Delay, Time Saved, and Travel Time Information for Freeway Traffic Management

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Five studies of freeway motorists' opinions were conducted to determine preferences and reported behavior with respect to hypothetical displayed messages about time delays. Major findings were that the average person stated that he or she would divert from a freeway if the delay duration displayed was 15-20 min and would divert to a bypass route if the time saved displayed was 5-10 min. Incident type, traffic condition, and regional differences in the driver samples were not important factors. The message MAJOR ACCIDENT implied at least a 22-min delay, and MINOR ACCIDENT implied no more than a 12-min delay. The term "delay" was used in reference to unusual conditions at the time of day the message was displayed rather than time held up in traffic. Avoiding delay, saving time, and comparing travel time are all effective messages for describing advantages in taking a bypass route, but comparative travel time takes longer to read.

This study was one of several laboratory and field studies conducted for freeway traffic management to determine which human factors need to be considered for actual motorist information displays. The findings have been incorporated into a human-factors design guide (1).

Although the literature is not consistent on the relative importance of displayed time (temporal) information (2-5), several agencies are currently displaying delay, time saved, or travel time information on changeable message signs (6). A series of studies was undertaken by the Texas Transportation Institute to determine drivers' interpretations of and preferences for specific types of such information signs.

LEVELS OF DELAY TIME

The first study was concerned with particular lengths (levels) of delay time that motorists would consider significant in terms of making a diversion decision. Knowing what percentage of drivers would divert their routes according to various delay increments would be useful in predicting their behavior in traffic.

Because it was suspected that a motorist's previous knowledge of a particular freeway would be an influencing factor, the study was conducted in four widely separated locations to increase the general validity of the findings. It was also suspected that the traffic conditions and type of incident would be relevant variables. Thus the test material was designed to vary the circumstances under which the delay occurred.

Method

The sample consisted of 240 drivers from College Station, Texas; 184 drivers from St. Paul, Minnesota; and 40 drivers from Los Angeles, California.

The drivers were instructed to imagine themselves on a freeway and were given a picture of either light or very heavy traffic as the situation in which they were traveling. Each subject was presented seven cards, in random order, each of which contained two messages: first the type of incident, then the delay period. Subjects were divided into matched groups. Each group received only one type of incident and one traffic picture. The incidents were ACCIDENT, ROADWORK, TRUCK OVERTURNED, RAIN, and ICE. Each card displayed a different delay period: 5, 10, 15, 20, and 30 min and 1 and 2 h.

The experimental task was to check on an answer sheet one of two alternatives, "Yes, Stay on Freeway" or "No, Get off Freeway." The diversion decision was based presumably on a combination of delay period, incident type, and traffic condition factors.

Results

Figures 1 and 2 present the findings for the College Station sample only. The results indicate a similar pattern of yes or no responses to the delay periods regardless of type of incident or the traffic condition pictured. For all types of incidents, 50 percent of the drivers stated they would divert for a delay of between 15 and 20 min. Longer delays naturally resulted in proportionately more drivers expressing an intent to divert. However, RAIN and ICE did not result in complete diversion even up to an hour's delay.

Figure 2 indicates a slight but consistent tendency to divert at a lower level of delay in heavy traffic than in light traffic, but the effect of traffic condition was not statistically significant.

Figure 3 presents the data from St. Paul and Los Angeles along with the College Station data. Drivers in St. Paul were given cards with the same incident types, except that RAIN was deleted. Drivers in Los Angeles received only the ACCIDENT descriptor. The data points almost exactly coincide up to 60 percent diversion. Figure 4 presents a composite, best-estimate function for the effects of delay on a diversion decision. The 2-h delay data are now shown, but they were virtually identical to those for 1-h delay for each incident type.

LEVELS OF TIME SAVED

Time saved can also be used to present temporal information. This descriptor is applicable to a corridor or bypass route rather than to a freeway itself and is one of several ways of describing the benefits of diverting.

Method

This part of the study was conducted in Los Angeles with 127 drivers. The previous study had indicated that type of incident and traffic conditions had little effect on a diversion decision, so only three descriptors—ACCIDENT, ROADWORK, and TRUCK OVERTURNED—were employed. The traffic state depicted was heavy traffic only.

The three incident messages were assigned to independent groups. After the incident, the message displayed was USE TEMPORARY BYPASS TO THE ASTRODOME—SAVE X MINUTES. The time savings were the same periods employed in study 1. Again, messages were presented in random order and instructions were to indicate whether or not one would divert according to the message.

Results

The findings of the time-saved study are depicted in Figure 5. Type of incident again had little effect on the decision to divert, except for five drivers in the TRUCK OVERTURNED sample who refused to divert regardless of the time-saved duration. A savings of longer than 30 min resulted in a virtual asymptote in the numbers of people diverting. There was no difference in effect between a display of 30 min and one of 2 h on reported diversion. In the delay study, only 1- and 2-h delays were equal in effecting diversion decisions.

A major finding was that the average person in this study indicated that he or she would divert at between 5 and 10 min. Figure 6 presents a composite curve for time saved across incident types compared with the composite curve for the delay-time studies.

Before concluding that the time-savings message was the primary contributor to the difference, we should note again that a temporary bypass route was recommended in the time-saved study, whereas, in the delay studies, no alternate route was specified.

MAJOR AND MINOR ACCIDENT MESSAGES

Although studies 1 and 2 indicated that type of incident has no major effect on a diversion decision, it was suggested that the adjectives MAJOR and MINOR modifying word ACCIDENT might well imply different levels of severity and expected delay durations. The research

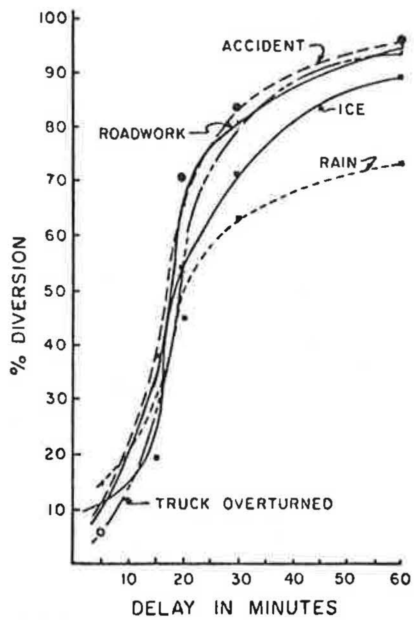


Figure 1. Effect of incident types and delay on percentage of driver diversion.

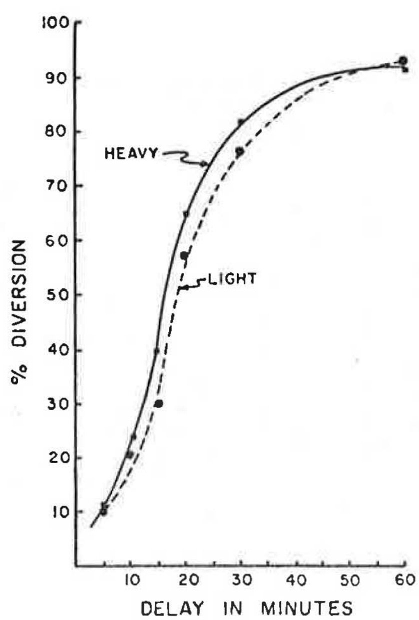


Figure 2. Effect of traffic conditions and delay on percentage of driver diversion.

Figure 3. Regional differences in percentages of driver diversion.

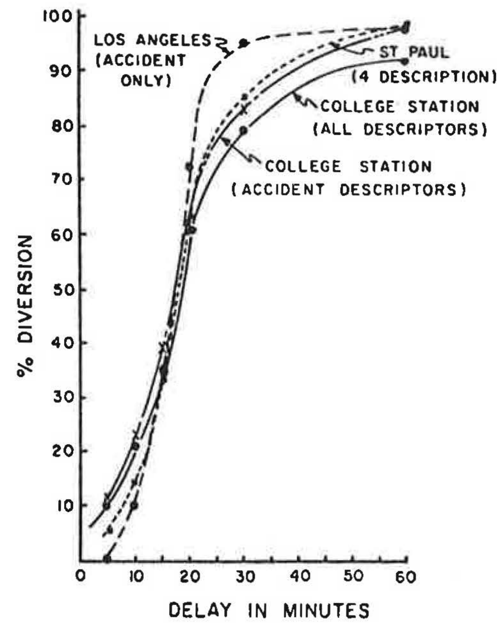
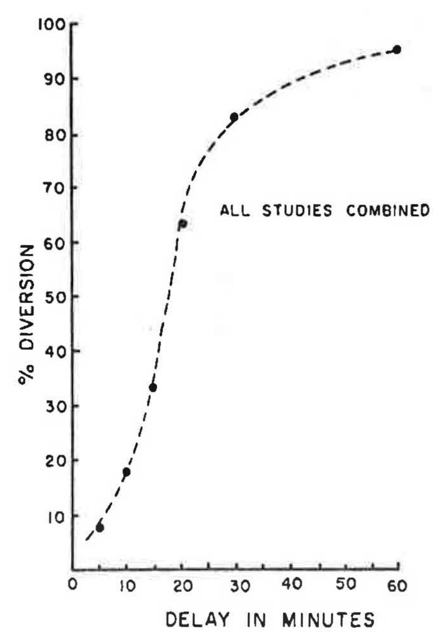


Figure 4. Effect of delay on percentage of driver diversion for all studies.



question related to the durations of delay implied by the messages.

Method

A small study was conducted in Dallas, where 40 drivers received the message MAJOR ACCIDENT and 20 drivers received MINOR ACCIDENT. Their instructions said that they were driving on a Dallas freeway when they saw the sign; they were then to indicate the delay they expected by checking one of the seven periods used in studies 1 and 2. The drivers given the message MAJOR ACCIDENT were to indicate the number of minutes or more they felt the message implied. The MINOR ACCIDENT receivers were instructed to report the number of minutes or less implied by the message. Thus, the values reported indicated slightly different meanings: minimum delay for a major accident and maximum delay for a minor accident.

Results

Figure 7 depicts the cumulative percentage of drivers who reported deciding to divert for various periods of anticipated delay and the respective incident messages. The average driver interpreted MINOR ACCIDENT as implying not more than a 12-min delay, whereas MAJOR ACCIDENT was taken to mean at least a 22-min delay. From study 1, the implications of these delays for a diversion decision may be extrapolated.

MEANING OF DELAY

The question has been raised about what specific meaning a given delay duration has for a driver in freeway traffic. For example, does it mean that the driver will be held up in traffic for the specified period or that he or she should expect to arrive at work that many minutes later than usual? What, specifically, was the driver's interpretation?

Method

A survey was conducted of 40 drivers in Los Angeles to determine which of five meanings of a 30-min delay message was most strongly conveyed. Drivers were assigned to two different random orders of the five interpretations. This procedure was undertaken to reduce the likelihood of bias from the order of statements in the questionnaire.

Drivers were instructed that they were approaching a freeway on their way to work and were told there had been an accident on the freeway and to expect a 30-min delay. Their task was to check on a five-point Likert scale their agreement with each of the five interpretations (i.e., strongly agree, agree, undecided, disagree, or strongly disagree). The five interpretations were

1. I will arrive at work 30 min later than usual;
2. I will travel for 30 min before the accident is removed;
3. I will travel for 30 min in bumper-to-bumper traffic;

Figure 5. Effect of incident types and time saved on percentage of driver diversion.

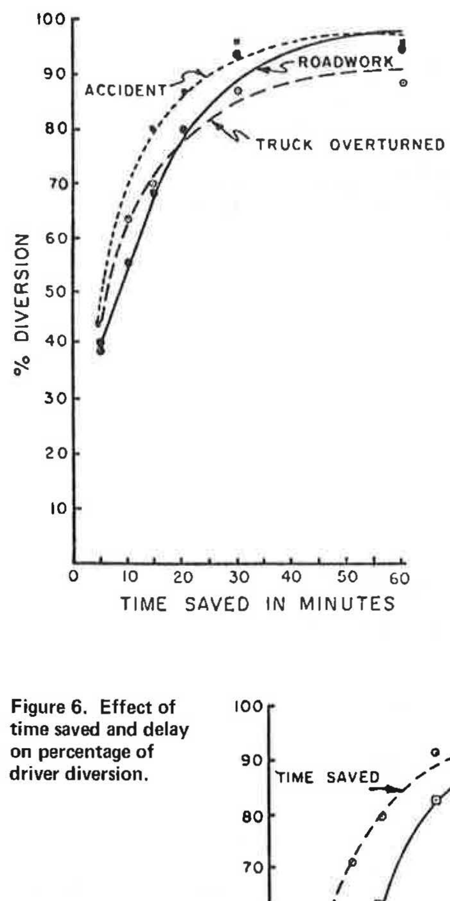


Figure 6. Effect of time saved and delay on percentage of driver diversion.

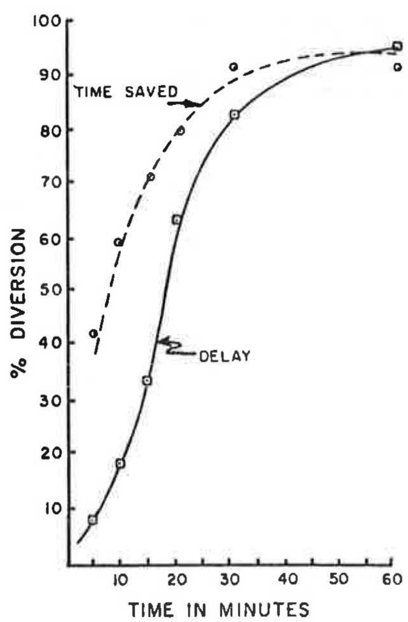
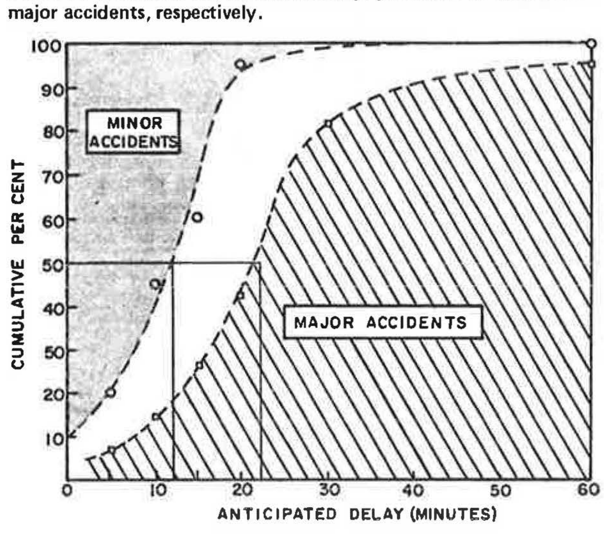


Figure 7. Maximum and minimum delays perceived for minor and major accidents, respectively.



4. Travel time on the freeway will be 30 min longer than usual; and
5. I will be completely stopped in freeway traffic for 30 min.

A score of 1 was assigned to "strongly agree" with the statement, a score of 5 to "strongly disagree". Thus, a lower mean score means closer agreement with the statement. Drivers could choose the same degree of agreement with two or more statements. Identical scores would indicate ambiguity of meaning.

Results

The table below summarizes the ratings in terms of both total rating scores and average rating assigned by the 40 drivers. The mean ratings all ranged from "agreement" to "undecided".

	Rating	
Interpretation	Sum of Scores	Average
1	95	2.375
2	119	2.975
3	114	2.85
4	88	2.2
5	125	3.125
Total	541	2.7

The most popular interpretations were that freeway travel would be 30 min longer than usual (4) and that one would arrive at work 30 min later than usual (1). A test of significance indicated that differences between statements were statistically significant at the 0.05 level (F_{4}, 156 = 5.59). In general, the study findings supported the view of delay as something relative to unusual conditions at that time of day rather than some absolute length of time during which one will be stopped or restrained in traffic.

MODES OF PRESENTING TEMPORAL INFORMATION

In addition to a statement of delay time, there are at least two other modes of expressing temporal information when an alternate route is also under traffic control and surveillance.

Study 5 was a preference study of the three modes of presenting temporal information:

1. Avoiding a 15-min delay by taking a bypass,
2. Saving 15 min (driving time) by taking a bypass, and
3. Saving 15 min or avoiding a 15-min delay as shown by travel times of 25 min on the Interstate and 10 min on the bypass.

Method

A survey of 70 drivers was conducted at a shopping mall in College Station. Drivers were told that they were traveling on I-94 in heavy congestion during rush hour. A lighted sign flashed them a congestion advisory and told them to get off and take a temporary bypass. The bypass rejoined the Interstate at a street beyond the congested area.

The drivers were told that this information would appear on the sign and that, in addition, the sign would show them the "advantage" of taking the bypass. Three different messages on three cards each gave a particular advantage of leaving the freeway. The drivers' task was to read each sign message carefully and to indicate which messages would be most and least likely to convince them to get off the freeway.

The first two parts of the three messages were the same. The message parts were CONGESTION AHEAD—USE TEMPORARY BYPASS TO WHITE BEAR AVENUE. The last part of the message displayed one of the three advantages of taking the bypass route.

Drivers were asked also to provide a reason for being or not being convinced to divert and were asked whether the three messages were communicating different messages or saying the same thing.

Results

The results of the study, in part, are presented below.

	Percentage of Drivers Agreeing	
Message	Message Most Likely to Convince	Message Least Likely to Convince
Avoid 15-min delay	38.6	17.0
Save 15 min	30.0	26.1
Travel time I-94: 25 min, bypass: 10 min	31.4	56.9

The percentage data indicate that the three messages were approximately equally effective in convincing the drivers to divert. However, 56.9 percent of the 65 respondents believed that the message giving comparative travel time would be the least likely to convince them.

The answers given to the open-ended question about reasons for being and not being convinced were extremely diverse. However, 23 of the 37 drivers who rated comparative travel time as least likely to induce diversion mentioned that the message took longer to read than the other messages. Sixty-two of the 68 respondents to the last question (88 percent) indicated that the three messages were saying essentially the same thing in a different way.

SUMMARY AND CONCLUSIONS

1. When delay information is presented along with a message about type of incident and level of congestion, knowing the duration of delay seemed to influence drivers more than other information in making a decision to divert. Three studies in different geographical regions indicate that the average subject will divert in response to a message advising of a 15- to 20-min delay.
2. There is some evidence to support the view that expressing information in terms of 5-10 min of time saved may result in diversion. However, this conclusion applies only when a temporary bypass route is also given in the advisory message.
3. Dallas drivers indicated that MINOR ACCIDENT meant a delay of 12 min or less, whereas MAJOR ACCIDENT meant a delay of 22 min or more.
4. A delay of x minutes was related to the driver's normal travel time (i.e., it normally meant that the travel time on the freeway would be that much longer than usual or that one would arrive at work that much later). Delay information did not necessarily imply stopped or bumper-to-bumper traffic of x minutes, nor did drivers think that the accident itself would necessarily be on the freeway for the indicated period.
5. Three modes of presenting temporal information (i.e., avoid x minutes' delay, save x minutes, and comparative travel time) were viewed as essentially synonymous and evoked no strong preferences. However, comparative travel time was disliked more often because the message took longer to read. Essentially, the driver must subtract one value from the other to obtain the benefits of taking an alternate route.

ACKNOWLEDGMENT

This study was conducted as part of the Federal Highway Administration contract for a project on human factors requirements for real-time motorist information displays. The contents of this paper reflect our views, and we are responsible for the facts and the accuracy of the data reported here. The contents do not necessarily reflect the official views or policy of the U.S. Department of Transportation.

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Publication of this paper sponsored by Committee on Freeway Operations.

Empirical Analysis of the Interdependence of Parking Restrictions and Modal Use

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The relation between modal use and parking restrictions was analyzed by examining changes in travel behavior over time during a period of substantial change in parking restrictions, transit service, and transit fares. The situation examined was choice of travel modes to a major trip generator, the campus of the University of Wisconsin-Milwaukee. This area has major parking-congestion problems that have been partially alleviated by special transit services and remote parking lots. These systems have also been developed in conjunction with changes in parking restrictions. From an analysis of modal choices over time, it was found that shifts to transit use have occurred as a result of tighter parking restrictions and that shifts away from transit have occurred as a result of fare changes. Carpoolers seem to be most sensitive to changes, while the drive-along category showed less sensitivity. An analysis of respondents' reactions to probable future situations also indicated similar results.

As cities throughout the United States move toward the development and implementation of transportation system management (TSM) plans, an increasing amount of attention is being given to the relation between parking policy and transit use. Changes in parking policy, such as increasing its price, changing the schedule of rates, removing parking, and increasing parking restrictions, all are seen as potential means of increasing both transit ridership and the efficiency of the existing transportation system. It is felt that by making parking more difficult the relative advantage of the automobile will diminish and the attractiveness of transit as an alternative to it will increase. Given the potential of this strategy, it is surprising to find that the subject has received only limited study.

Mode-shift modeling has been an important part of the transportation planning process for some time, and several recent studies have reported on developing hybrid models to analyze the impact of changes in these variables. One study in particular (1) concludes that subjective preferences are useful for studying travel-mode diversion but that better means of controlling and monitoring changes in modal split through changes in policy-related variables are needed.

Several studies have dealt with short-term changes caused by such things as parking taxes and operator strikes (2, 3), while others have directly addressed the issue of the impact of changes in parking policy on transit use without empirical documentation (4, 5). Some of the literature provides an insight into efforts by our European colleagues to adjust the balance between automobile and transit use, but the applicability of their project conclusions to U.S. urban areas is questionable (6).

Therefore, a review of current literature seems to substantiate the claim that the United States does indeed need to better control and monitor mode-split changes. There has been little work on empirically relating changes in policy variables to mode choice. This current project was intended to help fill the gap and to provide transportation policymakers with a real-world understanding of the interrelationship.