LECTURES 11 TO 15----ECONOMIC ANALYSIS

CASH FLOW DIAGRAM

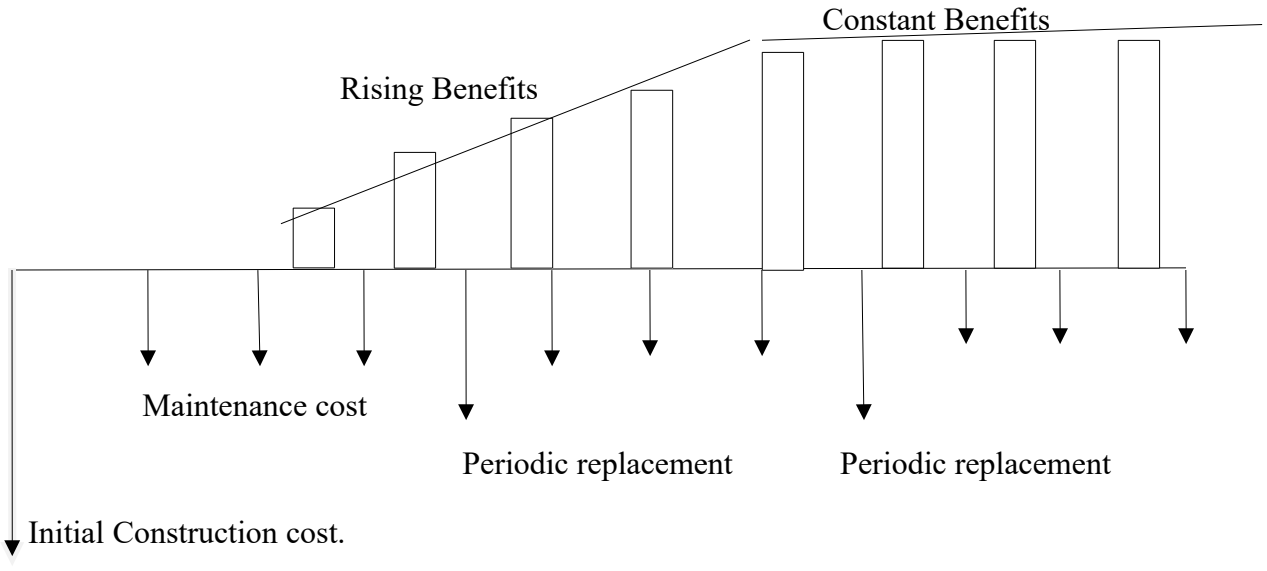
The graphic representation of each monetary value with time is called a cash flow diagram. The benefits are represented as upward arrows and costs as downward arrows. It is drawn to convert the time stream of monetary value into an equivalent single number. All cash flows are combined into an equivalent single lump sum at the end of a period. An example cash flow diagram is shown below. At the beginning, a large expenditure is made. Benefits are received thereafter every year.

It is to be noted, that all expenditure done on a project is included as cost. The cost can be fixed or continuous.

The fixed cost can be the initial construction cost where as there are repeated costs for maintenance. In a hydroelectric power plant, the initial cost shall be the cost of making a dam, various channels, cost of equipment, cost of acquiring land, cost of approach roads etc.

The variable cost (annual) shall be the cost of repairing, consumables used, wages to workers.
There is one more cost, i.e. periodic replacement of worn out of equipment, It may be carried out six monthly, yearly and so on. See the cash flow diagram given below

Arrows pointing downwards=cost
Arrows pointing upwards= Benefit



The benefits start to grow gradually as the project start their activity and reach a value after which the benefits remain constant, as indicated in the cash flow diagram.

Discounting Factors:-

i=rate of interest, n=number of years

The amounts at different times have different values. In order to compare them, all monetary values are converted into equivalent amounts at some definite time using discount factors. Many discount factors are used as given below.

Compound amount factor	An amount P invested at the beginning of first year grows to Q at the end of n years, $Q = P(1+i)n$
Present worth factor	Inverse of the above, gives the present value of a future amount, $P = Q/(1+i)n$
Sinking fund factor	The amount X that will be received at the end of each year to get Q at the end of n years, $X = Q\ i\ /\ [(1+i)n\ -1]$
Capital recovery factor	The amount X that should be invested at the end of each year, if amount P is invested at the beginning of first year, $X = P\ i\ (1+i)n\ /\ [(1+i)n\ -1]$
Series compound factor	The amount Q that will be received at the end of nth year, if an amount X is invested at the end of each year, $Q = X\ [(1+i)n\ -1]\ /\ i$
Series present worth factor	The present value of P if an amount X is invested at the end of each year, $P = X\ [(1+i)n\ -1]\ /\ i\ (1+i)n$

Sunk cost: The money spent already which has no economic relevance in deciding future alternatives .

Sunk cost is the cost lost due to a number of reasons

EXAMPLE:-
Suppose a project is approved for design. The project is an electricity generation project costing Rs. 10 crores. The project is to be carried out in two stages as per funds available as :-
First five years-----3 crores
2nd five years------7 crores
After first five years have been completed using the available funds of 3 srores, a new technology comes in which could make the **entire project** in 4 lacs only.
The project is abandoned to make the project completed in 4.5 lacs only, thus saving an amount of 7-4.5=2.50 crores crores. Under these circumstances, the 3.0 crores spent in the first five years are neglected.
The amount of 3.0 crores abandoned are termed as sunk cost.

Salvage value: The value of the unused life of an element at the end of the period of analysis. The salvage value, S = I (1 – U/L), where I = initial value, U = unused life and L = total life.

Salvage value actually tries to capture the remaining scrap of a particular machine, after its useful life of usage. Most of the time Companies buys new machinery after completion of the effective life of usage and sells the old machine on the basis of its scrap value. Again, the depreciation which was provided during the effective life of the machinery (in terms of money) actually revolves within the working capital of the company. The cost and installation of the machinery of new come from the bank balance of the company.

The salvage value formula requires information like purchase price of the machinery, depreciation amount, mode of depreciation, expected life of the machinery etc. to get the actual value of the scrap or the salvage amount of the machinery. Sometimes due to better than expected efficiency level, the machine tends to operate smoothly in spite of completion of tenure of expected life.

Depreciation is calculated in monetary terms. Due to regular wear and tear of the machinery, the efficiency level decreases and the output tends to decrease in the course of time. Thus to reflects this in the Financial statement of the Business, Depreciation is treated as an expense and is calculated in monetary terms. There are two types of depreciation methods which are used in Finance. These are "Straight-line depreciation" and "Diminishing balance method of depreciation". In Straight-line depreciation fixed amount of depreciation is followed whereas in Diminishing balance, a fixed rate is followed and the amount of depreciation decreases along with the changing value of the opening balance of the machinery. Thus, after deducting the depreciation over the expected years, the remaining amount is treated as the 'Salvage amount' and in the language of Finance, it is believed the operating power of the machinery is finished and the value of the parts is only available for sale.

EXAMPLE :-

Q.1 Engineering machinery costing INR 100,000 has a useful life of 7 years. The amount of depreciation is INR 10,000 / year. Calculate the Salvage value of the machinery after 7 years..

Salvage Value is calculated using the formula given below

S = P – (I * Y)

P=100,000, n= 7 years, I= Useful life scan=7 years
S=100000 - (7X 10,000)
S= 30,000.

Q2. An Engineering machinery costing INR 1,000,000 has a useful life of 10 years. The amount of depreciation is INR 100,000 per year. Calculate the Salvage value of the machinery after 10 years.
Salvage Value =INR 1,000,000 – (INR 100,000 * 10)
Salvage Value =INR 1,000,000 – 10,00,000
Salvage Value = **INR Nil**

EXAMPLE

- Let's say that an **irrigation firm** has purchased equipment at $100,000. The company finds out that the useful life of this equipment is 10 years and at the end of 10 years, the value of the equipment would be $10,000. **So the scrap value** of the equipment is $10,000.
- Now, as we know that the value of the equipment is $10,000, the depreciation for this equipment will be calculated on = ($100,000 – $10,000) = **$90,000.**
- $$Salvage\ Value\ (S) = P(1-i)^y$$
- **Here, P = Original cost of the asset, i = depreciation rate, y = number of years**

- So, to find out the scrap value, you first need to make sure that the depreciation rate should be determined. Along with that you also need to know how many years the asset will last (the useful life of the asset)
- When a company purchases an asset, first, it calculates the salvage value of the asset. Thereafter this value is deducted from the total cost of the assets and then the depreciation is charged on the remaining amount

EXAMPLE

A firm has bought an asset of $1 million. They figured that the useful life of the asset would be around 20 years. And the depreciation rate on which they will depreciate the asset would be 20%. Find out the salvage value of the asset the firm just purchased.

SOLUTION:-

In this example, we have been given the original price of the asset, i.e. $1 million. The useful life of the asset is also given, i.e. 20 years and the depreciation rate is also provided with, i.e. 20%.
Salvage value Formula = P $(1 - i)^y$ = $1 million $(1 - 0.20)^{20}$
= $1 million $(0.8)^{20}$ = $11,529.22

Discounting techniques

Discounting techniques are used to find the feasible one among various alternatives. Commonly used discounting techniques are (1) Benefit-cost ratio method (2) Present worth method (3) Rate of return method and (4) Annual cost method.

Benefit – Cost (BC) ratio method BC ratio, *R* is defined as the ratio of the present worth of benefits and the present worth of cost. It can be expressed as $R=B_t / C_t$ where t is the particular time.

The steps to be followed for choosing the best alternative are:
(i) Calculate the BC value for each alternative

(ii) Retain all alternatives with BC>1 and reject the rest. If sets of mutually exclusive alternatives are involved then go to steps (iii), (iv) and (v).

(iii) Rank the set of mutually exclusive alternatives in the order of increasing cost. Calculate the BC ratio using incremental cost and incremental benefit of the next alternative above the least costly alternative.

(iv) Choose the more costly alternative of the incremental BC >1. Otherwise choose the less costly alternative.

(v) Repeat the analysis for all alternatives in the order of rank.

EXAMPLE:-

Two alternative plans are feasible. The estimated cost of 1st plan is 70 lakhs and the corresponding benefit is 80 lakhs. The cost for the 2nd plan is 85 lakhs and benefit is 100 lakhs. Which plan should be selected?

Solution BC ratio for 1st plan = 80/70 = 1.14
BC ratio for 2nd plan = 100/85 = 1.176
Since BC ratios are >1, according to steps (iii) and (iv), rank the plans based on cost. Plan 1 is ranked 1 and plan 2 is ranked 2.

Now, incremental cost (2nd plan over 1st plan) = 85 – 70 = 15
Incremental benefit (2nd plan over 1st plan) = 100 – 80 =20
Incremental BC ratio = 20/15 = 1.33.
Since Incremental BC ratio > 1, the more costly alternative should be selected. Therefore, plan 2 is chosen.

CHALLENGES IN WATER RESOURCES SECTOR

The major challenges in water sector as per World Water Forum are listed below:

Meeting basic needs:- 20% of the world population do not have access to adequate safe drinking water. 3-4 million people die due to water-borne diseases every year. Access to water is a basic human need. While the participation of community is essential to ensure secure and sustainable supplies of water, women as the custodians of health and hygiene hold the key in such effort.

Protecting ecosystems:- Aquatic ecosystems are repositories of biodiversity and form or constitute a crucial part of hydrological cycle. The decline in their area and their quality will turn rivers into open sewers without any aquatic life and also reduce the biological diversity. A balance between human needs and the intrinsic value of ecosystems needs to be ensured.

Securing food supply:- Agriculture is the largest user of water (around 90%). The demand for food grains is expected to increase by 30-40 % in the next 25 years due to the increase in population and also change in the consumption patterns.

Sharing water resources:- River basins as the main source of freshwater, need a cooperative management. Upper states should consider the interests of other riparian states in the same basin.

Dealing with hazards :-Too much water and also too little water affects people and property. Floods and droughts are recurrent phenomena that cannot be prevented. Government is responsible to provide security from such hazards. Both structural (embankments, dams etc) and non-structural (forecasting systems, contingency plans etc) methods are to be adopted for a sustainable flood and drought management.

Valuation of water :-It is necessary to understand the economic, social and cultural values of water. Wastage decreases when the price is high. For effective water management, the concerned agencies must have adequate resources. The valuation of water resources and charging for water services need active participation of stakeholders.

Governing water wisely:- River basin management requires a suitable institutional framework. Governing bodies should allocate water effectively and also manage water resources based on legitimate requirements as per agreed policies and laws. An integration of private and public sectors and also frequent interactions between stakeholders will create an enabling environment. The main actions to be taken to solve problems in water sector are:

a) Integrated management of river basins

b) Participation of community in the management

c) Improved agricultural practices

d) Extensive and reliable database of information dissemination

e) Proper valuation of water

Need for Planning and Management of water Resources Projects

Planning and management of water resources systems are essential due to following reasons :----------

(1) Severity of the adverse consequences of droughts, floods and excessive pollution. These can lead to(a) Too little water due to growing urbanization, additional water requirements, in stream flow requirements etc. Measures should be taken to reduce the demand during scarcity times.(b) Too much water due to increased flood frequencies and also increase in water requirements due to increased economic development on river floodplains.(c) Polluted water due to both industrial and household discharges.

(2) Degradation of aquatic and riparian systems due to river training and reclamation of floodplains for urban and industrial development, poor water quality due to discharges of pesticides, fertilizers and wastewater effluents etc.

(3) While port development requires deeper rivers, narrowing the river for shipping purposes will increase the flood level

(4) River bank erosion and degradation of river bed upstream of the reservoirs may increase the flooding risks

(5) Sediment accumulation in the reservoir due to poor water quality. Considering all these factors, the identification and evaluation of alternative measures that may increase the quantitative and qualitative system performance is the primary goal of planning and management policies.

Planning and Management – Approaches

Two approaches which lead to an integrated plan and management policy are the top down or the command and control approach. and the bottom up or the grass-roots approach.

Top down approach: Water resources professionals prepare integrated, multipurpose “master” development plans with alternative structural and non-structural management options. There is dominance of professionals and little participation of stakeholders. In this approach, one or more institutions have the ability and authority to develop and implement the plan. However, nowadays,

since public have active participation in planning and management activities, top-down approaches are becoming less desirable or acceptable.

Bottom up approach: In this approach there is active participation of interested stakeholders – those affected by the management of the water and land resources. Plans are being created from the bottom up rather than top down. Top down approach plans do not take into consideration the concerns of affected local stakeholders. Bottom up approach ensures cooperation and commitment from stakeholders. The goals and priorities will be common among all stakeholders by taking care of laws and regulations and by identifying multiple alternatives and performance criteria. Tradeoffs are made between conflicting goals or measures of performance.

Integrated Water Resources Management (IWRM)

According to Global Water Partnership (GWP, 2000), IWRM is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of the vital ecosystems.

An integrated water management model develops solutions by involving all the essential components into an optimization scheme. The resources are used in relation to social and economic activities and functions. There is a need for laws and regulations for the sustainable use of the water resources. Dublin principles for a good water resources management as described by the United Nations Water Conference in 1977 are:

The "**ecological principle**" – to treat water as a unitary resource within river basins, with particular attention to ecosystems.

The "**institutional principle**" – to respect the principle of subsidiary through the involvement of government, civil society and the private sector.

The "**instrument principle**" – to recognize water as a scarce economic community by imposing various penalties for excessive usage. A management policy must be developed only after considering the factors such as cost effectiveness, economic efficiency, environmental impact, ecological and health considerations etc.

Planning and Management Aspects

Technical aspects

It is first necessary to identify the characteristics of resources in the basin, including the land, the rainfall, the runoff, the stream and river flows and the groundwater Technical aspects of planning involves Predicting changes in land use/covers and economic activities at watershed and river basin levels Estimation of the costs and benefits of any measures being and to be taken to manage the basin's water resource including engineering structures, canals, diversion structures Identification and evaluation of alternative management strategies and also alternative time schedules for implementing those measures

Economic and Financial aspects

Water should be treated as an economic commodity to extract the maximum benefits as well as to generate funds to recover the costs of the investments and of the operation and maintenance of the system. Water had been treated for long as a free commodity. Revenues recovered are far below the capital cost incurred. Financial component of any planning process is needed to recover construction costs, maintenance, repair and operation costs. In management policies, financial viability is viewed as a constraint that must be satisfied; not as an objective whose maximization could result in a reduction in economic efficiency, equity or other non-monetary objectives.

Institutional aspects

Successful project implementation needs an enabling environment. National, provincial and local policies, legislation and institutions are crucial for implementation of the decisions. The role of the government is crucial since water is (i) not a property right (ii) a resource that often requires large investment to develop and (iii) a medium that can impulse external effects. The main causes of failure of water resources development project are insufficient institutional setting and lack of a sound economic evaluation and implementation

CONCEPT OF A SYSTEM

A system can be defined as a set of objects which interact in a regular, interdependent manner. It is a collection of various factors arranged in an ordered form with some purpose or goal. A system is characterized by: A system boundary: Rule that determines whether an element is a part of the system or the environment Statement of input and output interactions with the environment Statement of interrelationships between the various elements of the system called feedback State of the system represents the conditions or indicates the activity in the system at a given time e.g. water level in a reservoir, depth of flow. System analysis deals with arriving at the management decisions based on the systematic and efficient organization and analysis of relevant information.

System Components

Water resources management involves the interaction of three interdependent subsystems:

1. Natural river subsystem in which the physical, chemical and biological processes takes place

2. Socio-economic subsystem, which includes the human activities related to the use of the natural river system

3. Administrative and institutional subsystem of administration, legislation and regulation, where the decision, planning and management processes take place Inadequate attention to one subsystem can reduce the effect of any work done to improve the performance of the others.

Classification of Systems:-

Physical system:-- One that exists in the real world

Sequential system:-- A physical system with input, working medium and output

Static system:-- Output depends only on current input

Dynamical system :-- Output depends only on current and previous inputs

Time-varying system: - Kernel changes with time (A kernel is a weighting function used to estimate the probability density function of a random variable in a nonparametric way)

Time-invariant system: -- Kernel does not change

Deterministic system: -- Kernel and inputs are known

Stochastic system:-- Kernel and inputs are not exactly known

Continuous-time systems: - Inputs, outputs and kernel vary continuously with time

Discrete time systems:-- Inputs, outputs and kernel are known at discrete times. Hydrologic systems are distributed in time and space. Systems are divided into sub-systems for the purpose of solution. Hydrologic system is a physical, sequential and dynamic system. The input-output relationship can be expressed as: $y(t) = \Phi [x(t)]$ where x(t) and y(t) are time functions of input and output respectively; and $\Phi[x(t)]$ is the transfer function or the operation performed to transform input to output. For a catchment system, the input is water or energy of various forms and the transfer function may be the unit hydrograph

System Analysis :-- In system analysis an optimal plan is selected through a systematic search and evaluation of various alternatives that meet the objectives and constraints. System analysis consists of five steps: Defining the problem, Identifying the system and its elements , Defining the objectives and constraints, Identify feasible alternatives that satisfy the above said constraints, Identify the most efficient alternative that best meets the objectives

Advantages of System Approach

* Focuses on definite goals and objectives .
* Systematic searching for alternatives.
* Provides with modern technology to analyse the system scientifically and objectively
* Forces the user to identify the known and not readily known elements of the system .
* Regularly provides feedback from each step thus providing flexibility for correction and modification.
* Can deal with highly complex multi-objective multi-constraint problems

Disadvantages of System Approach

* System approach is not suitable when there is a lack of proper and full understanding of water resources systems and its conflicting objectives. Most of the decisions are irreversible in nature and hence hazardous if used without recognizing and integrating the quantitative and non-quantitative dimensions of the system (physical, social, economic, political etc.)

* Can face some practical difficulties due to the gap between the theory and the practice. The transfer of technological advances to practical on field use requires professionals with both theoretical background and practical experience.

* Most water resources systems are complex thereby demanding difficult mathematical computations.

* Unavailability or high cost of software and also unavailability of a part of the data required Dealing with intangibles.

* Systems are not that simple to be fully expressed in mathematical terms

PRINCIPLES OF ENGINEERING ECONOMICS

The Seven Principles:

Each of the seven principles of engineering economics moves you a step closer toward making an economics-related decision.
The first two principles -- making a list of alternatives and identifying the differences between each alternative -- set up the thought process.
The next three principles focus on evaluation criteria. These include establishing consistent evaluation criteria, developing common performance measurements and considering all relevant monetary and non-monetary criteria.
The final two principles focus on analysis. These include weighing risks against potential rewards and performance monitoring. The seven principles are :-

1**. Develop the Alternatives** :- The final choice (decision) is among alternatives. The alternatives need to be identified and then defined for subsequent analysis.

2. Focus on the Differences:- Only the differences in expected future outcomes among the alternatives are relevant to their comparison and should be considered in the decision.

3. Use a Consistent Viewpoint :-The prospective outcomes of the alternatives, economic and other, should be consistently developed from a defined viewpoint (perspective).

4. Use a Common Unit of Measure :-Using a common unit of measurement to enumerate as many of the prospective outcomes as possible will make easier the analysis and comparison of alternatives.

5. Consider All Relevant Criteria Selection of a preferred alternative (decision making) requires the use of a criterion (or several criteria).

6. Make Uncertainty Explicit :- Uncertainty is inherent in projecting (or estimating) the future outcomes of the alternatives and should be recognized in their analysis and comparison.

7. Revisit Your Decisions :-Improved decision making results from an adaptive process; to the extent practicable, the initial projected outcomes of the selected alternative should be subsequently compared with actual results achieved.