, a constant representing the travel time associated with the free travel speed, and the second term on the right-hand side is a function of congestion. Congestion is often captured by the ratio between the actual flow and the capacity of the link. This function is normally non-decreasing.

The total travel time (incurred by all motorists using that link) is given by:

$$Tt = Vt = V\,[C + f(\text{Congestion})]$$

where V is the volume of vehicles using the link.

The marginal travel time is given by the first derivative of the total travel time with respect to the volume or:

$$MTt = C + f(\text{Congestion}) + V f'(\text{Congestion})$$

$$MTt = t + V f'(\text{Congestion}) = ATt + \text{Externality}$$

where MTt is the marginal travel time and, ATt is the average travel time. The externality is the difference between the marginal cost and the average cost.

If the use of a road is priced at the value of the externality, the users would be paying the actual cost of their usage of the road and, that would be the optimal price.

TECHNOLOGY FOR THE APPLICATION OF CONGESTION PRICING

It has been argued that the practical implementation of congestion pricing might worsen the problem it is intended to solve. Toll collection or enforcement at entrance points of a restricted zone or facility could cause additional congestion because vehicles have to come to a complete stop. That assumption would be true if traditional methods of toll collection are used.

However, recent advances in the area of Automatic Vehicle Identification make possible the collection of tolls without slowing down the traffic. Radio Frequency Identification Technology consists of a passive identity card posted inside the windshield or a small, inexpensive and robust solid state device called "electronic license plate" placed underneath the vehicle (device used in the Hong Kong Electronic Road Pricing Pilot Project; Ref. 3) The identity card is similar to the electronic license plate. These devices do not require any electrical connection and once placed in site do not need manual intervention and are maintenance free. When the vehicle passes through a collection point, the card is made active by an outside power source that sends a signal. The signal is sent back and read by an overhead or pavement embedded automatic reader that identifies the unique vehicle number. The reader passes the information to roadside cabinets that contain microcomputers. The information is then decoded and sent to a central control that checks the identification number allowing the vehicle to cross the tolling point. The central control keeps record of the entrance point and, when the vehicle exits the tolled facility, the identification number is read again and the corresponding toll applied. If the vehicle is not identified or the card has any problem a message is displayed and the vehicle directed to an attended booth. The complete operation is done in fractions of a second without the vehicle having to stop. A record of the different transactions is kept by the central control. A statement is sent to the vehicle's owner at the end of a period, commonly once every month. Payment of the bill can be made by mail, charged to a credit card or directly at the operating company's office. The account can be prepaid in the form of a debit account.

If the vehicle does not have the required card, it will be directed to an attended toll booth where the toll is paid automatically when using correct change or manually when change is needed. If the vehicle passes the collection point without paying, the vehicle plate number is photographed by a closed-circuit (CCTV) enforcement system. A ticket can be sent to the owner or an enforcement official can be sent to catch the intruder. The technology is designed so that only the number plate can be identified without knowing about the driver or passengers in the vehicle.

Another concern has been the privacy of users. If the system can identify the vehicle, it would then be possible to track down the movement of a person, thereby infringing upon his/her privacy. This problem has been solved using an advanced form of the identity card, the read and write cards. These cards have two memory components, one permanent that contains the account information, vehicle identification number and classification. The other can be overwritten to keep variable information such as records of the balance and of the entrance and exit points so the correct toll is deducted (Ref. 4). Read and write cards have a display element that requires electrical connections and a power source making the device more expensive than the read-only card. The read and write cards allow the system not only to identify the vehicle, but also to automatically deduct the amount of the toll from a prepaid amount. The current balance is displayed inside the vehicle so the driver knows it. When the funds reach a pre-specified low level the driver is advised to put more money in the account or go to an attended toll booth.

Although read and write cards are, by their components, more expensive than the read only cards, the whole system using read and write cards should be less expensive. The toll collection system is decentralized eliminating the communication system to the central control and the central control itself making the total costs go down. The whole system requires audit equipment that compares the loop counts with the transactions registered so that any inconsistency or equipment failure detected.

EXPERIENCE WITH CONGESTION PRICING

US Experience with Congestion Pricing

US experience with congestion pricing has been very limited due in large part to strong public opposition to any kind of movement restraint. Higgins (Ref. 5) provides an account of the limited demonstration projects contemplated in the seventies. He describes how, in 1976, then Secretary of Transportation William T. Coleman offered limited funding for the implementation of a Singapore' type pricing scheme to cities where decision makers seemed to be concerned with traffic problems. None of the largest cities were included due to the high costs of transit improvements needed to complement the application of congestion pricing. In the Singapore type scheme the vehicles would be provided with stickers that would allow the drivers to enter restricted zones during pre-specified times.

Of the cities that received the offer, only three were interested in further discussion about the implementation of a congestion pricing scheme. Madison, Wisconsin; Berkeley, California; and Honolulu, Hawaii. Other cities were more interested in demonstration of auto free zones and some others considered that practical, technical political, and financial problems would affect the possible application of congestion pricing. Concerns about businesses in downtown areas were also raised.

After preliminary work for the three cities, the outcome was the same: no further study was recommended, and proposed application of congestion pricing was abandoned.

Higgins (Ref. 5) mentions that the main reason for such lack of interest in the demonstration projects was the absence of sufficient understanding of congestion pricing by the general public. This misunderstanding was exacerbated by the media that raised important concerns about freedom of movement, effect on local businesses and fairness of the system. The consequence was public overreaction to any further proposal in the area. With respect to decision maker support, Higgins suggests that stronger support from local politicians was needed but not achieved because of their lack of interest in the subject.

However, recent developments show renewed interest of U. S. Policy-makers in congestion pricing. By the end of 1992, the Federal Highway Administration, under a program authorized by the Intermodal Surface Transport Efficiency Act (ISTEA), invited applications from state and local governments for funding for up to five Congestion Pricing Pilot Programs. The ISTEA provided up to $25 million a year. The main requirements that needed to be satisfied by the proposals were that they (Ref. 6):

- "Indicate a clear intent to use congestion charges to modify driver behavior;
- Include comprehensive applications of congestion pricing, including the use of road pricing;
- Include congestion pricing as a part of a program for addressing congestion, air quality, and energy goals;
- Demonstrate public and private involvement in the development of the program;
- Demonstrate the likelihood of early implementation;
- Indicate that the pricing project will not have major adverse effects on alternative routes or modes;
- Include plans for monitoring and evaluating proposed projects;
- Incorporate the use of advanced electronic toll and traffic management technologies;
- Include sound financial and management plans for pilot projects; and
- likely to add to the base of knowledge of congestion pricing applications."

The initial deadline for the submission of proposals, January 23, 1993, was extended twice, first to October 14, 1993, and later was left open (Ref. 7) Of 16 applications received from urban areas in nine states, only one met the conditions of the original solicitation - a proposal to raise peak period-period tolls on the Oakland-San Francisco Bay Bridge to control demand (Ref. 8) This will be the first of the demonstration projects. Its implementation is underway.

One successful experience in the use of congestion pricing in the US is the scheme used at the Los Angeles Airport to control the number and time that buses and taxis spent in the airport area. Lampe (Ref. 9) describes the scheme as follows: at Los Angeles airport 60,000 vehicles use the central terminal area every day. There are about 500 commercial carriers that operate some 5,500 vehicles. Commercial vehicles compete with private vehicles for curb passengers, creating curbside congestion while waiting for additional passengers. The airport authority imposed an access charge for commercial vehicles based on an honor system, where the operators reported the number of times they entered the central terminal area.

However, authorities were not convinced that the honor system worked effectively. In 1989, after evaluating then available technologies, they decided to install an Automatic Vehicle Identification (AVI) system to reduce traffic congestion and to maximize revenues collected from commercial operators. The system's installation was completed in September 1990.

The AVI system consists of electronic tags and readers. Forty-one antennas were mounted on existing overhead structures of the central terminal area. Tags were installed in all the 5,500 commercial vehicles. They are counted each time they enter the zone and the corresponding fee is assessed. The system is capable of charging different tolls according to the vehicle type.

Since the system was implemented congestion has been reduced by 20 percent and revenue collection has gone up by more than 250 percent when compared to the honor system previously used.

International Experiences with Congestion Pricing

International experience with congestion pricing has been considerably more extensive than in the US. A congestion pricing scheme has been in operation in the central area of Singapore since 1977. A pilot study for a similar system was conducted in Hong Kong in 1985. Some Norwegian cities are now applying a form of congestion pricing in central areas, and others are considering its implementation (London.)

Singapore. The best documented experience in congestion pricing is Singapore's central Area License Scheme (ALS). There, as mentioned by Morrison (Ref. 10), "...the relative isolation of the region from outside traffic makes administration and enforcement easier". Besides, the percentage of commuters affected by the application of the ALS was relatively small. The public transit system had enough capacity to accommodate those who left their cars parked. Morrison also makes note of the political acceptability of government actions in Singapore. Government is seen as acting in the interest of the general public and the single level of government makes things much easier than in a multilevel government.

The Singapore system consisted of daily or monthly stickers that were needed to enter the restricted zone. The stickers were initially sold in especially designated places for about US $1.30 a day. The restricted zone consists of the areas with congestion problems, leaves diversion routes for automobiles with destinations outside the restricted zone and minimizes the number of entry points. The restricted times were initially from 7:30 A.M. to 9:30 A.M. were extended but after implementation until 10:15 A.M. due to the congestion that developed after 9:30 A.M.

In addition to the stickers, a Park-and-Ride scheme and parking policies were also implemented. The Park-and-Ride provided ten thousand park spaces outside the restricted zone with special shuttle buses serving these parking lots. Parking was increased by one hundred percent at public parking lots within the restricted zone. The price structure was modified to encourage short-term use.

General fiscal measures such as increased registration fees or gas taxes were not use since they do not discourage the use of the automobile in specific zones or times; vehicle metering would have required special equipment that was not available in the needed number; the application of street tolls would have required complicated collection facilities.

Among the benefits reported in conjunction with the Singapore scheme, it is worth noting the reduction in the number of cars entering the restricted zone by about 73 per cent; the large increase in occupancy of the vehicles due to the exemption granted to car pools; the number of taxis entering the restricted zone fell to about one third of the pre-scheme level; the mean speeds increased by about 22 per cent during the restricted hours compared to the evening peak.

The effect of the scheme on area businesses is not entirely clear. Interviews with local store managers, bankers, wholesalers and property agents showed that they did not consider the scheme responsible for the reduction in activity. Some companies were directly affected since they had to buy licenses for company cars. Taxi drivers complained about the low level of activity during the morning hours.

Hong Kong. Another well documented and successful experience (Ref. 3), at least in the pilot stage, in congestion pricing is the project developed in Hong Kong in the years 1983 to 1985. The project was the first to apply extensively Electronic Road Pricing (ERP) technologies tied to the then recent advances in microelectronics. It consisted of a fully operational subset of a complete system. The technological components used were an electronic licence plate fixed underneath the vehicle; electronic loops embedded in the pavement that transmitted signals each time a vehicle crosses a tolling point; roadside cabinets that contain microcomputers to manage the information generated by the electronic loops and modems for communication to the central control. For purposes of enforcement a CCTV system was installed. The TV system provided pictures of the plates of the vehicles trying to cheat the system for later prosecution.

The central control included an accounting system that was able to bill vehicles for the use of the roads in the selected priced zones. Monthly statements were generated by the central control and bills, similar to a credit card statement, sent to the vehicle owners. The system offered diverse means of payment (mail, direct debit) and assured confidentiality by containing a single total for the month. No vehicle record is kept longer than necessary to ensure payment. It is claimed that the accuracy of the ERP system was above 99%.

The Hong Kong congestion pricing scheme was seen by the local government as an efficient alternative to the high car ownership taxes that were implemented in 1982. The traffic problems in the urban areas during working days were, at that time, so critical that the authorities were forced to increase the annual license fees and the first registration tax. Although these measures reduced, in the short term, the number of vehicles on the roads, they were expected to lose effectiveness over time given the fast-growing economy.

However, all the advantages of ERP shown in the pilot stage in Hong Kong were not sufficient to convince the local authorities of the desirabilty of its full implementation. Local opposition and the success of the other traffic restraint measures delayed the application of ERP.

Borins (Ref. 11) formulated hypotheses about the reasons why the ERP system was not further implemented in Hong Kong. He offered three possible explanations of that failure. The first is that the time in which the ERP was put in practice was a time when other political concerns were much more important for the Hongkonese. The second explanation is the lack of ability of the Transport Branch of the Hong Kong Government to introduce effectively electronic road pricing. The third is that electronic road pricing, even with its economic advantages, will not have a place in any democratic society since it will always be rejected if a referendum were held. He concluded that some combination of the three explanations can be attributed for such a failure and if no attention is given to them, and especially to the third one, congestion pricing will be shelved as an economical but not practical congestion management tool.

CHAPTER 3. EVALUATION METHODOLOGY

The first part of this chapter describes the elements to consider in the evaluation of a congestion pricing scheme. The second part describes the instruments used in this project for the evaluation of its application.

FRAMEWORK FOR THE EVALUATION OF CONGESTION PRICING

When implementation of a congestion pricing scheme is contemplated, careful consideration must be given to the effects that it will have on the users of the road network, the general public, businesses and commercial operators. The following six elements are key for the evaluation of the scheme: the users of the road network, the pricing scheme characteristics, the road network characteristics, the general public, businesses and commercial operators.

The users' attributes that are likely to influence their reaction to a congestion pricing scheme include: income level, educational level, occupation, place of employment and age. Information on income level will allow evaluation of the effect of pricing on different segments of the population. It is assumed that users with lower income will be more adversely affected by pricing. However, a compensation scheme could also be considered if income level information is at hand. The educational level is likely to affect how well the user is willing to accept pricing as a measure to control congestion. The higher the user's education level, the more knowledgeable he/she is likely to be of the objectives of pricing and of its advantages and disadvantages. Information on occupation will help to define the percentage of the population that will be affected by pricing. Some of the users will be able to switch departure times and avoid congestion tolls. Others will be forced to pay those tolls when there is no flexibility in their arrival time to the workplace because of the nature of their occupation. The place of employment will also affect users differently under congestion pricing. Those who do not need to work at a fixed place will be able to avoid congestion tolls. Those with a fixed place of employment will be forced to pay the necessary tolls. In particular, those with the opportunity to work from home or participate in other forms of telecommuting have considerably more flexibility in their response to congestion tolls.

The pricing scheme characteristics to consider are: the time of day when the scheme is in effect, e.g. peak morning and evening hours vs. a charge during the whole day; whether the tolls are fixed or variable according to the level of congestion; whether the scheme is area specific, such as in a central zone of a city, or facility specific, such as in a bridge or a freeway. If the scheme is area specific, the tolls may depend on crossings or on length of travel or time spent inside the restricted zone. If it is facility specific, it may depend on entering the facility or on the length of travel.

The network characteristics to take into account include: the links' length and capacity, the network geometry, the existence of alternate routes to specific destinations, the free travel times, and the signal settings for the traffic lights.

With respect to the public, it is important to know its perception towards congestion, its concerns for the environment and energy consumption. It is also important to know the reaction of businesses and of commercial operators such as taxis and delivery companies.

The combination of the users', pricing scheme, and network characteristics will define the specific user responses. Those responses can lead to changes in schedules, travel routes, transportation modes, destinations or even postponement or cancellation of a trip. Changes in user behavior will have impacts on travel times and congestion due to the redistribution of vehicles in the road network, air quality for the section where congestion pricing is implemented as well as over the whole urban area. They will also affect energy consumption and will have an impact on the generation of revenues for businesses and commercial operators.

The magnitude of the impacts and the attitudes and perceptions of the general public, business and commercial operators will lead to the acceptance or rejection of a congestion pricing scheme.

One of the main objectives of this project was to evaluate the effect that the application of a congestion pricing scheme would have on the users of road networks in the State of Texas. Would they select a different travel time or switch modes? Would they follow a different route or forego the trip? Not less important is the evaluation of the reaction of the general public to the application of congestion charges. Would the public consider more valuable a clean environment and compliance with federal mandates than a perceived reduction in mobility? Would the current idea that the roads have been already paid for and that no additional charge should be imposed prevail, and worsening levels of congestion and environmental degradation continue to be accepted? Those are the kind of questions that the evaluation of a congestion pricing scheme should attempt to answer.

No specific groups such as politicians, public officials, businesses or commercial vehicle operators were considered at this stage of the project, because of the absence of a specific proposal for congestion pricing in Texas. However, should a specific congestion pricing project be contemplated, it will be necessary to consider the position of these groups. The lack of consideration of these and the absence of adequate information to and communication with such groups is a sure recipe to kill the possibility of congestion pricing projects before any serious steps towards implementation are ever taken.

EVALUATION INSTRUMENTS

Several approaches and techniques have been identified to gather and generate the range of information needed to evaluate both user and public responses to the implementation of a congestion pricing scheme, and the resulting operational and environmental impacts at the network level. Those approaches range from the conduct of attitude surveys to the full implementation of a congestion pricing scheme in a city or certain facility, as in Singapore in the seventies. Other possible forms include detailed interviews, experiments with a limited number of participants, the use of a dynamic traffic assignment simulation model, and the application of pilot projects such as those implemented in the 80's in Hong Kong. Table 1 summarizes the different instruments or techniques that can be used for the evaluation of a congestion pricing scheme and the information that can be obtained from each instrument. The quality and amount of information obtained from those different instruments vary accordingly with the scope and complexity of the effort. The greater the scope and more complex the activity, the larger the amount of information that can be gathered. However, the cost also varies with scope and complexity, not only from the economical standpoint, but also from the political one. If an incorrect activity is set up and public involvement is high, the risk of losing all support for possible future implementation is also high.

In light of the above considerations, it was determined that the most practical way to perform the evaluation of the user and public responses, and the resulting effects at the network level, was to use a combination of two instruments: an attitude survey and the theoretical exploration of the effect of congestion pricing at the network level.

Two approaches were considered for the attitude survey, a telephone or a mail survey. Telephone surveys have the advantage of relatively high response rates since the interview is conducted only after the respondent accepts to participate, which saves time. The questions can be explained at the level of detail required by the particular respondent and clear and precise answers can be obtained. However, the use of telephone surveys is limited to areas within local calling zones because of the high cost of long distance calls. Others limitations of telephone surveys include the lack of willingness to trust strangers calling, the time that the interviewers need to spend to get a sufficient number of responses, the difficulty of reaching working members of households, and the prevalence of answering machines. On the other hand, mail surveys can be more cost effective than telephone surveys. The typically low rate of response, of about 15-30% for similar surveys (Ref. 12), is compensated by low mailing costs and could be enhanced through follow up mailings. A large and diversified number of possible respondents can be targeted. The use of official letterhead and clear identification of the purposes of the survey

Table 1. Information for the Analysis of a Congestion Pricing Scheme

Instrument / Information	Surveys	Interviews	Stated Preferences Experiments	Dynamic Traffic Simulator	Pilot Project	Full Implementation
Predicted User Reaction	X	X	X	X		
Public Perception About Congestion Pricing	X	X				
Predicted Effects on Commercial Operators		X	X			
Predicted Effects on Business		X	X			
Predicted Effects on Environment	X	X	X	X		
Predicted Effects on Energy Consumption	X	X	X	X		
Predicted Effects on Travel Times	X	X	X	X		
Predicted Public Reaction	X	X				
Actual User Reaction					X	X
Effects on Commercial Operators					X	X
Effects on Business					X	X
Effects on Environment						X
Effects on Energy Consumption						X
Effects on Travel Times						X
Public Reaction					X	X

helps establish credibility and gain public confidence allowing respondents to feel the importance of their participation.

In this study, an extensive mail survey was undertaken towards fulfilling the desired objectives. The questionnaire was designed to address both travel to specific zones of a city, (e.g. CBD) and the use of specific freeway facilities. Different price levels were included to elicit the respondents' stated preferences and willingness to pay. The survey included a section on general attitudes towards congestion, its effects and possible solutions, as well as demographic questions to characterize the sample. The number of questions reflected a compromise between the need to keep the survey short to increase the response rate, and the desire to obtain information on the users' attitudes and likely responses to congestion pricing. Plain language was used, and only the absolutely necessary instructions were included. A more detailed description of the survey and of its results are given in the next chapter of this report.

Regarding the theoretical exploration of the effect of congestion pricing at the network level, ongoing work at the Center for Transportation Research on the development of dynamic network traffic assignment capabilities is being used to estimate the spatial distributive effects of imposing prices on selected network links at particular times.

A modified version of DYNASMART (DYnamic Network Assignment-Simulation Model for Advanced Road Telematics) is used in the dynamic traffic assignment algorithm to explore the effects of pricing at the network level. DYNASMART is designed to model traffic patterns and evaluate overall network performance under real time information systems, for a given network configuration (including traffic control system) and given time dependent Origin-Destination demand pattern. The modeling approach integrates traffic flow models, traffic control systems, network path processing, user behavior rules and information supply strategies. A principal feature is that vehicle paths are modeled explicitly as the outcome of individual path selection decisions at each node of the network. Thus DYNASMART is used primarily as a simulator to replicate the dynamics of traffic for a given assignment of vehicles to paths. Traffic flow is represented using a hybrid approach where vehicles are tracked individually or as macro particles, and moved consistently with macroscopic traffic flow relations between speed and concentration on a roadway link. Junction control and delay are explicitly modeled. Multiple user classes categorized by vehicle types and information availability are also implemented in DYNASMART. Vehicles of different classes are routed in the network according to individual decisions made at decision points, under real time information availability. A single user class version of DYNASMART which considers the passenger car mode only is used. This version of DYNASMART is more efficient computationally and incorporates efficient data structures, and hence is the desired code for application to the single user class problem. The three major components of DYNASMART are described below.

Traffic Simulation Component

DYNASMART uses a fixed time increment simulation approach to move vehicles in the network. Two major aspects are link movement and node transfer. Link movement is a process for moving vehicles on links during each scanning time interval in the simulation. Node transfer performs the link-to-link or segment-to-segment transfer of vehicles. For interrupted flow, the node transfer allocates appropriately the right of way according to the control element at the intersection. The node transfer implements all the inflow and outflow constraints that limit the number of vehicles entering and leaving each link segment under the prevailing traffic control.

User Behavior Component

DYNASMART is designed to allow the incorporation of different user behavior rules in relation to different information supply strategies. Basic information available to the drivers includes travel times on alternate routes. A boundedly-rational behavior rule, which has been supported by experimental evidence, is incorporated in the version of DYNASMART used.

Path Processing

The path processing component of DYNASMART is essential to translate link-level travel time information (including queuing delays) from the simulation to the path-level attributes needed in the user decisions component. For this purpose, a K-shortest path algorithm with left turn penalties is interfaced with the simulation model to calculate K different paths for every origin-destination pair. However, in order to maintain computational performance, the K shortest paths are not recalculated for every simulation time step, but at pre-specified intervals. In the interim, travel times on the set of K current paths are updated using the prevailing link travel times at each simulation time step. A complete description of DYNASMART and of its capabilities can be found in Jayakrishnan, Mahmassani and Hu (Ref. 13).

CHAPTER 4. PUBLIC ACCEPTABILITY AND USER RESPONSE IN TEXAS

Critical to the potential implementation of congestion pricing are the issues of public acceptability and user responses to actual pricing schemes. A mail survey was conducted in the Spring of 1994 between February and April to characterize these aspects.

SAMPLE DETERMINATION

Typical response rates of transportation surveys range from ten to twenty percent, (when no explicit response enhancement techniques are used). Therefore, similar results were anticipated from this survey. Accordingly, a mailing to about 12,000 households was determined to be appropriate to achieve a sufficiently large number of responses to have statistical significance. A rented mailing list consisted of an equal number of randomly generated addresses for the cities selected on the basis of metropolitan area (by population), air quality status, and demographics.

The cities selected include Dallas, El Paso, Houston, and San Antonio. The metropolitan area had to be large enough to experience congestion that impacts the majority of residents. Therefore, the largest metropolitan areas in Texas were targeted for consideration. With respect to air quality status as measured by National Ambient Air Quality Standards, Dallas, Houston, and El Paso have reached non attainment status and are in the process of finding ways to reduce pollutants so that compliance can be reached. Conversely, San Antonio has not yet reached this point, although worsening air quality is placing San Antonio closer to non attainment status. The number of households in the survey was 3000 per city. An English version of the survey was sent to the Dallas area and a bilingual version, English-Spanish, to the other three cities. Among the four cities, a broad range of demographics was desired.

SURVEY FORMAT AND DESCRIPTION

After pre-testing the survey on 50 randomly-selected University of Texas at Austin employees, the final version consisted of six sections (Appendix A, Survey), with one page per section. This survey is based on stated preference techniques, in that respondents are asked to indicate their preferences or probable behavior under essentially hypothetical situations. This is the only approach possible in the absence of actual pricing experiments in Texas, which would have allowed measurement of revealed preferences.

An official cover letter encouraged recipients to respond so that better understanding could be attained of different measures being considered to help mitigate congestion. As is usual practice with such surveys, a postage-paid envelope was included. An optional Spanish version included in the mailing with the standard English version reduced the likelihood of non response due to limited proficiency with the English language.

To obtain valid, usable responses, it was desired to make the response process as simple as possible. Therefore, an easy-to-understand format was adopted so that most questions required only checking a box or circling a number.

Section A - Characteristics of Downtown Travelers

Responses to this section were solicited from travelers familiar with downtown traffic conditions. Familiarity was considered on the basis of travel to or through the downtown area occurring at least one time per week. If a respondent did not travel to or through the downtown area at least one time per week, he/she was requested to skip Section A and begin with Section B.

Of primary concern in this section were perceptions of traffic conditions in the Central Business District (CBD) of the metropolitan area being surveyed and the purpose of the incurred downtown trip(s). For a selected time period (e.g. 8-11 a.m.), traffic conditions were rated on a scale of 1 to 5, with 5 corresponding to heavy congestion and 1 to free flowing movement. For the times for which travel conditions were provided by the respondent, an associated trip purpose (either work, shopping, or other) and frequency were requested. Additionally, characteristics were obtained for distance from home to downtown, mode of travel, route, and incurred parking fees.

Section B - User Characteristics of Freeway Travelers

This section addressed the use of freeways in the metropolitan area. For freeways used at least once a week, survey recipients were asked to indicate responses in a provided matrix of freeways. One check mark was requested beneath the corresponding number of times per week a freeway is used, and a second check mark was requested for the associated trip purpose (work, business, shopping, leisure, or other.)

A second matrix allowed respondents to check the time(s) of day in which he/she typically uses a freeway and circle a corresponding traffic condition (rated on a scale of 1 to 5, 5 corresponding to heavy congestion and 1 to free flowing movement.)

Sections C & D - User Response to Pricing Schemes

Different scenarios were presented regarding the use of toll charges during congested periods; when congestion is not present, no toll is charged. The availability of such "free" period improves the level of public acceptability if it is perceived that times exist during which no out of pocket cost is incurred.

Studies suggest that toll elasticity of demand is lower when the toll is collected electronically rather than manually via an operator at a booth (Ref. 3). The extent of such a phenomena is not known. Therefore, fifty percent of the surveys mailed to Dallas and Houston (1500 to Dallas, 1500 to Houston) specified that electronic toll tag technology would be used in the collection of tolls; Dallas and Houston were selected because certain freeways in these areas already utilize electronic toll tag technology (e.g. Dallas North Tollway) (Appendix B, Pricing Schemes Specifying Toll Tag Technology.) The remaining fifty percent of the survey to Dallas and Houston (1500 to Dallas, 1500 to Houston) did not specify the manner in which tolls were to be collected. In these two sections, "most likely" responses were desired for a given scenario in which respondents ranked from one to three (one corresponds to most likely) their three most likely responses of the following seven possible responses:

- pay the extra cost and not change travel habits
- leave home earlier to avoid the extra cost
- leave home later to avoid the extra cost
- carpool to split the extra cost
- use public transit to avoid the extra cost
- forego the trip to avoid the area
- select a different route

Areawide Scheme. The first scenario in Section C stipulated a toll charge of $0.50 for every time an area (e.g. a downtown area) is entered during a congested period; when the region is not congested, no charge is imposed. In scenario two, the toll is increased to $1.00 for the same situation. A toll of $2.00 is imposed in scenario three, and a toll of $3.00, $4.00, and $5.00 for scenarios 4, 5, and 6, respectively.

The surveys (sent to Dallas and Houston) that specified electronic toll tag technology indicated that, one's vehicle could be equipped at no extra charge, with an electronic tag that allows prepayment of tolls (with electronic storage of the amount in the tag). Each time the vehicle passes a toll plaza, the amount is subtracted from the prepaid dollar amount in the tag without having to stop at a toll booth. Scenario one stipulated a toll of $0.50, taken automatically from the electronic tag every time the downtown area is entered during congested periods; no toll is charged when there is no congestion in the area. In scenario two, the toll automatically debited is increased to $1.00 for the same situation. For scenario three, the toll is $2.00. A toll of $3.00, $4.00, and $5.00 is imposed in scenarios 4, 5, and 6, respectively.

Distance Based Scheme. In an analogous manner, user response was investigated in Section D regarding a scheme in which the toll is based upon the distance traveled along a freeway during congested periods; when the freeway is not congested, no toll is charged. The first scenario imposes a maximum toll of $0.50 for use of the freeway during congested periods. In scenario two, the toll is increased to $1.00 for the same situation. A toll of $2.00 is imposed in scenario three, and a toll of $3.00, $4.00, and $5.00 for scenarios 4, 5, and 6, respectively.

The Dallas and Houston surveys that specified electronic toll tag technology were modified in a manner analogous to the previous case. Thus, each time the vehicle passes a toll plaza, the amount is subtracted from the prepaid dollar amount in the tag without having to stop at a toll booth. Scenario one stipulated a maximum toll of $0.50, taken automatically from the electronic tag based on distance traveled along the freeway during congested periods; no toll is charged in the absence of congestion. In scenario two, the maximum toll automatically taken is increased to $1.00 for the same situation. For scenario three, the toll is $2.00. A toll of $3.00, $4.00, and $5.00 is imposed in scenarios 4, 5, and 6, respectively.

Section E - Attitudes

Public acceptability is expected to present a serious obstacle to implementation of a pricing scheme, and is probably responsible for stifling previous attempts at congestion pricing in the United States (Higgins, 1994). Therefore, to develop a successful strategy for possible implementation (if at all), an understanding is needed of public attitudes and perceptions of Texas residents. Respondents were asked to identify on a scale from 1 to 5 how strongly they felt (1 = strongly agree, 5 = strongly disagree) regarding 24 different questions. Questions focused on five primary areas, including congestion, out of pocket driving costs, equity considerations with regard to roadway pricing, car ownership and use, and transit.

Section F - Demographics

Typical demographics used in urban planning analyses were obtained for purposes of correlation with other attributes. These included gender, age, passenger vehicles, number of drivers in a household, education level, occupation, and gross annual income of the household.

EXPLORATORY ANALYSIS OF DATA

A total of 1,531 returned surveys comprise the sample (187 of Dallas Version 1, 176 of Dallas Version 2, 361 of El Paso, 188 of Houston Version 1, 170 of Houston Version 2, and 449 from San Antonio.) (Appendix C, Demographics.) When accounting for returned surveys due to unknown addresses, the individual response rates were 12%, 12%, 12%, 13%, 11%, and 15% for Dallas Version 1, Dallas Version 2, El Paso, Houston Version 1, Houston Version 2, and San Antonio, respectively. The most likely respondent was found to be a 30-40 year old college-educated male of a household with above average income.

Demographic Distributions

The samples from all four cities were found to have somewhat non-typical distributions of four different characteristics: gender, age, education, and income. It is unknown whether this is due to inherent biases associated with the original mailing list, or if the bias developed during the response process, but appropriate analytical methods unaffected by bias can be employed in analyzing the data and drawing subsequent inferences.

Among all cities, a strong gender bias was found, with male respondents outnumbering females by more than 2:1. This bias is in fact rather typical in travel surveys. This should be taken into account as different travel patterns may be associated with men and women.

Among the age groups, the 30-40 group was most represented, which is consistent with census data on population age groups. Low responses (10% or less) were obtained for the over 60 group and less than 2% from the under 20 category. These are two groups with unique mobility needs, thereby warranting a need for an understanding of the impacts of pricing schemes on these groups. The retired group is the fastest growing segment of the population, and they may react strongly to pricing due to their long-standing attitudes regarding "free" travel as well as their fixed income. Given the large proportion of teenagers who work (predominantly at low-paying jobs), pricing schemes may also have a strong impact on this group.

More than 90% of respondents indicate possession of at least one vehicle for household use; approximately 40% have 2 vehicles while approximately 15-20% revealed having 3 or 4 vehicles. These values are consistent with US. census data and reveal a trend in increasing numbers of households having 3 or more vehicles. Further, it confirms the notion that residents are part of an automobile society.

Distributions of education levels are skewed toward well-educated individuals. In the Dallas area, 20% of respondents earned a Master's or other advanced degree; in El Paso this level was 10%. These are in excess of levels reported in the 1990 census data. Low responses (less than 5%) were obtained from those with less than a high school education, which is less than would be anticipated from census data. Nearly one third of respondents had at least some college while another one third finished college.

Gross annual household incomes are also strongly biased upward. Between 15 and 20% of households in Dallas, Houston, and San Antonio reported gross annual incomes of greater than $75,000; in El Paso, 10% did. Thirty to forty percent of respondents fell into the range of gross annual income of $15,000 to $45,000. Again, such biases towards better educated, higher income tripmakers are fairly typical in travel surveys. There are nonetheless sufficient responses from the less represented groups to reach meaningful conclusions.

Exploratory Factor Analysis

Factor analysis procedures can be used to investigate underlying factors that may influence stated attitudes. This type of analysis refers to a variety of statistical techniques whose common objective is to represent a set of variables (i.e. the responses to different questions) in terms of a smaller number of underlying variables. This can then be used to investigate whether observed correlations among variables/questions may be caused by the existence of an underlying variable.

A factor analytic approach produces a factor pattern consisting of a matrix of critical correlation coefficients between variables (survey questions) and underlying factors. Using a two-tailed t-test at a given confidence interval, statistically significant critical correlation coefficients, underlying factors are identified by interpreting similarities between variables with high critical correlation coefficients.

A varimax rotation was employed to simplify the interpretation of the factor pattern, resulting in the identification of three underlying factors accounting for approximately 60% of the total variance among factors. Factor 1 can be interpreted as an automobile attraction factor due to the high critical correlation coefficient with questions regarding the use of taxes for roadways and automobile use for satisfying mobility needs, and Factor 2 can be taken to represent environmental consciousness because of the strong critical correlations with questions regarding air pollution and air quality. Lastly, Factor 3 suggests sensitivity to out of pocket costs due to high critical correlation with questions on financial disincentives for automobile use.

Understanding the underlying factors that influence attitudes and perceptions is particularly important given the political sensitivity of congestion pricing. If implementation and subsequent success are to be achieved, an knowledge must be had of how to appeal congestion pricing to the public. Further, understanding of attitudes can lead to greater understanding of driver behavior, leading to more effective techniques of congestion management. Accordingly, the preliminary factor analytic approach suggests that a given scheme that appeals to environmental consciousness and out-of-pocket driving costs may be more easily accepted.

Response Frequencies

Attitudes and Perceptions Frequency distributions of questions from Section E reveal several attitudes that create a substantial barrier to public acceptability of possible pricing schemes; the issue of acceptability is a critical one due to the political sensitivity associated with congestion pricing. Figure 1 depicts relative frequency distributions of key attitudinal questions while a complete compilation of relative frequencies of attitudinal questions is contained in Appendix D. Therefore, for implementation to be successful, a thorough understanding must be had of the public's perception of these transportation issues.

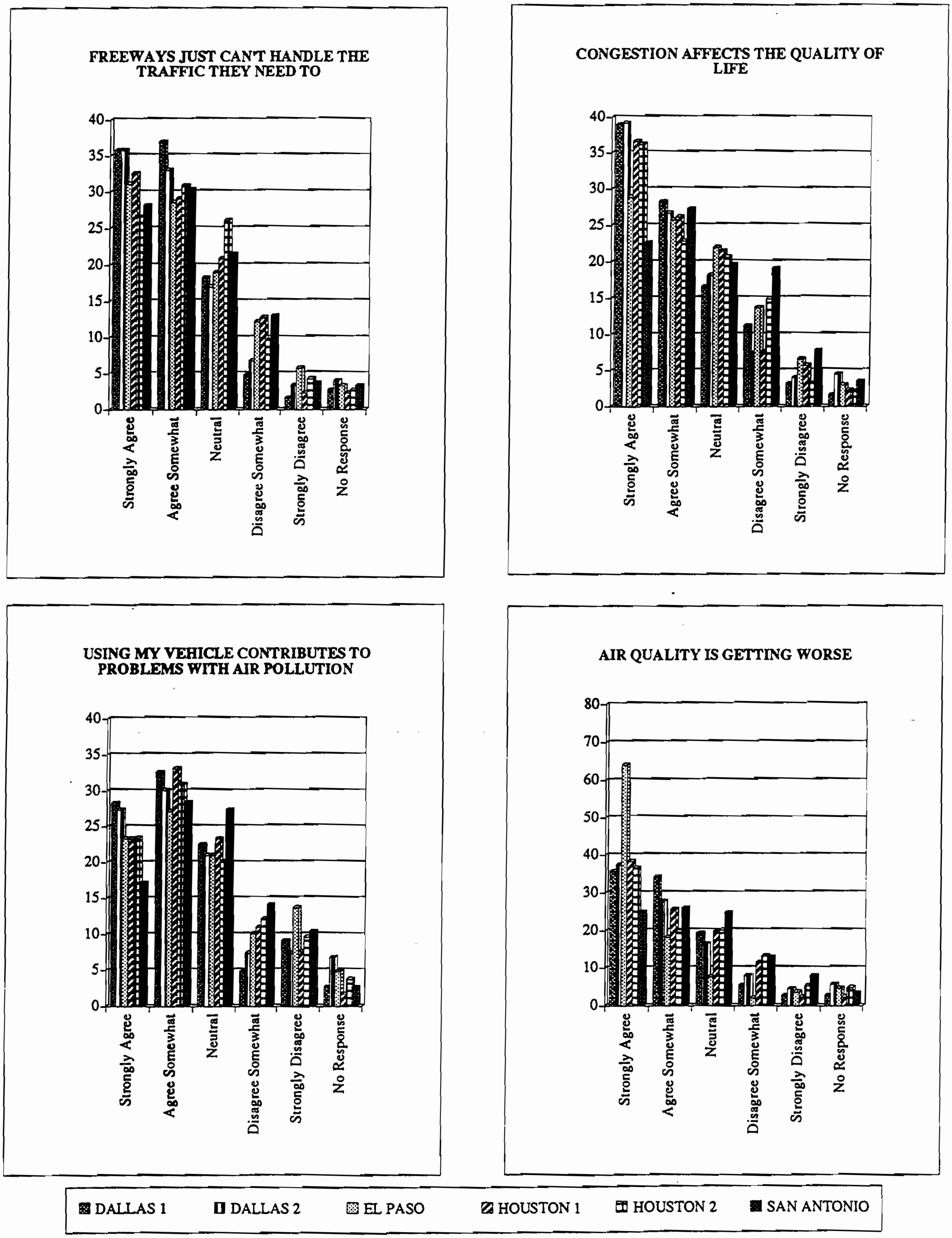
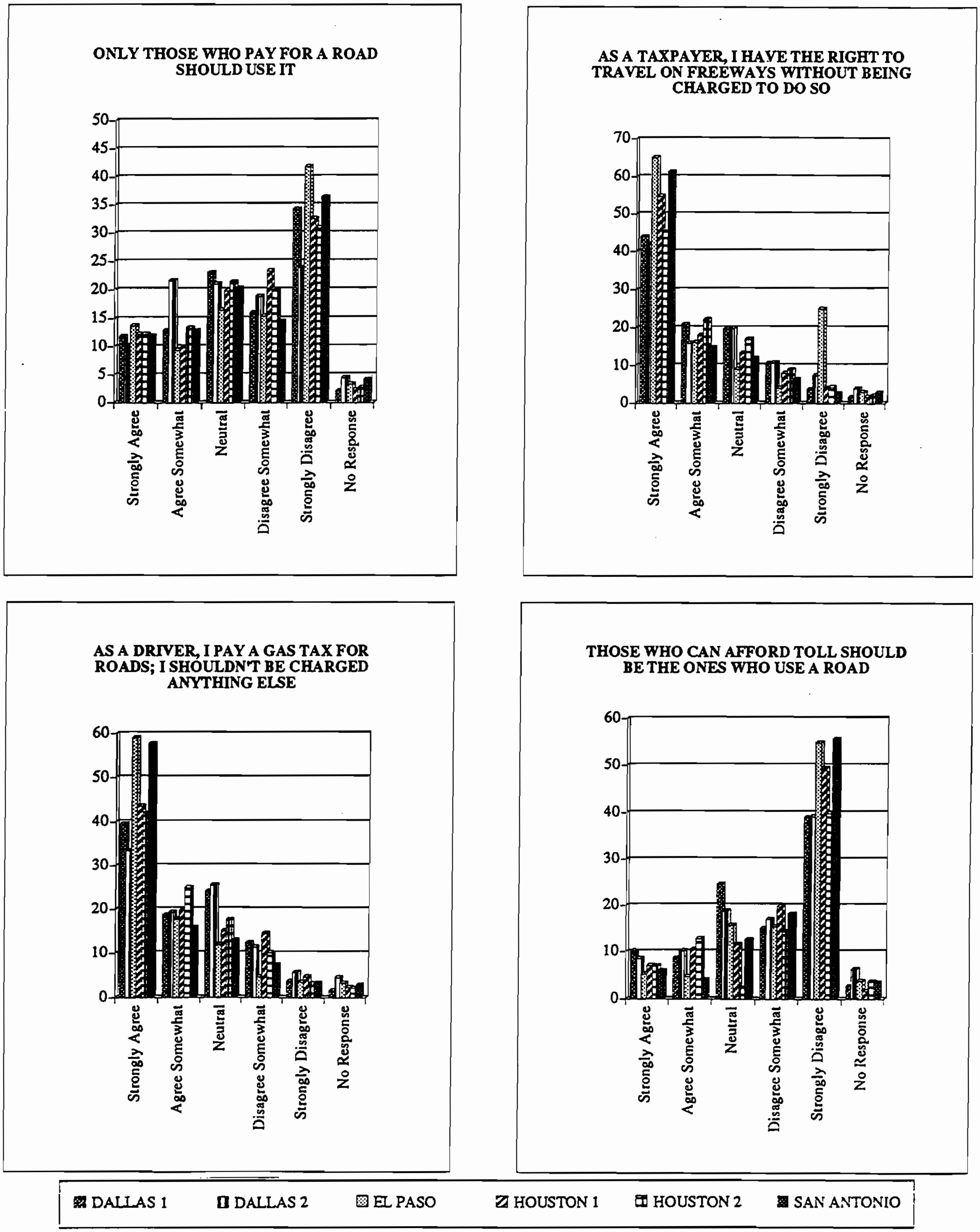
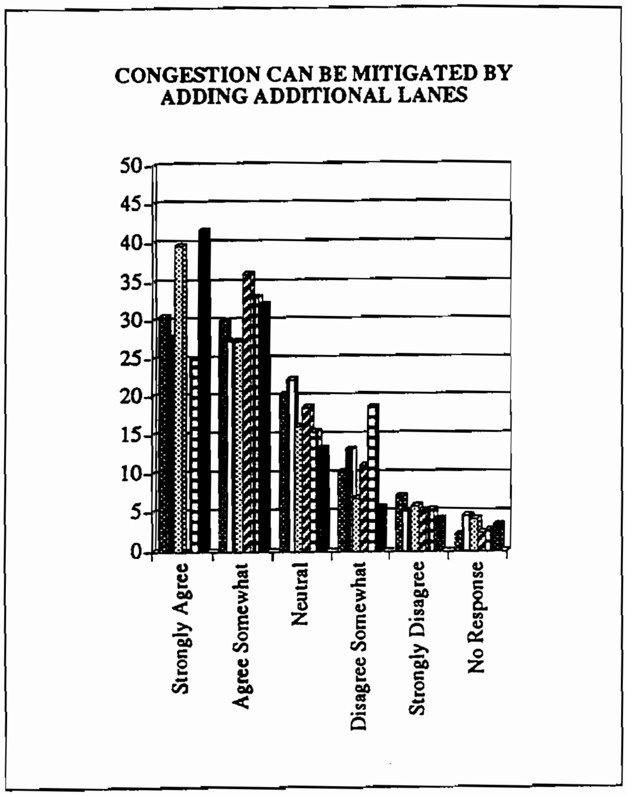
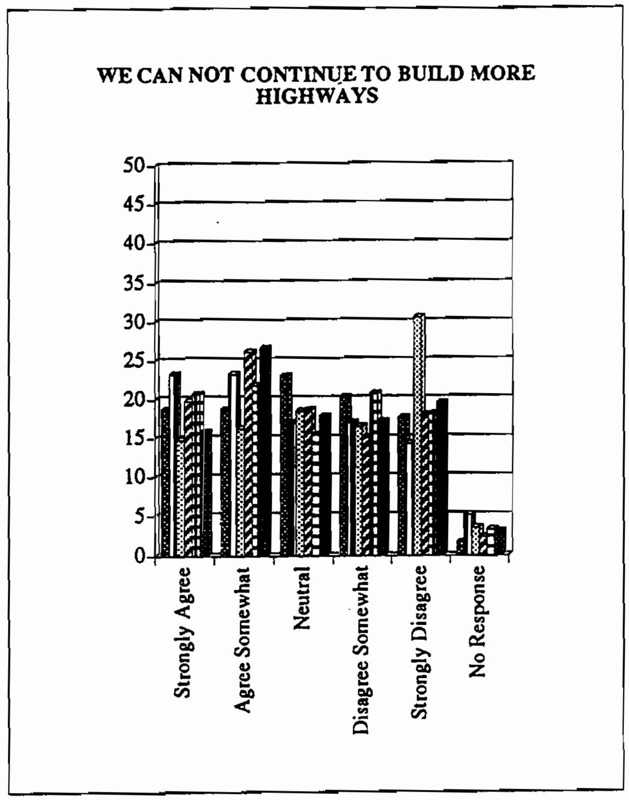
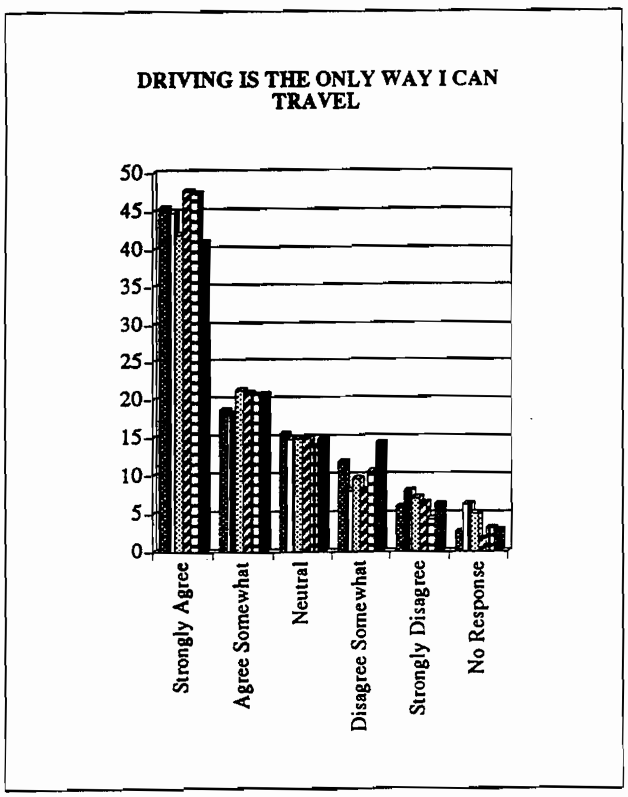


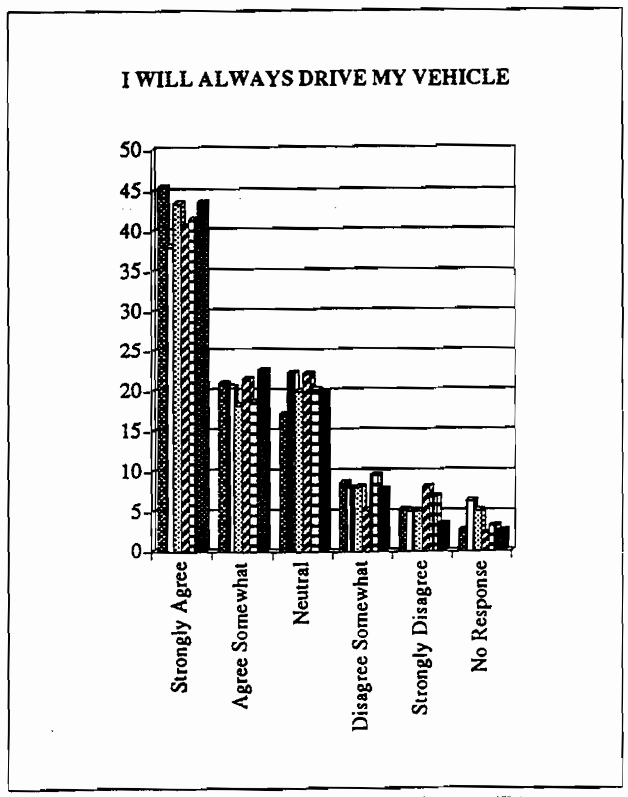
Figure 1. Relative frequency distributions.


ONLY THOSE WHO PAY FOR A ROAD SHOULD USE IT
50
45
40
35
30
25
20
15
10
5
0
Strongly Agree
Agree Somewhat
Neutral
Disagree Somewhat
Strongly Disagree
No Response
AS A TAXPAYER, I HAVE THE RIGHT TO TRAVEL ON FREEWAYS WITHOUT BEING CHARGED TO DO SO
70
60
50
40
30
20
10
0
Strongly Agree
Agree Somewhat
Neutral
Disagree Somewhat
Strongly Disagree
No Response
AS A DRIVER, I PAY A GAS TAX FOR ROADS; I SHOULDN'T BE CHARGED ANYTHING ELSE
60
50
40
30
20
10
0
Strongly Agree
Agree Somewhat
Neutral
Disagree Somewhat
Strongly Disagree
No Response
THOSE WHO CAN AFFORD TOLL SHOULD BE THE ONES WHO USE A ROAD
60
50
40
30
20
10
0
Strongly Agree
Agree Somewhat
Neutral
Disagree Somewhat
Strongly Disagree
No Response
DALLAS 1
DALLAS 2
EL PASO
HOUSTON 1
HOUSTON 2
SAN ANTONIO

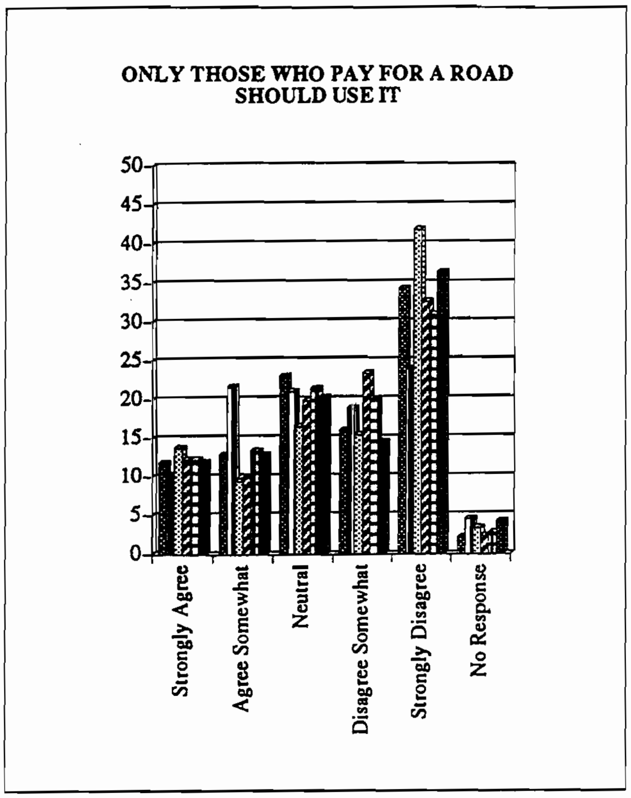


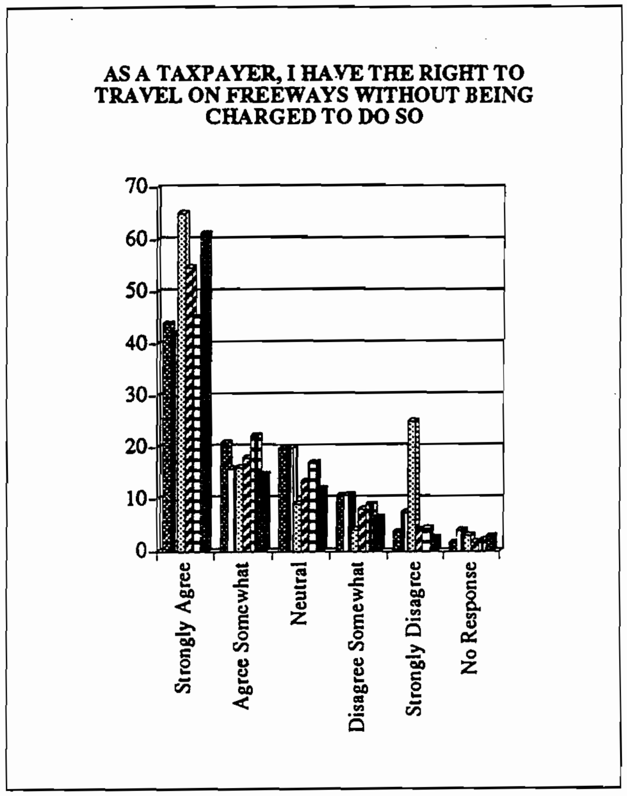


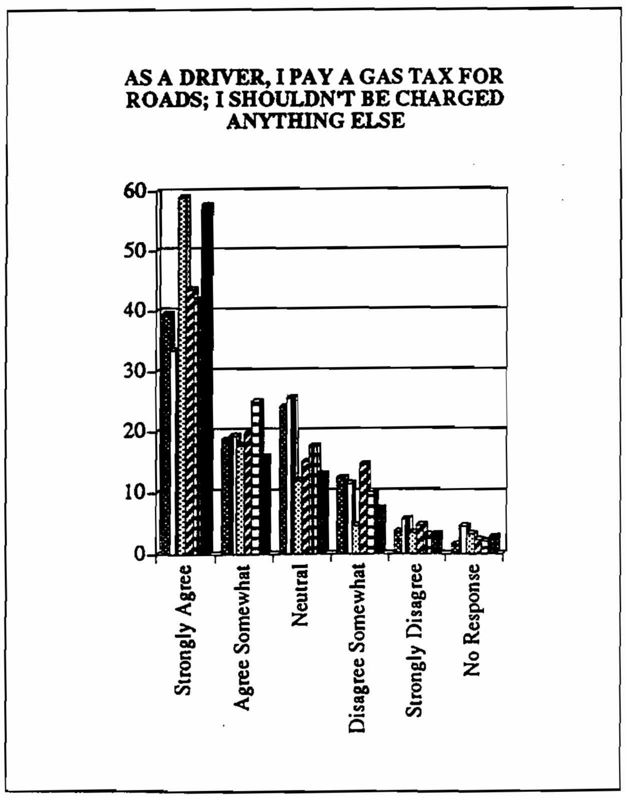


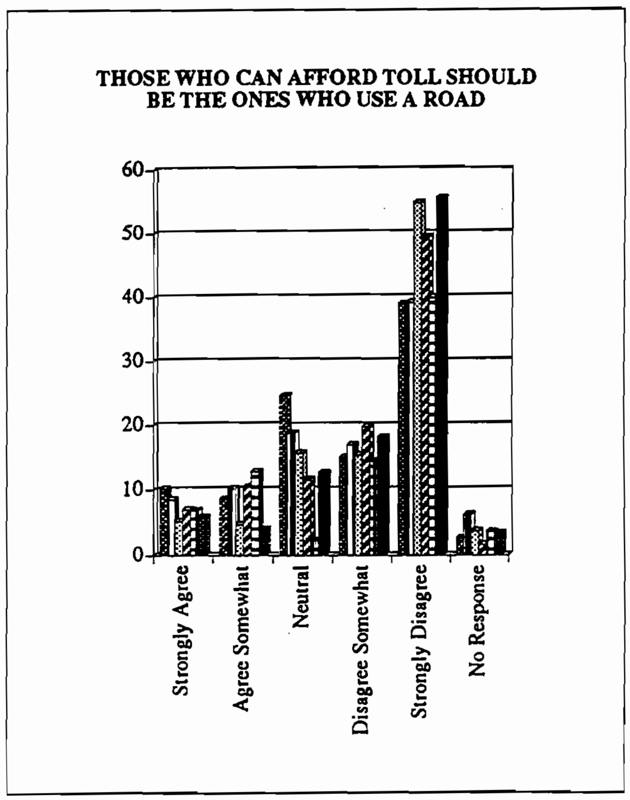


DALLAS 1 DALLAS 2 EL PASO HOUSTON 1 HOUSTON 2 SAN ANTONIO

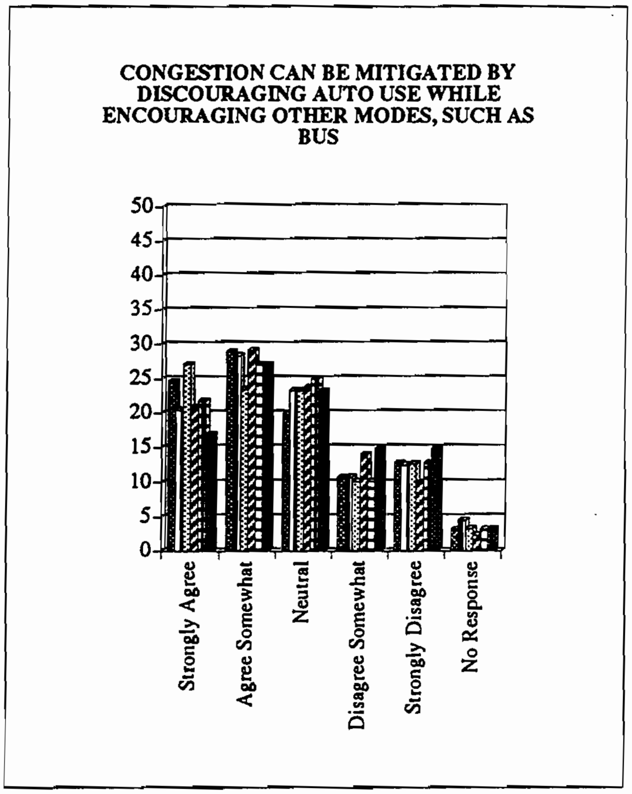


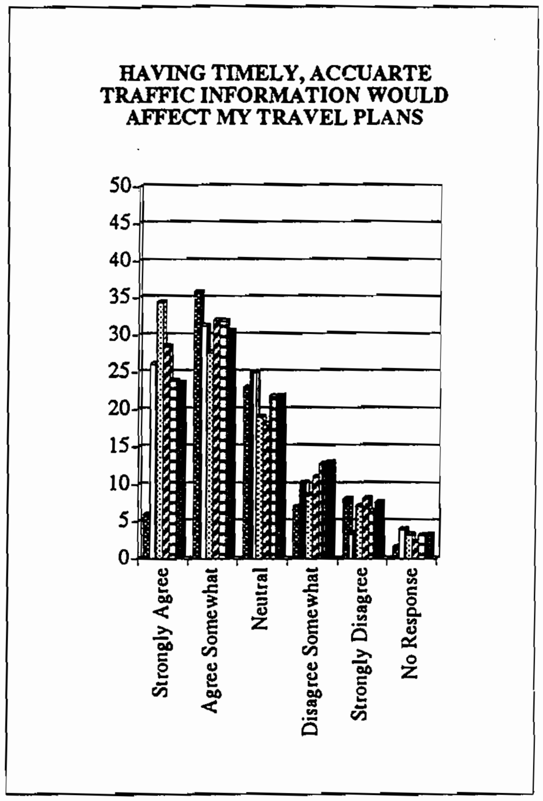






DALLAS 1 | DALLAS 2 | EL PASO | HOUSTON 1 | HOUSTON 2 | SAN ANTONIO





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Analysis indicates that the majority of respondents recognize problems associated with congestion and air quality. The majority concede that freeways cannot handle the levels of traffic that they need to and that congestion affects their quality of life. Additionally, there is agreement that using their vehicle contributes to problems of air pollution and that air pollution is getting worse.

While there is recognition of these issues, there is a lack of understanding that changes are needed in the way that transportation needs should be met. More than half agree strongly or somewhat that congestion can be mitigated by adding additional lanes, while twenty percent agree strongly that we cannot continue to build more highways. Such attitudes suggest a continued reliance on the automobile for meeting mobility needs. More directly, sixty percent of respondents agree strongly or somewhat that driving is the only way they can travel; the same level of respondents agree strongly or somewhat that they will always drive their vehicle.

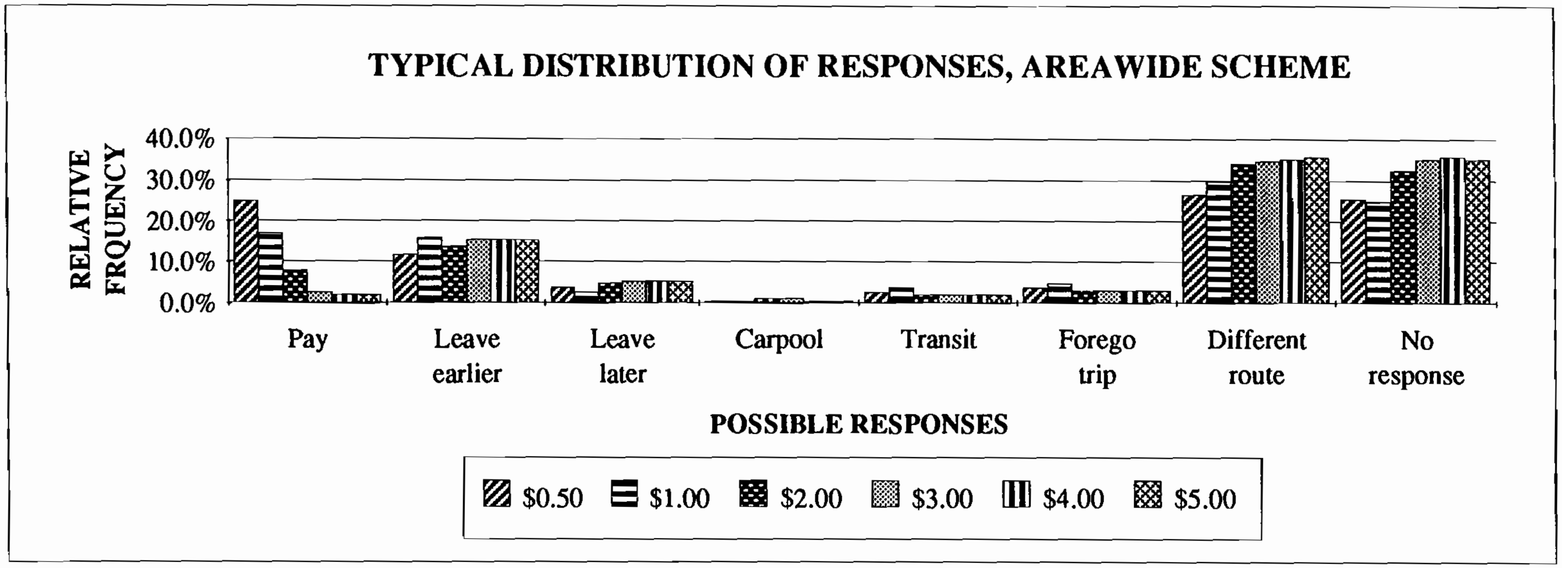
Offering disincentives to automobile use seems to have little impact on respondents' willingness to decrease vehicle use. Less than 20% agree strongly or somewhat that increases in gasoline costs discourage them from driving; similar levels of agreement were found with regards to increases in parking costs. A slight increase to approximately 30% agreement was found when the disincentive was changed to tolling.

Automobile users reveal little willingness to incorporate new approaches to traditional transportation issues. Approximately 20% strongly agree that congestion can be mitigated by discouraging auto use while encouraging other models, such as bus. Approximately 30% agree that having timely, accurate travel report affects their travel plans, but an equal is neutral to the idea.

Strong attitudes exist regarding equity issues. Nearly two thirds strongly or somewhat agree with the idea that as a taxpayer, it is a right to travel on freeways without being charged to do so. Further, the same level of respondents agree that as a driver, a gas tax is paid for roads, thereby creating an attitude that they should not be charged for anything else. Additionally, it is believed that roadways are for the use of all motorists, not just those who can afford it; less than 20% agree that only those who can afford toll should be the ones who use a road. Approximately 20% agree that only those people who pay for a road should use it.

Stated Responses to Pricing Schemes

Two different pricing schemes were defined, and respondents were asked to indicate their three most likely responses (from a given set of seven options) for different levels of tolling. Responses to an area-wide pricing scheme varied somewhat from distance-based scheme in terms of price elasticity of demand, however overall trends of responses were similar between the two as



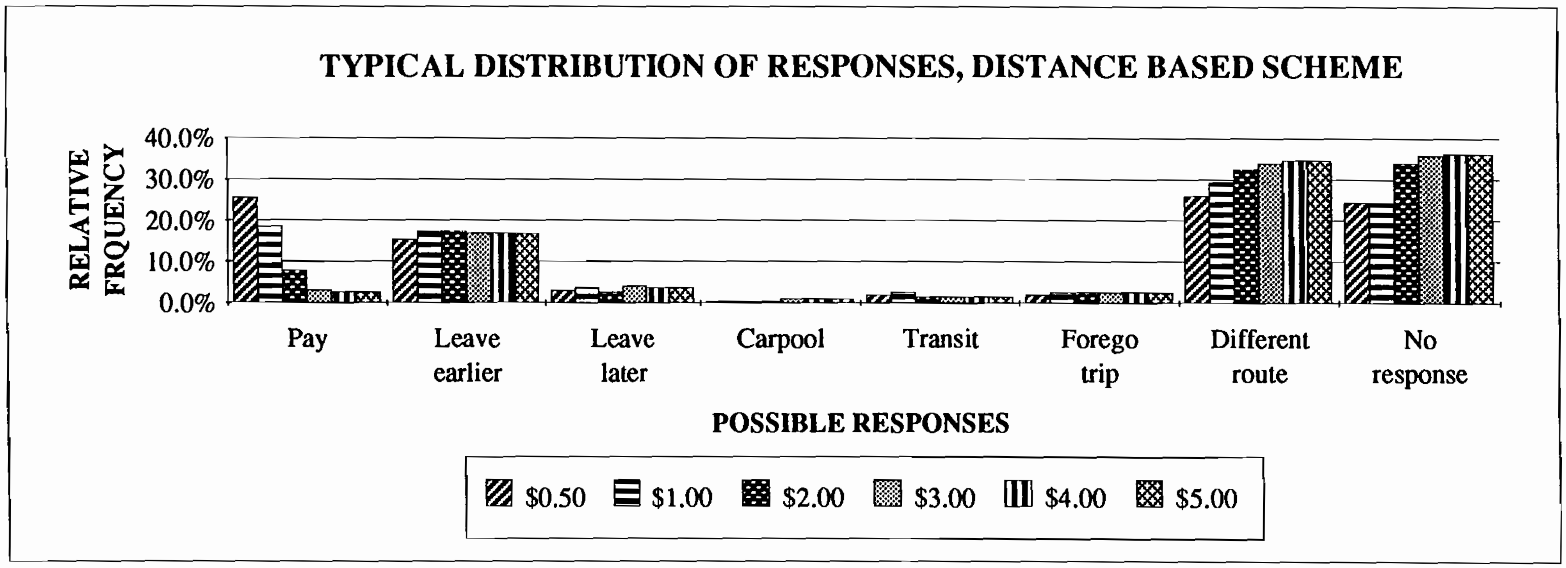


Figure 2. Typical Distribution of Responses.

seen in Figure 2. (Appendix E, Areawide Scheme - Distributions Stratified by Toll Level; Appendix F, Areawide Scheme - Distributions Stratified by Response Type; Appendix G, Distance Based Scheme - Distributions Stratified by Toll Level; Appendix H, Distance Based Scheme - Distributions Stratified by Response; Appendix I, Distributions Stratified by City.)

Developed price elasticities were based on a simplified hyperbolic relation in which demand is a function of only price. Elasticities based on most likely responses indicate an elastic nature of demand in Dallas and Houston when no information was provided regarding the method of toll collection (i.e. traditional methods of using a toll-booth attendant were implied). (Appendix J, Peice Elasticities of Demand.) However, when electronic toll tag technology was specified, demand becomes inelastic to price. Given the income and education bias of respondents, perhaps these aggregate elasticities are also biased, thereby indicating a need for further analysis using techniques to reduce sampling bias.

While the assumption of demand as a function of price only is an oversimplification, the aggregate elasticities provide insight into the level of acceptable tolling. Further investigation of elasticties is needed by developing multivariate formulations of demand that reveal level of elasticity related to demographics (particularly income), underlying factors, and/or perceived levels of congestion.

Responses to the pricing schemes indicate an unwillingness to shift from the drive-alone automobile trip. Even at high levels of tolls ($5.00), less than 5% of respondents indicated a most likely or 2nd most likely response of carpooling or using transit to accomplish their trip. Greater than one third indicated they would simply use a different route in order to avoid the toll. These responses indicate a need for network level modeling to investigate the impacts of tolls on connecting arterials and feeder routes, but they also suggest a strong need to motivate Texas residents to rethink how they perceive ways of satisfying their transportation needs.

As the level of toll increased from $0.50 to $5.00, the number of respondents willing to leave earlier to avoid the toll increased from 10-20% to 15-25%. This suggests a need for "free" alternatives to maximize the level of acceptability. Less than 5% indicated a most likely or 2nd most likely response of leaving later, which is perhaps due to little flexibility with hours of employment. As flex time and other new corporate strategies become more prevalent, perhaps these levels will change. It is also important to recognize that as greater numbers have the opportunity to participate in flex-time work hours, this decreases the ability to carpool while simultaneously increasing the need for timely, frequent transit for longer peak periods.

Identification of Candidate Locations

Perceived congestion is of importance in maximizing the likelihood of motorists' interest or concern in the problem. Therefore, for roadways used at least one time per week, respondents were instructed to indicate their perceptions of traffic conditions on a scale of 1 to 5, with 1 equating to free-flow movement and 5 corresponding to heavy congestion. (Appendix K Perceived Traffic Conditions by Roadway). Averages were then found for the different time period associated with each roadway to establish an initial understanding of responses. However, low response levels for certain time periods for some roadways indicates a need for further analysis in order to create a valid framework for establishing candidate locations.

FEASIBILITY OF PRICING IN TEXAS/SURVEY CONCLUSIONS

Previous experiences with congestion pricing attempts in the United States have shown that political acceptability and public cooperation are critical elements. Therefore, measures must be taken to ensure that a well-defined strategy incorporates elements to maximize these two factors.

Given the analysis of survey responses, it is apparent that a large barrier exists between auto-alternatives and acceptability. Given the prevalent auto culture that dominates the major cities of Texas, it is a great challenge to restructure the thinking of residents such that they consider alternatives to the drive alone vehicular trip. Currently, little interest exists in carpooling or using transit, and financial disincentives such as gas taxes and increased parking costs appear to have little impact on the decreasing auto use. Tolling has only a moderately greater influence.

While residents concede that congestion and air quality are problems affecting their respective cities, little interest is shown in alleviating the concerns. Most respondents feel that the automobile is the only way they can travel and they will always travel by auto. Additionally, it is believed that building additional lanes on freeways is a viable solution to alleviating congestion.

Therefore, given current public attitudes, attaining a level of acceptability for congestion pricing will be a difficult task. A strong influence is needed to catalyze a transformation in the public's transportation thinking, and it is unclear what the influence should be. Nonetheless, it is important to establish a framework and current understanding of pricing so that when the political climate is more favorable, a scheme could be pilot tested.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the findings of this study with regard to the feasibility of congestion pricing in Texas, and presents recommendations for the identification of candidate locations for congestion pricing applications.

FEASIBILITY OF CONGESTION PRICING IN TEXAS

Previous experience with congestion pricing attempts in the United States have shown that political acceptability, user and public cooperation are critical elements. Therefore, measures must be taken to ensure that a well-defined strategy incorporates elements to maximize these three factors. A good example of this cooperation is given by the Los Angeles congestion pricing scheme.

After the analysis of survey responses, apparently a large barrier exists between auto-alternatives and acceptability. Given the prevalent auto culture that dominates the major cities of Texas, it is a great challenge to restructure the thinking of residents such that they consider alternatives to the drive alone vehicular trip. Currently, little interest exists in carpooling or using transit, and financial disincentives such as gas taxes and increased parking costs appear to have little impact on decreasing auto use. Tolling has had only moderately greater influence.

While residents concede that congestion and air quality are problems affecting their respective cities and quality of life, little interest is shown in alleviating those concerns by changing their own behavior. They blame someone else for the problem. They also feel that the problem is not so important as to require radical measures; after all, congestion levels are still acceptable. Most respondents feel that the automobile is the only way they can travel since no real alternatives are provided and, that they will always travel by auto. Additionally, it is believed that building additional lanes on freeways and new facilities is a viable solution to alleviate congestion regardless of the financial costs. Any measure that considers restrictions on the use of the car is not acceptable.

Therefore, given the current public attitude, attaining a level of acceptability for congestion pricing will be a difficult task. A strong influence is needed to catalyze a transformation in the public's transportation thinking, and it is unclear what the influence should be. Nonetheless, it is important to establish a framework and current understanding of pricing so that when the political climate is more favorable, a scheme can be pilot tested.

This report has shown the directions that the practical implementation of congestion pricing in Texas could follow. A step by step process with modest objectives in the beginning and areawide implementation once the effectiveness of congestion pricing is presented in the next section. Current conditions in Texas are still not adequate for the full implementation of congestion pricing, but they might well be as soon as the effects of the regulations on non-attainment areas start to affect driving patterns in those cities, or congestion problems become so important that radical measures are called for by the public.

REQUIREMENTS FOR CANDIDATE LOCATIONS

Experience in the implementation of congestion pricing outside the US and the strong reaction found in some of responses to the mail survey suggest that, if a congestion pricing scheme were implemented in Texas, it must be carefully introduced so as to maximize the likelihood of success. This section presents a set of guidelines or directions that may be followed towards this goal.

Start with places that have facilities where tolling is already in place or has been in place sometime before, and that have problems with congestion. In this manner, the burden of paying a toll would not be seen as new form of taxing. Dallas and Houston have facilities that fulfill those conditions. Congestion pricing can also be implemented in places projecting the construction of new facilities. For this case any city in Texas close to non-attainment status or already there can justify the implementation of the scheme. However, particular attention should be given to the legal aspects of tolling those new facilities.

Start with single facilities. The system could be extended later to downtown zones. It will be always easier to start with single facilities, analyze the effects of congestion pricing, the public and user reactions and then, if the appropriate environment is provided, extend the schemes to specific areas such as Central Business Districts. This direction is substantially different from the order that has been followed outside the US, but the strong feelings of some population groups against new forms of taxation or government run programs suggest that it would be desirable to first demonstrate some of the benefits before applying any areawide scheme.

Combine the introduction of pricing with improvements in transit services . It has been seen that congestion pricing cannot work by itself. It requires real transportation alternatives to be offered, such as better transit services, parking outside the restricted zones and benefits for carpooling.

Increase parking fees in the restricted areas. This would complement congestion pricing making it even less attractive to drive to the restricted zones.

Proposed Schemes

A congestion pricing scheme may have many different characteristics. With respect to the affected zone, the scheme can be facility specific or areawide. The charge can be by length of travel, time spent in the restricted zone, entering, existing or crossing the boundary of the area or facility. Different prices can be charged according to the time in which the facility is used or the area is visited i.e. a flat price for the whole day or during the daytime; two different prices, one for the pre-peak and post peak times and another for the peak period; or even three different prices, one for the morning peak hour, other for the inter-peak times and another for the afternoon peak.

The selection of the characteristics of the scheme will depend on the intended objectives. If it is desired to affect only the morning peak hours, it would be adequate to implement congestion pricing only during the morning. This will affect mainly the home to work trips without affecting businesses that have customers in the evening hours. If it is desired to reduce the number of vehicles in a certain zone for the whole day, a flat charge will be more adequate.

According to the conditions observed in Texas, it is recommended that a scheme where the charge varies with the length of travel be used for the case of freeways, and an entering boundary for the case of the areawide schemes. In both cases the use of pricing during the extended morning peak hours would be preferred, since it will affect only the morning commuters.

Regarding the price level, it would theoreticallybe desirable to have a price that adequately reflects the externality (an optimal price). However, externalities vary as soon as the network conditions change. If an optimal price scheme were applied the number of different prices will be so confusing for the users that the public outcry will kill the system in a short time. Experience has shown that it is better to use a single price during the congested period. Its calculation can be done for average peak conditions. Once this price is set, it is convenient to hold the price until the public becomes accustomed to it. If external conditions, such as inflation, affect that price or congestion is not reduced to the desired level then a new price can be estimated and put in practice for a new period.

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Appendix A - Survey

March 21, 1994

Dear Survey Participant:

We have all experienced traffic congestion, the air pollution associated with it, and the time wasted while waiting for traffic to move. Planners, engineers, and policy makers are looking for effective means to solve these problems. Improved public transit, high occupancy vehicle lanes and the application of advanced telecommunications technologies are some of the measures being considered. The Center for Transportation Research (CTR) at the University of Texas at Austin is one of the leading research groups in the nation studying traffic and developing innovative solutions. To understand the effects of possible measures, your help is needed.

We would greatly appreciate your assistance by completing the enclosed survey. Select either the English or Spanish version - whichever is more convenient. It has been designed to be completed in no more than fifteen minutes. You need only check off your answers or write a number in most cases, and a postpaid return envelope has been included for your convenience. All information provided will be kept strictly confidential and will be used only for statistical purposes. Should you have any questions, please contact Raymond Moore at (512) 471-8270.

Thank you for your time and effort. Your promptness is greatly appreciated.

Sincerely,

C. Michael Walton
Ernest H. Cockrell Centennial Chair in Civil
Engineering & Chairman

La versión en español de esta carta está al reverso de esta hoja.

|S1| | | | |

TRANSPORTATION SURVEY

Thanks for participating in this survey that is being conducted at the Center for Transportation Research at the University of Texas at Austin. Your help will allow a better understanding of different measures to alleviate congestion. Answers will be kept confidential, and a post paid envelope has been enclosed.

SECTION A

Section A concerns travel to or through the downtown area of your city. Answer this section only if you travel to or through the downtown area at least once per week; otherwise, begin with Section B . Check only one response unless indicated otherwise.

A1) What is the distance from your home to downtown?

_____ I live downtown
_____ less than 5 miles
_____ 5-10 miles
_____ more than 10 miles

A2) On a typical day, how do you usually travel to or through downtown? *(Check all that apply.)*

_____ car (drive alone)
_____ carpool
_____ taxi
_____ transit
_____ bicycle
_____ other

A3) What route do you normally take?
(List only major roadways, e.g. IH-35, Lamar Blvd.)

____
____

A4) If you drive downtown for work purposes, do you pay for parking?

_____ yes ($_____/month)
_____ no, employer pays
_____ no

A5) For the past week, circle the time(s) of travel in or through the downtown area, and check the number describing downtown traffic conditions for that time (5 = heavy congestion; 1 = free flowing movement.)

TIME	DOWNTOWN TRAFFIC CONDITIONS				
	5 heavy	4	3	2	1 light
6-7 a.m.					
7-8 a.m.					
8-11 a.m.					
11-3 p.m.					
3-4 p.m.					
4-5 p.m.					
5-6 p.m.					
other					

A6) For the time(s) circled in question 5, designate the primary purpose of the trip to or through the downtown area and the number of times per week this trip is usually made. (A round trip from your residence to downtown and then returning is considered 1 trip.)

TIME	PRIMARY PURPOSE				TIMES/WEEK
	work	shopping	recreation	other	
6-7 a.m.					
7-8 a.m.					
8-11 a.m.					
11-3 p.m.					
3-4 p.m.					
4-5 p.m.					
5-6 p.m.					
other					

SECTION B

Section B concerns your use of freeways in the metropolitan area. Answer the following questions regarding freeways you use at least one time per week for traveling throughout the metropolitan area.

B1) Circle the freeways you use and indicate the number of days per week you use the roadway. Indicate the primary purpose for the trip(s).

ROAD	NUMBER OF TIMES PER WEEK					PRIMARY PURPOSE OF TRIP
	1	2	3	4	more	work business shop leisure other
IH-35						
Mopac						

B2) Circle the freeway(s) that you usually use and select the time(s) you use the roadway(s). Select the number best describing the usual traffic conditions on a scale from 1 to 5 (5 = heavy, congested; 1 = light, free flowing movement.)

ROAD	TIME							TRAFFIC
	6-7am	7-8am	8-11am	11-4pm	4-5pm	5-6pm	other	
IH-35								1 2 3 4 5
Mopac								1 2 3 4 5

SECTION C

The following questions present different scenarios regarding toll charges during congested periods. Indicate how you would most likely respond to each of t he following situations

C1) The downtown region is consistently congested during the time you usually drive through the area. **For every time you enter this area** during the congested period, you are charged $0.50. When the region is not congested, there is no charge. Of the following, which **three** are you most likely to do? (Rank as 1, 2 or 3; 1= most likely.)

_______ I would pay the extra cost and would not change my travel habits
_______ I would leave home earlier to avoid the extra cost.
_______ I would leave home later to avoid the extra cost.
_______ I would carpool to split the extra cost
_______ I would use public transit to avoid the extra cost
_______ I would forego my trip to avoid the area.
_______ Since my ultimate destination is not in the area, I would select a different route not passing through the region

C2) For the same scenario as above, if the charge is increased to $1.00, which three of the following are you most likely to do? (Rank as 1, 2 or 3; 1= most likely.)

_______ I would pay the extra cost and would not change my travel habits
_______ I would leave home earlier to avoid the extra cost.
_______ I would leave home later to avoid the extra cost.
_______ I would carpool to split the extra cost
_______ I would use public transit to avoid the extra cost
_______ I would forego my trip to avoid the area.
_______ Since my ultimate destination is not in the area, I would select a different route not passing through the region

C3) For the same scenario as above, indicate how you would respond to each of the different prices. For each price, indicate your **three** most likely responses (rank as 1 , 2 or 3; 1 = most likely.)

	$2.00	$3.00	$4.00	$5.00
I would pay the extra cost and would not change my travel habits	____	____	____	____
I would leave home earlier to avoid the extra cost.	____	____	____	____
I would leave home later to avoid the extra cost.	____	____	____	____
I would carpool to split the extra cost	____	____	____	____
I would use public transit to avoid the extra cost	____	____	____	____
I would forego my trip to avoid the area.	____	____	____	____
I would select a different route not passing through the area.	____	____	____	____

SECTION D

The following questions present a different scenario that also considers toll charging during congested periods. Indicate how you would most likely respond.

D1) A freeway is consistently congested at the time you usually drive on it. **Based on the distance traveled on the freeway** during the congested period, you are charged a maximum of $0.50. When it is not congested, there is no charge. Of the following, which **three** are you most likely to do? (Rank as 1, 2 or 3; 1= most likely.)

_______ I would pay the extra cost and would not change my travel habits
_______ I would leave home earlier to avoid the extra cost.
_______ I would leave home later to avoid the extra cost.
_______ I would carpool to split the extra cost
_______ I would use public transit to avoid the extra cost
_______ I would forego my trip to avoid the area.
_______ I would select a different route.

D2) For the same scenario as above, if the charge is increased to $1.00, which three of the following are you most likely to do? (Rank as 1, 2 or 3; 1= most likely.)

_______ I would pay the extra cost and would not change my travel habits
_______ I would leave home earlier to avoid the extra cost.
_______ I would leave home later to avoid the extra cost.
_______ I would carpool to split the extra cost
_______ I would use public transit to avoid the extra cost
_______ I would forego my trip to avoid the area.
_______ I would select a different route.

D3) For the same scenario as above, indicate how you would respond to each of the different prices. For each price, indicate your **three** most likely responses (rank as 1 , 2 or 3; 1 = most likely.)

	$2.00	$3.00	$4.00	$5.00
I would pay the extra cost and would not change my travel habits	____	____	____	____
I would leave home earlier to avoid the extra cost.	____	____	____	____
I would leave home later to avoid the extra cost.	____	____	____	____
I would carpool to split the extra cost	____	____	____	____
I would use public transit to avoid the extra cost	____	____	____	____
I would forego my trip to avoid the roadway.	____	____	____	____
I would select a different roadway.	____	____	____	____

SECTION E

The following are a set of questions regarding various transportation issues. Indicate whether you strongly agree, agree somewhat, are neutral, disagree somewhat, or strongly disagree.

E1) The freeways just can't handle the traffic they need to.	1 strongly agree	2	3	4	5 strongly disagree
E2) Congestion is a problem affecting the quality of life in this area.	1 strongly agree	2	3	4	5 strongly disagree
E3) Congestion causes me delay.	1 strongly agree	2	3	4	5 strongly disagree
E4) Congestion can be mitigated by adding more lanes to roads.	1 strongly agree	2	3	4	5 strongly disagree
E5) We cannot keep building more highways.	1 strongly agree	2	3	4	5 strongly disagree
E6) Congestion can be mitigated by discouraging auto use while encouraging other modes, such as bus.	1 strongly agree	2	3	4	5 strongly disagree
E7) Charging drivers to use a freeway is a good idea for decreasing congestion on that roadway.	1 strongly agree	2	3	4	5 strongly disagree
E8) Having accurate, timely traffic reports would affect my travel plans.	1 strongly agree	2	3	4	5 strongly disagree
E9) Increases in gasoline costs discourage me from driving.	1 strongly agree	2	3	4	5 strongly disagree
E10) Increases in parking costs discourage me from driving.	1 strongly agree	2	3	4	5 strongly disagree
E11) Having to pay for tolls would discourage me from driving.	1 strongly agree	2	3	4	5 strongly disagree
E12) Only the people who use a road should pay for it.	1 strongly agree	2	3	4	5 strongly disagree
E13) As a taxpayer, I have the right to travel on freeways without being charged to do so.	1 strongly agree	2	3	4	5 strongly disagree
E14) As a driver, I pay a gas tax for roads; I shouldn't be charged anything else.	1 strongly agree	2	3	4	5 strongly disagree
E15) Those who can afford to pay tolls should be the ones who use a road.	1 strongly agree	2	3	4	5 strongly disagree
E16) Charging tolls is unfair to the poor.	1 strongly agree	2	3	4	5 strongly disagree

E17) Using my vehicle contributes to problems with air pollution	1 strongly agree	2	3	4	5 strongly disagree
E18) I have a responsibility to control air pollution.	1 strongly agree	2	3	4	5 strongly disagree
E19) Air pollution affects the quality of life in this area.	1 strongly agree	2	3	4	5 strongly disagree
E20) Air quality is getting worse.	1 strongly agree	2	3	4	5 strongly disagree
E21) Nonattainment status requires drastic reductions in emissions.	1 strongly agee	2	3	4	5 strongly disagree
E22) It is my right to own a car.	1 strongly agree	2	3	4	5 strongly disagree
E23) Driving is the only way I can travel.	1 strongly agree	2	3	4	5 strongly disagree
E24) Public transit is for those who can't afford cars.	1 strongly agree	2	3	4	5 strongly disagree
E25) I will always drive my vehicle.	1 strongly agree	2	3	4	5 strongly disagree

SECTION F

The following questions will be used only for determining sample demographics.

F1) What is your gender? ______ male ______ female

F2) What was your age on your last birthday?
______ under 20 ______ 20 -30
______ 30 - 40 ______ 40 - 50
______ 50 - 60 ______ over 60

F3) Indicate the make and model year of all the passenger vehicles in your household (including pickups and vans)? (e.g. '87 Ford Taurus) ____________________

F4) How many drivers are in your household? ______

F5) What is the highest level of education you attained?
______ less than high school ______ high school
______ some college ______ finished college
______ Master's degree ______ Ph.D.

F6) What is your occupation? (Examples: Store Manager, Mechanic, Clerk) ________________

F7) Which category describes your *household's* gross (before taxes) annual income?
______ under $15,000 ______ $15,000 - 30,000
______ $30,000 - 45,000 ______ $45,000 - 60,000
______ $60,000 - 75,000 ______ over $75,000

F8) Indicate the number and type of adult bicycles in your household. (e.g. 1 mountain bike) ____________

End of survey. Thanks for your help. Please feel free to make any comments on these sheet.

Appendix B - Modified Survey

SECTION C

The following questions present different scenarios regarding automated toll charges during congested periods. Indicate how you would most likely respond to each of the following situations.

C1) The downtown region is consistently congested during the time you usually drive through the area. Your vehicle is equipped with an electronic tag as standard equipment, and it allows you to pay tolls without stopping at toll booths. For every time you enter this area during the congested period, you are charged $0.50. When the region is not congested, there is no charge. Of the following, which three are you most likely to do? (Rank as 1 the option you are most likely to do, 2 as the second most likely option, and 3 as the third most likely option. SELECT ONLY THREE OPTIONS.)

_______ I would pay the extra cost and would not change my travel habits
_______ I would leave home earlier to avoid the extra cost.
_______ I would leave home later to avoid the extra cost.
_______ I would carpool to split the extra cost
_______ I would use public transit to avoid the extra cost
_______ I would forego my trip to avoid the area.
_______ Since my ultimate destination is not in the area, I would select a different route not passing through the region

C2) For the same scenario as above, if the charge is increased to $1.00, which three of the following are you most likely to do? (Rank as 1 the option you are most likely to do, 2 as the second most likely option, and 3 as the third most likely option. SELECT ONLY THREE OPTIONS.)

_______ I would pay the extra cost and would not change my travel habits
_______ I would leave home earlier to avoid the extra cost.
_______ I would leave home later to avoid the extra cost.
_______ I would carpool to split the extra cost
_______ I would use public transit to avoid the extra cost
_______ I would forego my trip to avoid the area.
_______ Since my ultimate destination is not in the area, I would select a different route not passing through the region

C3) For the same scenario as above, indicate how you would respond to each of the different prices. For each price, indicate your three most likely responses. (Rank as 1 the option you are most likely to so, 2 as the second most likely option, and 3 as the third most likely option. SELECT ONLY THREE OPTIONS FOR EACH PRICE.)

	$2.00	$3.00	$4.00	$5.00
I would pay the extra cost and would not change my travel habits	____	____	____	____
I would leave home earlier to avoid the extra cost.	____	____	____	____
I would leave home later to avoid the extra cost.	____	____	____	____
I would carpool to split the extra cost	____	____	____	____
I would use public transit to avoid the extra cost	____	____	____	____
I would forego my trip to avoid the area.	____	____	____	____
I would select a different route not passing through the area.	____	____	____	____

SECTION D

The following questions present a different scenario that also considers automated toll charging during congested periods. Indicate how you would most likely respond.

D1) A freeway with automated toll booths allows vehicles with electronic tags to pay tolls without having to stop at toll booths. This freeway is consistently congested at the time you usually drive on it, and your vehicle has an electronic tag as standard equipment. **Based on the distance traveled on the freeway** during the congested period, you are charged a maximum of $0.50. When it is not congested, there is no charge. Of the following, which **three** are you most likely to do? (Rank as 1 the option you are most likely to do, 2 as the second most likely option, and 3 as the third most likely option. SELECT ONLY THREE OPTIONS.)

_______ I would pay the extra cost and would not change my travel habits
_______ I would leave home earlier to avoid the extra cost.
_______ I would leave home later to avoid the extra cost.
_______ I would carpool to split the extra cost
_______ I would use public transit to avoid the extra cost
_______ I would forego my trip to avoid the area.
_______ I would select a different route.

D2) For the same scenario as above, if the charge is increased to $1.00, which **three** of the following are you most likely to do? (Rank as 1 the option you are most likely to do, 2 as the second most likely option, and 3 as the third most likely option. SELECT ONLY THREE OPTIONS.)

_______ I would pay the extra cost and would not change my travel habits
_______ I would leave home earlier to avoid the extra cost.
_______ I would leave home later to avoid the extra cost.
_______ I would carpool to split the extra cost
_______ I would use public transit to avoid the extra cost
_______ I would forego my trip to avoid the area.
_______ I would select a different route.

D3) For the same scenario as above, indicate how you would respond to each of the different prices. For each price, indicate your **three** most likely responseS. (Rank as 1 the option you are most likely to do, 2 as the second most likely option, and 3 as the third most likely option. SELECT ONLY THREE OPTIONS FOR EACH PRICE.)

	$2.00	$3.00	$4.00	$5.00
I would pay the extra cost and would not change my travel habits	_____	_____	_____	_____
I would leave home earlier to avoid the extra cost.	_____	_____	_____	_____
I would leave home later to avoid the extra cost.	_____	_____	_____	_____
I would carpool to split the extra cost	_____	_____	_____	_____
I would use public transit to avoid the extra cost	_____	_____	_____	_____
I would forego my trip to avoid the roadway.	_____	_____	_____	_____
I would select a different roadway.	_____	_____	_____	_____

Appendix C - Demographics

Summary of demographics, Dallas Version 1

GENDER

	Number of responses	Relative frequency
Male	132	70.6%
Female	51	27.3%
No response	4	2.1%

AGE

	Number of responses	Relative frequency
Under 20	0	0.0%
20-30	24	12.8%
30-40	74	39.6%
40-50	45	24.1%
50-60	25	13.4%
Over 60	14	7.5%
No response	5	2.7%

STRATIFICATION (BY AGE) OF FEMALE RESPONSES

	Number of responses	Relative frequency
Under 20	0	0.0%
20-30	10	19.6%
30-40	23	45.1%
40-50	14	27.5%
50-60	3	5.9%
Over 60	1	2.0%
No response	0	0.0%

STRATIFICATION (BY AGE) OF MALE RESPONSES

	Number of responses	Relative frequency
Under 20	0	0.0%
20-30	14	10.6%
30-40	51	38.6%
40-50	31	23.5%
50-60	22	13.7%
Over 60	13	9.7%
No response	1	0.8%

NUMBER OF VEHICLES

	Number of responses	Relative frequency
1	65	34.8%
2	82	43.9%
3	24	12.8%
4	6	3.2%
5	1	0.5%
6	0	0.0%
7	0	0.0%
No response	9	4.8%

NUMBER OF DRIVERS

	Number of responses	Relative frequency
1	49	26.2%
2	102	54.5%
3	16	8.6%
4	10	5.3%
5	0	0.0%
6	0	0.0%
7	0	0.0%
No response	10	5.3%

EDUCATION

	Number of responses	Relative frequency
Less than high school	3	1.6%
High school	12	6.4%
Some college	61	32.6%
Finished college	68	36.4%
Master's degree	32	17.1%
Ph.D. / Advanced	6	3.2%
No response	5	2.7%

INCOME (GROSS ANNUAL)

	Number of responses	Relative frequency
Under $15,000	8	4.3%
$15,000 - $30,000	31	16.6%
$30,000 - $45,000	36	19.3%
$45,000 - $60,000	27	14.4%
$60,000 - $75,000	24	12.8%
Over $75,000	51	27.3%
No response	10	5.3%

Summary of demographics, Dallas Version 2

GENDER

	Number of responses	Relative frequency
Male	119	67.6%
Female	48	27.3%
No response	9	5.1%

AGE

	Number of responses	Relative frequency
Under 20	0	0.0%
20-30	18	10.2%
30-40	57	32.4%
40-50	46	26.1%
50-60	30	17.0%
Over 60	18	10.2%
No response	7	4.0%

STRATIFICATION (BY AGE) OF FEMALE RESPONSES

	Number of responses	Relative frequency
Under 20	0	0.0%
20-30	12	25.0%
30-40	13	27.1%
40-50	13	27.1%
50-60	5	10.4%
Over 60	5	10.4%
No response	0	0.0%

STRATIFICATION (BY AGE) OF MALE RESPONSES

	Number of responses	Relative frequency
Under 20	0	0.0%
20-30	6	5.0%
30-40	44	37.0%
40-50	33	27.7%
50-60	24	20.2%
Over 60	12	10.1%
No response	0	0.0%

NUMBER OF VEHICLES

	Number of responses	Relative frequency
1	44	25.3%
2	85	48.3%
3	31	17.6%
4	4	2.3%
5	0	0.0%
6	1	0.6%
7	0	0.0%
No response	11	6.3%

NUMBER OF DRIVERS

	Number of responses	Relative frequency
1	35	19.9%
2	101	57.4%
3	19	10.8%
4	6	3.4%
5	0	0.0%
6	0	0.0%
7	0	0.0%
No response	15	8.5%

EDUCATION

	Number of responses	Relative frequency
Less than high school	1	0.6%
High school	18	10.2%
Some college	40	22.7%
Finished college	62	35.2%
Master's degree	36	20.5%
Ph.D. / Advanced	11	6.3%
No response	8	4.5%

INCOME (GROSS ANNUAL)

	Number of responses	Relative frequency
Under $15,000	4	2.3%
$15,000 - $30,000	19	10.8%
$30,000 - $45,000	32	18.2%
$45,000 - $60,000	32	18.2%
$60,000 - $75,000	26	14.8%
Over $75,000	51	29.0%
No response	12	6.8%

Summary of demographics, El Paso

GENDER

	Number of responses	Relative frequency
Male	334	72.5%
Female	108	23.4%
No response	19	4.1%

AGE

	Number of responses	Relative frequency
Under 20	3	0.7%
20-30	49	10.6%
30-40	134	29.1%
40-50	119	25.8%
50-60	92	20.0%
Over 60	45	9.8%
No response	19	4.1%

STRATIFICATION (BY AGE) OF FEMALE RESPONSES

	Number of responses	Relative frequency
Under 20	1	0.9%
20-30	17	15.7%
30-40	34	31.5%
40-50	38	35.2%
50-60	11	10.2%
Over 60	5	4.6%
No response	2	1.9%

STRATIFICATION (BY AGE) OF MALE RESPONSES

	Number of responses	Relative frequency
Under 20	2	0.6%
20-30	31	9.3%
30-40	100	29.9%
40-50	81	24.3%
50-60	80	24.0%
Over 60	40	12.0%
No response	0	0.0%

NUMBER OF VEHICLES

	Number of responses	Relative frequency
1	134	29.1%
2	209	45.3%
3	64	13.9%
4	21	4.6%
5	3	0.7%
6	0	0.0%
7	2	0.4%
No response	28	6.1%

NUMBER OF DRIVERS

	Number of responses	Relative frequency
1	79	17.1%
2	245	53.1%
3	76	16.5%
4	18	3.9%
5	5	1.1%
6	2	0.4%
7	1	0.2%
No response	35	7.6%

EDUCATION

	Number of responses	Relative frequency
Less than high school	16	3.5%
High school	63	13.7%
Some college	159	34.5%
Finished college	140	30.4%
Master's degree	44	9.5%
Ph.D. / Advanced	17	3.7%
No response	22	4.8%

INCOME (GROSS ANNUAL)

	Number of responses	Relative frequency
Under $15,000	52	11.3%
$15,000 - $30,000	86	18.7%
$30,000 - $45,000	116	25.2%
$45,000 - $60,000	85	18.4%
$60,000 - $75,000	38	8.2%
Over $75,000	54	11.7%
No response	30	6.5%

Summary of demographics, Houston Version 1

GENDER

	Number of responses	Relative frequency
Male	112	65.1%
Female	55	32.0%
No response	5	2.9%

AGE

	Number of responses	Relative frequency
Under 20	0	0.0%
20-30	19	11.0%
30-40	77	33.7%
40-50	116	22.7%
50-60	158	24.4%
Over 60	167	5.2%
No response	172	2.9%

STRATIFICATION (BY AGE) OF FEMALE RESPONSES

	Number of responses	Relative frequency
Under 20	0	0.0%
20-30	13	23.6%
30-40	17	30.9%
40-50	13	23.6%
50-60	9	16.4%
Over 60	3	5.5%
No response	0	0.0%

STRATIFICATION (BY AGE) OF MALE RESPONSES

	Number of responses	Relative frequency
Under 20	0	0.0%
20-30	6	5.4%
30-40	41	36.6%
40-50	26	23.2%
50-60	33	29.5%
Over 60	5	4.5%
No response	1	0.9%

NUMBER OF VEHICLES

	Number of responses	Relative frequency
1	54	31.4%
2	83	48.3%
3	19	11.0%
4	5	2.9%
5	1	0.6%
6	0	0.0%
7	1	0.6%
No response	9	5.2%

NUMBER OF DRIVERS

	Number of responses	Relative frequency
1	50	29.1%
2	100	58.1%
3	9	5.2%
4	4	2.3%
5	1	0.6%
6	0	0.0%
7	0	0.0%
No response	8	4.7%

EDUCATION

	Number of responses	Relative frequency
Less than high school	2	1.2%
High school	16	9.3%
Some college	53	30.8%
Finished college	61	35.5%
Master's degree	24	14.0%
Ph.D. / Advanced	11	6.4%
No response	5	2.9%

INCOME (GROSS ANNUAL)

	Number of responses	Relative frequency
Under $15,000	8	4.7%
$15,000 - $30,000	32	14.0%
$30,000 - $45,000	59	15.7%
$45,000 - $60,000	90	18.0%
$60,000 - $75,000	118	16.3%
Over $75,000	160	24.4%
No response	172	7.0%

Summary of demographics, Houston Version 2

GENDER

	Number of responses	Relative frequency
Male	128	68.1%
Female	55	29.3%
No response	5	2.7%

AGE

	Number of responses	Relative frequency
Under 20	2	1.1%
20-30	23	11.2%
30-40	90	35.6%
40-50	134	23.4%
50-60	176	22.3%
Over 60	182	3.2%
No response	188	3.2%

STRATIFICATION (BY AGE) OF FEMALE RESPONSES

	Number of responses	Relative frequency
Under 20	1	1.8%
20-30	9	16.4%
30-40	24	43.6%
40-50	11	20.0%
50-60	8	14.5%
Over 60	2	3.6%
No response	0	0.0%

STRATIFICATION (BY AGE) OF MALE RESPONSES

	Number of responses	Relative frequency
Under 20	1	80.0%
20-30	12	9.4%
30-40	43	33.6%
40-50	33	25.8%
50-60	34	26.6%
Over 60	4	3.1%
No response	1	0.8%

NUMBER OF VEHICLES

	Number of responses	Relative frequency
1	66	35.1%
2	84	44.7%
3	23	12.2%
4	6	3.2%
5	0	0.6%
6	0	0.0%
7	0	0.0%
No response	9	4.8%

NUMBER OF DRIVERS

	Number of responses	Relative frequency
1	51	27.1%
2	100	53.2%
3	17	9.0%
4	6	3.2%
5	1	0.5%
6	0	0.0%
7	0	0.0%
No response	13	6.9%

EDUCATION

	Number of responses	Relative frequency
Less than high school	5	2.7%
High school	15	8.0%
Some college	54	28.7%
Finished college	68	36.2%
Master's degree	24	12.8%
Ph.D. / Advanced	15	8.0%
No response	7	3.7%

INCOME (GROSS ANNUAL)

	Number of responses	Relative frequency
Under $15,000	7	3.7%
$15,000 - $30,000	12	6.4%
$30,000 - $45,000	44	23.4%
$45,000 - $60,000	30	16.0%
$60,000 - $75,000	29	15.4%
Over $75,000	52	27.7%
No response	14	7.4%

Summary of demographics, San Antonio

GENDER

	Number of responses	Relative frequency
Male	333	72.2%
Female	119	25.8%
No response	9	2.0%

AGE

	Number of responses	Relative frequency
Under 20	1	0.2%
20-30	51	11.1%
30-40	134	29.1%
40-50	116	25.2%
50-60	97	21.0%
Over 60	51	11.1%
No response	11	2.4%

STRATIFICATION (BY AGE) OF FEMALE RESPONSES

	Number of responses	Relative frequency
Under 20	0	0.0%
20-30	25	21.0%
30-40	36	30.3%
40-50	30	25.2%
50-60	12	10.1%
Over 60	14	11.8%
No response	2	1.7%

STRATIFICATION (BY AGE) OF MALE RESPONSES

	Number of responses	Relative frequency
Under 20	1	0.3%
20-30	26	7.8%
30-40	98	29.4%
40-50	86	25.8%
50-60	85	25.5%
Over 60	37	11.1%
No response	0	0.0%

NUMBER OF VEHICLES

	Number of responses	Relative frequency
1	137	29.7%
2	219	47.5%
3	63	13.7%
4	20	4.3%
5	1	0.2%
6	2	0.4%
7	2	0.4%
No response	17	3.7%

NUMBER OF DRIVERS

	Number of responses	Relative frequency
1	88	19.1%
2	259	56.2%
3	65	14.1%
4	19	4.1%
5	1	0.2%
6	1	0.2%
7	1	0.2%
No response	27	5.9%

EDUCATION

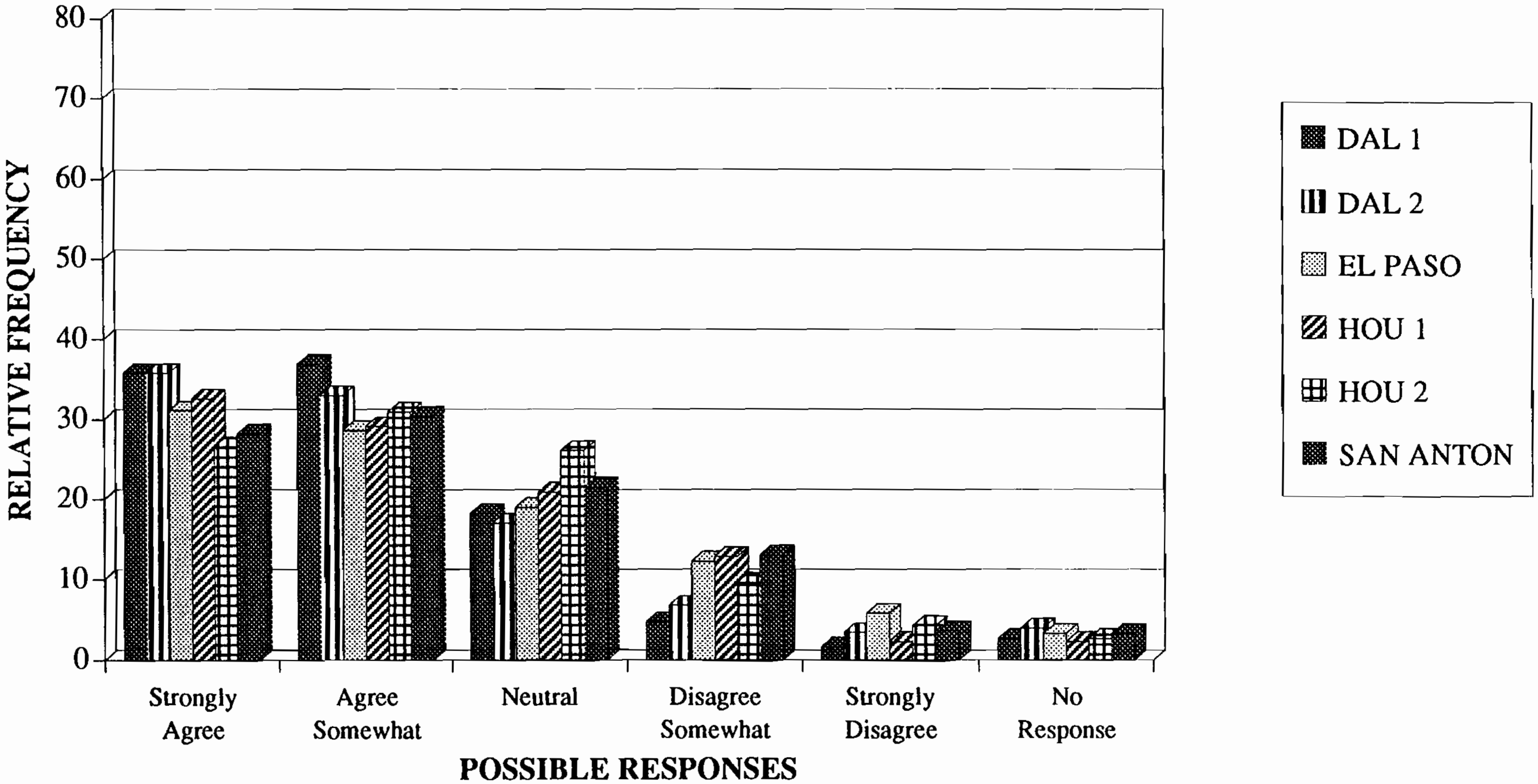
	Number of responses	Relative frequency
Less than high school	6	1.3%
High school	45	9.8%
Some college	162	35.1%
Finished college	148	32.1%
Master's degree	69	15.0%
Ph.D. / Advanced	18	3.9%
No response	13	2.8%

INCOME (GROSS ANNUAL)

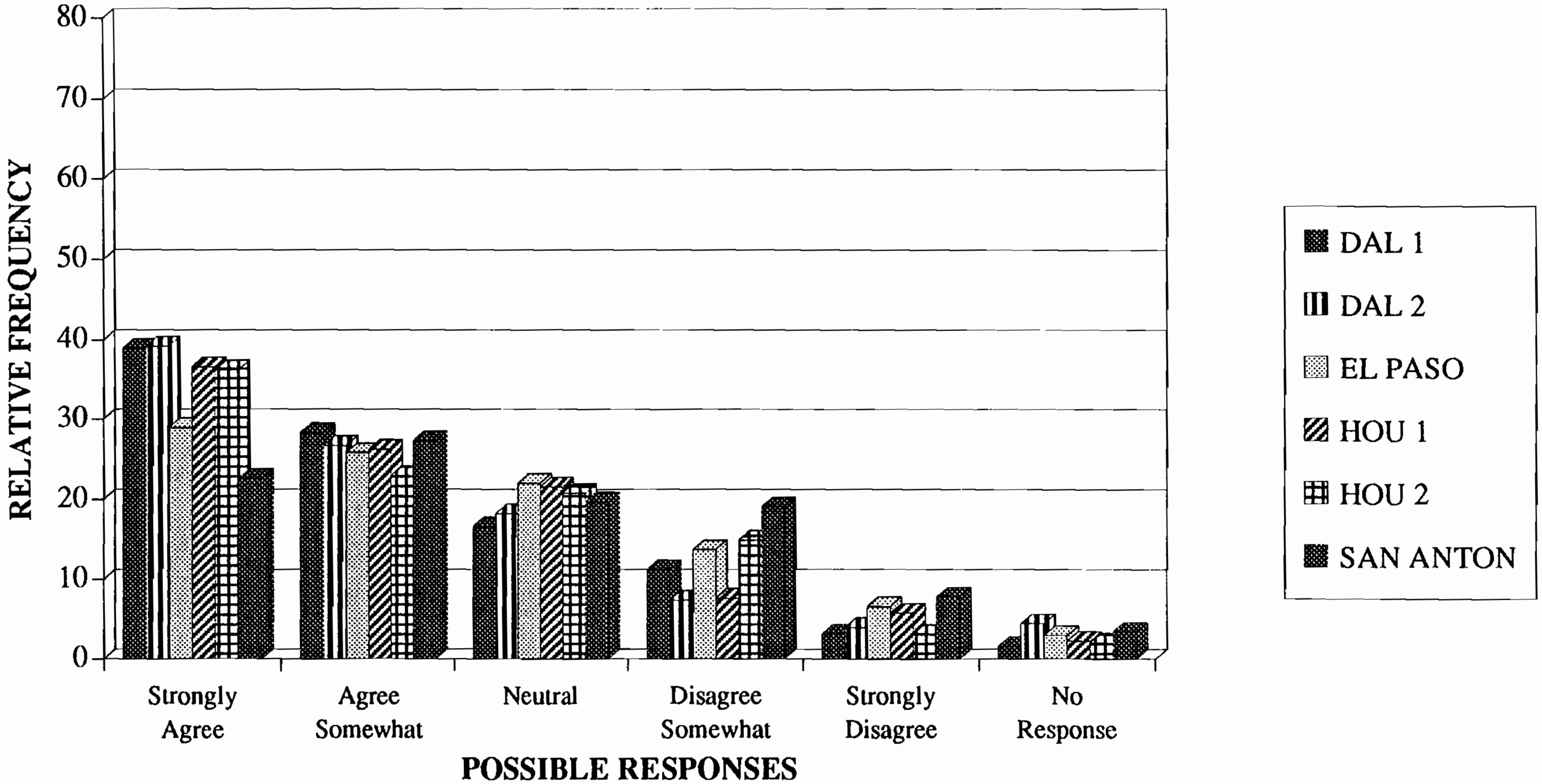
	Number of responses	Relative frequency
Under $15,000	18	3.9%
$15,000 - $30,000	70	15.2%
$30,000 - $45,000	123	26.7%
$45,000 - $60,000	91	19.7%
$60,000 - $75,000	44	9.5%
Over $75,000	84	18.2%
No response	31	6.7%

Appendix D - Distributions of Attitudinal Questions

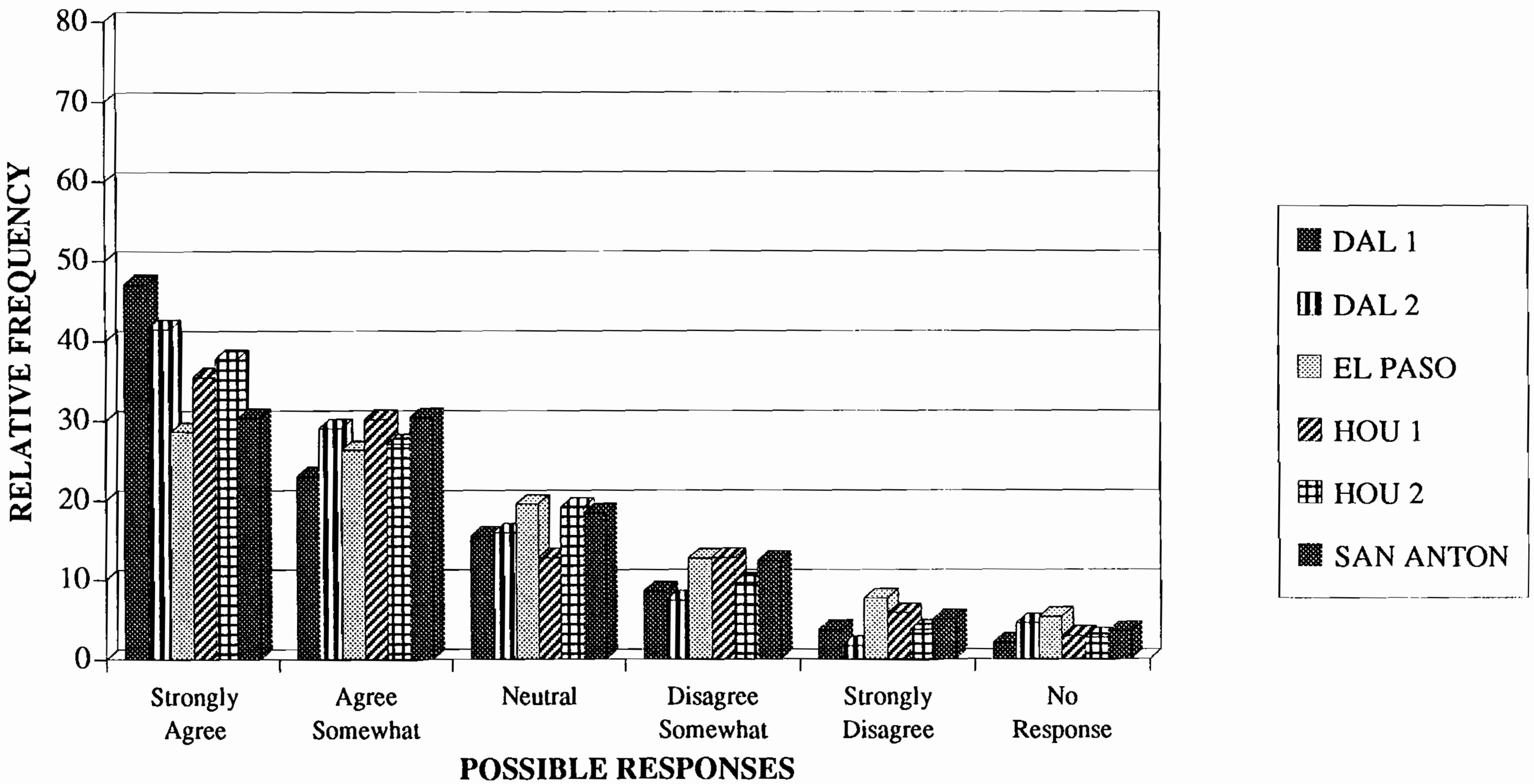
1. FREEWAYS JUST CAN'T HANDLE THE TRAFFIC THEY NEED TO



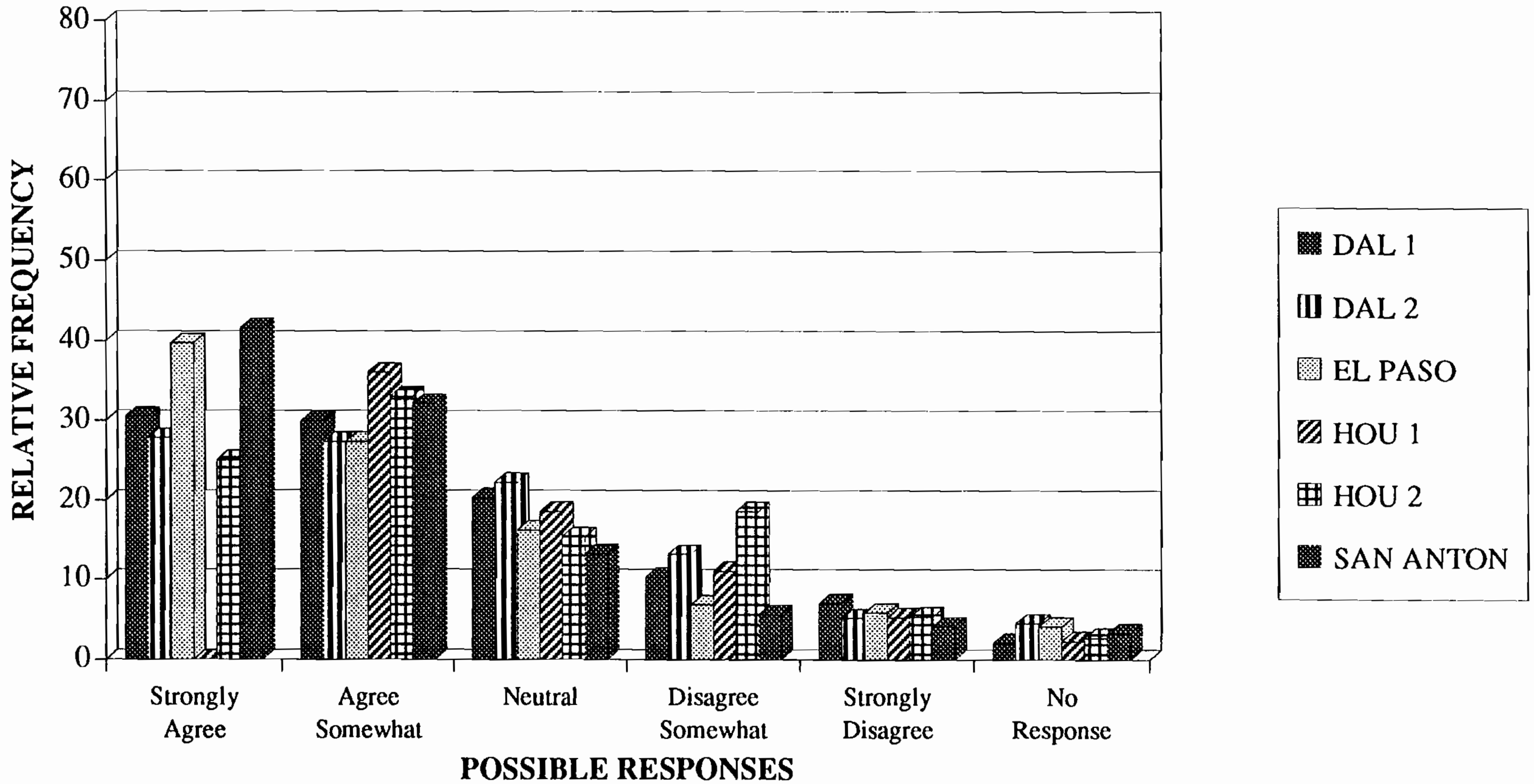
2. CONGESTION AFFECTS THE QUALITY OF LIFE IN THIS AREA



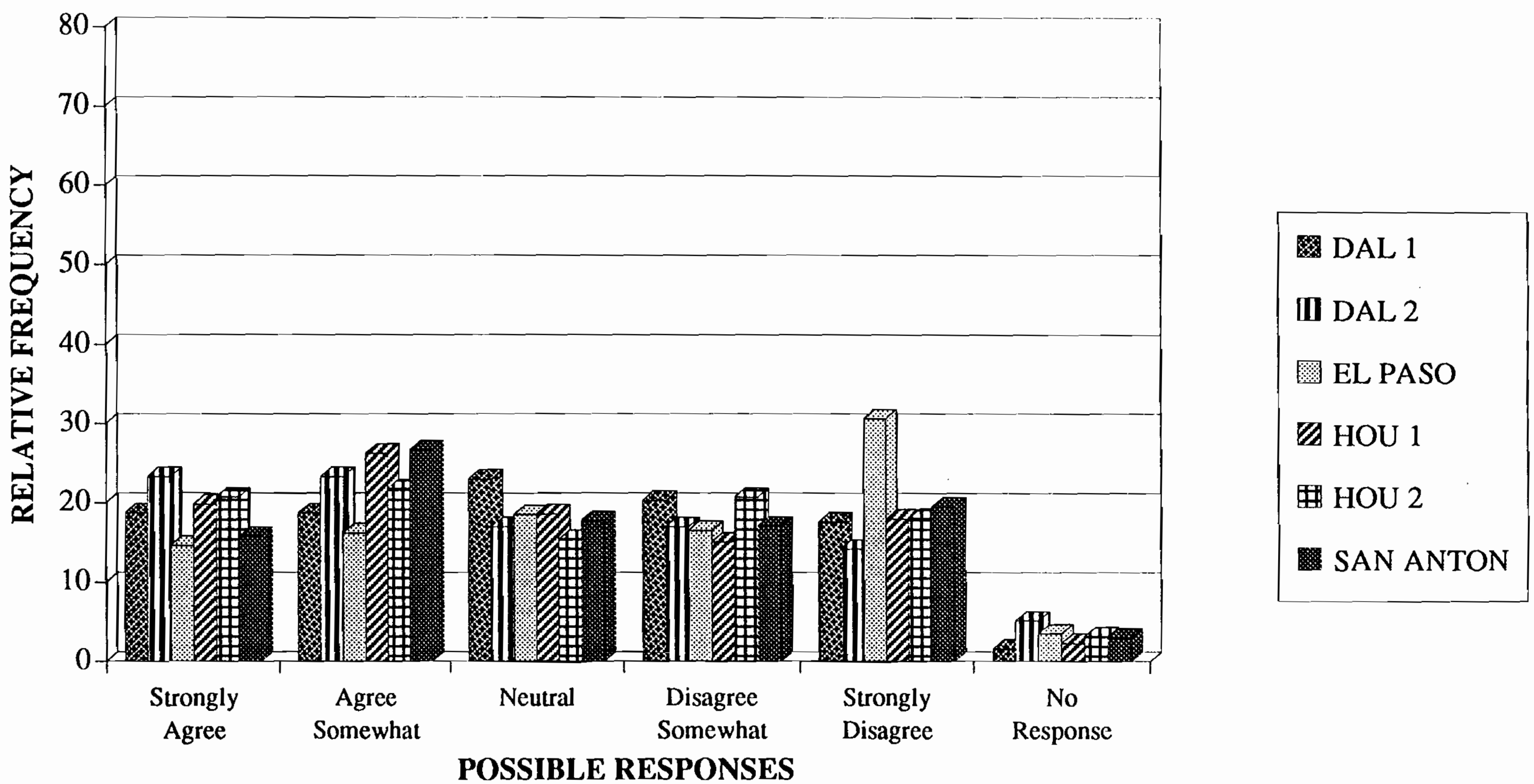
3. CONGESTION CAUSES ME DELAY



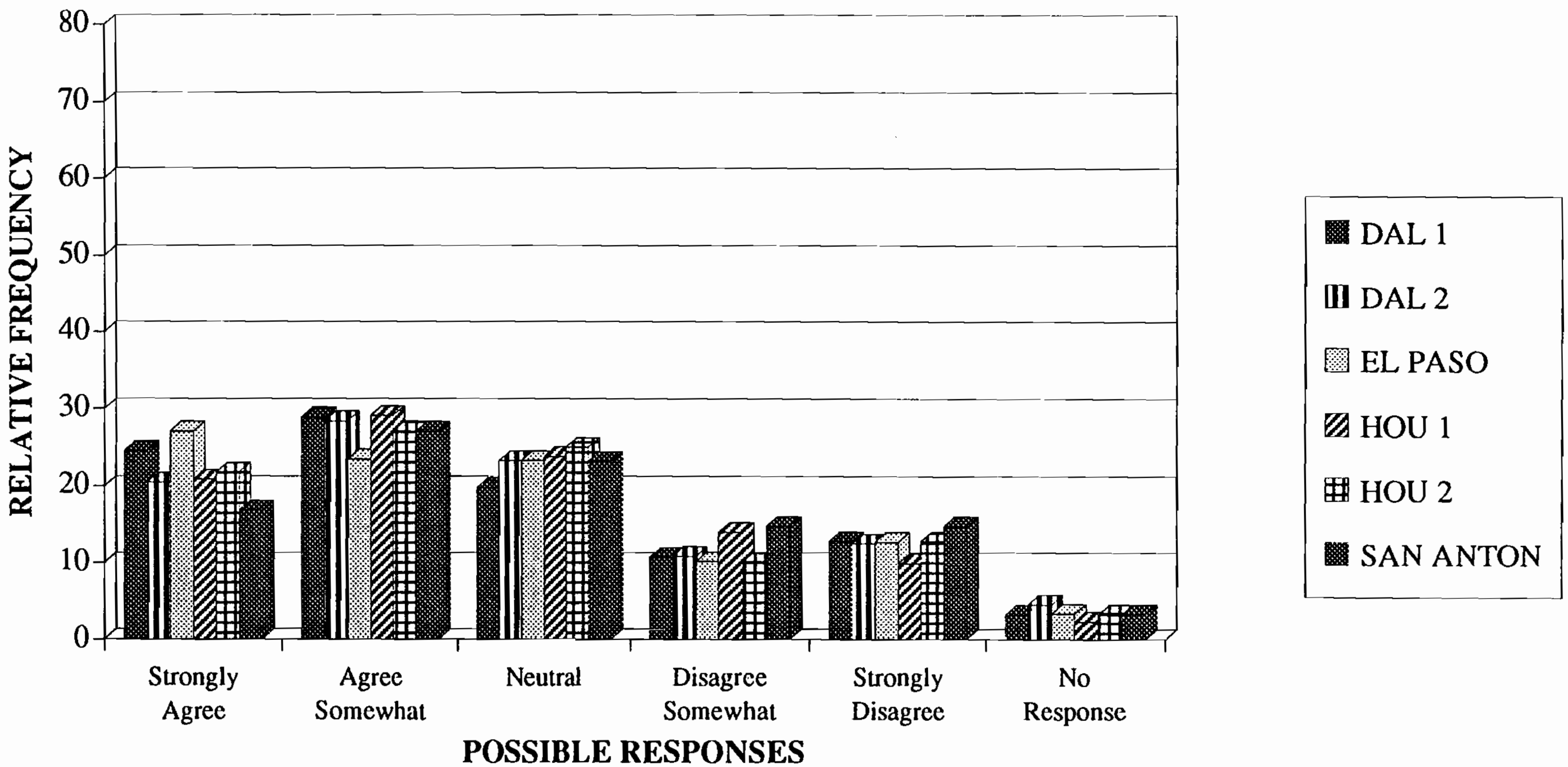
4. CONGESTION CAN BE MITIGATED BY ADDING MORE LANES



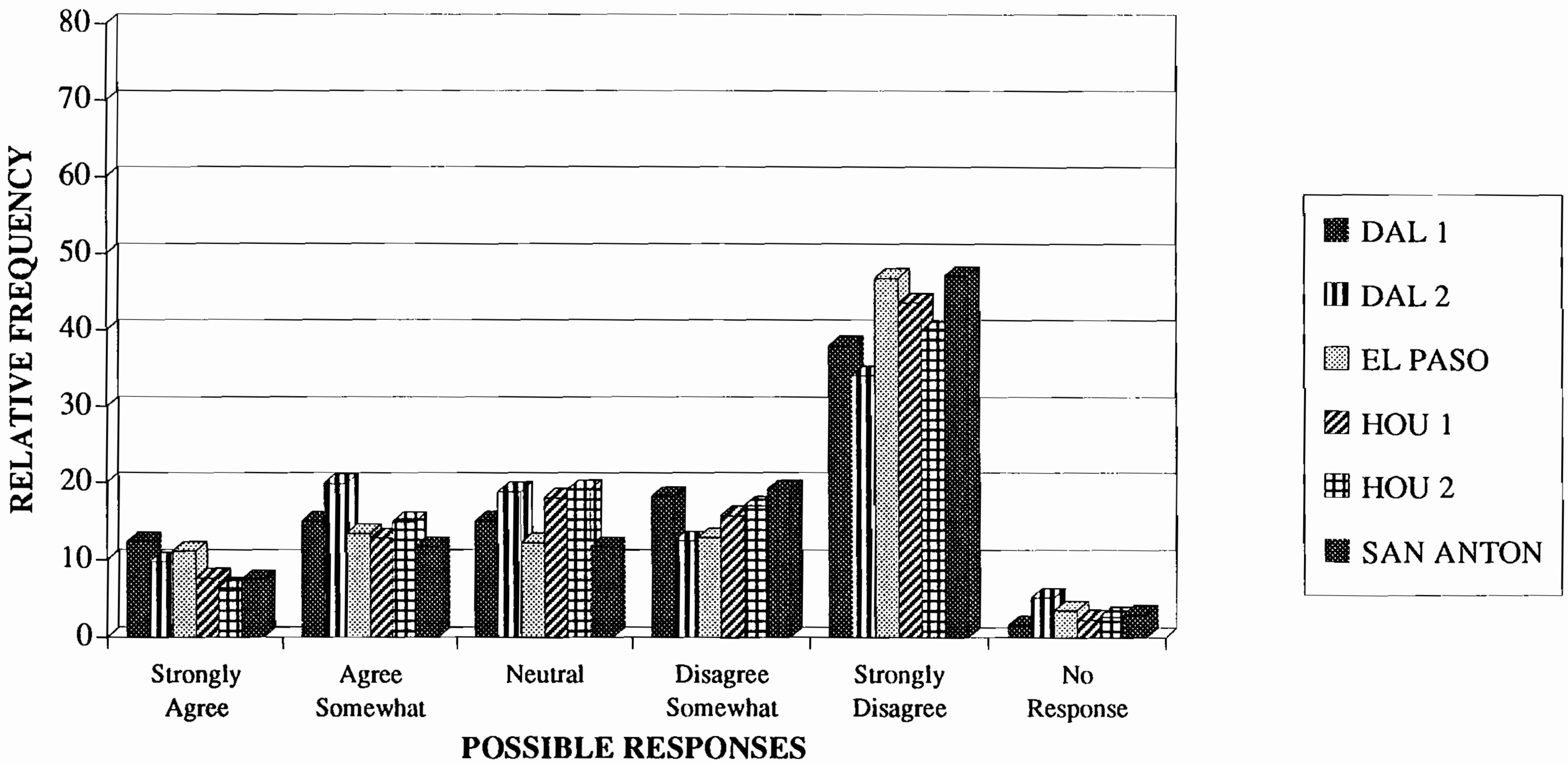
5. WE CANNOT KEEP BUILDING MORE HIGHWAYS



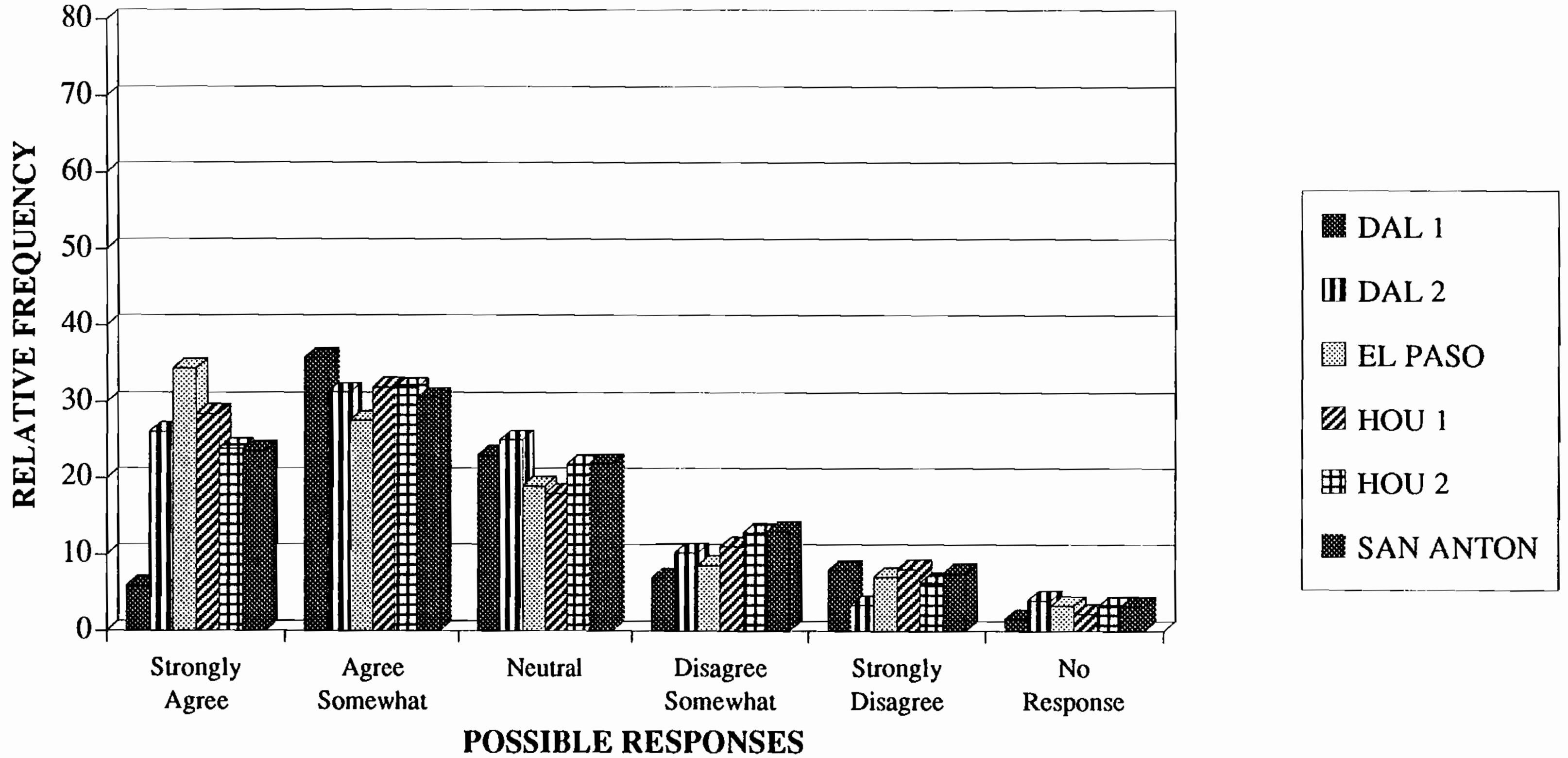
6. CONGESTION CAN BE MITIGATED BY DISCOURAGING AUTO USE WHILE ENCOURAGING OTHER MODES, SUCH AS BUS



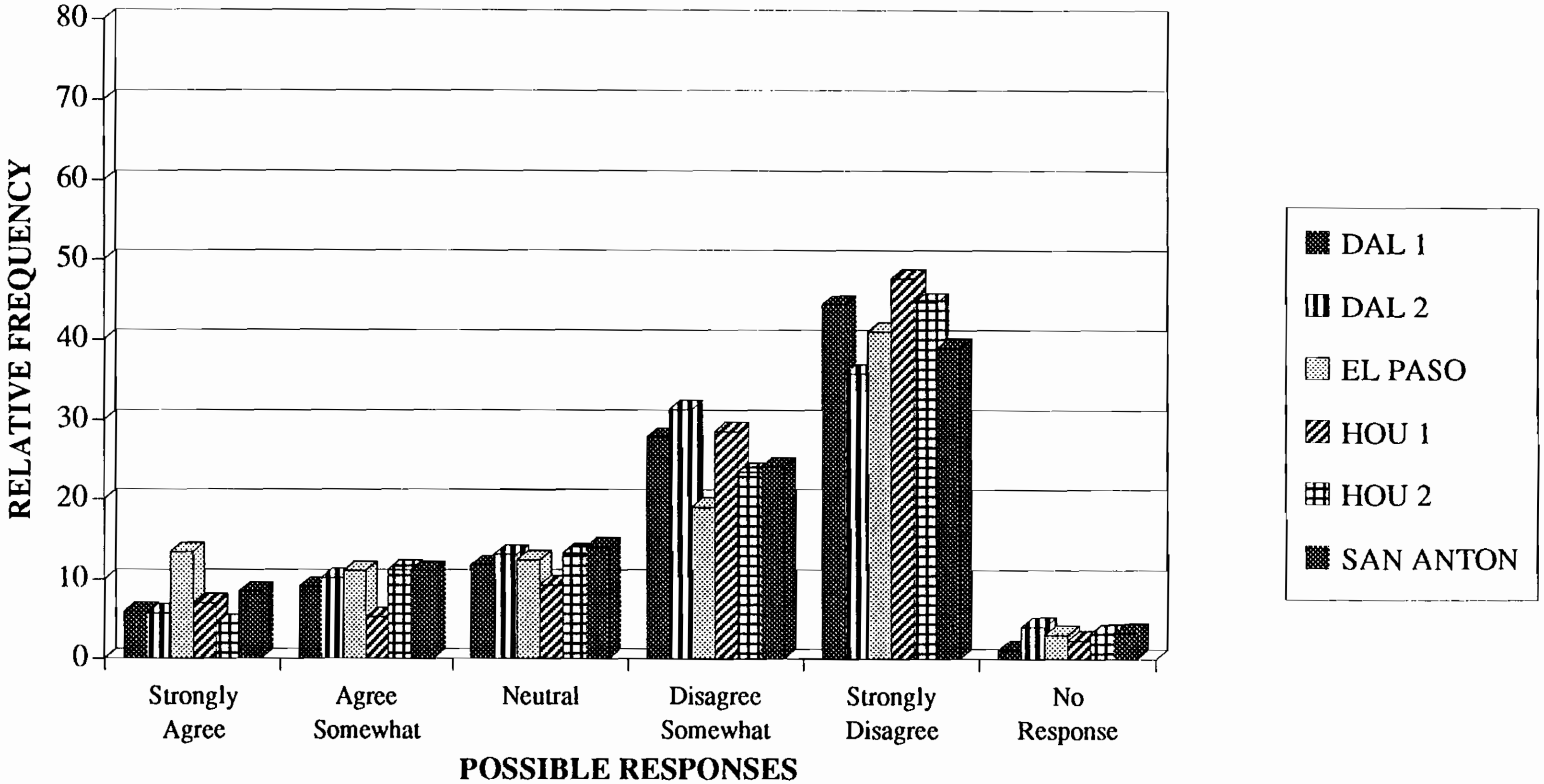
7. CHARGING DRIVERS TO USE A ROADWAY IS A GOOD IDEA TO REDUCE CONGESTION ON THAT ROADWAY



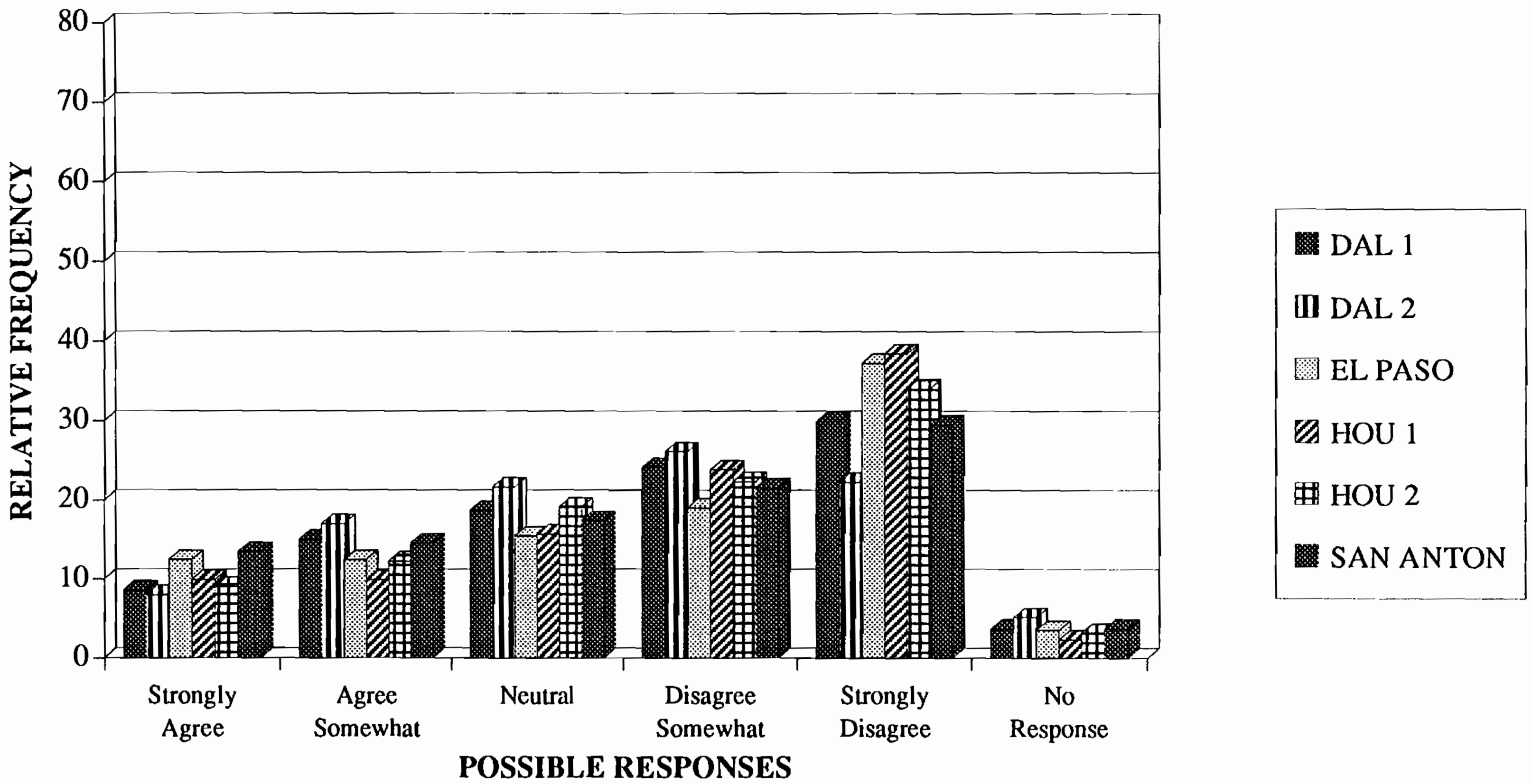
8. HAVING ACCURATE, TIMELY TRAVEL REPORTS WOULD AFFECT MY TRAVEL PLANS



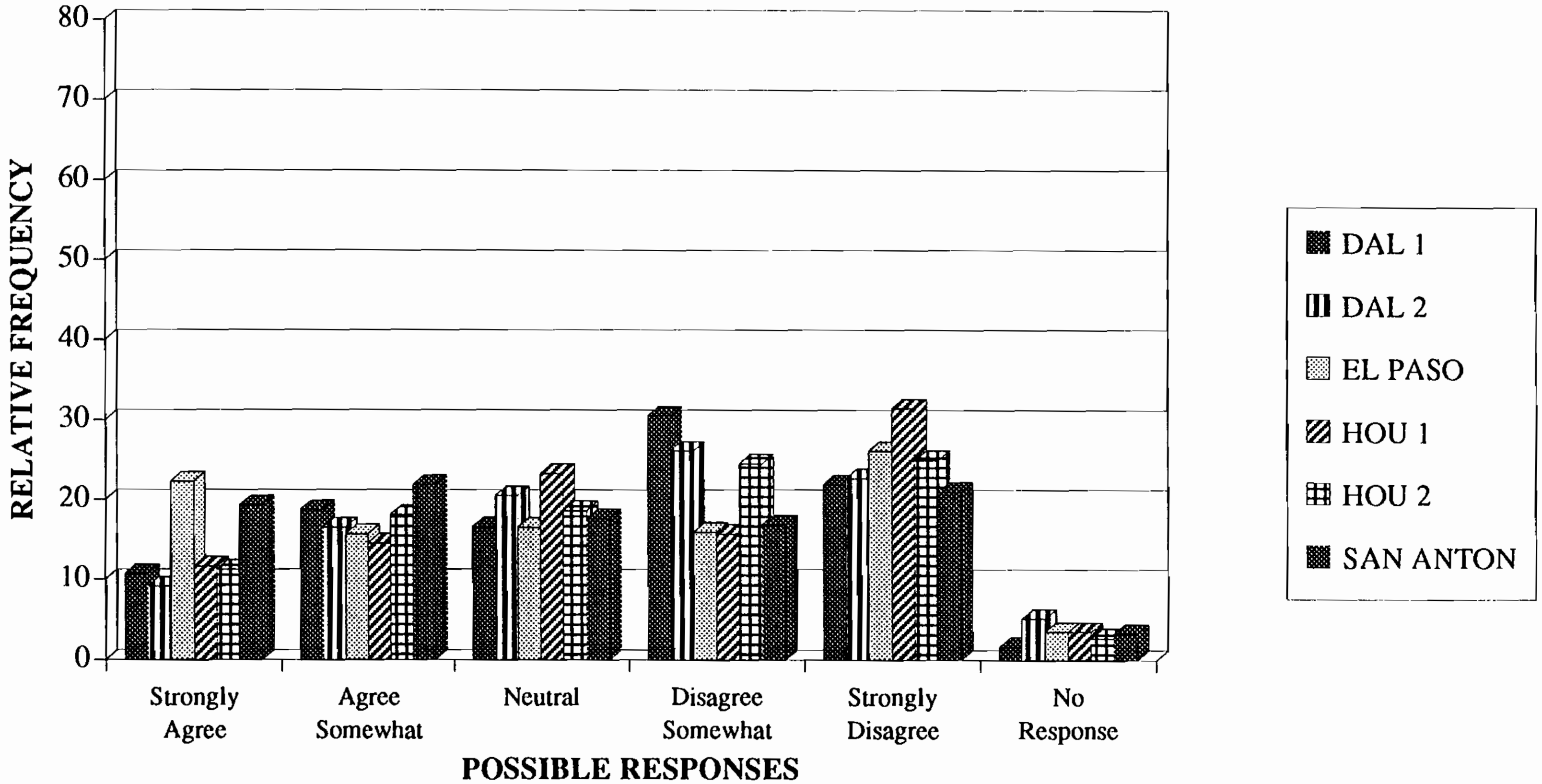
9. INCREASES IN GASOLINE COSTS DISCOURAGE ME FROM DRIVING



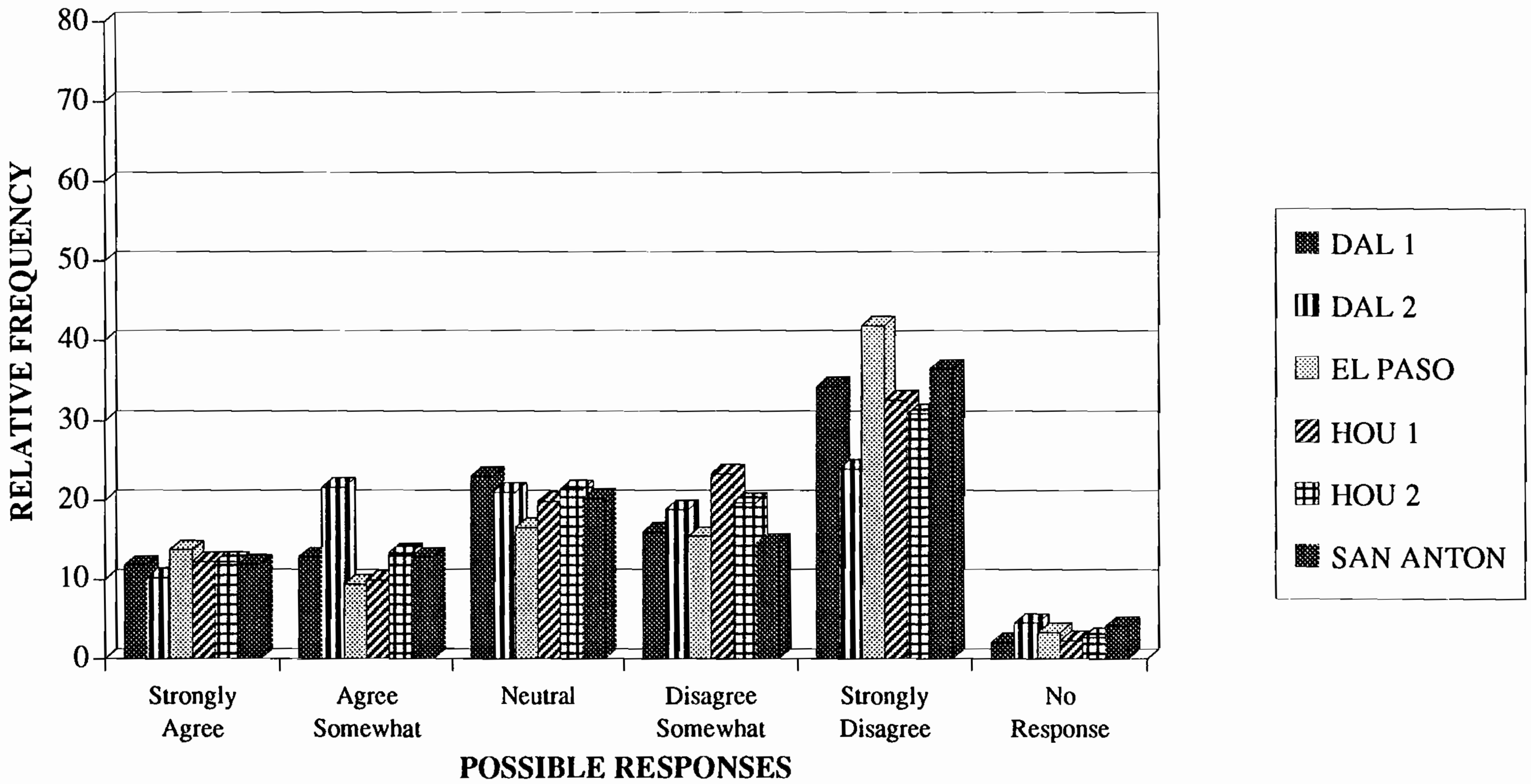
10. INCREASES IN PARKING COSTS DISCOURAGE ME FROM DRIVING



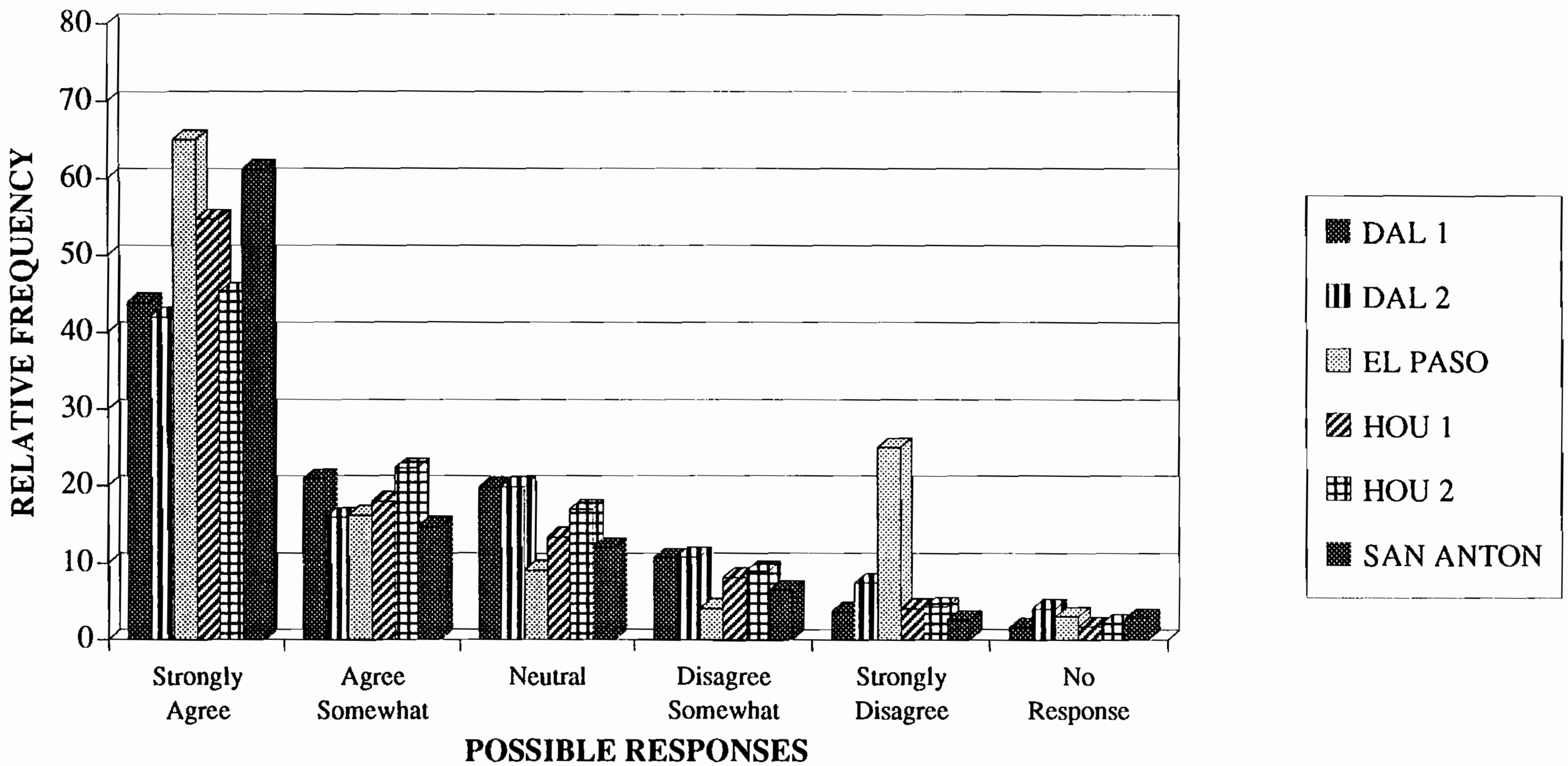
11. HAVING TO PAY TOLLS WOULD DISCOURAGE ME FROM DRIVING



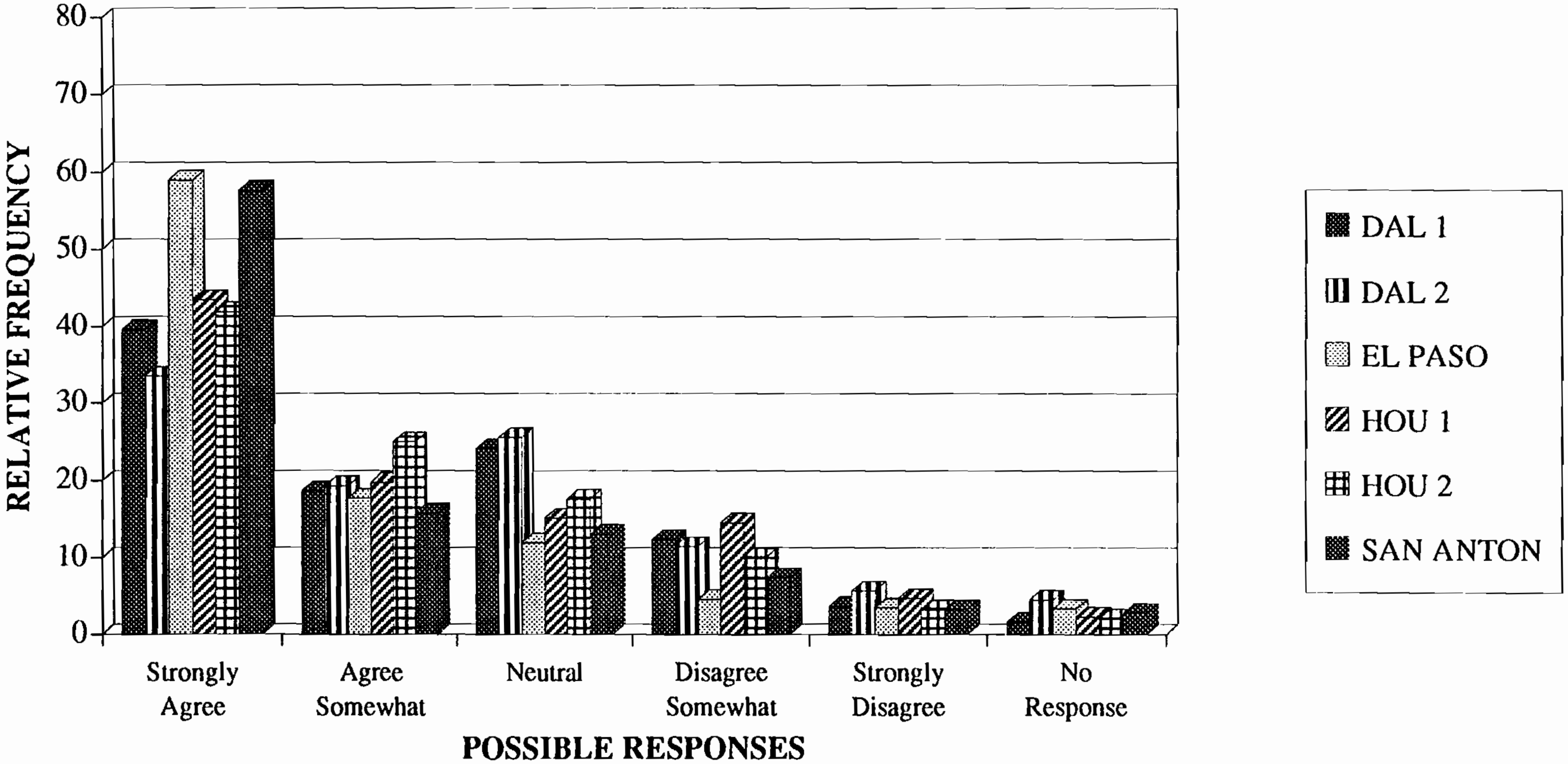
12. ONLY THE PEOPLE WHO PAY FOR A ROAD SHOULD USE IT



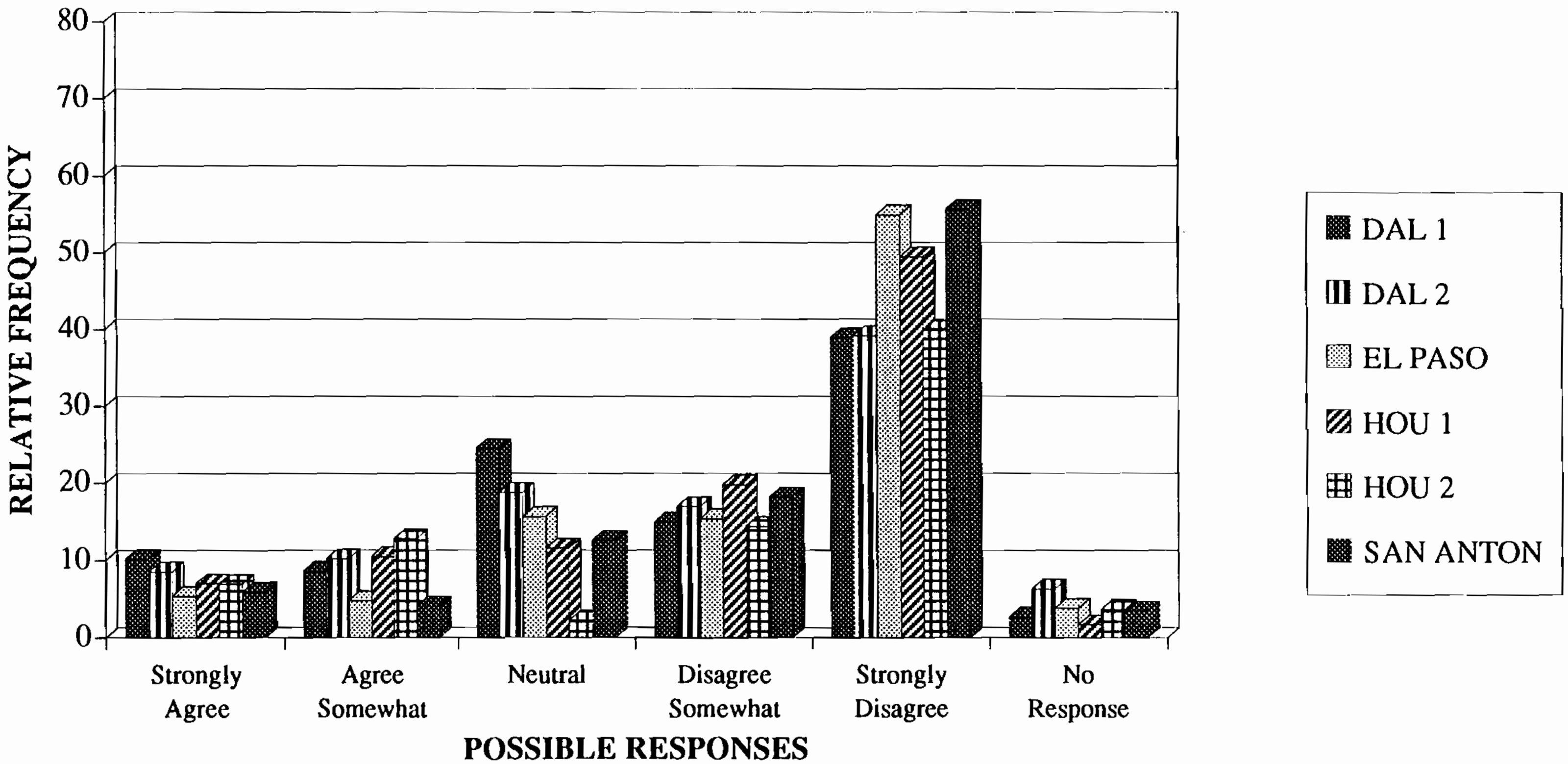
13. AS A TAXPAYER, I AHVE THE RIGHT TO TRAVEL ON FREEWAYS WITHOUT BEING CHARGED TO DO SO



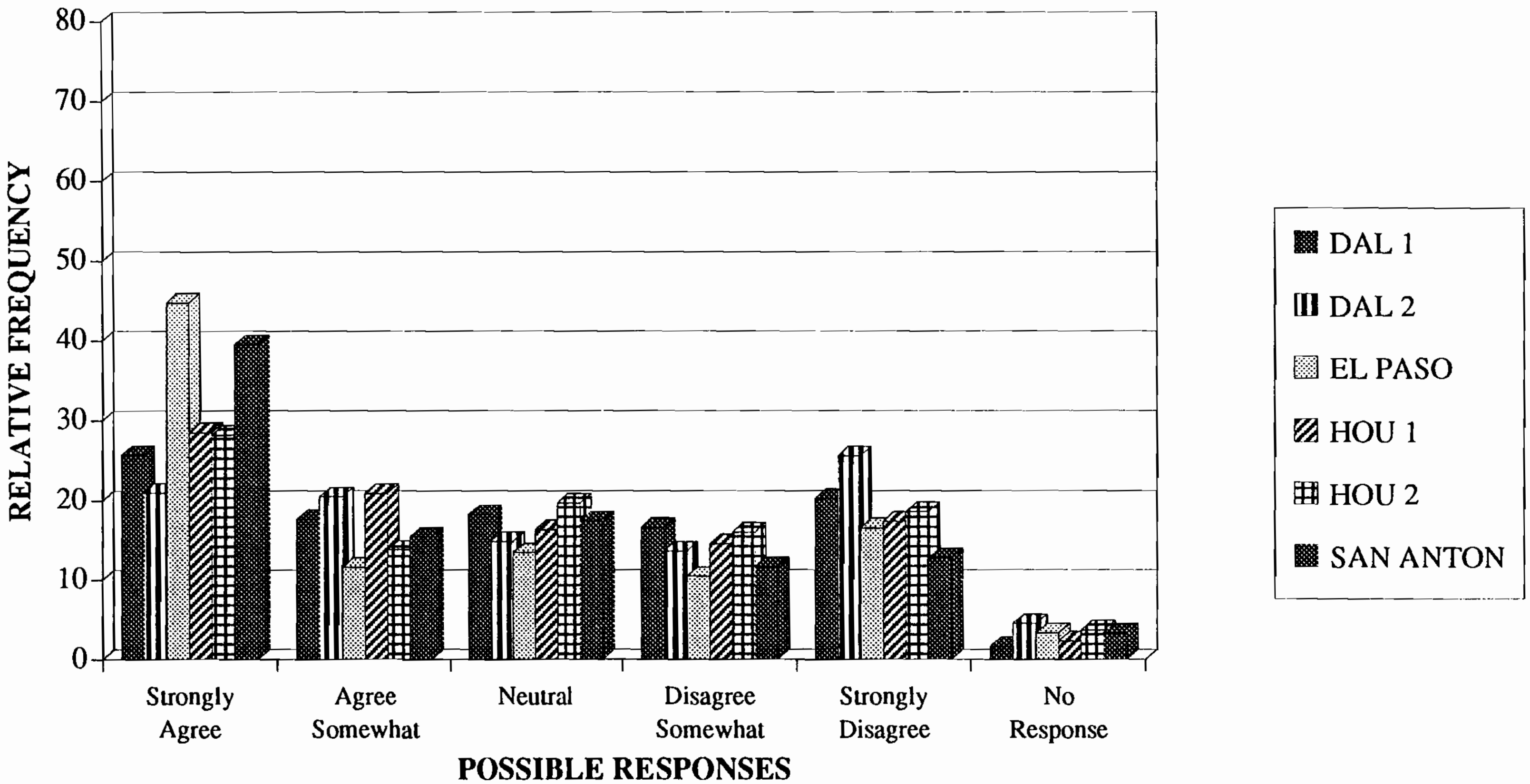
14. AS A DRIVER, I PAY A GAS TAX FOR ROADS; I SHOULDN'T BE CHARGED FOR ANYTHING ELSE



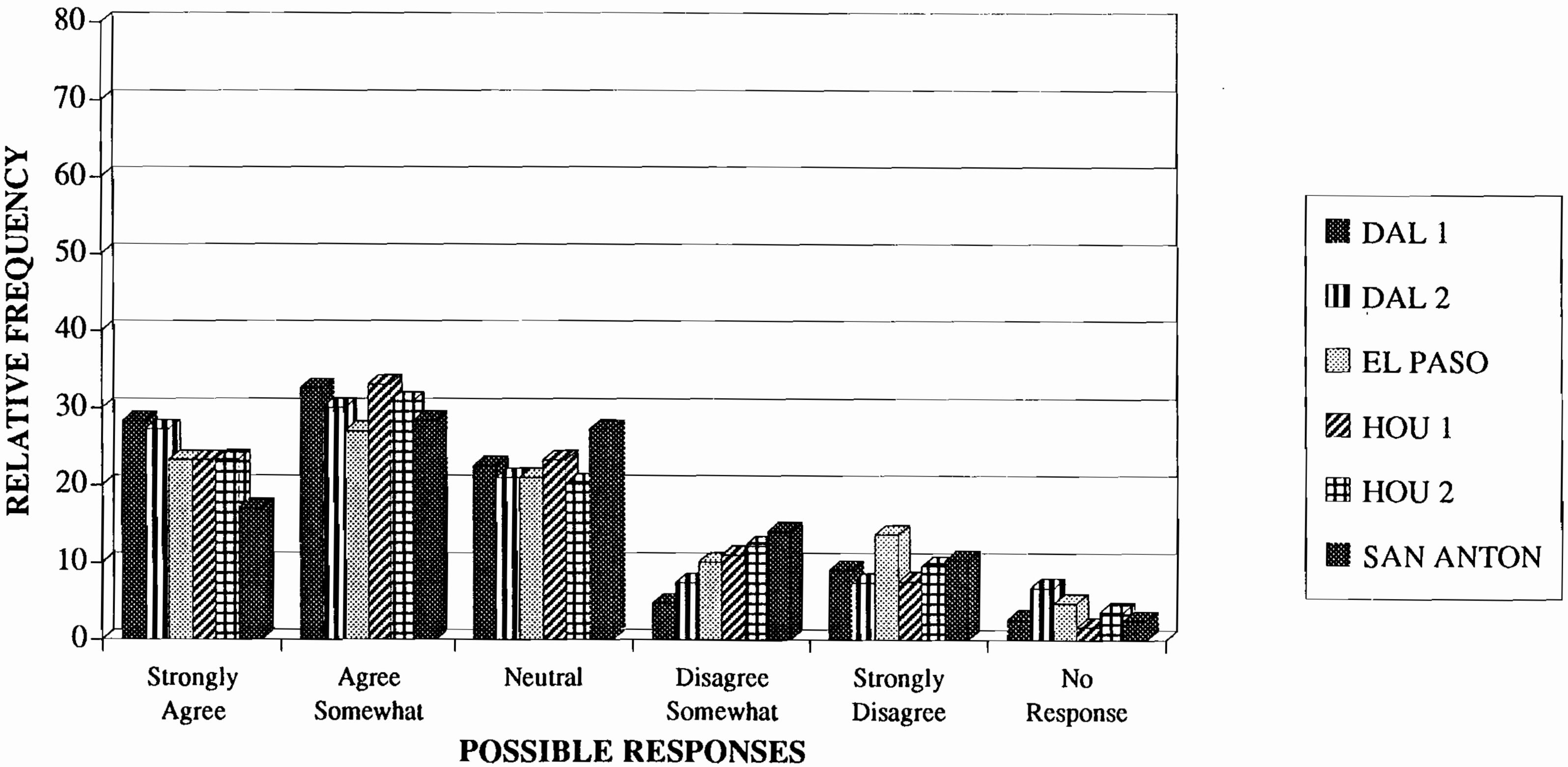
15. THOSE WHO CAN AFFORD TOLLS SHOULD BE THE ONES WHO USE A ROAD



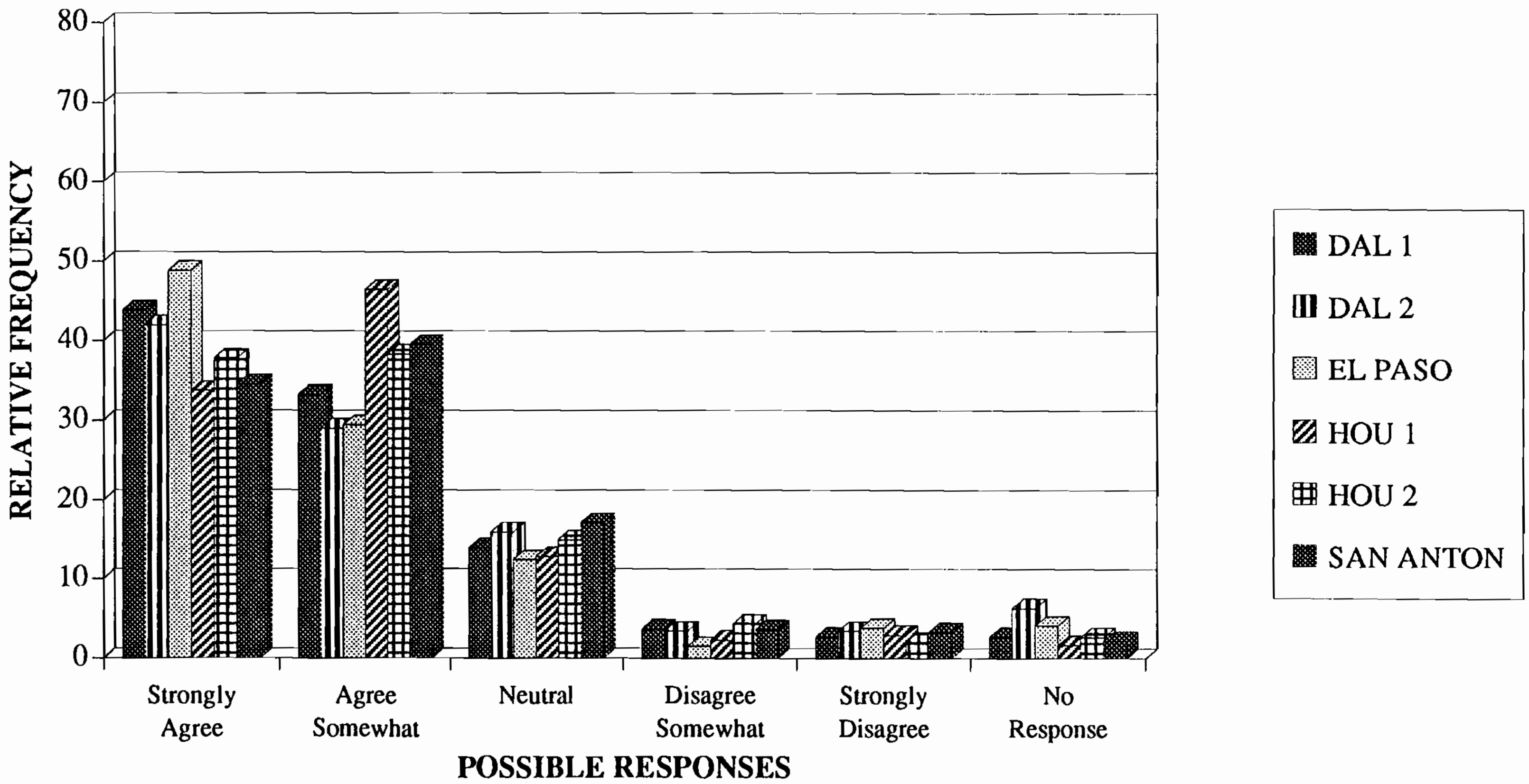
16. CHARGING TOLLS IS UNFAIR TO THE POOR



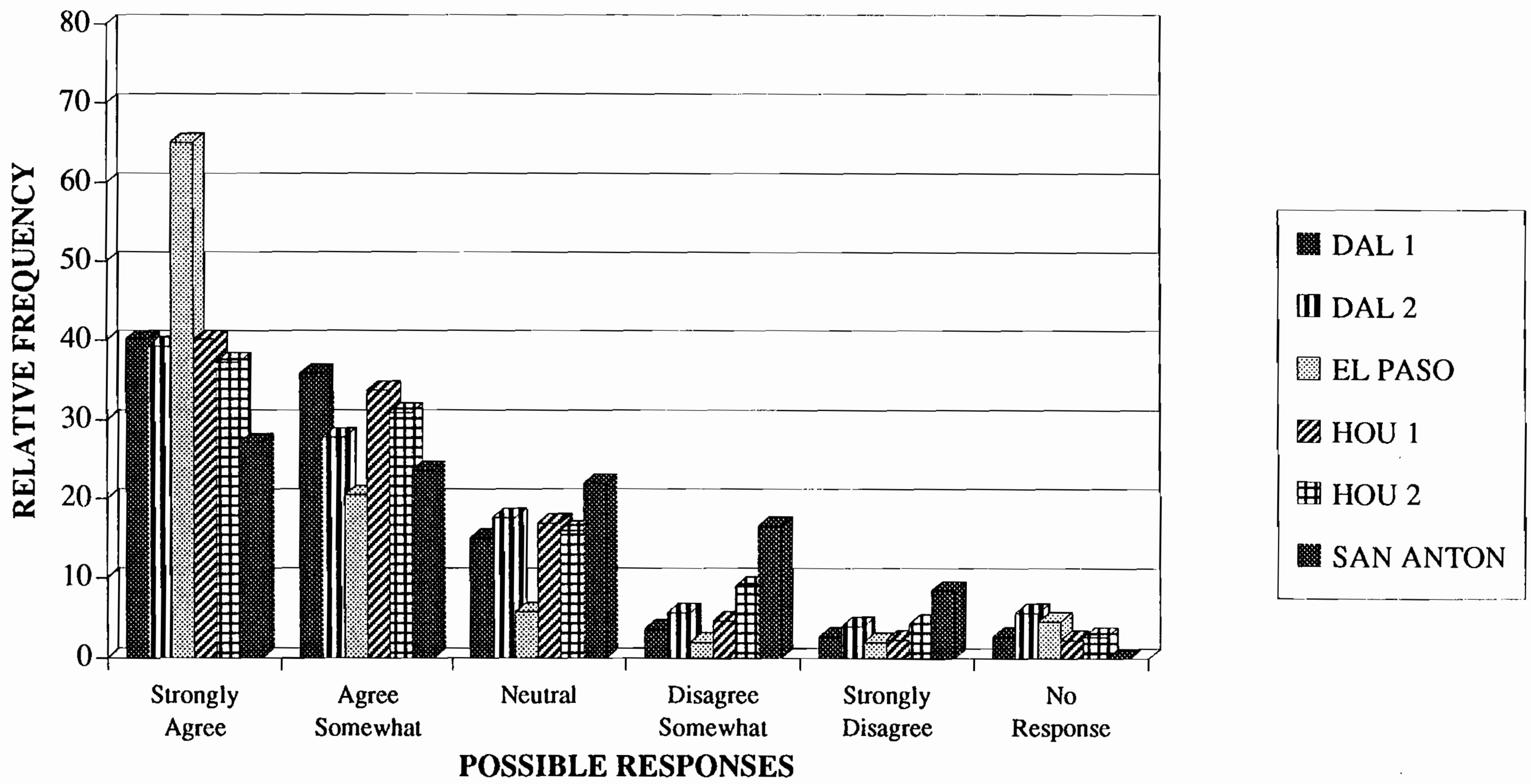
17. USING MY VEHICLE CONTRIBUTES TO PROBLEMS WITH AIR POLLUTION



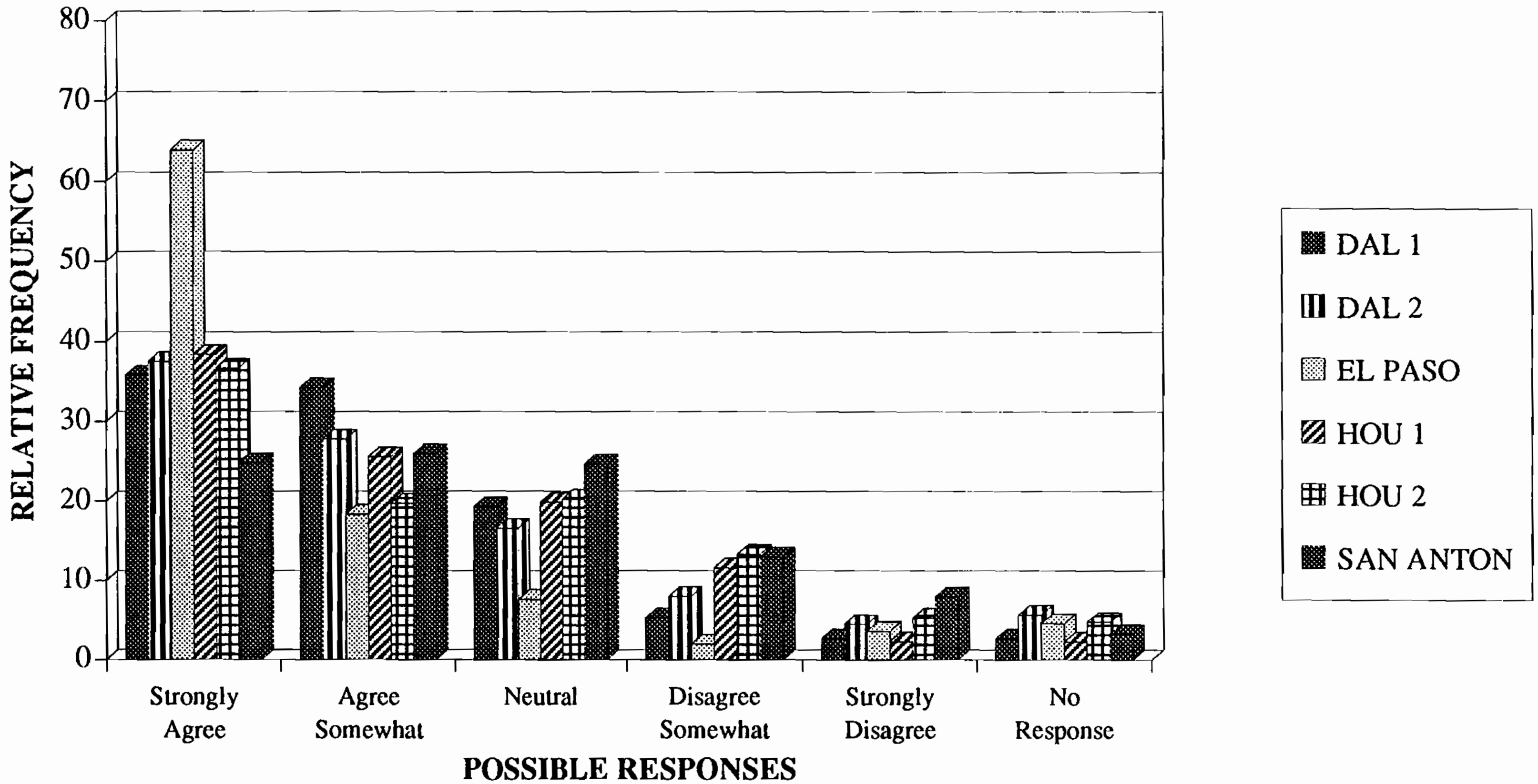
18. I HAVE A RESPONSIBILITY TO CONTROL AIR POLLUTION



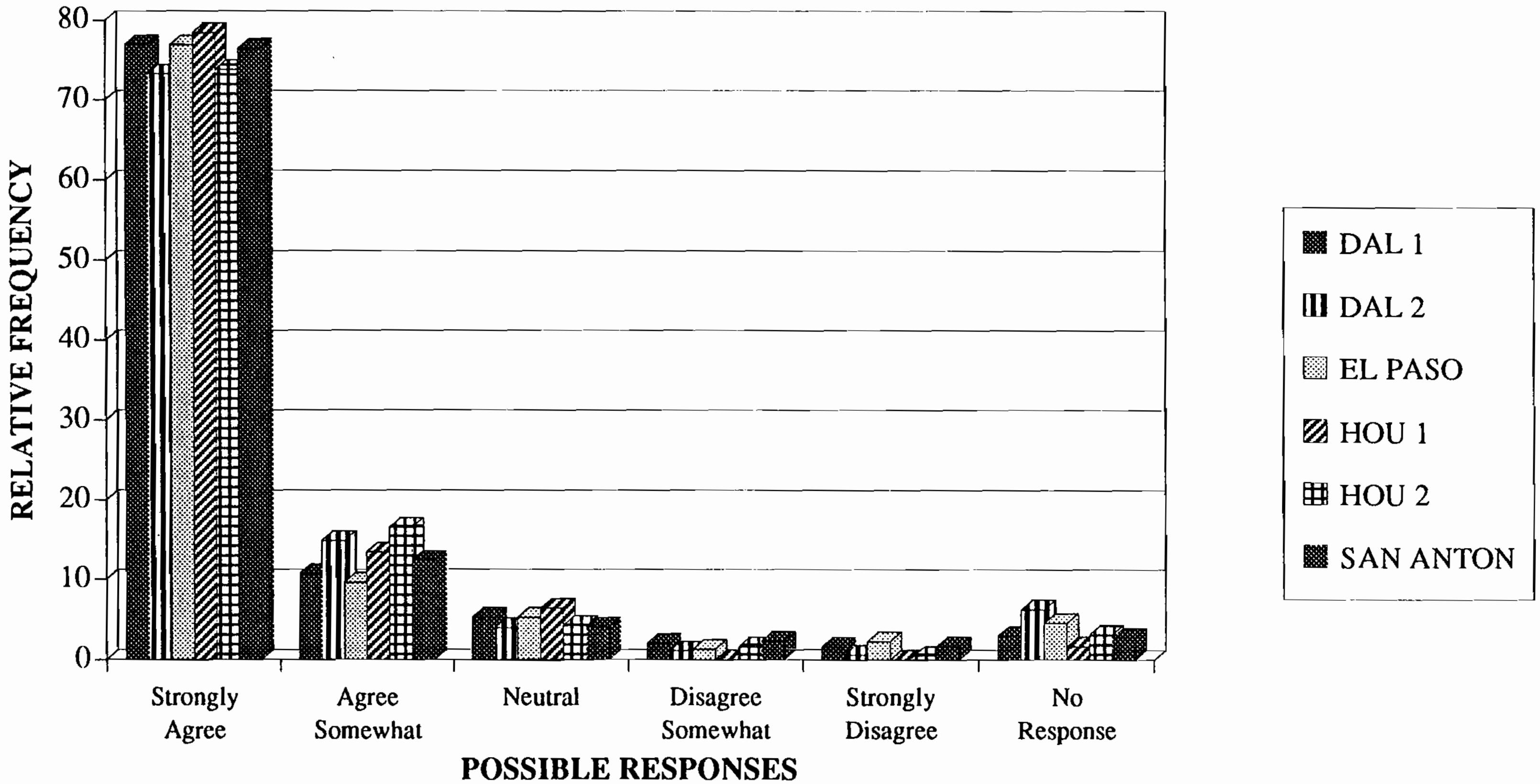
19. AIR POLLUTION AFFECTS THE QUALITY OF LIFE IN THIS AREA



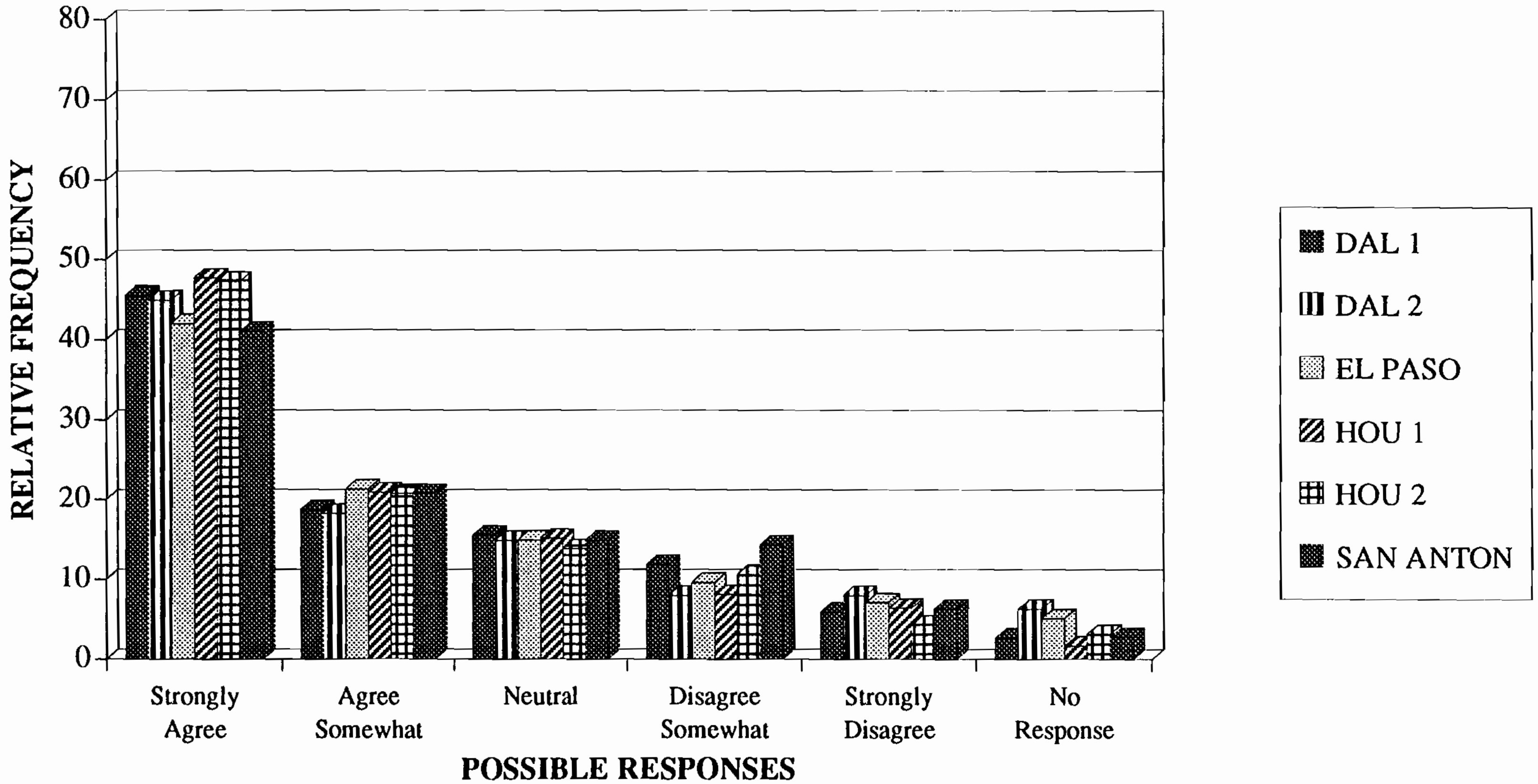
20. AIR QUALITY IS GETTING WORSE



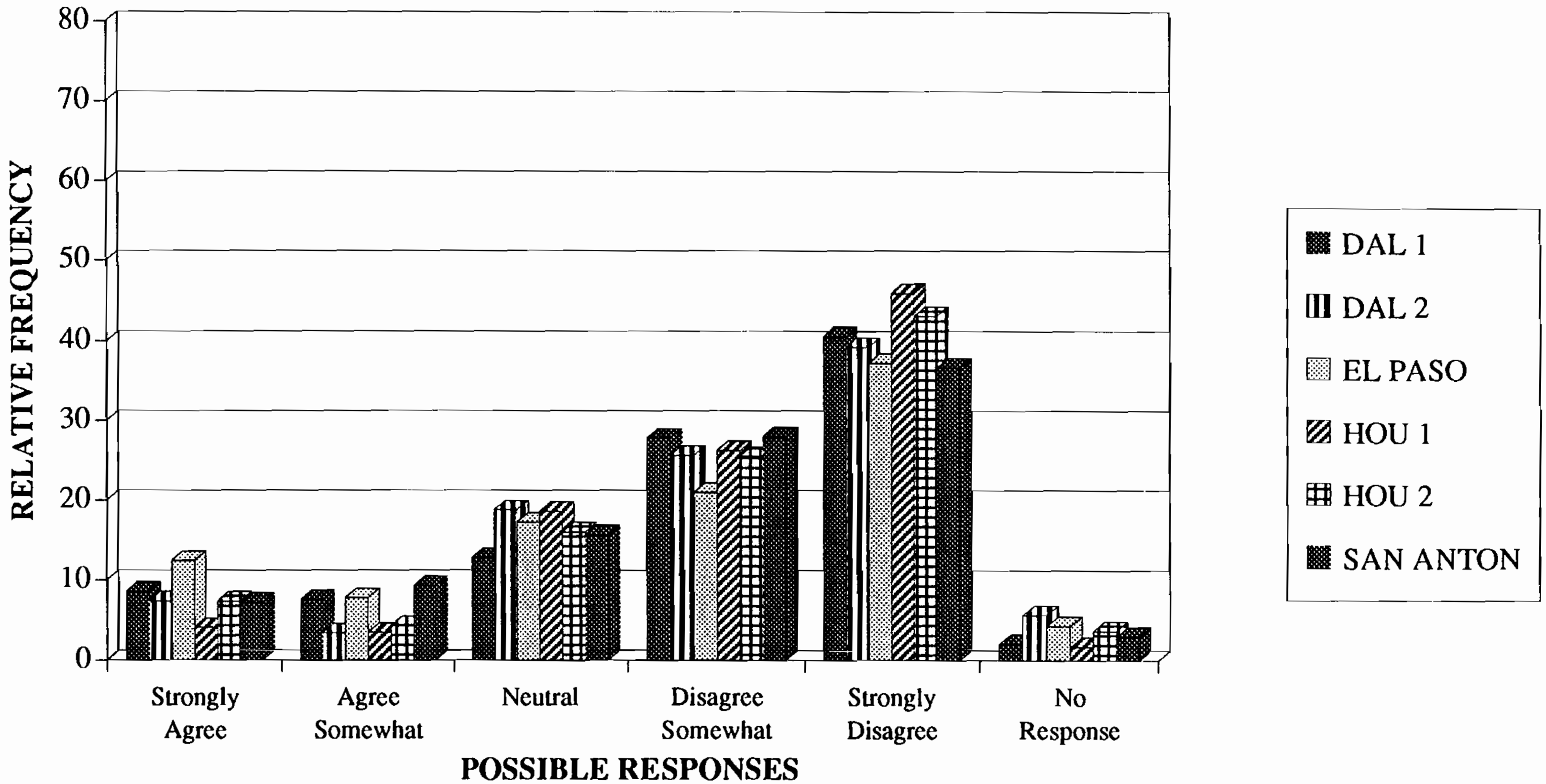
21. IT IS MY RIGHT TO OWN A CAR



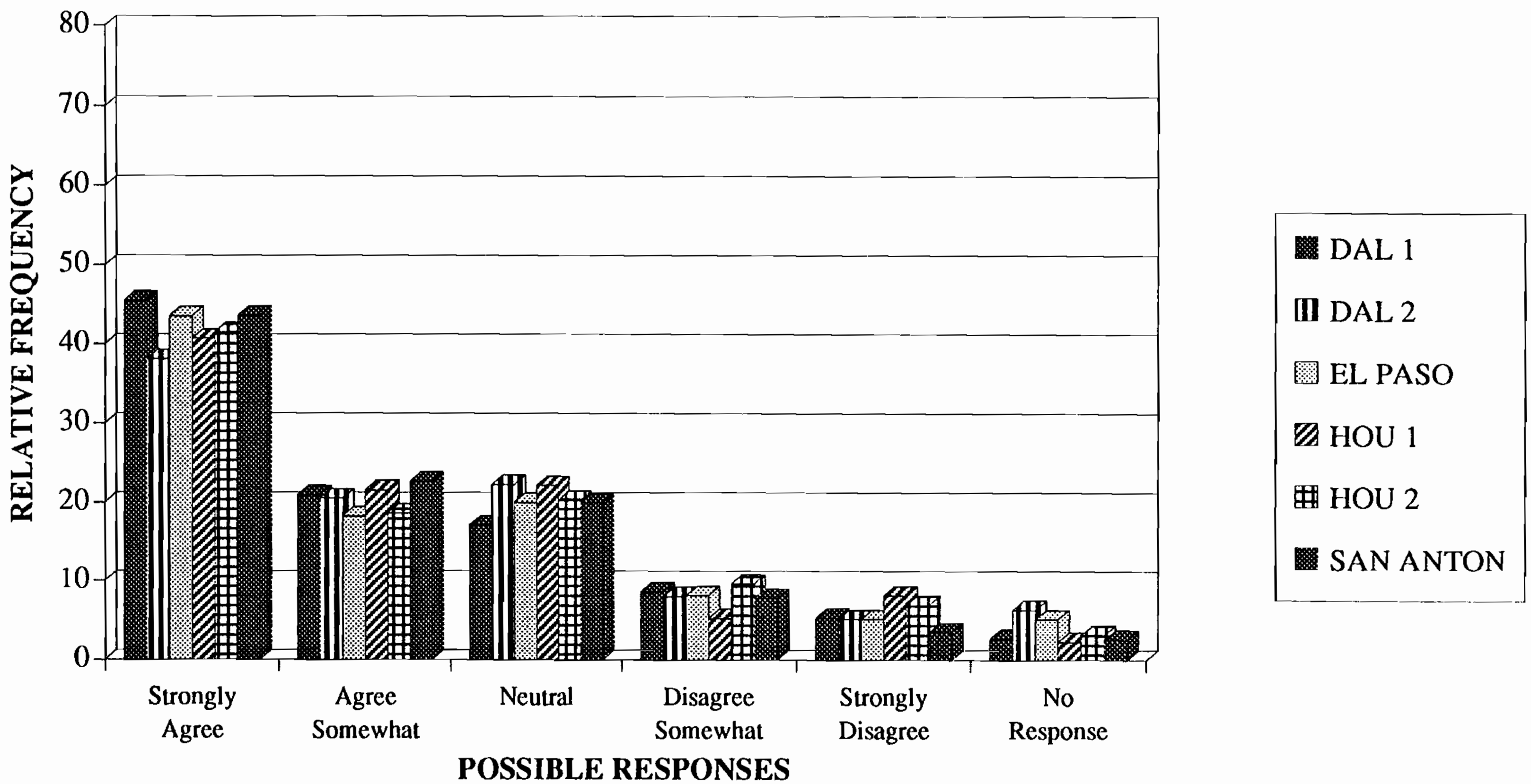
22. DRIVING IS THE ONLY WAY I CAN TRAVEL



23. PUBLIC TRANSIT IS FOR THOSE WHO CAN'T AFFORD CARS

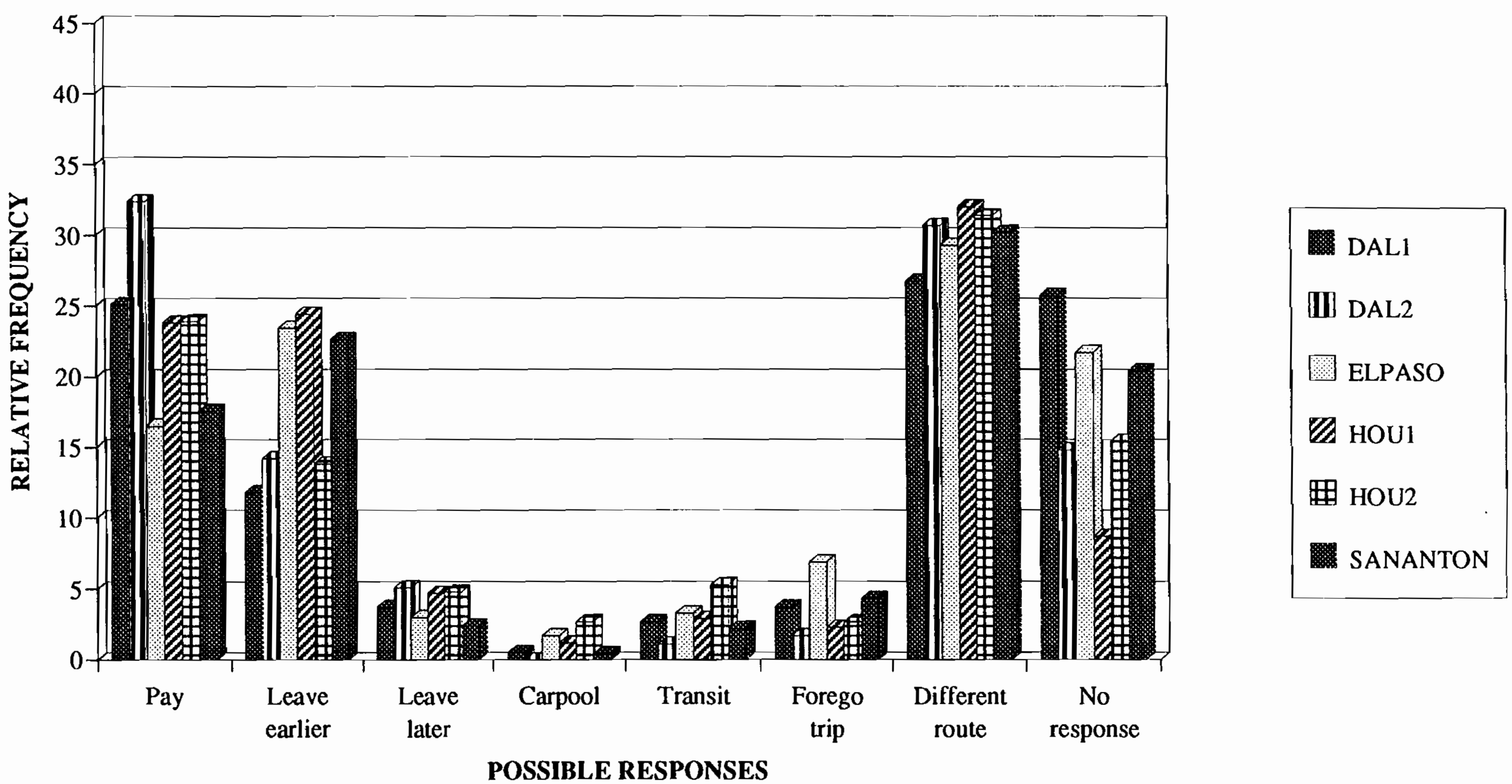


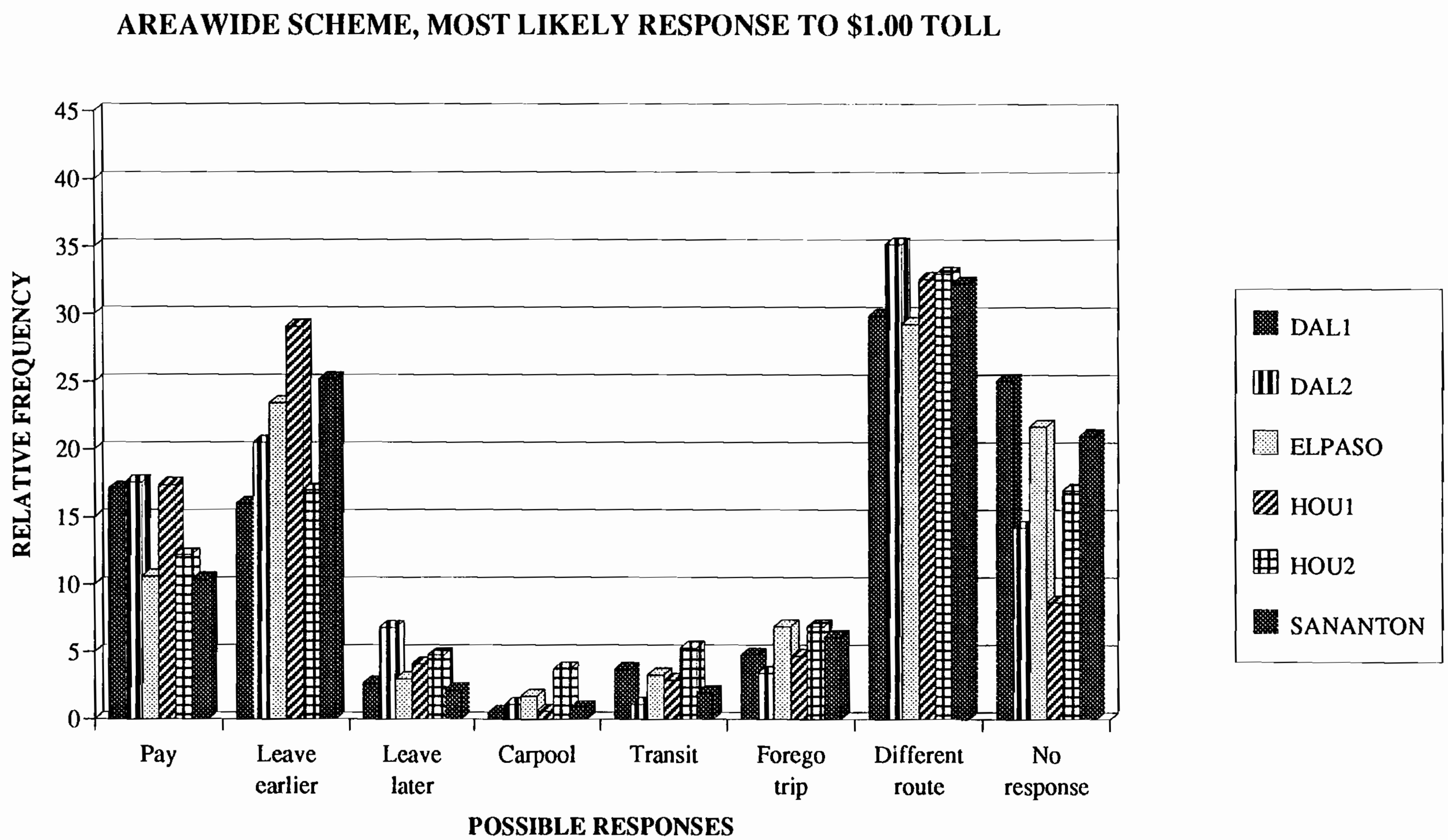
24. I WILL ALWAYS DRIVE MY VEHICLE



Appendix E - Areawide Scheme, Stratified by Toll Level

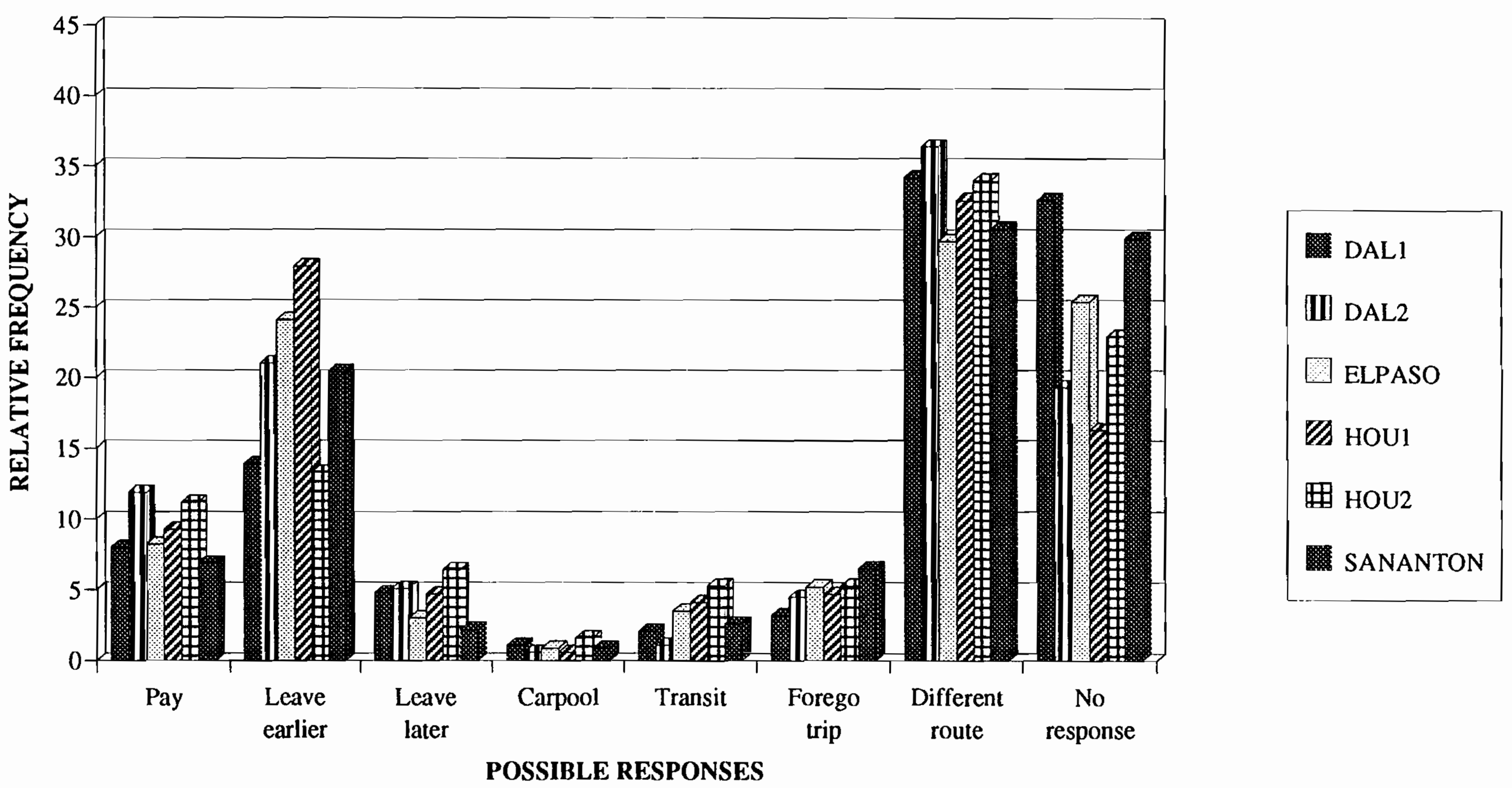
AREAWIDE SCHEME, MOST LIKELY RESPONSE TO $0.50 TOLL



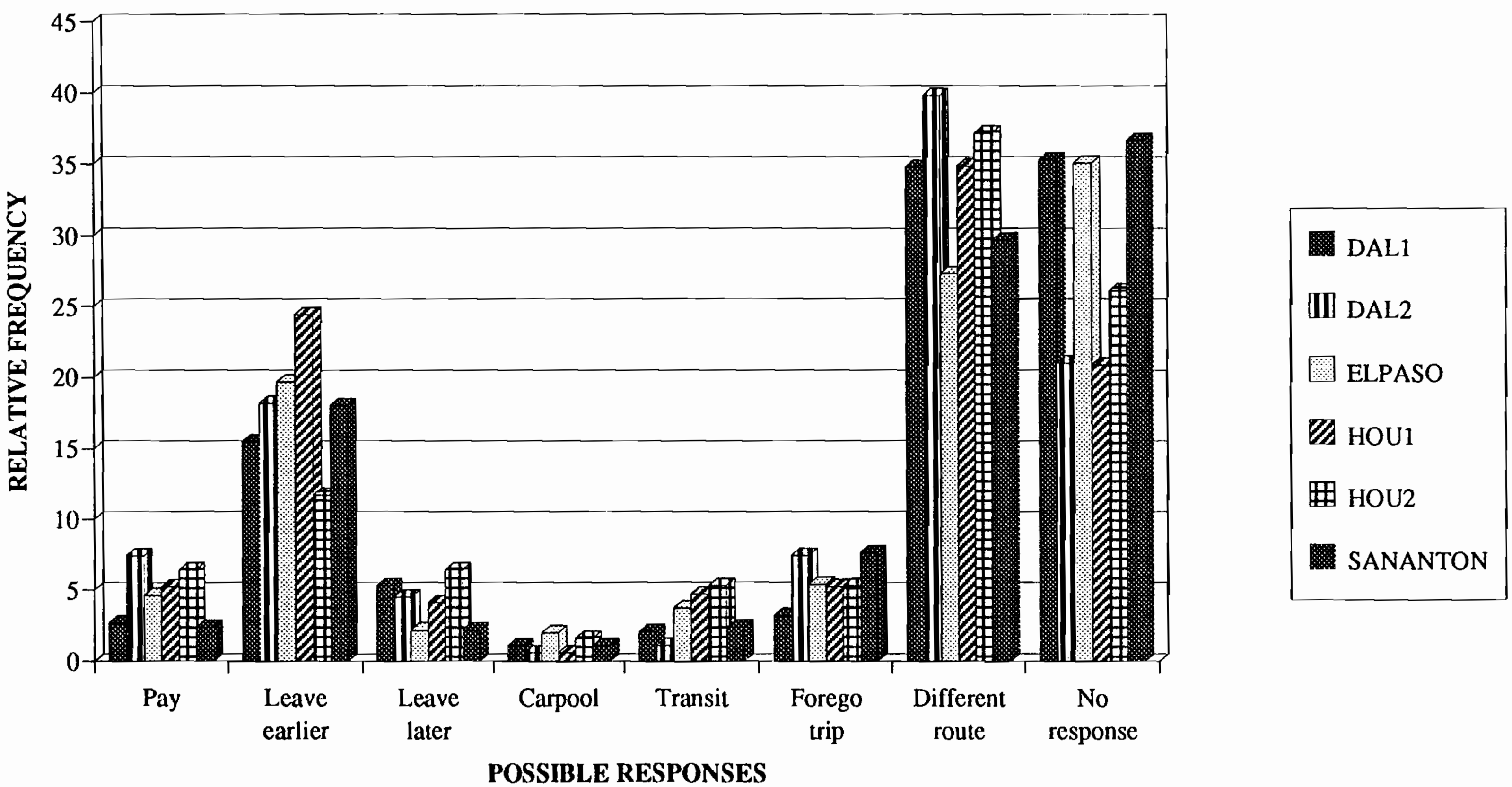


AREAWIDE SCHEME, MOST LIKELY RESPONSE TO $1.00 TOLL
RELATIVE FREQUENCY
0
5
10
15
20
25
30
35
40
45
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different route
No response
POSSIBLE RESPONSES
DAL1
DAL2
ELPASO
HOU1
HOU2
SANANTON

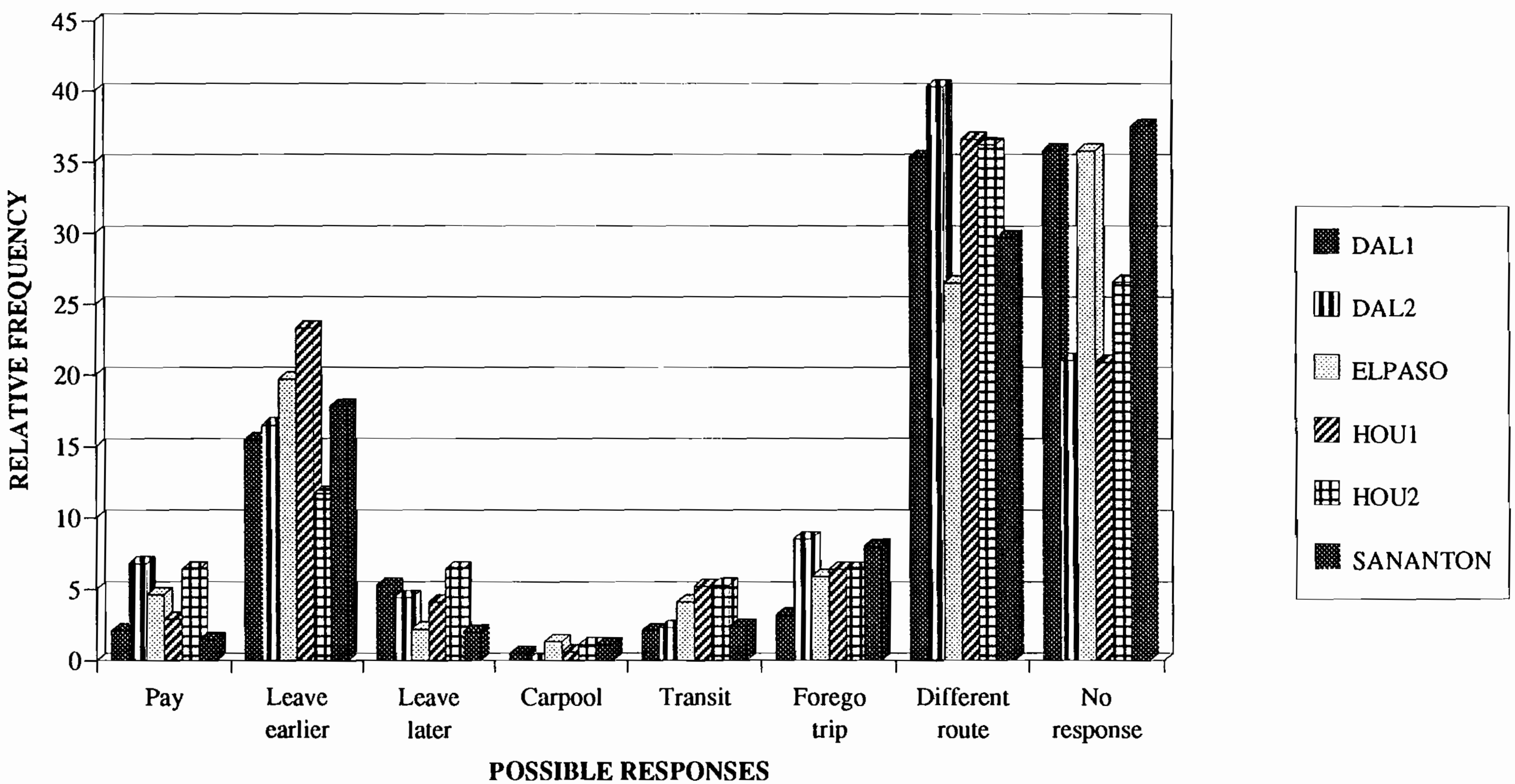
AREAWIDE SCHEME, MOST LIKELY RESPONSE TO $2.00 TOLL

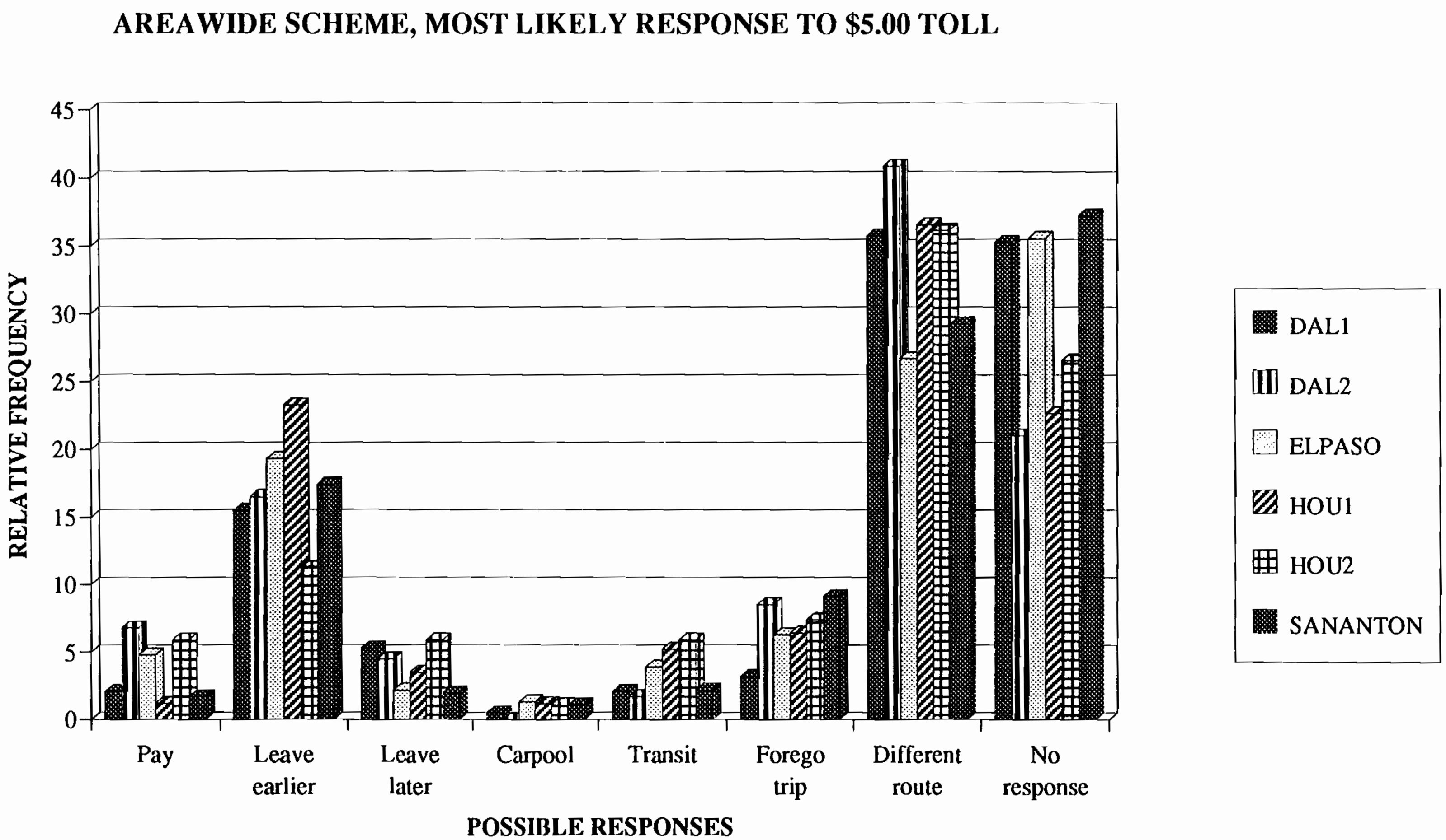


AREAWIDE SCHEME, MOST LIKELY RESPONSE TO $3.00 TOLL



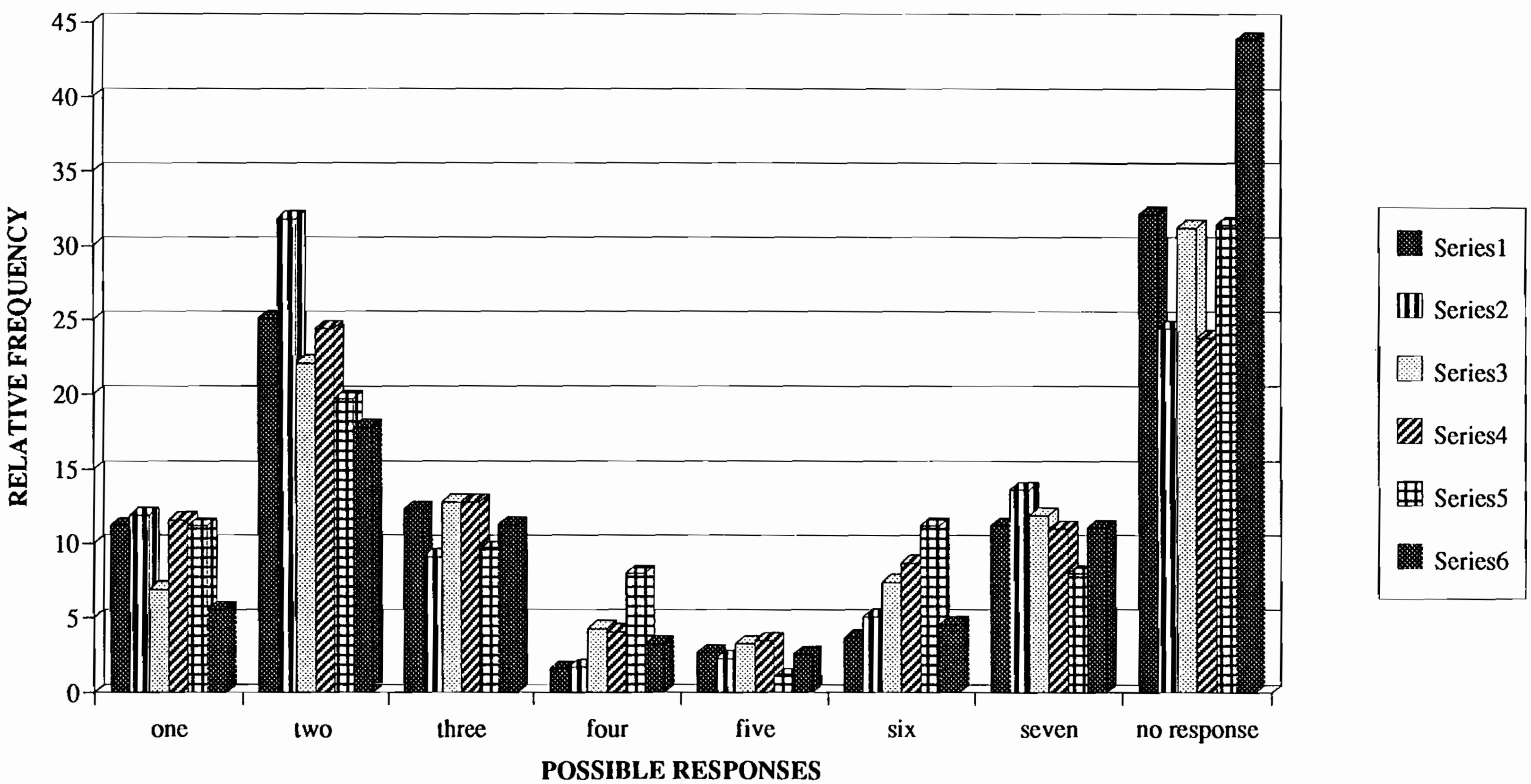
AREAWIDE SCHEME, MOST LIKELY RESPONSE TO $4.00 TOLL



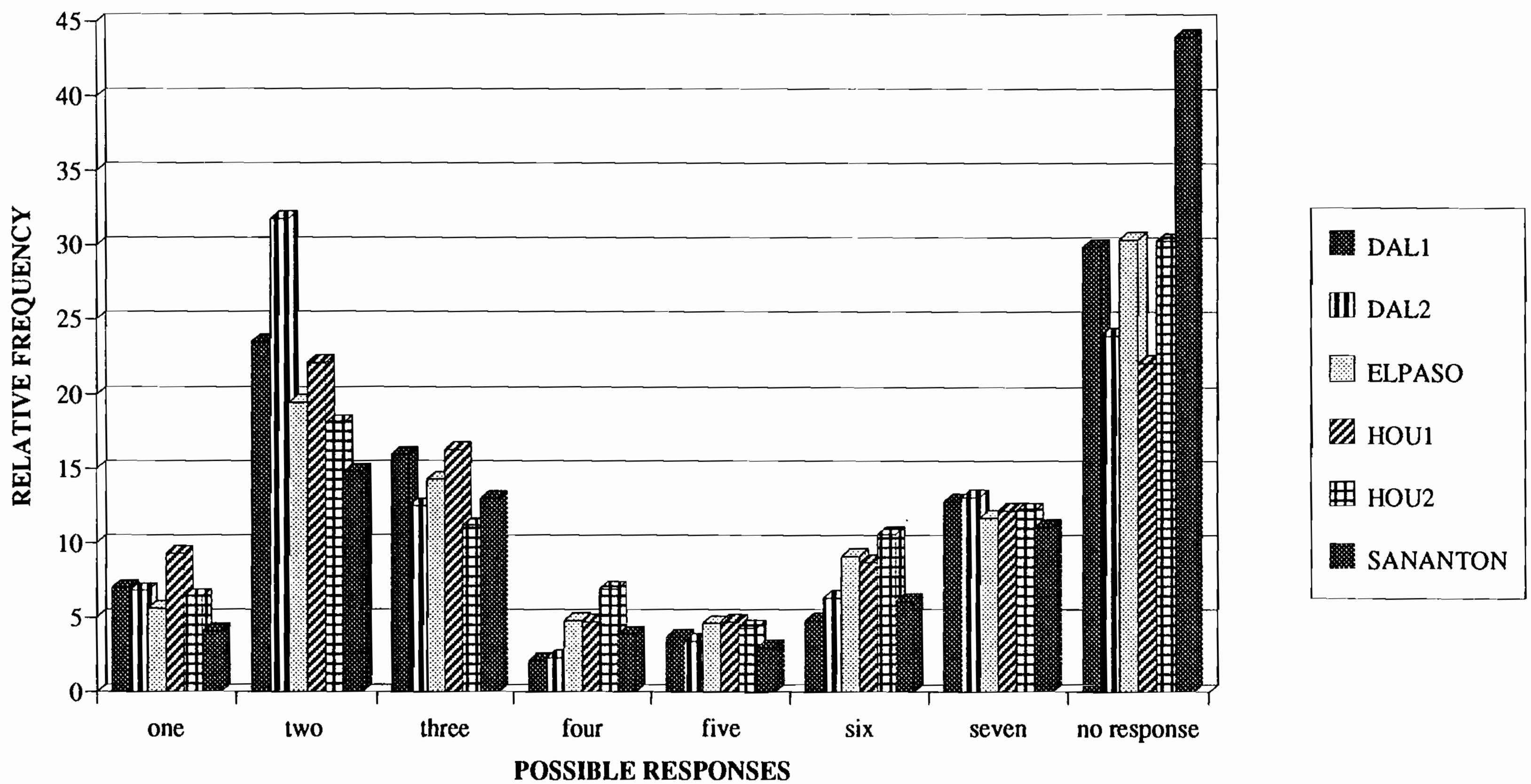


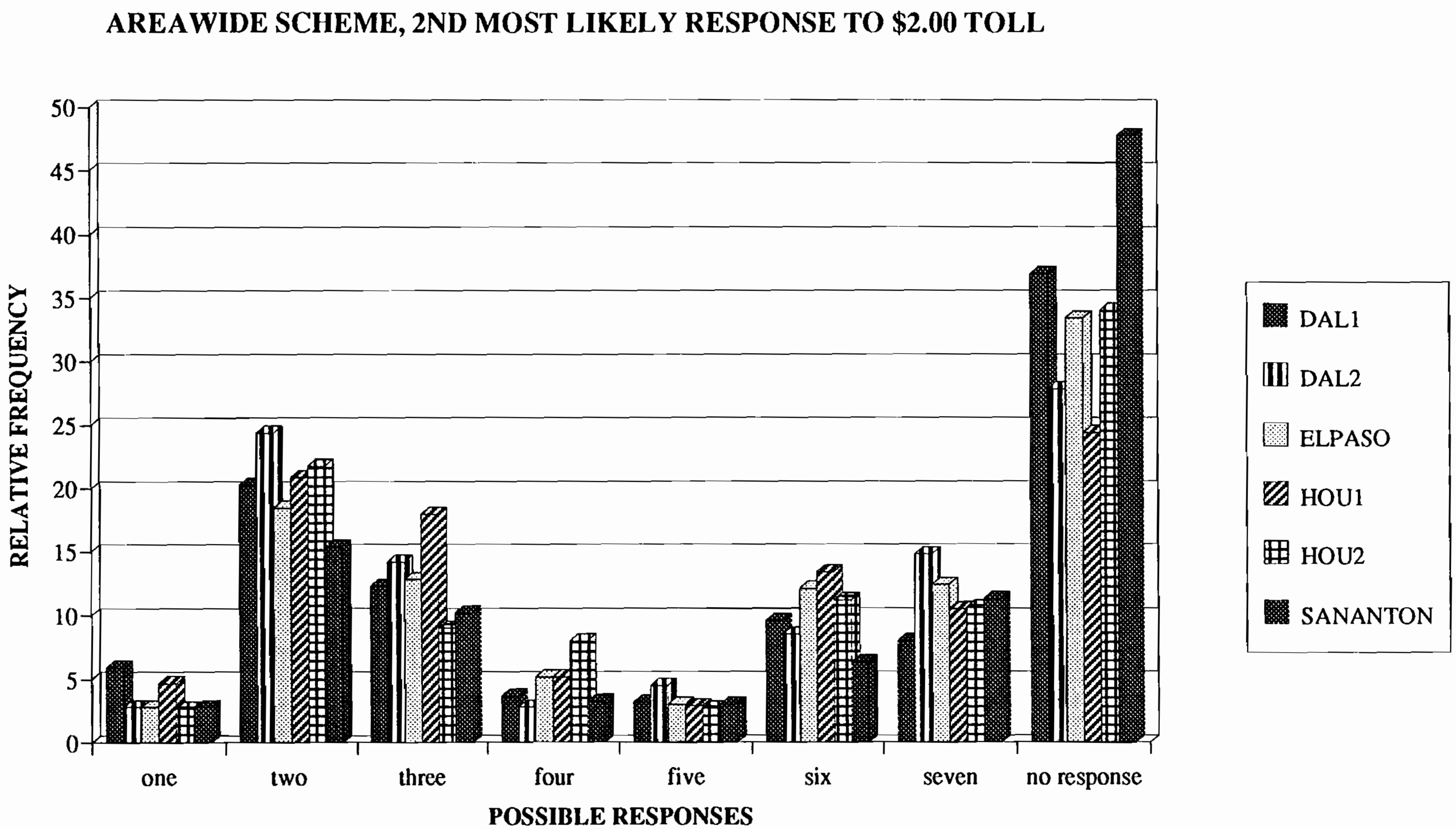
AREAWIDE SCHEME, MOST LIKELY RESPONSE TO $5.00 TOLL
RELATIVE FREQUENCY
0
5
10
15
20
25
30
35
40
45
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different route
No response
POSSIBLE RESPONSES
DAL1
DAL2
ELPASO
HOU1
HOU2
SANANTON

AREAWIDE SCHEME, 2ND MOST LIKELY RESPONSE TO $0.50 TOLL

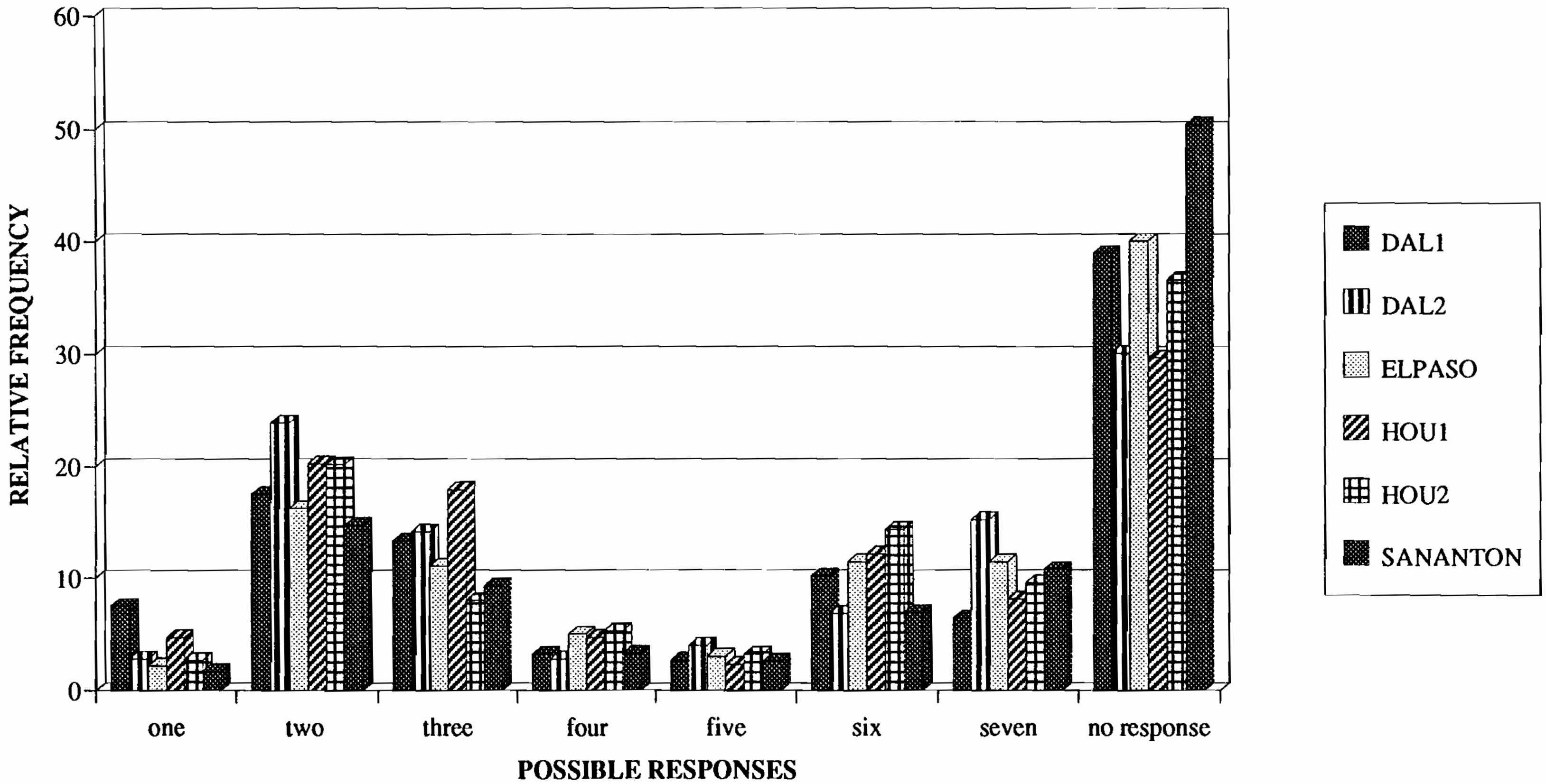


AREAWIDE SCHEME, 2ND MOST LIKELY RESPONSE TO $1.00 TOLL

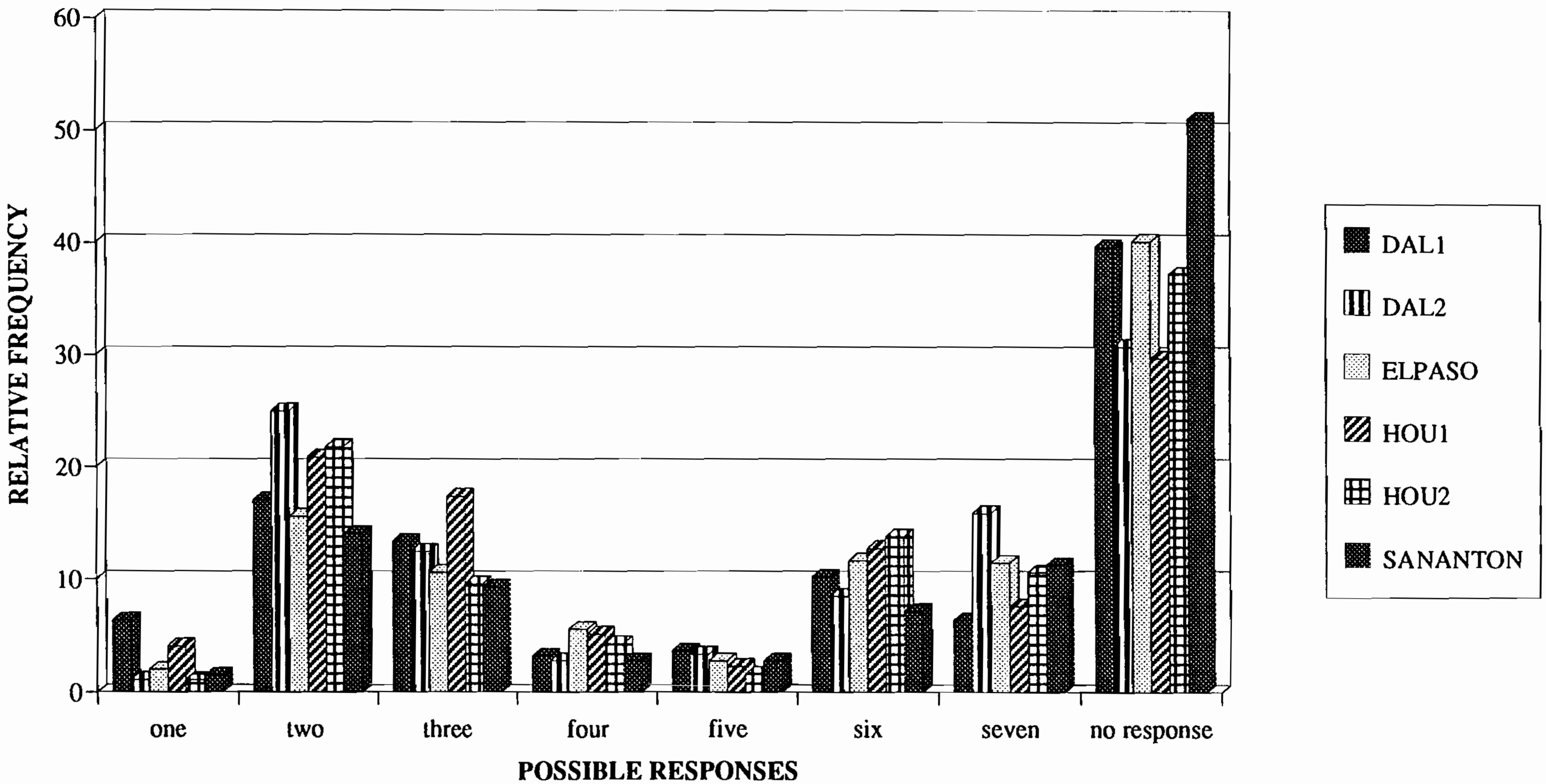



AREAWIDE SCHEME, 2ND MOST LIKELY RESPONSE TO $2.00 TOLL
RELATIVE FREQUENCY
0
5
10
15
20
25
30
35
40
45
50
one
two
three
four
five
six
seven
no response
POSSIBLE RESPONSES
DAL1
DAL2
ELPASO
HOU1
HOU2
SANANTON

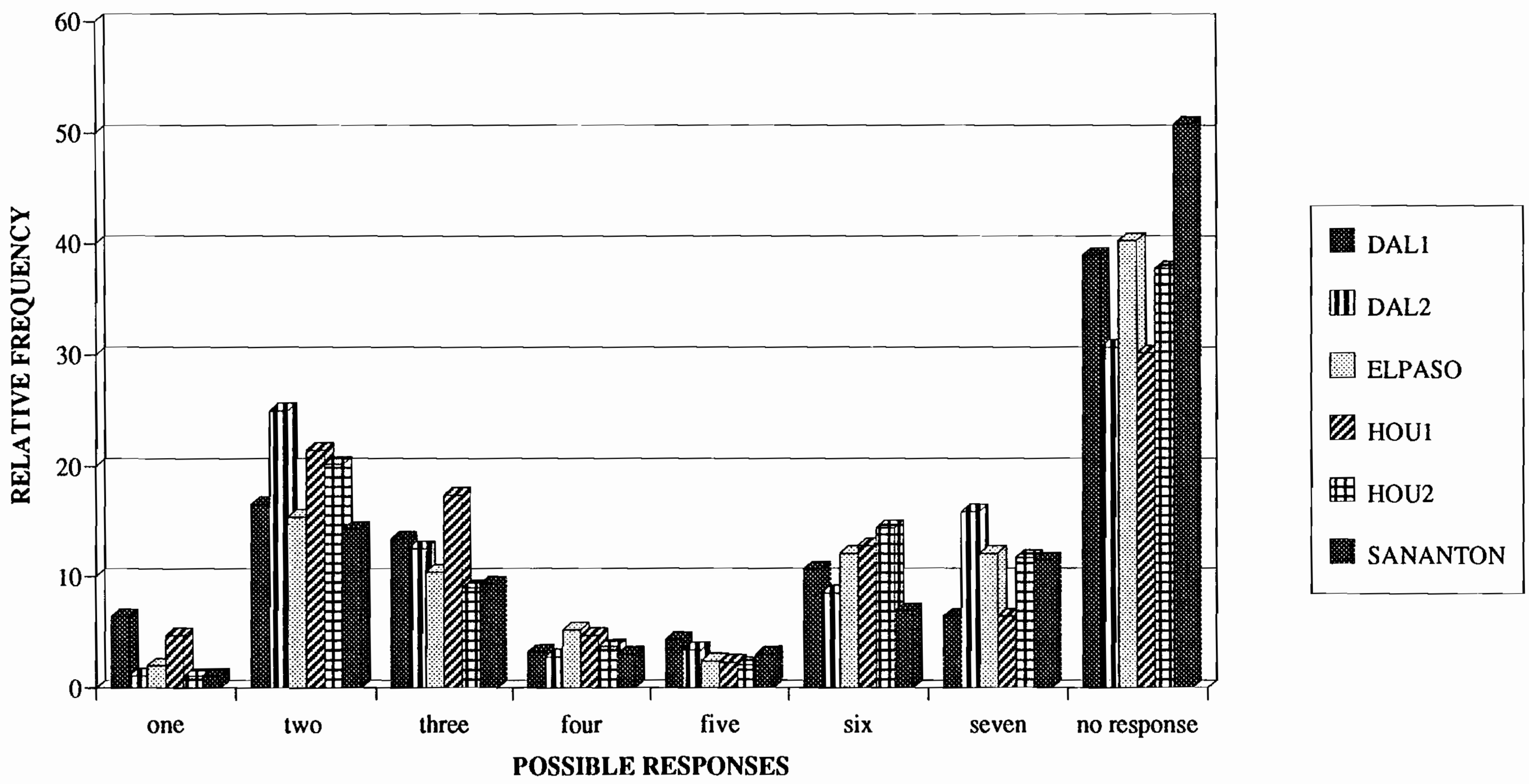
AREAWIDE SCHEME, 2ND MOST LIKELY RESPONSE TO $3.00 TOLL



AREAWIDE SCHEME, 2ND MOST LIKELY RESPONSE TO $4.00 TOLL

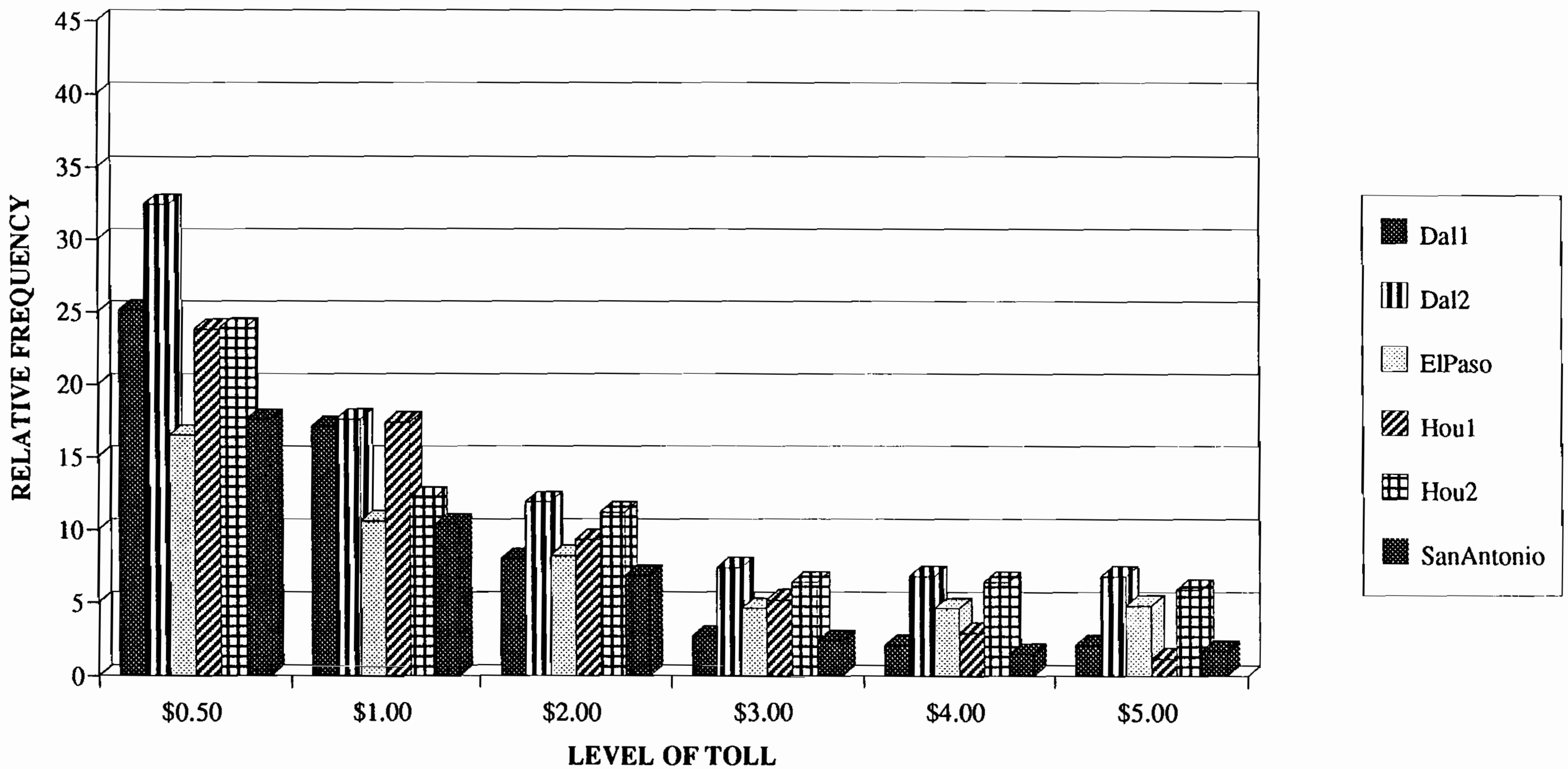


AREAWIDE SCHEME, 2ND MOST LIKELY RESPONSE TO $5.00 TOLL

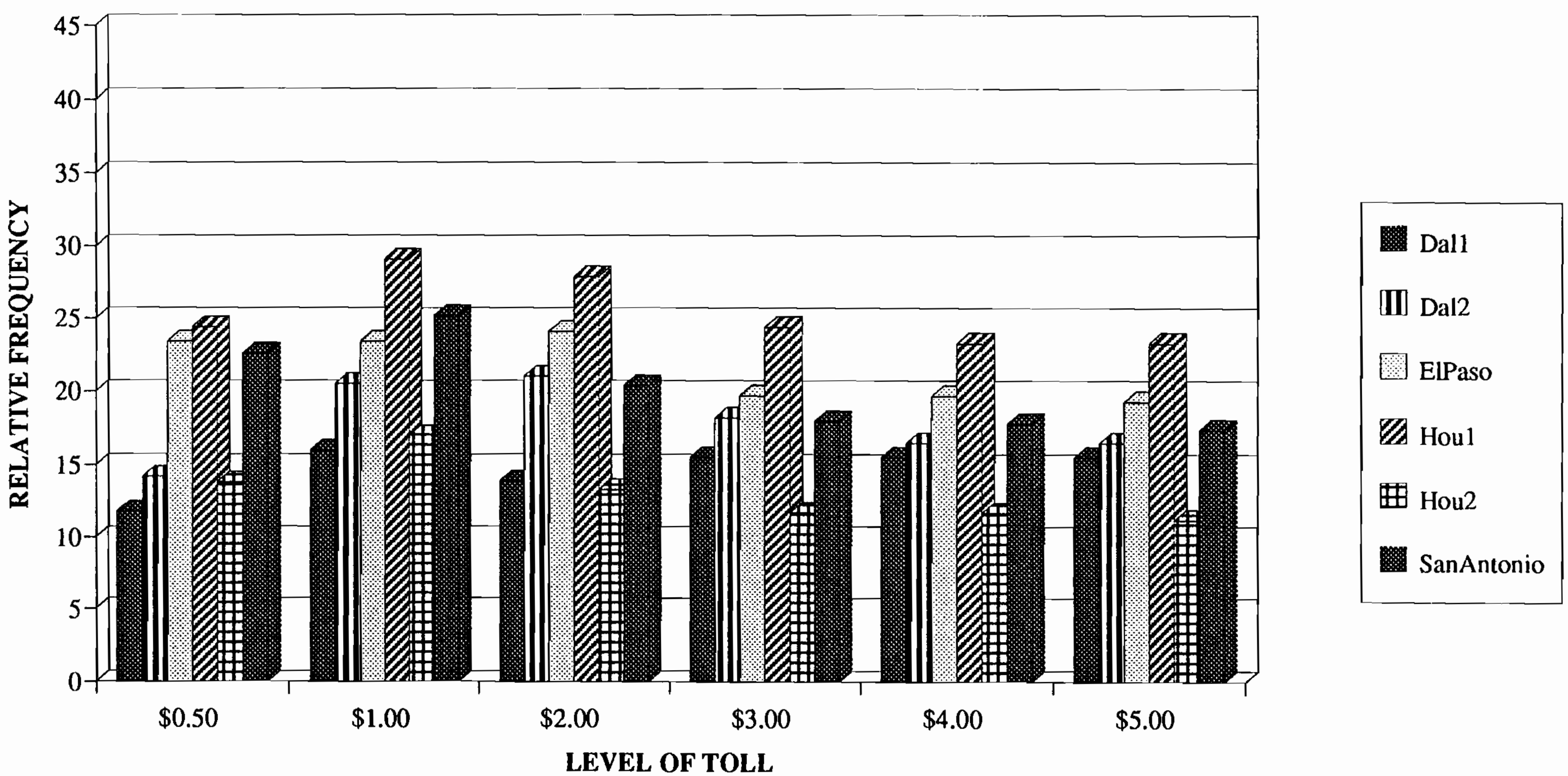


Appendix F - Areawide Scheme, Stratified by Response

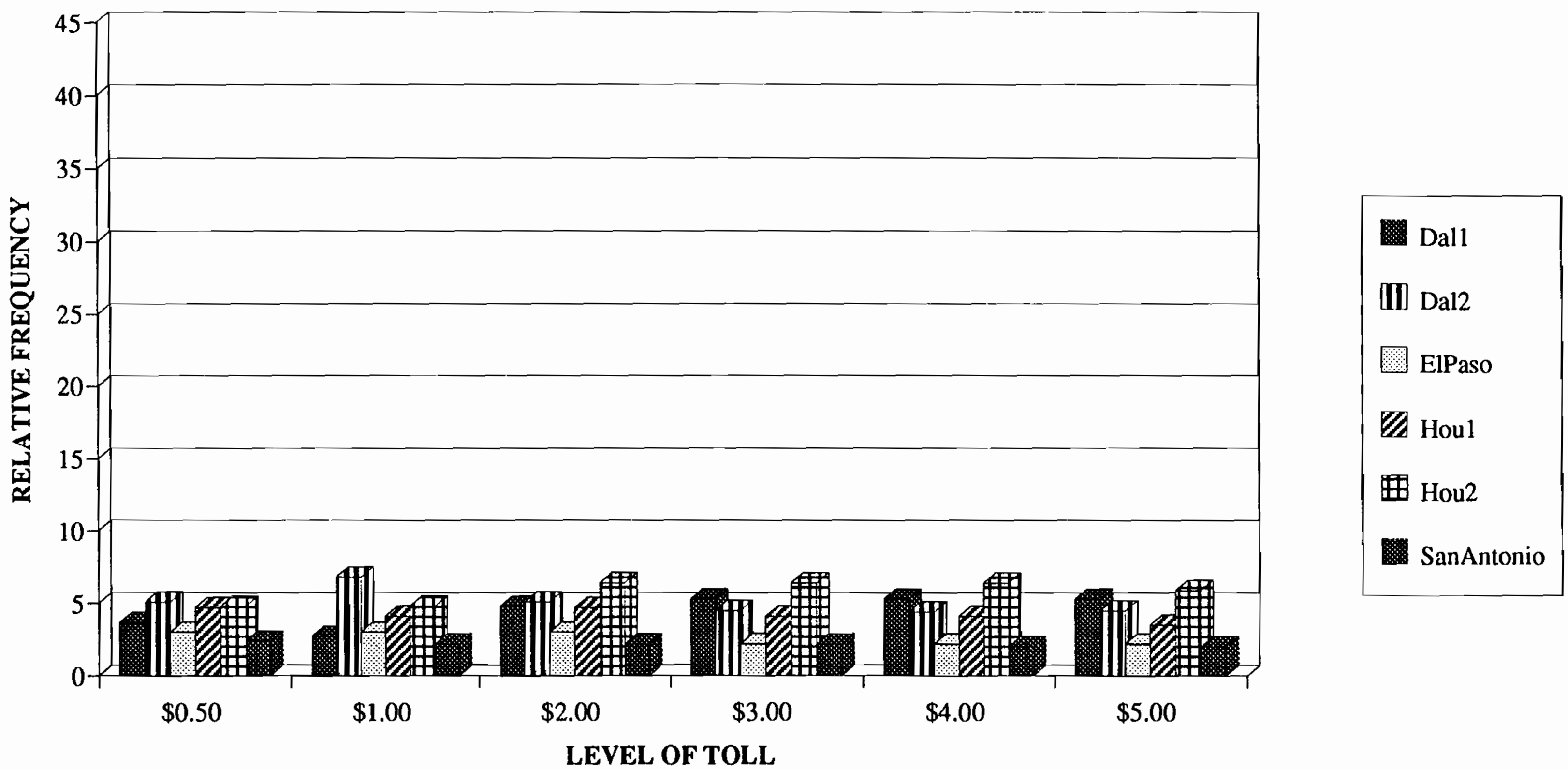
AREAWIDE SCHEME, MOST LIKELY RESPONSE IS TO PAY THE TOLL AND NOT CHANGE TRAVEL HABITS



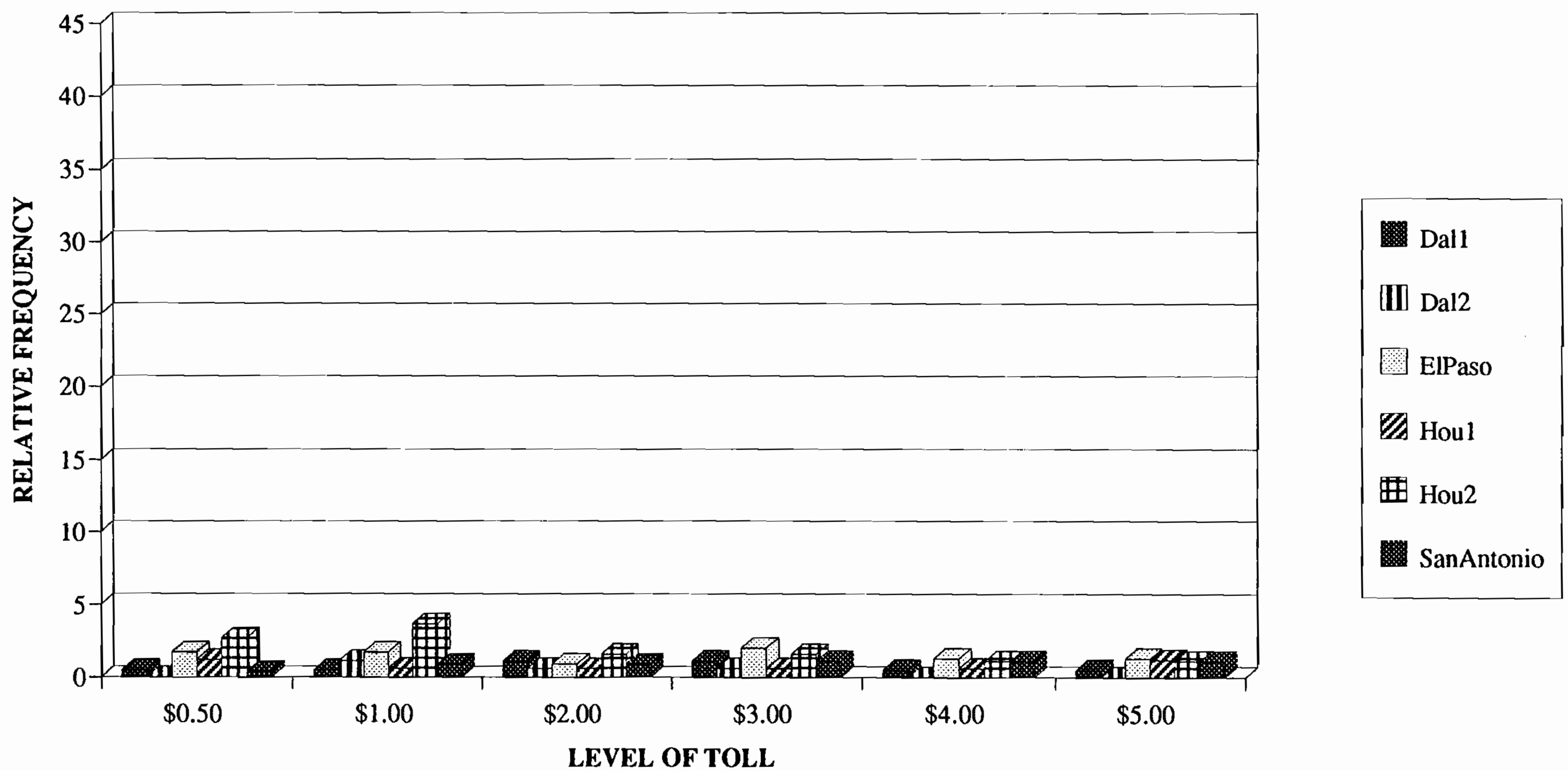
AREAWIDE SCHEME, MOST LIKELY RESPONSE IS TO LEAVE HOME EARLIER TO AVOID THE EXTRA COST



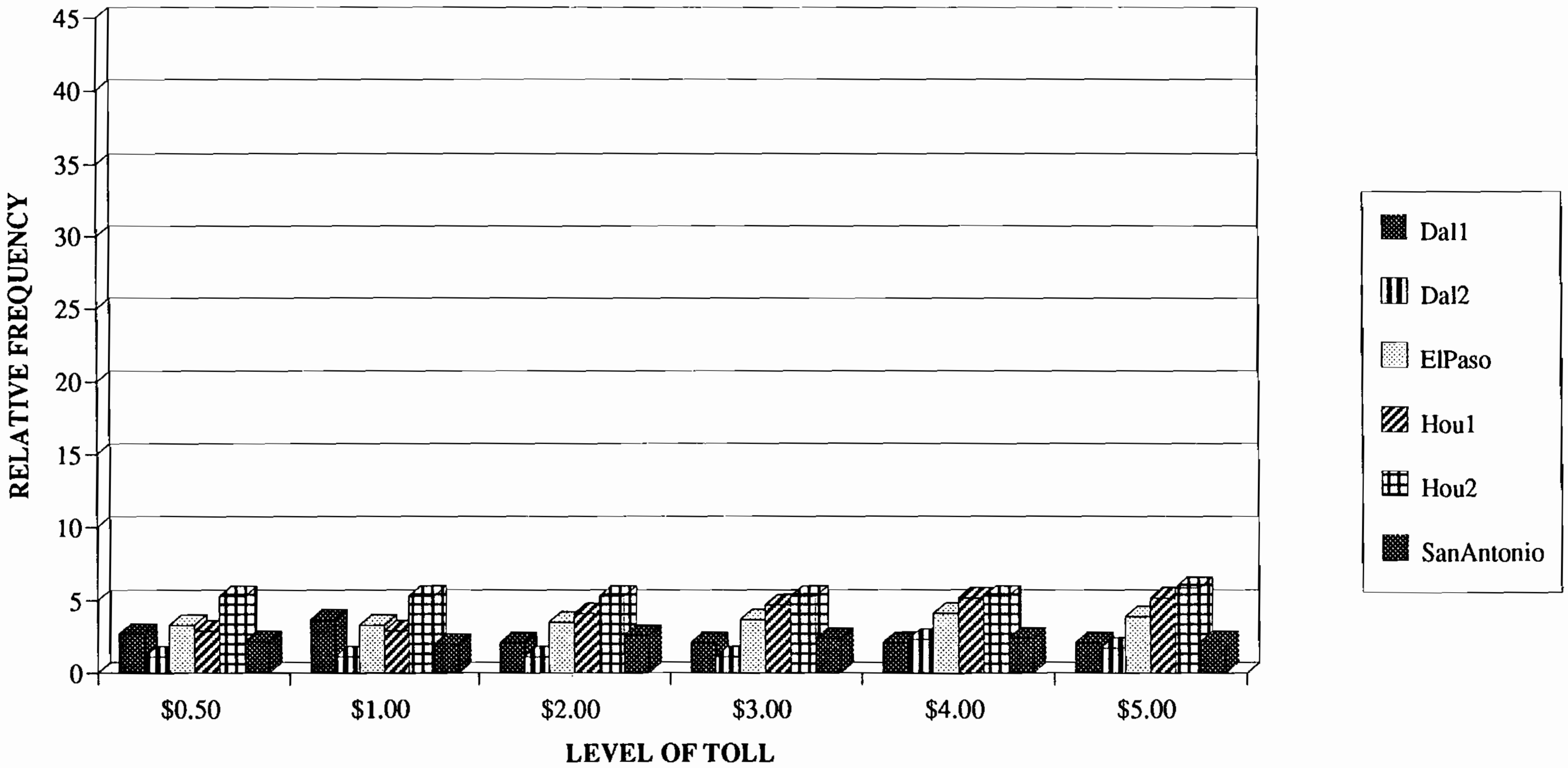
AREAWIDE SCHEME, MOST LIKELY RESPONSE IS TO LEAVE HOME LATER TO AVOID THE EXTRA COST



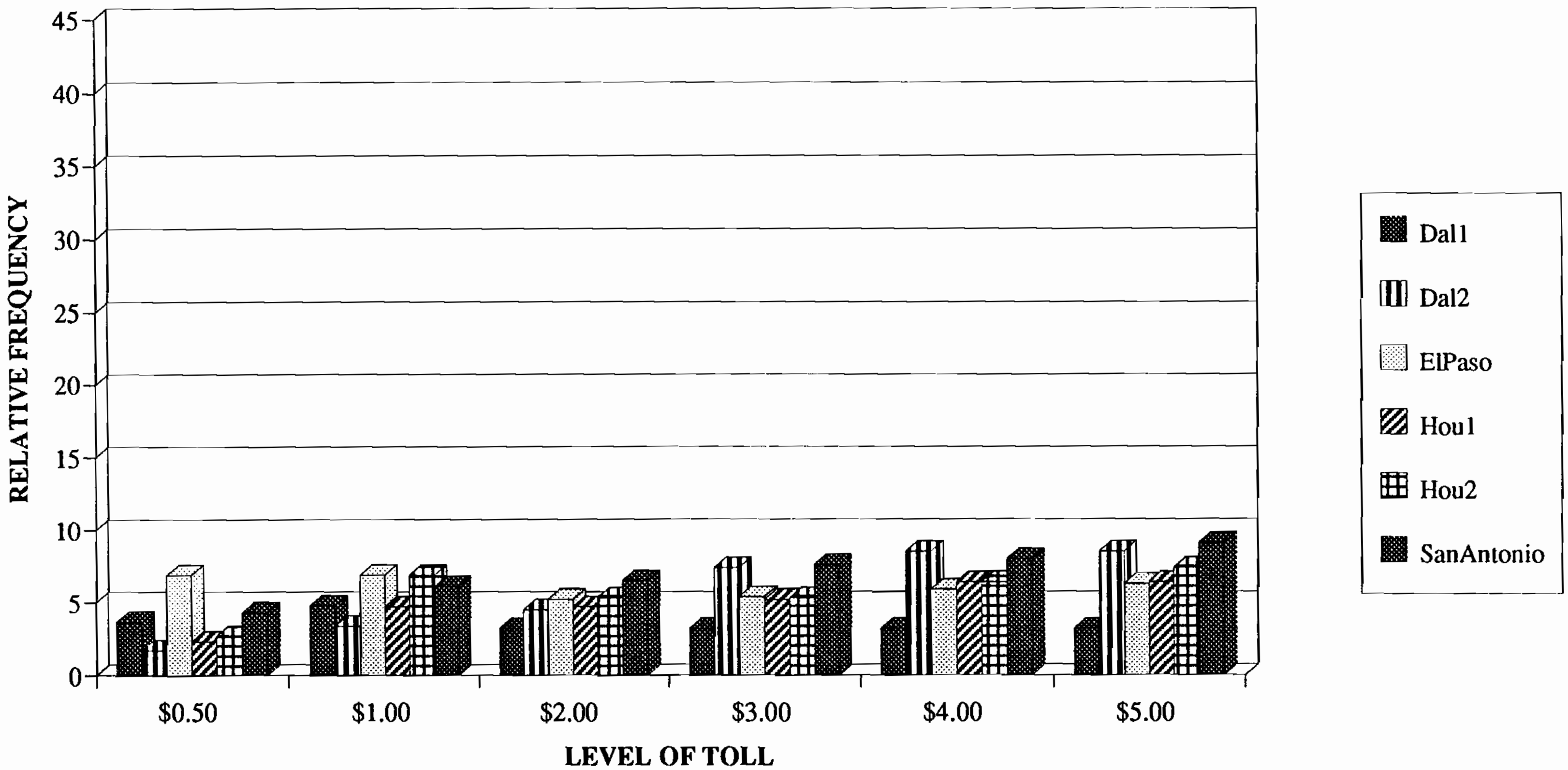
AREAWIDE SCHEME, MOST LIKELY RESPONSE IS TO CARPOOL TO SPLIT THE EXTRA COST



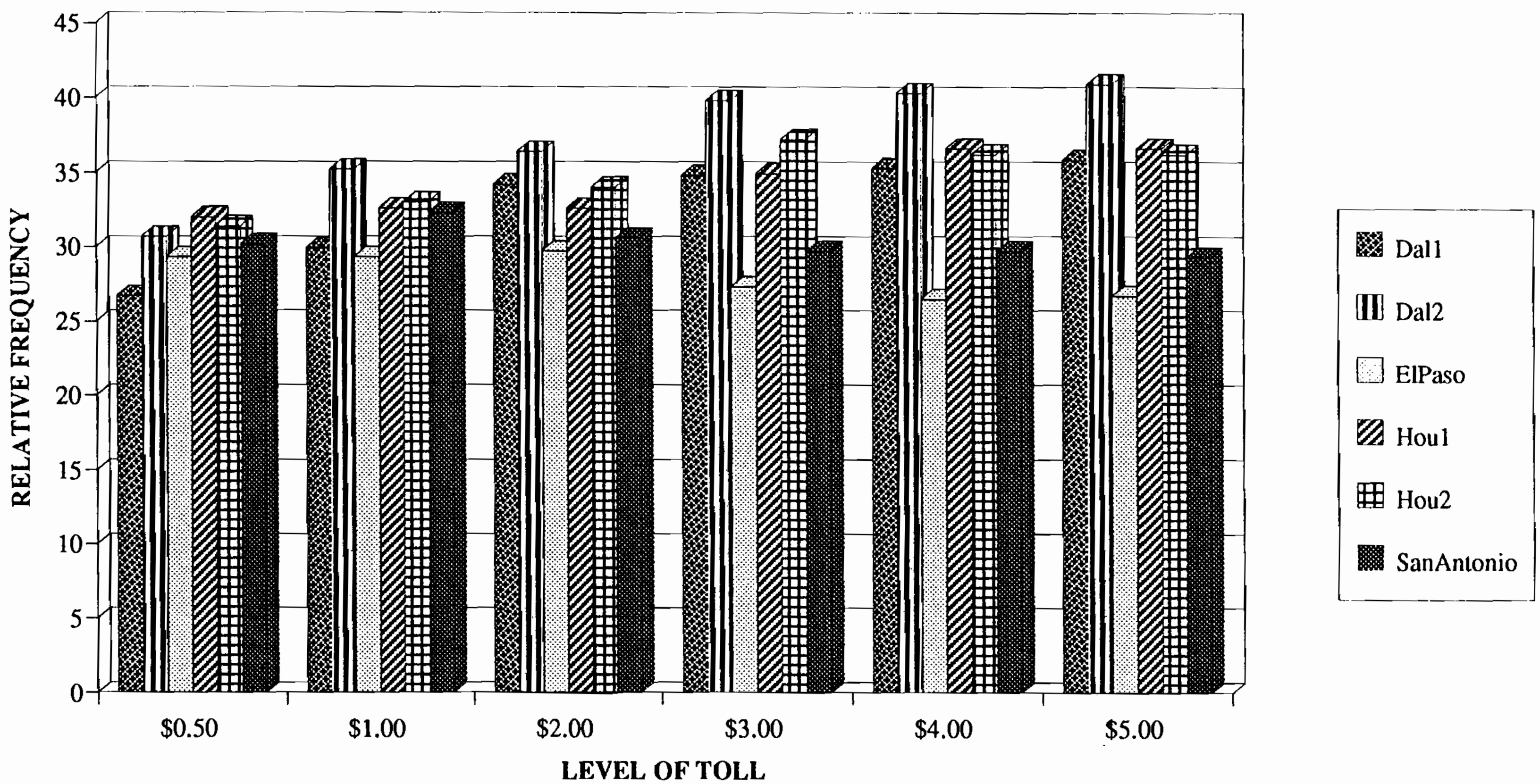
AREAWIDE SCHEME, MOST LIKELY RESPONSE IS TO USE PUBLIC TRANSIT TO AVOID THE EXTRA COST



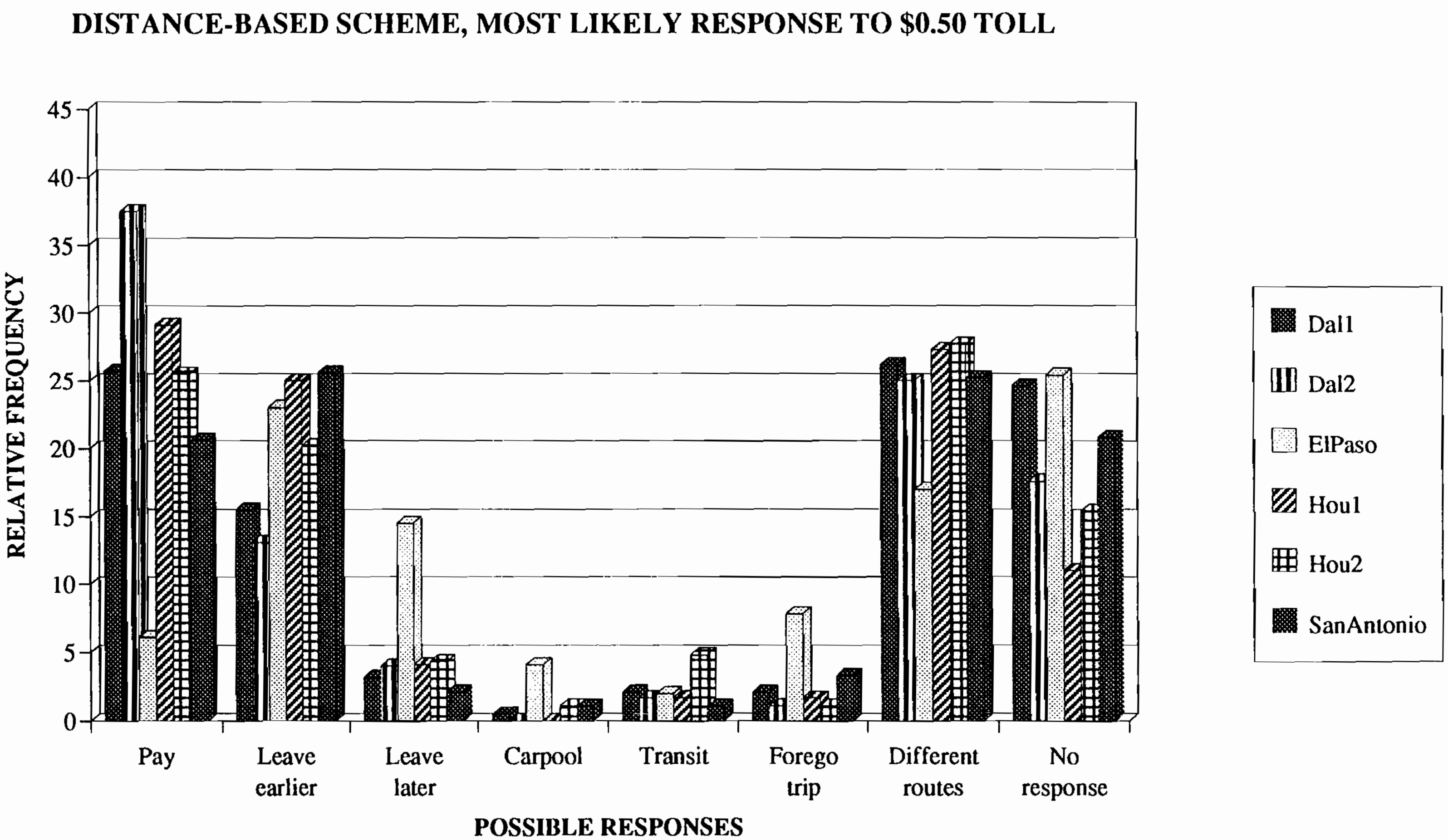
AREAWIDE SCHEME, MOST LIKELY RESPONSE IS TO FOREGO THE TRIP TO AVOID THE AREA

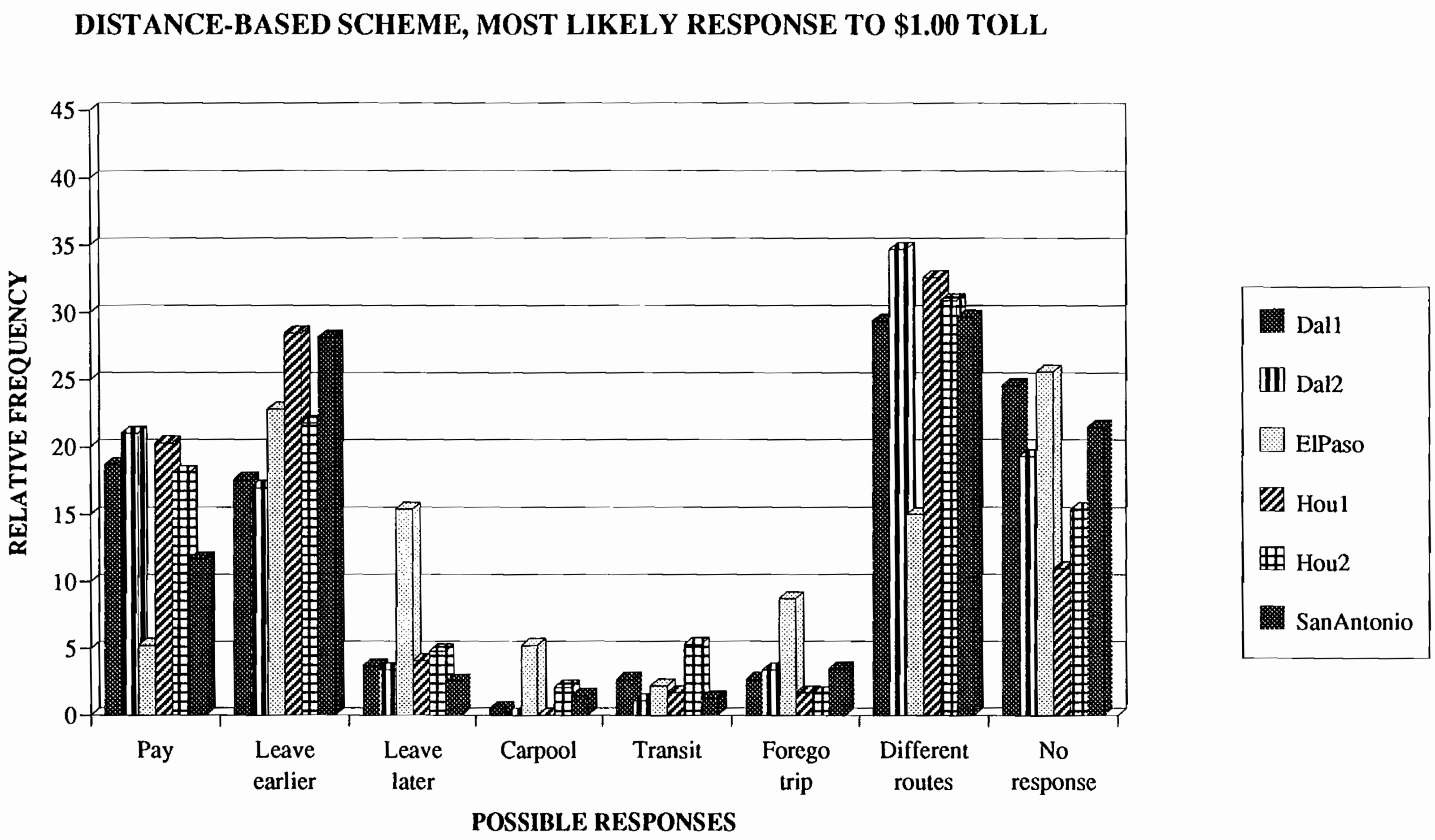


AREAWIDE SCHEME, MOST LIKELY RESPONSE IS TO SELECT A DIFFERENT ROUTE

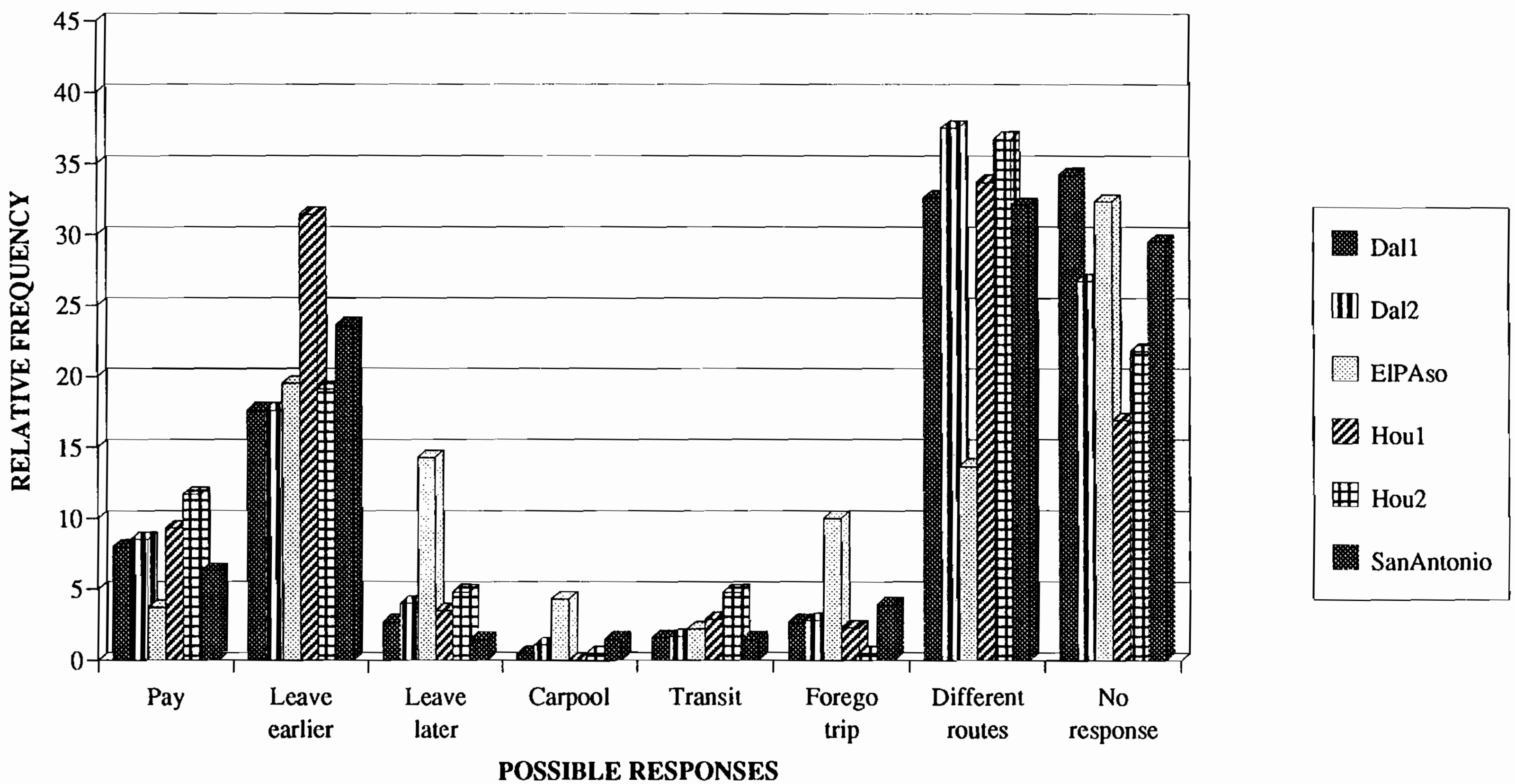


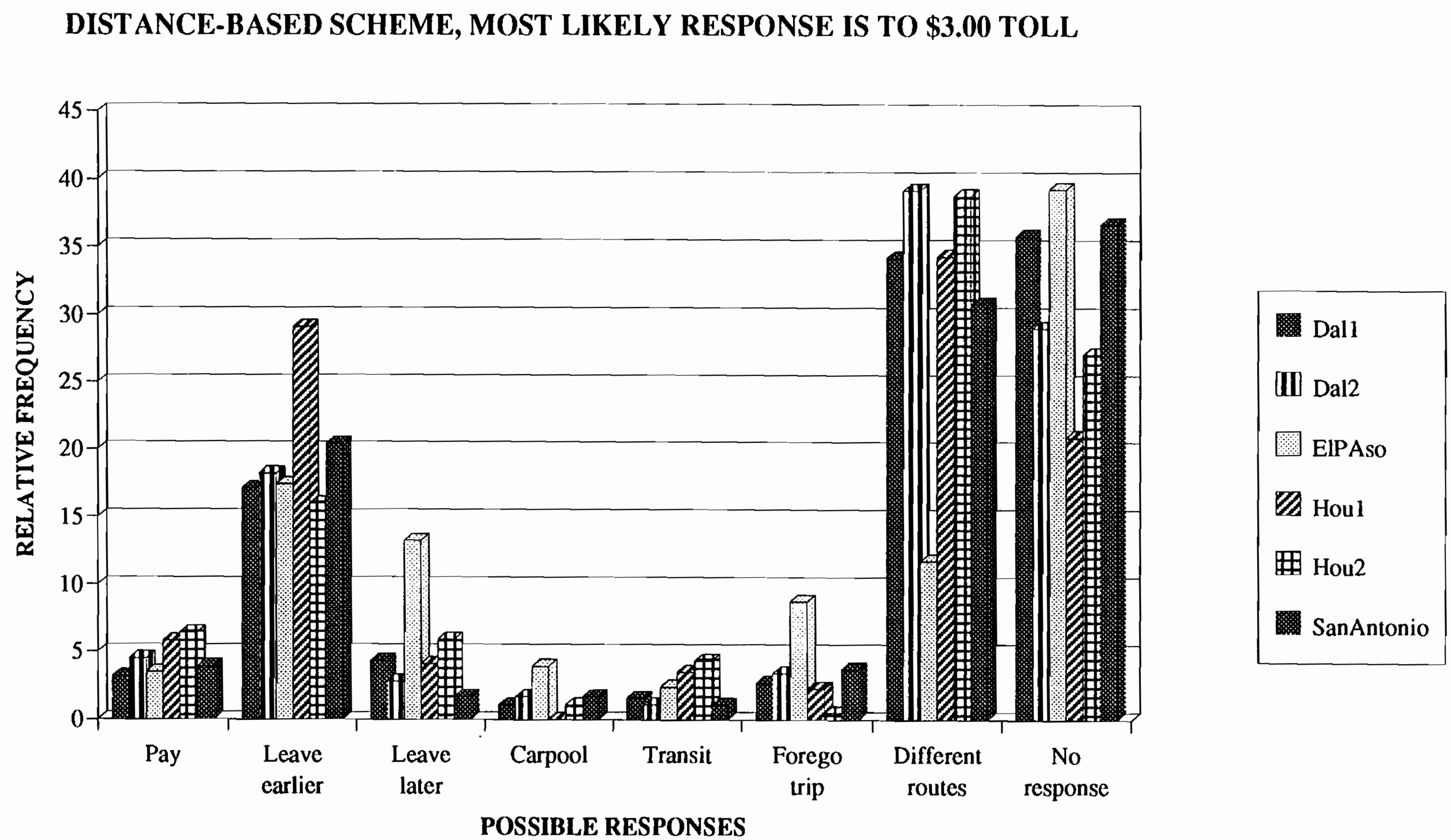
Appendix G - Distance Based Scheme, Stratified by Toll Level


DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE TO $0.50 TOLL
RELATIVE FREQUENCY
0
5
10
15
20
25
30
35
40
45
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different routes
No response
POSSIBLE RESPONSES
Dal1
Dal2
ElPaso
Hou1
Hou2
SanAntonio


DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE TO $1.00 TOLL
RELATIVE FREQUENCY
45
40
35
30
25
20
15
10
5
0
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different routes
No response
POSSIBLE RESPONSES
Dal1
Dal2
ElPaso
Hou1
Hou2
SanAntonio

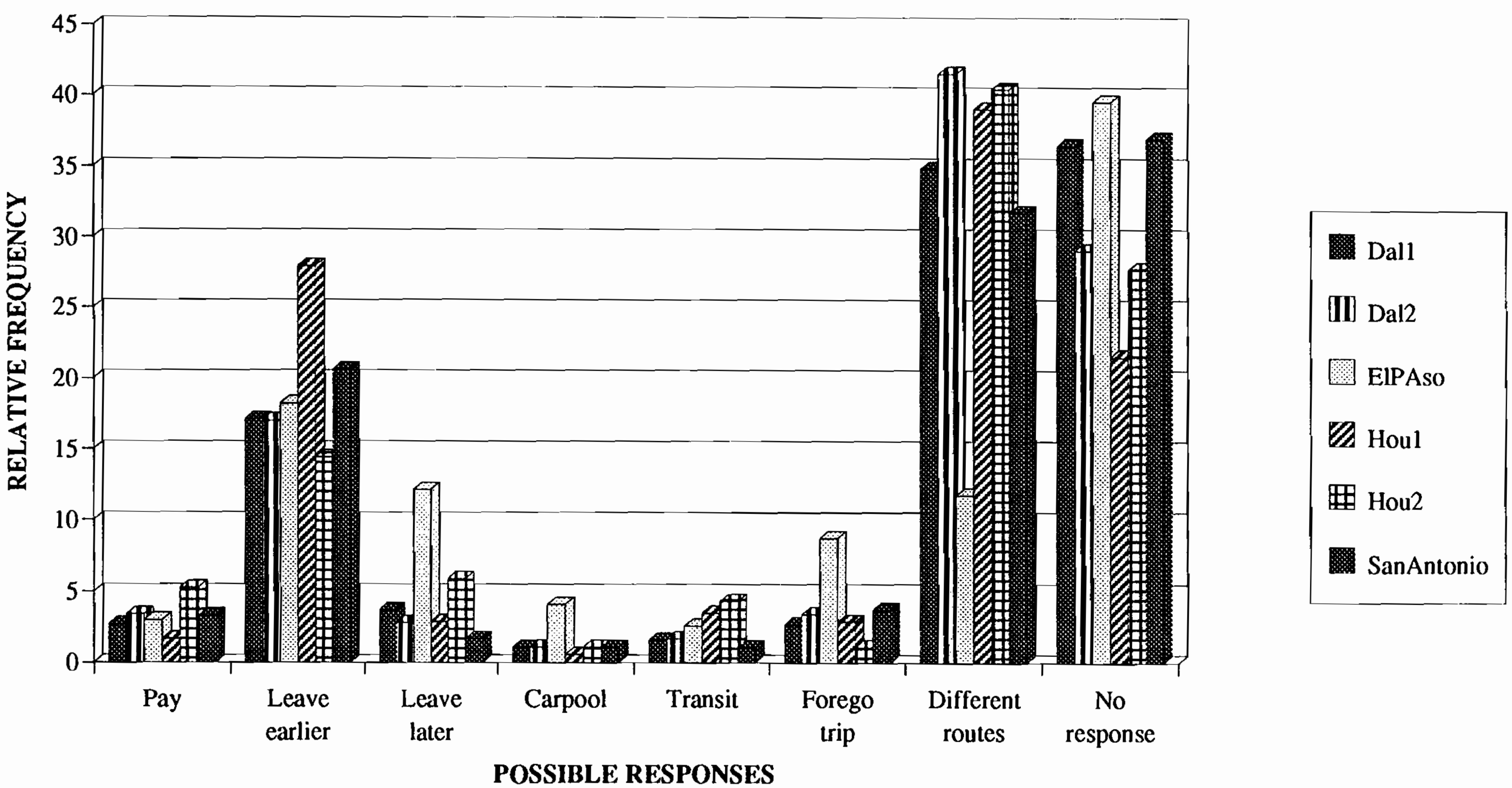
DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE IS TO $2.00 TOLL



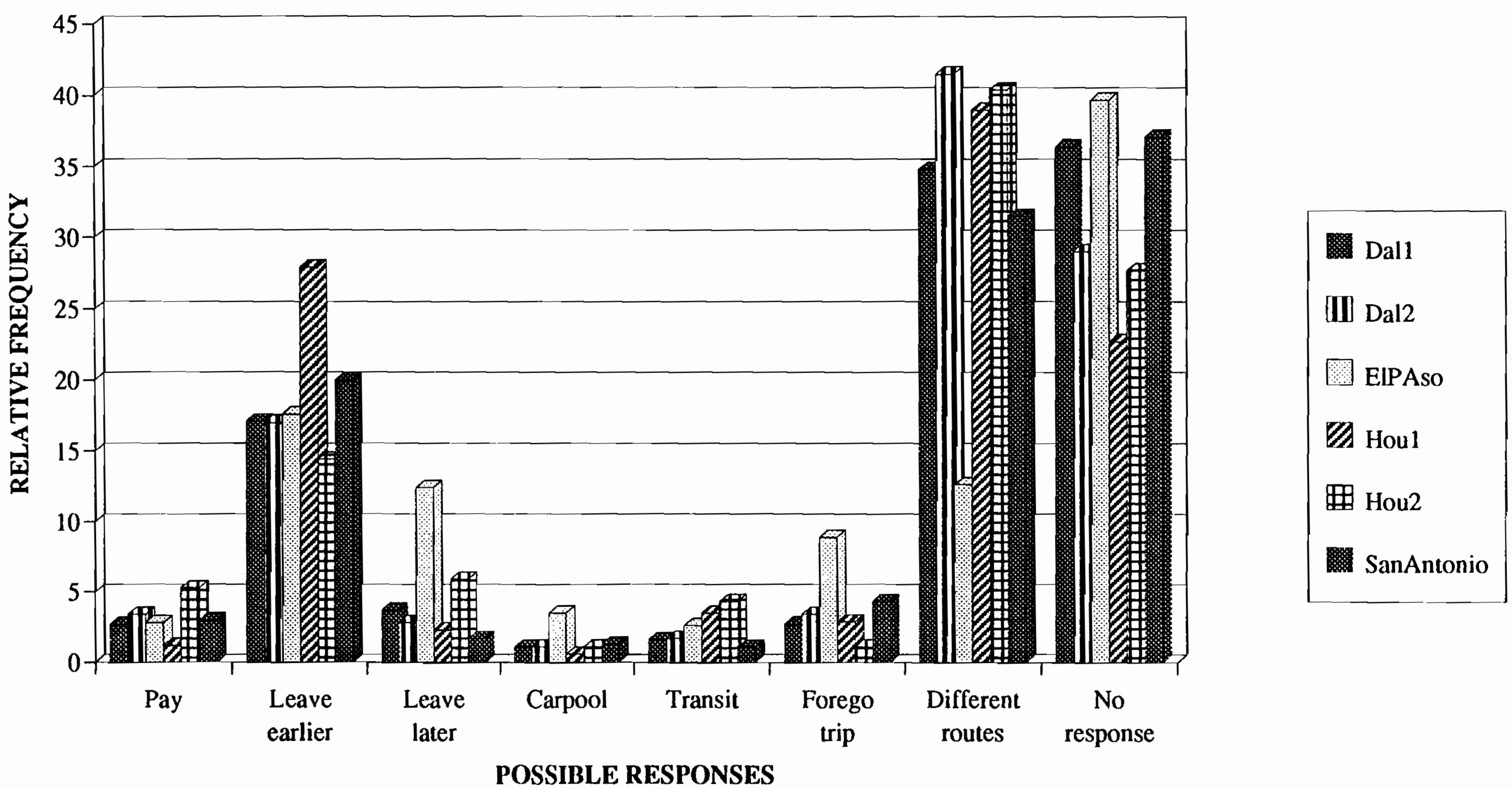


DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE IS TO $3.00 TOLL
RELATIVE FREQUENCY
45
40
35
30
25
20
15
10
5
0
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different routes
No response
POSSIBLE RESPONSES
Dal1
Dal2
ElPAso
Hou1
Hou2
SanAntonio

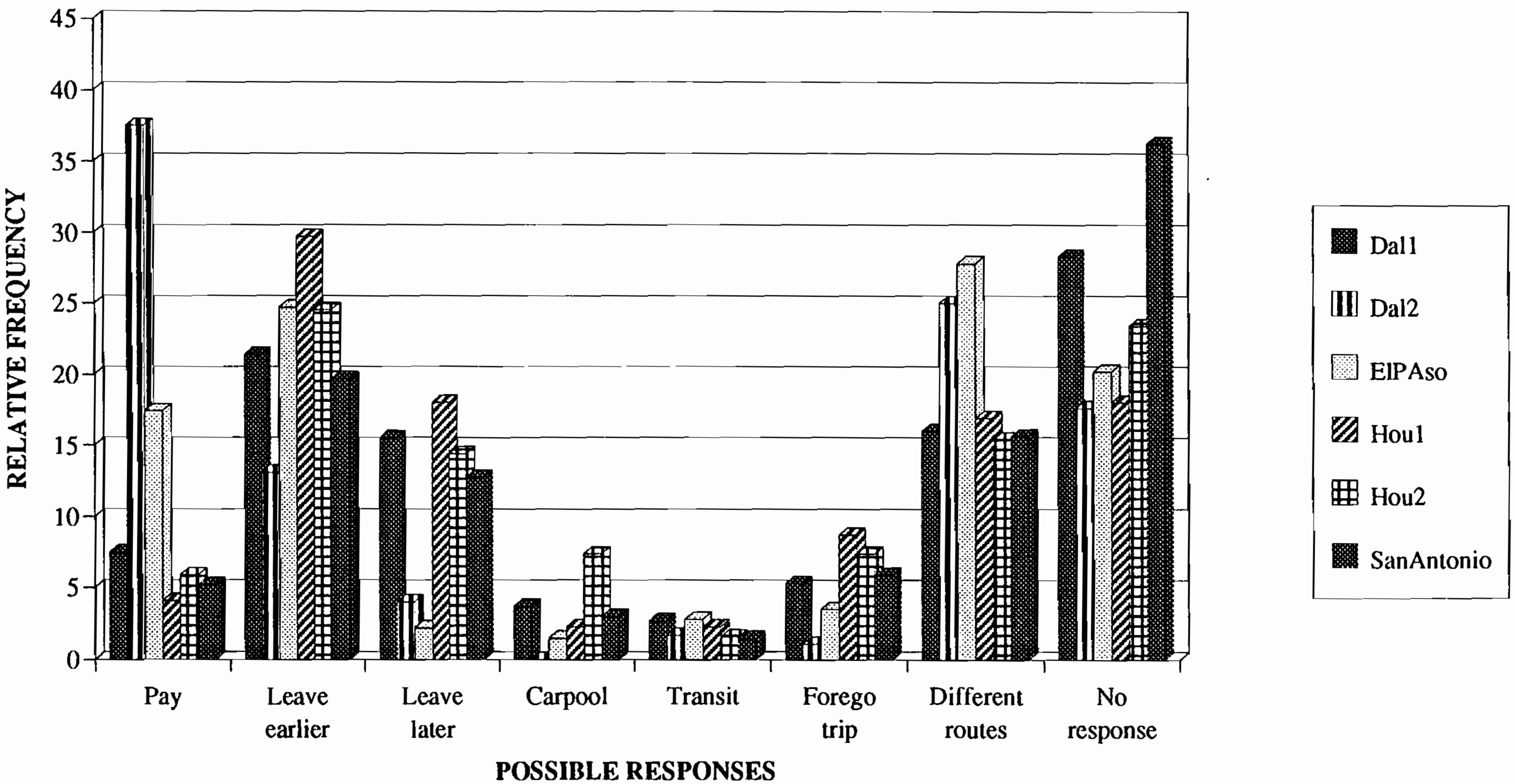
DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE TO $4.00 TOLL



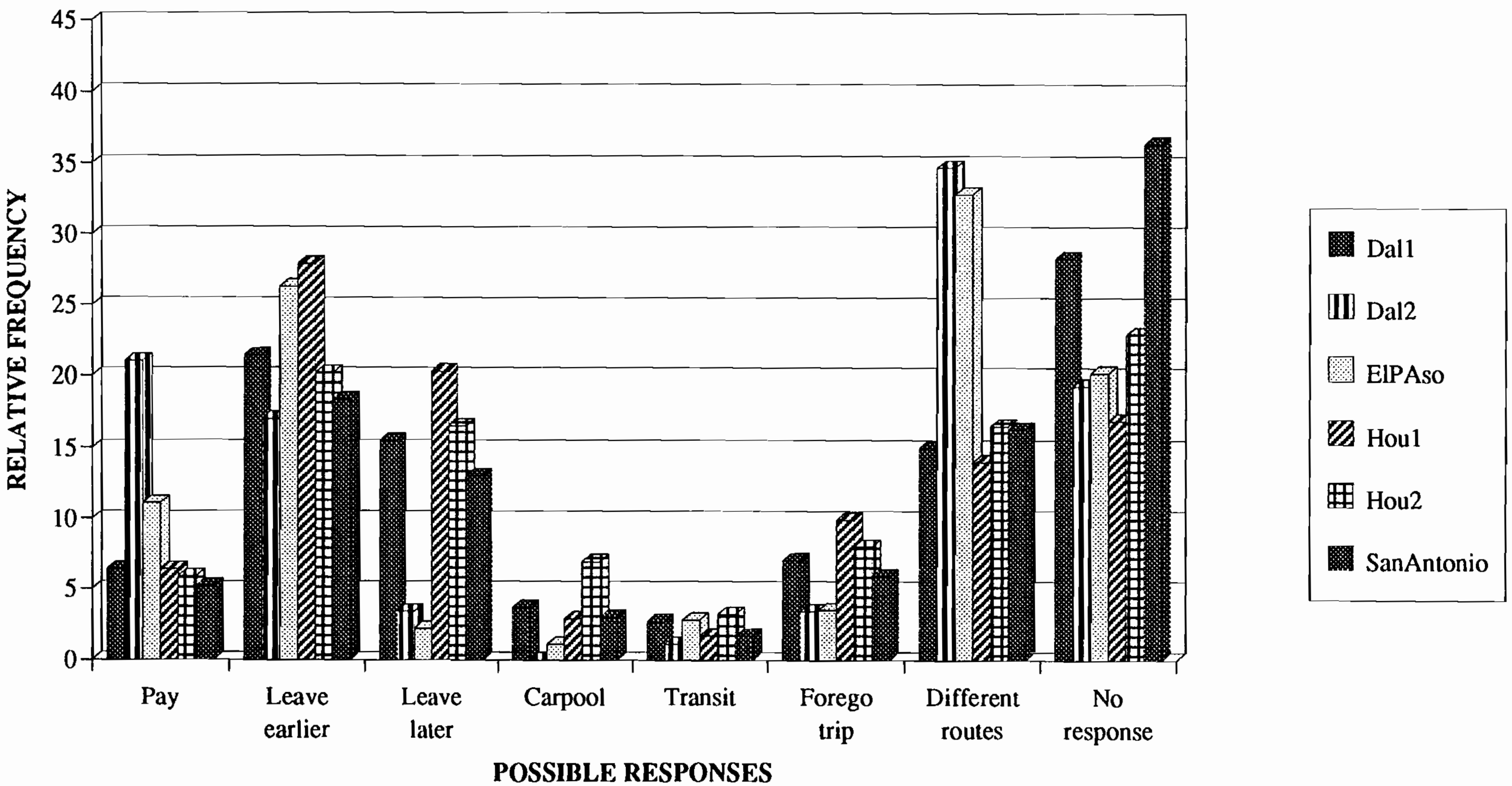
DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE TO $5.00 TOLL



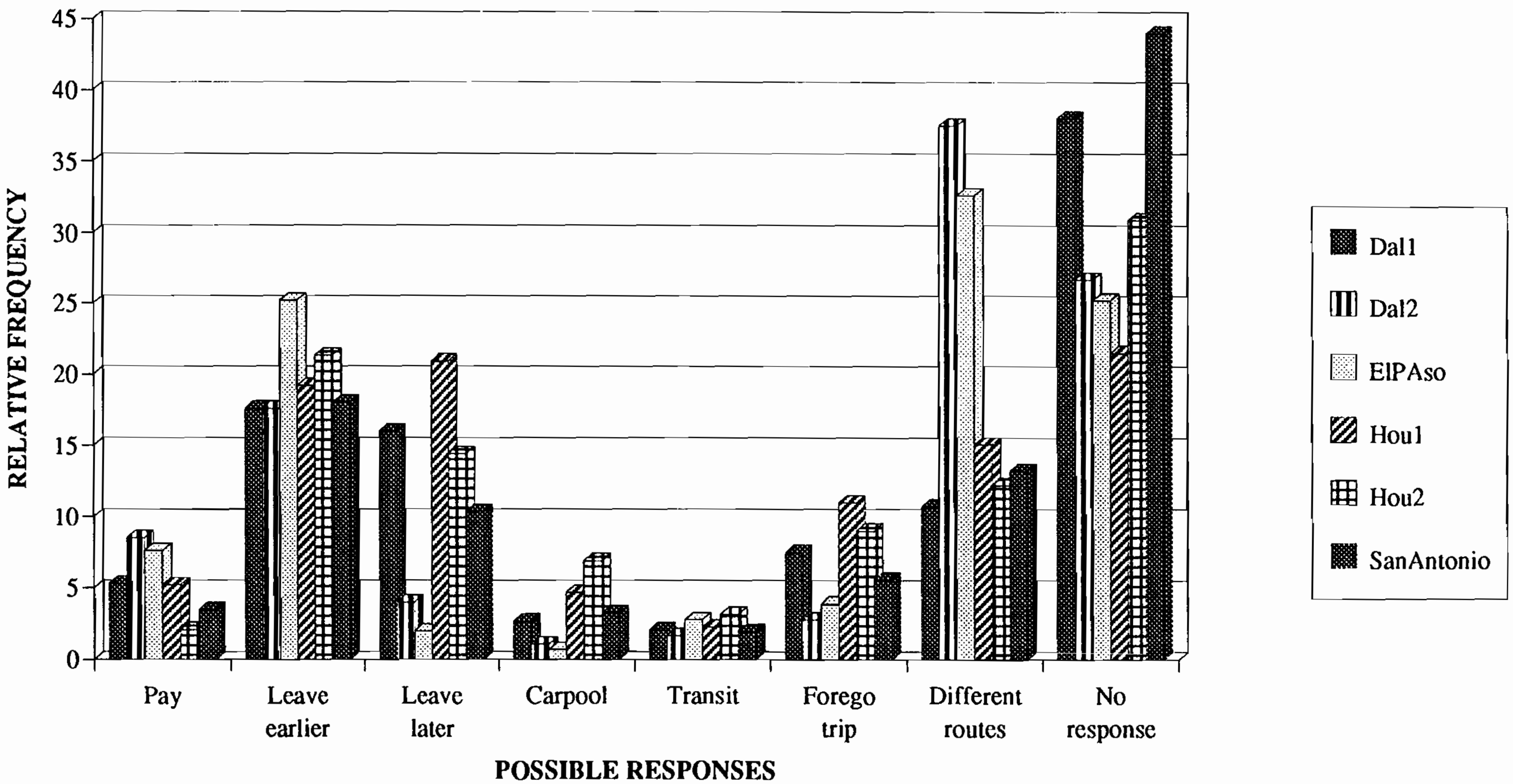
DISTANCE-BASED SCHEME, 2nd MOST LIKELY RESPONSE TO $0.50 TOLL



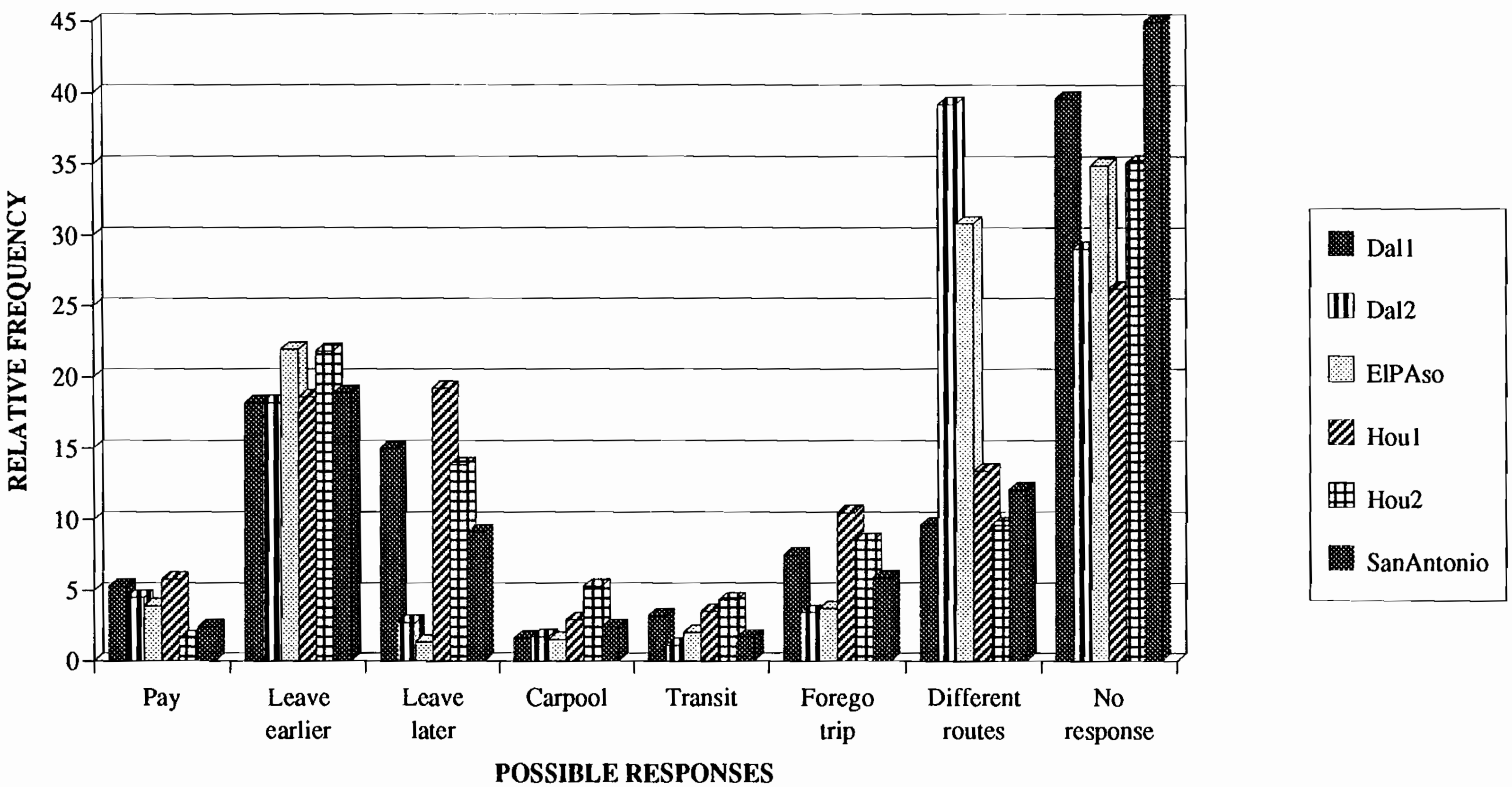
DISTANCE-BASED SCHEME, 2nd MOST LIKELY RESPONSE TO $1.00 TOLL



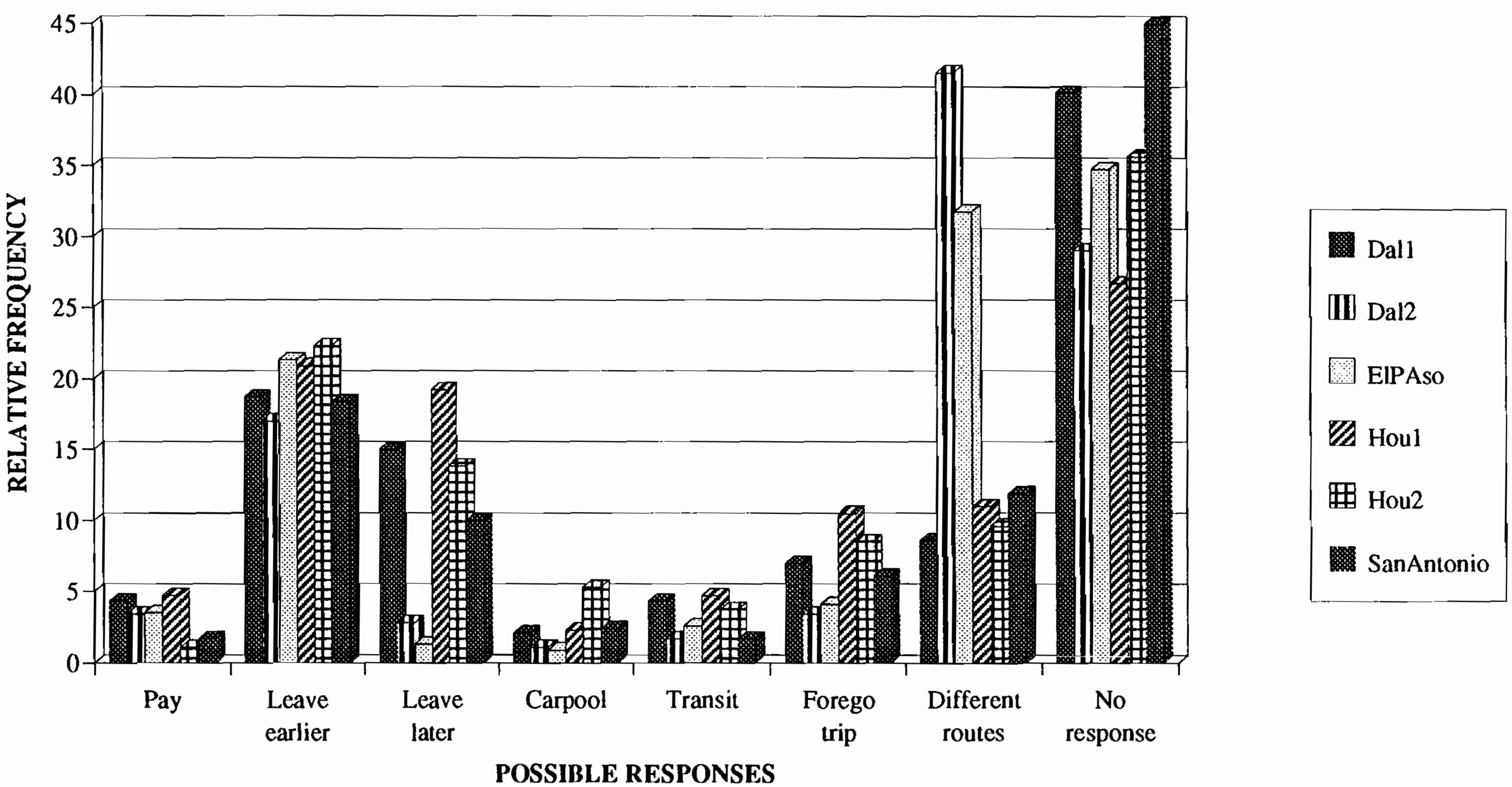
DISTANCE-BASED SCHEME, 2nd MOST LIKELY RESPONSE TO $2.00 TOLL



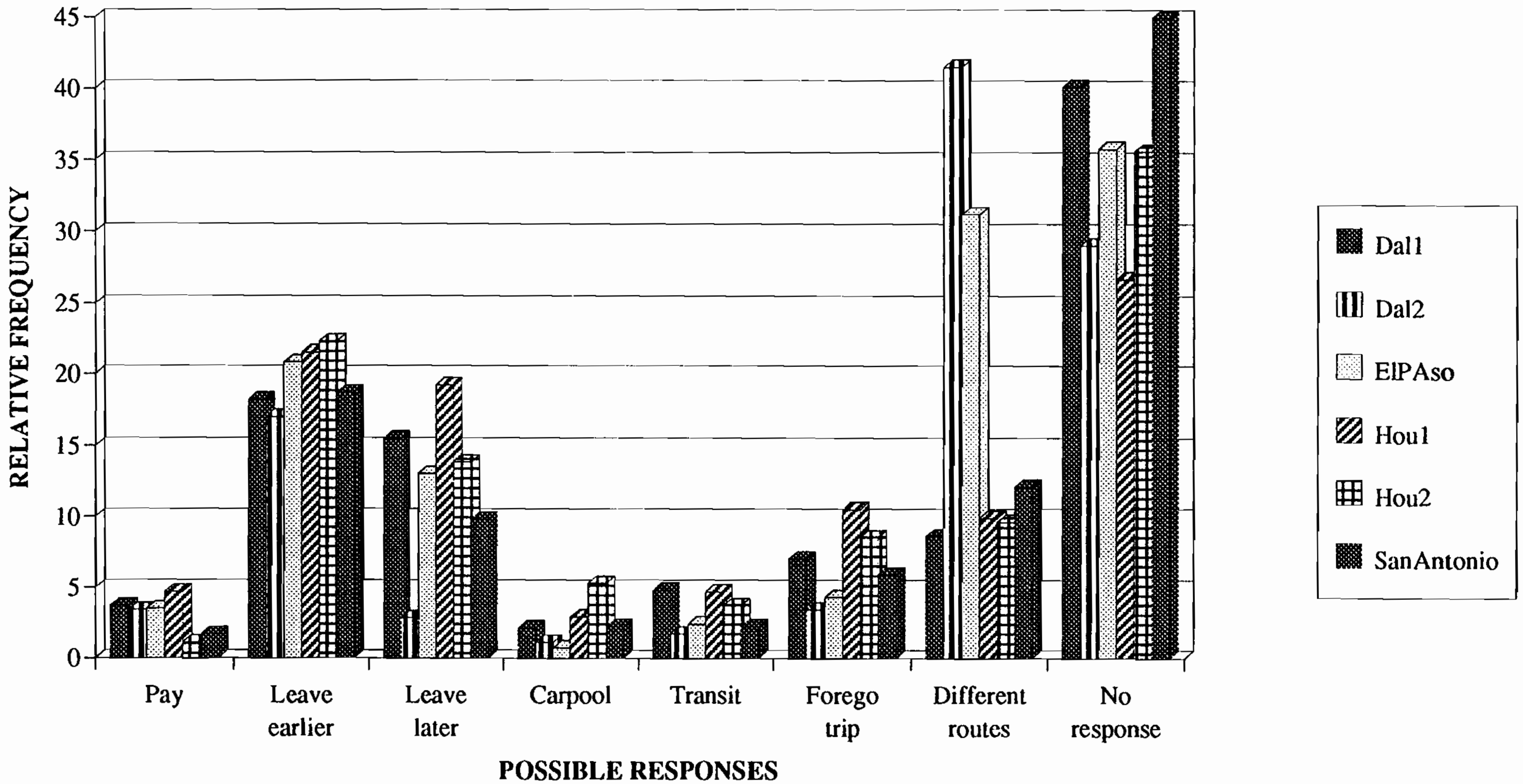
DISTANCE-BASED SCHEME, 2nd MOST LIKELY RESPONSE TO $3.00 TOLL



DISTANCE-BASED SCHEME, 2nd MOST LIKELY RESPONSE TO $4.00 TOLL

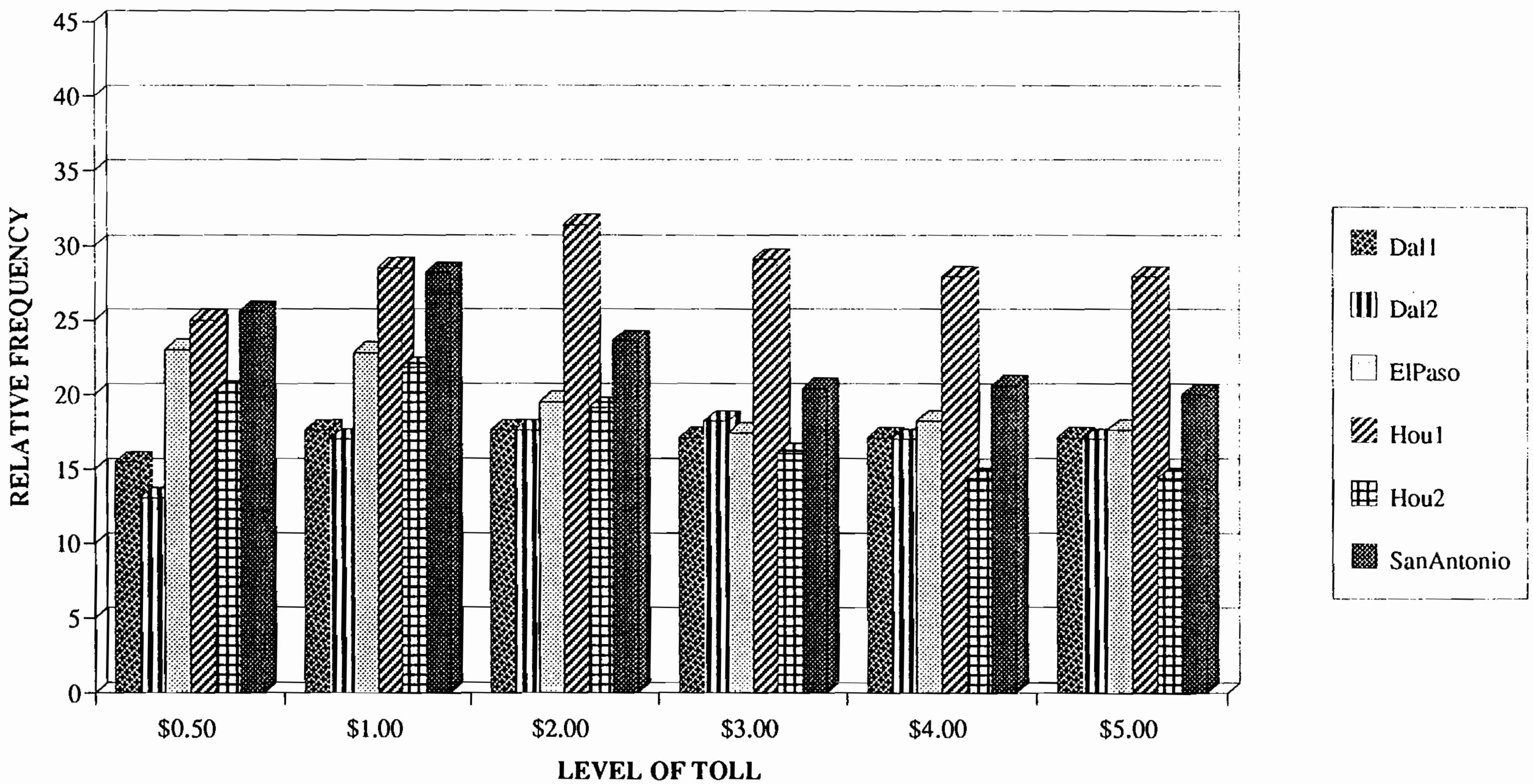


DISTANCE-BASED SCHEME, 2nd MOST LIKELY RESPONSE TO $5.00 TOLL

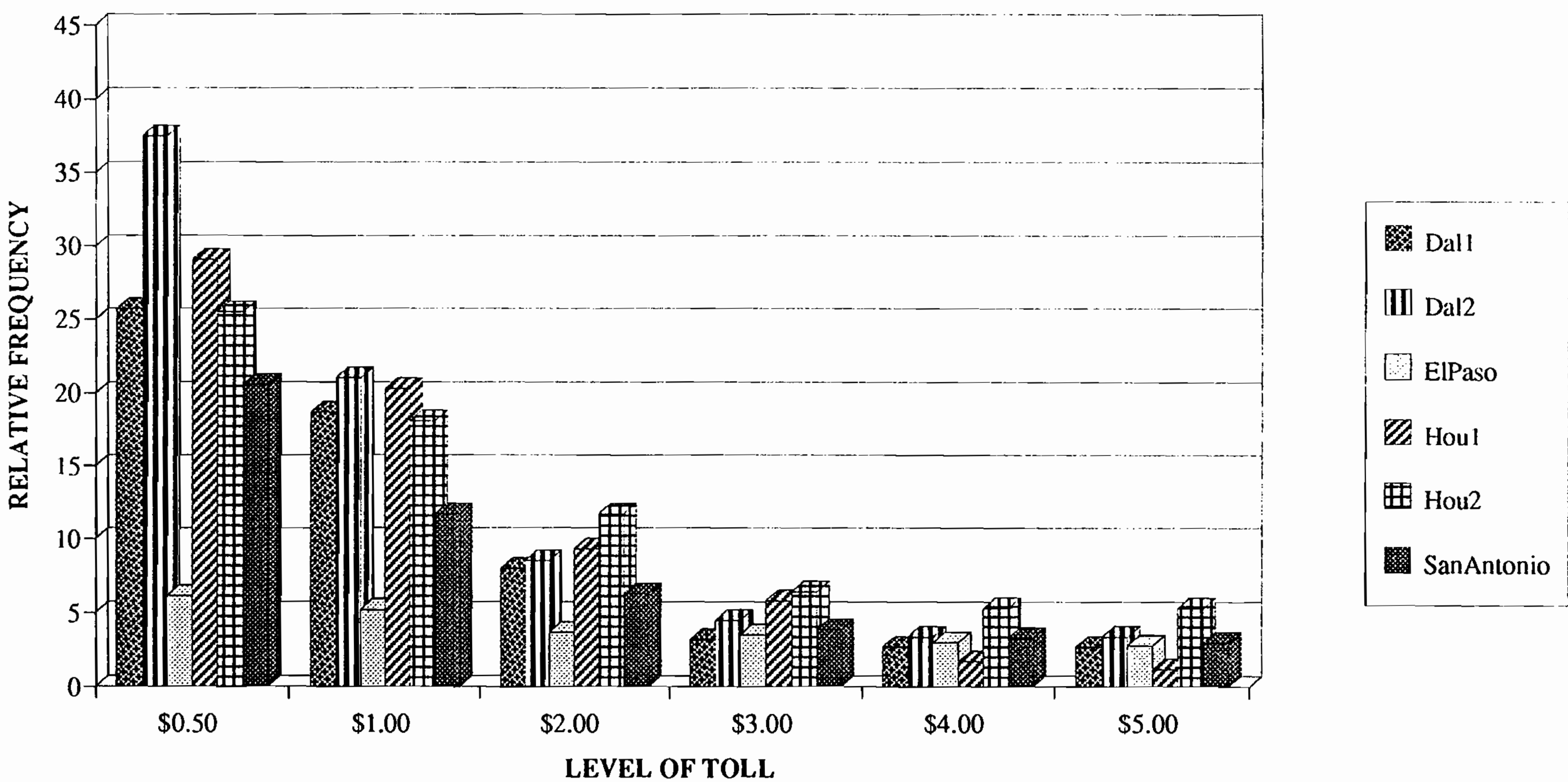


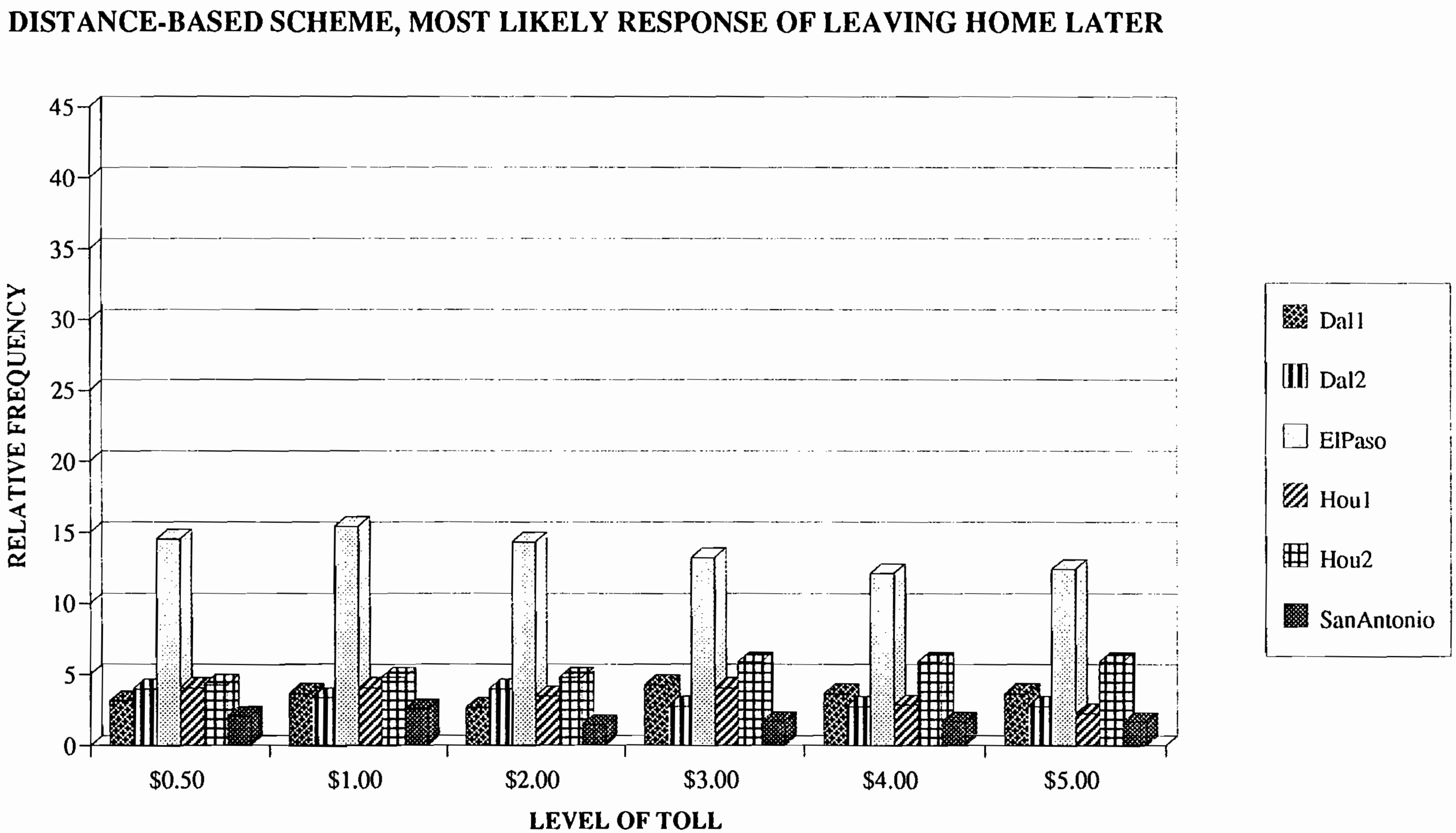
Appendix H - Distance Based Scheme, Stratified by Response

DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE OF LEAVING HOME EARLIER

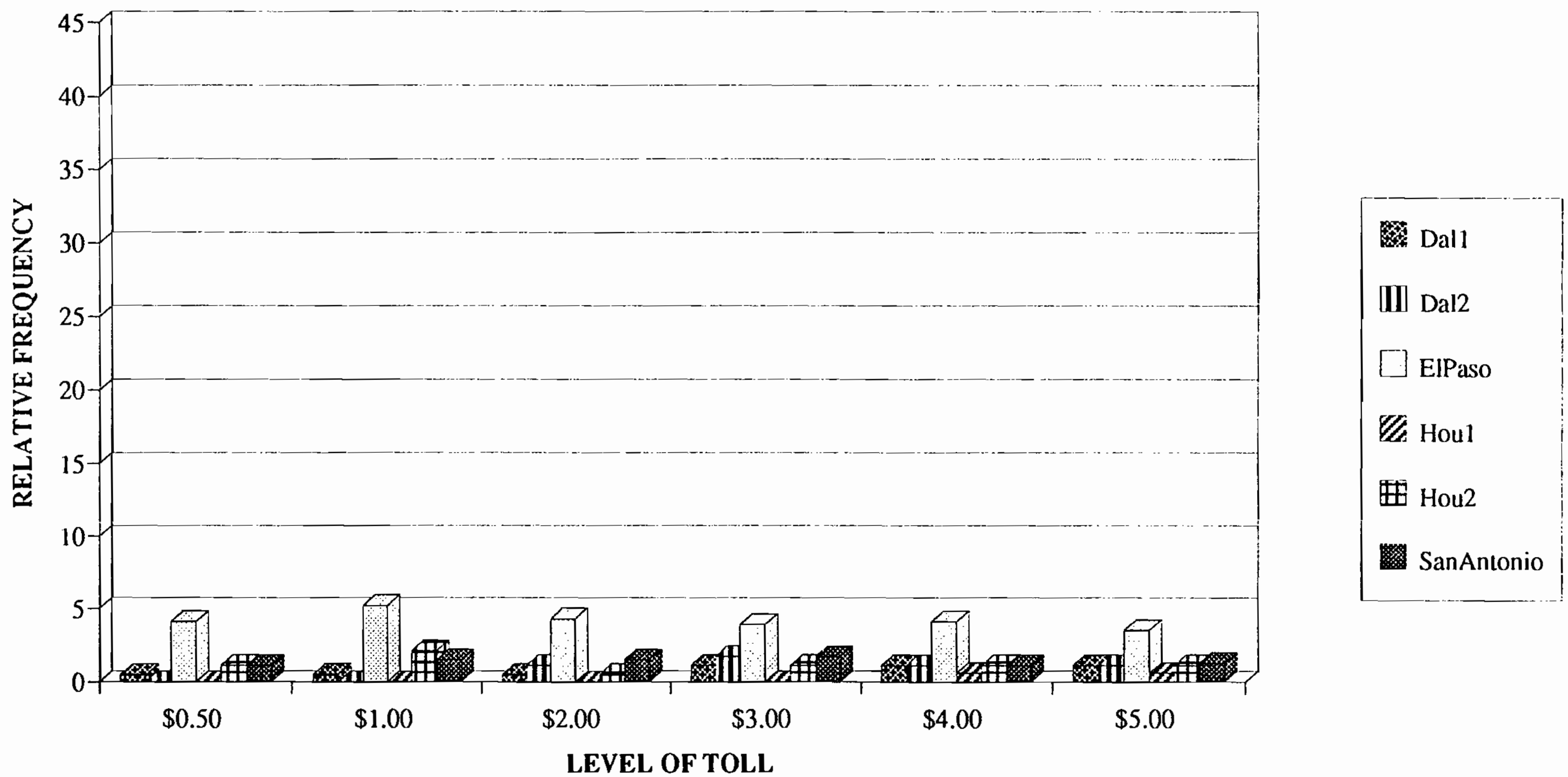


DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE OF PAYING THE TOLL AND NOT CHANGING TRAVEL HABITS

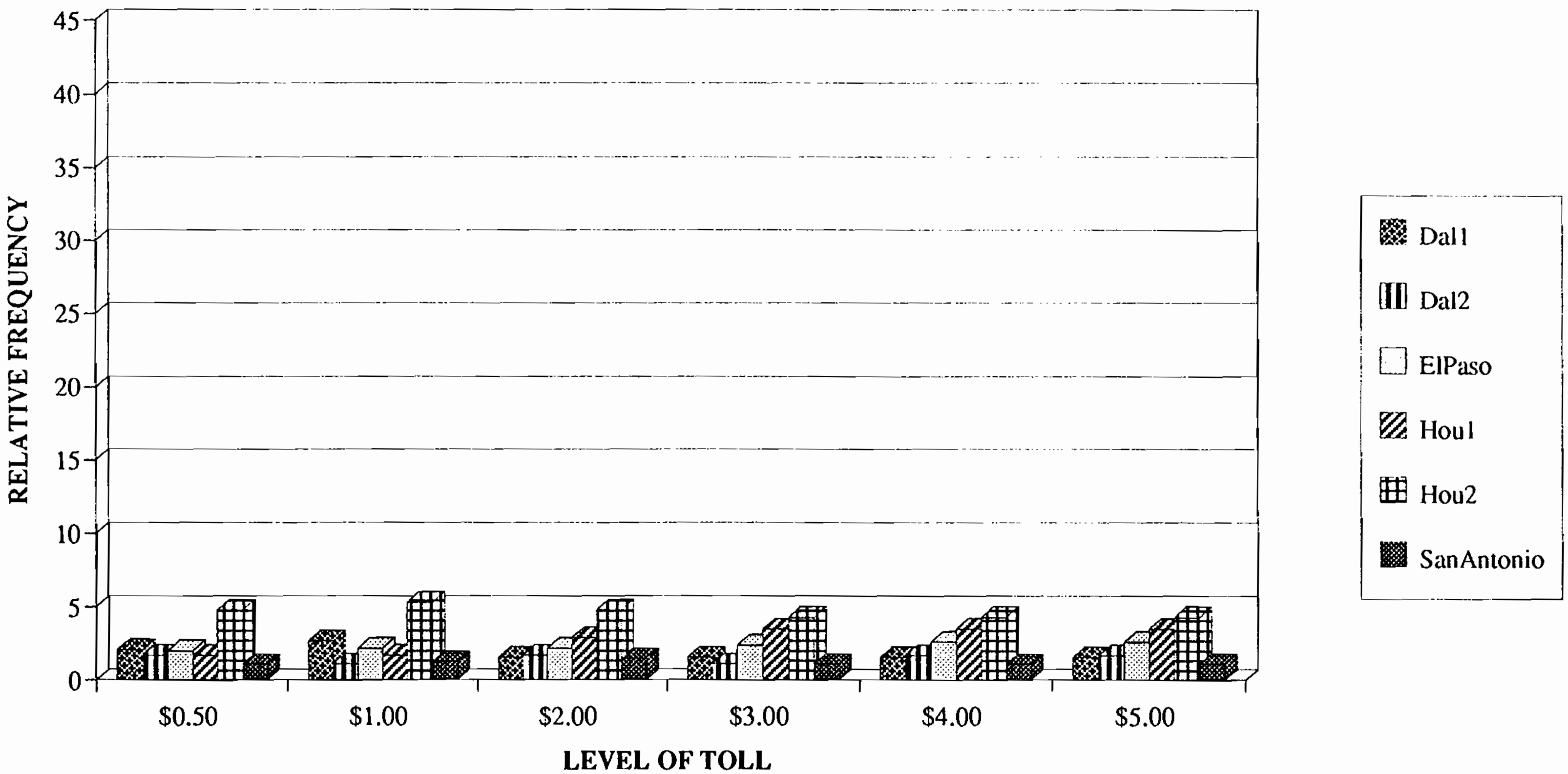


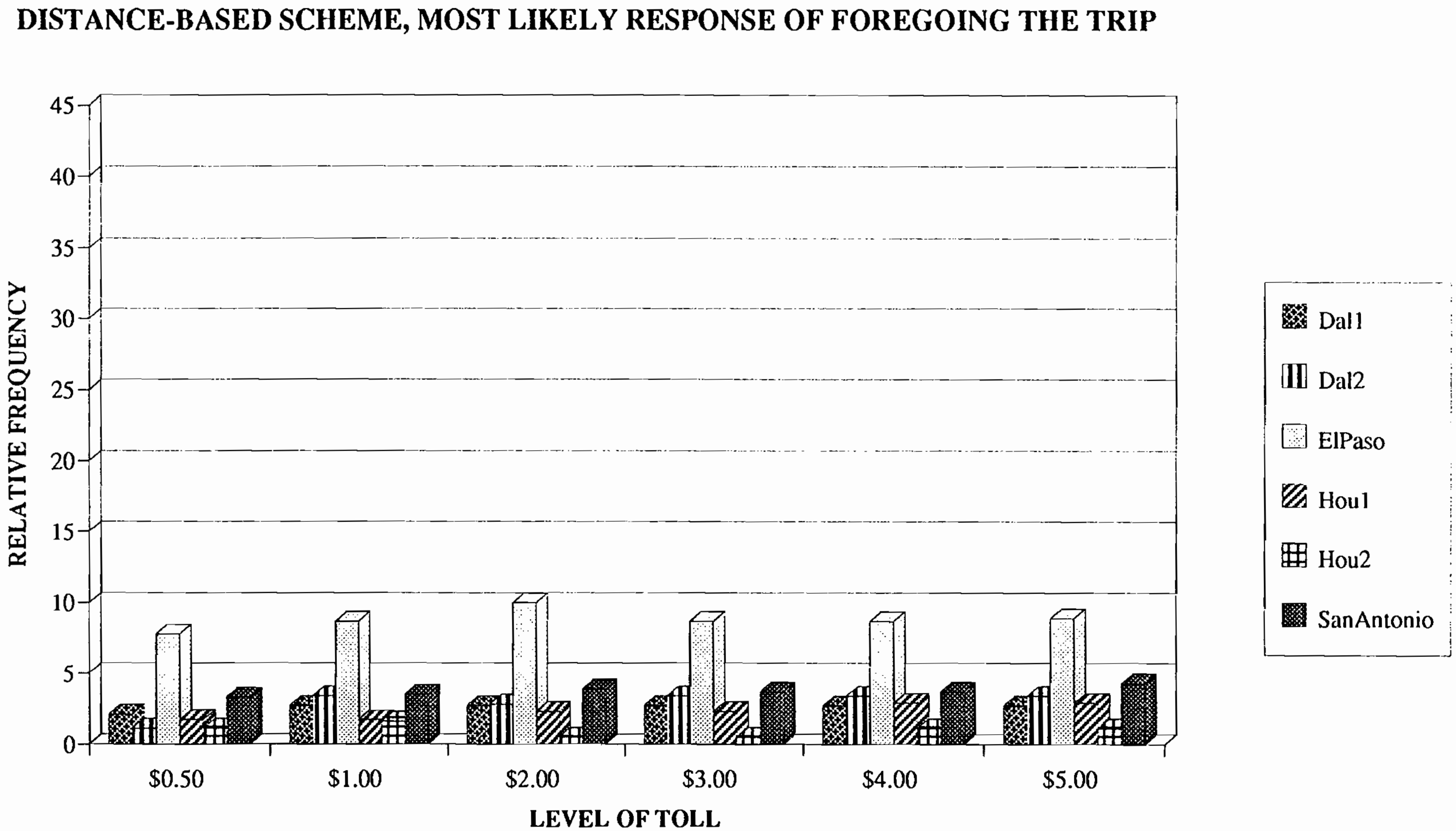

DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE OF LEAVING HOME LATER
RELATIVE FREQUENCY
0
5
10
15
20
25
30
35
40
45
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00
LEVEL OF TOLL
Dal1
Dal2
ElPaso
Hou1
Hou2
SanAntonio

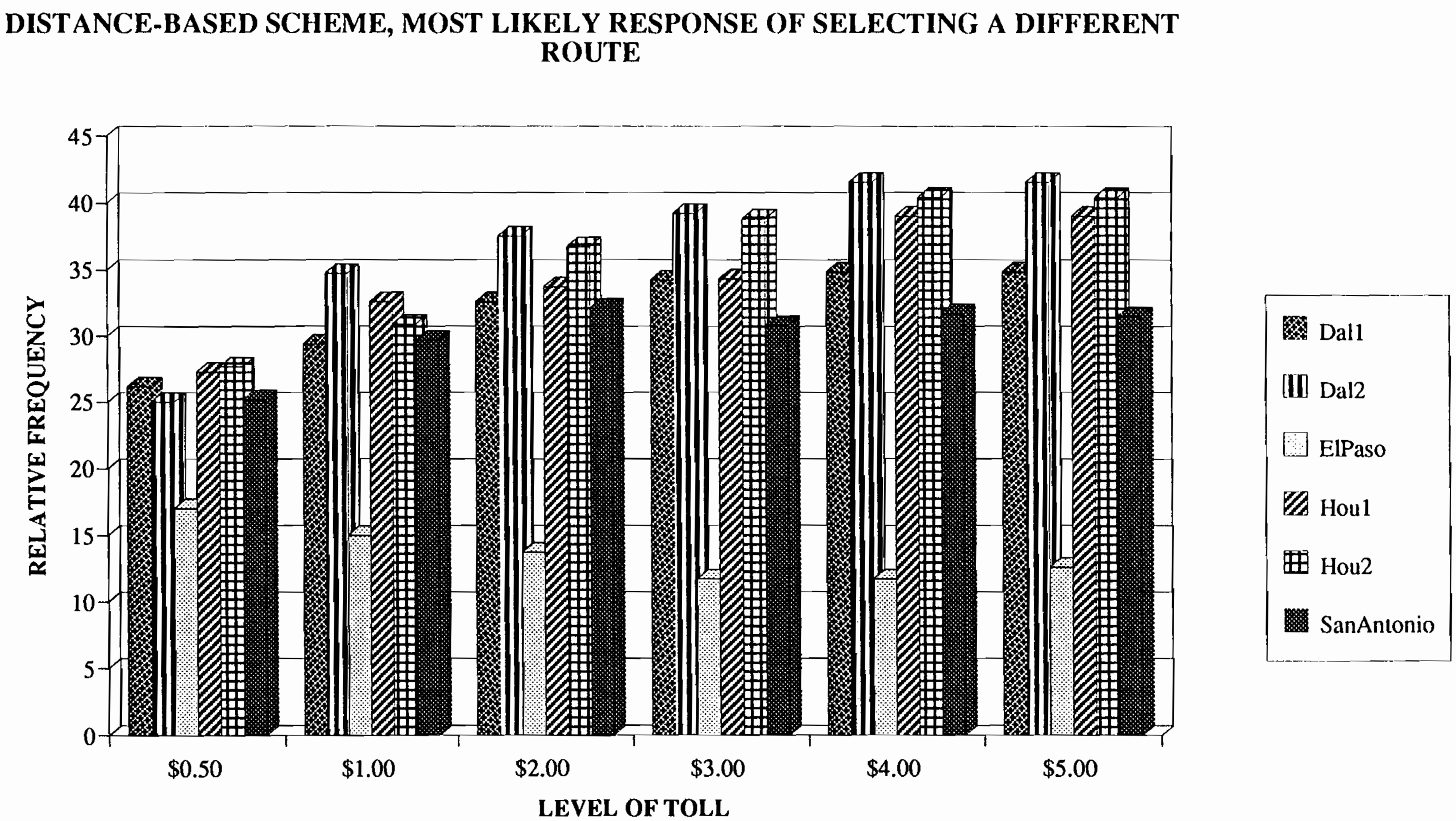
DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE OF CARPOOLING TO SPLIT THE EXTRA COST



DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE OF USING PUBLIC TRANSIT TO AVOID THE EXTRA COST

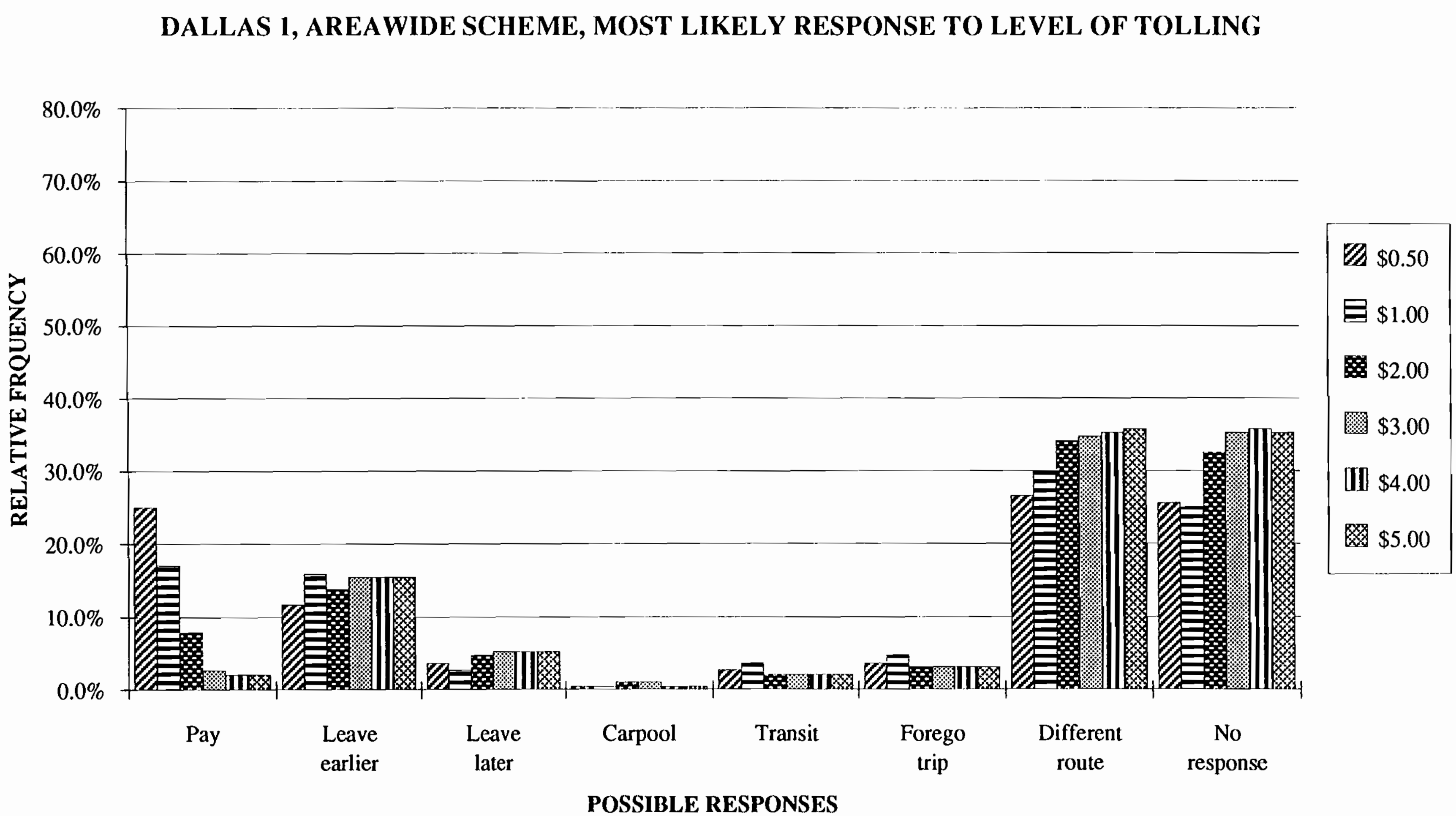


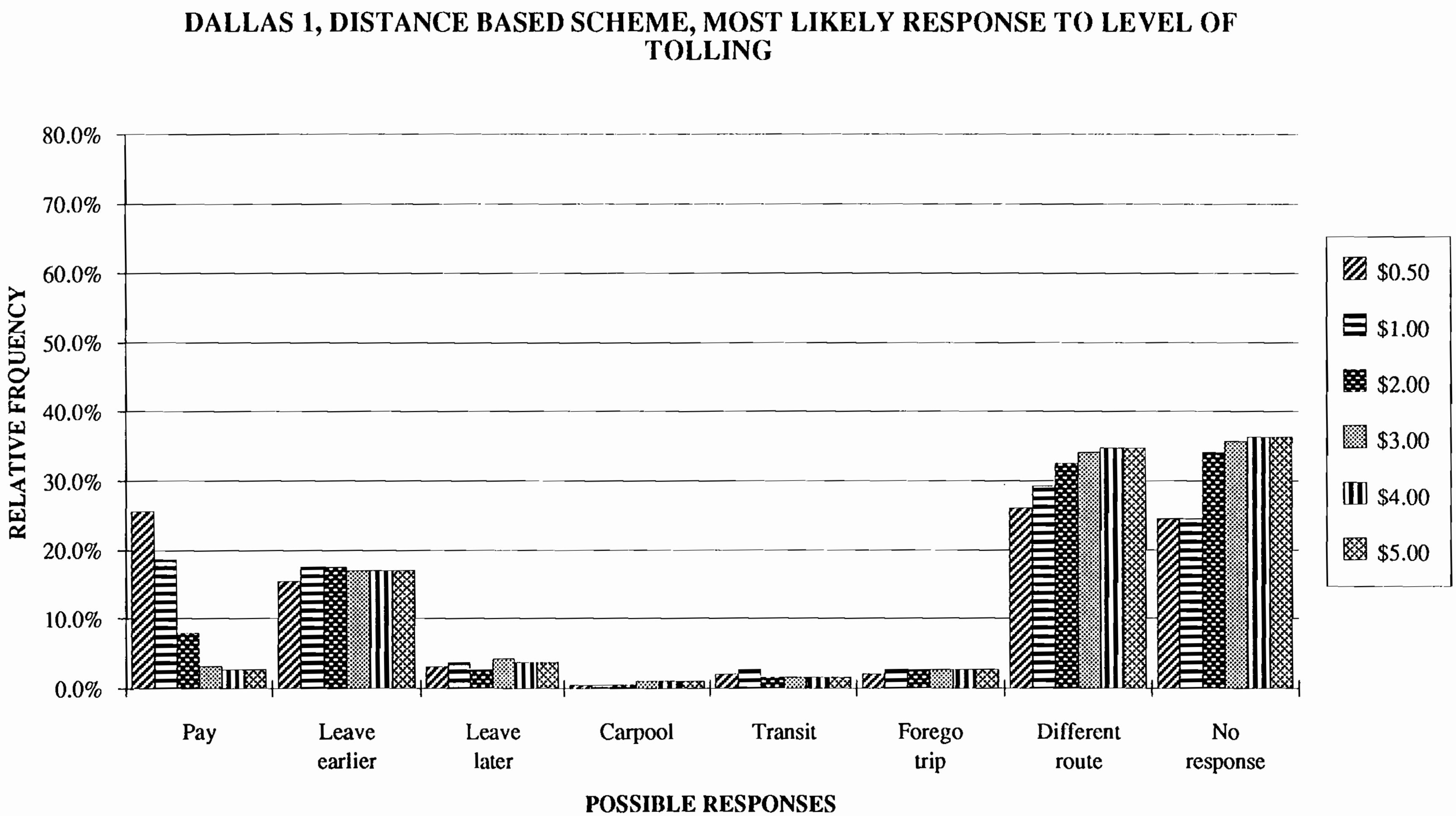

DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE OF FOREGOING THE TRIP
RELATIVE FREQUENCY
45
40
35
30
25
20
15
10
5
0
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00
LEVEL OF TOLL
Dal1
Dal2
ElPaso
Hou1
Hou2
SanAntonio



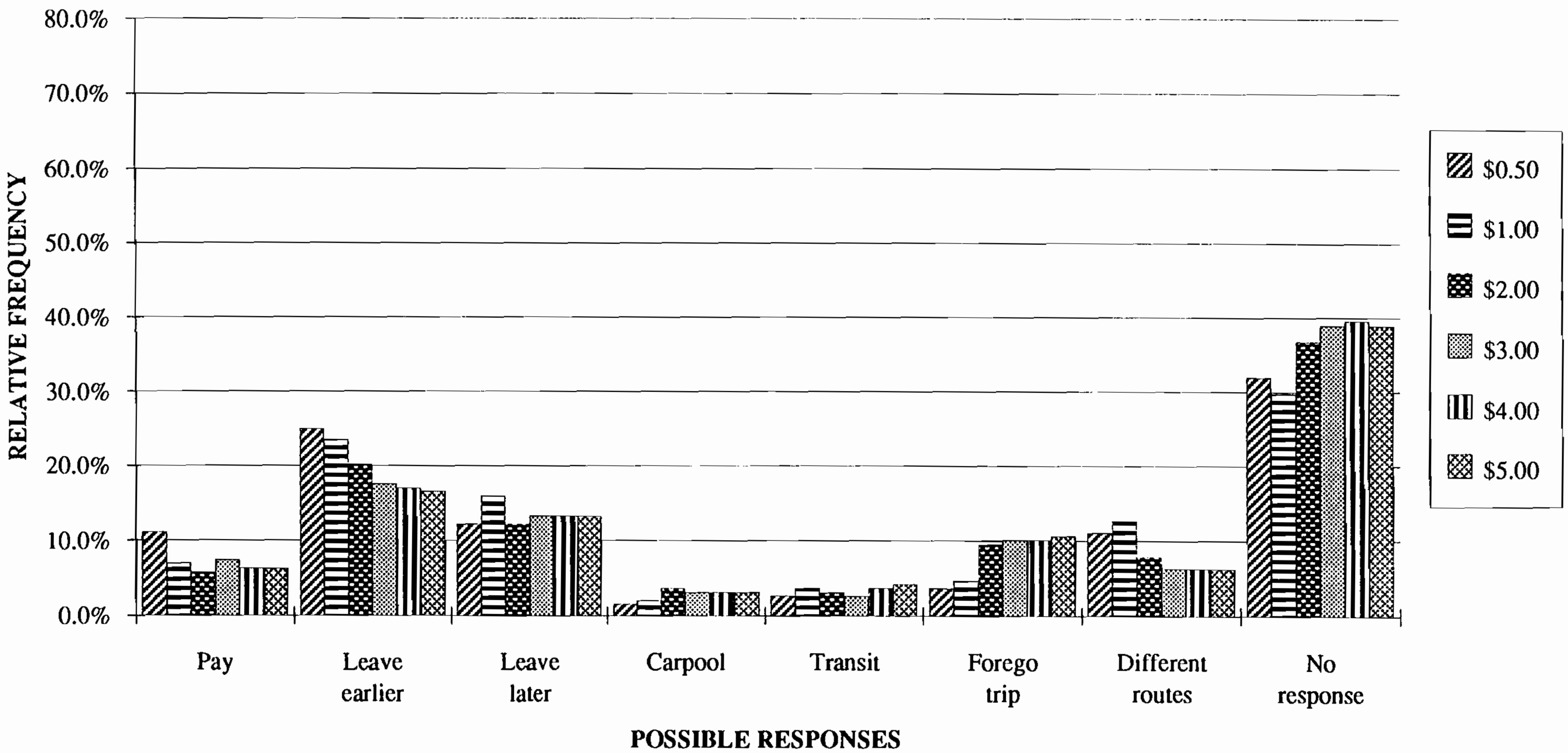
DISTANCE-BASED SCHEME, MOST LIKELY RESPONSE OF SELECTING A DIFFERENT ROUTE
RELATIVE FREQUENCY
0
5
10
15
20
25
30
35
40
45
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00
LEVEL OF TOLL
Dal1
Dal2
ElPaso
Hou1
Hou2
SanAntonio

Appendix I - Pricing Schemes, Stratified by City

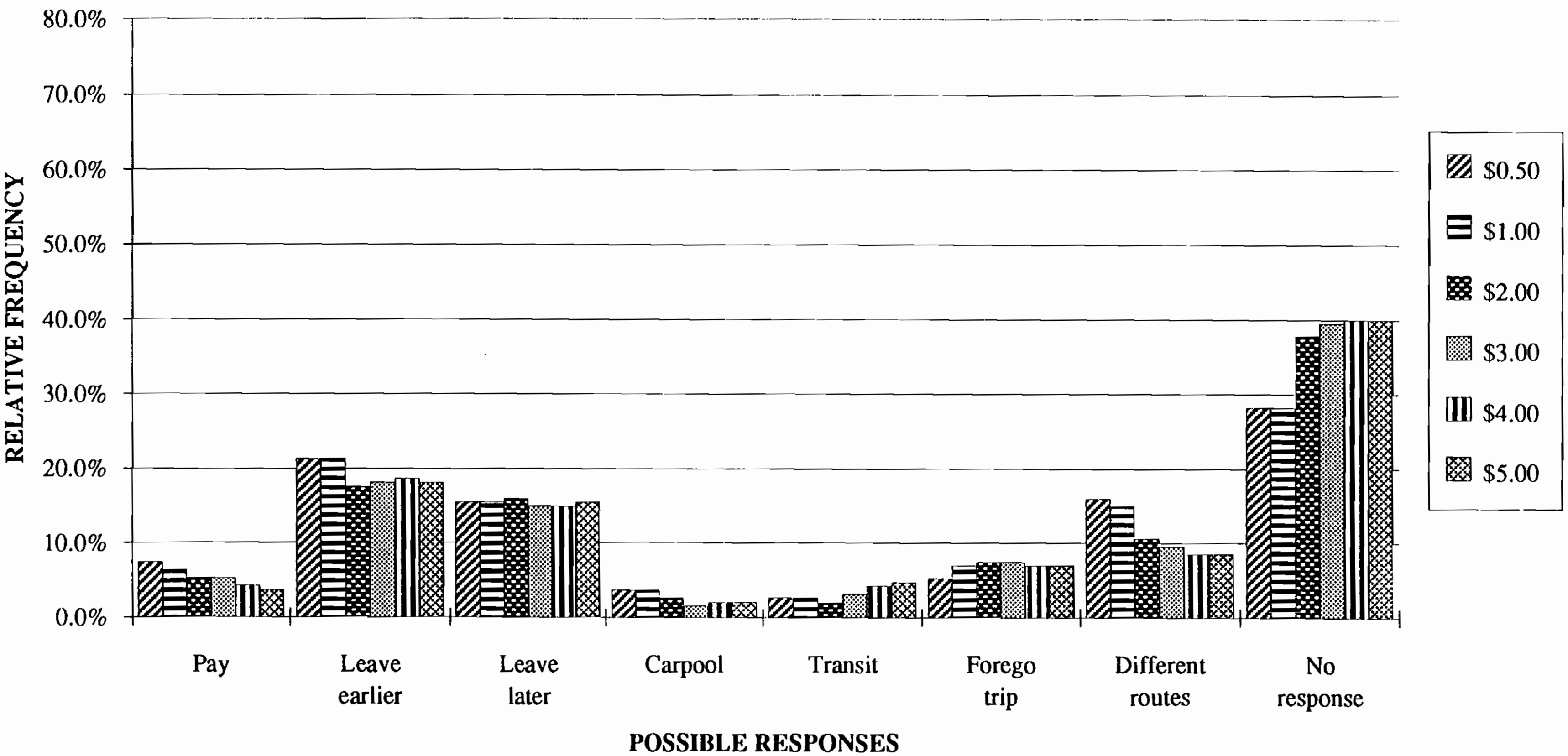

DALLAS 1, AREAWIDE SCHEME, MOST LIKELY RESPONSE TO LEVEL OF TOLLING
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
RELATIVE FRQUENCY
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different route
No response
POSSIBLE RESPONSES
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00


DALLAS 1, DISTANCE BASED SCHEME, MOST LIKELY RESPONSE TO LEVEL OF TOLLING
RELATIVE FRQUENCY
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different route
No response
POSSIBLE RESPONSES
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00

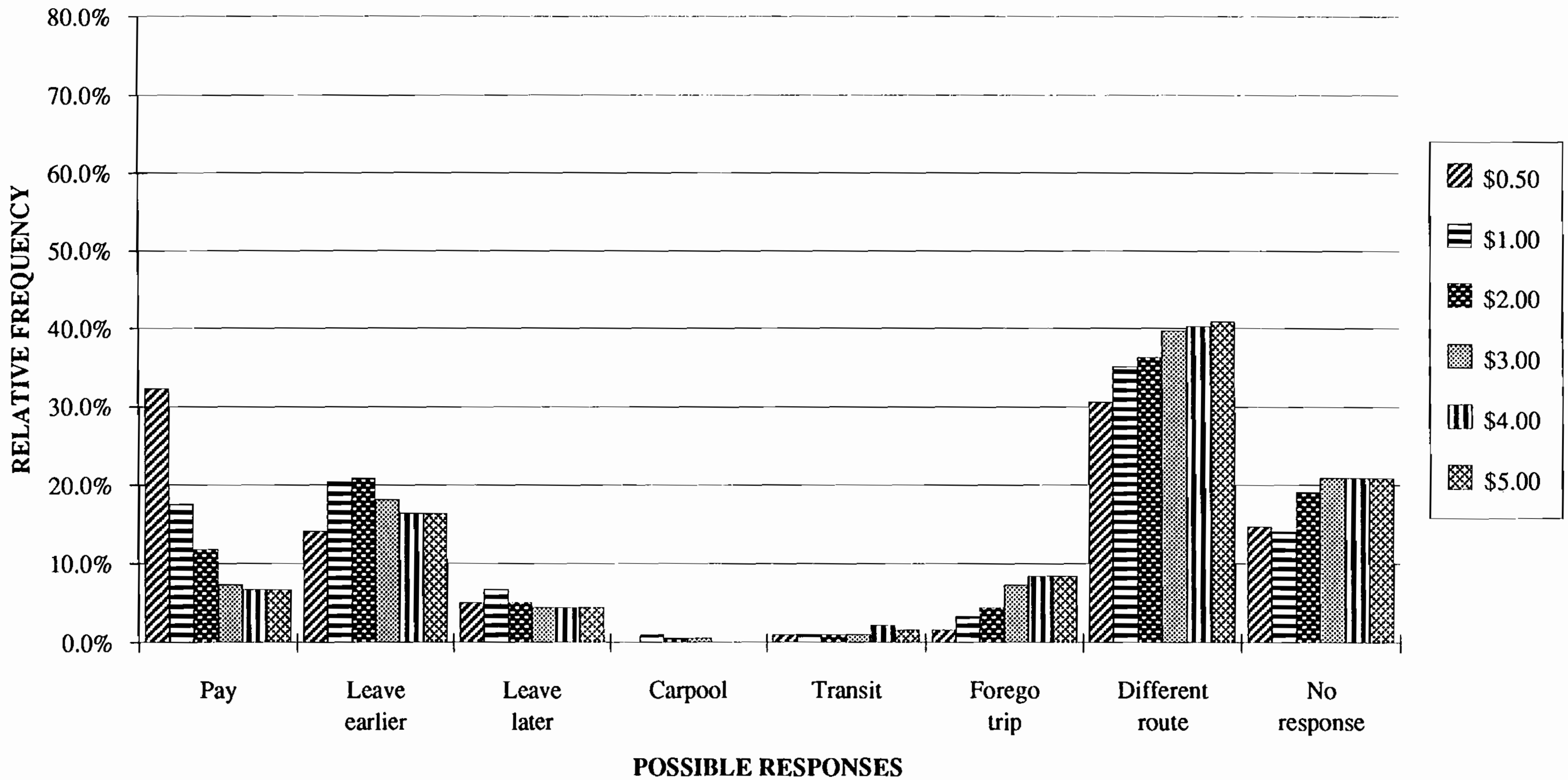
DALLAS 1, AREAWIDE SCHEME, 2ND MOST LIKELY RESPONSE TO LEVEL OF TOLLING

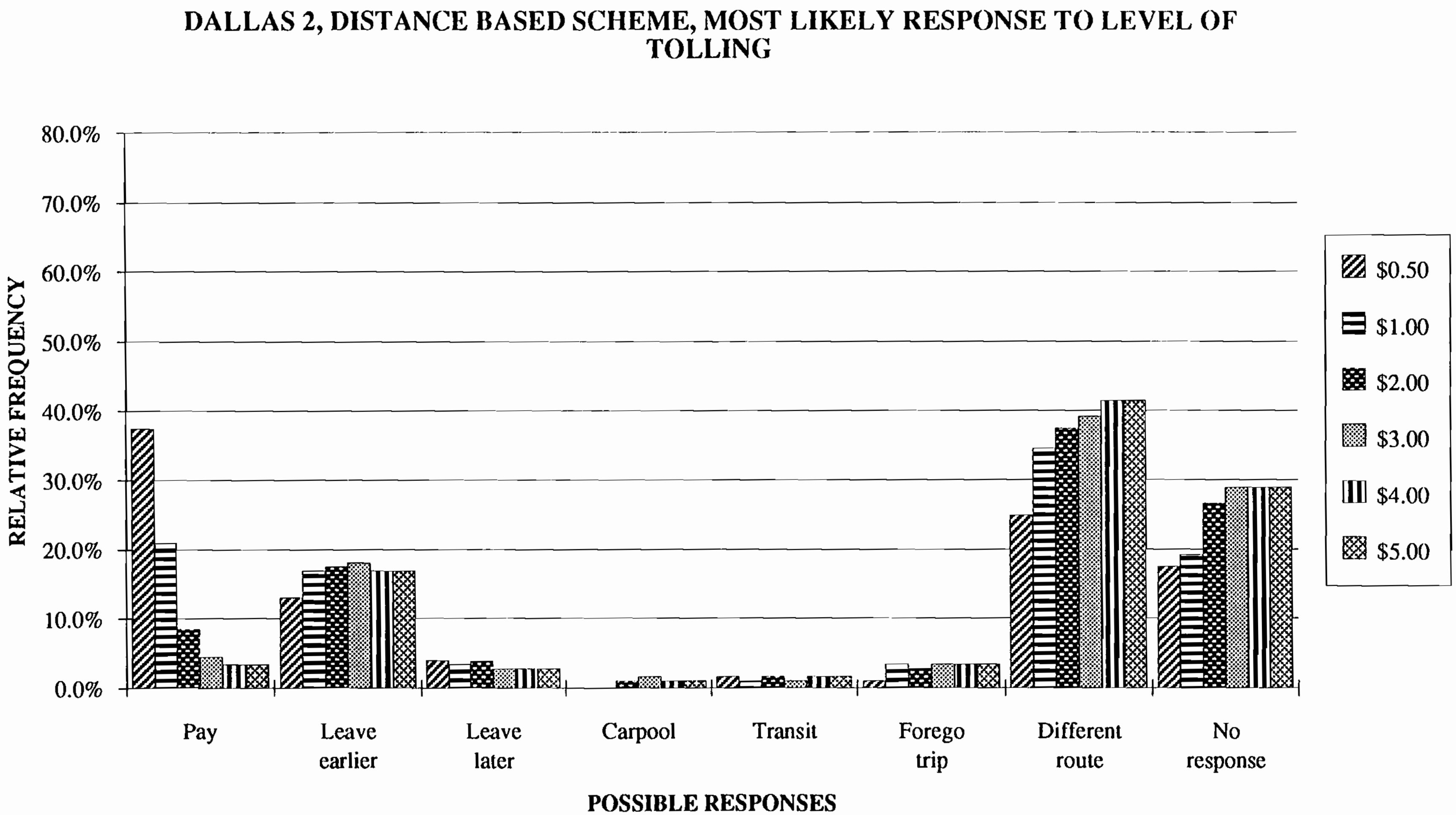


DALLAS 1, DISTANCE BASED SCHEME, 2ND MOST LIKELY RESPONSE TO LEVEL OF TOLLING



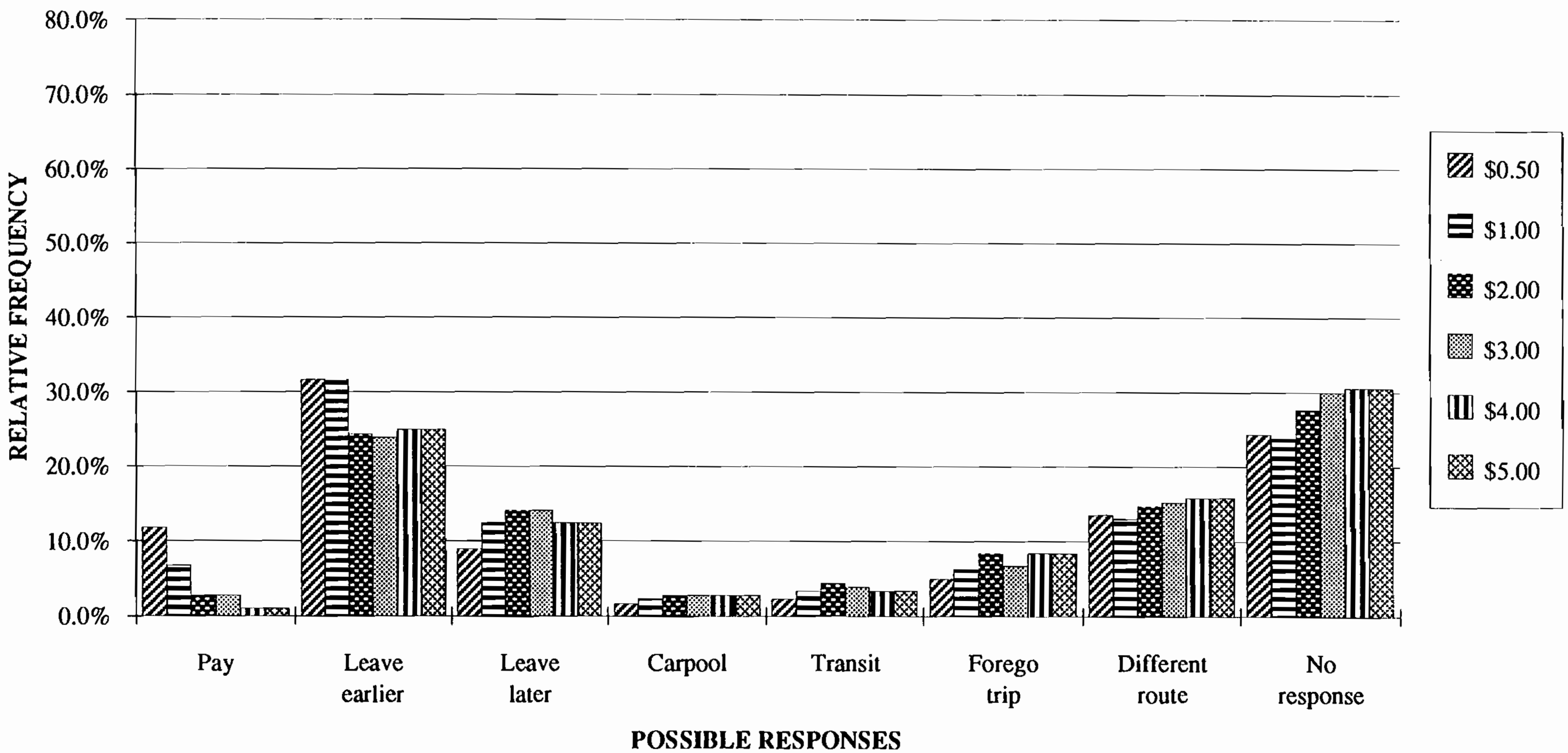
DALLAS 2, AREAWIDE SCHEME, MOST LIKELY RESPONSE TO LEVEL OF TOLLING



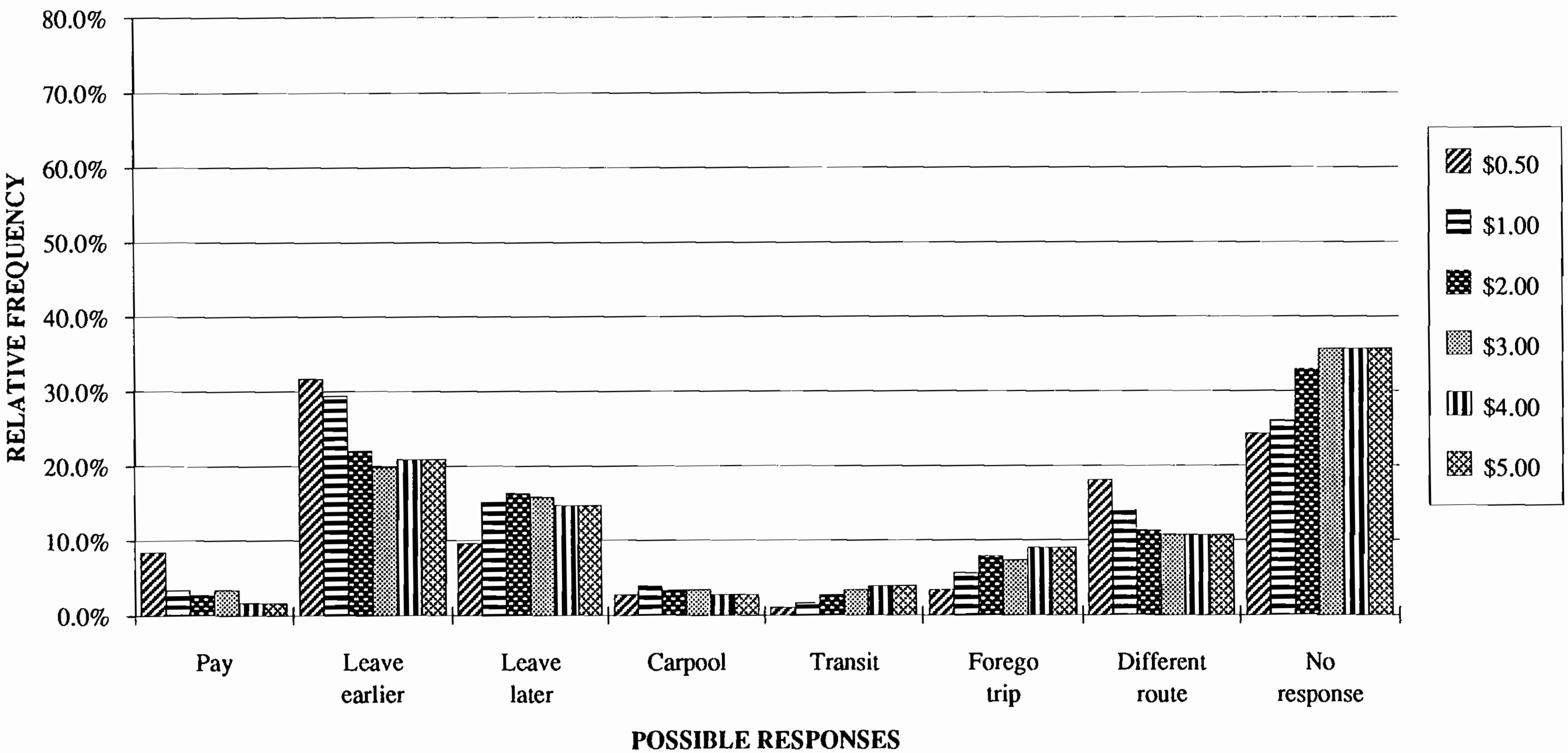


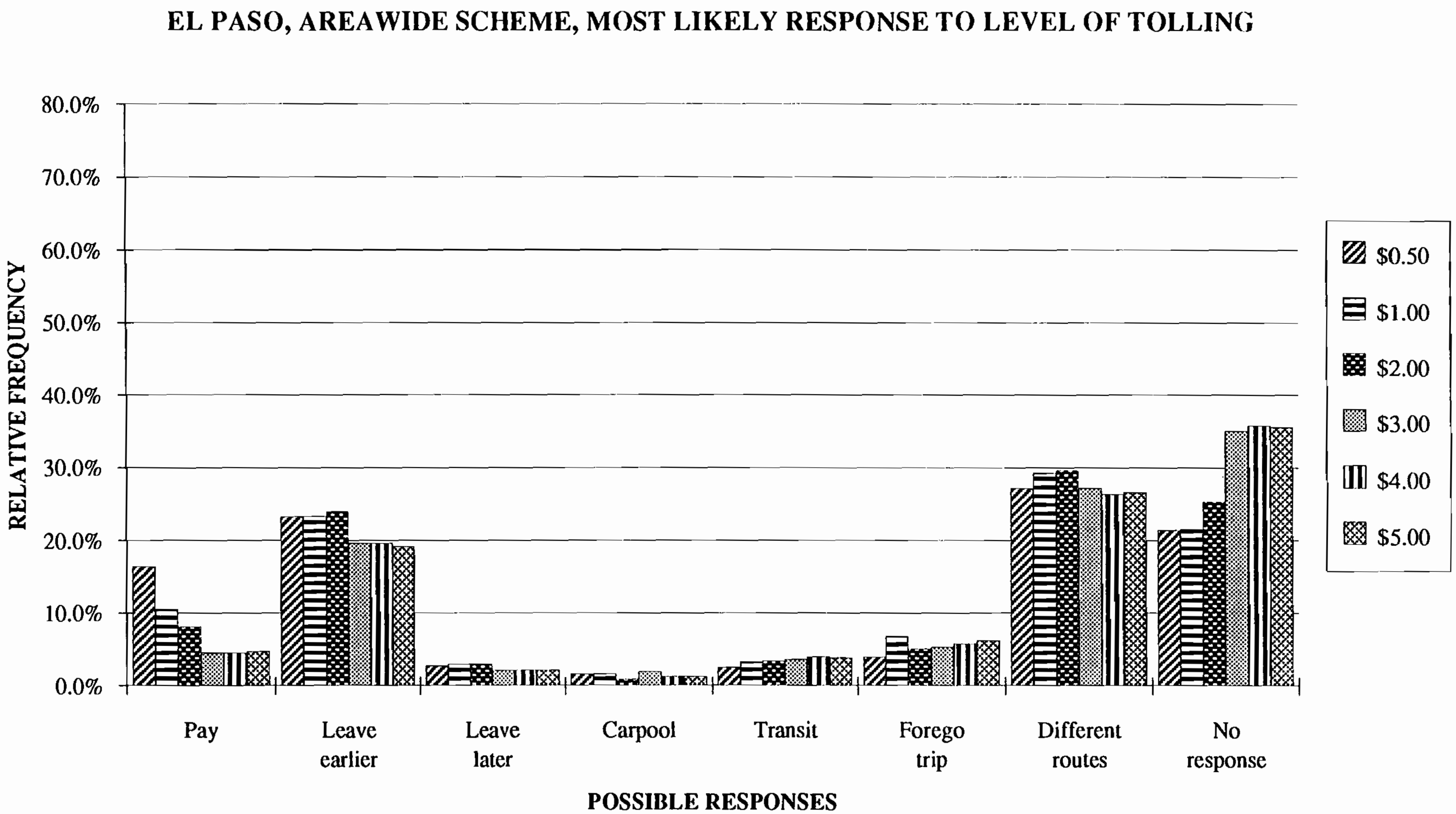
DALLAS 2, DISTANCE BASED SCHEME, MOST LIKELY RESPONSE TO LEVEL OF TOLLING
RELATIVE FREQUENCY
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different route
No response
POSSIBLE RESPONSES
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00

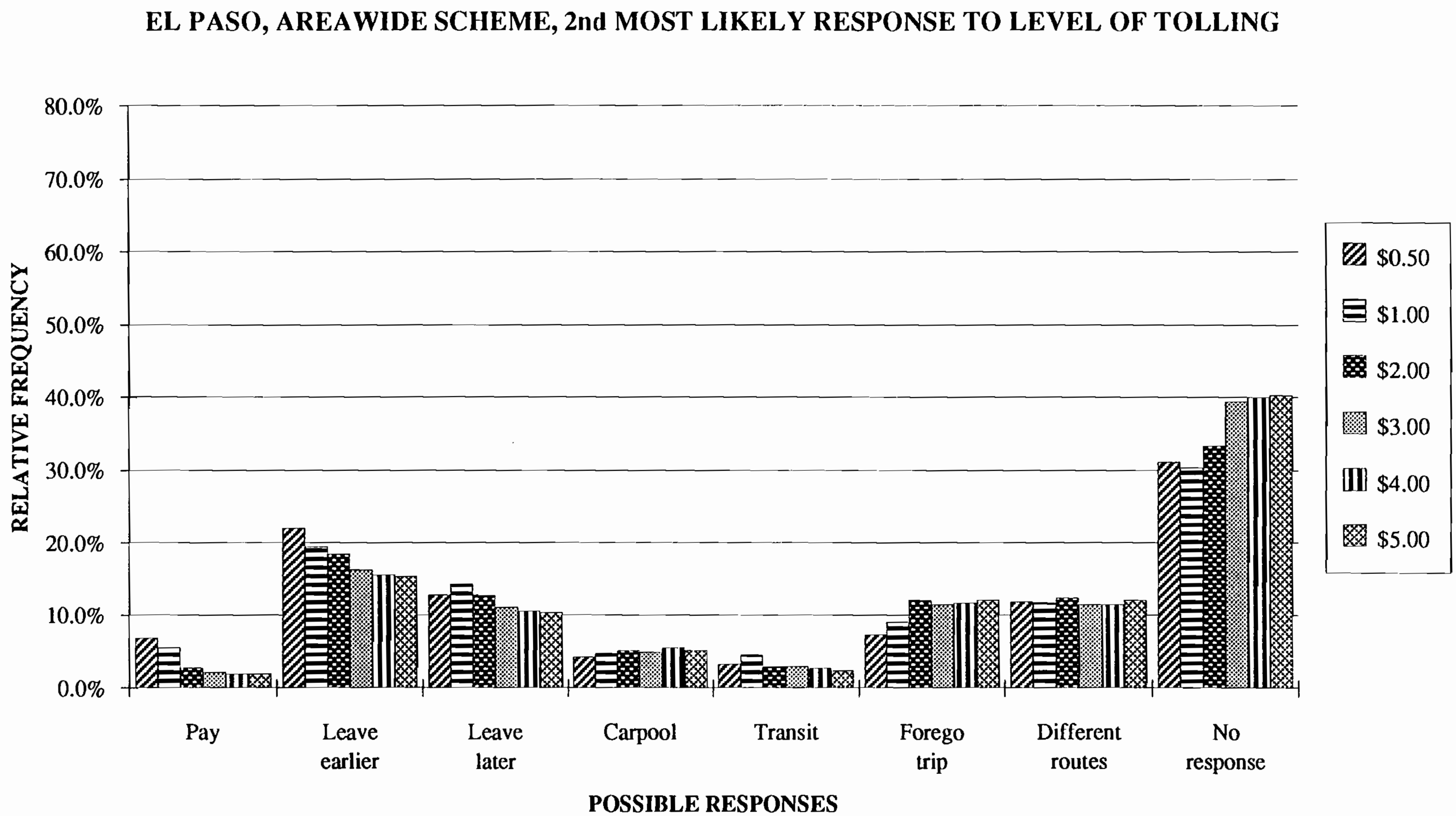
DALLAS 2, AREAWIDE SCHEME, 2ND MOST LIKELY RESPONSE TO LEVEL OF TOLLING



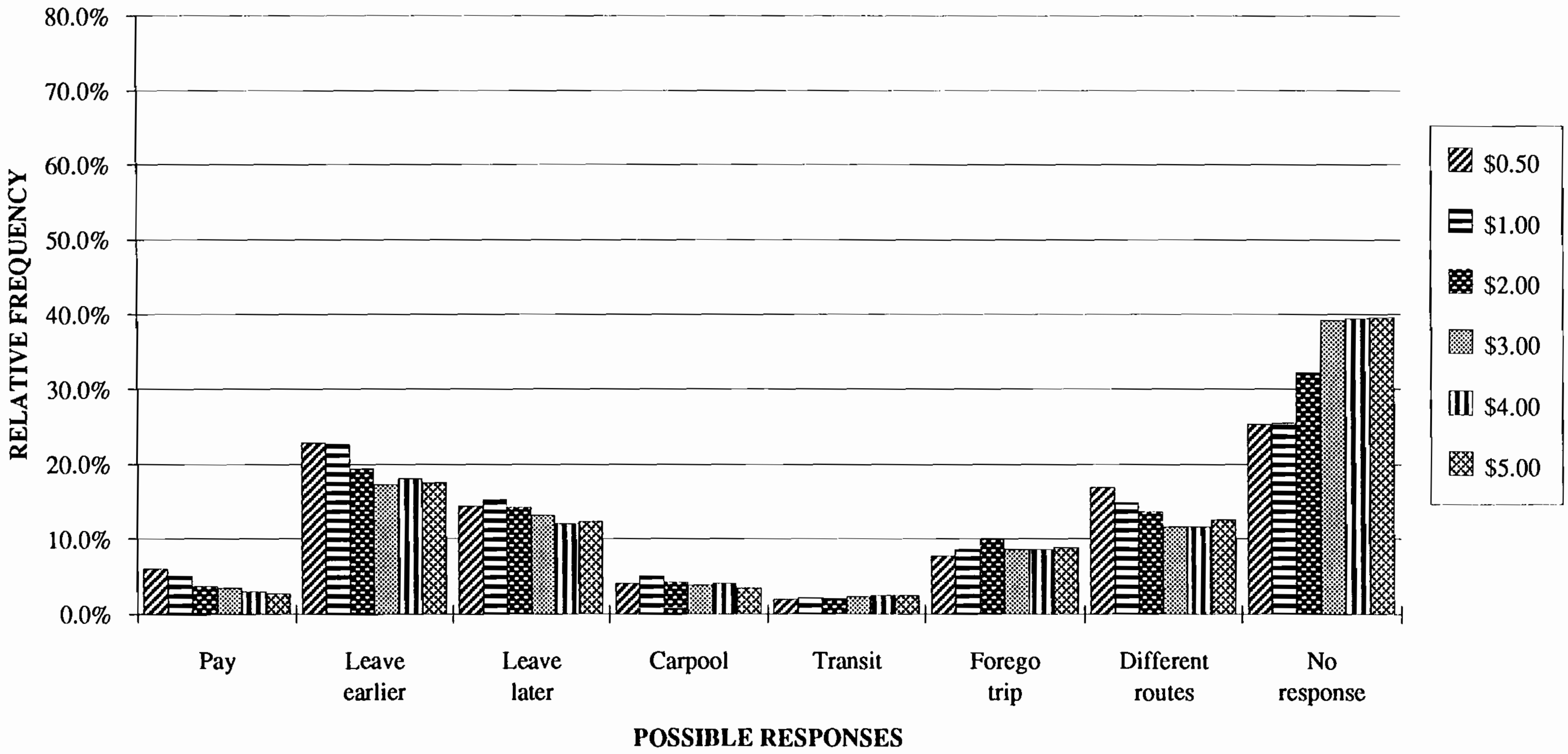
DALLAS 2, DISTANCE BASED SCHEME, 2ND MOST LIKELY RESPONSE TO LEVEL OF TOLLING



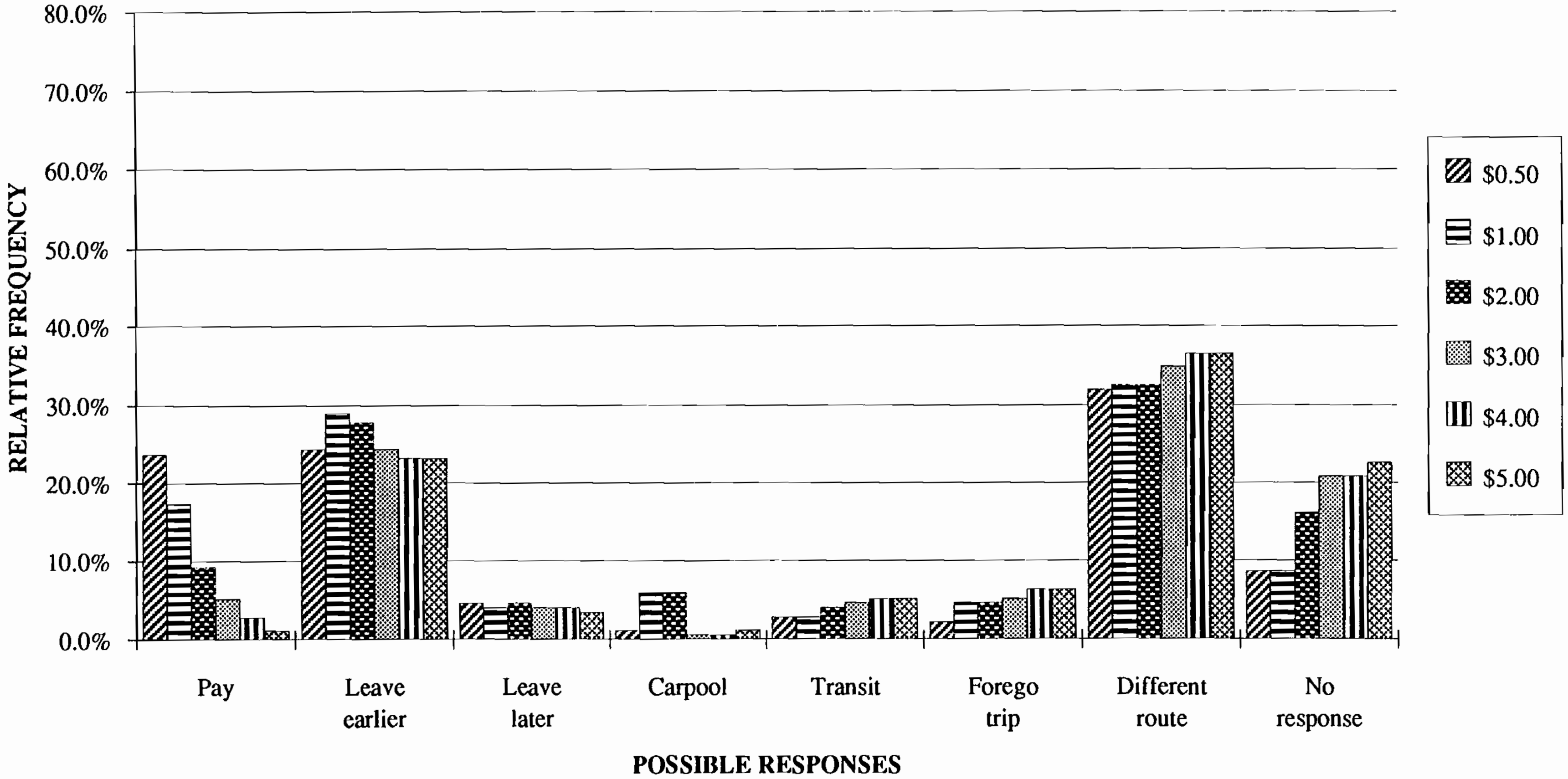

EL PASO, AREAWIDE SCHEME, MOST LIKELY RESPONSE TO LEVEL OF TOLLING
RELATIVE FREQUENCY
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different routes
No response
POSSIBLE RESPONSES
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00

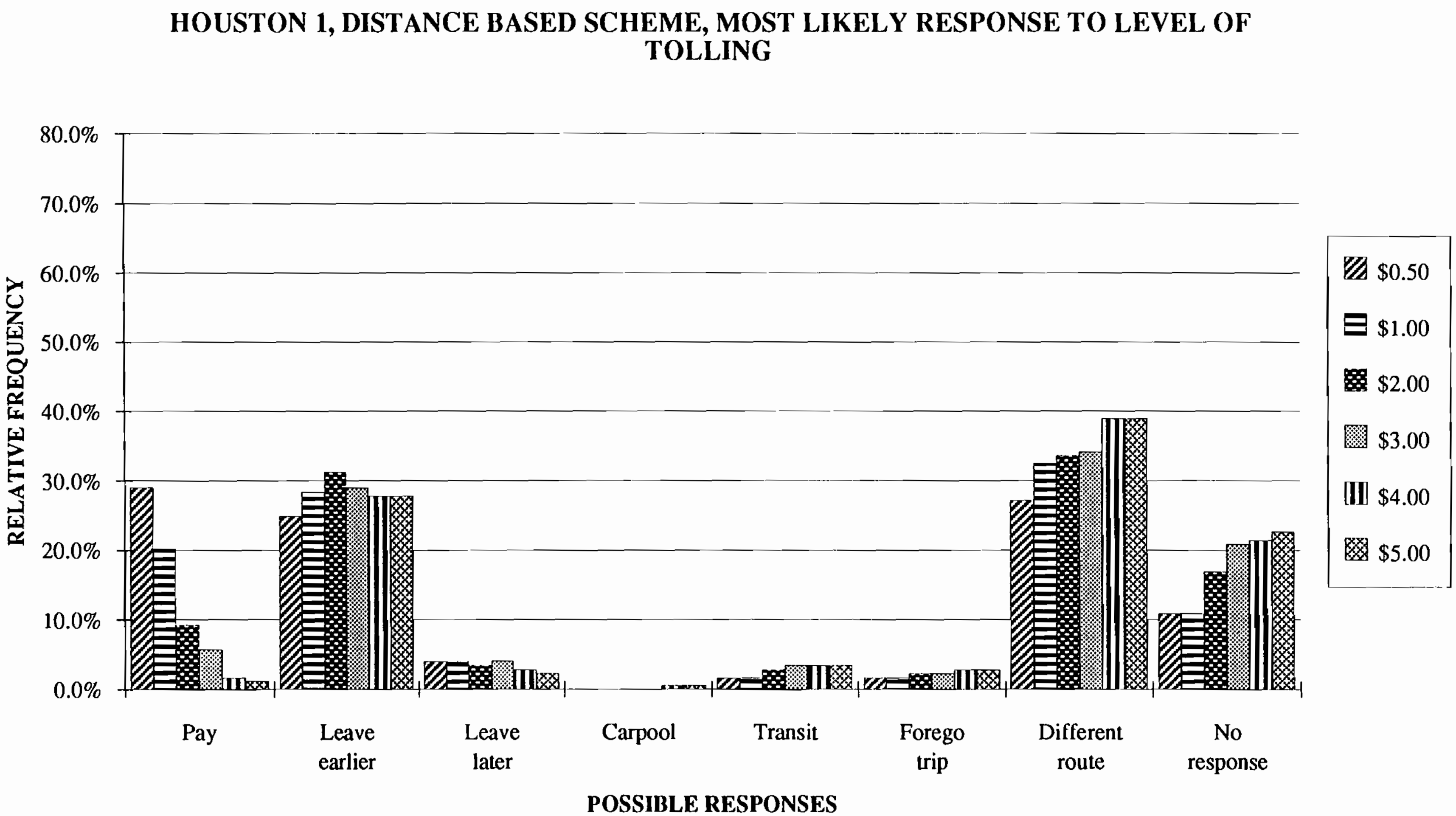

EL PASO, AREAWIDE SCHEME, 2nd MOST LIKELY RESPONSE TO LEVEL OF TOLLING
RELATIVE FREQUENCY
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different routes
No response
POSSIBLE RESPONSES
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00

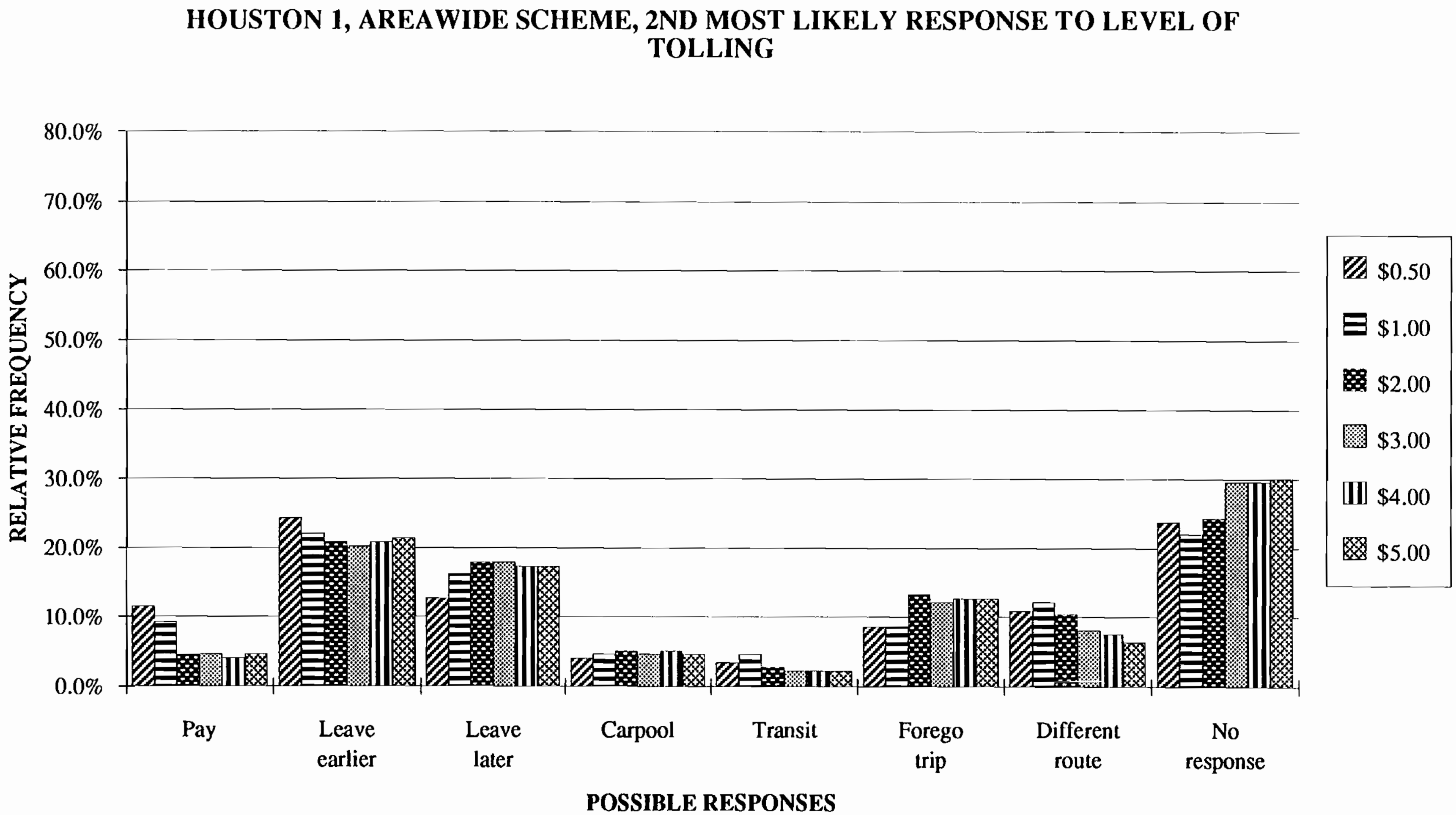
EL PASO, DISTANCE BASED SCHEME, 2ND MOST LIKELY RESPONSE TO LEVEL OF TOLLING



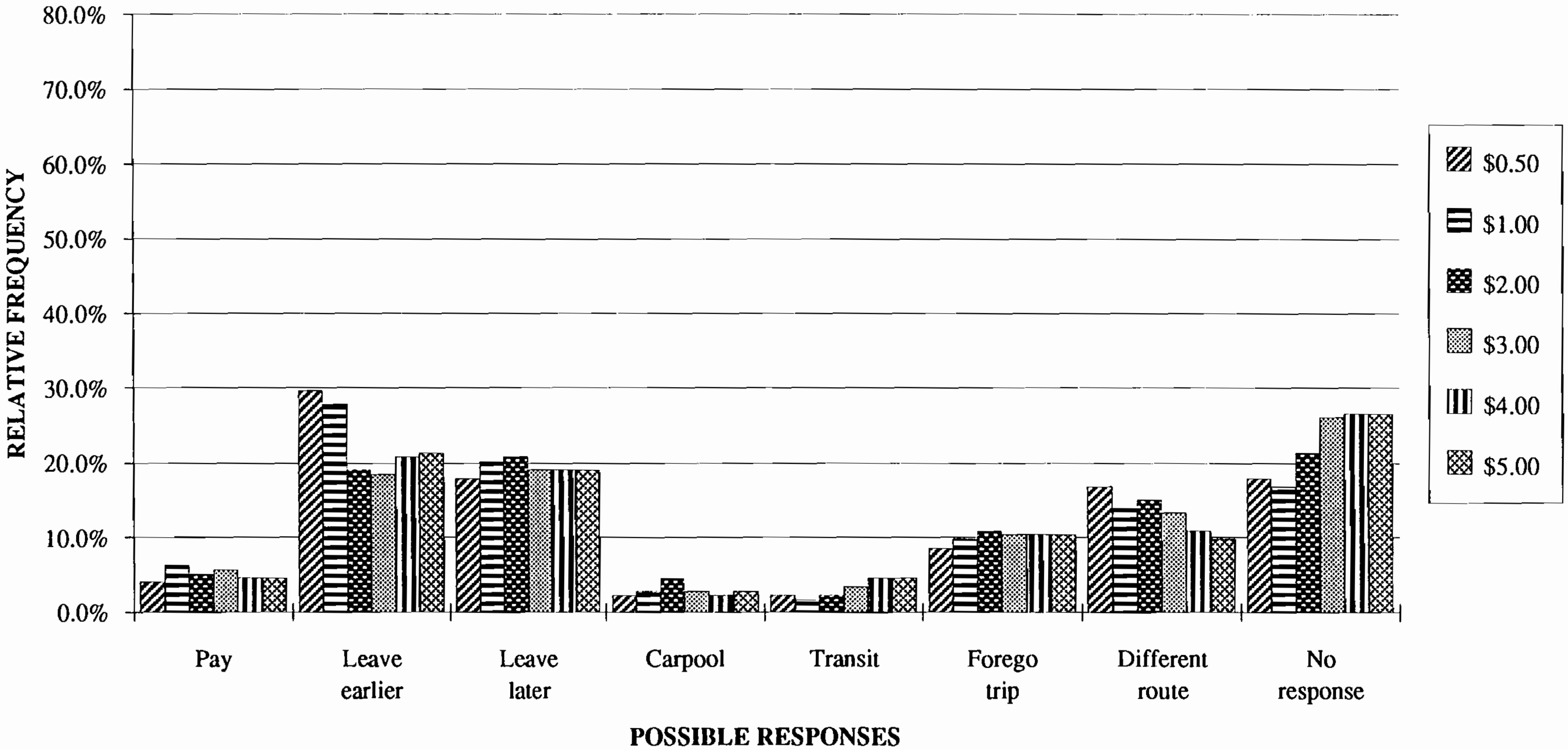
HOUSTON 1, AREAWIDE SCHEME, MOST LIKELY RESPONSE TO LEVEL OF TOLLING

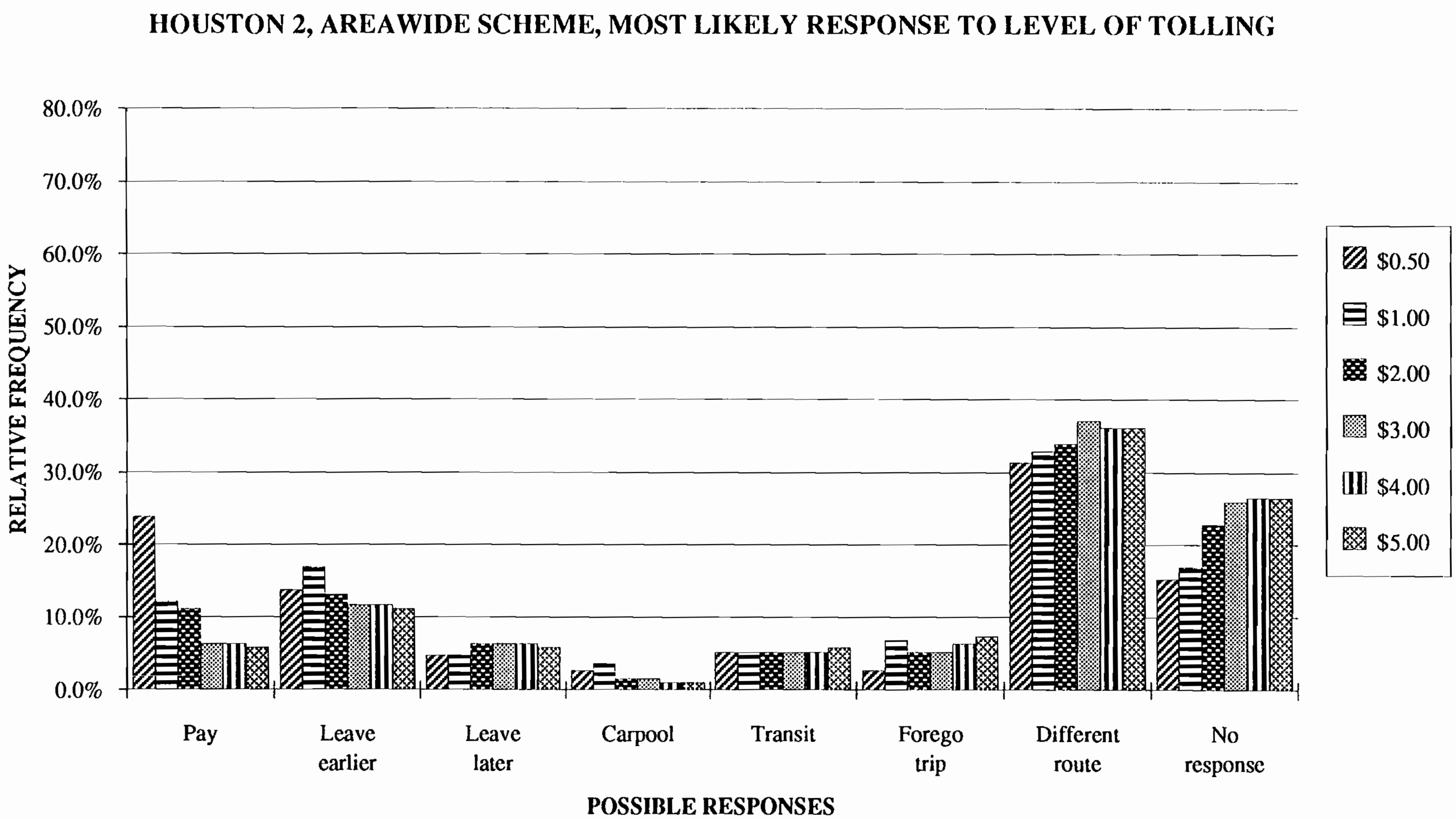



HOUSTON 1, DISTANCE BASED SCHEME, MOST LIKELY RESPONSE TO LEVEL OF TOLLING
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
RELATIVE FREQUENCY
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different route
No response
POSSIBLE RESPONSES
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00

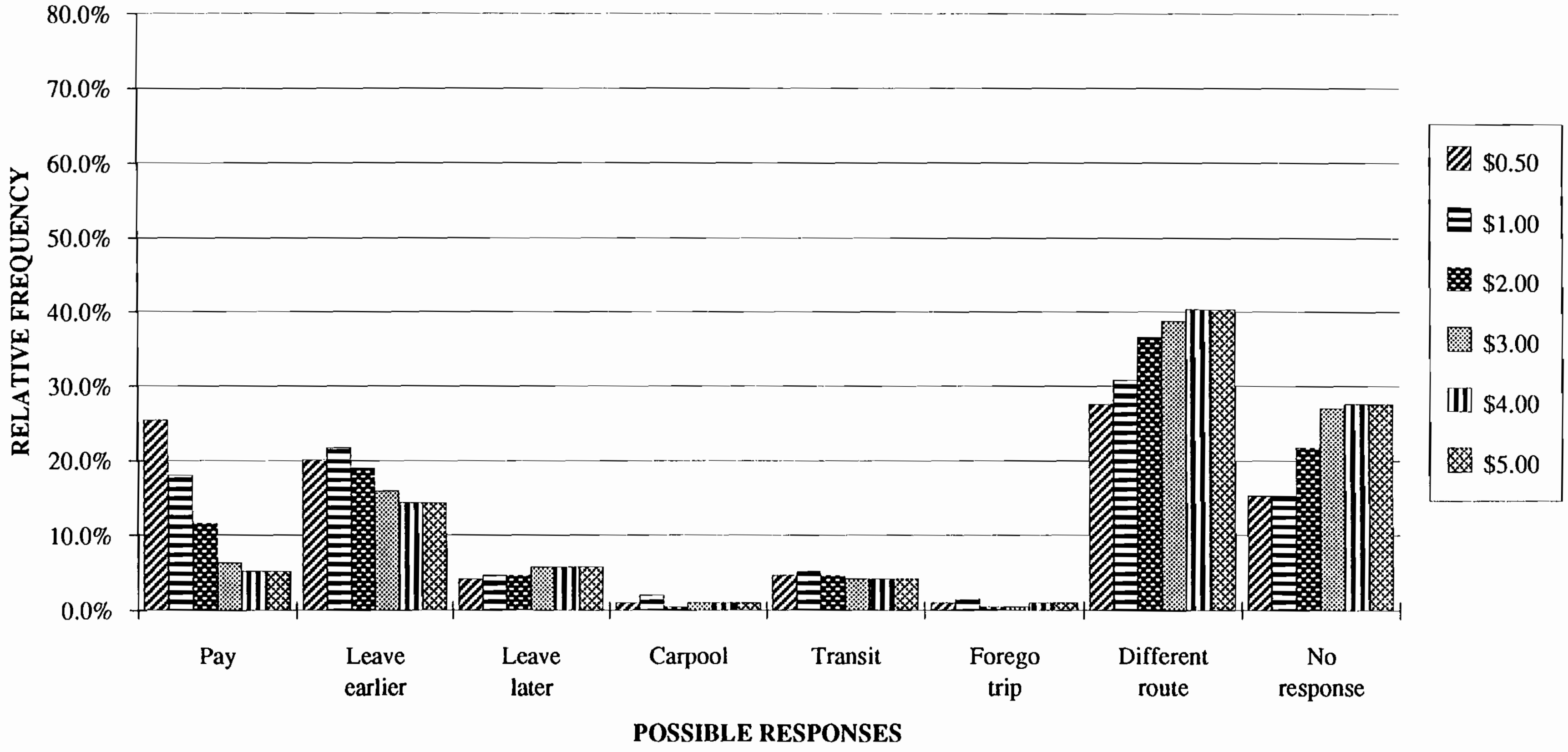

HOUSTON 1, AREAWIDE SCHEME, 2ND MOST LIKELY RESPONSE TO LEVEL OF TOLLING
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
RELATIVE FREQUENCY
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different route
No response
POSSIBLE RESPONSES
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00

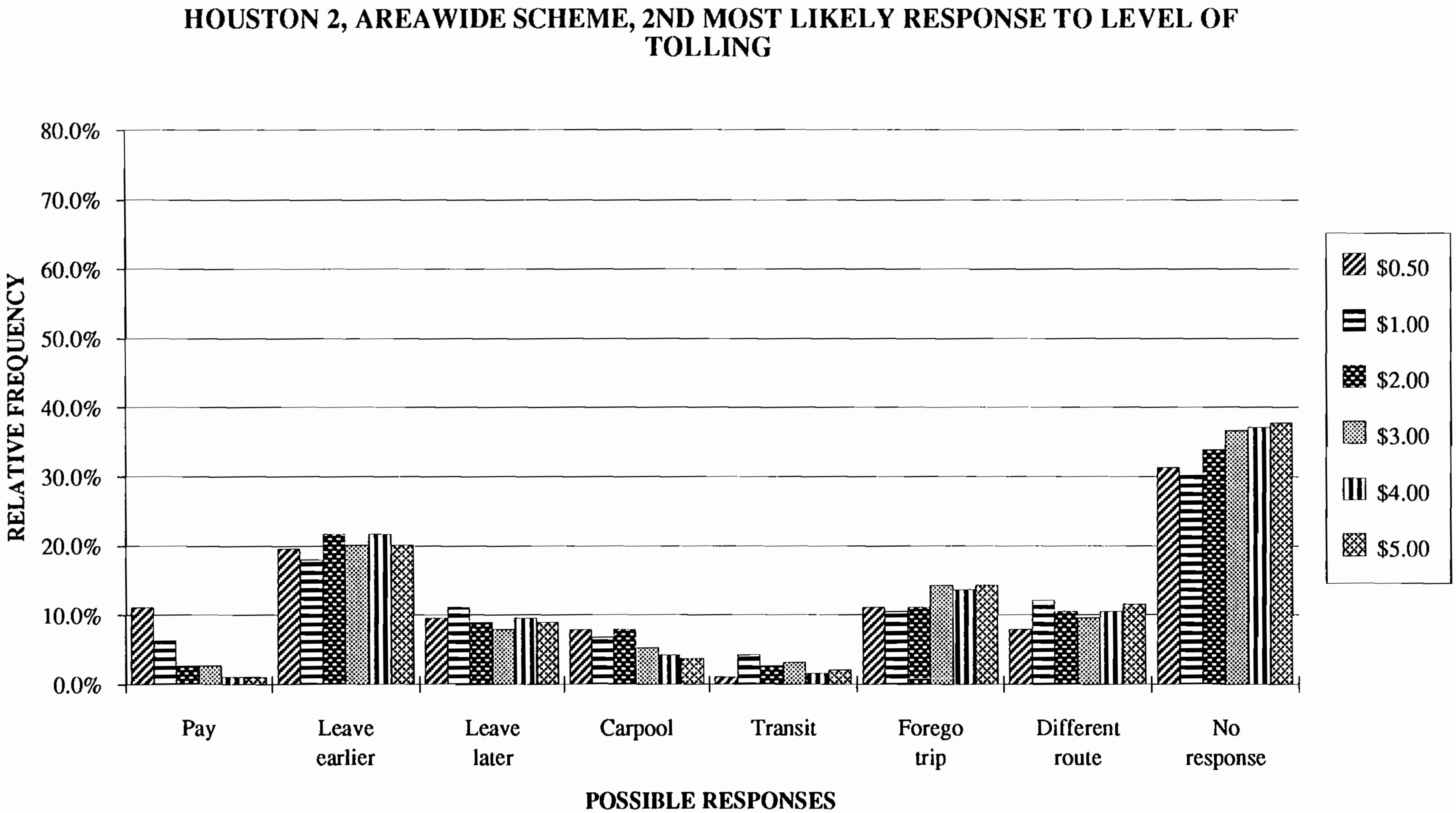
HOUSTON 1, DISTANCE BASED SCHEME, 2ND MOST LIKELY RESPONSE TO LEVEL OF TOLLING



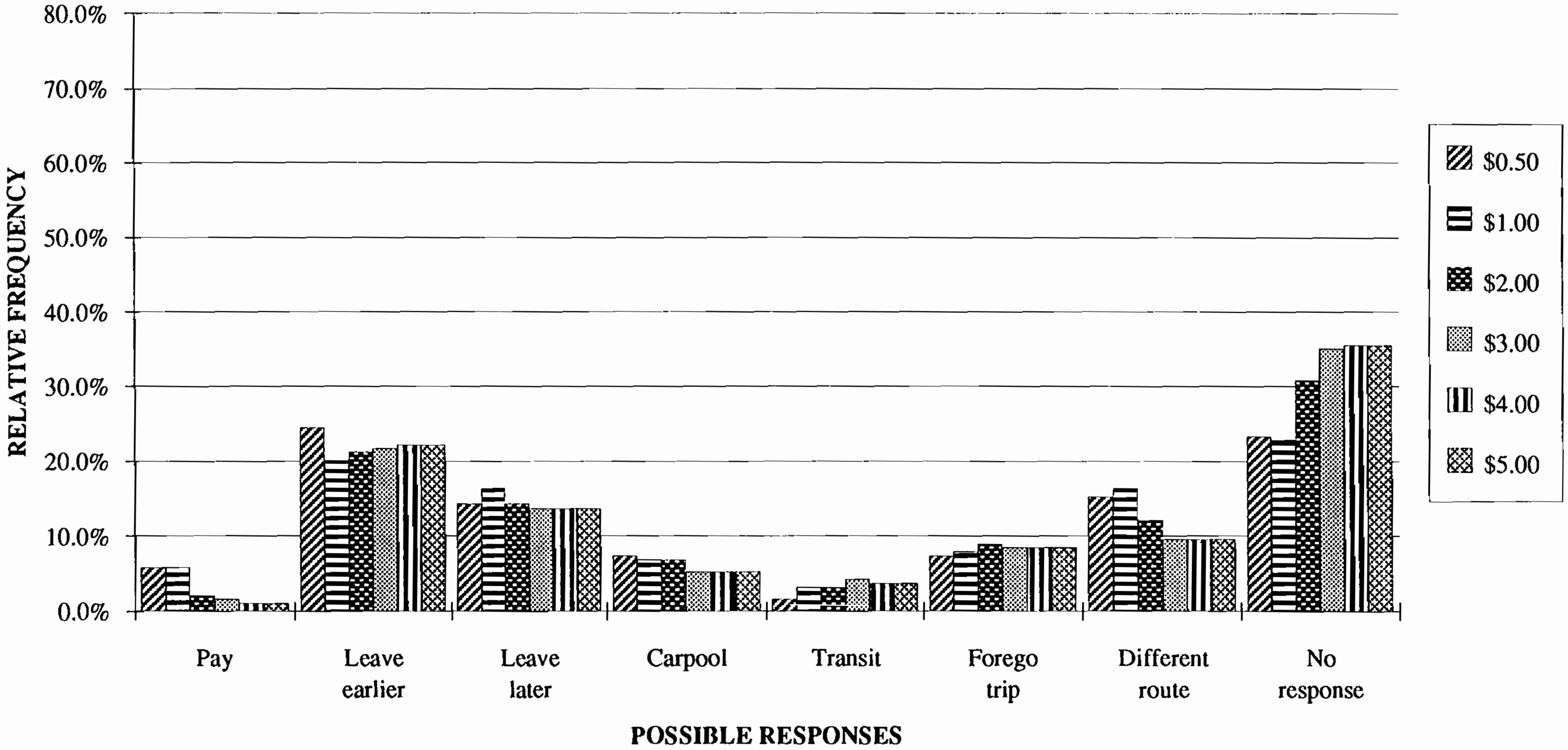

HOUSTON 2, AREAWIDE SCHEME, MOST LIKELY RESPONSE TO LEVEL OF TOLLING
RELATIVE FREQUENCY
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different route
No response
POSSIBLE RESPONSES
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00

HOUSTON 2, DISTANCE BASED SCHEME, MOST LIKELY RESPONSE TO LEVEL OF TOLLING

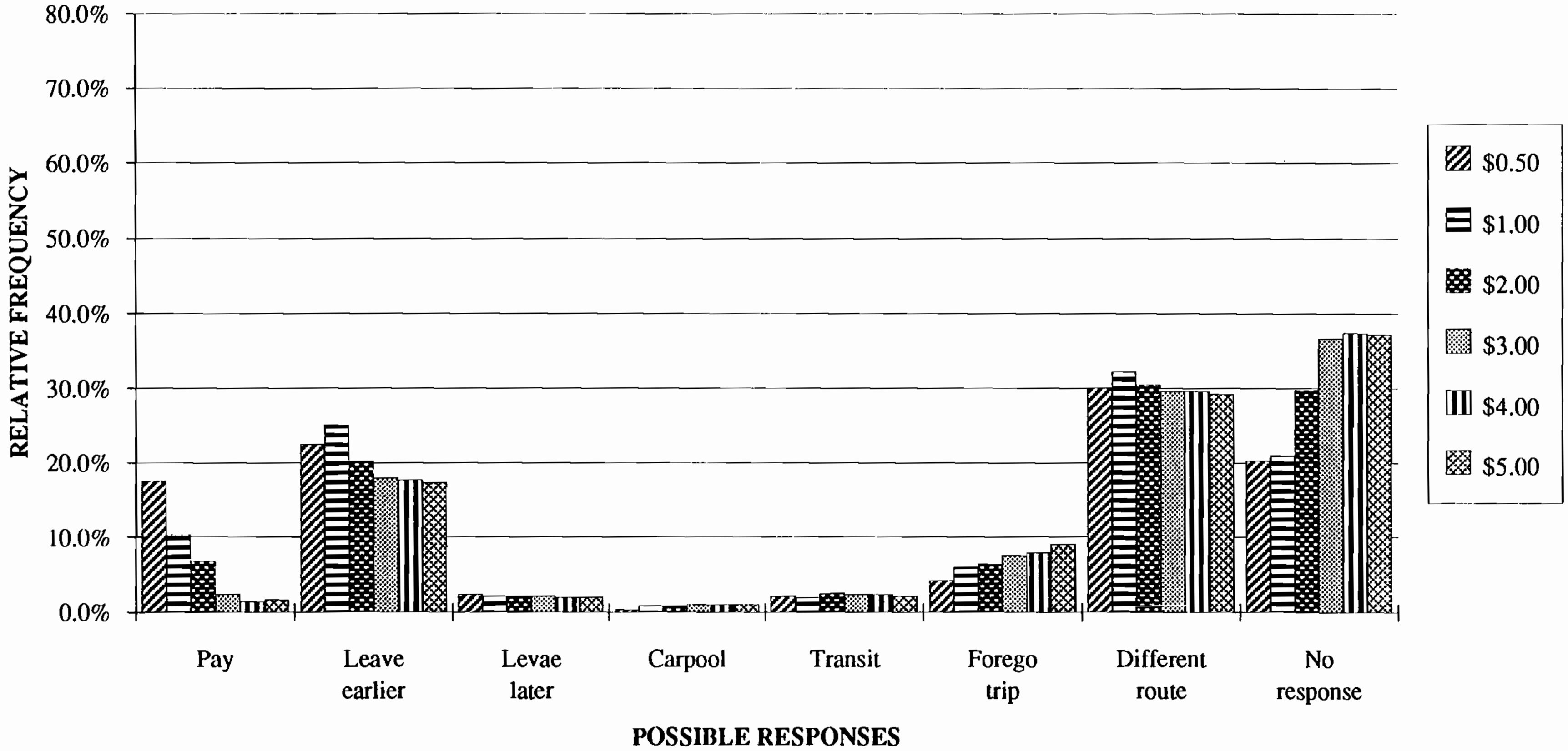


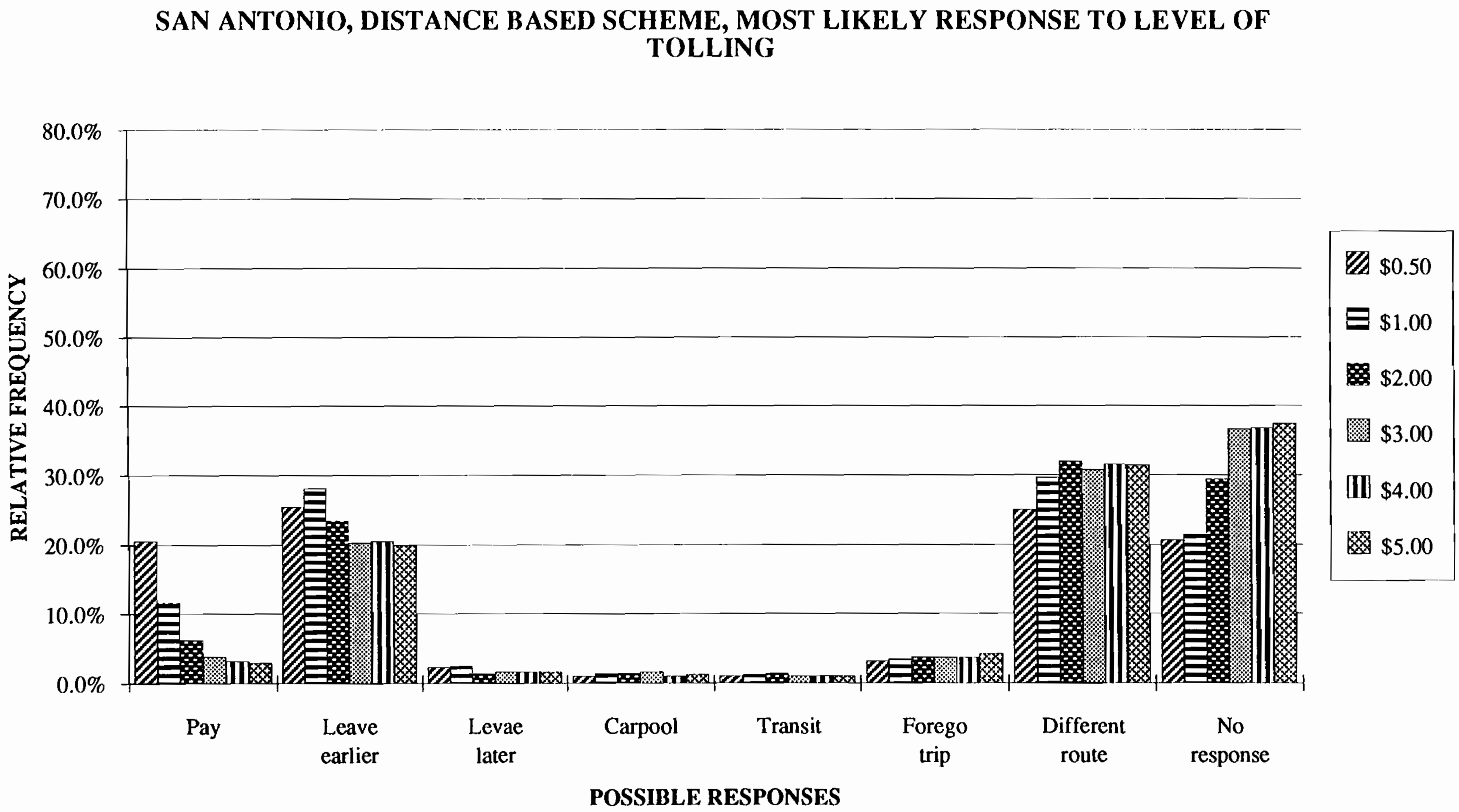

HOUSTON 2, AREAWIDE SCHEME, 2ND MOST LIKELY RESPONSE TO LEVEL OF TOLLING
RELATIVE FREQUENCY
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different route
No response
POSSIBLE RESPONSES
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00

HOUSTON 2, DISTANCE BASED SCHEME, 2ND MOST LIKELY RESPONSE TO LEVEL OF TOLLING

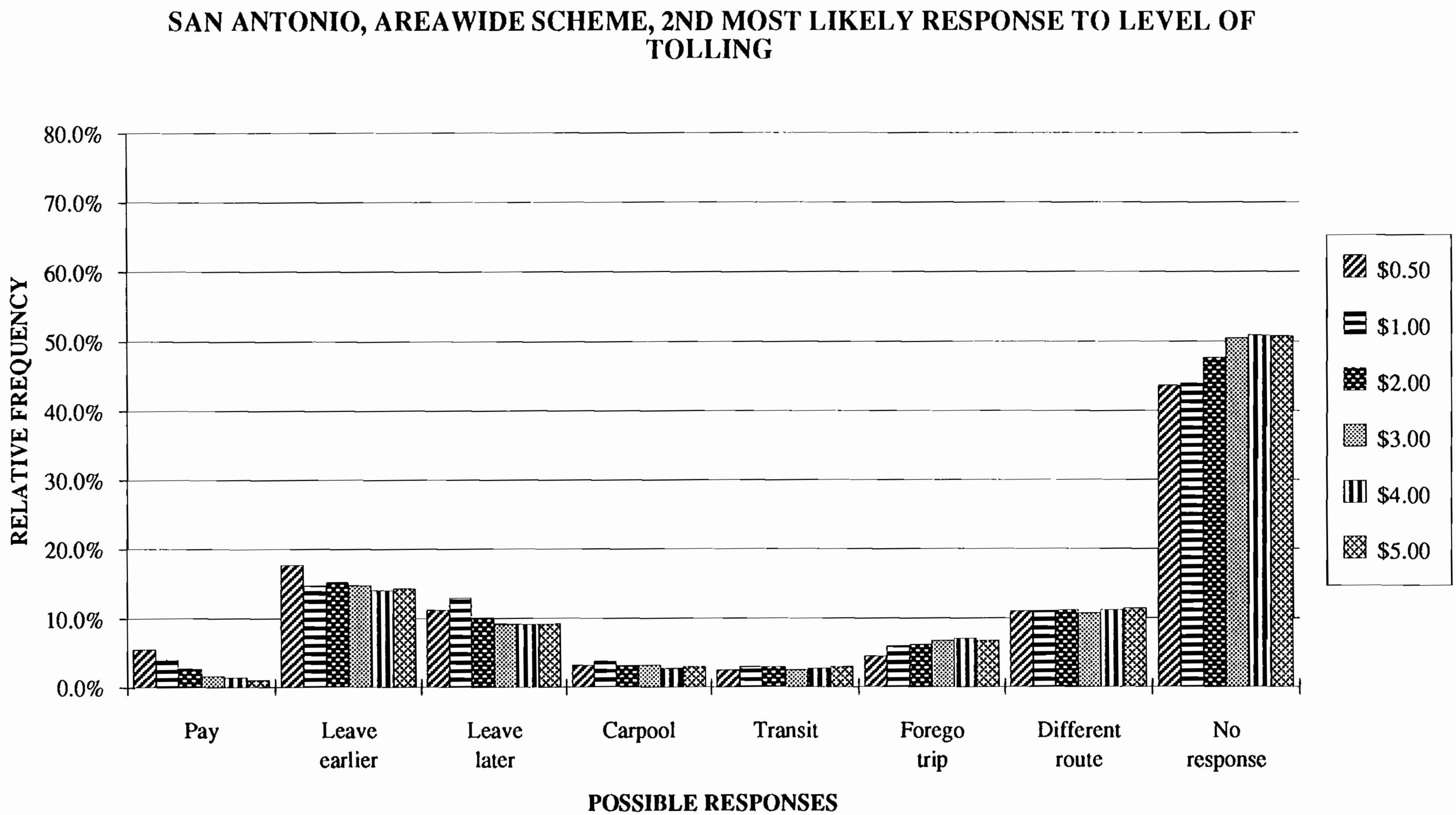


SAN ANTONIO, AREAWIDE SCHEME, MOST LIKELY RESPONSE TO LEVEL OF TOLLING



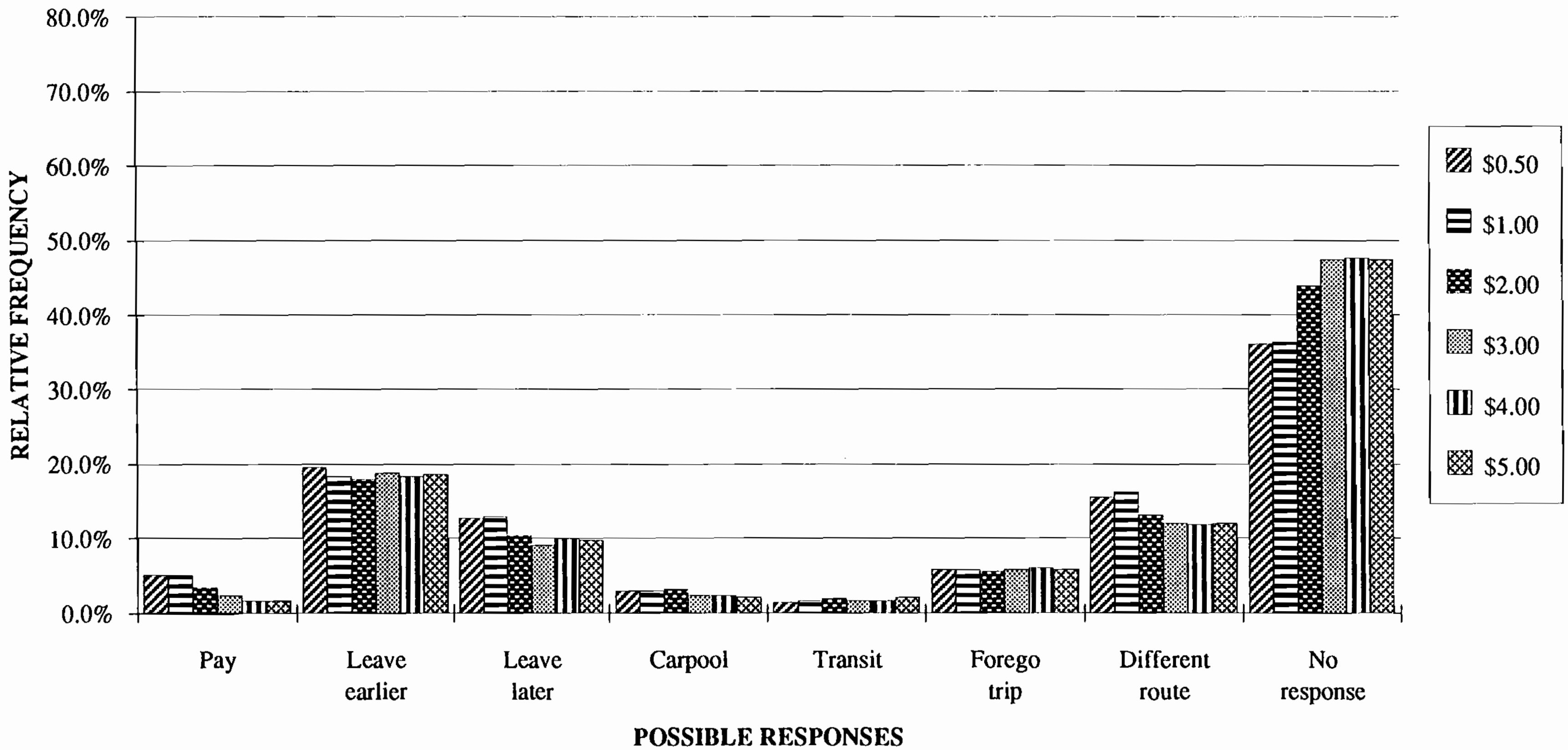


SAN ANTONIO, DISTANCE BASED SCHEME, MOST LIKELY RESPONSE TO LEVEL OF TOLLING
RELATIVE FREQUENCY
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Pay
Leave earlier
Levae later
Carpool
Transit
Forego trip
Different route
No response
POSSIBLE RESPONSES
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00



SAN ANTONIO, AREAWIDE SCHEME, 2ND MOST LIKELY RESPONSE TO LEVEL OF TOLLING
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
RELATIVE FREQUENCY
Pay
Leave earlier
Leave later
Carpool
Transit
Forego trip
Different route
No response
POSSIBLE RESPONSES
$0.50
$1.00
$2.00
$3.00
$4.00
$5.00

SAN ANTONIO, DISTANCE BASED SCHEME, 2ND MOST LIKELY RESPONSE TO LEVEL OF TOLLING



Appendix J - Price Elasticities of Demand

Summary table of price elasticities of demand
(Demand as a hyperbolic function of price)

AREAWIDE PRICING SCHEME - MOST LIKELY RESPONSE

	Elasticity	R-squared
Dallas, Version 1	-1.2158	0.947
Dallas, Version 2	-0.7090	0.976
El Paso	-0.5870	0.943
Houston, Version 1	-1.2045	0.890
Houston, Version 2	-0.5753	0.938
San Antonio	-1.1272	0.933

DISTANCE-BASED PRICING SCHEME - MOST LIKELY RESPONSE

	Elasticity	R-squared
Dallas, Version 1	-1.1162	0.951
Dallas, Version 2	-1.1369	0.984
El Paso	-0.7566	0.964
Houston, Version 1	-1.3878	0.898
Houston, Version 2	-0.7494	0.966
San Antonio	-0.8736	0.994

AREAWIDE PRICING SCHEME - 2ND MOST LIKELY RESPONSE

	Elasticity	R-squared
Dallas, Version 1	-0.1971	0.569
Dallas, Version 2	-1.0610	0.951
El Paso	-0.6080	0.957
Houston, Version 1	-0.4674	0.882
Houston, Version 2	-1.0320	0.953
San Antonio	-0.7017	0.968

DISTANCE-BASED PRICING SCHEME - 2ND MOST LIKELY RESPONSE

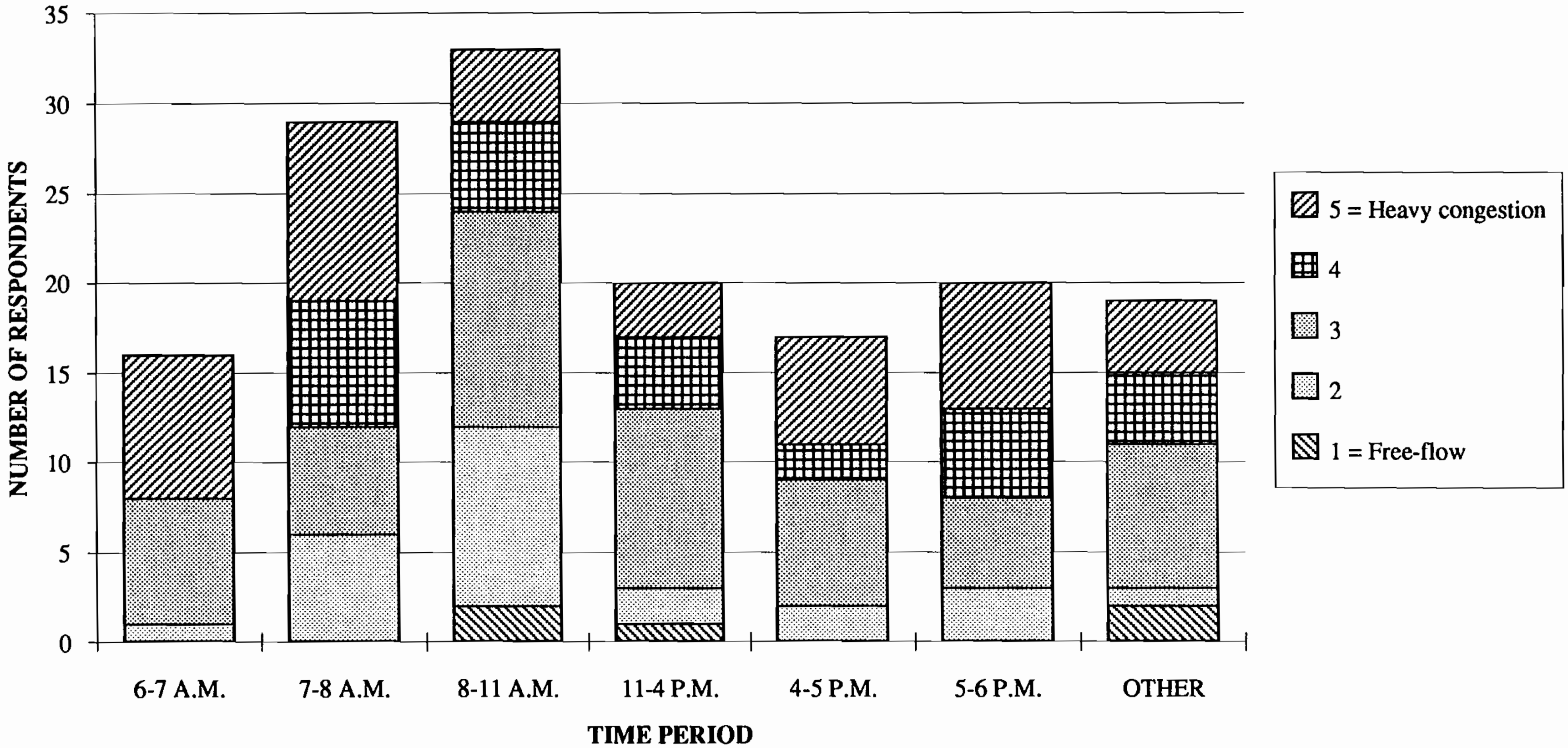
Dallas, Version 1	-0.2796	0.924
Dallas, Version 2	-0.6158	0.835
El Paso	-0.3472	0.984
Houston, Version 1	-	-
Houston, Version 2	-0.8457	0.93
San Antonio	-0.5531	0.899

Appendix K - Perceived Traffic Conditions, by Roadway

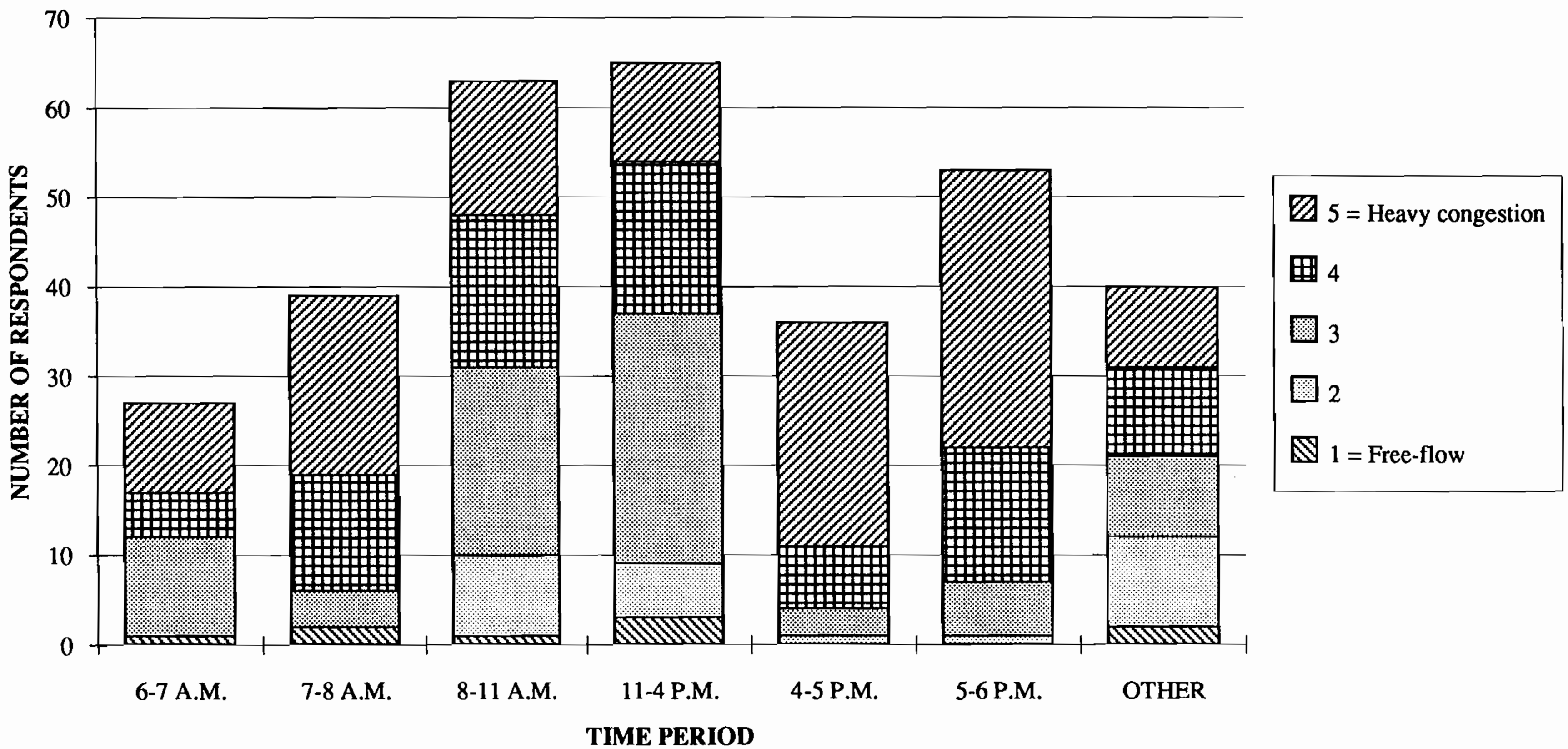
Table 1
Average perceived traffic conditions, Dallas freeways*

	6-7 A.M.	*7-8 A.M.*	*8-11 A.M.*	*11-4 P.M.*	*4-5 P.M.*	*5-6 P.M.*	*OTHER*
IH-30 / THORNTON FREEWAY	3.94	3.72	2.97	3.30	3.71	3.80	3.37
number in sample	16	29	33	20	17	20	19
IH-635 / L. JOHNSON FREEWAY	3.85	4.26	3.61	3.42	4.56	4.43	3.35
number in sample	27	39	63	65	36	53	40
IH-610 / NORTH LOOP	5.00	0.00	5.00	2.50	3.00	5.00	1.00
number in sample	1	0	1	2	1	1	1
IH-45 / SCHEPPS FREEWAY	2.50	2.00	2.33	2.50	2.67	2.13	3.00
number in sample	4	5	12	6	3	8	3
IH-20	2.50	2.73	2.40	2.18	2.33	3.18	2.00
number in sample	6	11	15	11	9	11	14
IH-35E	4.46	4.03	3.44	3.19	3.91	3.90	3.52
number in sample	24	34	43	41	23	30	21
US 80	3.00	3.40	2.20	2.67	3.00	3.00	2.83
number in sample	1	5	5	3	2	1	6
US 67 / MARY LOVE FREEWAY	0.00	3.50	3.00	2.67	1.00	3.80	1.50
number in sample	0	4	9	6	2	5	6
US 59 / EASTEX FREEWAY	ID	ID	ID	ID	ID	ID	ID
number in sample	0	0	0	0	0	0	0
US 175 / 2ND AVENUE	3.25	3.21	3.39	3.52	3.24	4.10	3.74
number in sample	2	1	10	2	2	2	1
US 183	3.67	4.25	3.12	3.10	3.50	4.00	3.00
number in sample	6	8	17	10	8	8	10
US 114	5.00	8.00	11.00	8.00	3.50	3.50	3.29
number in sample	5	8	11	8	2	6	7
US 75 / CENTRAL EXPRESSWAY	3.87	4.14	3.65	3.83	4.26	4.06	3.16
number in sample	15	22	40	40	22	35	32
DALLAS NORTH TOLLWAY	3.00	4.06	3.97	3.42	3.00	3.83	9.00
number in sample	9	17	32	33	10	30	19

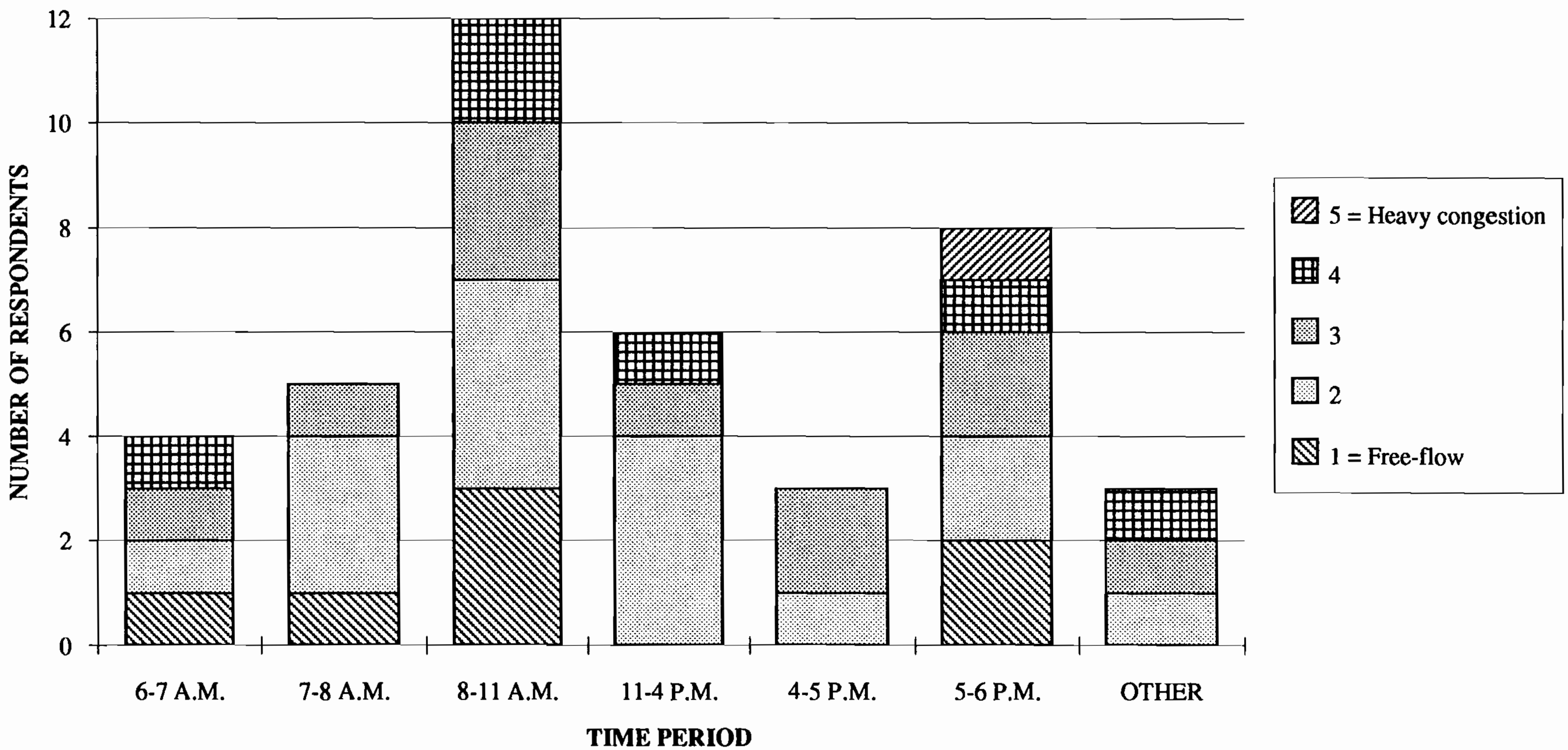
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-30 / THORNTON FREEWAY (DALLAS)

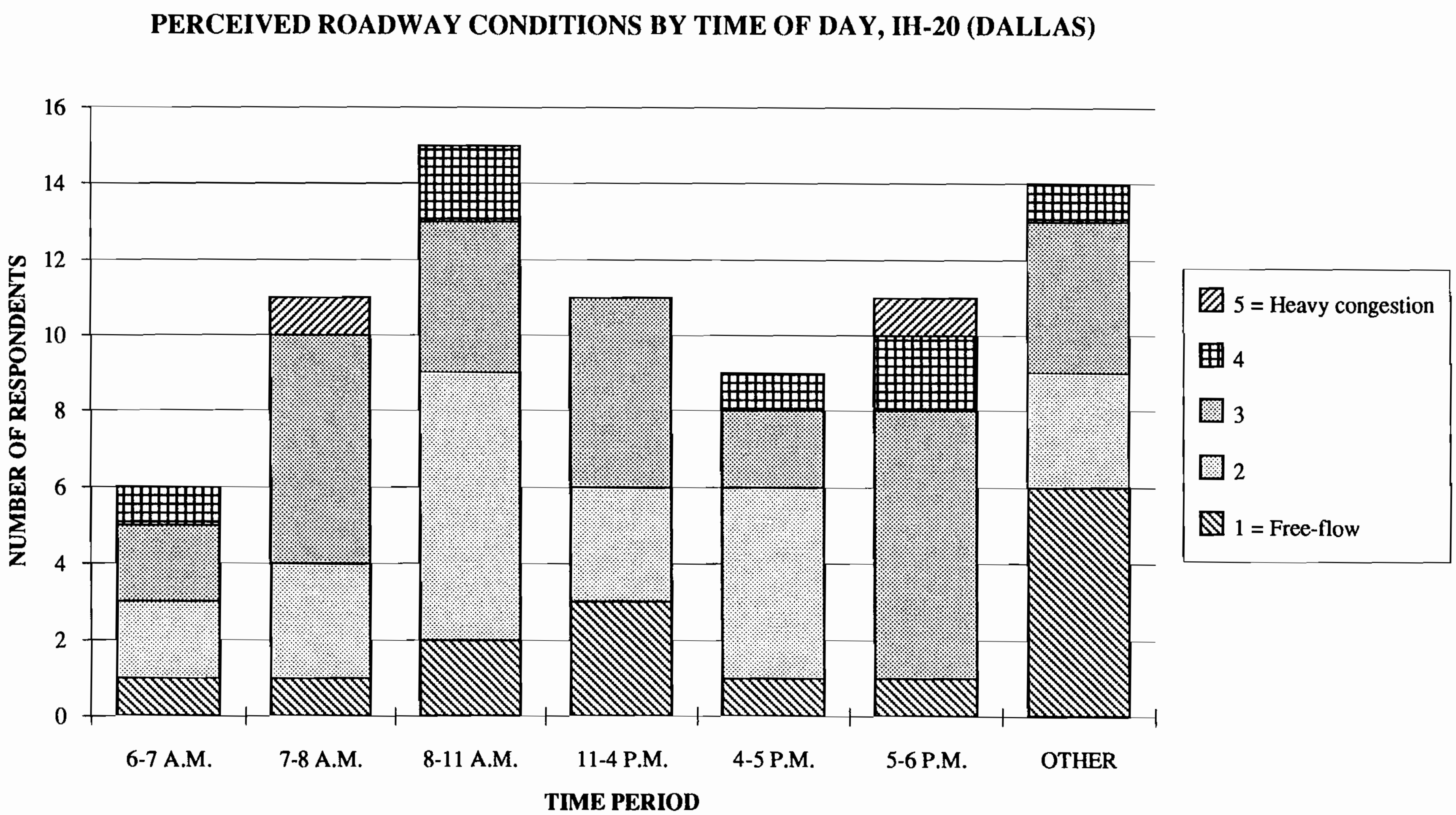


PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-635 / L. JOHNSON FREEWAY (DALLAS)

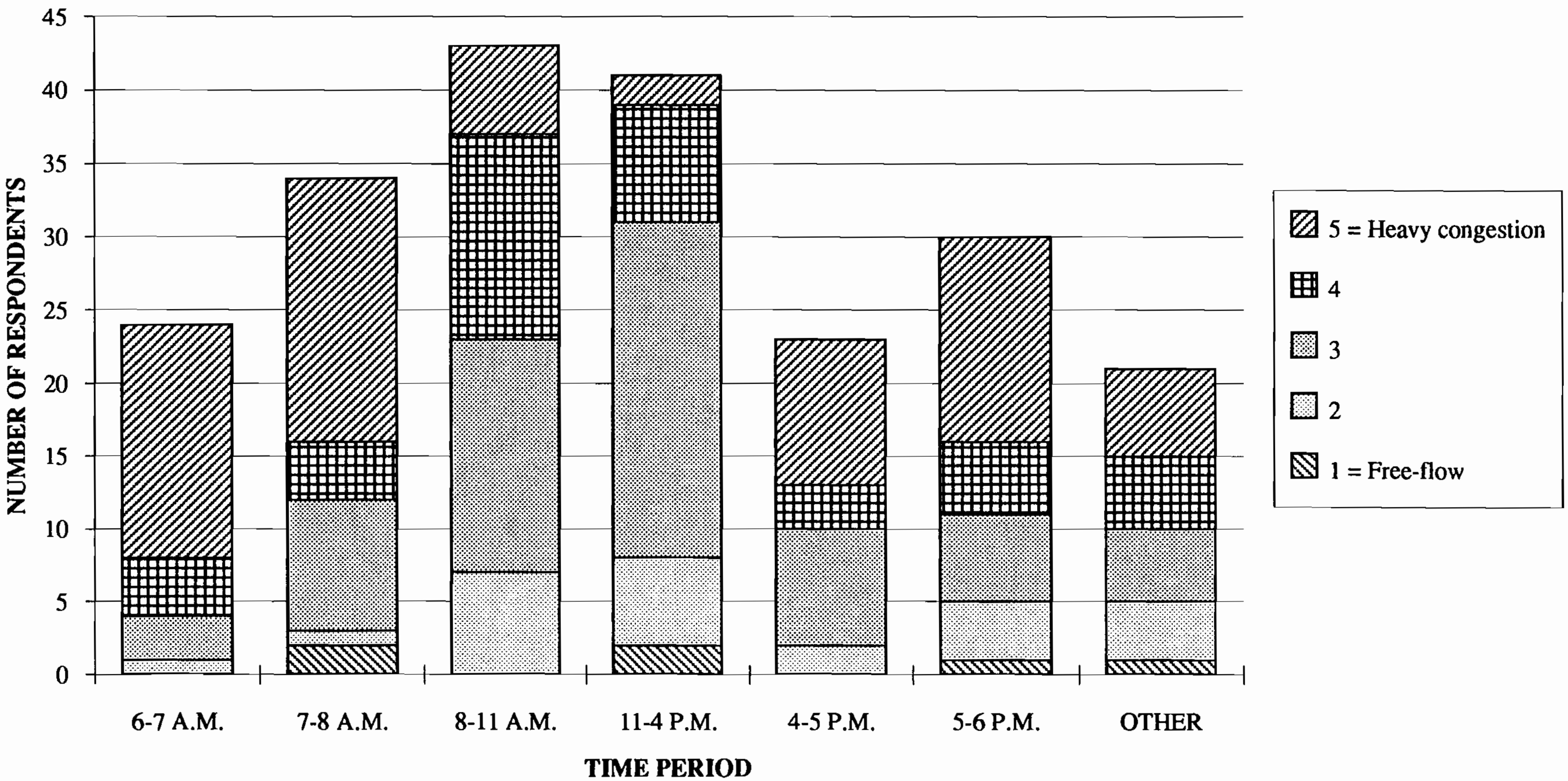


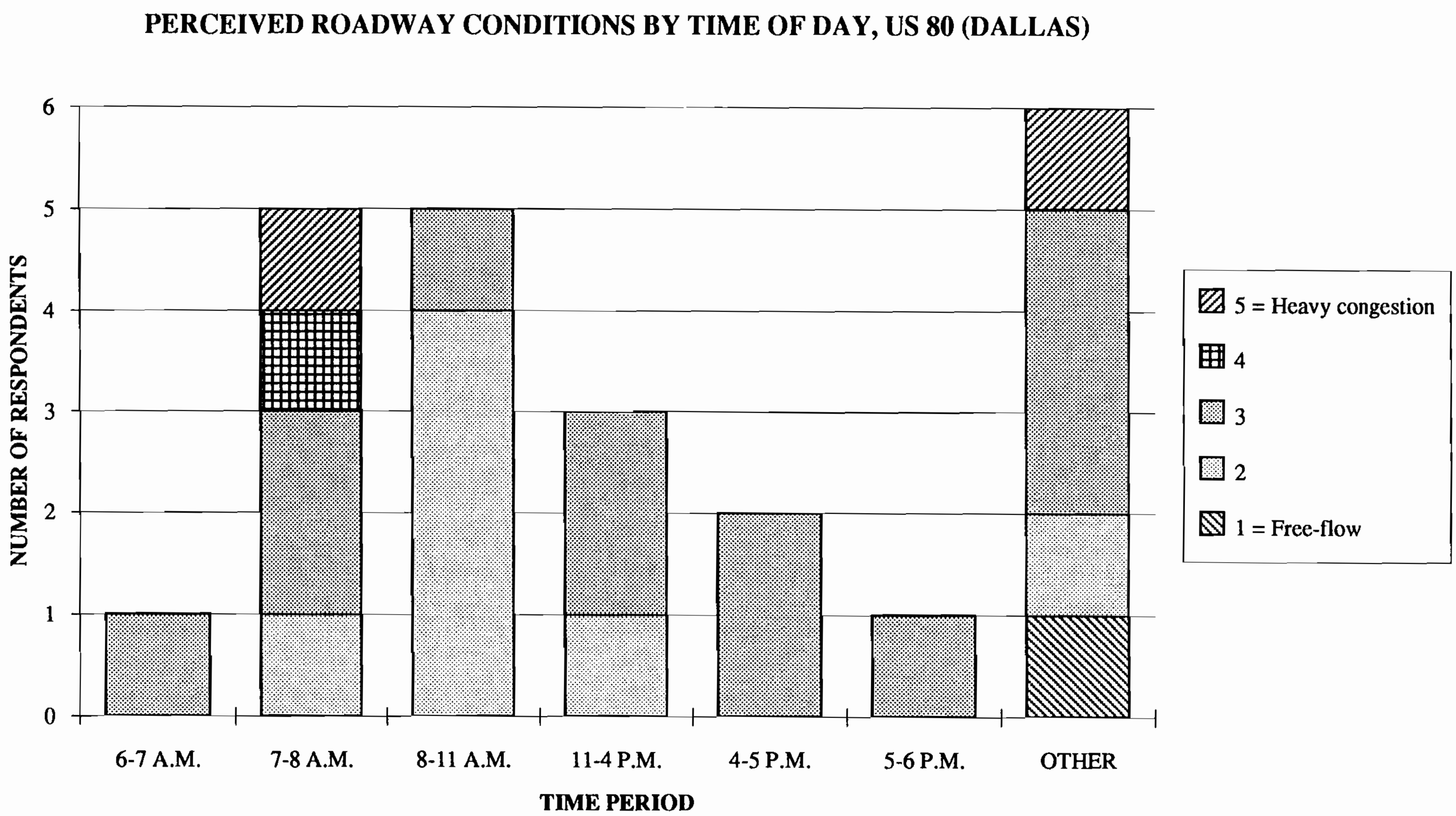
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-45 / SCHEPPS FREEWAY (DALLAS)



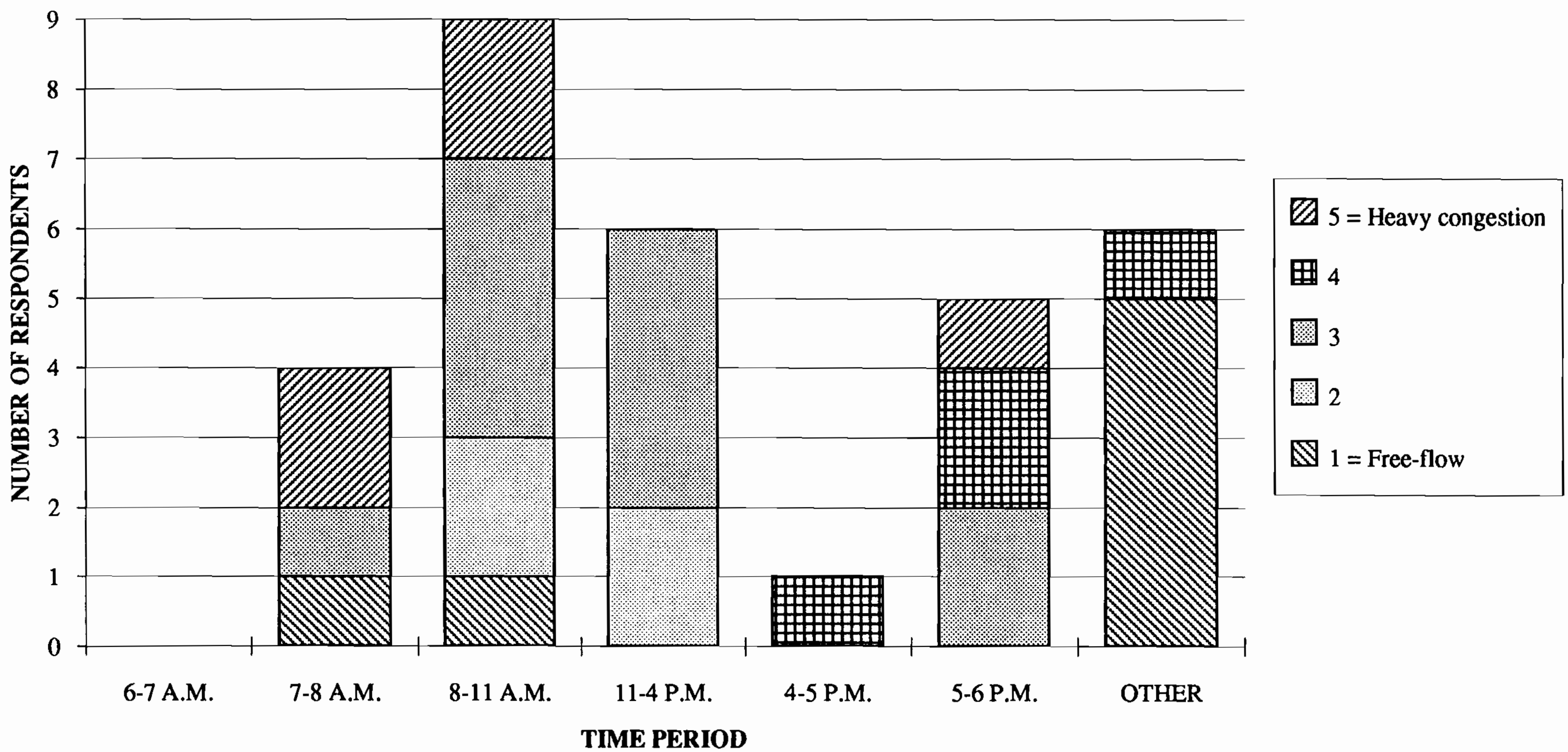

PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-20 (DALLAS)
NUMBER OF RESPONDENTS
0
2
4
6
8
10
12
14
16
6-7 A.M.
7-8 A.M.
8-11 A.M.
11-4 P.M.
4-5 P.M.
5-6 P.M.
OTHER
TIME PERIOD
5 = Heavy congestion
4
3
2
1 = Free-flow

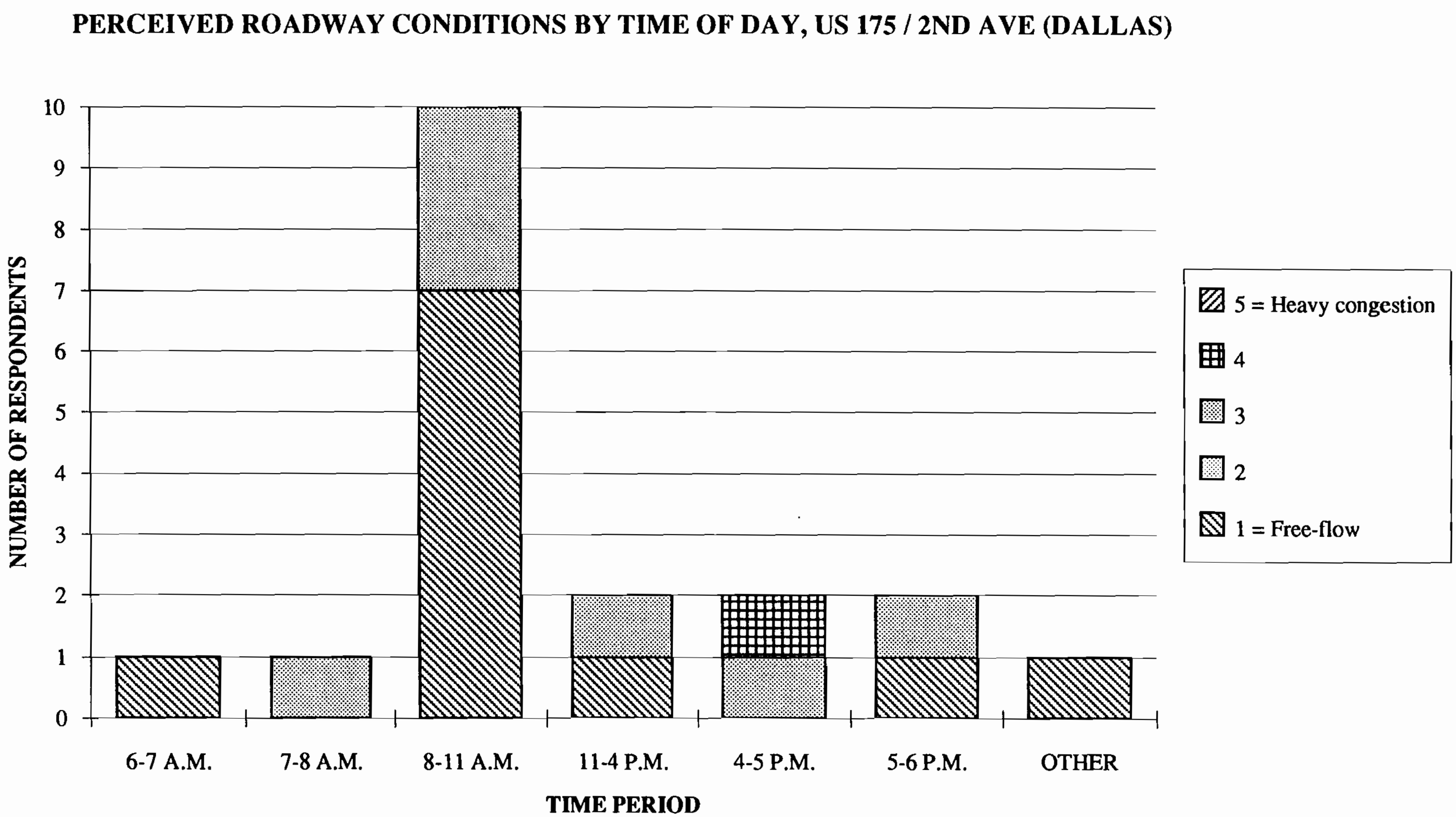
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-35E (DALLAS)



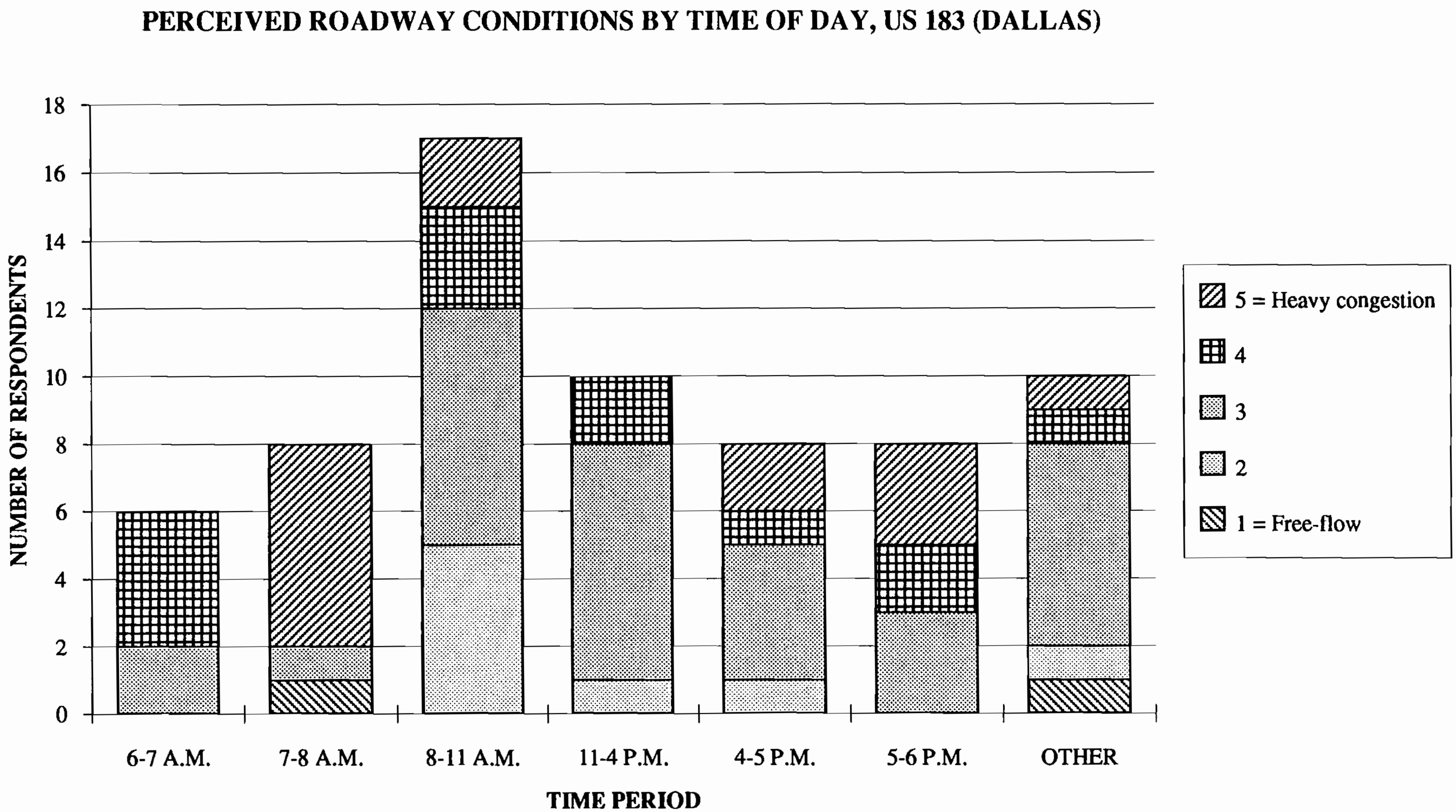

PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 80 (DALLAS)
NUMBER OF RESPONDENTS
0
1
2
3
4
5
6
6-7 A.M.
7-8 A.M.
8-11 A.M.
11-4 P.M.
4-5 P.M.
5-6 P.M.
OTHER
TIME PERIOD
5 = Heavy congestion
4
3
2
1 = Free-flow

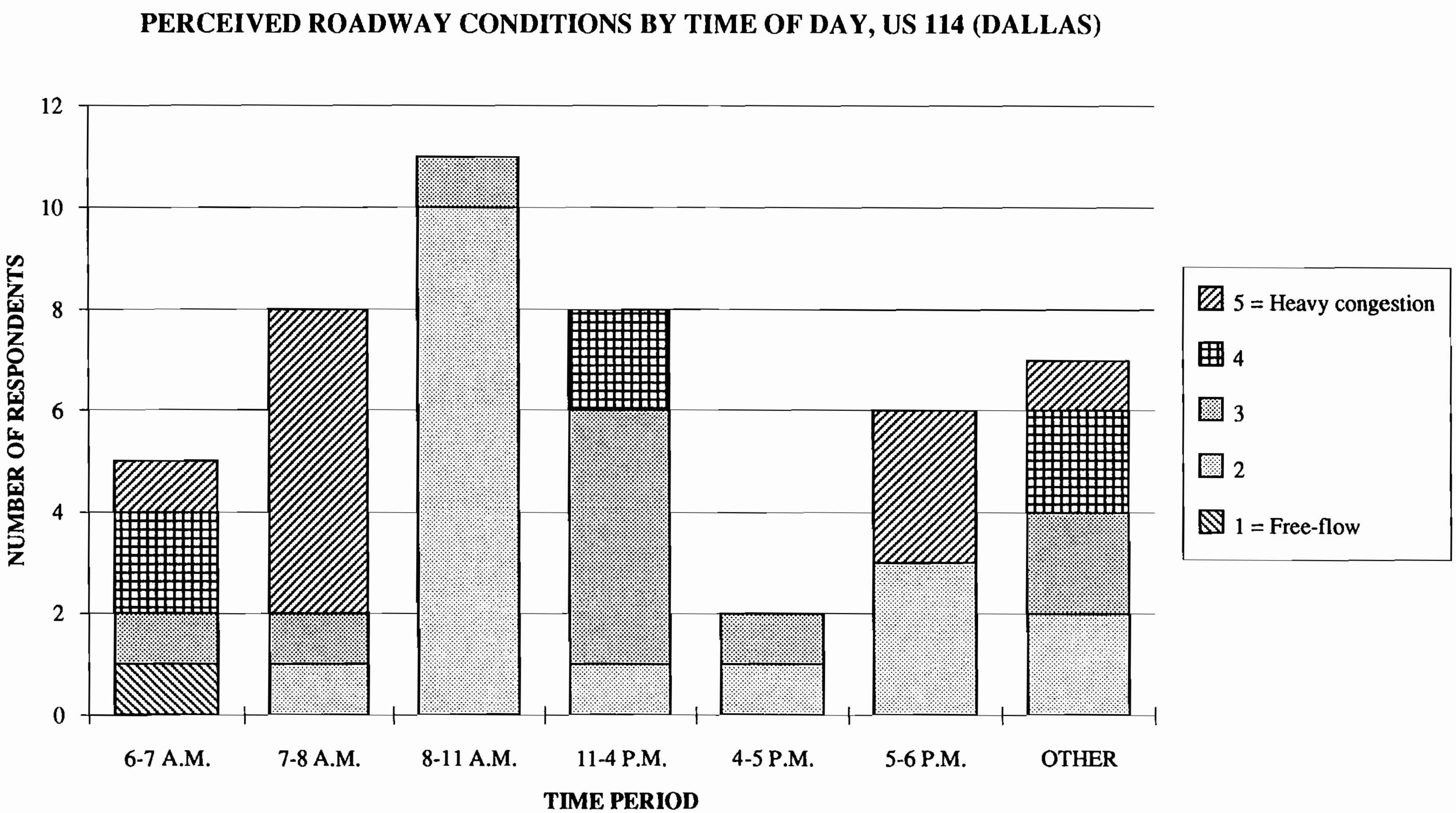
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 67 / MARY LOVE EXPRESSWAY (DALLAS)

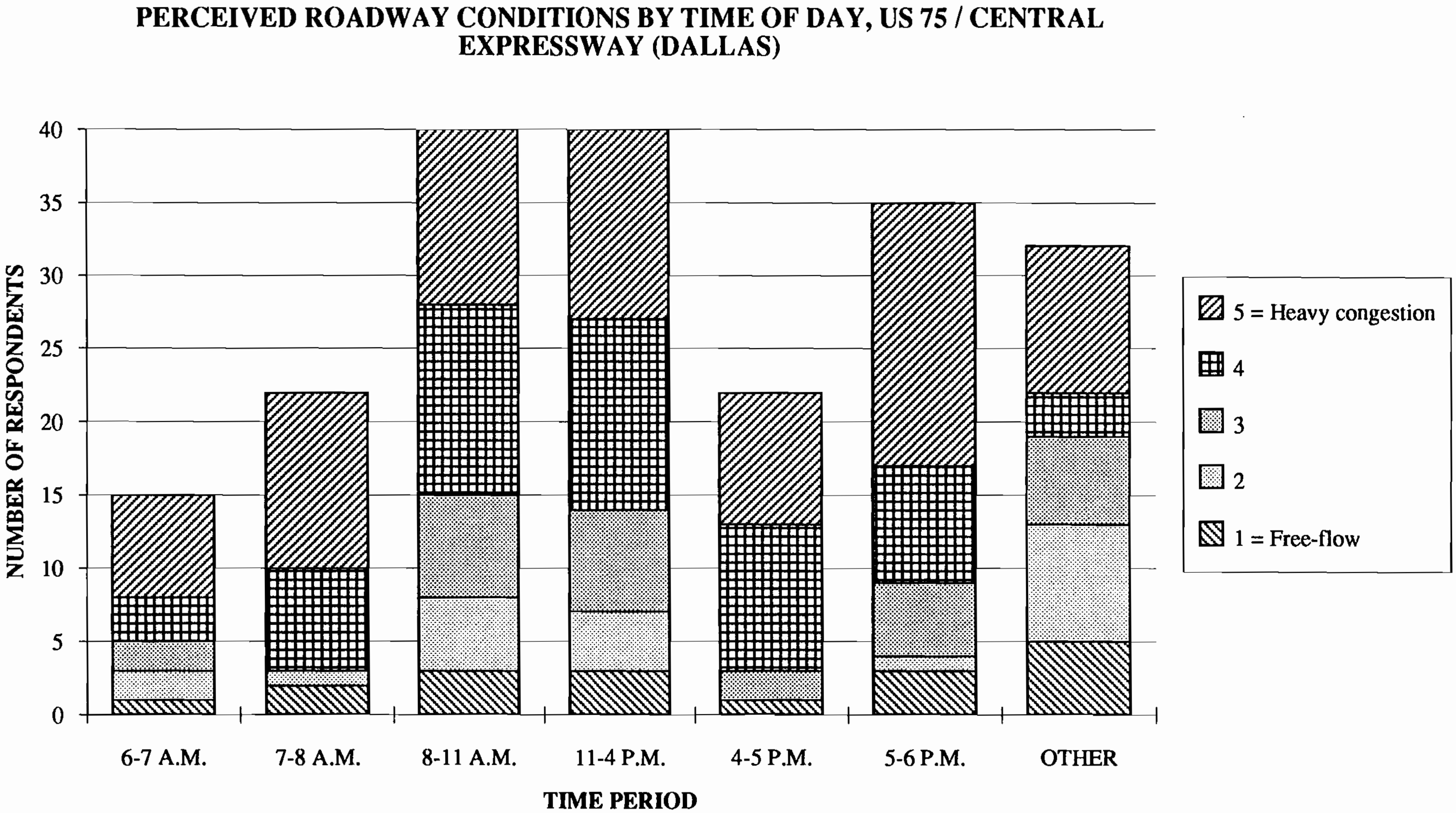




PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 175 / 2ND AVE (DALLAS)
NUMBER OF RESPONDENTS
0
1
2
3
4
5
6
7
8
9
10
6-7 A.M.
7-8 A.M.
8-11 A.M.
11-4 P.M.
4-5 P.M.
5-6 P.M.
OTHER
TIME PERIOD
5 = Heavy congestion
4
3
2
1 = Free-flow


PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 183 (DALLAS)
NUMBER OF RESPONDENTS
0
2
4
6
8
10
12
14
16
18
6-7 A.M.
7-8 A.M.
8-11 A.M.
11-4 P.M.
4-5 P.M.
5-6 P.M.
OTHER
TIME PERIOD
5 = Heavy congestion
4
3
2
1 = Free-flow


PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 114 (DALLAS)
NUMBER OF RESPONDENTS
0
2
4
6
8
10
12
6-7 A.M.
7-8 A.M.
8-11 A.M.
11-4 P.M.
4-5 P.M.
5-6 P.M.
OTHER
TIME PERIOD
5 = Heavy congestion
4
3
2
1 = Free-flow


PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 75 / CENTRAL EXPRESSWAY (DALLAS)
NUMBER OF RESPONDENTS
0
5
10
15
20
25
30
35
40
6-7 A.M.
7-8 A.M.
8-11 A.M.
11-4 P.M.
4-5 P.M.
5-6 P.M.
OTHER
TIME PERIOD
5 = Heavy congestion
4
3
2
1 = Free-flow

PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, DALLAS NORTH TOLLWAY (DALLAS)

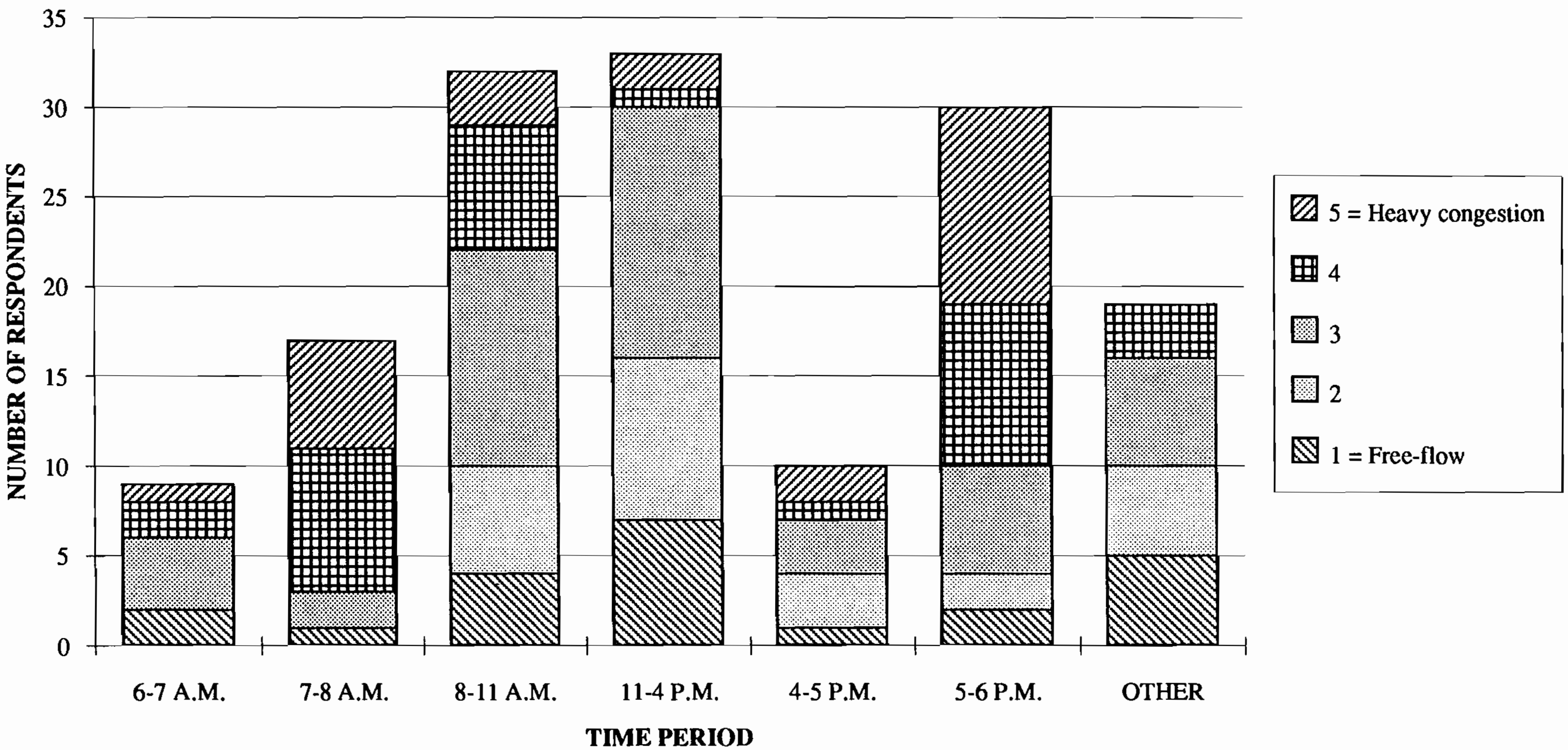
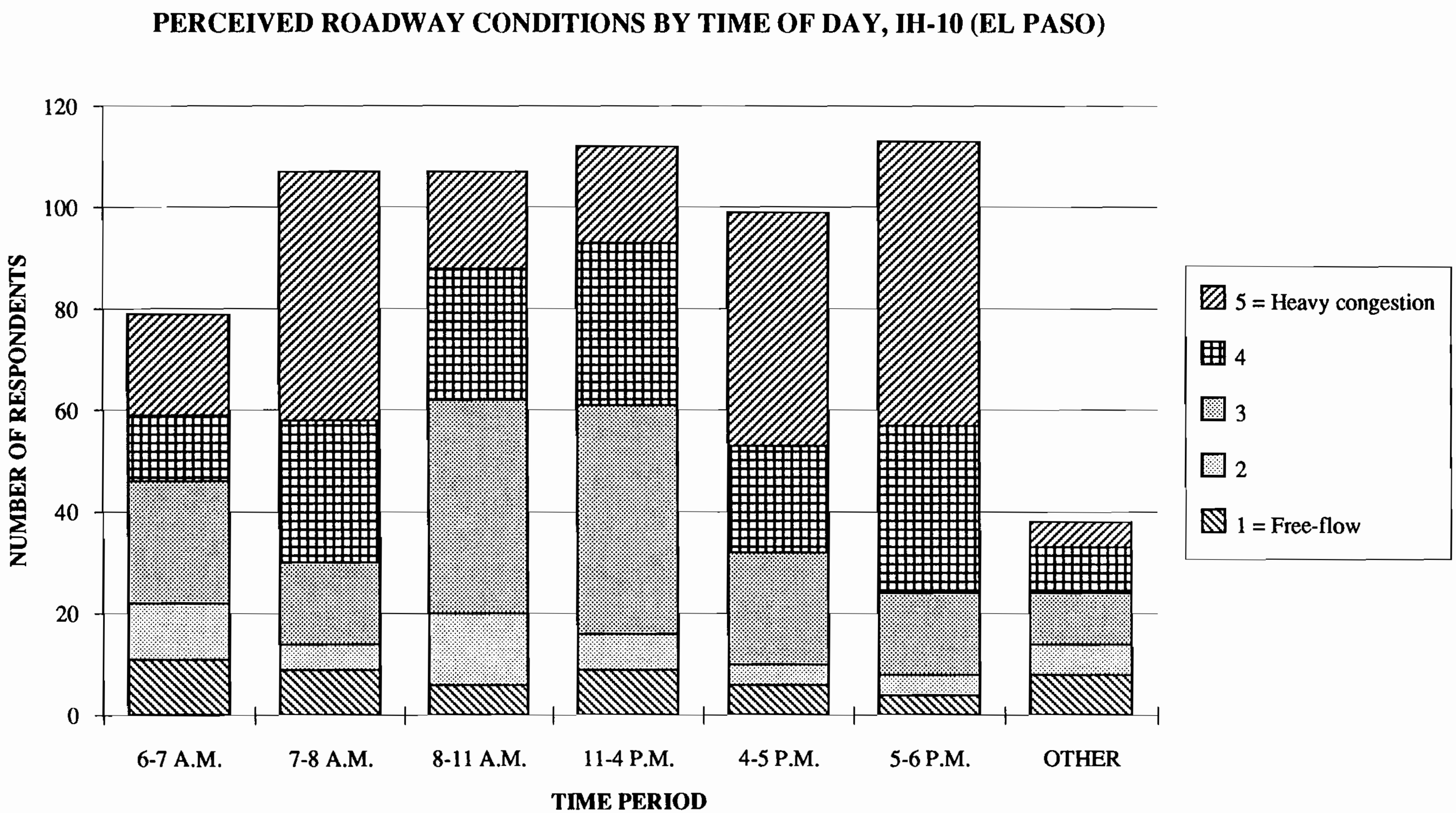


Table 3
Average perceived traffic conditions, El Paso freeways*

	6-7 A.M.	*7-8 A.M.*	*8-11 A.M.*	*11-4 P.M.*	*4-5 P.M.*	*5-6 P.M.*	*OTHER*
IH-10	3.70	4.37	3.86	3.71	4.21	4.46	3.34
number in sample	79	107	107	112	99	113	38
US 54	3.19	3.73	3.91	3.44	4.07	3.64	3.40
number in sample	27	38	28	31	27	25	14

* 1 = light, free flowing movement; 5 = heavy, congested movement


PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-10 (EL PASO)
NUMBER OF RESPONDENTS
120
100
80
60
40
20
0
6-7 A.M.
7-8 A.M.
8-11 A.M.
11-4 P.M.
4-5 P.M.
5-6 P.M.
OTHER
TIME PERIOD
5 = Heavy congestion
4
3
2
1 = Free-flow

PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 54 (EL PASO)

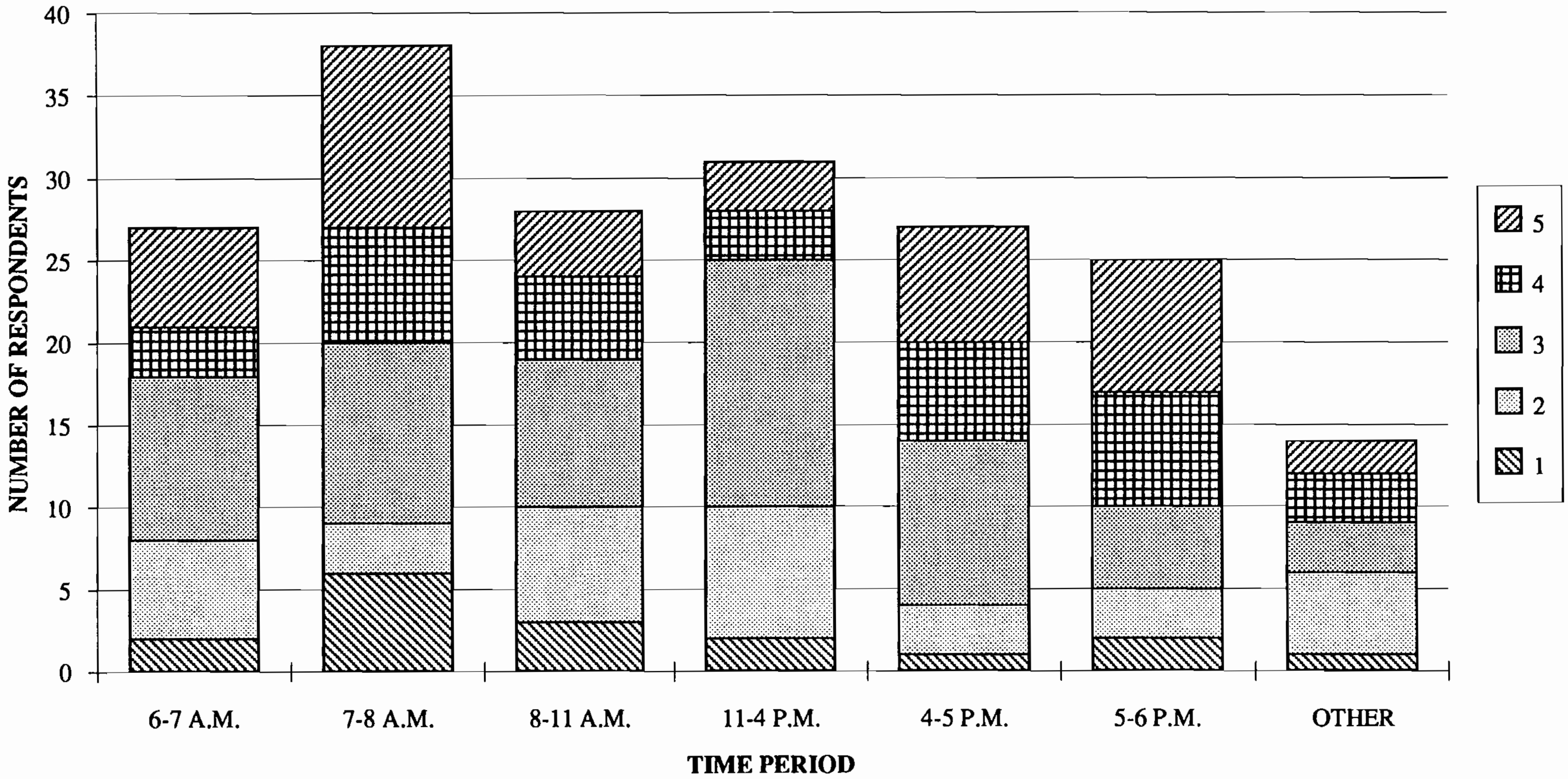
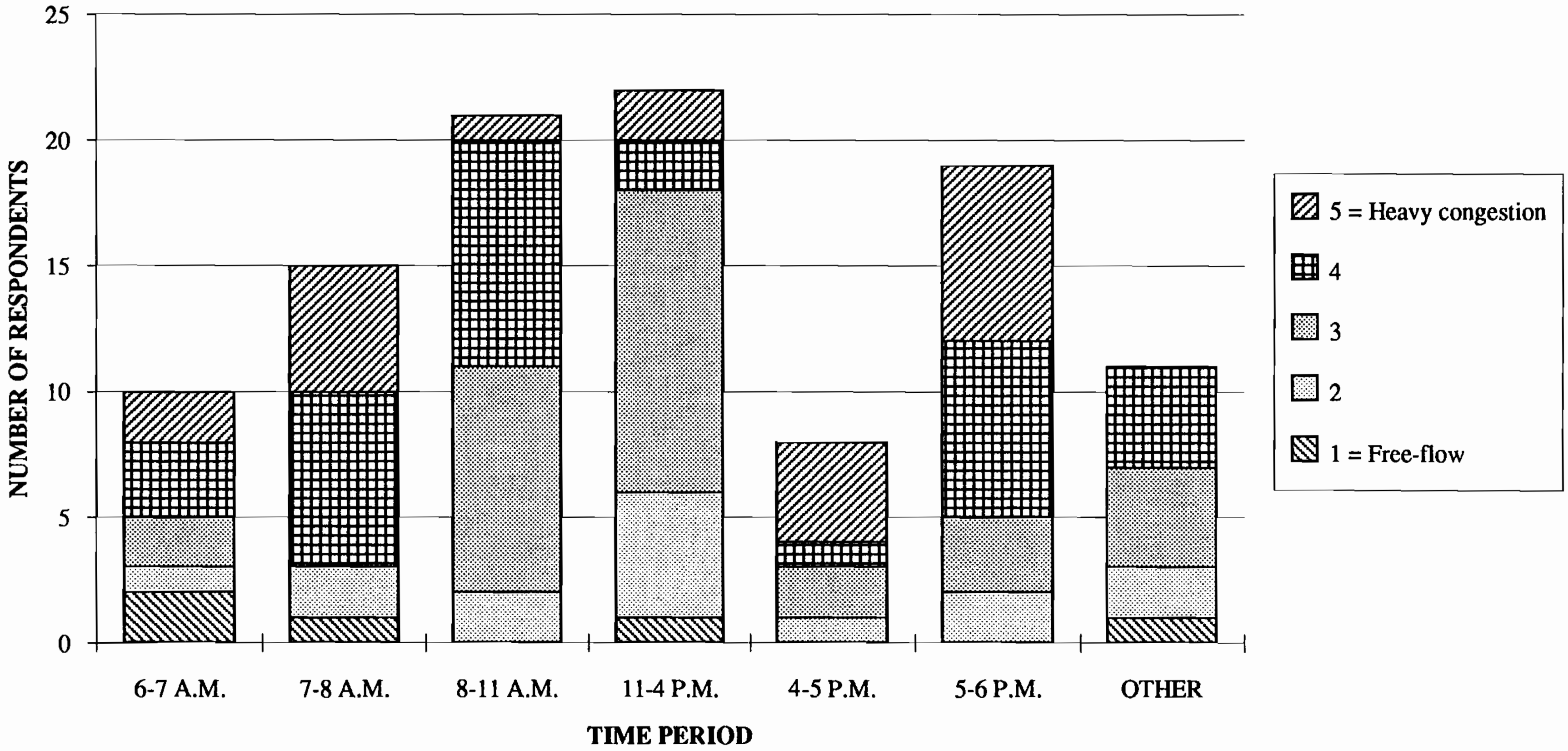


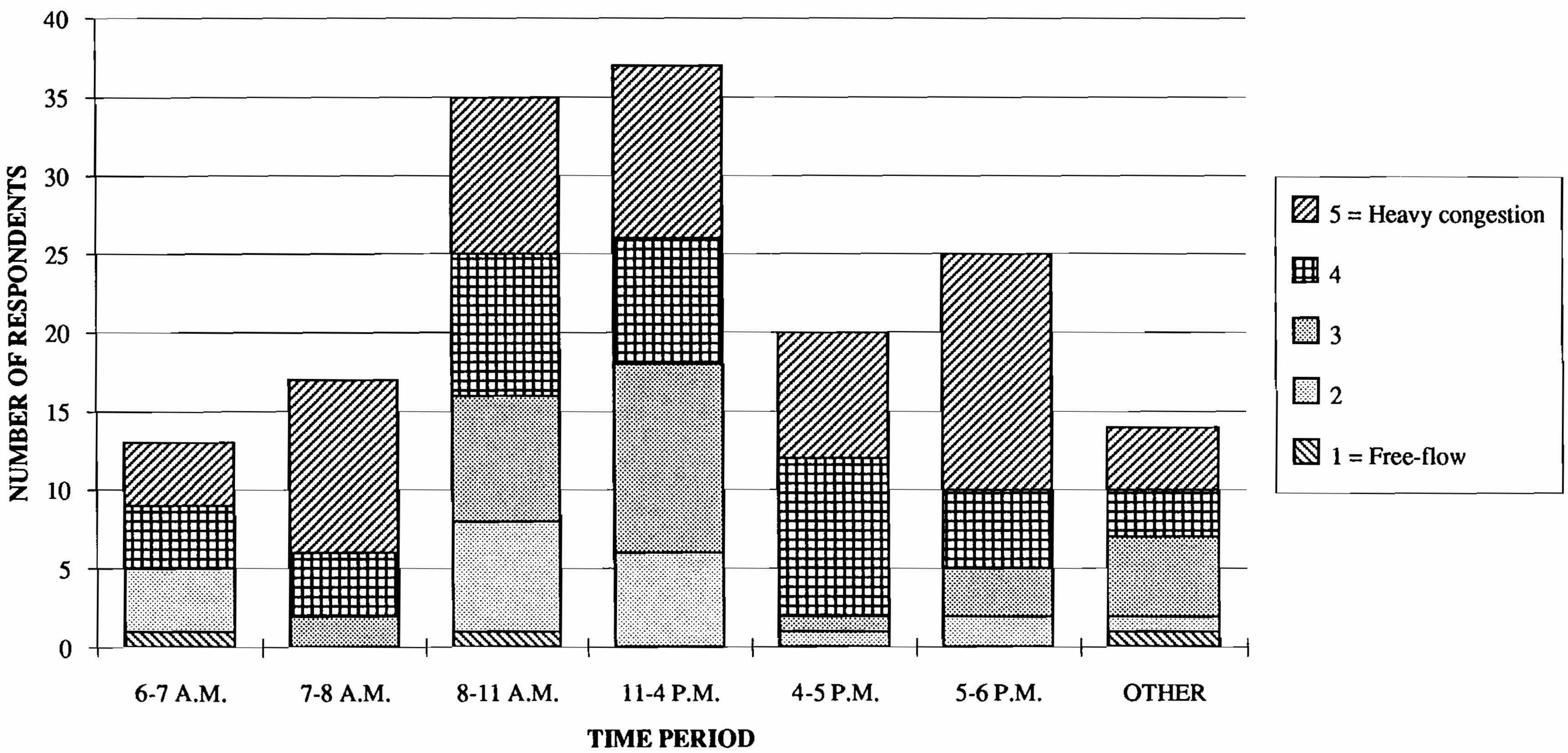
Table 2
Average perceived traffic conditions, Houston freeways*

	6-7 A.M.	*7-8 A.M.*	*8-11 A.M.*	*11-4 P.M.*	*4-5 P.M.*	*5-6 P.M.*	*OTHER*
IH-610 / SOUTH LOOP	3.20	3.87	3.43	2.95	4.00	4.00	3.50
number in sample	10	15	21	22	8	19	11
IH-610 / WEST LOOP	3.86	4.78	3.57	3.71	4.25	4.50	3.57
number in sample	13	17	35	37	20	25	14
IH-610 / NORTH LOOP	2.33	3.62	3.38	2.83	3.20	4.17	3.17
number in sample	3	13	13	12	5	12	5
IH-610 / EAST LOOP	3.50	3.43	3.50	4.00	4.00	3.38	4.50
number in sample	4	7	6	6	1	8	2
IH-10 / KATY FREEWAY	3.00	4.00	4.11	3.79	4.21	4.11	3.00
number in sample	15	21	26	39	19	28	16
IH-10 / EAST FREEWAY	3.00	2.75	3.50	2.75	3.17	3.55	2.00
number in sample	8	4	6	4	6	10	2
IH-45 / NORTH FREEWAY	2.70	4.82	3.73	3.90	3.17	4.60	4.14
number in sample	10	10	15	19	12	10	5
IH-45 / GULF FREEWAY	3.60	3.76	3.29	3.24	3.57	3.81	3.67
number in sample	10	17	17	21	14	16	8
US 59 / SOUTHWEST FREEWAY	3.74	4.68	3.32	3.06	4.76	3.93	3.26
number in sample	21	18	28	30	14	25	19
US 59 / EASTEX FREEWAY	3.75	5.00	2.00	2.75	3.83	4.00	5.50
number in sample	4	3	3	8	6	4	1
US 290 / NORTHWEST FREEWAY	3.27	4.67	3.90	2.40	4.00	4.00	3.33
number in sample	11	15	9	10	9	10	6
SR 225 / LA PORTE FREEWAY	3.00	4.83	4.17	5.00	2.57	2.37	5.00
number in sample	4	5	5	2	7	8	2
US 288 / SOUTH FREEWAY	4.00	4.00	3.25	3.45	2.67	3.75	3.33
number in sample	3	4	4	10	3	4	3
SAM HOUSTON TOLLWAY	2.17	2.25	1.57	1.80	2.00	2.27	1.90
number in sample	6	16	14	20	7	15	10
HARDY TOLL ROAD	2.00	2.00	2.00	0.00	1.50	2.00	2.50
number in sample	1	2	2	0	2	2	1

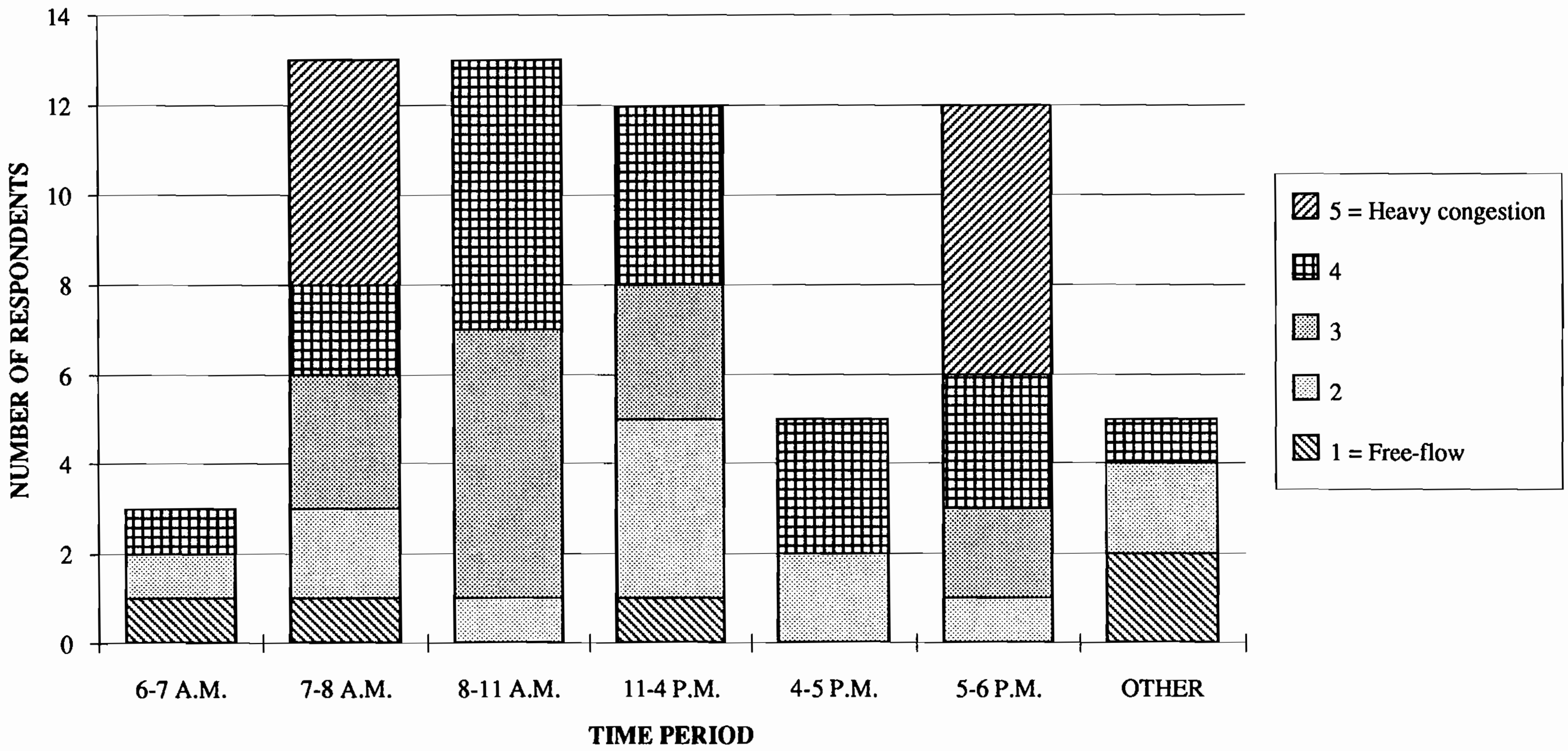
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-610 / SOUTH LOOP (HOUSTON)

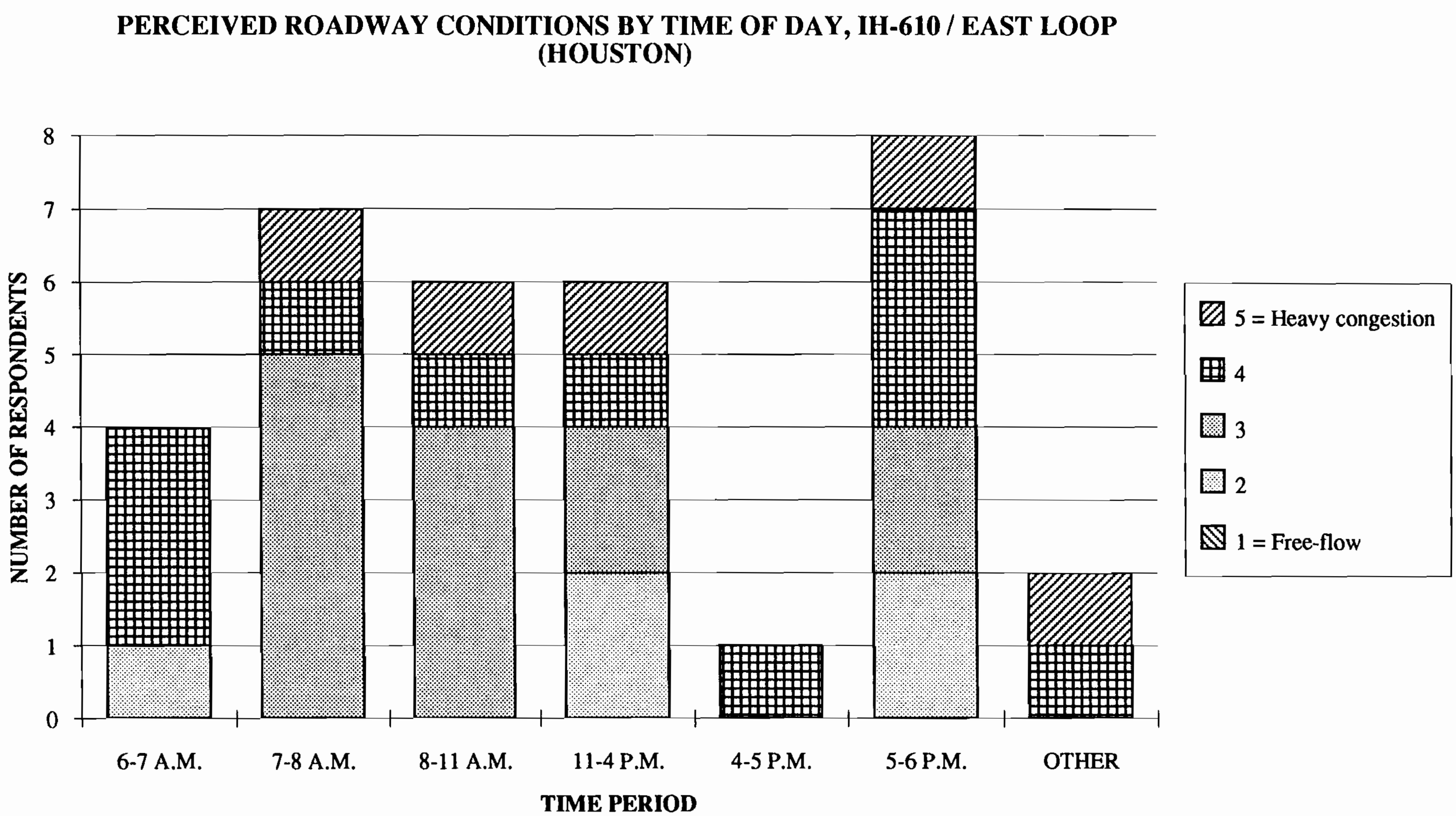


PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-610 / WEST LOOP
(HOUSTON)

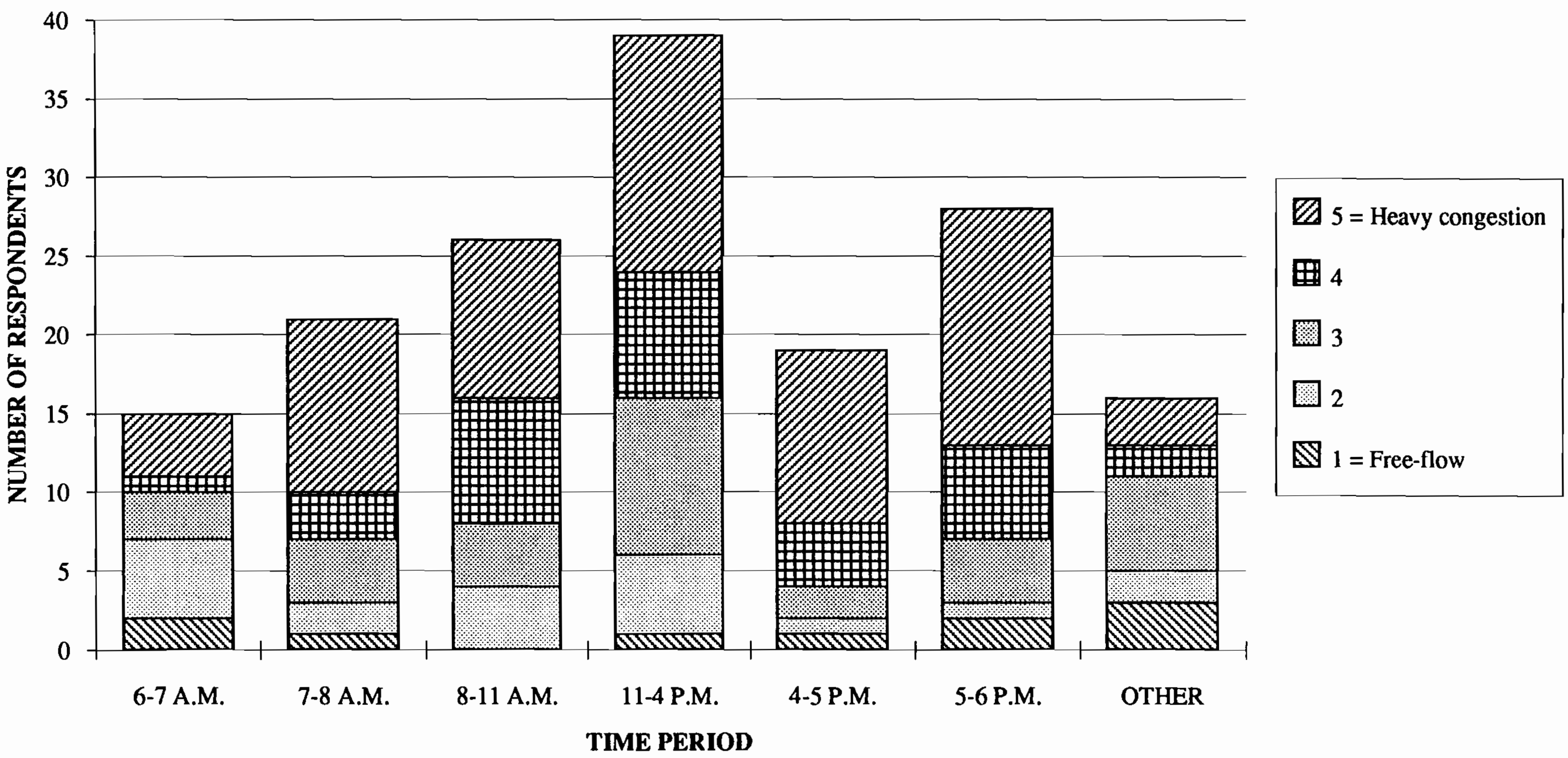


PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-610 / NORTH LOOP (HOUSTON)

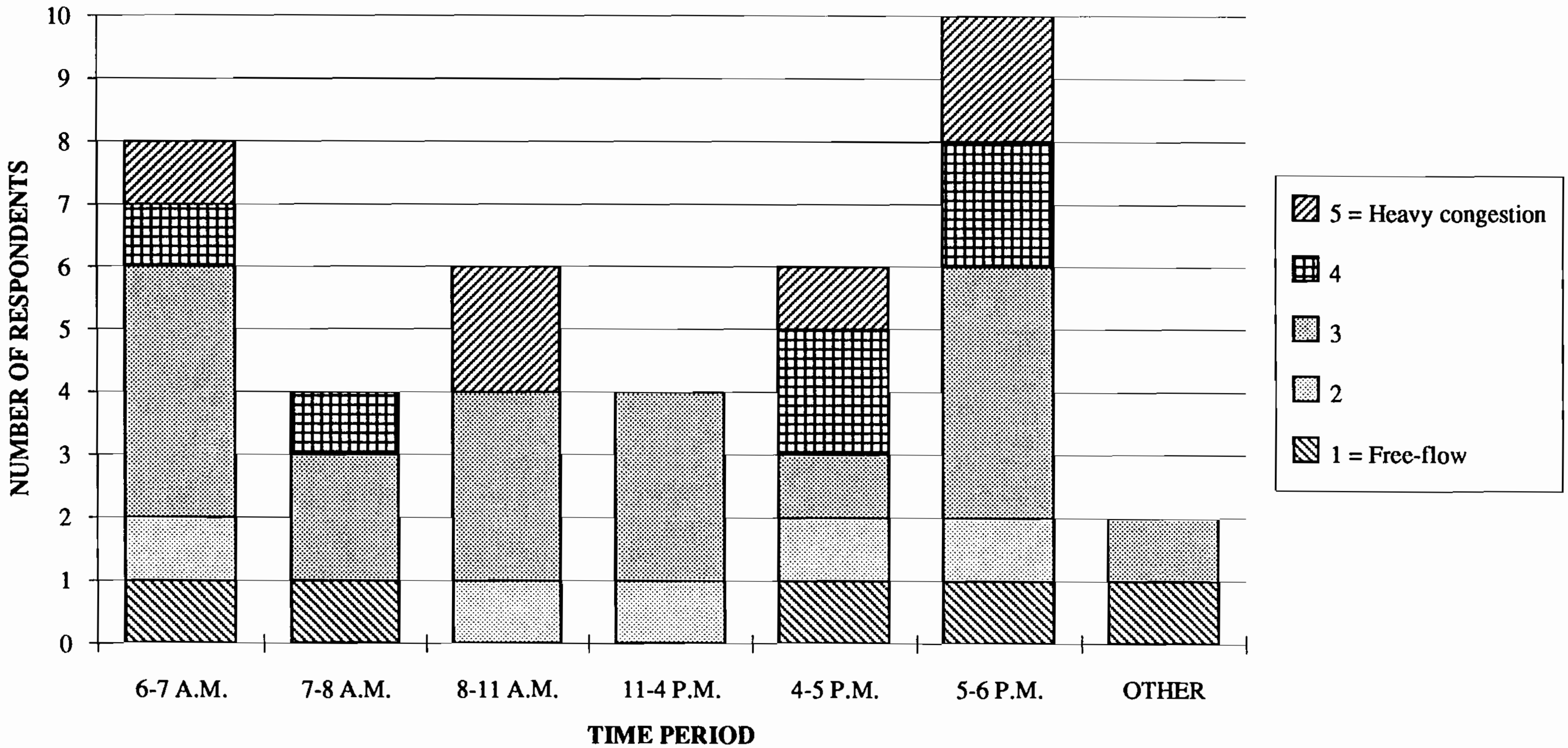



PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-610 / EAST LOOP
(HOUSTON)
NUMBER OF RESPONDENTS
8
7
6
5
4
3
2
1
0
6-7 A.M.
7-8 A.M.
8-11 A.M.
11-4 P.M.
4-5 P.M.
5-6 P.M.
OTHER
TIME PERIOD
5 = Heavy congestion
4
3
2
1 = Free-flow

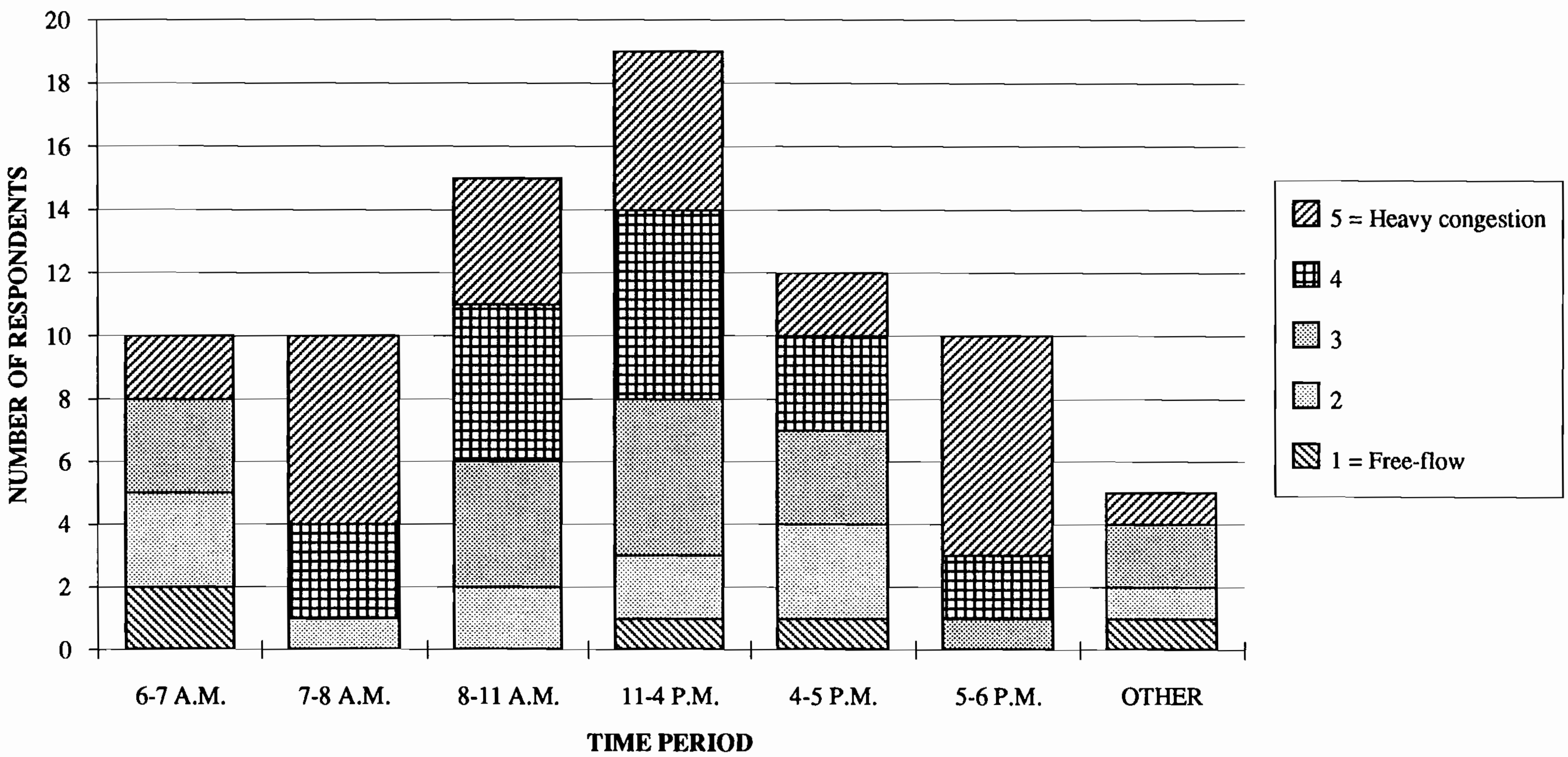
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-10 / KATY FREEWAY (HOUSTON)



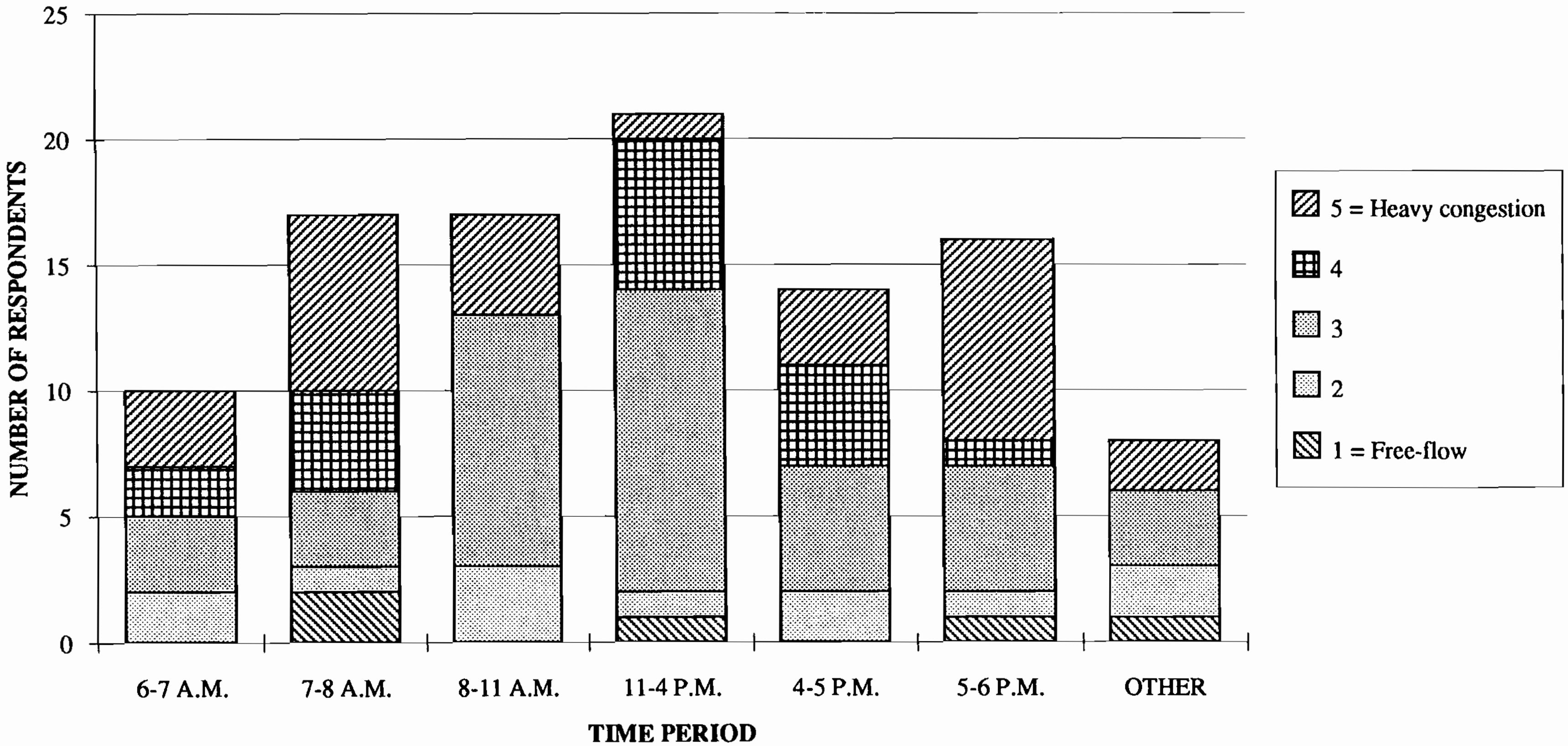
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-10 / EAST FREEWAY (HOUSTON)



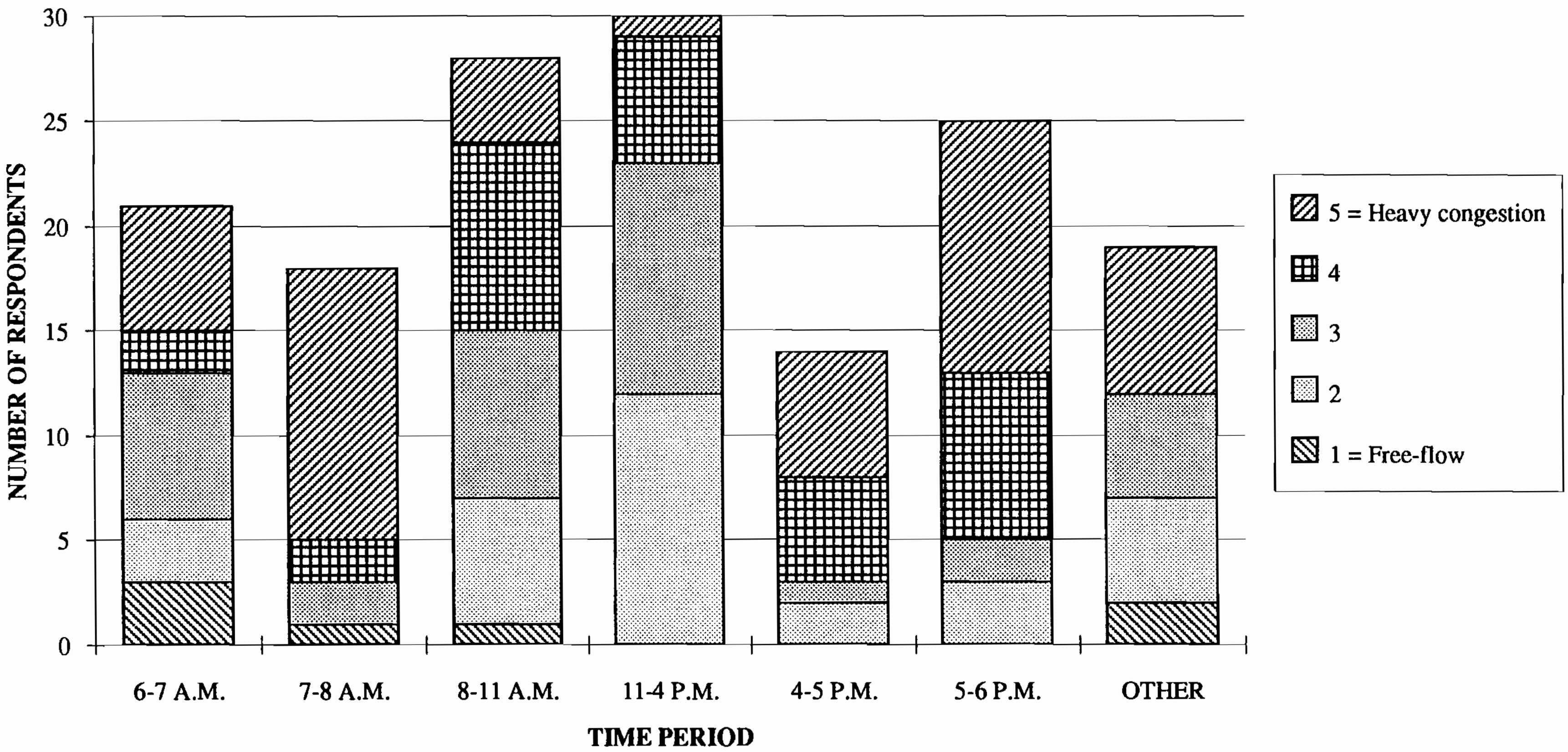
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-45 / NORTH FREEWAY (HOUSTON)



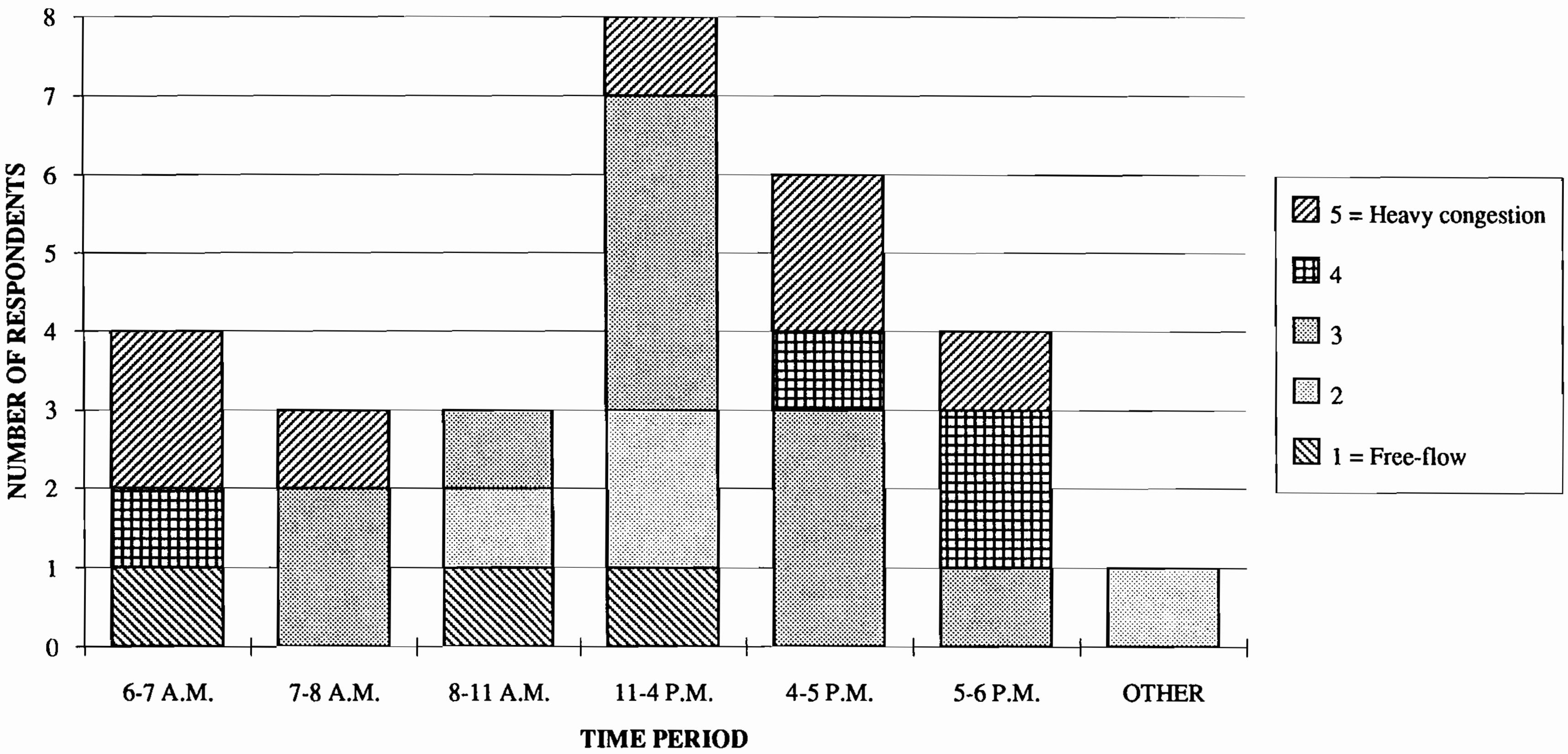
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-45 / GULF FREEWAY (HOUSTON)



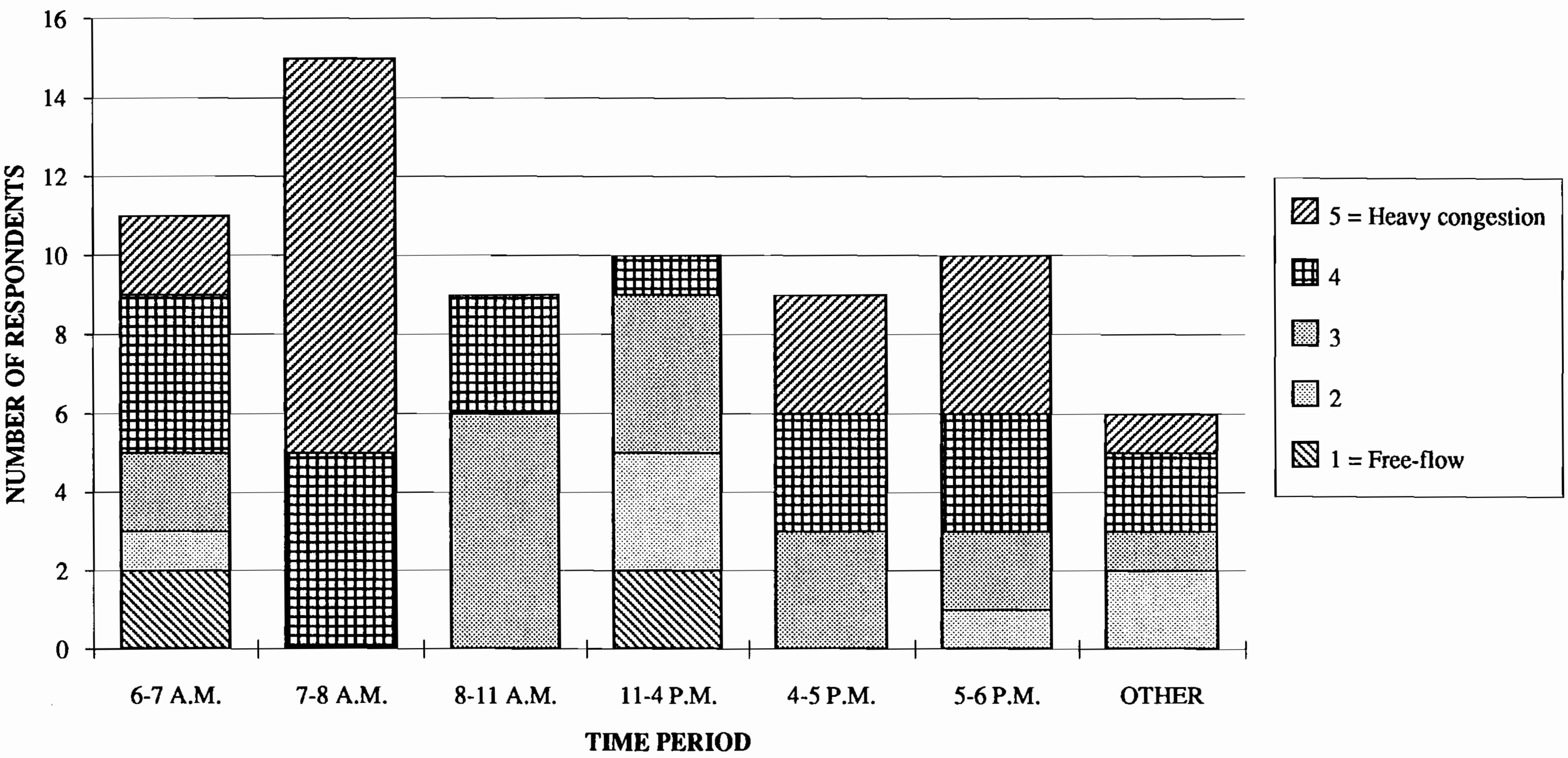
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 59 / SOUTHWEST FREEWAY (HOUSTON)



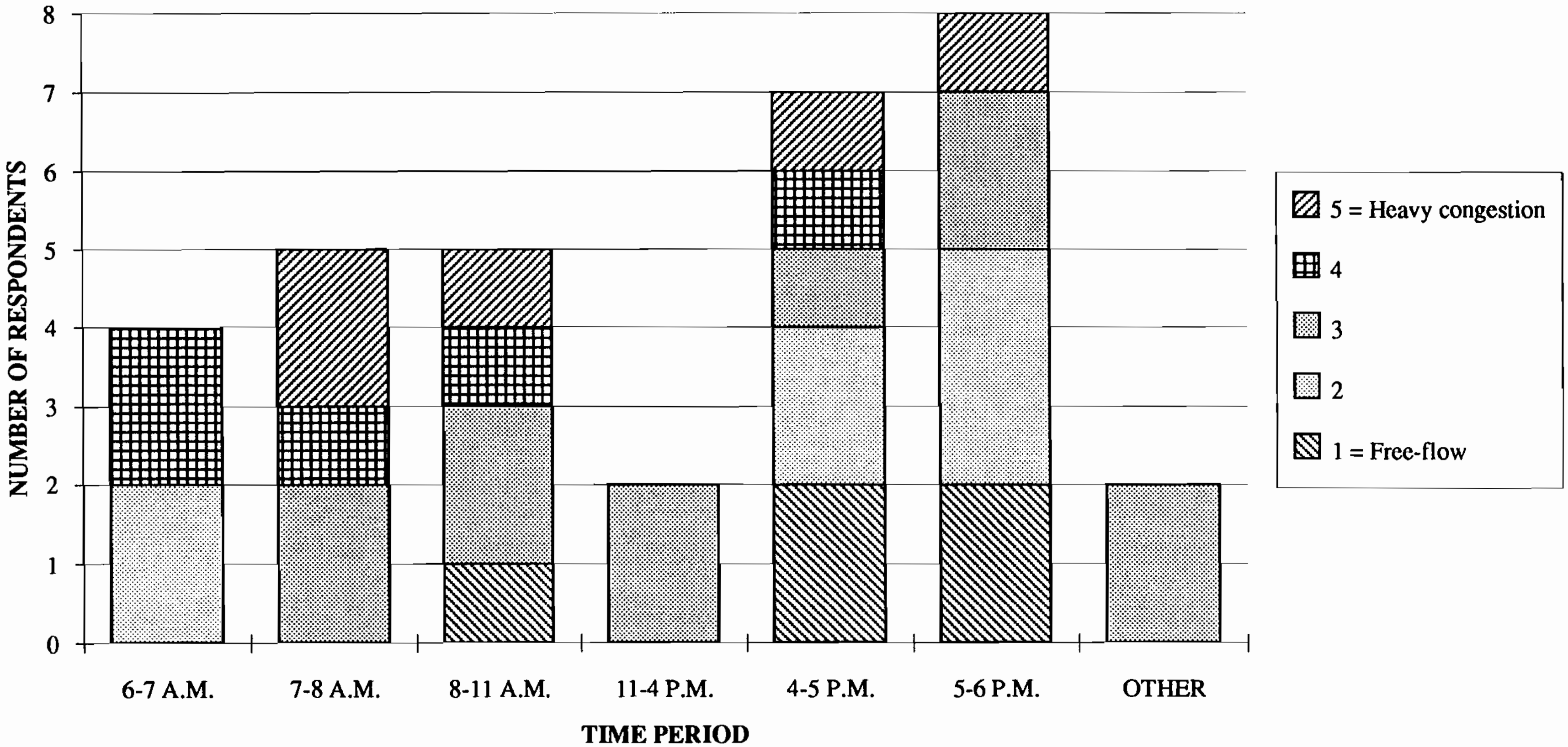
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 59 / EASTEX FREEWAY (HOUSTON)



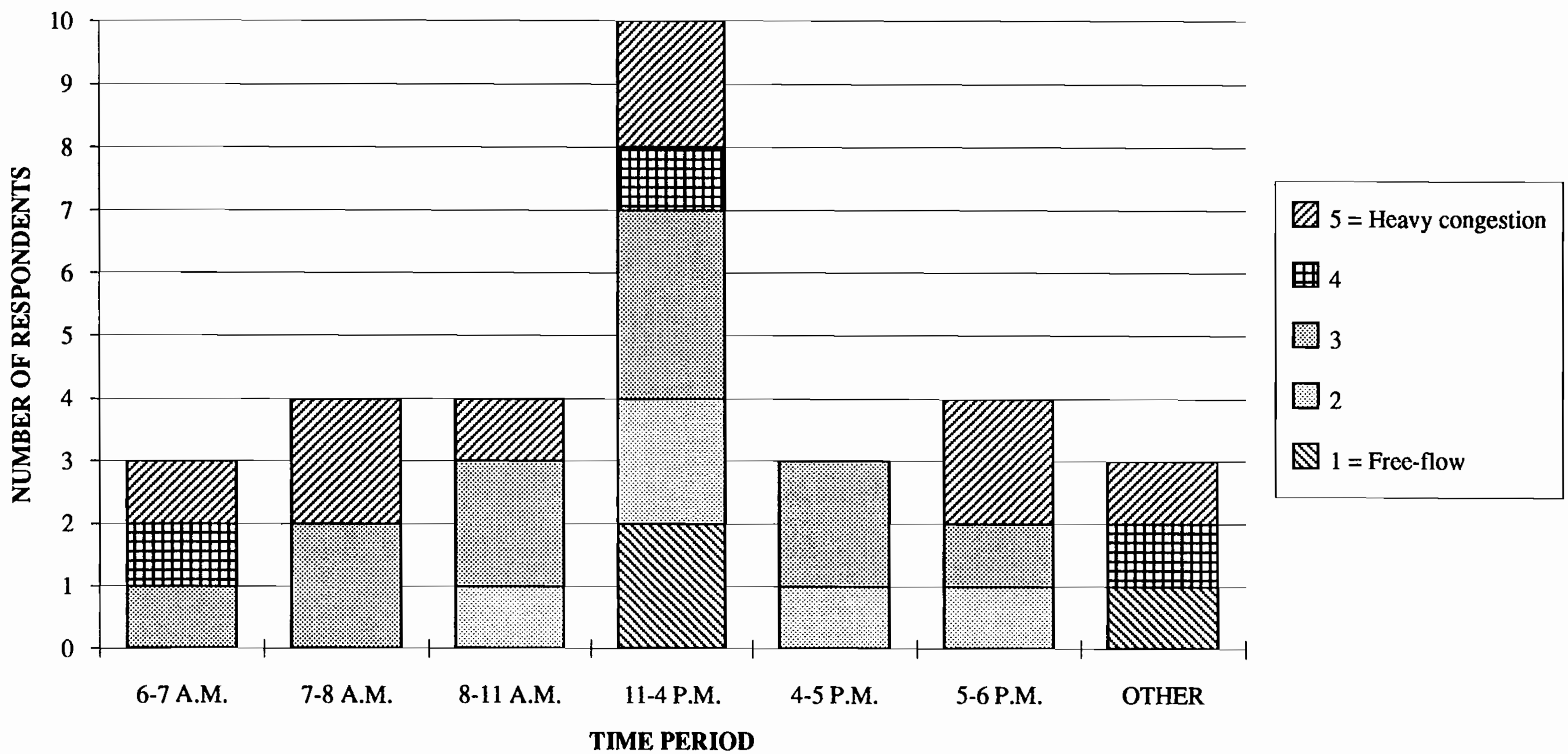
PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 290 / NORTHWEST FREEWAY (HOUSTON)



PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, SR 225 / LA PORTE FREEWAY (HOUSTON)



PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 288 / SOUTH FREEWAY (HOUSTON)



PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, SAM HOUSTON TOLLWAY (HOUSTON)

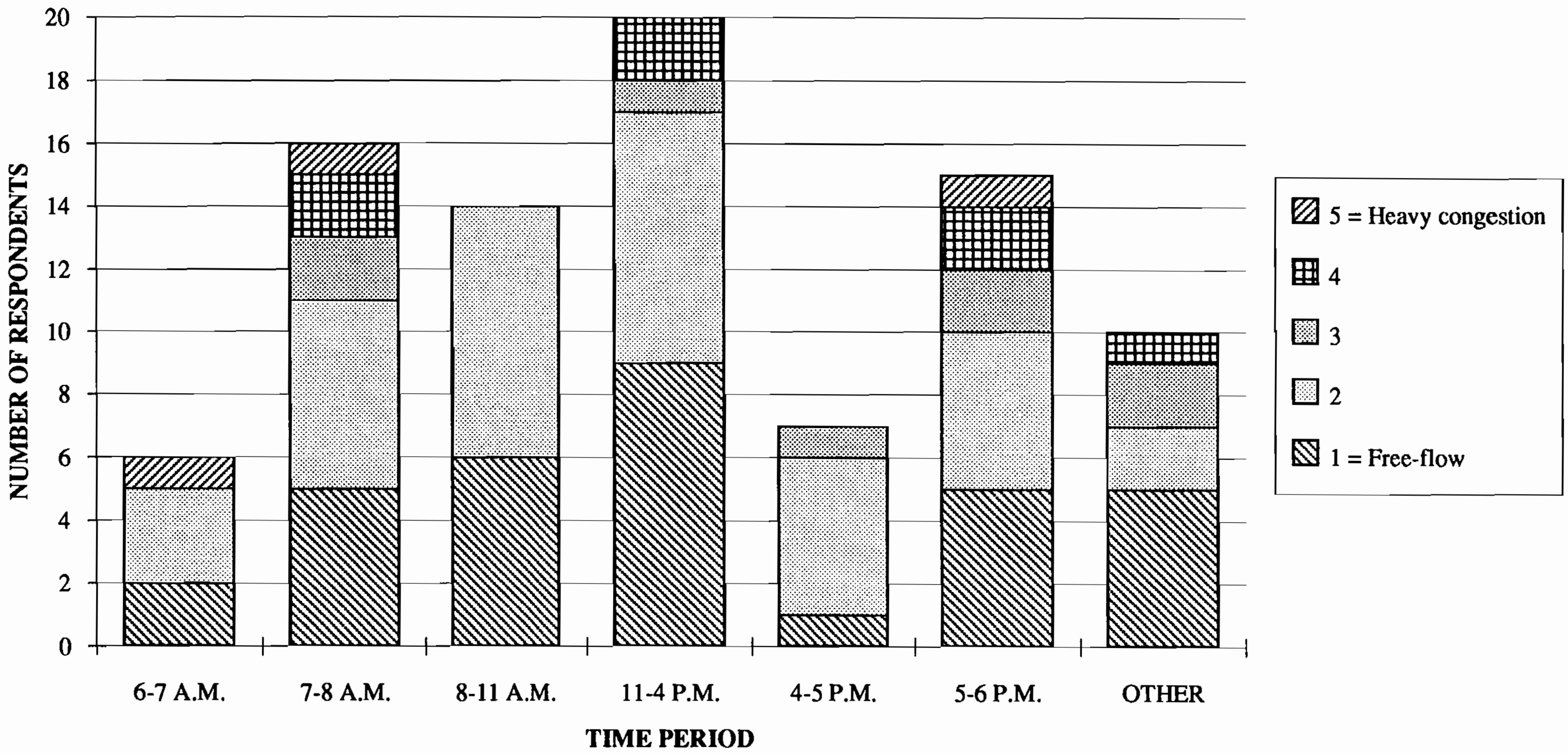
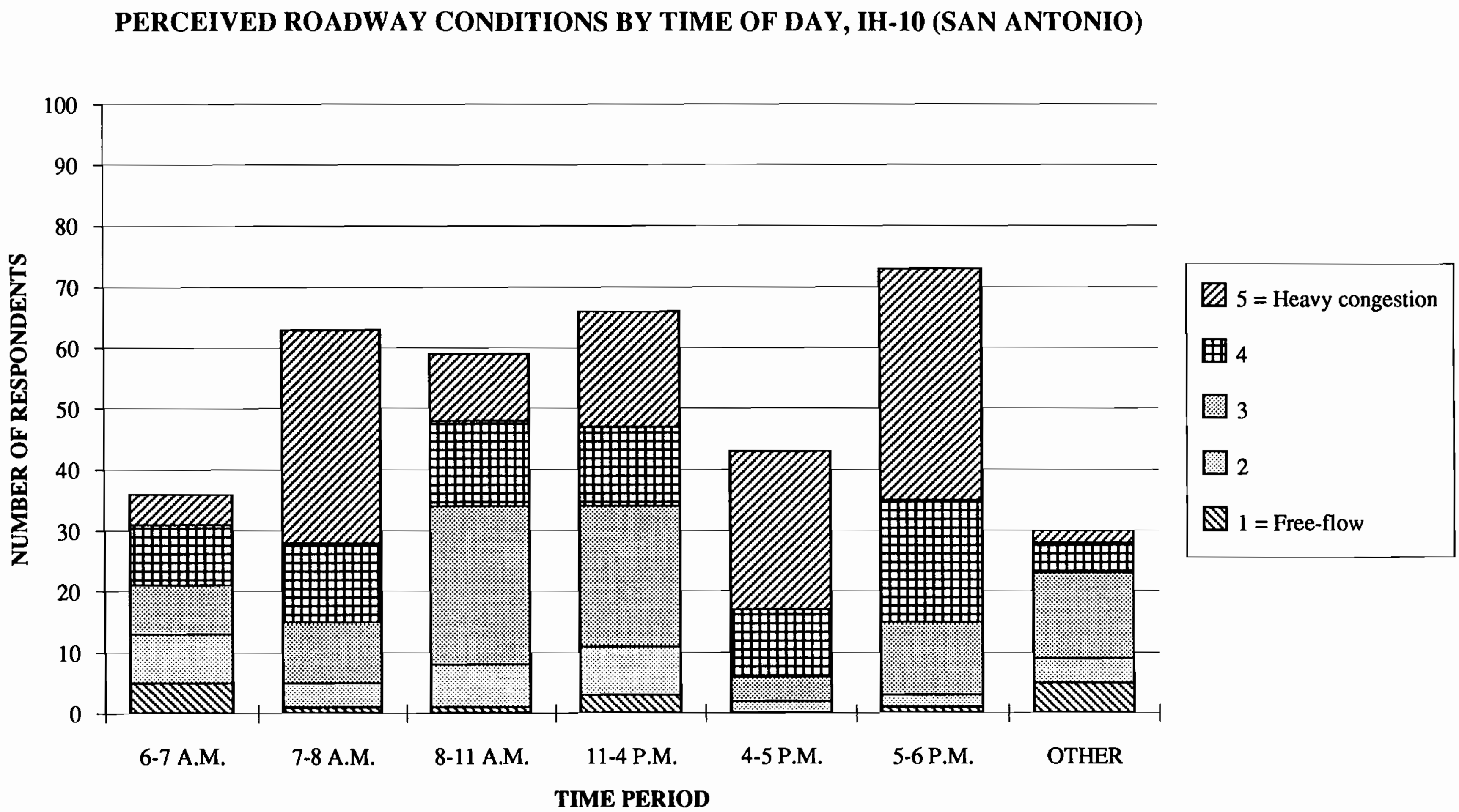


Table 4

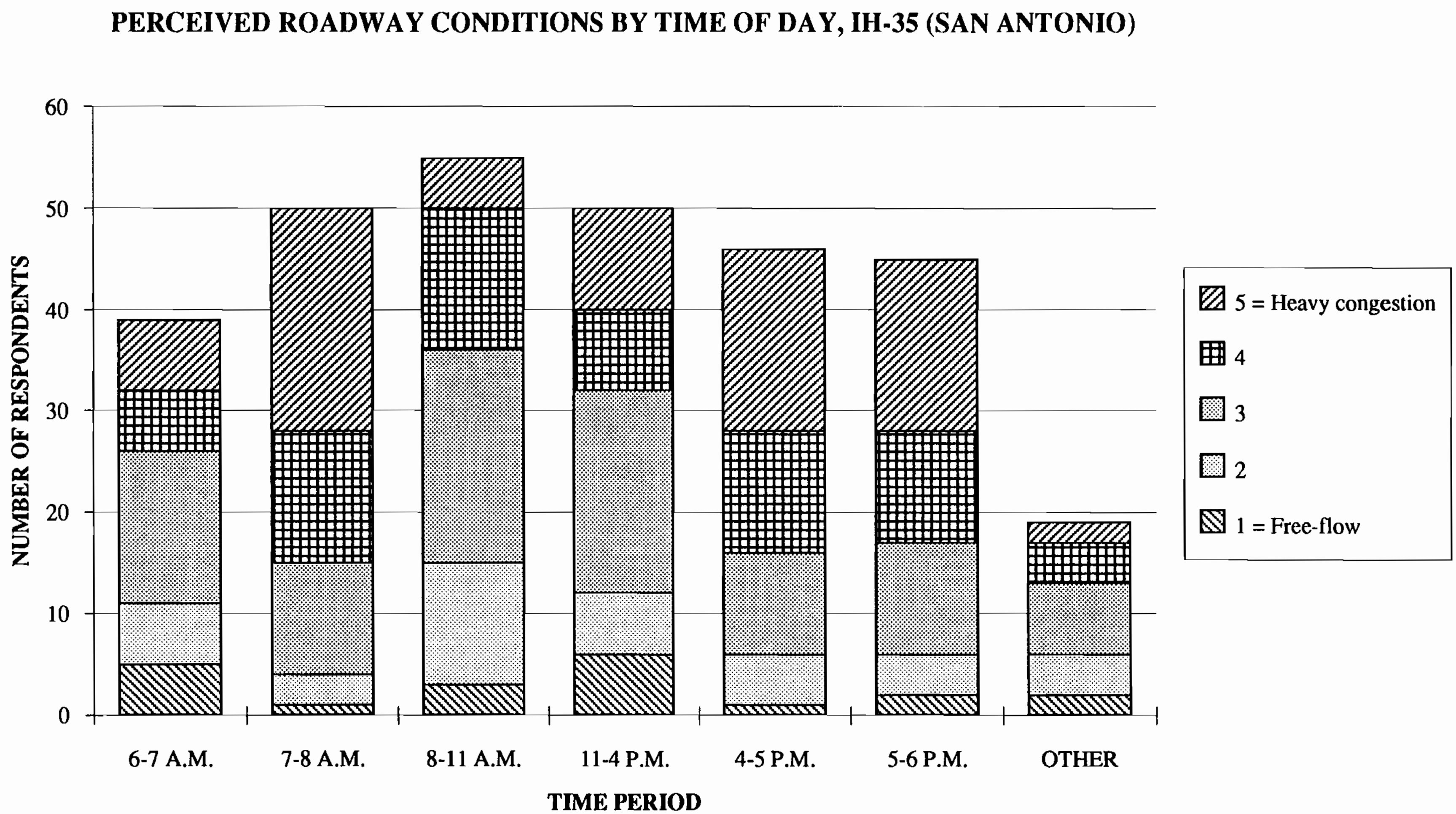
Average perceived traffic conditions, San Antonio freeways*

	6-7 A.M.	*7-8 A.M.*	*8-11 A.M.*	*11-4 P.M.*	*4-5 P.M.*	*5-6 P.M.*	*OTHER*
IH-10	3.06	4.22	3.81	3.72	4.52	4.26	2.83
number in sample	36	63	59	66	43	73	30
IH-35	3.25	4.04	2.92	3.31	3.89	3.82	3.30
number in sample	39	50	55	50	46	45	19
IH-37	3.40	3.89	3.61	2.88	4.36	3.68	2.60
number in sample	20	28	26	34	26	33	20
IH-410	3.46	4.17	3.56	3.43	4.04	4.30	3.04
number in sample	53	63	76	76	50	65	53
US 90	4.23	3.63	3.50	2.95	4.22	3.39	2.55
number in sample	20	24	12	20	18	18	11

1 = free flowing movement; 5 = heavy, congested movement

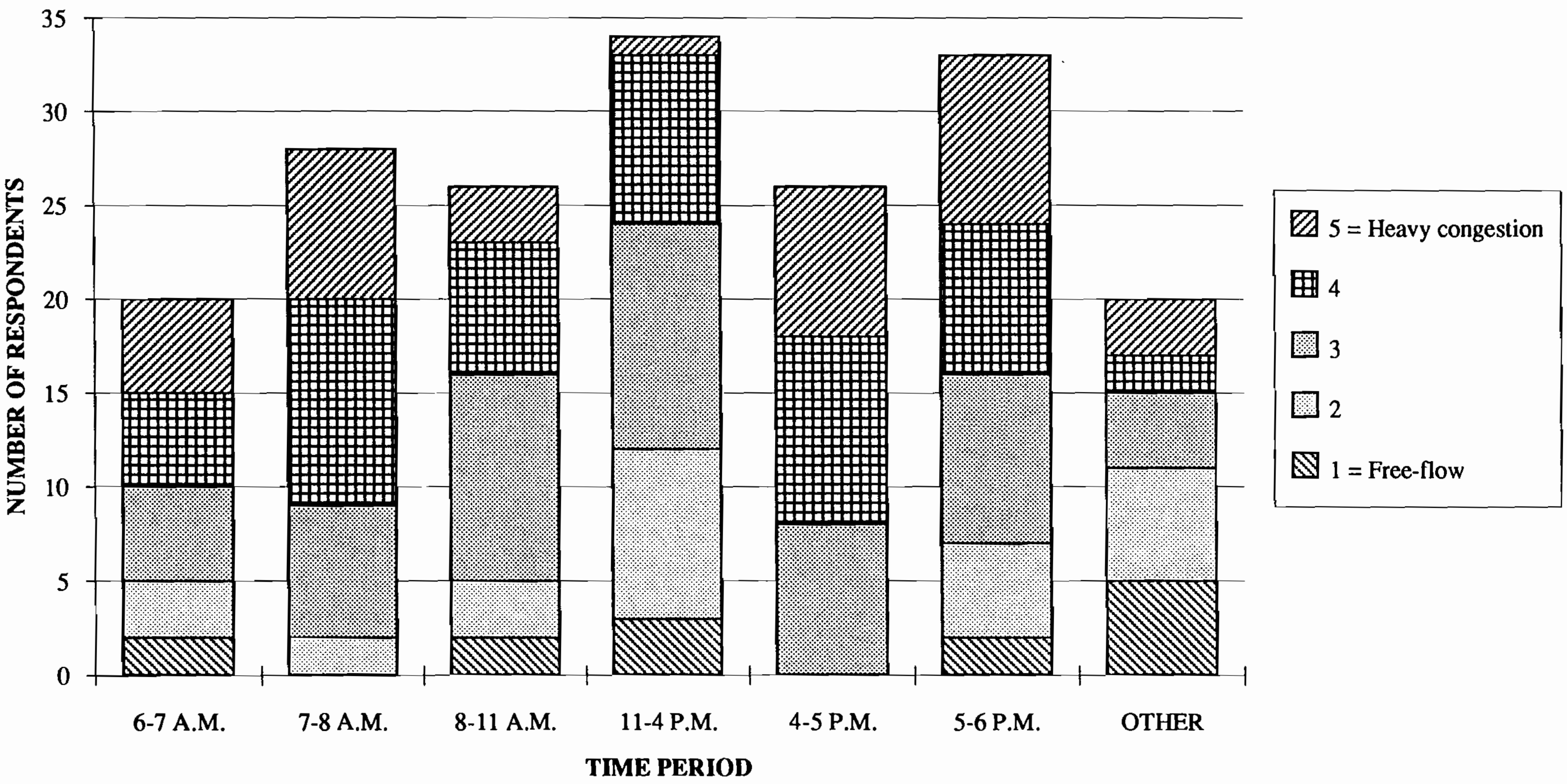


PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-10 (SAN ANTONIO)
NUMBER OF RESPONDENTS
100
90
80
70
60
50
40
30
20
10
0
6-7 A.M.
7-8 A.M.
8-11 A.M.
11-4 P.M.
4-5 P.M.
5-6 P.M.
OTHER
TIME PERIOD
5 = Heavy congestion
4
3
2
1 = Free-flow

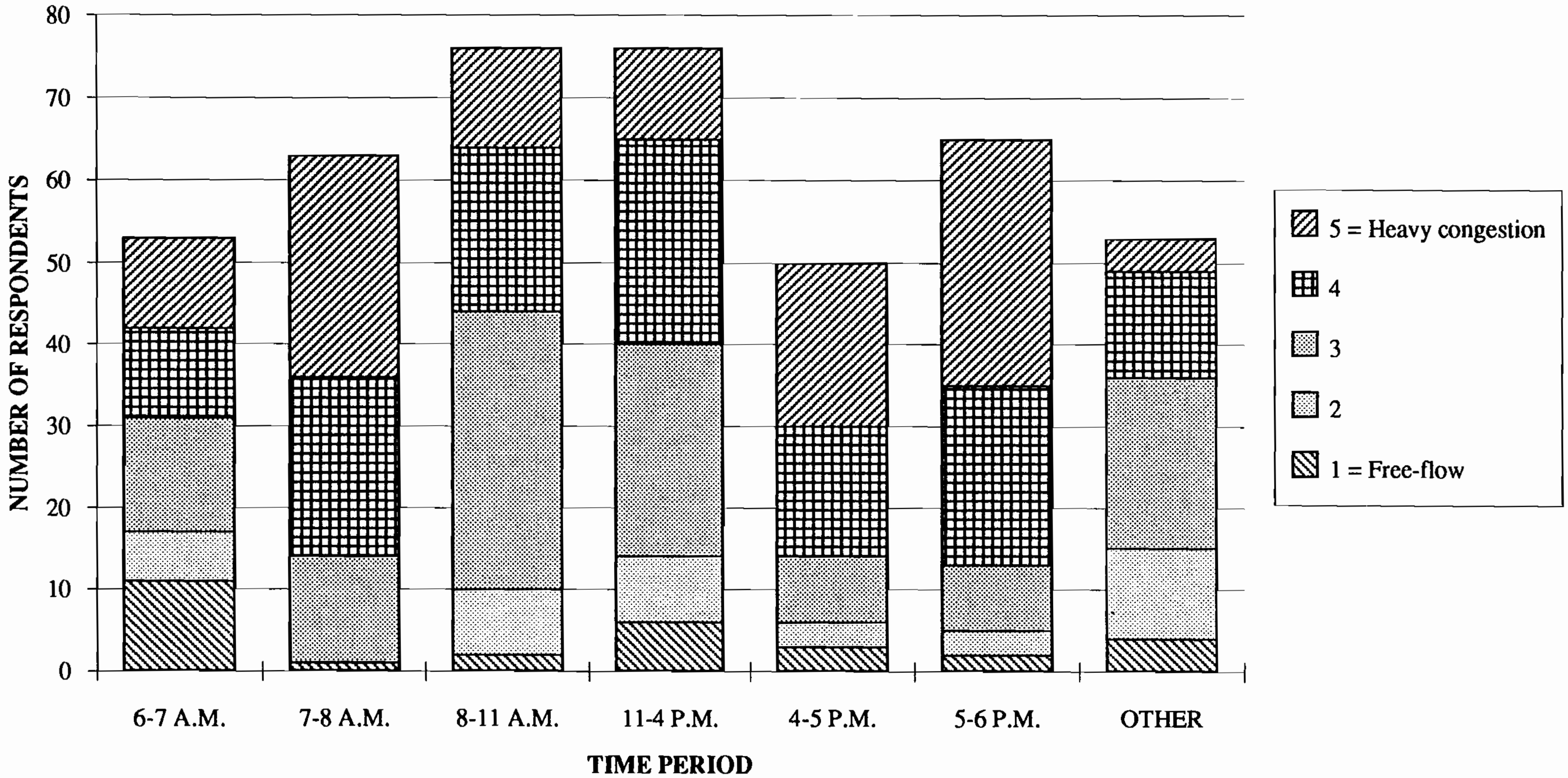


PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-35 (SAN ANTONIO)
NUMBER OF RESPONDENTS
0
10
20
30
40
50
60
6-7 A.M.
7-8 A.M.
8-11 A.M.
11-4 P.M.
4-5 P.M.
5-6 P.M.
OTHER
TIME PERIOD
5 = Heavy congestion
4
3
2
1 = Free-flow

PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-37 (SAN ANTONIO)



PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, IH-410 (SAN ANTONIO)



PERCEIVED ROADWAY CONDITIONS BY TIME OF DAY, US 90 (SAN ANTONIO)