
Module 5: HIGHWAY ECONOMICS & FINANCE

INTRODUCTION

Better highway system provides varied benefits to the society. Improvements in highway results in several benefits to the road users such as :

- || Reduction in vehicle operational cost per unit length of road.
- || saving travel time and resultant benefits in terms of time cost of vehicles and the passengers
- || Reduction in accident rates.
- || Improved level of service and ease of driving.
- || Increased comfort to passengers.

Therefore the level of service of a road system may be assessed from the benefits to the users

The improvement in road network also benefits the land owner by providing better access and consequently enhancing the land value. The cost of improvements in the highway of land, materials, construction work and for the other facilities should be worked out. From the point of view of economic justification for the improvements, the cost reductions to the highway users and other beneficiaries of the improvements during the estimated period should be higher than the investments made for the improvement. In the planning and design of highways there is increasing need for analysis to indicate justification of the expenditure required and the comparative worth of proposed improvements, particularly when various alternatives are being compared.

The government or any other agency finances highway developments. The funds for these are generally recovered from the road users in the form of direct and indirect taxations. Highway Finance deals with various methods of raising and or providing money for the highway projects.



HIGHWAY USER BENEFITS

General Benefits

Several benefits are brought to highway users and others due to the construction of a new highway or by improving a highway. Road user benefits are the advantages, privileges or savings that accrue to drivers or owners through the use of one highway facility as compared with the use of another. The various benefits due to highway improvement may be classified into two categories: (i) quantifiable or tangible benefits in terms of market values and (ii) non quantifiable or intangible benefits.

Quantifiable Benefits

Various benefits which can be quantified include benefits to road user such as reduction in vehicle operation cost, time cost and accident cost. The other benefits include enhancement in land value. These are briefly explained below:

- ||| Saving in vehicle operation cost is due to reduction in fuel and oil consumption and reduction in wear and tear of tyres and other maintenance costs. A road with sharp curves and steep grades require frequent speed changes; presence of intersections require stopping idling and accelerating; vehicle operation on road stretches with high traffic volume or congestion necessitates speed changes and stopping and increased travel time.

Non-quantifiable Benefits

The non-quantifiable benefits due to improvements in highway facilities include reduction in fatigue and discomfort during travel, increase in comfort and conveniences and improvement in general amenities, social and educational aspects, development of recreational and medical services, improved mobility of essential services and defence forces, aesthetic values, etc..

Motor Vehicle Operation Cost



The factors to be considered for evaluating motor vehicle operation cost would differ depending on the purpose of the analysis. The vehicle may be classified in different groups such as passenger cars, buses, light commercial vehicles, single unit trucks combination vehicles etc., for the purpose of cost analysis. The motor vehicle operation costs depend on several factors which may be grouped as given below:

- ||| Cost dependent on time expressed as cost per year such as interest on capital depreciation cost, registration fee, insurance charges, garage rent, driver's license salaries etc. as applicable.
- ||| Cost depending on distance driven expressed as cost per vehicle-kilometer. The items which may be included here are fuel, oil, tyres, maintenance and repairs etc.
- ||| Cost dependent on speed include cost of fuel, oil and tyre per vehicle-km-time-cost of vehicles, travel time value of passengers, etc.
- ||| Cost dependent on type of vehicle and its condition. Operation costs of larger vehicles are comparatively higher. The operation cost of old vehicles maintained in poor condition is also higher.
- ||| Accident costs.

The costs of vehicle operation and time for unit distance may be taken as:

$$T = a + \frac{b+c}{\text{Speed}} \quad (14.1)$$

Speed

Where

a = running cost per unit distance, independent of journey time

b = a fixed hourly cost, dependent on speeds

c = the portion of the running cost which is dependent on speed

Therefore the operation costs may be considered to consist various components like motor fuel cost, lubricating oil consumption, tyre costs, vehicle repair and maintenance, depreciation, cost due to slowing, stopping, idling and standing delays, costs related to



pavement surface and its condition, grades, curves and traffic volumes. Also the time costs and accident costs are taken into consideration.

Example 14.1

Calculate the operating cost of a passenger car for 100 km length of a rural highway with no sharp curves for most economical speed of vehicles operation using the following

HIGHWAY COSTS

General

The total Highway Cost for road user benefit analysis is the sum of the capital costs expressed on an annual basis and the annual cost of maintenance. The total cost for highway improvement is obtained from the estimate prepared from the preliminary plans. The total cost of each highway engineering improvement proposal is calculated from the following five components

- (i) Right of way
- (ii) Grading drainage, minor structures
- (iii) Major structures like bridges
- (iv) Pavement and appurtenances
- (v) Annual cost of maintenance and operation



Computation of total annual highway cost based on summation of the annual cost of individual items of improvements and their average useful lives is considered to be a proper and accurate approach. It is difficult to estimate the service lives of highway elements as there are several variables such as soil, climate topography and traffic. Road life studies enable estimation of lives of pavements, bridges and other roadway facilities.

Annual Highway Cost

The items to be included while computing annual highway cost are

-
- (i) Administration (a portion) Personal service, building, equipment operation, office, insurance etc.
 - (ii) Highway operation Equipment. building vehicle operation including capital costs of vehicle.
 - (iii) Highway maintenance
 - (iv) Highway capital cost : Cost of highway components such as right of way, damage, earthwork, drainage system. pavement bridges and traffic services depreciation cost and interest on investment.
 - (v) Probable life and salvage value at the end of this period.

The average annual highway cost for a road system may be summed up by the formula.

$$Ca - H + T + M + Cr$$

where

- Ca = average annual cost of ownership and operation
- H = average cost for administration and management at head quarters
- T = average annual highway operation cost.
- M = average annual highway maintenance cost.
- Cr = average annual capital cost of depreciation of investment
capital or the capital recovery with return on capital

The annual cost is considered in the economic assessment of highway projects. Instead of considering the overall cost of a project the annual repayment of a capital loan plus the interest over a specified period of time of the annual capital cost is considered in the analysis. The first cost of a capital improvement is converted into equivalent uniform annual cost by the formula:



$$Cr = P \left[\frac{i(1-i)^n}{(1+i)^n - 1} \right]$$

$$= P (CRF)$$

Where

Cr = receipt in a uniform series for n periods to cover P at a rate of interest i

P = first cost of improvement of an element of a highway

i = rate of interest per unit period

n = period of time in number of interest periods

$$CRF = \text{Capital recovery factor} = \frac{i(1-i)^n}{(1+i)^n - 1}$$

At the end of the service life of road pavement, some of the items could be assigned some salvage value. However the salvage value of some other items may be negligible.

The average annual capital cost Cr for a project considering salvage value may be estimated by the use of the formula (for the capital-recovery with salvage value):

$$Cr = (C - V_s) \left[\frac{i(1-i)^n}{(1+i)^n - 1} \right] + i V_s$$

$$= (C - V_s) CRF + i V_s \quad (14.4)$$

Where C = total investment on construction

V_s = salvage value at the end of n years

i = interest rate applicable

n = number of years of expected use of the facility

The compound amount accumulated sum S on the principal sum of proposed improvement cost or single payment P , including interest rate, i in n years is given by:

$$s = P (1 + i)^n \quad (14.5)$$

economical proposal among various alternatives, in the analysis for economic justification of the proposed improvement, it is required to use judgment such as quantitative selection of the factors in which annual highway cost depends and the estimation of AADT of each class of vehicle considering the normal increase in traffic and the generated traffic.

Methods of Analysis

The procedure for the economic evaluation of highway projects consists of qualification for cost component and the benefits arising out of the project and to evaluate by one of the methods of analysis.

There are several methods of economic analysis. Some of the common methods are. Annual-cost Method, Rate-of-Return Method and Benefit-Cost Method.

Annual-Cost Method

The annual cost of each element of capital improvement is found by multiplying by the appropriate CRF value calculated for the assume life span. The annual cost C_r may be found using the relation (Eq. 14.3).

$$C_r = \frac{P \cdot i(1+i)^n}{(1+i)^n - 1} = P(\text{CRF})$$

Rate-of-Return Method

There are number of variations for the determination of raw of return of a highway improvement. In the rate of return method, die interest rate at which two alternative solutions have equal annual cost is found, If the rate of return of all proposed projects are known, the priority for the improvement could be established.

Benefit Cost ratio Method

Principle of this method is to assess the merit of a particular scheme by comparing the annual benefits with the increase in annual cost

$$\begin{aligned}\text{Benefit cost ration} &= \frac{\text{Annual benefits from improvement}}{\text{Annual cost of the improvement}} \\ &= \frac{R - R1}{H1 - H}\end{aligned}$$

Where R = total annual road user cost for axisting highway

R1 = total annual road user cost for proposed highway improvement

H = total annual cost of existing road

H1 = total annual cost of proposed highway improvement

The benefit-cost ratios are determined between alternate proposals and those plans dub are not attractive are discarded. Then the benefit cost ratios for various increments of added investment are computed to arrive at the best proposal. hi order to justify the proposed improvement, the ratio should be greater than 1.0. However, the choice of interest rate would affect the results of the benefit-cost solutions.

Total annual road user cost for proposal B = RB = Rs. 2491,125

Benefit-cost ratio,

$$B = RA - RB = 3081,330 - 2491.125 = 590,205 = 2.874$$

$$A \quad HB - HA \quad 381,900 - 176,527 \quad 205,373$$

Total annual highway cost of proposal C = HC = Rs.3,75,100

Total annual highway cost of proposal C = HC = Rs.2377,245

Benefit – cost ratio,

$$C = RA - RB = 3081,330 - 2377.245 = 704,085 = 3.546$$

$$A \quad HC - HA \quad 375,100 - 176,527 \quad 198,573$$

Therefore, alternative C is the best one with higher benefit-cost ratio.

HIGHWAY FINANCE

Basic principle in highway financing is that the funds spent on highways are recovered from the road users. The recovery may be both direct and indirect.

Two general methods of highway financing are:

Pay-as-you-go method

Credit financing method

In pay-as-you-go method, the payment for highway improvements, maintenance and operation is made from the central revenue. In credit financing method, the payment for highway improvement is made from borrowed money and this amount and the interests are re-paid from the future income.

Distribution of highway cost

The question of distributing highway cost among the Government, road-user and other has been a disputed task in several countries. Many economists are of the view that the financial responsibility for roads should be assigned only among the beneficiaries on the basis of the benefit each one receives.

There are several theories suggesting the method of distribution of highway taxes between passenger cars and other commercial vehicles like the trucks. However in India the annual revenue from transport has been much higher than the expenditure on road development and maintenance. Therefore there is no problem of distributing the highway cost among other agencies. Also the taxation on vehicles is being considered separately by the states and there seems to be no theory followed for the distribution of taxes between various classes of vehicles.

Sources of Revenue

The various sources from which funds necessary for highway development and maintenance may be made available, are listed below:

Taxes on motor fuel and lubricants.

Duties and taxes on new vehicles and spare part including tyres

Vehicles registration tax.

Special taxes on commercial vehicles

Other road user taxes

Property taxes

Toll taxes

Other funds set apart for highways

There should be an equitable distribution of revenues available for highways.

Highway financing in India

The responsibility of financing different roads lies with the Central Government, State Governments and local bodies including Corporations, Municipalities, District Boards and Panchayats.

Taxes levied by Central Government for highway financing are:

- Duties and taxes on motor fuel

- Excise duty on vehicles and spare parts, tyre etc.

- Excise duty on oils, grease, etc

Taxes levied by the State Governments include:

- Registration fees for vehicles and road tax

- Permits for transport vehicles

- Passenger tax on buses

- Sales tax on vehicle parts tyre etc.

- Fees on driving licenses

Taxes levied by local bodies are mainly the toll tax.

Ever since the introduction of Central Road Fund (CRF) in the year 1929 by taxing motor fuel, this has been the main source of finance for the State Government to meet the road development needs, without having to go through the time consuming process of special sanctions each time. However of late the CRF is also being merged with the general revenue, in March 1976 the Lok Sabha has passed the resolution Of the Ministry of Transport ensuring the existence of the CRF separately with the specified objectives. An Amount of not less than 3.5 paise per litre out of the duty of customs and excise on motor spirit would be set apart towards the CRF for the road development. While utilizing this fund, greater attention

would be given to schemes of all-India importance. Twenty percent of the fund would be retained by the central Government as reserve. The fund will also be used for road research schemes, traffic studies, economics surveys and training arrangements for young engineers. The gross revenue from road transport in India during the sixth plan period 1978-83, 1980-85 was about Rupees 12,000 Crores
