Benefits of using economic analysis :-

Benefits of using economic analysis includes :

(1) Cost effective design & construction

Economic analysis can inform highway agencies as to which of several project designs can be implemented at the lowest life cycle cost to the agency and the lowest work zone delay cost to the traveller and it can identify the best affordable balance between these cost.

(2) Best Return on investment

Economic Analysis can help in planning and implementing transport programmes with the best rate of return for any given budgets or it can be used to help in determining an optimal programme budget.

(3) Understanding complex projects

Highway agencies and other decision makers need to under-stand the true benefits of these projects as well as the effect that such projects will have on regional economics. This information is often very helpful for informing the environment assesment process.

(4) Documentation of decision process.

The decipline of quantifying and valuing the benefits and costs of highway projects also provided, excellent documentation process to explain the decision process to the legislature and the public.

Cost and Benefits of the transport projects

Basic Principle of Economic Evaluation :—

The basic principle behind economic evaluation of any project is to estimate the costs and benefits that likely to occur, and to compare the two. The most difficult part of economic evaluation of a transportation planing is the identification and quantification of various costs and benefits components.

Cost includes :—

(1) Construction cost
(2) Maintence cost
(3) Repairing cost
(4) labour cost
(5) Accident cost
(6) cost of delay
(7) Operation cost (VOC)
(8) Planning & design cost

Benefits includes :—

The basic principal behind economic evaluation of any project to estimate the costs and benefits and to compare the two. The most difficult part of economic evaluation of the transport plan is the identification and quantification of various costs and benefit components.

Benefits :—

(a) Saving travel time
(b) Reduction in VOC (vehicle operation cost)
(c) Taxes.

Cost components can be divided into two cost :—

1) Agency cost :— Agency cost is the cost incurred by the agency (government or private) for construction and maintenance of a highway facility.

→ Construction cost :— involves, the cost of (i) surveying, planning and design, (ii) acquisition of land, (iii) construction of highway, (iv) installation of traffic control devices, (v) cost of supervision, quality control and administrative costs, (vi) installation of other transportation facilities etc.

→ Maintenance cost :- involves the cost of planning and implementation of various maintenance measures implemented on the in-service roads in various time phases. The maintenance costs are cost of (i) periodic repair, (ii) major rehabilitation, (iii) operational expenditure of traffic facility, (iv) supervision and installation charges etc.

2) User cost :- Unlike the case of determination of cost of construction, the evalution of the cost incurred by the users is sometimes difficult to estimate. In some cases, it is not possible to measure also, for example, the pain and grief caused by accidents. Various user cost are :-
(1) Vehicle operating cost (VOC)
(2) cost due to traffic congestion and restraint.
(3) cost due to accident
(4) cost of travel time
(5) cost due to delay.
(6) Accident cost.

Benefits components

Benefits usually represent the difference between the cost of operating on a new transport facility and cost of operating of an existing facility. The various possible forms of benefits are :-

1. → Road user benefits :- It includes, benefits due to : (i) saving in VOC, (ii) saving of travel time, (iii) saving in terms of accident cost, (iv) saving in the cost of maintence etc., (v) saving in delay (in travelling)

2. Non-user benefits (social benefits) :- This type of benefit includes, benefits due to improvement in administration, health, education, agriculture, industry, trade, environmental standards etc. like pollution (air, noise)

In respect of above the benefits may be identified as :- (i) VOC, (ii) Travel time, (iii) Accident cost, (iv) benefit to generated traffic (v) benefits due to diverted traffic, (vi) Environmental effects

→ comfort & convience
→ Indirect benefit :- Taxes

Parameters used in Economic Analysis :-

(1) Time Horizon

The investment for highway construction, maintenance, and its benefits are spread over a time span, and is called as the time horizon of economic assesment. This is generally selected as twenty to thirty years for a highway project, depending on policy or type of road. Time horizon, basically, is the economic analysis period.

(2) Interest Rate

Money earns its interest intrinsically (fundamentally). Interest rate is the return obtained after the end of the year as percentage of the capacital invested at the beginning of the year. Interest rate could be simple or a compound one. This interest rate is an extra cost charged to the highway project and is payable to the source where from the investment has been generated. This is because of the reason, that the money, which has been invested in highway project, could have been invested elsewhere to earn the same interest. This interest rate is used to calculate what would be the amount of money at a future date. And the discount rate, on the other hand, is used to calculate the present equivalent amount of money, of the amount which will be actually invested in future.

(3) Inflation :-

In Construction of major highway project, inflation plays a major role. Construction of major highway project takes a number of years, and meanwhile the cost of material, labour, equipment etc. undergoes price escalation due to inflation. At the same time, due to inflation, the Vehicle operating cost

increases, thereby reducing the benefit. Thus in the benefit-cost considerations, the effect of inflation also needs to be considered. in all the cost and benefit components.

4) Salvage Value :- The estimated value of an asset at the end of its useful life. Salvage value (S) is the worth of the structure at the end of the analysis period. This value is carried over to the next analysis period. There could be different basis of calculating the salvage value. If, after the expiry of the first analysis period, it is assumed that the pavement materials would be recycled, then the cost of existing pavement materials (to be used for recycling) are considered in computation of salvage value. Alternatively, if the pavement life is extended further by putting overlay, in the next analysis period, the salvage, S, could be calculated in the following way :-

$$S = \left(1 - \frac{Y}{X}\right) O_{n_M}$$

where, Y is the number of years between the last overlay (which is done in the year n_M) and the analysis period for which O_{n_M} was the cost incurred and X is the number of years it is expected to actually serve. This is based on the assumption that the service life of the last resurfacing overshoots beyond the analysis period, and accordingly a proportionate salvage value is assigned.

5) Present worth :-

Present worth is the total cost of the project, when investments in various years (during the analysis period) are brought back to the equivalent worth of present year. The present worth can be expressed in the form of the following equation :-

$$\text{Present worth} = C + \left[\sum_{k=n_1}^{n_M} O_k \times \frac{1}{(1+r)^k}\right] - S \times \frac{1}{(1+r)^{n_M}}$$

where, C = cost of construction

n_1 = 1st year in which major maintenance (say, overlay) is done

n_M = last year within the analysis period in which maintenance job is carried out,

O_k = is the cost of maintenance in the k^{th} year,

S = Salvage Value

r = discount rate.

⑥ Capital Recovery factor :- The concept of capital recovery factor is used when only the recurring investments at different periods of time, is brought back to the equivalent investment put at the beginning of the project. This could be made clear by taking the example of the middle terms of above equation by given below, using the following simplifications :-

$$\text{Present worth} = C + \left[\sum_{k=n_1}^{n_M} O_k \times \frac{1}{(1+r)^k}\right] - S \times \frac{1}{(1+r)^{n_M}}$$

(i) Maintenance is done periodically in each year

(ii) the maintenance expenditure is same always, say x,

(iii) the total maintenance expenditure calculated as the 1st year as the base year is equivalent to an one-time expenditure of y. Then,

$$y = \sum_{k=1}^{N} x \times \frac{1}{(1+r)^k} \quad ; \quad N = \text{analysis period.}$$

or

$$y = x \times \frac{(1+r)^N - 1}{r(1+r)^N}$$

The term $\frac{r(1+r)^N}{(1+r)^N - 1}$ = Capital Recovery factor.

Methods of Economic Evaluation

Basic principle of economic evaluation :- $PV = x \frac{1}{(1+r)^n}$

x = cost / after 'n' year benefit

n = year of cost benefit, r = discount rate, PV = present value

Methods :- 1. Rate of Return Method :- (a) Benefit - cost Ratio
(b) First year rate of return

2. Discount cash flow Method :-
(a) Net present value (NPV)
(b) Internal Rate of Return (IRR)

1. Benefit - cost Ratio

It is a ratio of the net present value of all benefits to that of all costs incurred over the analysis period. An investment with a BCR exceeding 1 is considered to be economically feasible, and the alternative with the highest BCR value is considered the best alternative.

$$B\text{-}C \text{ Ratio} = \frac{R - R_1}{H_1 - H}$$

R = total annual cost of road user for existing highway.
R_1 = total annual cost of road user for proposed highway impr.
H = total annual cost of existing road.
H_1 = total annal cost of proposed highway improvement.

Example 14.5 (S.K. Khanna) :-

Single lane road of length 40 km is to be widen to two lanes at the cost of Rs. 6.5 lakhs per km and $r = 10\%$ per year. Cost of maintence of the existing single lane = Rs. 7000 per km. and that of improved 2-lane = Rs. 9,000/km.
Average VOC on existing road = Rs. 1.30 per vehicle-km
" " " improved road = Rs. 1.15 per vehicle-km.
Present traffic is = 2000 motor veh. per day
Design period = 15 years, traffic is estimated to be doubled.

Soln :-

(i) Average traffic during the design period
$= \left(\frac{2000 + 4000}{2}\right) = 3000$ mv/day.

(ii) Average RUC on existing road per year =
$365 \times 40 \times 3000 \times 1.30 =$ Rs. 569.4 lakh.

(iii) Average road user cost on improved road per year =

$365 \times 40 \times 3000 \times 1.15 = Rs.\ 503.7$ lakh.

Total benefits = $569.4 - 503.7 = Rs.\ 65.7$ lakhs.

(iv) Total cost of improvement, $= 6.5 \times 40 = Rs.\ 260.0$ lakhs.

(v) Present annual cost of improvement, $C_r = P.CRF$

$$CRF = \frac{i(1+i)^n}{(1+i)^n - 1}, \quad i = 10\%, \ n = 15 \text{ years.}$$

$$= \frac{10(1+10)^{15}}{(1+10)^{15} - 1} = 0.13147$$

$C_r = 260 \times 0.13147 = Rs.\ 34.182$ lakhs.

(vi) Additional maintance cost per year = Rs. $(9000 - 7000) \times 40$
$= Rs.\ 0.80$ lakh.

(vii) Total cost = Rs. $(34.182 + 0.80) = Rs.\ 34.982$ lakhs

(viii) B-C Ratio $= \frac{65.7}{34.982} = 1.878 > 1$, project is economically viable.

2. First year Rate of Return :-

It is used to indicate the best start day of project. The correct theoratical basis for determining the optimal start time would be to calculate the incremental benefit cost ratio of starting a project in year one comparing to the defering the project to year 2 or a later year.

However, this is a relatively complex calculations for most projects. First year rate of return provides an equivalent basis for determining the best start date. For all projects the first year rate of return shall be calculated for the preffered option.

First year rate of return expressed as a %age. It is defined as the project benefits in the first year following completion of construction divided by the project cost over the analysis period.

$$FYRR = \frac{\text{Present value of project benefit in the first year fully yr following completion.}}{\text{Present value of the project cost over the analysis period.}}$$

3. Net present value :-

In the net present value method, the cost and the benefits of the individual years are discounted to the present value and compared across various alternatives. The Net present value (NPV) at the base year can be written as :-

$$NPV = \sum_{i=0}^{n} \left(\frac{B_i - C_i}{(1+r)^n} \right)$$

$$= (B_0 - C_0) + \frac{(B_1 - C_1)}{(1+r)^1} + \frac{(B_2 - C_2)}{(1+r)^2} + \dots \frac{(B_n - C_n)}{(1+r)^n}$$

The NPV of an investment is the difference between the present worth of benefits and that of costs.

NPV is often considered as the most appropriate of all economic efficiency indicators because it provides a magnitude of net benefits in monetary terms.
Among competing transportation projects or policies, the alternative with the highest NPV is considered the most "economically efficient."

4. Internal Rate of Return Method (IRR)

The IRR method determines the interest rate that is associated with a zero net present value (NPV) and is consequently associated with an equivalency of the present worth of benefits and present worth of costs. The discount rate can be obtained by setting the value of NPV in above equation and solving for 'r'. If the rate of return thus calculated is more than the market interest, then the project is adjudged to be acceptable.

Comparison of Various Methods :-

1. Cost - benefit model is simple to use, but sometimes, when the cost - benefit ratio of two models are close to each other, it becomes difficult to interpret, and choose the best option. Sometimes it appear confusing to take decision which is cost or which is benefit, because saving in cost is benefit in other words.

2. In the NPV or C-B Ratio methods, some discount rate is assumed, and various alternative projects are compared. If different discount rate is assumed instead, the order of choice among the alternatives may change.

3. IRR method itself finds out the discount rate, and therefore inaccuracy in analysis in assuming some arbitary discount rate (as is done in C-B Ratio or in NPV Method) is taken care.

   Thus, IRR method seems to be the most preferred economic analysis tool.

- The FYRR is quick to use but its limitation is that one project may have attractive benefits initially which may thereafter abruptly. Thus IRR is best economic analysis tool.

(Chapter- 6)

Highway Finance

Principle of 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 :-

(1) Pay-as-go method (2) Credit financing method

1. Pay-as-go :- The pavement for highway improvements, maintenance and operation is made from the central revenue.
2. Credit financing :- 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 distribution of highway cost among the government, Road-users 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.

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 taxation on vehicles is being considered separately by the states and there seems to be no theory followed for the distribution of taxes b/w various classes of vehicles.

Sources of Revenue :-

(1) Taxes on motor fuel and lubricants
(2) Duties and taxes on new vehicles and spare parts including tyres.
(3) Vehicles registration tax
(4) Special taxes on commercial vehicles
(5) Other road user taxes
(6) Property taxes
(7) Toll taxes
(8) Other funds set apart for highways.

Highway financing in India

An approximate estimation of the expenditure in the road sector in india, has been carried out for the coming ten years, which amounts to Rs. 25,000 crore for expressways, Rs. 120,000 crore for national highways, and Rs. 70,000 crore for state highways. The funding sources of this huge investment can be tapped from the (1) government sector, (2) international bank loans (3) private sector, and so on.

Taxes levied by central government for highway financing are :-

1. Duties and taxes on motor fuel.
2. Excise duty on vehicles and spare parts, tyres etc.
3. Excise duty on oils, grease, etc.

Taxes levied by the state government include :-

1. Registration fees for vehicles and road tax
2. Permits for transport vehicles
3. Passenger tax on buses
4. Sales tax on vehicle parts tyre etc.
5. Fees on driving licenses.

Taxes levied by local bodies are mainly the toll tax.

→ The golden quadrilateral and North-south and East-west corridors will involve an approximate expenditure of Rs. 58,000 crores. This is as per NHAI (2005).

→ The fundings of these projects have tentatively been arranged from various organisations, such as approximately Rs 20,000 crore from cess (from petrol and diesel), Rs. 20,000 crore from the world Bank and the Asian Development Bank loans, Rs 1,20,000 crore from market borrowings, and Rs. 6000 crore from the private sector. (NHAI 2005)

→ For the ~~Exam~~ PMGSY project, it has been decided that the finance will come from 50% of diesel cess, market borrowings, and external funding agencies. (PMGSY, 2005)

→ The Government funding may come from various sources, such as budgetary allocation, special Road development bonds, fund out of cess on diesel or petrol (known as Central Road Fund, CRF).

→ Toll revenue can be utilized for raising the debt finance or supporting the maintenance activities on that particular road stretch, and needs to be operated by government or a private agency. The difficulty with the toll financing for debt realization is that the 'recovery' time-period is long, and fluctuative. If at least the Maintenance requirement of a particular stretch can be completely financed from toll, it can stay away from the competition with the maintenance requirements of the other roads in the network.

→ Shadow Tolling :- In this government pays the investor for each vehicle that enters the stretch. Shadow tolling works better than direct toll from vehicles.

Ques :- what are policies adopted by govt. for incouraging participation of private org. in highway projects?

→ Funding for transportation projects can also be attracted from private organisations. The following policies have been adopted by govt. for incouraging participation of private organisation in highway construction project (NHAI, 2005) (MORTH, 2005) :-

Ans :-

1. Declaration of Road sector as an Industry.
2. Provision of capital grant subsidies (subsidy) up to 40% of project cost on case to case basis.
3. Duty free imports of certain identified high quality construction plant and equipments.
4. 100% tax exemption (exception) for 5 years, 30% relief for next 5 years which may be availed of in 20 years.
5. Provision of encumbrance (encumbrancement) - free site for work i.e govt. shall meet all expenses relating to land and other pre-construction activities.

6. Foreign investment upto 100% in road sector. (for indirect)

7. Easier external commercial borrowing loans. (norms)

8. High concession period upto 30 years.

9. Right to collect and retain toll.

Ques:- Models for involvement of private organization in highway projects?

There could be various models of degree of involvement of private organizations in a transportation project financing include:-

(i) Completely owned, financed and operated by a private body.

(ii) Build, operate, and transfer (BOT) approach.

(iii) Build, transfer, and operate (BTO) approach.

(iv) Finance, build, and lease approach.

Out of these models, the BOT is generally considered the most effective form of privatization. several variations of the BOT approach exist, such as, build, own, and operate (BOO); build, own, operate, and sell (BOOS); build, own, operate, and transfer (BOOT), built, operate, lease and transfer (BOLT).

Transportation project requires large outlay of investment; therefore, all the funding possibilities may have to be explored for successful implementation of a conceived project.

→ The cost of a proposed highway construction incurred by the agency (govt. or private) is rather easier to estimate than estimating the equivalent costs incurred and/or benefits enjoyed by the road users. The agency cost involves cost of construction and maintenance of a highway facility. The cost (or benefit) of the road user includes vehicle operating cost, congestion cost, accident cost, travel time cost etc.

→ Economic viability of a proposed project can be adjudged through mainly three alternative approaches, viz. cost-benefit ratio method, net present value method and internal rate of return method.

→ The finance to highway projects are arranged from various sources, eg., government funding, loan from financial organizations, private investment, imposition of cess to fuel, floating public bond, tolling etc.

BoT types :- (1) Build, Own and Operate (BOO)
(2) Build, Own, Operate and Sell (BOOS)
(3) Build, Own, Operate and transfer (BOOT)
(4) Build, Operate, Lease and Transfer (BOLT).