

CURRENT HIGHWAY USER ECONOMIC ANALYSIS

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This paper describes the result of a survey made of the current state highway user economic analyses. The survey was made in conjunction with the researchers' work on National Cooperative Highway Research Program Project 2-12, Highway User Economic Analysis, the objective of which is to produce a revised version of the 1960 AASHO Informational Report by Committee on Planning and Design Policies on Road User Benefit Analyses for Highway Improvements (Red Book). From the survey, it is estimated that 50 to 70 percent of the states currently perform highway economic analyses on a fairly regular basis. The results of the survey include information regarding types of applications of highway economic analyses; scope of such studies, amount of effort expended on them, and backgrounds of persons performing them; and types of data collected and values used in calculations. The paper concludes with a summary of suggestions derived from the questionnaire of what should be included in the revised Red Book.

•STANFORD Research Institute (SRI) is revising the 1960 AASHO Red Book (1) for the National Cooperative Highway Research Program (2). The purpose of the Red Book is to aid highway engineers and transportation planners in evaluating highway improvements for user operating costs, travel time, and accident experience. For example, an agency that wished to straighten out a curved section of highway could use the manual to compare its construction costs to highway users' savings in operating costs, travel time, and accidents.

To produce a document of maximum utility, the researchers distributed a questionnaire to all state highway departments on the status of their highway economy studies. We believe that the results of the questionnaire, which we present in this paper, in addition to assisting us in producing the revised Red Book (1) are of general interest to those in the highway community. They also provide feedback to transportation economists on current applications of economics in evaluating highway improvements in the real world. This paper also compares the answers from the states that participated in the survey.

This survey has been done twice before. The first survey (3), performed in 1962, revealed that, in almost 40 percent of the cases reported, economic analysis was never used; in those states that did use economic analysis, errors such as applying too low a discount rate, not including accident costs, not including maintenance costs, calculating road user benefits incorrectly, and not comparing alternatives correctly were prevalent. Unfortunately, many of these same criticisms still hold true today. The second survey (2) showed some increase in the number of agencies making economic evaluations of potential investments, but, very frequently, they used inappropriate or inadequate methods.

In this survey, started in May 1974, a 5-page questionnaire was sent to either the chief highway engineer, his deputy, the director of planning, programming, or budgeting, or to personal contacts, when available, in all of the 50 states plus the District of Columbia, Puerto Rico, and Guam. In this paper, these 3 territories will be called

states. A copy of the questionnaire is an appendix to this paper¹. The addressee was requested to have the proper individual prepare a response and to tell us the name and address of this individual. Forty responses were received; the last came in 4 months after the questionnaire was sent out. Thirty-five replies included completed questionnaires; this was a 66 percent rate of return. The 1962 study (3) received 50 replies to the 52 questionnaires sent out, which was a 96 percent rate of return. The 1966 survey (4) received 21 replies from the 47 states questioned, which was a 45 percent rate of return. We followed up on only 2 of the states from which we received no answer, and 1 replied. We followed up on no more because we felt that we had received a sufficient number of returns. Some of the states, in addition to returning the questionnaire, included copies of highway user economic evaluations that they had performed previously. These reports have given us as much useful data as has the questionnaire itself, and we plan to include some of them in the revised Red Book (1) as examples. A few of the states (most notably California and Oregon) gave us copies of highway user economy analysis manuals that they prepared for their own use. These also have proved to be valuable to our research.

Highway user economy studies are conducted by 27 states out of 39 replying (69 percent); 8 states conduct limited studies. Only 1 state responding to our survey does not perform this type of analysis; 3 others conduct them only rarely or would like to start performing this type of analysis soon. We assumed that a large fraction of those states that did not respond to our survey do not perform highway economy studies. Thus we estimate that from 50 to 70 percent of the states perform these analyses on a more or less regular basis. This is 10 to 20 percentage points higher than the results of the 1962 questionnaire (3).

The second question asked at what point in the transportation planning process these analyses occur. Seven states said that they are performed at the initial highway feasibility stage; 12 states said that they are performed during prelocation corridor planning; and 20 states said that they are performed during alternate route location selection. Of course, some of these states conduct analyses at 2 or 3 of these points. Six states report performing an economic analysis for design or pavement selection. Three to 5 states indicated that they conducted road user benefit analyses in the statewide or systems planning stage in conjunction with preparing environmental impact statements for highway maintenance, during reconstruction or rehabilitation, or when requested by upper management.

The third question asked whether economic analyses were used for solving the types of problems given in Table 1. A weighting similar to that used by Glancy (3) was employed: Yes = 1.0; qualified yes = 0.75; qualified no = 0.25; and no = 0. It is interesting that interchange justification was a write-in by the 5 states who indicated it; we had not included it on the questionnaire form. If we had included it, more states probably would have indicated the use of highway economic analysis for justification of freeway interchange location and spacing.

The median number of person days required for a typical economic analysis was 5 to 10. The range was from 3 person hours to 15 person days or more. Seven states indicated that they would like their analyses to take approximately half as long to perform as they do now.

Twenty-four states would prefer to have a highway user economic analysis methodology that is as simple as possible as long as it is reasonably accurate. Nine states, however, would like to have the capability to perform a more detailed analysis, especially one that could be run on a computer.

The number of highway economy analyses performed per year by the states varies widely. Two states perform only 2 such analyses per year. Two other states, however, can do up to 2,000 per year. The median is 18 user benefit analyses per year.

¹The original manuscript of this paper included an appendix, Questionnaire on the Conduct of Highway Economy Studies. The appendix is available in Xerox form at cost of reproduction and handling from the Transportation Research Board. When ordering, refer to XS-59, Transportation Research Record 550.

Table 1. Weighted percentage of states performing economic analyses.

Type of Highway Problem	States Replying	
	1974 (N=35)	1962 (N=50)
Construction of new highways	71	82
Deciding among alternative routes	87	92
Road surface selection	19	70
Safety improvements	44	82
Widening existing roads	36	Not reported
Straightening curves	31	Not reported
Grade reductions or passing lanes on mountainous roads	39	Not reported
Interchange justification*	14	2
Other, e.g., rehabilitation, drainage, routing of detours, and grade separation	14	Not reported

*Write-in response; actual use is probably higher than that shown.

Table 2. Who conducts the analyses.

Analyzers	Experience	Number of States
Highway engineers	Experienced	14
	Relatively inexperienced	5
	Unspecified	3
Civil engineers	Experienced	11
	Relatively inexperienced	3
	Unspecified	1
Design engineers	Experienced	2
	Relatively inexperienced	1
	Unspecified	2
Economists	Experienced	6
	Relatively inexperienced	2
	Unspecified	1
Planners	Experienced	9
	Relatively inexperienced	5
	Unspecified	4
Technicians and others		9

Table 3. Values for capital costs, accidents, and time.

Variable	Number of States Responding	Median Value
Discount rate (cost of capital)	24	7 percent/year
Social cost of fatalities	20	\$52,000/fatality
Societal cost of injuries	20	\$2,700/injury
Amount of property damage	7*	\$415/property-damage-only incident
Value of time for each passenger car occupant	16	\$1.85/hr

*Write-in response.

Our next series of questions attempted to find out something about the individuals who conduct road user benefit analysis. Their backgrounds can be described by the data given in Table 2. The category of technicians and others includes people who might be described as research assistants, accident analysts, or traffic specialists. Many technicians perform highway user economy studies regularly and are quite skilled in performing the calculations even though they may not fully understand the underlying theory.

In most states, the fraction of time spent by individuals performing these analyses is small. The median value is 8 percent. The activities with which they usually concern themselves are as follows:

<u>Responsibility</u>	<u>Number of Agencies</u>
Engineering	12
Planning	13
Traffic Analysis	10
Design	7
Research	7
Highway investment programming	2
Environmental assessment	5

We then asked what type of computing equipment is available for these analyses. Twenty-six states have computers available for performing the calculations (13 of these computers are IBM 370s), and 5 of these use their computers for this. Oregon has a highway investment rate of return program, and California is refining a sophisticated highway economic evaluation program model. Fourteen states use electronic calculators in performing the calculations, and 2 others have calculators (including a calculator that can be programmed) available for use. Eight states perform manual (paper, pencil, and slide-rule) computations.

The next series of questions concerned the type of field data that is collected by the states for performing the evaluations. The following tabulation describes the data collected by the states:

<u>Type of Field Data</u>	<u>Number of Agencies</u>
Traffic volumes	23
Speed	8
Geometrics	12
Vehicle categories, percentage of trucks	6
Accident experience	6
Costs	9
Trip origin-destination	8
Other	7

The category of other includes data on type of pavement, pavement condition, service life, traffic control, land use, and socioeconomics.

Next we asked which reference books are used to assist the states in performing their road user benefit analyses. Twenty-five states still refer to the 1960 Red Book, and 13 of these still use the original 1959 unit price values in the book. They realize, of course, that these numbers have been rendered obsolete by inflation and technological changes, but they use them nevertheless. In fact, they requested that we produce in our revised methodology a technique that would enable them to justify highways on a cost basis because the values that they have for construction have been inflated greatly

since 1959. Some of the other 12 states use the format in calculations in the Red Book and merely update the cost values. Five states use NCHRP Report 111 (5), and 7 use NCHRP Report 133 (6). Fourteen states use Robley Winfrey's Economic Analysis for Highways (7), and 7 states use other references such as NCHRP Report 122 (8), manuals that have been prepared by the state, and books by Woods and Wiener.

The next question requested information on the actual values that the states assume for the costs of capital, accidents, and time. The results are given in Table 3. It is significant that 25 states (71 percent) reported that they use a non-0 discount rate. The comparable value for the 1962 survey was only 55 percent. High interest rates notwithstanding, several state highway departments have become aware of the time value of money in the last 10 years. There has been a tremendous increase in the inclusion of accident costs in an economic analysis. In the 1962 study (3), only 2 states considered accident costs, and only 4 states included them in the 1966 survey (4). Twenty-one states in our sample reported the inclusion of accident costs in their analyses.

The next question concerned the actual effectiveness measure that is used in analysis. Thirty-two states perform cost-benefit analysis. Twenty-four of these compute benefit-cost ratios. One uses a marginal benefit-cost ratio, and a few include maintenance costs in either the numerator or the denominator. Eight states used other indicators, such as net present worth, net benefit, a comparison of total or annual system costs, and rate of return.

The final questions were on the recommendations that the states made concerning NCHRP Project 2-12 (2). These are given in outline form.

1. Suggestions for incorporation into revised Red Book
 - a. Include a discussion of net present worth, net worth of costs, rates of return, and the like that can be understood by those not well versed in economics and can be presented to the uninitiated general public.
 - b. Provide a sensitivity analysis to illustrate the relative importance of the various components of highway user costs and show the sensitivity of the final answer to assumed values for time and interest rates.
 - c. Include a detailed working of simple to complex sample problems, including some with incomplete data.
 - d. Show the effect of air-pollution-control devices on highway user costs.
 - e. Indicate highway user costs for different levels of service and types of roads. When representing running costs as a function of speed, start with a lower operating speed than that used in the Red Book and use 5- or 10-mph (8- or 16-km/h) increments rather than 4-mph (6-km/h) increments that are used now in the Red Book.
 - f. Express speed change cycles as a function of congestion levels
2. Comments on manual format
 - a. Use larger pages than are used in the present Red Book.
 - b. Tables, charts, and graphs should be easily reproducible.
3. Requests for work beyond scope of NCHRP Project 2-12
 - a. Include a treatment of social, economic, environmental, and community impacts in addition to user costs.
 - b. The computer programs that are being used for comprehensive transportation and traffic forecasting should be extended to calculate user costs.
4. General comments
 - a. Include a discussion of motor vehicle costs in urban areas, and use average daily traffic instead of hourly traffic in the calculations.
 - b. Develop an economic methodology and updating procedure that is simple to apply; develop also a rough, shortcut approach for feasibility determination.
 - c. Make the procedure flexible and interchangeable so that it can be used for many different applications.
5. Suggestions for further research
 - a. Discuss deterioration in performance due to vehicle age.
 - b. Include the costs for different classes of vehicles, such as trucks and recreational vehicles.
 - c. Devise an accurate method for estimating speed and determine the effects of buses and trucks in the traffic stream on average speed now that national speed limits are lower.
 - d. Model queuing due to bottlenecks.
 - e. Derive a methodology for treating accidents and delay for interchanges, intersection improvements, auxiliary lanes, ramp metering, and the like.

We have found that many of these suggestions will be valuable to us in revising the Red Book.

REFERENCES

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