EVALUATION OF AN EMERGENCY CALL BOX SYSTEM

by

Merrell E. Goolsby

and

William R. McCasland

Research Report 132-1F

Evaluation of an Emergency Call Box System
Research Study 2-8-68-132

Sponsored by

The Texas Highway Department
in cooperation with
U.S. Department of Transportation
Federal Highway Administration
Bureau of Public Roads

December 1969

TEXAS TRANSPORTATION INSTITUTE
Texas A&M University
College Station, Texas

ABSTRACT

A four-button (police, ambulance, fire, service) emergency radio call box system was installed by the Texas Highway Department on an eleven-mile section of I45 in Houston. This report evaluates the system in terms of usage, maintenance, driver acceptance, service offered, and cost effectiveness. Stopped vehicle studies were conducted to determine the magnitude and characteristics of the stopped vehicle problem.

Rate of usage of the system was found to be 6.3 calls per million vehicle-miles or 2050 calls per year. The benefit-cost ratio was estimated to be 1.5 indicating the system is cost effective.

SUMMARY

Disabled vehicles on urban freeways often exert a profound influence on traffic flow and safety. Emergency call box systems are one means of both aiding disabled motorists and improving freeway operations by providing the disabled motorist with a communication link to needed assistance. The Texas Highway Department designed and installed an experimental emergency call box system on Interstate Highway 45 in Houston in 1969. Texas Transportation Institute was requested to evaluate the effectiveness of the system.

Each call box has the capability of transmitting requests for four types of assistance (police, ambulance, fire, service) by pressing a push button. Call boxes were installed at one-quarter mile intervals on the freeway main lanes and major interchange ramps on an eleven-mile length of freeway. The system incorporates several reliability features never before used in a call box system. Operation and maintenance of the system is the responsibility of the City of Houston. The receiving console for the system is located in the Houston Police Department.

Stopped vehicle studies were conducted to define the nature and extent of the disabled vehicle problem. It was found that approximately 27,000 vehicles per year stop in the eleven-mile section as observed by a moving patrol operating on a fifteen-minute frequency. Of these stops, 10,270 vehicles stopped longer than thirty minutes. Mechanical problems caused 34% of the stops, while 24% stopped with tire problems, and 15% ran out of gas. Average length of time stopped for all vehicles observed in

the stopped vehicle study conducted before installation of the call box system was 54 minutes.

Call box usage data was compiled for a six-month period after installation of the system. During this period 1,025 calls were placed for a daily average of 5.6 calls. One-third of these calls were classed as "gone-on-arrival" because the calling motorist left the scene before service arrived. These calls cannot necessarily be considered as false calls since their reason for leaving is unknown.

Total travel in the call box section on the freeway lanes during the six-month usage study was 145 million vehicle-miles giving a usage rate of 6.3 calls per million vehicle-miles.

Individual box usage was found to be a function of distance to alternate assistance, with the greatest usage occurring in the elevated-interchange section where average walking distance to alternate aid is 1,900 feet. Usage rates expressed as calls per million vehicle-miles for three sections labeled elevated-interchange, urban and suburban were 11.6, 3.9, and 3.7 respectively.

Usage and driver interview data indicate driver understanding and acceptance of the system is not complete. Driver interviews showed that over one-third of the disabled motorists were not aware of the system. Another one-third indicated they did not use the system because of the cost involved when requesting "service". Eleven percent of the callers requested the wrong service.

During the six-month study period, 184 maintenance calls were handled. Yearly maintenance cost is estimated by the City of Houston to be $20,000.

Estimates of the benefits attributable to the system were made. The primary benefit which could be evaluated was motorists' travel time savings resulting from the early removal of accidents reported on the call box system. Many intangible and unmeasurable benefits could not be estimated with assurance. However, using quantifiable benefits, the system was found to have a benefit-cost ratio of 1.5.

Implementation Statement

This report documents the operation of a motorist aid system on an urban freeway. Such documentation of new or infrequently used techniques and devices provides a base of information essential to potential users. This study quantified the stopped vehicle problem and usage of an emergency call box system in terms that should be generally comparable to most urban freeways. No attempt was made to establish warrants for a motorist aid system since this study concerned the evaluation of a single call box system.

Based on this study and personal observations of the authors, the following are considered necessary steps in the implementation of a motorist aid system:

1. Justification - The need for a motorist aid system must be established through analysis of roadway geometrics, adequacy of existing services, estimated usage, cost, and benefits of the system. It must be recognized that intangible benefits exist which cannot be quantified.
2. System Design - System objectives must be established by the participating agencies to guide in the formulation of design criteria. Physical design of the system will be determined by these design criteria, a study of the site requirements, available hardware systems, and cost analysis.

3. Agency Cooperation - All agencies and departments of government involved in the design, maintenance, and operation of the proposed systems must make accurate assessments of their individual responsibilities and be in full accord with the design and operation of the system.

4. Evaluation - The system should be monitored and evaluated on a continuing basis to insure adequate performance in hardware reliability, operational procedures, and service offered to calling motorists.

TABLE OF CONTENTS

LIST OF TABLES

List of Tables Cont.

LIST OF FIGURES

INTRODUCTION

One of the greatest losses of efficiency experienced on urban freeways results from disabled vehicles in moving traffic lanes. A recent survey of research on traffic surveillance, communication, and control[1] indicated the most urgent problem was the speedy removal of bottleneck conditions, regardless of the cause. In many cases the bottleneck is created by vehicles disabled by mechanical malfunction or vehicle collisions. The congestion and accompanying delay to other freeway vehicles, in most cases, is more significant than the incident which causes the congestion. Even minor traffic disturbances have a far-reaching impact on urban freeways operating at high flow rates. Disabled vehicles are becoming a more critical factor in the safety and operation of freeways as freeway mileage and total travel increase. The inherent nature of freeways, characterized by limited access design, creates problems for the disabled vehicle. For example, a walk of nearly one mile is necessary to reach the nearest telephone on some sections of Interstate Highway 45 in Houston, the area studied in this project.

The impact on freeway efficiency is but one aspect of the disabled vehicle problem. The presence on a freeway of a disabled vehicle increases the accident potential both at the scene and in the traffic congestion upstream of the incident.

The problem of the disabled vehicle on freeways is recognized as a significant one.[2,3] Several driver communication concepts, both active and passive in nature, have been proposed to address this problem. Some, such as the passive stopped vehicle detection system, are very elaborate and costly, while others, such as a voluntary motorist reporting system are very simple and inexpensive.

One available system is the emergency call box system, of which several are now in existence.[4] Such a system is classified as an active one since it requires the person needing assistance to deliberately call for aid. The objective of a call box system is to provide stranded motorists with a communication link to needed assistance, with the net effect of reducing the time required to obtain assistance.

The Texas Highway Department designed and installed an experimental emergency call box system on I45 in Houston in January 1969. The Texas Transportation Institute was requested to evaluate the effectiveness of the system in terms of usage, maintenance, effect on traffic, service offered, and adequacy of design.

SYSTEM DESCRIPTION

System Design

Design and construction of the emergency call box system was accomplished by the Houston Urban Office of the Texas Highway Department. The designers attempted to avoid problems experienced with previous systems by incorporating several reliability features never before used in an emergency call box system. The total cost of the system was $154,975.

The system was installed on the main lanes and major interchange ramps of I45 from Scott Street to Little York Road in Houston (Figure 1). The system is 11.1 miles in length with call boxes spaced at approximately ¼-mile intervals. Maximum walking distance to a box is therefore 1/8-mile or 660 feet. Assuming that stops occur randomly, the average walking distance to a box is then 330 feet. The system incorporates battery operated radio call boxes, with 65 master transmitter boxes and 80 secondary (slave) boxes. Secondary units depend on an interconnected master unit for signal transmission to the receiving unit located in the Houston Police Department. A master unit can support up to three secondary units. Figure 2 shows a typical call box installation.

Call boxes are located so that a stranded motorist is not required to cross main-lane traffic to place a call. Thus, a typical location contains four boxes (one master, three secondaries) located on either shoulder in each direction of travel. No call box is located on the median where no median shoulder exists.

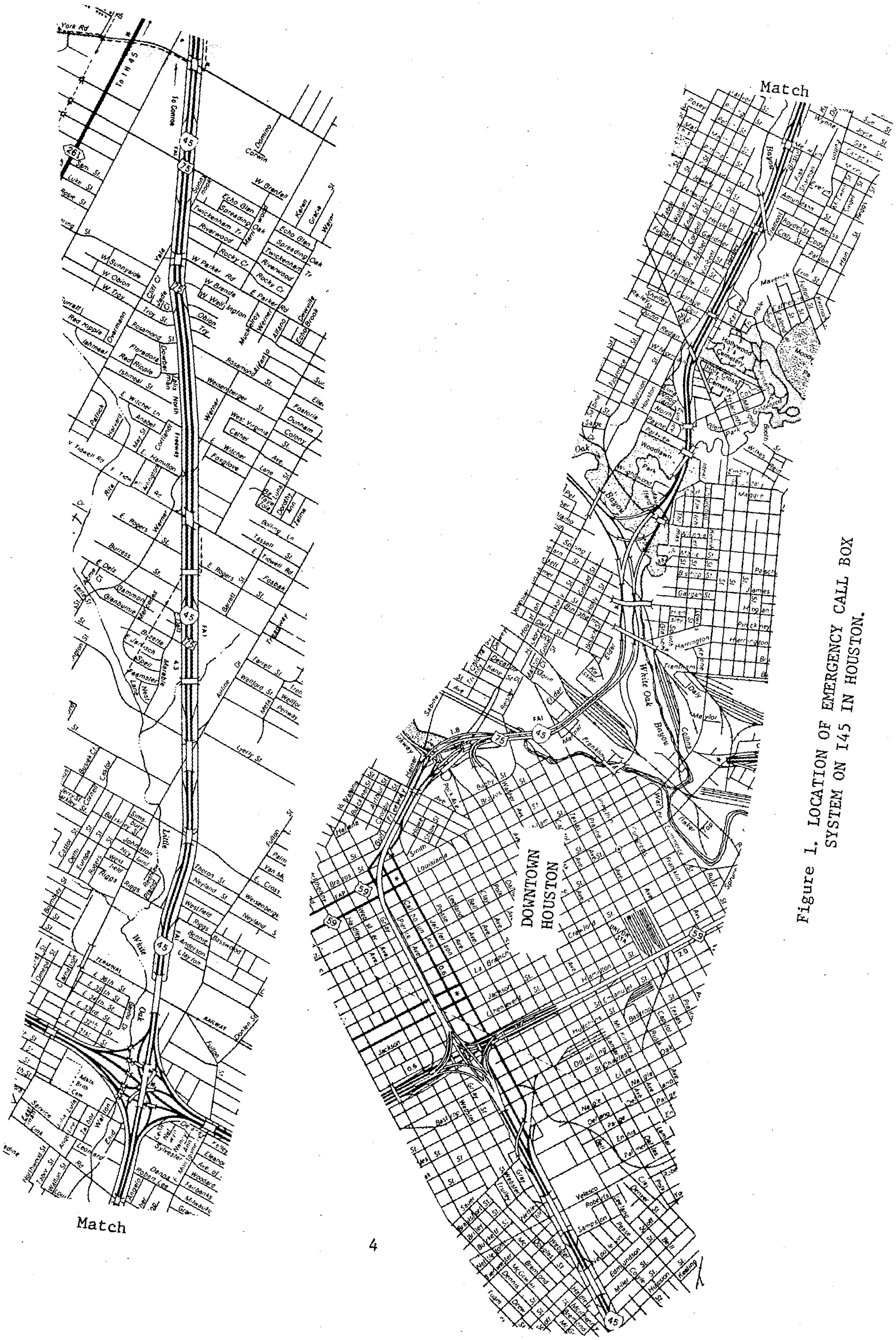

Figure 1. LOCATION OF EMERGENCY CALL BOX SYSTEM ON I45 IN HOUSTON.

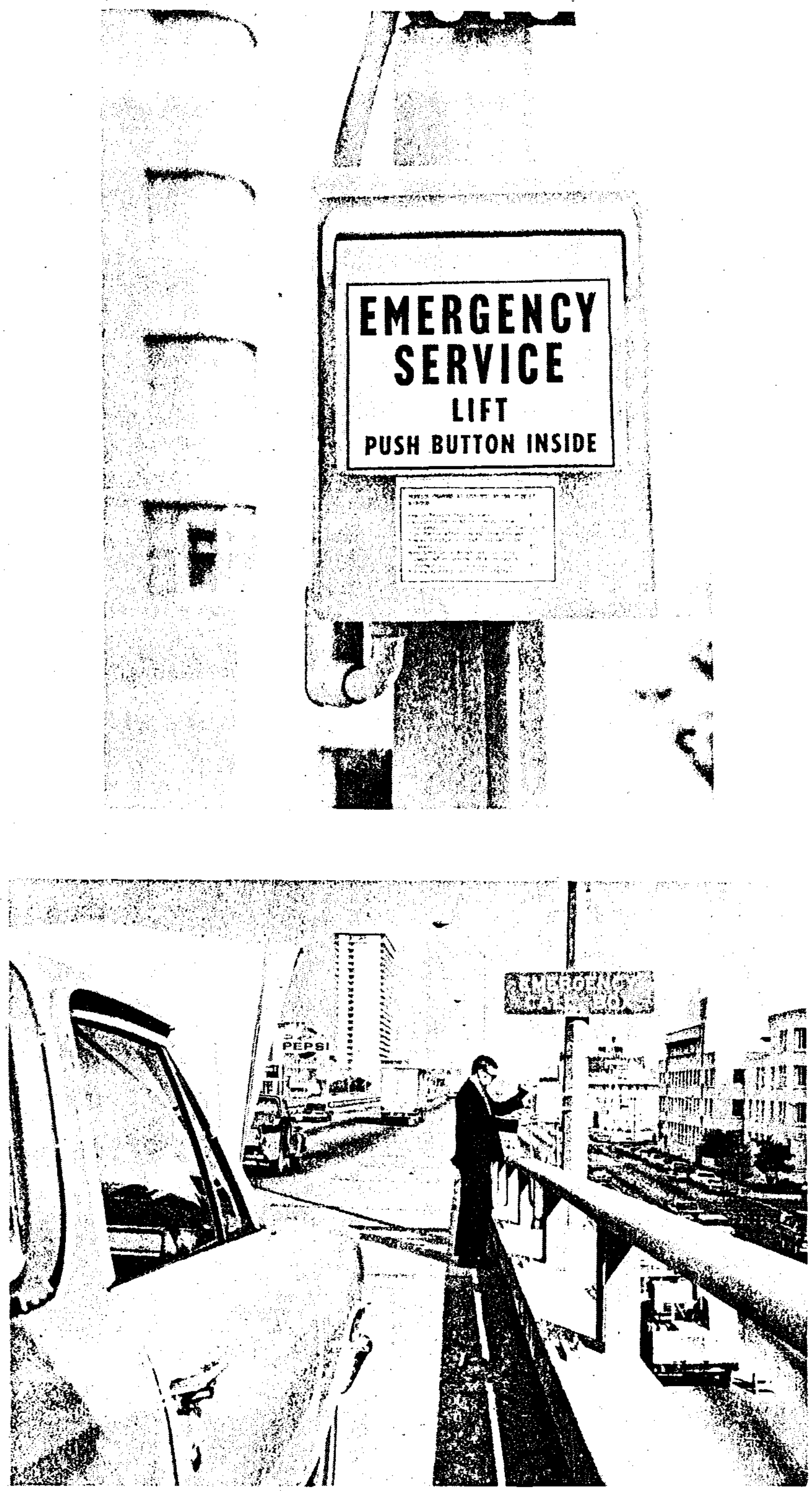

Figure 2. TYPICAL CALL BOX INSTALLATION.

Each call box has four buttons providing for the request of police, ambulance, fire, or service (tow truck). An illustration of the faceplate on the call box is shown in Figure 3. Provision is made for verification of calls through "Message Sent-Message Received" lights on the call box face. These are activated as the radio message is transmitted and when acknowledgement is made from the receiving console. Battery condition of the call box is indicated on the receiving console when a call is made. When a call box battery deteriorates to 85% charge a call is placed indicating the battery condition. The battery can norm continue to function for two additional weeks after falling below the 85 level, giving adequate time for maintenance. The boxes make a "check-in call once a day so that malfunctions can be located and corrected. A tamper-knockdown call is automatically placed when any box is tilted causing the closure of a mercury switch in the box.

The receiving console is located in the dispatch room of the Houston Police Department and is shown in Figure 4. The console unit decodes radio calls, as well as records and displays the information received. Features of the console include: indicator lights which give a visual display of the call; printed tape record of calls; audible alarm actuated by a call; and signal waveform recorder for use by maintenance personnel.

Operation Procedures

Operation and maintenance of the emergency call box system is the responsibility of the City of Houston. The Houston Police Department receives all calls and relays them to the appropriate agencies for servicing.

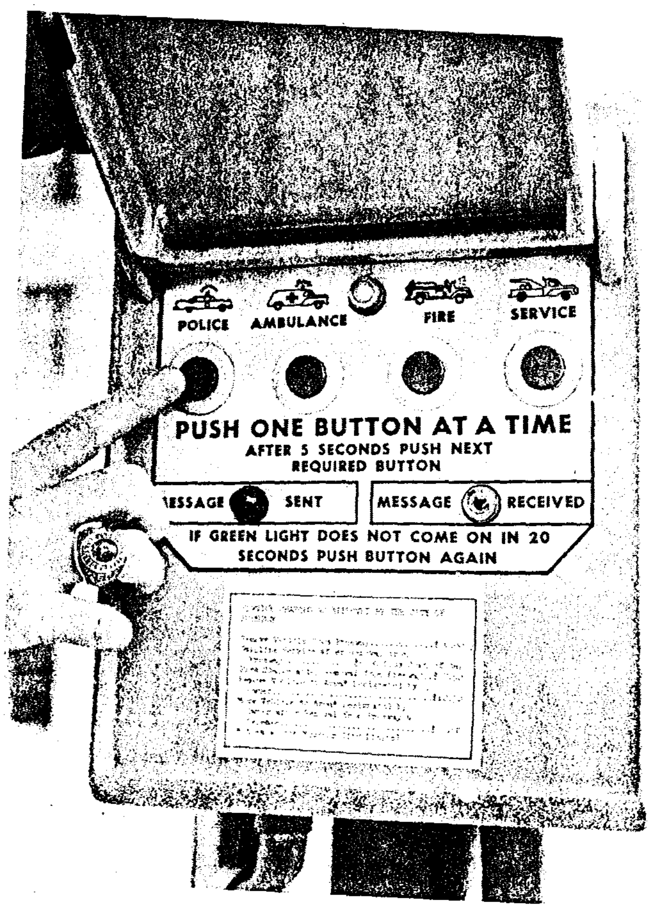

Figure 3. FACEPLATE OF CALL BOX.

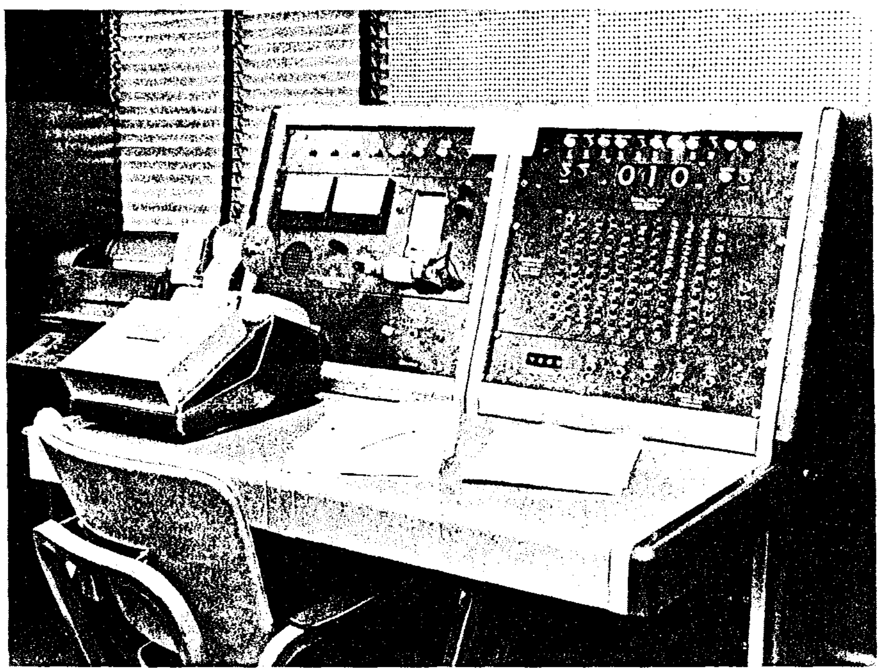

Figure 4. RECEIVING CONSOLE.

The following is a description of the procedures established to handle calls for assistance:

Police - When this call is received, the nearest available police unit is dispatched for investigation of the call.

Ambulance - A police unit is dispatched to the scene to determine if an ambulance is actually needed. If needed, an ambulance is requested by the police officer from the scene.

Fire - All fire calls are relayed immediately to the Houston Fire Department for their handling.

Service - A police unit is first dispatched to the scene to determine the validity of the call. If service is needed, the policeman requests the dispatch of a service vehicle. All service calls are handled by the Houston Wrecker Association. A schedule of charges is prominently displayed on the face of each call box. The schedule of charges is shown below, as it appears on the box.

SERVICE CHARGES AS APPROVED BY THE CITY OF HOUSTON

Remove Vehicle from Freeway.............$ 6.00
Gasoline Service after Removal from
Freeway.............$6.00 Plus Cost of Gas
Tire Change after Removal from Freeway..$ 8.50
Remove Vehicle to Area* Designated by
Owner................................$12.50
Move Vehicle to Area* Designated by
Owner after Removal from Freeway &
Release.............................$18.50

*(Area within Houston City Limits)

It should be noted that operationally the system functions as a two-button system (Fire-Police) since a police unit is sent in the case of a call for police, ambulance, or service.

Maintenance Procedures

System maintenance is the responsibility of the Department of Traffic and Transportation, City of Houston, which has qualified maintenance personnel capable of all levels of maintenance on the call box system. Maintenance is accomplished on an "as needed" basis with no scheduled preventive maintenance or servicing. This approach is possible because of the check-in features of the field units. Weak batteries and malfunctions which affect the ability of any unit to transmit a signal are detected routinely through the "check-in" and "battery condition" features of the equipment.

When a malfunction has been noted by the Police Dispatcher, a call is placed to the Department of Traffic and Transportation which processes the request. If possible, a maintenance crew corrects the malfunction the same day that the notice is received. If a maintenance call is received after business hours, the crew makes its check the following day. When a unit is taken to the shop for repair, a spare unit when available, is used to replace it. If a spare unit is not available, an "Out-of-Order" sign is placed on the box until repairs are made. As soon as shop repairs are completed, the unit becomes a spare or is returned to the field if necessary.

STOPPED VEHICLE STUDIES

Frequency and nature of vehicle stoppages on the freeway were investigated to provide a frame-of-reference in which to consider call box usage data. Studies were conducted before and after installation of the call box system to quantify the disabled vehicle problem and the effect of the system. Extensive machine and manual traffic counts were made to determine traffic flow patterns.

Study Procedures

Identical stopped vehicle studies were conducted six months prior, and three months after installation of the call box system. These consisted of two separate studies; one a patrol study covering the entire call box section, the other an elevated freeway study covering a short section of the elevated portion of the freeway. Procedures for these studies are outlined below:

Patrol Study: A one-week, 24-hour per day patrol was used to obtain stopped vehicle data for the eleven-mile section. Four patrol vehicles operated concurrently on closed routes which met but did not cross, to give complete coverage. These patrols maintained a fifteen-minute frequency. When a vehicle was observed stopped on the freeway main lanes or shoulder the questionnaire shown in Figure 5 was completed. If the stopped vehicle was attended, the driver was interviewed to yield a complete questionnaire. Patrols were

STOPPED VEHICLE SURVEY

DATE______________

OBSERVATION ONLY

1.TIME (note A.M. or P.M.) ______

2.REASON FOR STOP ______
1.gas or oil
2.tire
3.mechanical______________
4.accident
5.other______________

3.VEHICLE TYPE ______
1.private car
2.bus or taxi
3.2-axle truck (pickup,panel, etc.)
4.S.U.3-axle truck
5.3 axle semi-trailer
6.tractor-trailer
7.other__________

4.VEHICLE LICENSE NUMBER______________
State______________

5.POSITION OF VEHICLE ______
1.right shoulder
2.left shoulder
3. in lanes

6.DIRECTION OF TRAVEL ______
1.North 3.East
2.South 4.West

7.LIGHTING ______
1.daylight 2.twilight 3.darkness

8.WEATHER ______
1.fair 2.cloudy 3.rain

9.PAVEMENT ______
1.dry 2.wet

10.VISIBILITY ______
1.clear 2.limited

11.CALL BOX OBVIOUS? ______
1.yes 2.no

12.ESTIMATED TIME VEHICLE WAS STOPPED ______________

13.NEAREST REFERENCE MARKER ______________

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

INTERVIEW

14.WILL YOU NEED HELP? ______
1.yes 2.no

15.HAVE YOU TRIED TO SUMMON HELP YET? ______
1.yes 2.no

16.HOW WOULD(DID)YOU TRY TO SUMMON HELP? ______
1.call box
2.signals on vehicle
3.walk to service
4.passing vehicle
5.police
6.do not know
7.telephone
8.other__________

17.WHY NOT USE THE EMERGENCY CALL BOX? ______
1.not aware of them
2.forgot about them
3.cost too much
4.not an emergency
5.bad weather
6.unable or unwilling to leave
7.did not have chance
8.other______________

18.RESIDENCE(STREET AND BLOCK)
____

19.HOW OFTEN DO YOU USE THE FREEWAY? ______
1.frequently
2.occasionally
3.rarely
4.never before

20.WHERE DID YOU BEGIN THIS TRIP?
____

21.WHERE WILL YOU END THIS TRIP?
____

22.ENTERED FREEWAY
____

23.PURPOSE OF TRIP ______
1.work
2.social-recreation
3.vacation
4.shopping
5.goods transit
6.serve passenger
7.personal business
8.household movers
9.others ______________

24.DRIVER ______
1.male 2.female

25.OCCUPANTS(INDICATE NUMBER)
M___F___C___

26.AID RENDERED BY INTERVIEWER
____
____
____
____

INTERVIEWER______________ CODED BY ______________

Figure 5.

QUESTIONNAIRE USED FOR STOPPED VEHICLE STUDIES.

manned by uniformed off-duty policemen driving official police vehicles furnished by the Houston Police Department.

Elevated Freeway Study: A continuous surveillance study of a section of elevated freeway was conducted to gain a better understanding of driver actions. Because of the inherent limitations of the patrol method, it also provided a true measure of frequency and duration of stops. Observers were placed in two multi-story buildings overlooking a 1.3-mile section of the freeway on weekdays between 7:00 AM and 7:00 PM for the three week period.

Characteristics

The field studies provided certain basic information concerning the stopped vehicle problem. Data from both before and after studies were combined to give larger samples in cases where the data were independent of assistance received. Note that the sample sizes for data items from the questionnaire vary because of the varying degree of completeness of the questionnaires.

There was a total of 1,040 stops observed during the two patrol studies. Distribution of vehicle stops and traffic volume by day of the week is shown in Table 1. Figure 6 gives a similar comparison between distribution of stops and traffic volumes for an average weekday. The direct relationship of the number of stops to traffic volume is apparent.

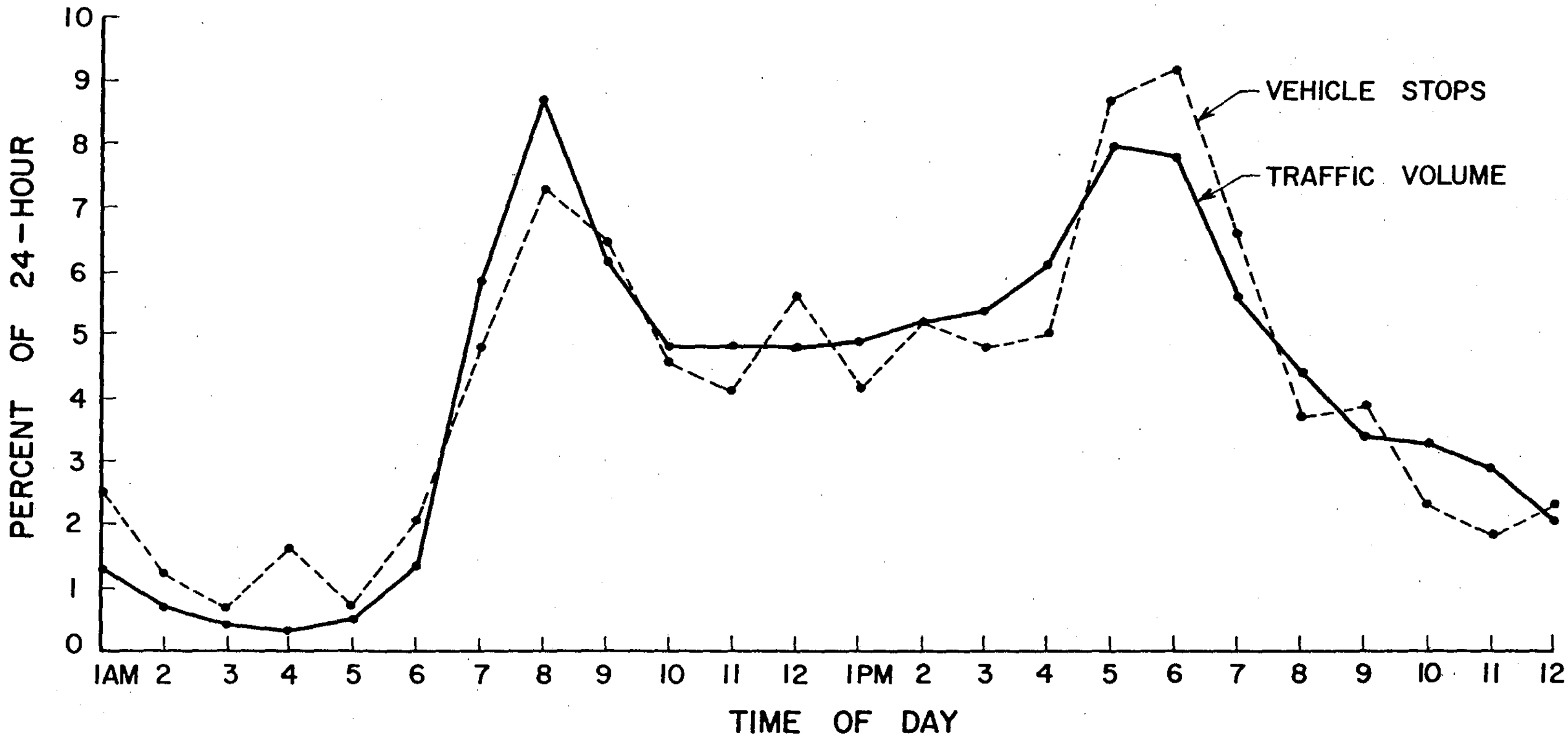

FIGURE 6. DISTRIBUTION OF VEHICLE STOPS AND TRAFFIC FLOW ON WEEKDAYS.

TABLE 1 DISTRIBUTION OF VEHICLE STOPPAGE AND TRAFFIC VOLUME BY DAY OF WEEK

	Stops(%)	Traffic Vol.(%)
Sunday	11.4	11.6
Monday	16.4	14.8
Tuesday	15.9	14.7
Wednesday	16.0	14.8
Thursday	14.1	15.1
Friday	14.6	15.8
Saturday	11.6	13.2

Drivers attending their stopped vehicle when the patrol vehicle arrived were asked how often they used the I45 Freeway. A summary of their responses is shown in Table 2. Those who rarely used the freeway comprised 8.6% of those interviewed. Vehicle classification data are shown in Table 3. Private automobiles accounted for 67% of the stops while trucks comprised 30%. This percentage of truck stoppages is considerably higher than the percentage of trucks in the traffic stream.

TABLE 2 FREQUENCY OF FREEWAY USE BY STOPPED DRIVERS

	Number	Percent
Frequently	490	78.0
Occasionally	84	13.4
Rarely	54	8.6
	628	100.0

TABLE 3 CLASSIFICATION OF STOPPED VEHICLES

	Number	Percent
Private Auto	676	66.6
Bus or Taxi	9	0.9
Single-Unit Truck	244	24.1
Truck Combination	64	6.3
Other	21	2.1
	1014	100.0

The problems which caused vehicle stoppages are indicated in Table 4. Those causes classified as "other" were usually very minor in nature, i.e. securing load, checking vehicle, and reading map. Lateral placement on the freeway of stopped vehicles was recorded for both the patrol and elevated studies as summarized in Table 5. Six percent of the stops observed by patrols occurred in moving traffic lanes. This is a conservative figure which does not necessarily reflect the original point of stoppage, but in many cases only the final resting place for the vehicle. The elevated study, through continuous surveillance, gives more accurate data on this subject and indicated that fourteen percent of the stops occurred in moving traffic lanes. The left shoulder of the elevated freeway had low usage because it is narrow and not designed to serve as a parking lane.

TABLE 4 REASON FOR STOPS FROM PATROL STUDY

	Number	Percent
Gas	131	14.8
Tire	207	23.6
Mechanical	299	34.0
Accident	50	5.7
Other	194	21.9
	881	100.0

TABLE 5 POSITION OF STOPPED VEHICLE

	PATROL STUDY		ELEVATED STUDY	
	No.	%	No.	%
Right Shoulder	850	83.5	531	81.8
Left Shoulder	109	10.7	29	4.5
In Lanes	59	5.8	89	13.7
	1018	100.0	649	100.0

Traffic volume counts were made during the two periods before and after installation of the system. The total travel in the eleven-mile section for the "before" condition was 820,000 vehicle-miles on an average weekday. This increased to 840,000 vehicle-miles for the "after" period, due primarily to the completion of I10 which interchanges in the study section with I45.

The relationship of the occurrence of stopped vehicles to travel on the freeway is contained in Table 6. This table relates the number of vehicles observed stopped to the amount of travel in the call box section. Stop rates are expressed in units of stops per million vehicle-miles for various time periods. The stopping rate at night is ten percent higher than during daylight hours.

TABLE 6 STOPPED VEHICLE RATES
BY TIME PERIODS - PATROL STUDY

Time Period	Stops/Million Veh-Mi.
Weekdays	117
Weekday Peak Periods	105
Day (Weedkay 7AM-7PM)	114
Night (Weekday 7PM-7AM)	126
Total Week	110

Other comparisons were made of stoppages on the elevated freeway and those on at-grade portions of the freeway using data from the patrol study. The elevated freeway rate for weekdays is 100 stops per million vehicle-miles compared to 128 stops per million vehicle-miles for the at-grade sections. This difference may be a reflection of the influence of optional stops which might tend to occur more often in the at-grade sections.

Considering stopped vehicle data from the elevated freeway section only, a true measure of the number of stops is possible. The patrol technique used along the entire eleven mile section would be expected to miss many vehicles stopped for short durations. The elevated study did not have this limitation since it utilized continuous observation. Combining both before and after stop data for the elevated study, it was found that 213 stops per million vehicle-miles occurred. If only stops lasting longer than seven minutes are considered, the stop rate becomes 82 stops per million vehicle-miles.

Before Study Results

The following items of before study data were not combined with after study data in the previous section because of the possible influence of the call box system on the results. Table 7 compares the distribution of stopped times observed in the elevated study to those observed in the patrol study. The average duration of stops observed in the patrol study is more than double that obtained in the elevated study. Over 73% of the stops in the elevated study lasted less than fifteen minutes. From the standpoint of potential call box usage, this fact is of minor concern since short term stoppages have little to benefit from the existence of a call box system, although their effect on traffic flow and safety should not be discounted. Table 8 shows average duration of stops for several catagories.

TABLE 7 DISTRIBUTION OF STOPPED TIMES FOR BEFORE STUDIES

Stopped Time (Min)	Patrol Study Freq.	Patrol Study %	Patrol Study Cum.%	Elevated Study Freq.	Elevated Study %	Elevated Study Cum.%
1	102	17.5		102	25.1	25.1
2				55	13.5	38.6
3				31	7.6	46.2
4				19	4.7	50.9
5				14	3.4	54.3
6				20	4.9	59.2
7			17.5	8	2.0	61.2
8-14	115	19.7	37.2	51	12.5	73.7
15-29	147	25.2	62.4	43	10.6	84.3
30-44	75	12.8	75.2	15	3.7	88.0
45-59	42	7.2	82.4	16	3.9	91.9
60-119	51	8.7	91.1	22	5.4	97.3
120-239	27	4.6	95.7	8	2.0	99.3
≥ 240	25	4.3	100.0	3	0.7	100.0
	584			407		
Avg. Stopped Time			53.7 Min.			19.2 Min

TABLE 8 AVERAGE STOPPED TIME FOR REASONS FOR STOP-BEFORE PATROL STUDY

	Avg. Stopped Time (Min)
Gas	30.9
Tire	41.4
Mechanical	82.3
Accident	72.6
Other	14.6

Driver interviews indicated that forty percent of attended vehicles were in need of assistance. These drivers were asked how they would obtain the needed help. The response to this question (Table 9) indicates that over two-thirds of stranded drivers walk to assistance or a telephone where help is summoned.

TABLE 9 RESPONSE TO BEFORE PATROL STUDY QUESTION: HOW WILL (DID) YOU SUMMON HELP?

	Number	Percent
Walk to Service	45	27.5
Hail Passing Vehicle	46	28.1
Walk to Telephone	70	42.7
Other	0	0.0
Do Not Know	3	1.8
	164	100.0

After Study Results

Stopped vehicle data are presented here to compare to data of the previous section. The one factor which changed for the after study is the existence of the call box system. The after study sample size is smaller than the before sample for both patrol and elevated studies and can only be attributed to random variation. The impact of the call box system on the factors which can be compared from the before and after studies is so subtle that differences cannot be attributed to the system with any assurance.

Distribution of stop durations is shown in Table 10 for the patrol study and elevated freeway study. Average length of time stopped decreased from 53.7 minutes in the before study (Table 7) to 39.6 minutes in the after study. This reduction in stopped time is too large to be attributed entirely to the call box system, since only 24 calls were received on the system during the week of the study. Average duration of stops for several catagories are shown in Table 11.

TABLE 10 DISTRIBUTION OF STOPPED TIMES FOR AFTER STUDIES

Stopped Time (Min)	Patrol Study Freq.	%	Cum.%	Elevated Study Freq.	%	Cum.%
1				65	27.0	27.0
2				22	9.1	36.1
3				19	7.9	44.0
4	88	20.6		17	7.0	51.0
5				7	2.9	53.9
6				12	5.0	58.9
7			20.6	7	2.9	61.8
8-14	61	14.3	34.9	39	16.2	78.0
15-29	102	24.0	58.9	25	10.4	88.4
30-44	71	16.7	75.6	10	4.1	92.5
45-59	37	8.7	84.3	7	2.9	95.4
60-119	35	8.2	92.5	7	2.9	98.3
120-239	20	4.7	97.2	0	0.0	98.3
$\geq$ 240	12	2.8	100.0	4	1.7	100.0
	426			241		
Avg. Stopped Time		39.6 Min.			20.2 Min	

TABLE 11 AVERAGE STOPPED TIMES FOR REASONS FOR STOP-AFTER PATROL STUDY

	Avg. Stopped Time (Min)
Gas	32.4
Tire	29.9
Mechanical	48.7
Accident	47.6
Other	30.5

The means of summoning assistance was determined by interviewing drivers of attended vehicles. Table 12 gives a listing of their responses and should be compared to Table 9 to determine the effect of the call box system. For those needing assistance but not using or intending to use the call box, the question of Table 13 was posed. It is interesting to note that thirty-eight percent were unaware of the system even though interviews from the patrol study indicate that only about nine percent of the drivers rarely use the freeway. An additional thirty-six percent did not use the system because service charges were excessive.

TABLE 12 RESPONSE TO
AFTER PATROL STUDY QUESTION:
HOW WILL (DID) YOU SUMMON HELP?

	Number	Percent
Use Call Box	24	22.0
Walk to Service	25	22.9
Hail Passing Vehicle	19	17.5
Go to Telephone	35	32.1
Other	4	3.7
Do Not Know	2	1.8
	109	100.0

TABLE 13 RESPONSE TO QUESTION:
WHY NOT USE CALL BOX?

	Number	Percent
Not Aware	21	31.8
Forgot About It	4	6.1
Costs Too Much	23	34.9
No Chance	14	21.2
Unable/Unwilling to Leave Vehicle	4	6.0
	66	100.0

An advantage of the continuous observation method used in the elevated study is the ability to determine the actions of stranded drivers. Of 236 stopped vehicles observed, only 52 needed assistance. Initial action of those needing assistance is shown in Table 14. Eleven drivers appeared to consider using the call box, as indicated by their approaching the call box. Of the eleven, seven actually placed calls while the other four rejected the alternative of using the system. Duration of stops classified by the actions of drivers are shown in Table 15. A large number of stops (42) were made by vehicles attempting to render aid to stranded motorists.

TABLE 14 INITIAL ACTION OF DRIVERS NEEDING ASSISTANCE - AFTER ELEVATED STUDY

	Number	Percent
Used Call Box	7	13.5
Looked at Call Box-- Did Not Use	4	7.7
Walked to Help	11	21.1
Caught Ride	4	7.7
Assisted by Passing Vehicle	26	50.0
	52	100.0

TABLE 15 AVERAGE STOPPED TIME BY DRIVER ACTION - AFTER ELEVATED STUDY

	Number	Avg. Stopped Time (Min)
Did Not Need Assistance	142	7.7
Used Call Box	7	43.3
Went to Call Box-- Did Not Use	4	25.0
Walked for Help	11	19.1
Caught Ride	4	49.5
Assisted by Passing Vehicle	26	55.5
Stopped to Render Aid*	42	7.4
	236	

*This does not include police vehicles, ambulances or wreckers.

SYSTEM USAGE

Data describing the actual usage of the call box system are the primary input to this evaluation study. This section discusses usage patterns based on two sources of data: (1) Log maintained by the Houston Police Department Dispatcher detailing the nature and disposition of all requests for aid made from call boxes, (2) Traffic flow counts which define the flow pattern of the freeway. The objective of this section is to document actual call box usage for six months and to relate it to the factors which influence usage of the system.

Usage Log

The Houston Police Department maintains a log of all calls received from the emergency call box system. This log includes time of call, response time and disposition of call for all calls placed. Data for six months of operation from February 9, 1969 through August 9, 1969 were available for the analyses in this report.

During the six months of operation of the call box system 1025 calls were placed, an average of 5.6 calls per day. Of the calls placed, 685 were classed as "confirmed" calls; that is, the person placing the call was at the scene when service arrived. The other 340 calls were classed as "gone on arrival" (GOA). These GOA calls cannot necessarily be considered as false calls since some of those people placing calls for assistance may have received aid or helped themselves, leaving the scene before the requested service arrived. Identification of false calls was not feasible in this study.

The distribution of all calls by day of the week in Table 16 indicates no particular daily pattern. The greatest number of calls were made on Thursdays whereas the smallest number of calls occurred on Mondays. Table 17 shows the distribution of usage by time of day.

TABLE 16 DISTRIBUTION OF CALLS FOR DAYS OF WEEK

	Number	Percent
Sunday	144	14.0
Monday	122	11.9
Tuesday	156	15.2
Wednesday	151	14.7
Thursday	183	17.9
Friday	140	13.7
Saturday	129	12.6
	1025	100.0

TABLE 17 DISTRIBUTION OF CALLS BY TIME OF DAY

Period	No. Calls	Percent of Calls
Midnight-2 AM	56	5.6
2-4 AM	21	2.1
4-6 AM	20	1.9
6-8 AM	108	10.8
8-10 AM	94	9.3
10-Noon	79	7.8
12-2 PM	87	8.6
2-4 PM	108	10.8
4-6 PM	166	16.5
6-8 PM	127	12.7
8-10 PM	75	7.4
10-Midnight	66	6.5
	1007	100.0

The types of calls placed are shown in Table 18. This table shows data for total calls and confirmed calls.

TABLE 18 SERVICE REQUESTED BY SYSTEM USERS

	Confirmed Calls		Total Calls	
	Number	Percent	Number	Percent
Service	401	58.5	591	47.7
Police	237	34.6	360	35.1
Ambulance	32	4.7	47	4.6
Fire	15	2.2	27	2.6
	685	100.0	1025	100.0

The nature of trouble resulting in use of the call box system is shown in Table 19. This distribution should be compared to Table 4 which shows the distribution of reasons for stops of all vehicles as observed in the stopped vehicle study.

TABLE 19 NATURE OF TROUBLE FOR CALL BOX USERS

	Number	Percent
Gas	155	25.1
Tire	72	11.6
Mechanical	177	28.6
Accident	192	31.0
Other	23	3.7
TOTAL	619	100.0

Factors Influencing Usage

The need for, and usage of, the system is affected by a number of factors such as accessibility of alternative assistance, personal danger, convenience, degree of emergency, and exposure to the system (traffic volume). It was possible to quantify two of these factors in this study; the first and the last.

Average weekday total travel in the call box section was 840,000 vehicle-miles. This expands to total travel for the six-month study period of 145 million vehicle-miles, and a rate of usage for the main lane boxes of 6.3 calls per million vehicle-miles.

The relationship of usage of individual call boxes to two factors, traffic volume passing a call box and distance to alternate aid (nearest telephone), is shown in Table 20. Table 21 shows the same information for boxes located on interchange ramps. The same relationship is illustrated graphically in Figure 7, using data from main lane boxes only. This figure contains usage rate plotted against distance to alternate aid for all boxes on the freeway. Linear and parabolic least square analyses were conducted resulting in the regression line shown in Figure 7 as the best fit. The correlation coefficient is 0.81 while the standard error of the estimate is 6.42. The equation of the regression line describing usage is:

$$y = 0.23\,x - 0.42$$

Where: y is usage rate expressed as calls per million vehicles passing the call box.

x is distance to alternate aid in hundreds of feet.

Accessibility of alternate aid for the entire 11-mile section of freeway is plotted in Figure 8 along with the usage data. Both are plotted as cumulative percentages so that a comparison can be made. Fifty percent of the freeway is farther than 650 feet from alternate aid, while fifty percent of all calls placed on the call box system were made from boxes located farther than 1150 feet from alternate aid.

TABLE 20 USAGE RELATED TO DISTANCE TO ALTERNATE AID AND TRAFFIC VOLUME PASSING BOX-- MAIN LANE CALL BOXES

Box No.	Distance to Alternate Aid (Feet)	6-Month Volume (Millions)	Number of Calls (6-Mth)	Usage Rate (Calls/Million Vehicles)
10	200	23.23	19	0.82
11	300	24.91	20	0.80
12	300	13.46	14	1.04
13	1700	6.57	21	3.20
14	1700	6.89	24	3.49
15	3100	13.46	51	3.79
16	3000	13.46	59	4.38
17	1700	13.46	49	3.64
18	800	13.46	45	3.35
19	1000	5.16	9	1.75
20	1000	4.72	4	0.85
21	1700	10.12	29	2.90
22	1700	7.98	36	4.53
23	1200	7.98	33	4.14
24	1700	10.12	21	2.07
25	1100	7.98	22	2.76
26	900	10.12	49	4.85
27	2600	4.67	23	4.89
28	2000	7.66	32	4.18
29	4000	4.67	28	5.96
30	3300	7.66	26	3.38
31	2200	18.16	47	2.58
32	400	16.73	18	1.08
33	200	16.73	15	0.90
34	200	16.57	13	0.78
35	500	15.29	11	0.72
36	900	16.18	30	1.85
37	1100	9.08	21	2.31
38	1100	15.06	43	2.85
39	1200	15.06	18	1.19
40	100	12.26	7	0.57
41	500	10.21	7	0.69
42	800	9.37	6	0.64
43	500	9.37	8	0.85
44	600	9.53	10	1.05
45	700	9.53	9	0.95
46	200	8.02	2	0.25
47	200	8.02	10	1.25
48	300	8.48	10	1.18
49	400	6.38	9	1.41
50	100	6.77	3	0.44

TABLE 21 USAGE RELATED TO DISTANCE TO ALTERNATE AID AND TRAFFIC VOLUME PASSING BOX-- RAMP CALL BOXES

Box No. Call Boxes	Distance to Alternate Aid (Feet)	6-Month Volume (Millions)	Number of Calls (6-Mth)	Usage Rate (Calls/Million Vehicles)
110	400	1.76	10	5.68
111	300	2.25	2	0.89
112	900	5.18	5	0.97
113	1150	3.27	5	1.53
114	1050	2.11	8	3.79
210	800	5.12	3	0.59
211	1000	3.42	2	0.58
212	2000	3.42	21	6.10
213	1000	1.73	12	6.94
310	350	0.95	3	3.16
311	500	2.65	3	1.13
312	300	0.95	1	1.05
313	1000	2.65	2	0.75
314	950	3.24	3	0.93
315	300	0.75	5	6.67
316	400	2.09	1	0.48
317	300	2.65	2	0.75
318	500	0.95	7	7.37
319	550	3.24	7	2.16
320	350	2.09	1	0.48
321	200	0.75	1	1.33
322	200	2.09	2	0.96
323	350	0.75	2	2.67

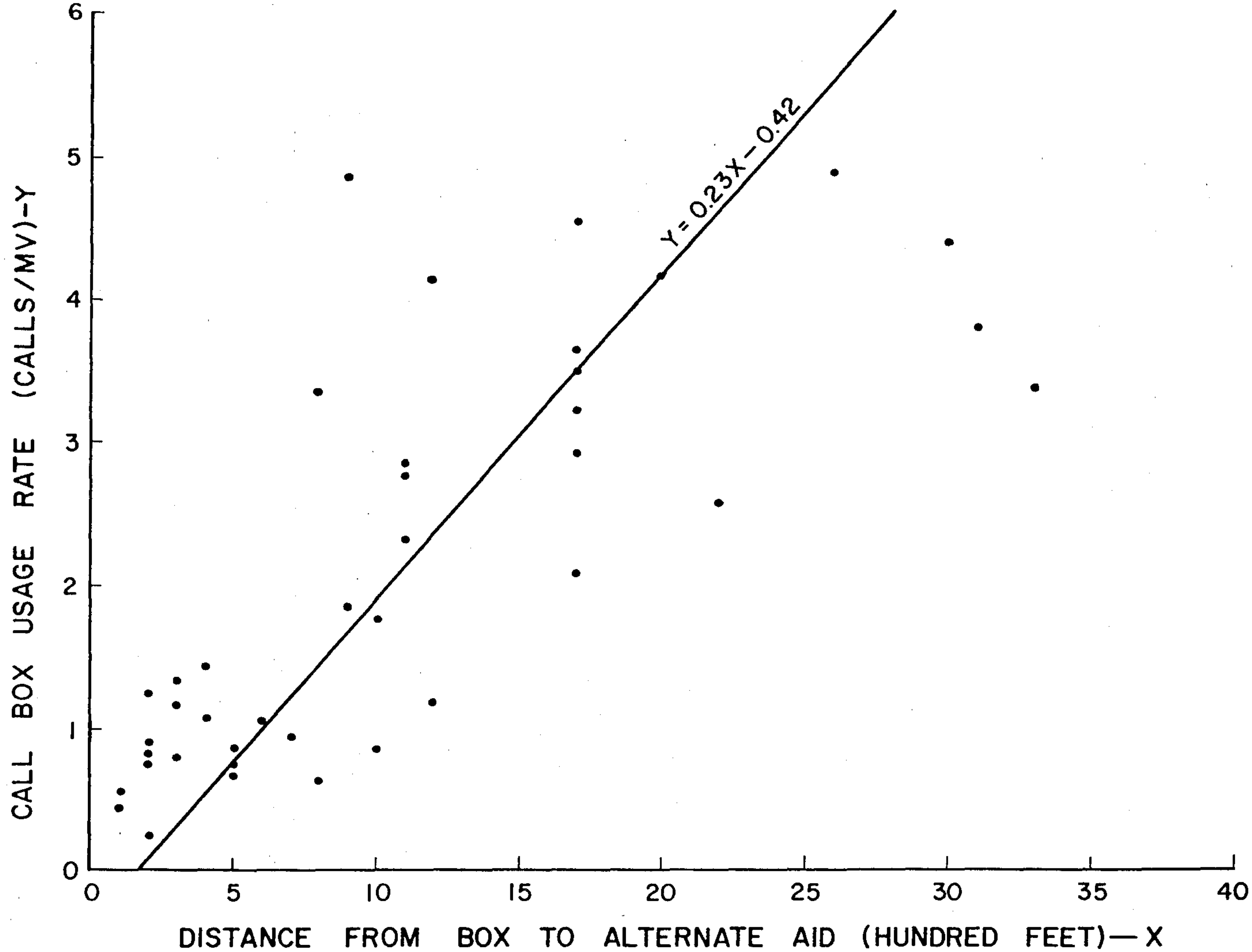

FIGURE 7. RELATIONSHIP OF CALL BOX USAGE TO DISTANCE TO ALTERNATE AID.

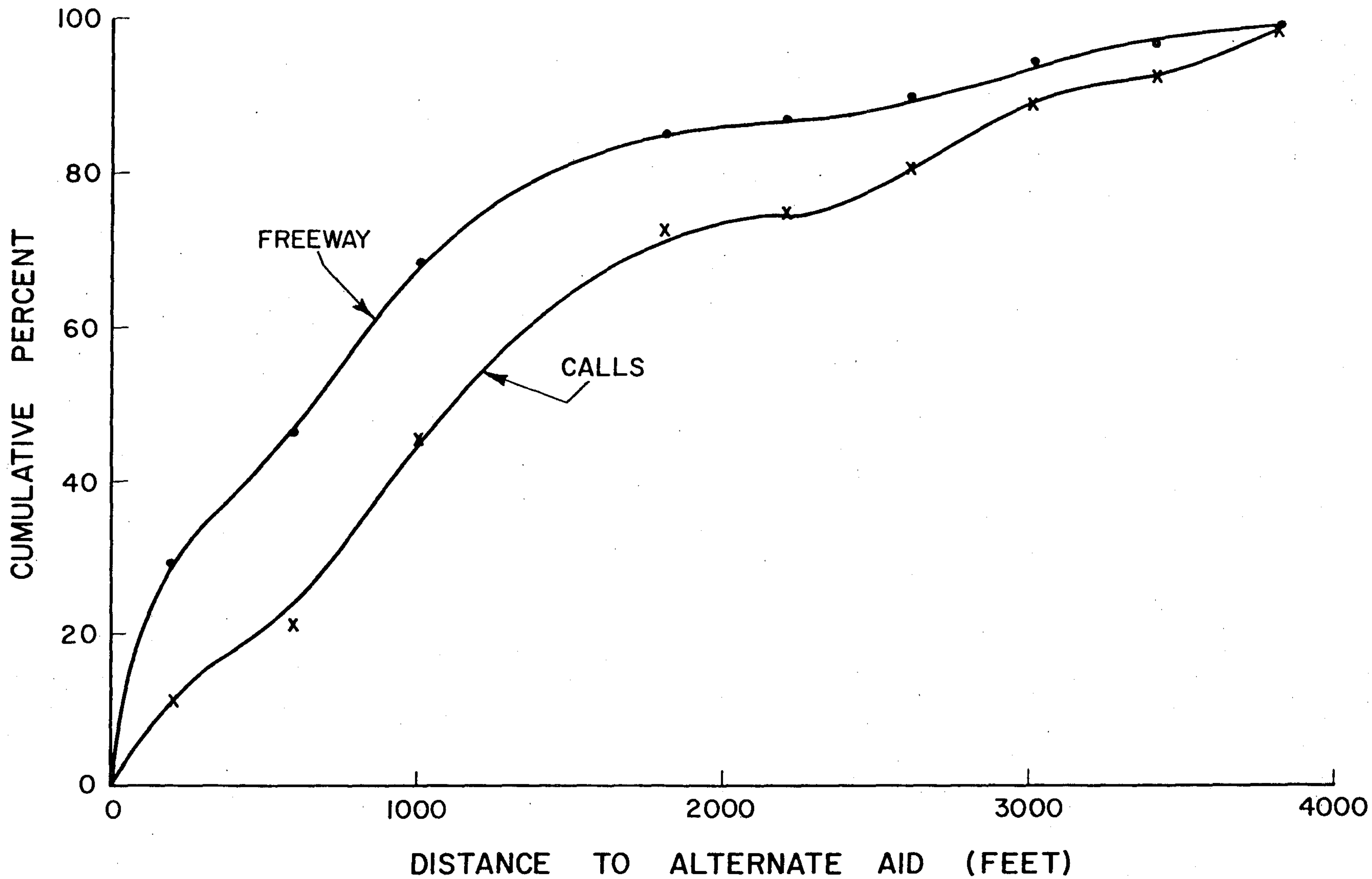

FIGURE 8. CUMULATIVE DISTRIBUTION OF CALLS COMPARED TO DISTANCE TO ALTERNATE AID.

Since emergency call box systems are not designed as isolated point installations but as linear systems, the usage data are more meaningful if viewed in freeway sections rather than as individual box locations. To make this comparison three essentially homogeneous sections of the freeway totaling 10.1 miles were selected. Usage data for six months are expressed in terms of a rate (calls per million vehicle-miles) for the same six months in Table 22.

TABLE 22 COMPARISON OF BOX USAGE BY FREEWAY SECTIONS

Section	Length (miles)	6-Month Total Travel (Million Veh-Mi)	Total No. Calls (6-Mth)	Rate (Calls/Million Veh-Mi)
Elevated and Interchange (Box 13-30)	3.34	48.3	561	11.6
Urban (Box 31-36)	2.20	34.6	134	3.9
Suburban (Box 37-50)	4.62	44.3	163	3.7

The first section contains the elevated freeway and "spaghetti bowl" interchange from Dowling Street to Quitman Street. It is difficult for a stranded motorist to reach alternate assistance in this section, with an average distance to alternate aid of 1900 feet. The second section, called "urban" for lack of a better description, includes the freeway from Quitman to the I610 interchange, and requires an average walk to alternate aid of 750 feet. The third section, labeled "suburban", includes the freeway from I610 interchange to the Houston City Limits and requires an average walk of 560 feet to alternate aid. From this comparison of usage rates it can be inferred that the need for assistance in the elevated-interchange section is three times greater than in the other sections.

Relative Usage

During the one week after study, a total of 24 confirmed calls were placed on the call box system. The study found 430 stopped vehicles with 40% of the interviewed drivers indicating a need for assistance. Assuming the interviewed drivers are representative of the total sample, 172 stopped vehicles required assistance. This is a conservative assumption since the presence of unattended vehicles implies that the driver is somewhere seeking assistance. The percent usage, those needing assistance who used the call box, of the call box system can be estimated at 14%.

User Acceptance - Understanding

The key person in the function of an emergency call box system is the user. Therefore, it is important to investigate his understanding of the purpose of the system and how to use it. Questions were asked of stopped vehicle drivers encountered in the patrol study and driver actions were recorded during the elevated freeway study in an attempt to determine driver understanding and acceptance of the call box system.

Table 13 indicates why people in need of help did not use the system to obtain it. Over one-third said they either were not aware of, or had forgotten about the call box system. Another one-third indicated they did not use the system because of the cost involved.

The elevated freeway study (Table 14) shows that only twenty percent of the disabled motorists requiring assistance even looked at the call box at close range. There are three possible reasons why a motorist would not even look at the call boxes: (1) he already knew about the system and rejected the idea of using it; (2) he did not know of its existence; (3) he was willing to handle the situation through conventional means. It was not feasible to determine which of the three reasons were predominant.

The manner in which calls were placed is worthy of note. The average number of times a button was pressed for a single call was 3.5 with 21 callers pressing the button more than 15 times. There are two possible reasons for this repeated placing of calls. The police dispatcher may have been delayed in actuating the "message received" signal to the user, or the user merely wanted to make certain of his call for help by placing repeated calls.

The usage log shows that some users of the system make a request for the wrong assistance. Of the 685 confirmed calls, 77 needed a different service than that requested. Thus, eleven percent of the users apparently did not understand how to properly request aid. Table 23 gives a breakdown of these calls. The greatest number of erroneous calls were made for police when service was the aid needed.

TABLE 23 CALLS PLACED
REQUESTING WRONG ASSISTANCE

Aid Requested	Aid Needed: Service	Police	None	Total
Service	-	7	4	11
Police	47	-	3	50
Ambulance	4	7	1	12
Fire	3	0	1	4
TOTAL	54	14	9	77

An indication of understanding of the system by the total driving population is difficult to determine since a comparison of those needing a particular service and those requesting it via the system is difficult to obtain. The best means of comparing actual needs to system usage is available through an analysis of accident records. State law requires that accidents resulting in damage greater than twenty-five dollars be reported to the police. Documentation of all accidents occurring in the call box section is available in police accident files, while the usage log reveals how many of them were reported on the system.

An analysis was made of police accident records and call box usage logs for the six-month period. During the period, 470 accidents were reported in the call box section of which 192 were reported on call boxes. This suggests a usage of 41 percent. Since there is no user charge for reporting an accident it must be suspected that those electing not to use it did not know of the system or had a more convenient means of reporting the accident. There is no easy way of determining which of the two reasons is predominant, but based on the access limitations of the freeway and the call box spacing, the former possibility seems more plausible.

In summary, the above data suggest that the existence and purpose of the system, as well as how to use it, are not clearly understood by all stranded motorists.

MAINTENANCE EXPERIENCE

A log of all maintenance services required by the call box system is available for the first six months of operation of the system. During the six-month period 184 maintenance calls were handled. Eighteen were related to the receiving console at the Police Department, and 166 for call boxes in the field. Call box problems occurred primarily in the master units which contain the logic units, transmission components, and batteries.

Three major problems were encountered by maintenance personnel: (1) failure of clocks in master boxes; (2) failure of integrated circuits; and (3) battery failure due to moisture in cabinets and corrosion of connections.[5] The types of maintenance problems encountered are reflected in Table 24 which lists the frequency of several maintenance services. It is ironic that the major maintenance problem was malfunctioning clocks, whose sole purpose is to place test calls at preset times so that malfunctioning units may be detected. There were no maintenance calls which could be attributed to vandalism.

TABLE 24 NATURE OF MAINTENANCE PROBLEMS FOR SIX MONTHS

	Freq.	Percent
Defective Clock	60	32.6
Battery	52	28.3
Electronic Component Failure	39	21.2
Knockdown of Box	4	2.2
Antenna	3	1.6
Display Lamp Replaced	7	3.8
Other	19	10.3
Vandalism	0	0.0
	184	

Ninety percent of the malfunctions were corrected on the same day observed. Counting each of these as one day, the average "out-of-service" time for all repairs was 5.3 days. This average is biased by a small number of very lengthy "downtimes" due to the back-orders of replacement parts.

Maintenance of the entire system is estimated at $20,000 per year.[5] This estimate is based on the current (August, 1969) level of maintenance and does not reflect the break-in period when the rate of maintenance was higher. This estimate includes labor, overhead, and replacement parts incident to repair of emergency call box system components.

LEVEL OF SERVICE

The Houston Police Department has accepted the call box system with some reservations. The traditional police preference of a voice communications system was expressed by the Houston Police Department after six months of operation. "The officers would like to have telephone contact with the complainant in order to determine the need. As it stands, we tie up a patrol car to make this determination."[6] This view seems somewhat limited since the call box is capable of four different requests, and it is police procedure which ties up a patrol car to determine exact needs.

The system is operated as a two-function system with an officer dispatched for police, service, and ambulance requests. Although this procedure decreases the inconvenience to wrecker and ambulance operators, it does not

This proced

an ambulanc

the inconve

sponse time

These response times appear reasonable, although those for ambulance and service could be shortened with the direct dispatch of the requested assistance. The response time for ambulance calls of 15.7 minutes, seems low since operational procedures call for the arrival of a police unit before summoning an ambulance. This apparent inconsistency was explained by the police ambulance dispatcher. Most of the requests for ambulances in the call box section are received by other means as well as by the call box. When a request for an ambulance is received by any means other than call box, an ambulance is dispatched immediately. A request for ambulance made solely on the call box system would require a longer response time.

It should be pointed out that the operational policies are not known to the public and therefore did not affect the validity of the usage data of this study. No adverse publicity of the system was generated during the course of this study which could have influenced usage and the probability of repeat usage of the call box by the same person, or even by a person knowing a previous user in the six months period is also remote. Thus, the stranded motorists' decision to use the call box would not have been influenced by a prior knowledge of the system operation and service.

COST EFFECTIVENESS

System costs and estimated benefits attributable to the call box system are discussed in this section. The benefits are derived from time savings analyses with cost-effectiveness estimates developed for the total system and three subsystems. Estimates used are based on current traffic patterns, call box usage and maintenance cost.

System Costs

Total capital expenditure for the system was $161,025 including $6,050 for the establishment of a call box maintenance facility by the City of Houston. Considering a system life of fifteen years, the annual capital cost is $10,700. Yearly maintenance is estimated to be $20,000 by City of Houston, giving a total annual cost of $30,700. The cost of operating the system by the Houston Police Department is minimal and is not added to the yearly costs.

Subsystem costs were obtained by using the following unit costs: master box $1400, secondary box $560, and console $38,000. Costs of maintenance and the console were pro-rated based on the number of master boxes in each subsystem. Subsystem costs thus derived are listed in Table 26.

TABLE 26 SUBSYSTEM COSTS

Subsystem	Total Capital Cost	Annual Capital Cost	Annual Maint.	Total Annual Cost
Elevated-Interchange (Box 13-30)	$42,490	$2,830	$5,540	$8,370
Urban (Box 31-36)	21,060	1,400	1,850	3,250
Suburban (Box 37-50)	49,140	3,270	4,305	7,575
Ramps	42,100	2,800	7,070	9,870

Benefits of System

Benefits derived from an emergency call box system fall into two catagories: (1) to the user of the system; and (2) to other motorists delayed by traffic congestion created by a disabled vehicle. Some benefits can be quantitatively stated in terms of "time saved" or "dollars saved". However, there are certain benefits of a system which are intangible, unmeasurable, or highly variable at present, e.g., the value of a minute saved in summoning an ambulance to a serious accident.

By reducing congestion and decreasing the pedestrian activity at freeway incidents a call box system should reduce the number of accidents occurring in the call box section. Accident frequency in the call box section was determined for a six-month period before and six-month period after installation of the system (February-July 1968 and February-July 1969), in an attempt to define the impact of the system on decreasing so-called secondary accidents. Hypothetically, the call box system should reduce accident frequency, however, this trend did not appear in the analysis. The total number of before period accidents was 392 compared to 470 for the after period. Since travel in the section increased from one period to the other, a computation of accident rates was made. For the before period the rate was 2.77 accidents per million vehicle-miles, while the after period rate was 3.23. This increase in accidents must be considered as random, masking the measurement of any accident reduction fostered by the call box system.

In this section only time savings to confirmed system users and affected motorists will be used to estimate the benefits of the call box system. Other benefits are considered to exist but are unmeasurable in this study.

When a stranded motorist uses the system, he saves a certain amount of time which varies from box to box, depending on its proximity to alternate aid. Time savings to box users were computed based on walking time to the nearest call box, assumed to be an average of 330 feet away and the walking time to the nearest alternate aid. Walking speed was assumed to be four feet per second. The savings per call for each box location were then expanded to a one-year time savings by applying the usage data for the system.

User savings for the system were found to be 114 hours per year, an average of 5.0 minutes saved per confirmed call placed. Table 27 lists the user savings for the three freeway sections discussed previously. The greatest savings accrue in the elevated-interchange section because of the high usage and the longer distances to alternate assistance. Average time saved per call is correspondingly greater for this section, as well. The dollar value of time savings accrueing to the user is small, only \$333 based on a very conservative value of \$2.92 per vehicle-hour.[7]

TABLE 27 YEARLY USER TIME SAVINGS FOR FREEWAY SECTIONS

Section	Yearly Time Savings-Conf. Calls Only (Hrs)	Conf. Calls Per Year	Avg. Saving Per Call (Min)
Elevated and Interchange (Box 13-30)	92	790	7.0
Urban (Box 31-36)	9	172	3.1
Suburban (Box 37-50)	4	220	2.0
Ramps (Box 110-232)	5	128	2.5
Total (Including Boxes Not Shown Above)	114	1370	5.0

The presence of stranded vehicles on freeways has an influence on traffic flow which varies with placement of the stranded vehicle, traffic demand, and nature of the disability. A stranded vehicle in moving traffic lanes during peak traffic periods has a profound effect on the travel time of other vehicles. A typical peak period accident creates a bottleneck which causes delay to thousands of motorists passing the scene before normal flow returns. The presence of a call box near the scene of such an incident can significantly reduce the motorist delay by expediting the removal of the incident. A delay model and a study of accident characteristics on the Gulf Freeway were applied to peak period accidents in the call box section to provide a gross estimate of motorists' savings resulting from the call box system.

A study of the effect of accidents on traffic flow was made on a six-lane section of the Gulf Freeway in Houston.[2] This study showed that one and one-half lanes of capacity are lost when a minor accident blocks a single traffic lane. Furthermore, the presence of vehicles and police investigators on the freeway shoulder during investigation of an accident causes a loss of two-thirds the capacity of a traffic lane. These values of lost capacity are used for accidents occurring in the call box study section for the purpose of estimating savings to motorists. The study area contains four-, six-, eight-, and ten-lane sections with eight lanes predominant in the urban section and six lanes in the suburban section. The Gulf Freeway study found that an average accident was moved to the shoulder 15 minutes after being reported to police. The accident remained on the shoulder during the police investigation for an average of 25 minutes.

These values were used in the delay model for estimating motorists benefits.

The relationships between capacity, flow, and delay (illustrated graphically in Figure 9) were used to estimate the delay caused by an accident. Traffic flow is the slope of the service volume curve and delay is the area between the demand and service volume curves. When an accident occurs, a severe drop in capacity results (slope decreases requiring a longer period of time to service the demand). The area bounded by the normal service volume curve and service volume curve for an accident represents the delay created by the incident. Use of the call box system saves the driver of the disabled vehicle a varying amount of time in obtaining assistance as shown in Table 27. These average values are used to estimate the motorist savings for each section. An estimation of the delay prevented at an accident scene by the call box system is then the average time saved times the number of vehicles which pass the scene that are affected by the reduction in reporting time.

The relationship described above was used to estimate aggregate delay due to peak period weekday accidents in the three sections. Since each accident is unique in location, magnitude and time of occurrence, some assumptions were necessary. The location in each section where the greatest number of accidents occurred was used to compute delay. It was assumed that all southbound morning peak accidents occurred at 7:30 AM and all northbound evening peak accidents occurred at 4:55 PM. Both times fall at the approximate midpoint of the peak period traffic demand. Only weekday accidents occurring during the southbound morning peak period (7-9 AM) and the northbound evening peak period (4-6 PM) were assumed to create significant traffic delay. This is a conservative a   on since many accidents occurrin

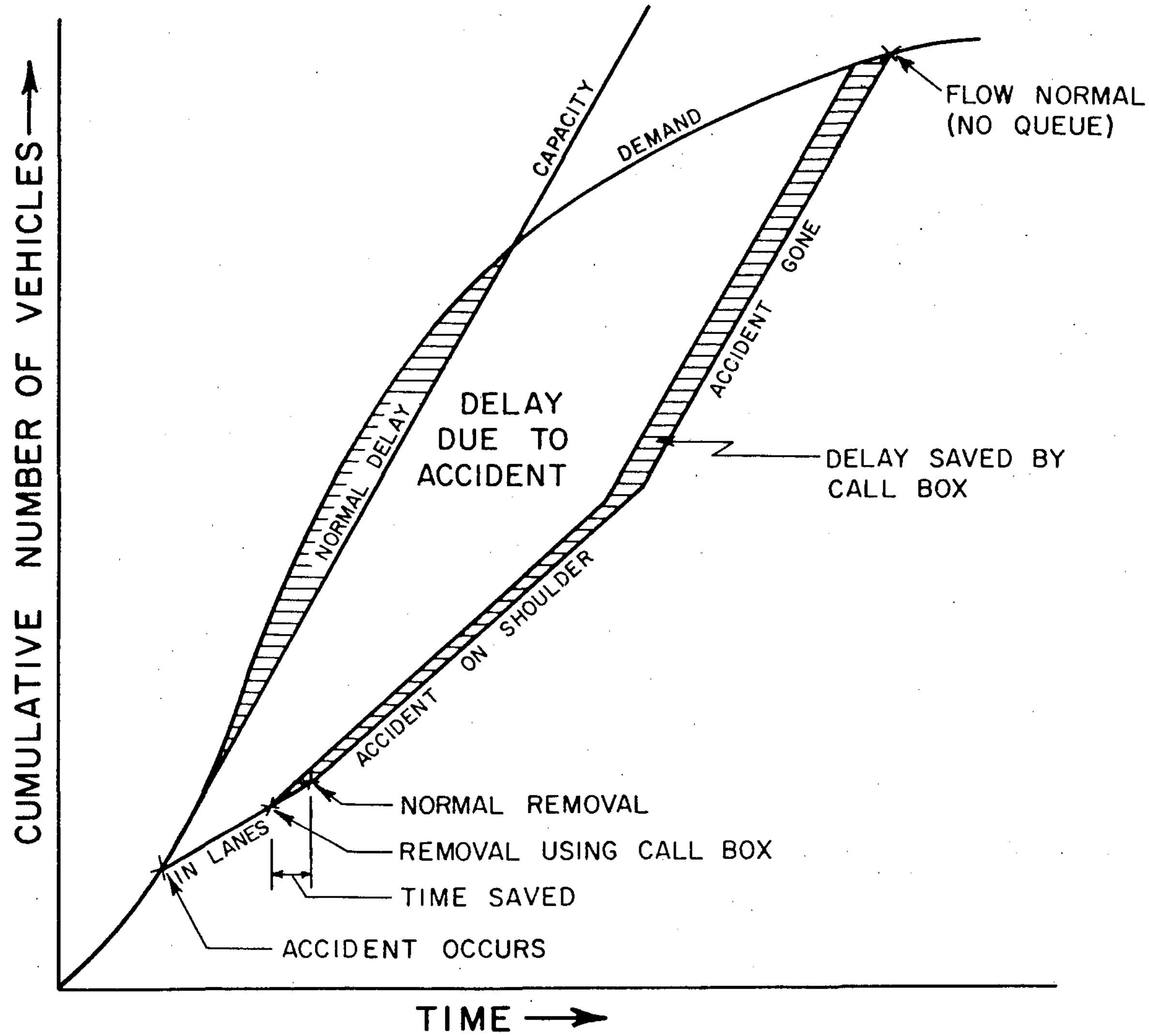

FIGURE 9. RELATIONSHIP OF FLOW CAPACITY AND DELAY.

other times create substantial delay.

Traffic demand data from volume counts were available for the peak periods in all sections studied. With the demand and service volumes thus established, the computation of delay savings was possible. Freeway sections were further divided because of differing demand patterns and cross-sections so that realistic delay estimates could be made.

Tables 28 and 29 show the travel time savings attributable to accidents reported on the call box system in each freeway section. The tables also contain an expansion of the savings to six months by applying call box usage data. These data are further summarized in Table 30 for each of the three primary freeway sections discussed previously. No analysis was made for the boxes located on the ramps since the effect of accidents on ramp capacity is unknown. However, only four peak period accidents occurred on ramps and the travel time savings is considered minimal.

TABLE 28 MOTORISTS SAVINGS FROM CALL BOX USE PM PEAK NORTHBOUND

Section	Savings Per Accident (Hours)	No. of Accidents	Travel Time Savings (Hours)
Scott-Dowling (8 lane)	0	2	0
Dowling-Jackson (4 lane)	432	0	0
Jackson-Walker (6 lane)	134	2	268
Walker-I10 (10 lane)	0	4	0
I10-Quitman (8 lane)	315	3	945
Quitman-I610 (8 lane)	243	4	972
I610-Little York (6 lane)	63	7	441

SIX-MONTH SAVINGS 2626

TABLE 29 MOTORISTS SAVINGS FROM
CALL BOX USE
AM PEAK SOUTHBOUND

Section	Savings Per Accident (Hours)	No. of Accidents	Delay Savings (Hours)
Little York-I610 (6 lane)	63	10	630
I610-Quitman (8 lane)	181	12	2170
Quitman-I10 (8 lane)	414	2	838
I10-McKinney (10 lane)	490	1	490
McKinney-Jackson (6 lane)	181	2	362
Jackson-Dowling (4 lane)	473	2	946
Dowling-Scott (8 lane)	0	1	0

TABLE 30 MOTORISTS
SAVINGS BY FREEWAY SECTION

	Six-Mth Savings (Hours)	Annual Savings (Hours)
Elevated-Interchange (Box 15-30)	3839	7678
Urban (Box 31-36)	3142	6284
Suburban (Box 37-50)	1071	2142
TOTALS	8052	16104

Annual costs and benefits for the entire system and the three subsystems are shown in Table 31. Stating annual costs and benefits as a ratio, the overall system is cost effective (B/C greater than unity). However, the suburban section is not cost effective when the three sections are considered separately.

TABLE 31 COSTS-BENEFITS BY FREEWAY SECTION

	Annual Cost (dollars)	Annual Savings (dollars)*	Benefit/ Cost Ratio
Elevated-Interchange (Box 15-30)	8,370	22,400	2.7
Urban (Box 31-36)	3,250	18,300	5.6
Suburban (Box 37-50)	7,575	6,300	0.8
Total System (including boxes not listed above)	30,700	47,000	1.5

*Using value of $2.92 per vehicle-hour.[7]

It must be remembered that the benefits presented here are a function of the accident frequency in the freeway sections. Since the system is intended to serve more than accident calls, system effectiveness should be considered in terms of overall needs and usage as well as travel time savings. The disparity in applying usage or accident frequency singly as measures of effectiveness is evident for the elevated-interchange section where overall call box usage is the highest while the benefit-cost ratio is less than that for the urban section.

SUMMARY OF FINDINGS

Listed below are some of the more significant findings of this investigation:

1. There were 10,200 disabled vehicles per year stopped longer than thirty minutes in the call box section.
2. Forty percent of stopped vehicle drivers interviewed needed assistance.
3. There were 2050 calls per year placed on the call box system.
4. One-third of the motorists placing calls were gone when service arrived.
5. Total travel in the call box section is 290 million vehicle-miles per year.
6. There were 6.3 calls per million vehicle-miles of travel placed on the freeway main lane boxes.
7. Usage of an individual box is a function of the distance to alternate aid.
8. Highest usage occurred in the elevated-interchange section near downtown where usage rates were three times greater than the other sections.
9. Thirty-eight percent of interviewed stopped motorists were unaware of the call box system.
10. Eleven percent of the system users placed a call for the wrong assistance.
11. Average response time to calls was 17.7 minutes.
12. Maintenance cost is estimated at $20,000 per year.
13. Benefit-cost ratio for the system is 1.5.

RECOMMENDATIONS

The following recommendations apply to the design and operation of the Emergency Call Box System on I45 in Houston:

1. The system should remain in operation and the following recommendations should be implemented by the proper agencies to improve the effectiveness of the system.

2. Operational procedures by the Houston Police Department should be modified to improve the service time for ambulance and service calls.

3. Changes in the posted charge schedule for service should be made to encourage the use of the call box system.

4. The operational agencies should make a concerted and continuing effort to publicize the system through official news releases and radio and television programs. This should become a part of the traffic safety program of the City.

5. Minor modifications to the design should be made to improve the nighttime identification of the call boxes.

6. A larger faceplate or less confusing instructions should be required in future box designs.

7. Use of the check-in feature in future designs should require more reliable clocks.

8. A completely weatherproof call box housing should be required in future designs.

9. Justification of call box systems should be based on two factors: anticipated motorists savings and accessibility of freeway sections to emergency assistance.

Discussion

The system has been in operation for less than a year. Usage, although less than expected, is significant; particularly on sections of the freeway that have no alternate aid readily accessible. Abandonment or replacement of the system should not be considered until further experience is gained with the system as modified according to the recommendations.

Procedures employed by the Houston Police Department for operation of the call box system have been discussed in detail in a previous section. Improvement in the handling of requests for ambulance and service appears necessary to obtain a maximum level of service for the stranded motorist. In the case of a request for service (tow truck) or ambulance, a direct dispatch of the requested aid seems justifiable. Such a procedure would, in fact, reduce demands on the police since 58 percent of calls are for service--a call which requires no police assistance.

The Houston Automobile Wrecker Association receives all requests for service made on the call box system. Charges for these services are prominently displayed on each call box, thus influencing the use of the service button as reflected in Tables 6 and 7. Removal of this charge schedule from the box would increase the usage of the system. Such an action would help accomplish the objective of quick removal of disabled vehicles, although some users might be surprised at having to pay for this convenience.

Another approach to the service problem is provision by the operating agency of wreckers whose sole responsibility is the removal of disabled vehicles which impede traffic. These contracted, or city-owned, wreckers would be concerned with the maintenance of traffic capacity rather than operating for profit based on number of hauls. Some cities presently operate wreckers for this purpose and the application to a call box system should be considered.

Public awareness of the system was measured by the questionnaire data, which indicated that 38 percent of the drivers of disabled vehicles did not know of the system's existence. Such a high proportion cannot be completely attributed to out-of-towners or drivers unfamiliar with the freeway, since only nine percent indicated they "rarely" used the freeway, and the other 91 percent classified their driving in the call box section as "frequent" or "occasional".

Publicity generated by the call box system has been minimal, with no reliance on the media for public education on the system's purpose or use. A news release was distributed when the system was placed into operation. Local newspapers and television stations made brief mention of the system at the time.

It appears that more publicity should be given to a call box system than other highway improvements since the motorists' understanding plays an important roll in the use and success of the system. Not only is a concentrated publicity effort necessary when the system is installed, but a continuous public awareness effort should be exerted.

Signing for the system consists of two sign types. Signs measuring 13 feet by 7 feet are placed at each end of the system and at I 610 for southbound traffic and at Quitman Street for northbound traffic. The purpose of the sign is to inform motorists of the existence of the system and the spacing of boxes. The legend on these signs reads: "EMERGENCY CALL BOX EVERY ¼ MILE NEXT ________ MILES". In addition, a 4 feet by 1 foot sign is mounted above each call box identifying it as "EMERGENCY CALL BOX". A misunderstanding has resulted for some people because of the use of the word "emergency" to describe the system. There is an indication from driver interviews that some drivers of disabled vehicles did not identify their situation as an emergency and did not consider using a call box. These people thought the system was intended for calling only police, fire, or ambulance and therefore did not consider placing a call for out-of-gas or mechanical problems. Conversely, there does seem to be a need for a strong identification of the box to insure rapid identification and to encourage usage for emergency situations. Future study should be devoted to determining the best description for "that box".

Night usage of the system, as a function of traffic, is ten percent higher than during the day, with thirty-four percent of all calls placed between 7:00 PM and 7:00 AM during which time only twenty-seven percent of the travel occurs. The night user should be given consideration in the design of a system. There are two provisions made for him in the Houston system: (1) a small light illuminates the box faceplate when the cover is lifted; (2) informational signs, identifying the system and the individual boxes, are reflectorized. An improvement in the nighttime identification of call boxes could be made with some illumination device which does not depend upon an external light source. The use of a colored light at each site could make location and identification of the box by stranded motorists less difficult.

Usage records show that eleven percent of the persons placing calls requested the wrong service. This is an indication that instructions on the box are not easily understood by the user. Figure 3 shows these instructions. Although each button is identified, the faceplate is small in comparison to the quantity of instructional wording. A total of 4 buttons, 3 lights, 4 symbols, and 34 words, excluding the schedule of charges, are contained on the 5-inch by 7-inch faceplate. A rearrangement or enlargement of the instructions and messages could result in better understanding.

One objective of the project was to evaluate the system design and develop a modified design. Evaluation of the adequacy of the design features was limited since only one call box system was studied. No conclusion can be reached concerning such design features as box spacing, number of call buttons, and mode of transmission, although some design features are discussed in this report.

Because of these limitations, only a reconfiguration of basically the same type system based on usage or cost effectiveness considerations can be attempted as a modified design. Benefit-cost data indicate both the "urban" and "elevated-interchange" sections are cost effective. The "elevated-interchange" section experienced three times the usage of other sections. Accepting these two sections as a complete system, the total cost is $73,550 with a yearly maintenance of $7,390. This converts to a yearly cost of $11,620 and estimated dollar benefits of $40,700 for a benefit-cost ratio of 3.5. In addition, the usage of this modified system would be 1390 calls per year for a usage rate of 8.4 calls per million vehicle-miles.

CONCLUSIONS

1. The four-button, battery operated radio call box system functioned according to the plans and specifications.

2. Acceptance of the system by the motoring public and the operating agency has been questionable.

3. Usage of the system can be improved if the following steps are taken:

   a) The operating agency establishes a procedure for improving the service time.
   b) The costs for services rendered are reduced.
   c) The public is made aware of the system and its operation through a concerted public information program.

4. No conclusions can be drawn concerning the effect of the call box system on accident reduction.

5. There are no data that support basic changes in the design of the system, although a more cost effective system can be achieved by eliminating those areas of low need.

6. The existing system is cost effective, however, benefits must be interpreted in a cautious manner. Despite the attempts to obtain adequate samples of data through surveillance studies, interviews and questionnaires, assumptions were necessary to quantify the tangible benefits.

REFERENCES

1. "Analysis and Projection of Research on Traffic Surveillance, Communications, and Control," by Karl Moskowitz, NCHRP Report 3-9.

2. "Accident Reporting and Clearance Procedures on the Gulf Freeway," by Merrell E. Goolsby, Texas Transportation Institute Report 139-1.

3. "Effects of Traffic Accidents on Freeway Operation," by Roy L. Wilshire and Charles J. Keese, Texas Transportation Institute Bulletin 22.

4. "An Evaluation of the Northway Emergency Telephone System," New York State Department of Public Works.

5. King, Jerry L., City of Houston, Communication to M. E. Goolsby, August 11, 1969.

6. Short, H. B., Houston Police Department, Communication to M. E. Goolsby, August 11, 1969.

7. "Evaluation of the Benefits of Traffic Surveillance and Control on the Gulf Freeway," by W. F. McFarland, W. G. Adkins, and W. R. McCasland, Texas Transportation Institute Report 24-22.