SESSION THREE

Thursday, September 17, at 7:30 P.M.
THE DETERMINATION AND MEASUREMENT OF HIGHWAY COSTS
ROBLEY WINFREY, Bureau of Public Roads, Presiding

Cost Elements in Economic Analysis of Highway Programming, Location and Design

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● THE MAIN PURPOSE of an economic analysis of a proposed expenditure for a highway facility is to determine: (a) whether the investment is justified by the calculated benefit-cost ratio, or the prospective rate of return; and (b) as between alternates being considered which is the best economically.

The term "costs" as associated with the analysis consists generally of the same items of expenditures considered in determining the probable merit of any other investments. Principal of these is the periodical charge necessary to return interest on the capital invested and secure eventual recovery of the capital amount. The term for this charge is amortization, or capital costs.

Another primary item of cost to be considered is the aggregate of expenditure for physical maintenance and upkeep, and for operation of the plant, or operating costs. There may be other items, such as overhead and general supervision, but generally capital costs and operating costs are the principal factors of cost in the determination of the economic worth of a proposed highway investment, having the greatest effect upon the result.

By the benefit-cost ratio method of analysis, as outlined in the AASHO Report, amortization of the investment is the result of applying the capital recovery factor for a pre-chosen rate of interest, at estimated service lives, for the calculation of captial recovery costs during a given period of study.

All three variables (interest rate, period of study, and service lives) are functions of the annual capital cost; not only in the computation of the benefit-cost ratio, but also in any other analysis requiring a calculation of capital recovery.

In the AASHO proposed method of analysis the method and rate of depreciation, and consequent salvage value, are undetermined and, as such, are not preliminary factors of the problem. The estimated service life, or lives, fixes the capital recovery factor at the assumed rate of interest. The depreciation may, or may not, be equal to the amount of capital recovered, and the salvage value also may, or may not, be the amount of the investment unamortized. Only if the interest rate chosen happens to coincide with the rate of return on the investment does the unamortized capital at the end of the period equal the salvage value. Otherwise, the ratio found is only an index by which to

compare a proposed investment with other investments for which an index has been similarly calculated using the same assumptions as to rate of interest and service lives.

By the usual method of calculating a prospective rate of return, that is, determining the rate at which the sum of the present worths of a series of net receipts and the salvage value will equal the original investment, it becomes necessary to introduce the probable salvage value at the end of the time period of study as a factor of the computation. For this purpose, it is necessary to select a definite method and rate of depreciation, or probably better, a realistic estimate of the salvage value at the end of the study period regardless of the times and rates by which the depreciation occurred, but based upon a value determined by past experiences and observations of similar cases.

Some questions concerning determination of capital costs as they are, or should be, applied to highway economic analysis are as follows:

1. Is a 20-yr study period a proper one to use in all cases? This period has been generally used, probably because it appears to be advised as the maximum period for reliable projection of traffic growth. Traffic predictors seem to be dubious of making forecasts beyond 20 years. But if traffic beyond the 20-yr period should be thought to be stable at the maximum attained at the 20th year, or possibly to grow even at a lesser rate, another 5 or 10 yr added to the period would add appreciably to the average annual benefit.
2. Are the estimates of service lives of the component items of construction (as generally used because of their introduction in the AASHO report; namely, 20 yr for pavement, 40 yr for grading, drainage and structures, and 100 yr for right-of-way) or in line with best practice for economic analysis in light of knowledge gained from studies of actual service lives; especially for pavements? What changes are recommended?

It may be that the 3 classifications are too broad and restrictive. For instance there are many items which probably should be segregated for more rapid depreciation, such as signs, signals, and guardrails. Where the cost of right-of-way includes damages such as for loss of access, or buildings or structures to be removed, or such items as utility changes, having no salvageable intrinsic value, it appears that their costs should be segregated for a write-off period not greater than the period of the study. Like treatment may be given to the contract item for maintenance of traffic during construction.

3. How will an appraisal of salvage value be anticipated 20 years in advance?
4. For use in the computation of a benefit-cost ratio, why not account for the salvage value by applying the capital recovery factor only to the amount to be depreciated (original investment less the estimated salvage at the end of the period) during the period of study, and add annual interest on the unamortized balance (salvage value)?
5. In a calculation of the benefit-cost ratio, what criteria should be applied in selecting an interest rate? Opinions by those responsible for such analyses vary from the extremes of no interest to a rate approximating the yield on capital borrowed by private indivuals, or a rate selected as the minimum desirable return. It is recommended by some that the rate be used that is paid for interest on road bond borrowing. Such rates vary, and the trend at the present time is higher rates. Regardless of the varying bond rate, should not studies of different proposals made for the same authority at different times be at the same rate to indicate the relative merit?
6. It may be suggested that the charges for right-of-way, considering the worth of land only without improvements, be made as rental on a permanent investment, and thus chargeable as a current expense deductible from current income (benefits). This concept would need exploration, and it may be found that with the use of a 100-yr life for amortization, the difference in charges would not be of consequence. The effect of the reduction of amortizable investment, compared to a probably similar relative reduction in net benefits, would be toward a larger rate of return. It may be doubted that the relative standing of alternates would be affected.

Thus far, nothing has been said about other annual costs, such as overhead, general supervision, maintenance and the type that generally can be lumped as operating costs.

It would appear that for those that can be readily determined or estimated there is not much uncertainty about their place in the analysis. In the benefit-cost analysis it would appear that they should be reduced to a probable annual average figure and added to the annual capital cost to appear in the denominator of the ratio. In a calculation of the prospective rate of return, the figure should be deducted from the average annual benefits to determine a figure analogous to net profits of a business enterprise.

Discussion

Winfrey. —In connection with right-of-way, many analysts in the state and consulting engineering offices may use a 100-yr period in the calculation of the annual capital cost of right-of-way. In their initial right-of-way cost they include the full expenditure for such items as land, severance costs, damages, buildings that they buy and tear down, and all other costs directly associated with acquiring title to the property.

If I were to use—and I say "were" because I am not inclined to do so—a long period, even more than 50 yr, for right-of-way, I would be inclined to separate the land value from damages, severances, and buildings. These items have no value whatsoever to the highway after the land is obtained. Certainly in the long run they have no value.

Another way of handling right-of-way, would be, as Rothrock suggests with other items, to set up a salvage value for the land. Certainly the only salvage value to right-of-way would be the value of the land.

Rothrock. —The possibility, of considering salvage was offered to me by a lawyer. In Ohio, they have the right to borrow money from certain state funds to made advance purchases of right-of-way. It appears that such purchases might be made by a separate authority who would charge the State Highway Department rent on the land and whereby they could issue revenue bonds or some sort of bond which would stand good for the payment to the purchaser of the bond. It would introduce the business rental concept into that particular element (land) of cost. I do not know whether it would stand up or not. The plan would probably need some exploration if it has any merit.

St. Clair. —If you have $100,000 in right-of-way, of which $40,000 is in these items other than the market value of the land, how would you treat that $40,000?

Rothrock. —My opinion is that it should be written off as rapidly as you can, at least within the period of the study. These damage items have no salvable value, nothing intrinsic about them at all.

Winfrey. —Certainly not longer than the first cycle of payment.

St. Clair. —On the other hand, it is an expense you will never have again on that road.

Gardner. —So long as the original acquisition is the only amount of right-of-way you are going to have for 100 yr. The probability, however, is that you are going to widen your highway some day and take more right-of-way and then have these same elements of costs associated with the new improvement. I agree with the immediate write-off.

Grant. —How good are the maintenance costs with regard to types of pavement? Clark Oglesby was a part time consultant for Stanford Research Institute in connection with the economics on a flood control project. One of the bits of information that was important had to do with the flooding of certain roads. He thought he could get from the county engineer information about maintenance costs, so he asked the question, "How about maintenance costs on your highway system." The county engineer said, "Oh we are clean, we can account for every nickel." But when it came to finding out how much had been spent on any particular highway there was no information, whatsoever. They knew they spent about $2,000,000 a year, that on the average they worked on about half of the mileage of the county system, and this was all they knew.

Are the state maintenance costs in better shape than those of this particular county? Is that a uniquely bad example, or is it a common example ?

Rothrock. —I think it is very common. The accounting of maintenance costs in the states that I have any knowledge of is very poor. As an example, I have seen work being done on one system, say the secondary system, but charged to the money which

was available on the primary system. They just used available money to switch around as they pleased, charging work to any section that was convenient. Maintenance cost is very poorly kept as a general rule. We get our maintenance costs, or an approximation of them (the ones that are used in our studies) from our maintenance department and just take their word for the costs.

Jorgensen. —For the purposes of this kind of an analysis, don't you think that the average values you get for maintenance are really reasonable... are a reasonable approximation of what you are going to have? They are not a seriously weak spot in this kind of analysis.

One should not get the wrong impression from the fact that there may be some discrepancies in the way things are charged, for in total I think our maintenance charges are reasonably representative and valid for this kind of analysis.

Rothrock. —The maintenance costs generally are a small part of the annual costs as compared to the amortization costs... a rather small percentage, so they don't make a lot of difference.

Fritts. —If we will take a look at the statutes in each state we will find that there are legal requirements about the reporting of expenditures of highway funds. I think we can all agree that even when the highway department reports its expenditures on maintenance, for instance, they have to be reported as maintenance expenditures. I know that one maintenance foreman may charge something to one section that should be charged to another, but even if it comes to the county, the county has to report legally certain expenditures.

These things are fairly accurately presented, so I don't think we have any bear by the tail in this situation.

Rothrock. —Maintenance is not a large percentage of total annual cost and you can be off on your maintenance costs 50 percent and still not be too far off in your total costs.

Burch. —In answer to what is maintenance cost, this kind of reply is often made: "How much does it cost to maintain a son in college?" The answer is, "All you have." That is about the way that total highway maintenance expenditures have been determined. It is how much you have available to spend. I don't mean to imply the existence of waste. The states, counties, and cities have a great pride in trying to do the best they can in maintaining their roads in as good condition as they can, but the limit they can go depends on how much money is available.

The second point on maintenance cost is how do you define it? Is it the amount necessary, or is it the amount expended? There is, as you know, quite a difference between cost, properly defined, and expenditure, on the other hand. Some accountants will say there is no difference, what you spend is what it costs, but that is not necessarily true. Ed. Note: Universal Standards for maintenance have not been defined. The 100 percent level has not been set.

As to record keeping I agree that there is no use to worry about it. Cost records undoubtedly are not kept in detailed form, road by road, section by section, as well as they might be. If you were to ask the ordinary housekeeper, "How much do you spend for salt, for sugar, for coffee, for lard, etc," you could probably get an excellent accounting of how much it costs to run the kitchen, but no breakdown on itemization. We have to fall back on what I call experienced appraisal. Experienced judgment and the composite of the experience of many maintenance people over many years comes up with figures which to me have great stability and are acceptable.

Rothrock. —This question of maintenance costs chargeable in an economic analysis is not too important. If you use a figure, you are estimating for the future anyway. You are not going to the past except to get a basis of projection. If you use a figure which appears reasonable in the light of the knowledge that you have about the past, you cannot be very far off. The principal item of financial charges is the amortization costs and the recovery of capital. These costs may vary considerably, depending upon the interest rate.

Shall we take an entrepreneur's point of view of depreciation and salvage, or realistic value based upon our experience? For instance, a man going into business will

recover his capital as rapidly as the Government will allow him to recover. Should we do that, or be more realistic and make our probable salvage equal exactly to what we think it will be? The business man looks for a quick return of his capital even at the expense of reportable profits now, in the hope he will make profits later.

How about an average life calibrated by dollar weighting of each component?

Zettel. —I would make one amendment, that no business man can recover his capital over what the Government will allow. You have to add one other factor. That is competition and what will the market allow, which is more important than what the Government will allow. You don't go into any business assuming a complete monopoly and that you are going to recover your investment with only the restrictions that Government imposes in income tax returns. You have to consider the market situation. I interpose the statement that Government is not the control on how fast you recover. The market is the thing we are talking about. My point is that it is not a matter of what the Government will allow, but the market.

Rothrock. —That is a matter of accounting.

Zettel. —It is only a matter of how you can price your product.

Rothrock. —Yes, but that is for accounting purposes only. We are making a projection of something else.

Zettel. —But he is projecting what he can sell his product for.

Rothrock. —We are not governed by that. What shall we do?

Fritts. —That is our difficulty. We are not governed by what the market says you can do, we are governed by what the Government says you can do.

Rothrock. —I mean that the highway analyst is not governed in setting his rate of depreciation by any figures the Government gives him; whereas the business man is limited.

Zettel. —This isn't the basic determination. The basic determination is that the Government derives its regulations not from an accountant saying, "I am going to allow so much," but on some kind of judgment, the same kind of judgment we are involved in here.

Rothrock. —The question is, what is the best method or rate of derpeciation to use in our analysis, or what service lives?

Winfrey. —There are two concepts for us to follow. One is, we can make our economic analysis on the basis of our best judgments as to the ultimate number of years of service of the facility in its total, or by component parts, including the best estimate of the salvage value at the end of those service lives. Second, we can make our analysis over some shorter period which I choose to call the analysis period, in which, for economic analysis only, we do not need to pay attention to service lives, except that our analysis period must not exceed the period of useful service of the facility.

I prefer the latter, that is, using an analysis period. This plan is universally used in industry in economic analyses. This economic analysis is not to be confused in any way whatsoever with cost accounting to determine a profit and loss in business, not to determine the annual cost of owning and operating a highway system. When we do that we come over and must use our best judgment as to service lives and salvage values.

Ed. Note: Salvency quotients on the other hand should be based on cost of owning and operating.

In either case, however, it seems an economist and business manager and financier must be on the conservative side. It is only good judgment to use low salvage values in connection with long lives because the risk factor is so much greater. We don't know what will happen 100, 75, or 50 years from today. We are more apt to know what is going to happen 20 years from today, so if I use 20 years, I use a more liberal salvage value than if I use 75, 50 or 100 years.

But I want us to remember that there are two separate things we are discussing—cost accounting and economic analysis. They are not the same.

Rothrock. —In my paper I said that net benefits, after taking the summation of the consequences, would be analogous to gross return to a business, after deducting the annual costs of operation, to get the net returns. Is that proper, in order to determine the rate of return?

Winfrey. —It is the way I would do it, and therein, gentlemen, is something which was not mentioned previously. Annual maintenance cost is more critical than you may think, particularly if it is high with respect to benefits, or if it is high or extremely low with respect to capital cost. The ratio of maintenance cost to investment will alter the rate of return that you will calculate. The rate of return solution is sensitive to the relationship of annual maintenance cost to capital cost.

Rothrock. —How does one handle the annual costs and financial costs on a project constructed by stages?

Make the assumption, for instance, that 2 lanes are built now to satisfy the traffic demand for the next 10 years. Ten years from now an additional 2 lanes are constructed. The difference in costs is that you add presumably double your initial cost at the end of half of the 20-yr study period. To get an average cost over the 20-yr period my solution was to charge capital recovery on the first $100,000, through the whole 20-yr period and also charge through the whole 20-yr period a sinking fund charge to create the $100,000 at the end of 10 years.

Winfrey. —Were you interested in determining economic analysis or highway costs?

Rothrock. —The financial costs for the 20-yr period, as an average over the 20-yr period.

Ross. —In response to the question relative to the forecasting of traffic for a 20-yr period and then the use of a different period possibly for computing road user benefits, in Idaho we are using a 15-yr period for a computation of our road user benefits, even though we project traffic for a 20-yr period.

Rothrock. —You are using the traffic you expect in 15 years as an average over the time, not a straightline growth of traffic?

Ross. —We feel it is more realistic than the 20-yr design.

Rothrock. —The question I meant to ask was, supposing there is something like a straightline growth of traffic during the period. Why not use a 25-yr period instead of a 20-yr period if you think the growth continues on at the end of the 20-yr period for another 5 years.

The reason is, we have always used 20 years for the design year. Why do we need to use the design year? Is it desirable to use the average of the design year and the first year as the mid-point or the average traffic over the period? Whereas another few years added to the period of analysis would add a little something more to the average traffic.

We are dealing with averages here. Of course, that is not true, either, because the income benefits on the lower amount of traffic the first year is nothing like the benefits to double that amount of traffic in the 20th year. However, I have determined that that does not make a lof of difference. In some rates of amortization the average does not make a lot of difference as compared to a straightline individual present worth of each year.

Ross. —We were looking for traffic to justify these routes, particularly Interstate, and therefore, whereas the Bureau requests that we take a design period of 25 years, we feel we are much more justified in taking a mid-point of 15 years or making the total period of 30 years.

Winfrey. —I can give you a simple solution, one which I have recently read in a report from one of the states. They made an analysis of their annual benefits as of the present time, using present day traffic. Then they said in the next 40 years these benefits will double, so they just doubled the benefits, did not take the present worth of these distant benefits and came out with a very nice answer. Very simple!

Fritts. —I know in some of the states like Idaho, Montana, and South Dakota, they are troubled with this economic problem. On the Interstate System, for instance, where today the traffic is 1,200, 1,500 ADT, they anticipate the traffic to 1975 or some period beyond. There is an economic problem whether to build 2 or 4 lanes. There is, in my judgment, some confusion in the minds of the men out there about the economic justification of building 4 lanes now, or building 2 lanes and then maybe it will cost them a little more 15 years from now to build the other 2 lanes. What is the economic justification? I don't know what the answer is. I wonder if our economic analysis provides a good answer to that kind of problem.

Ross. —I would like to point out further with respect to Idaho that you can oftentimes justify 4 lanes in the beginning by virtue of your sight distance restriction that you are building into a 2-lane versus a 4-lane highway, plus the operational problems you encounter at your interchanges.

Zettel. —I don't mean to be facetious, but when we talk about the Interstate System state-by-state we are going to have differences of approach to these problems, and differences in factors. If you were going to establish priorities for the Interstate System you would have to look at it on a nationwide basis.