

**B.Sc Civil
Engineering**

CONTRACT



Project & Contract Management CE 206

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Engineering Economics

Money-Time Relationship

Engineering Economy

- Engineering economy involves formulating, estimating, and evaluating the expected economic outcomes of alternatives designed to accomplish a defined purpose.

OR

- It is a collection of techniques that simplify comparisons of alternatives on an *economic basis*.
- Mathematical techniques simplify the economic evaluation of alternatives.
- Engineering economy is not a method or process for determining what the alternatives are.
- On the contrary, engineering economy begins only after the alternatives have been identified.

Alternatives

- *An alternative is a stand-alone solution for a given situation.*
- In engineering practice, there are always several ways of accomplishing a given task, and it is necessary to be able to compare them in a rational manner so that the **most economical alternative** can be selected.
- The alternatives in engineering considerations usually involve such items as purchase cost (first cost), anticipated useful life, yearly costs of maintaining assets (annual maintenance and operating costs), anticipated resale value (salvage value), and the interest rate.
- After the facts and all the relevant estimates have been collected, an engineering economy analysis can be conducted to determine which is best from an economic point of view.

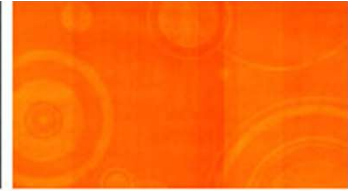
Alternative Selection

- Every situation has at least two alternatives.
- In addition to the one or more formulated alternatives, there is always the alternative of inaction, called the *do-nothing (DN) alternative*. *This is the as-is or status quo condition.*
- *In any situation, when one consciously or subconsciously does not take any action, he or she is actually selecting the DN alternative.*
- Of course, if the status quo alternative *is selected*, *the* decision-making process should indicate that doing nothing is the most favorable economic outcome at the time the evaluation is made.

Evaluation Criteria

- Whether we are aware of it or not, we use criteria every day to choose between alternatives.
- For example, when you drive to campus, you decide to take the “best” route.
- But how did you define *best*? *Was the best route the safest, shortest, fastest, cheapest, most scenic, or what?* Obviously, depending upon which criterion or combination of criteria is used to identify the best, a different route might be selected each time.
- In economic analysis, *financial units (dollars or other currency) are generally used as the **tangible basis for evaluation.***
- Thus, when there are several ways of accomplishing a stated objective, the alternative with the lowest overall cost or highest overall net income is selected.

Evaluation Criteria - Intangible Factors



- In many cases, alternatives have noneconomic or intangible factors that are difficult to quantify.
- When the alternatives under consideration are hard to distinguish economically, intangible factors may tilt the decision in the direction of one of the alternatives.
- A few examples of noneconomic factors are goodwill, convenience, friendship, and morale.

Capital

- **Capital** has a number of related meanings in **economics**, finance and accounting.
- In finance and accounting, **capital** generally refers to financial wealth, especially that used to start or maintain a business.
- In classical **economics**, **capital** is one of three factors of production, the others being land and labor. So the term refers to wealth in the form of money or property that can be used to produce more wealth.
- **Debt capital** is often called borrowed capital and is obtained from lenders. It is that part of a firm's total capital which commonly comprises of loan-capital and short term bank loans such as overdraft.

Equity Capital

- Invested money that, in contrast to debt capital, is not repaid to the investors in the normal course of business. It represents the risk capital staked by the owner through purchase of a company's common stock (ordinary shares).
- The value of equity capital is computed by estimating the current market value of everything owned by the company from which the total of all liabilities is subtracted.
- On the balance sheet of the company, equity capital is listed as stockholders' equity or owners' equity. Also called equity financing or share capital.

Cash Flows

- The estimated inflows (revenues) and outflows (costs) of money are called cash flows.
- These estimates are truly the heart of an engineering economic analysis.
- They also represent the weakest part of the analysis, because most of the numbers are judgments about what is going to happen in the *future*.
- *After all, who can accurately* predict the price of oil next week, much less next month, next year, or next
- decade?
- Thus, no matter how sophisticated the analysis technique, the end result is only as reliable as the data that it is based on.

Buying Behaviour

Here is a simple example of how your buying behavior can have varying results:

- Pretend you have \$100 and you want to buy a \$100 refrigerator for your room. If you buy it now, you end up broke. But if you invest your money at 6% annual interest, then in a year you can still buy the refrigerator, and you will have \$6 left over.
- However, if the price of the refrigerator increases at an annual rate of 8% due to inflation, then you will not have enough money (you will be \$2 short) to buy the refrigerator a year from now. In that case, you probably are better off buying the refrigerator now.
- If the inflation rate is running at only 4%, then you will have \$2 left over if you buy the refrigerator a year from now.
- Clearly, the rate at which you earn interest should be higher than the inflation rate in order to make any economic sense of the delayed purchase.

Buying Behaviour

- In other words, in an inflationary economy, your purchasing power will continue to decrease as you further delay the purchase of the refrigerator.
- In order to make up this future loss in purchasing power, the rate at which you earn interest should be sufficiently larger than the anticipated inflation rate.
- We must connect *earning power and purchasing power to the concept of time*.
- The way interest operates reflects the fact that money has a time value. This is why amounts of interest depend on lengths of time; interest rates. for example, are typically given in terms of a percentage per year.

Time Value of Money

- The economic value of a sum depends on when the sum is received. Because money has both **earning power and purchasing power over time** (i.e., it can be put to work, earning more money for its owner).
- A dollar received today has a greater value than a dollar received at some future time.
- When we deal with large amounts of money, long periods of time, or high interest rates, the change in the value of a sum of money over time becomes extremely significant.
- **Therefore, the change in the amount of money over a given time period is called the *time value of money*.**
- When deciding among alternative proposals, we must take into account the operation of interest and the time value of money in order to make valid comparisons of different amounts at various times.
- It is the most important concept in engineering economy.
- The method's final output is a *measure of worth*, for example, rate of return. This measure is used to accept/reject an alternative.

Interest Rate

- Money is a commodity, and like other goods that are bought and sold, money costs money.
- The cost of money is established and measured by an interest rate.
- *Interest is the manifestation of the time value of money, and it essentially represents “rent” paid for use of the money.*
- Computationally, interest is the difference between an ending amount of money and the beginning amount.
- There are always two perspectives to an amount of interest—interest paid and interest earned.
- Interest is *paid when* a person or organization borrows money (obtains a loan) and repays a larger amount.
- Interest is *earned when a person or organization saves, invests, or lends* money and obtains a return of a larger amount.

Interest Rate or Rate of Return (ROR)

- The computations and numerical values are essentially the same for both perspectives —interest paid and interest earned, but they are interpreted differently.

Interest = end amount - original amount

- When interest over a *specific time unit is expressed as a percentage of the original amount* (principal), the result is called the ***interest rate or rate of return (ROR)***.

$$\text{Interest rate or rate of return} = \frac{\text{interest accrued per time unit}}{\text{original amount}} \times 100\%$$

- The time unit of the interest rate is called the interest period. By far the most common interest period used to state an interest rate is 1 year.

Return on Investment (ROI)

- The term *return on investment (ROI)* is used equivalently with *ROR* in different industries and settings, especially where large capital funds are committed to engineering-oriented programs.
- The term *interest rate paid* is more appropriate for the borrower's perspective, while *rate of return earned* is better from the investor's perspective.

Minimum attractive rate of return (MARR)

- Engineering alternatives are evaluated upon the prognosis that a reasonable rate of return (ROR) can be realized. A reasonable rate must be established so that the accept/reject decision can be made for an alternative.
- The reasonable rate, called the *minimum attractive rate of return (MARR)*, must be higher than the cost of money used to finance the alternative, as well as higher than the rate that would be expected from a bank or safe (minimal risk) investment.
- For a corporation, the MARR is always set above its *cost of capital*, that is, the interest rate a company must pay for capital funds needed to finance projects.
- The following inequality must be correct for any accepted project.

$$\mathbf{ROR \geq MARR > \text{cost of capital}}$$

Elements of Transactions Involving Interest

- Many types of transactions involve interest-e.g., borrowing money, investing money, or purchasing machinery on credit-but certain elements are common to all of these types of transactions:
 1. The initial amount of money invested or borrowed in transactions is called the **principal (P)**.
 2. The **interest rate (i)** measures the cost or price of money and is expressed as a percentage per period of time.
 3. A period of time called the **interest period (n)** determines how frequently interest is calculated.

Elements of Transactions Involving Interest

4. A specified length of time marks the duration of the transaction and thereby establishes a certain **number of interest periods (N)**.
5. **A plan for receipts or disbursements (A_n) that yields a particular cash flow** pattern over a specified length of time. (For example, we might have a series of equal monthly payments that repay a loan.)
6. **A future amount of money (F)** results from the cumulative effects of the interest rate over a number of interest periods.

Inflation

- *Inflation is the increase in the amount of money necessary to purchase the same amount of a product or service over time.*
- *It occurs because the value of the currency has decreased, so it takes more money to obtain the same amount of goods or services.*
- **Purchasing power , or buying power ,** measures the value of a currency in terms of the quantity and quality of goods or services that one unit of money will purchase.
- **Inflation decreases the purchasing ability of money** in that less goods or services can be purchased for the same one unit of money.
- **Deflation** is the opposite of inflation, in that the purchasing power of the monetary unit is greater in the future than at present.
- That is, it will take fewer dollars in the future to buy the same amount of goods or services as it does today.

Inflation

- Associated with inflation is an increase in the money supply, that is, the government prints more dollars, while the supply of goods does not increase.
- To consider inflation when making comparisons between monetary amounts that occur at different time periods, the *different-value dollars must be converted to constant-value dollars so that they represent the same purchasing power.*
- *This* is an important consideration for alternative evaluation since all estimates are for the future.

Cost Escalation

- **Cost escalation** is defined as changes in the cost or price of specific goods or services in a given economy over a period.
- It is the increase in the cost of any construction elements of the original contract or base cost of a project due to passage of time.
- This is similar to the concepts of inflation and deflation except that escalation is specific to an item or class of items (not as general in nature), it is often not primarily driven by changes in the money supply, and it tends to be less sustained.
- Cost escalation may contribute to a project cost overrun.
- Escalation is usually calculated by examining the changes in price index measures for a good or service.
- In cost engineering and project management usage, escalation are included in project estimates and budgets.

Depreciation

- Over time the value of assets declines or depreciates, ultimately to the point where the value is Nil.
- For businesses it is important to recognise this fact by reducing the value of assets shown on the balance sheet in accordance with the depreciation policy set by the directors.
- Because different types of asset lose value at a faster rate than others it is usually the case that a business will have different rates of depreciation for different classes of asset. The value of a company car may be reduced over 4 years or at 25% per annum, whilst fixtures and fittings may be depreciated over 10 years or at 10% per annum.
- Businesses are free to decide their own depreciation rates and because depreciation is merely an accounting entry which does not involve expending actual funds, but which still reduces profit, it effectively provides a fund for replacing the asset at the end of its useful life.

Consumer Price Index (CPI)

- Consumers usually have a relative, if not a precise sense of how their purchasing power is declining.
- This sense is based on their experience of shopping for food, clothing, transportation, and housing over the years.
- Economists have developed a measure called the **consumer price index (CPI)**, which is based on a typical market basket of goods and services required by the average consumer.
- This market basket normally consists of items from eight major groups: (1) food and alcoholic beverages, (2) housing, (3) apparel (clothing), (4) transportation, (5) *medical care*, (6) *entertainment*, (7) *personal care*, and (8) *other goods and services*.
- The CPI compares the cost of the typical market basket of goods and services in a current month with its cost at a previous time, such as 1 month ago, 1 year ago, or 10 years ago.
- The point in the past to which current prices are compared is called the **base period**.
- The consumer price index is a good measure of the general price increase of consumer products.

Consumer Price Index

Selected Price Indexes between 1993 and 2002

Year (Base Period)	New CPI (1982-84)	Old CPI (1967)	Gasoline (1982)	Steel (1982)	Passenger Car (1982)
1993	144.0	461.2	63.9	116.0	129.8
1994	147.4	441.4	61.7	122.0	133.3
1995	152.2	455.0	63.7	128.8	134.0
1996	156.6	468.2	72.8	125.8	135.2
1997	160.2	479.7	71.9	126.5	135.2
1998	162.5	487.1	53.4	122.5	132.2
1999	166.2	497.8	64.7	114.0	121.4
2000	171.2	512.9	94.6	116.0	133.4
2001	176.6	530.4	90.5	109.7	138.9
2002	178.9	535.8	126.6	117.4	128.8

Consumer Price Index

- From Table shown in previous slide, *we can easily calculate the price index (or inflation rate) of gasoline from 2000 to 2001 as follows:*

$$\frac{90.5 - 94.6}{94.6} = -0.04334 = -4.334\%.$$

Indexation

- Inflation erodes the value of the asset over time. Take Rs 5,000. Over 5 years, assuming an annual rate of inflation of 5%, its actual value would drop to Rs 3,868. This impact of inflation over the value of an asset cannot be ignored. Hence it must be taken into account when computing tax on the difference between the buy and sell cost.
- The way it works is that it allows you to inflate the purchase price of the asset to take into account the impact of inflation.
- This is done so that the investor is taxed only on the capital gain over and above the price rise caused by inflation. The end result is that you get the benefit of lowering your tax liability.

Indexation

- **Indexation** is a technique to adjust tax payments by employing a price index which adjusts for inflation. Or, in other words, **indexation** is the process that takes into account inflation from the time you bought the asset to the time you sell it.
- Indexation helps in saving tax on capital gains as it allows investor to adjust for the effect of inflation on the gains made.
- In case there is a long term capital loss after adjusting purchase price for inflation, no tax is payable.

How indexation works?

- To avail benefit of indexation, one needs to increase the purchase price so it reflects inflation.
- For this, government releases the cost inflation index (CII) every year.
- CII is multiplied with the purchase price to arrive at the inflation adjusted purchase price for tax calculation on capital gain.
- Inflation adjusted purchase price is calculated as:
- $\text{Purchase Price} \times \text{CII of the year sold} / \text{CII of the year purchased}$

