

CE 401 Project Planning and Construction Management

Project Evaluation

Analysis of Capital Investment Decision

- ❑ The process of investment in land, productive equipment, buildings, working capitals, raw material deposits and other assets for future economic gain is particularly difficult and calls for careful analysis.
- ❑ We will discuss the analytical techniques which are used to support investment decisions.



CE 401 Project Planning and Construction Management

Project Evaluation

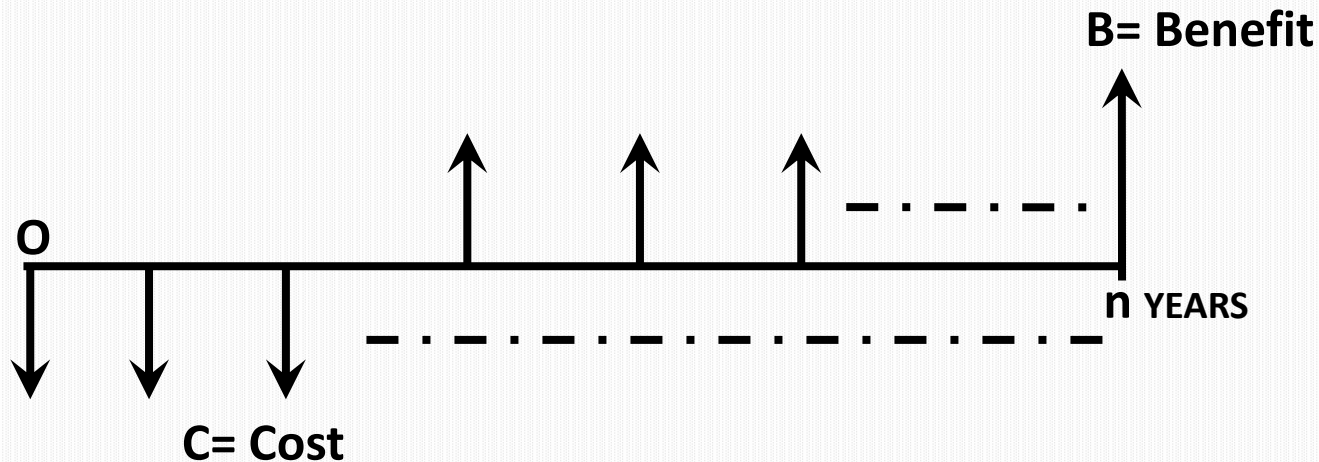
Analysis of Capital Investment Decision

- ❑ **Three elements of investment analysis**
 - **Net investment**
 - **Economic life.**
 - **Operating cash flows**



Project Evaluation

Analysis of Capital Investment Decision



Fundamental reason for investment of capital is “to obtain sufficient economic returns over a future period to justify the original outlay; i.e. **enough receipts to justify enough cash spent**”.

Project Evaluation

Method of analysis

Definitions

Net Investment

Refers to the net outlay

Operating Cash Flow

Are the not economic benefits.

Economic life

The time period over which one can expect to obtain the benefits.



Project Evaluation

Method of analysis

Pay back (Time Period) Is a simple relationship of the annual benefit of a project to the investment required.

$$\text{Pay back} = \frac{\text{Net Investment}}{\text{Av. Annual operating cash flow}}$$

Simple Return on Investment: - inverse of the payback

$$\text{Return on investment} = \frac{\text{Av. Annual Cash Flow}}{\text{Net Investment}}$$

Average Return on Investment

$$\text{Average Return} = \frac{\text{Av. Operating Cash Flow}}{\text{Av. Net Investment}}$$



Project Evaluation

Method of analysis

- ❑ **Advance concept (Time Value Concept)**

Use of time value of money

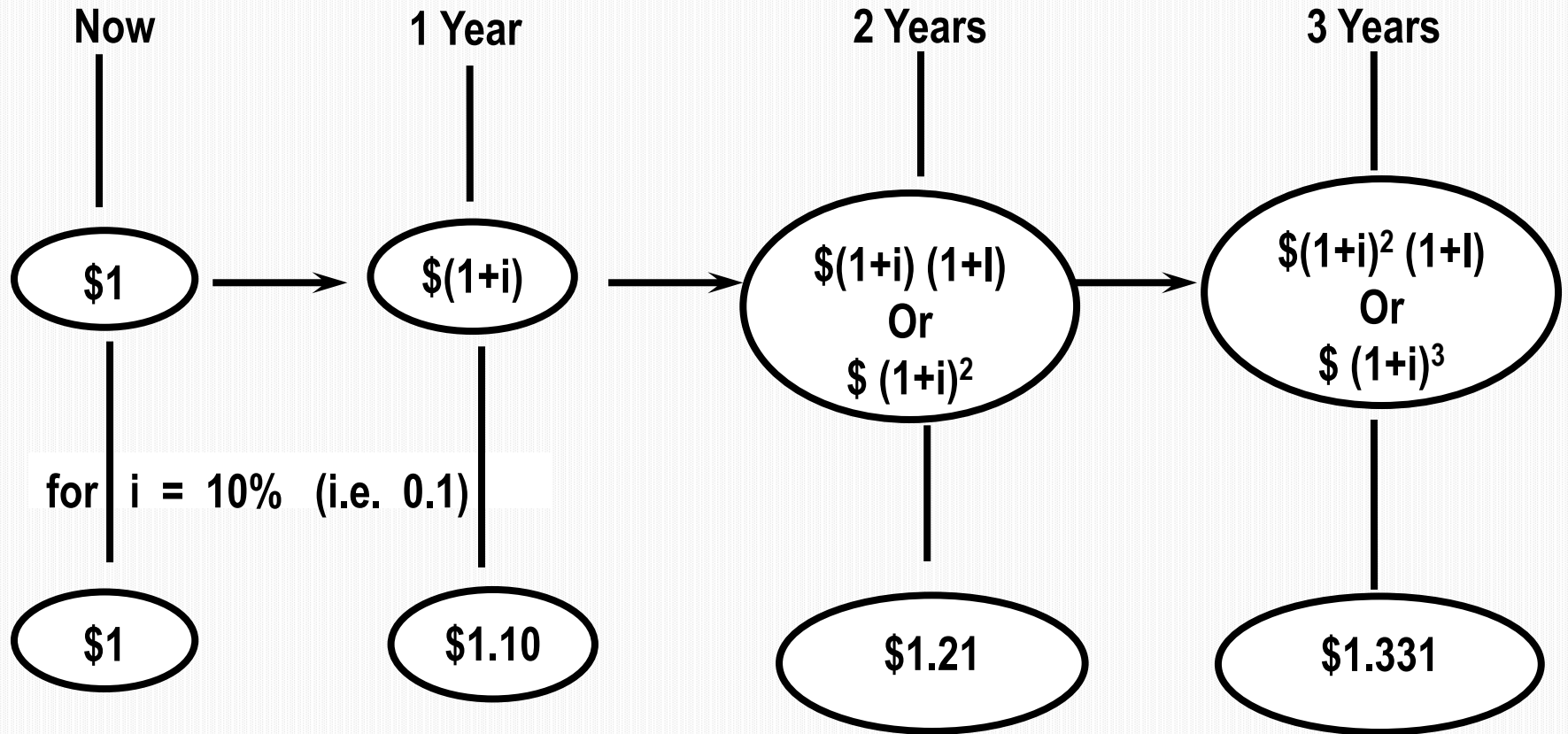
- ❑ **Present Value (PV) concept**

Techniques of Compounding and Discounting

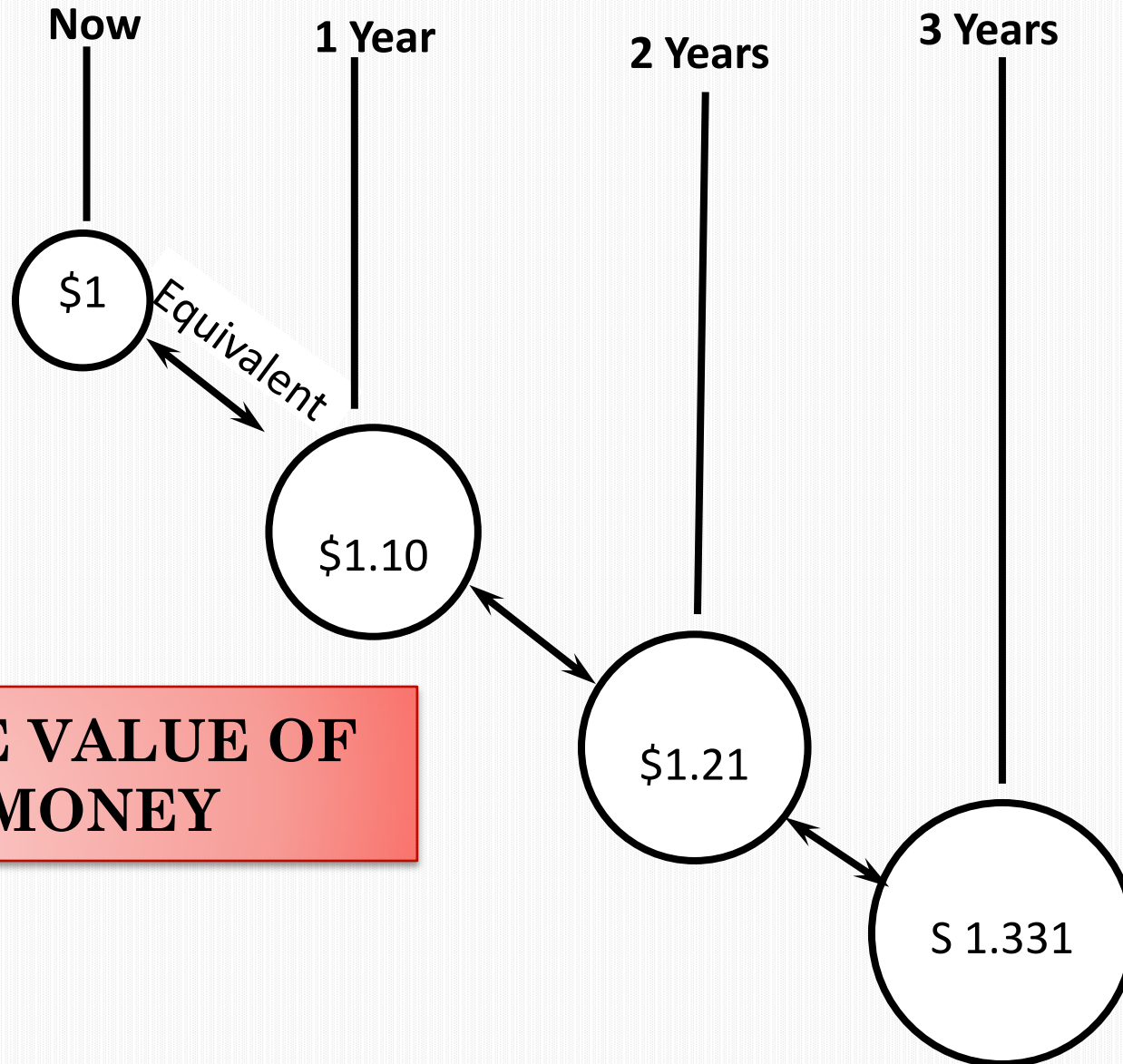


Project Evaluation

Compounding Growth



Project Evaluation

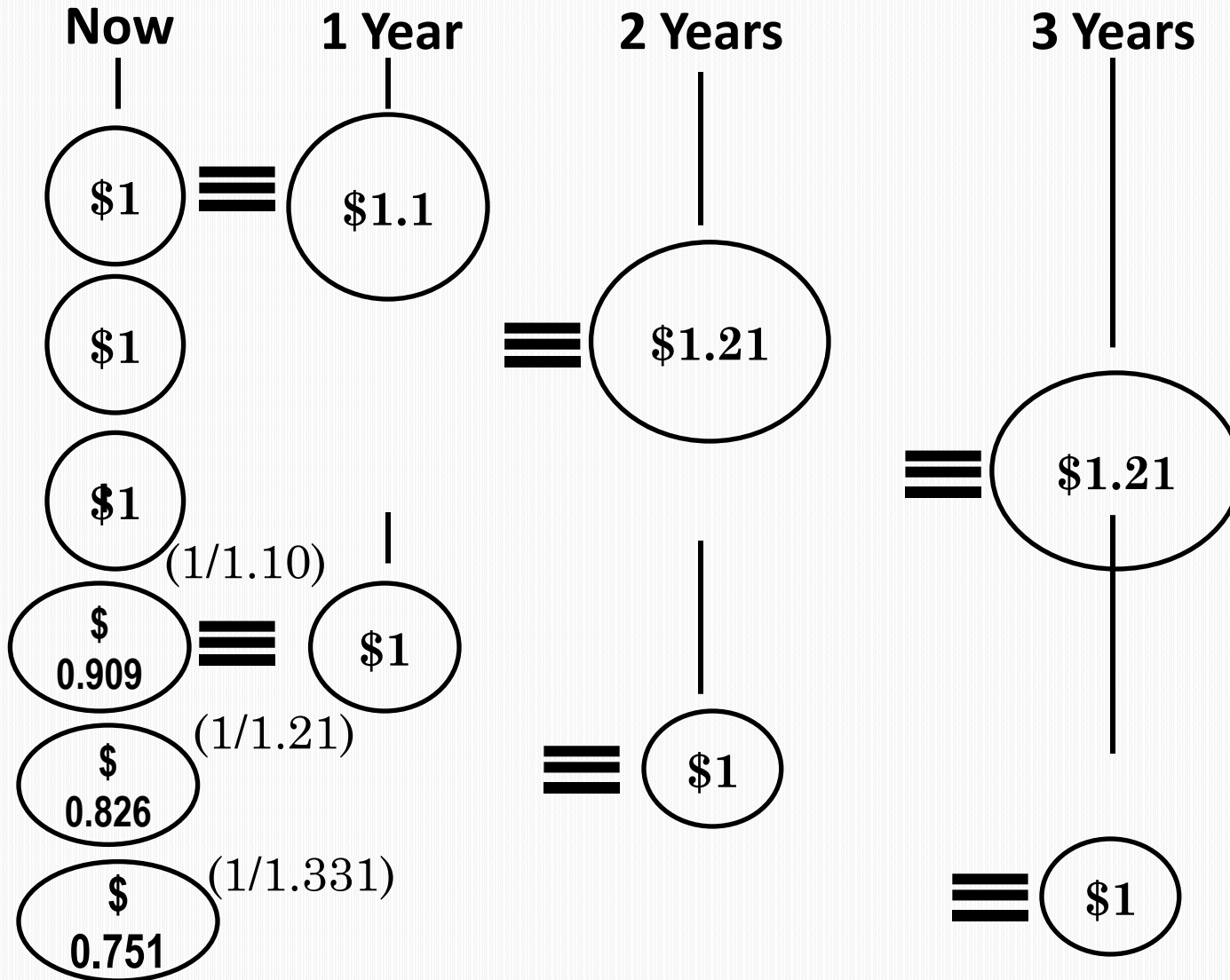


**TIME VALUE OF
MONEY**



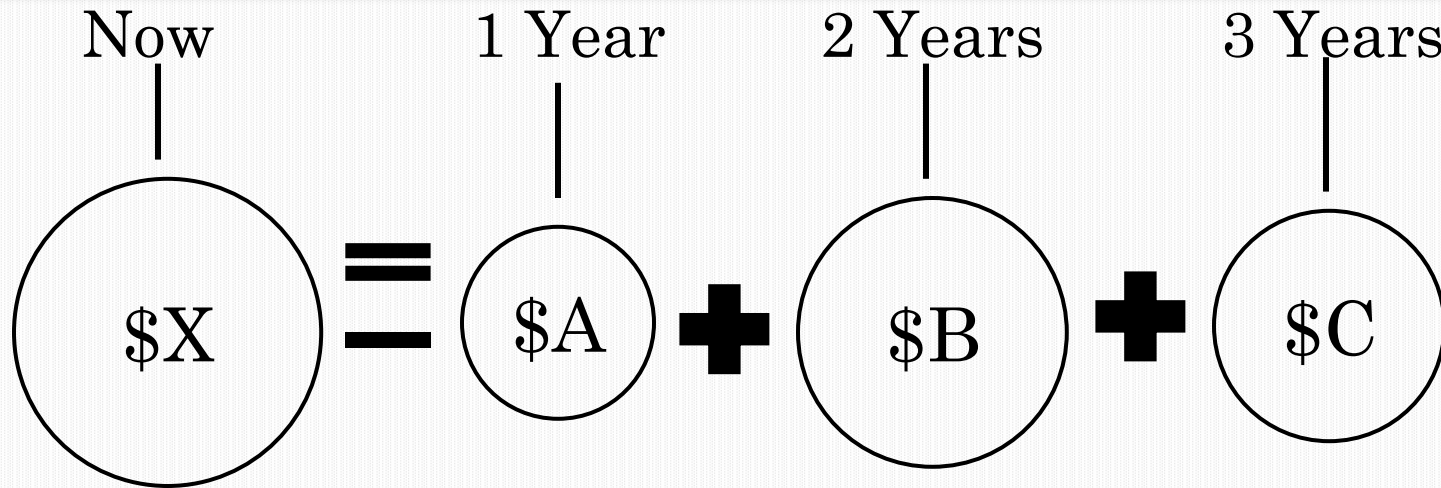
Project Evaluation

DISCOUNTING



Project Evaluation

SUM OF AMMOUNTS IN DIFFERENT YEARS



Considering the time value of money –

Is $\$X = \$ (A+B+C)$

Or, $\$X$ Greater than $\$ (A+B+C)$

Or $\$X$ Less than $\$ (A+B+C)$



Project Evaluation

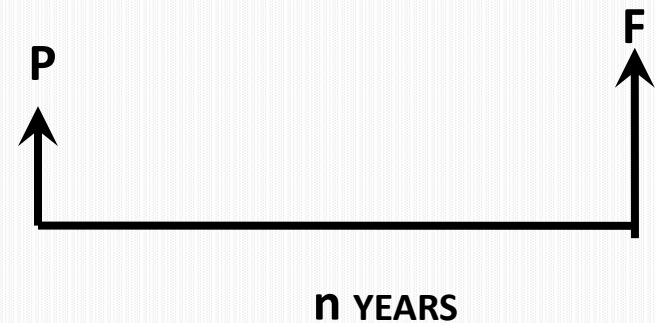
Method of analysis

1. **Compound Amount (CA):** Given P, Find F

$$CA = (1+i)^n$$

i = interest rate (Cost of Capital)

Opportunity Cost of Capital (OCC)



Project Evaluation

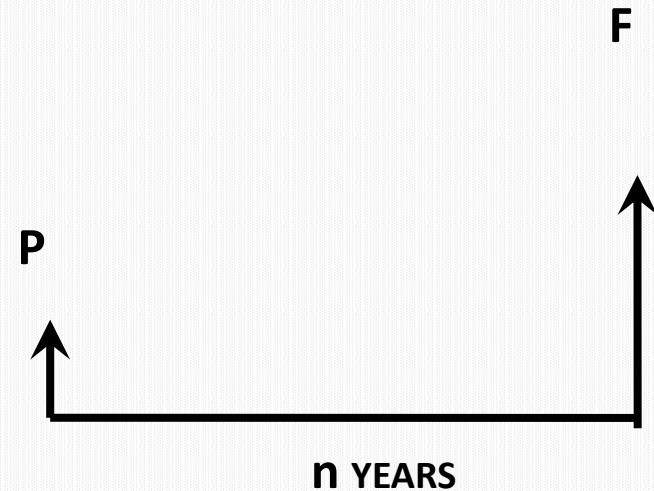
Method of analysis

2. Present Worth (PW)

Given **F**, to find **P**

$$PW = \frac{1}{(1+i)^n}$$

(discount factor)

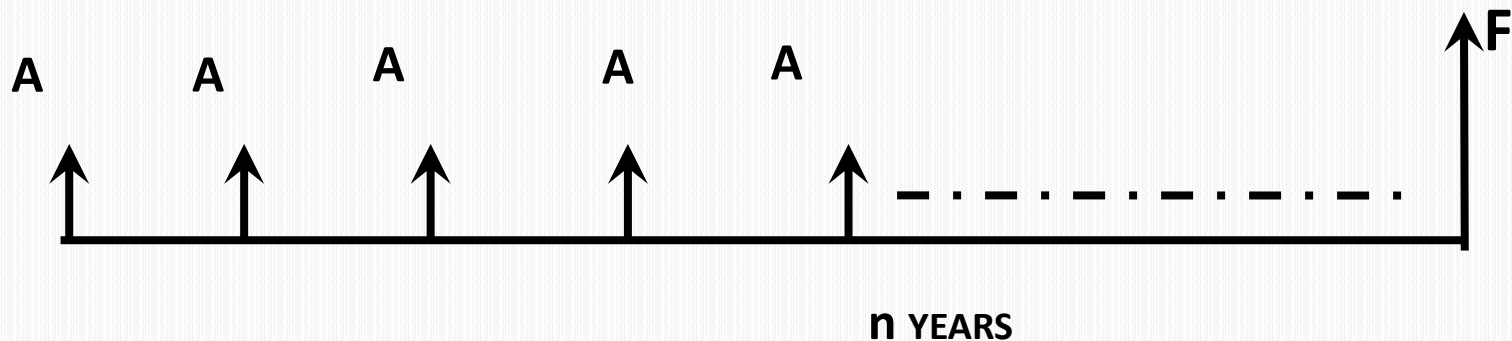


Project Evaluation

Method of analysis

3. Sinking Fund (SF)

For series amount Give F , to find A



i.e. How much must be deposited at $i\%$ each year for n years to have accumulated F ?

$$SF = \frac{1}{(1+i)^n - 1}$$



Project Evaluation

Method of analysis

Sinking Fund Provision

Problem:

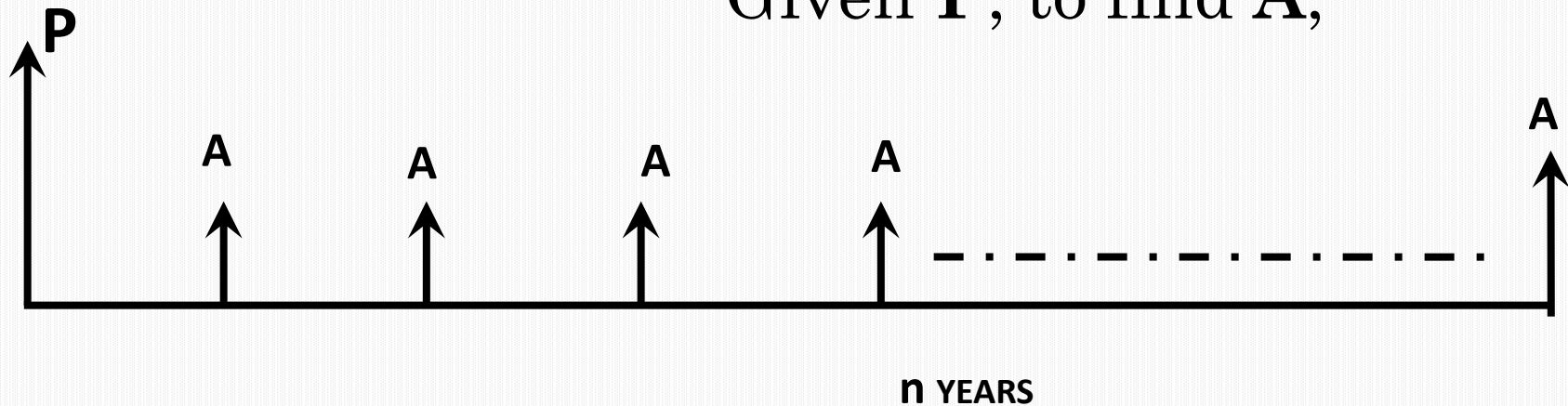
To replace the pumps in 15 years, will cost US \$ 875,000. How much should be the annual collection from the farmers?, given, $i=12\%$

Project Evaluation

Method of analysis

4. Capital Recovery Factor (CRF)

Given P , to find A ,



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

$$A = P \times \text{CRF}$$



Project Evaluation

Method of analysis

5. Compound Amount (Series)

Given **A**, to find **F**

$$SCA = \frac{(1+i)^n - 1}{i}$$

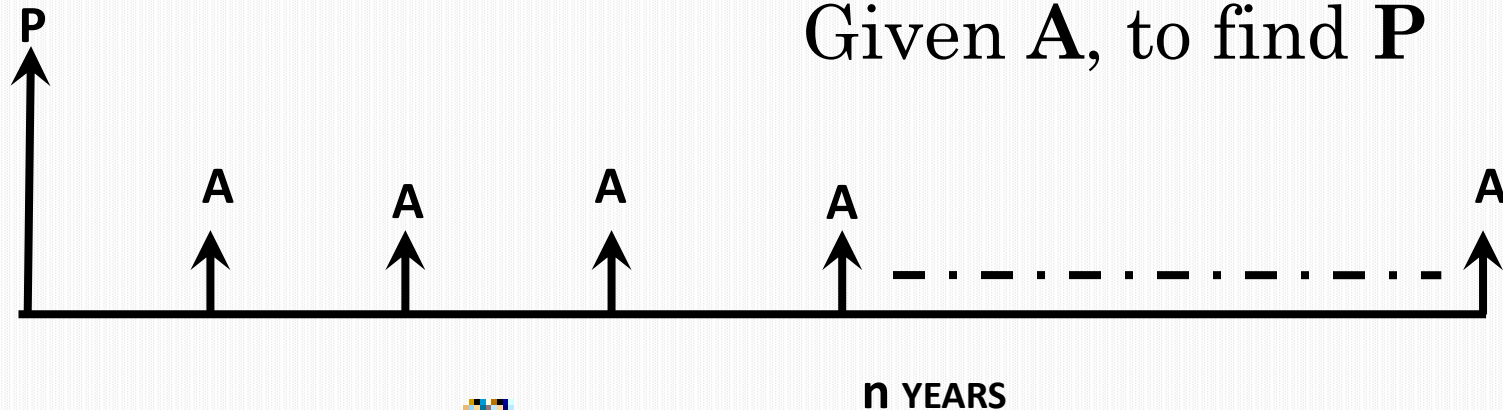


Project Evaluation

Method of analysis

6. Present Worth (Series) (SPW)

Given A, to find P



$$SPW = \frac{(1+i)^n - 1}{i(1+i)^n}$$

SPW = Annuity Factor

$$P = A \times SPW$$



Project Evaluation

Method of analysis

CBA= Const Benefit Analysis

Measures/Criteria for Investment Decisions

The most commonly used measures of discounted figures are

Net present value (NPV)

Benefit/Cost (B/C) ratio

Internal Rate of Return (IRR)

Present Value Payback(PVP),

Present Value Index (PVI)

First Year Rate of Return (FYRR) etc



Project Evaluation

Method of analysis

Example

Purchasing a piece of equipment a company may have the option of paying in two different ways. Each way involve payments over a five year period but the actual payments per year vary in each option as follows:

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|----------|--------|--------|--------|--------|--------|
| Option A | 10,000 | 20,000 | 30,000 | 40,000 | 60,000 |
| Option B | 45,000 | 30,000 | 20,000 | 20,000 | 20,000 |

If payments are made at the end of each year and the discount (interest) rate is constant over the five years and is equal to 10% p.a., which payment option should the company choose?

Project Evaluation

Method of analysis

Problem

Once a cement factory is in full production in 1997, the sixth year of the project (t_6), it will produce cement value Tk. 1,475,000 annually over the economic life of the plant, taken to be 15 years.

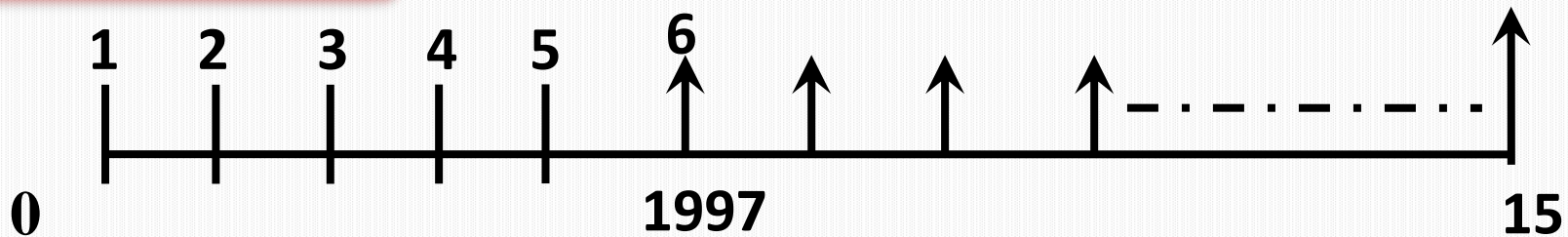
- What is the Present Worth of the cement production from 1997 through 2006 (t_6 - t_{15}) discounted at 12%?
- Find the Present Worth of an annuity Factor.



Project Evaluation

Method of analysis

Solution



$$A = 1,475,000$$

$$DF = \frac{1}{(1+i)^n}$$

$$SPW =$$

$$PWB = (SPW_{15} - SPW_6) * A$$

Here,

$$SPW_{15} = 6.811$$

$$SPW_6 = 3.605$$



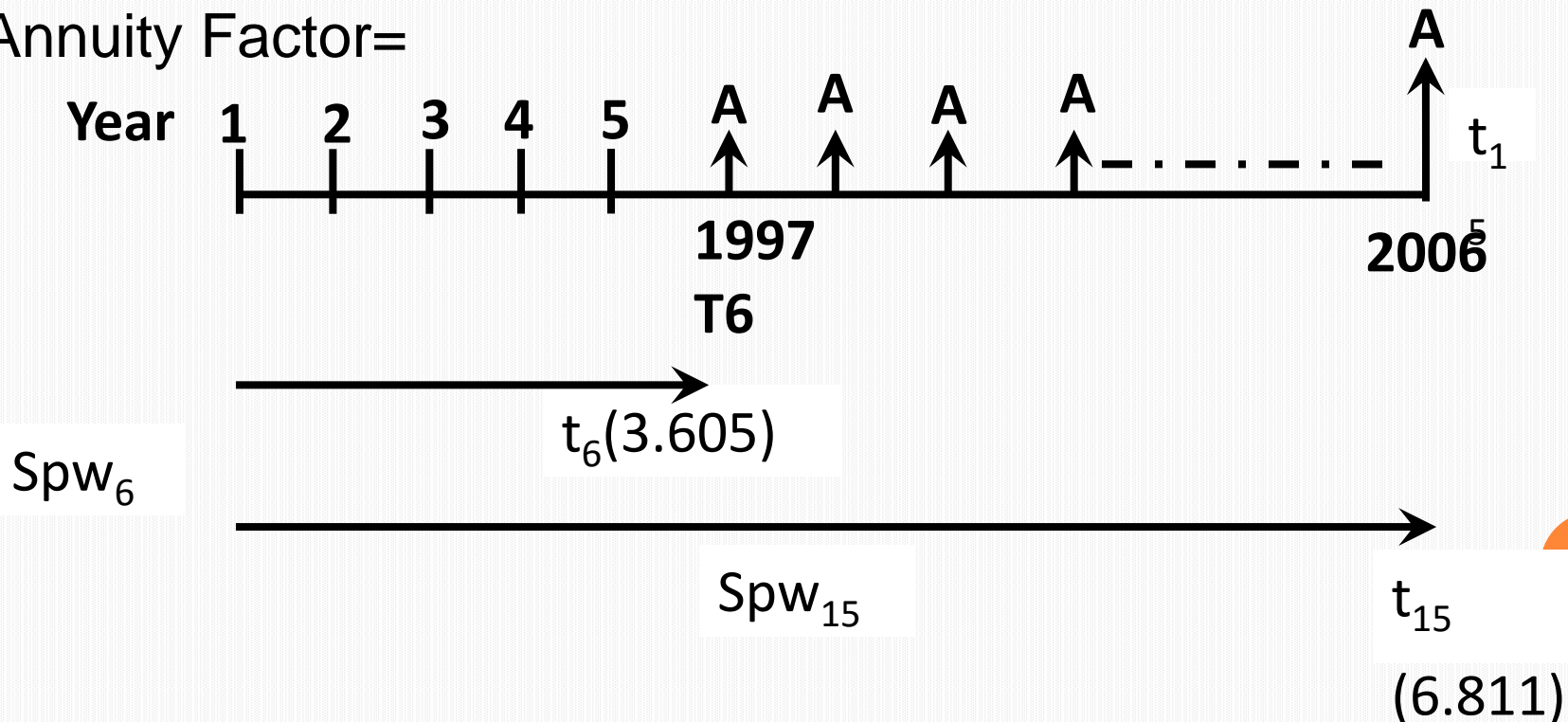
Project Evaluation

Method of analysis

Present Worth of Cement Production

Annual Production = 1,475,000

Annuity Factor =



Project Evaluation

Method of analysis

PW of Total Cement Production

$$= PWB$$

$$=(Spw_{15} - Spw_6) * A$$

$$= (6.811 - 3.605) * 1,457,000$$



Project Evaluation

Method of analysis

CBA (Cost Benefit Analysis)

Computational Exercise

Calculation of –

- I. Payback Period,
- II. Benefit-Cost Ratio,
- III. Net Present Value(NPV),
- IV. Internal Rate of Return (IRR) or Discounted Cash Flow (DCF) Return,
- V. First Year Rate of Return(FYRR)

Project Evaluation

Method of analysis

Problem

Case A : Discount Factor-10%

Case B : Discount Factor 20%

Test: “Sensitivity” Analysis



Project Evaluation

Method of analysis

CASE-A (DISCOUNT FACTOR-10%)

| Yr | Capital | O+M ¹ cost | Total cost | D.F ² 10% | PWC | Gross benefit | D.F ² 10% | PWB | Net benefit |
|--------------|--------------|--------------------------|---------------|-------------------------|--------------|-------------------|-------------------------|--------------|----------------|
| 1 | 7500 | - | 7500 | .909 | 6818 | - | .909 | - | (6818) |
| 2 | 6000 | - | 6000 | .826 | 4956 | - | .826 | - | (4956) |
| 3 | - | 1300 | 1300 | .751 | 976 | 6000 | .751 | 5606 | 3530 |
| 4 | - | 1300 | 1300 | .683 | 888 | 6000 | .683 | 4098 | 3210 |
| 5 | - | 1300 | 1300 | .621 | 807 | 6000 | .621 | 3726 | 2919 |
| 6 | - | 1300 | 1300 | .564 | 733 | 6000 | .564 | 3384 | 2651 |
| 7 | - | 1300 | 1300 | .513 | 667 | 6600 ³ | .513 | 3386 | 2719 |
| Total | 13500 | 6500 | - | - | 15845 | - | - | 19100 | 3255 |

Project Evaluation

Method of analysis

- 1 Operation and maintenance (O&M) costs
- 2 Discount Factor ($1/(1+i)^n$)
- 3 Includes Salvage value of 600

$$\begin{aligned} B/C &= PWB/PWC \\ NPV/NPW &= \text{Total PWB} - \\ &\quad \text{Total PWC} \end{aligned}$$

$$\text{IRR} = \text{Discount Rate at which NPV}=0$$

Exercise: Calculate

- (i) Payback
- (ii) B/C ratio at 10%
- (iii) Net Present Worth at 10% and 20% D.F.
- (iv) IRR (Internal Rate of Return)
- (v) FYRR

CASE-B: (D.F.= 20%)

Project Evaluation

Method of analysis

Results of Worksheet

Solution:

1. **Payback**
- | | |
|------------|----------|
| (i) at 10% | 3.8 yrs. |
| (ii) at 0% | 2.9 yrs. |

2. **B/C ratio** –at 10% $\frac{19100}{15845} = 1.21$

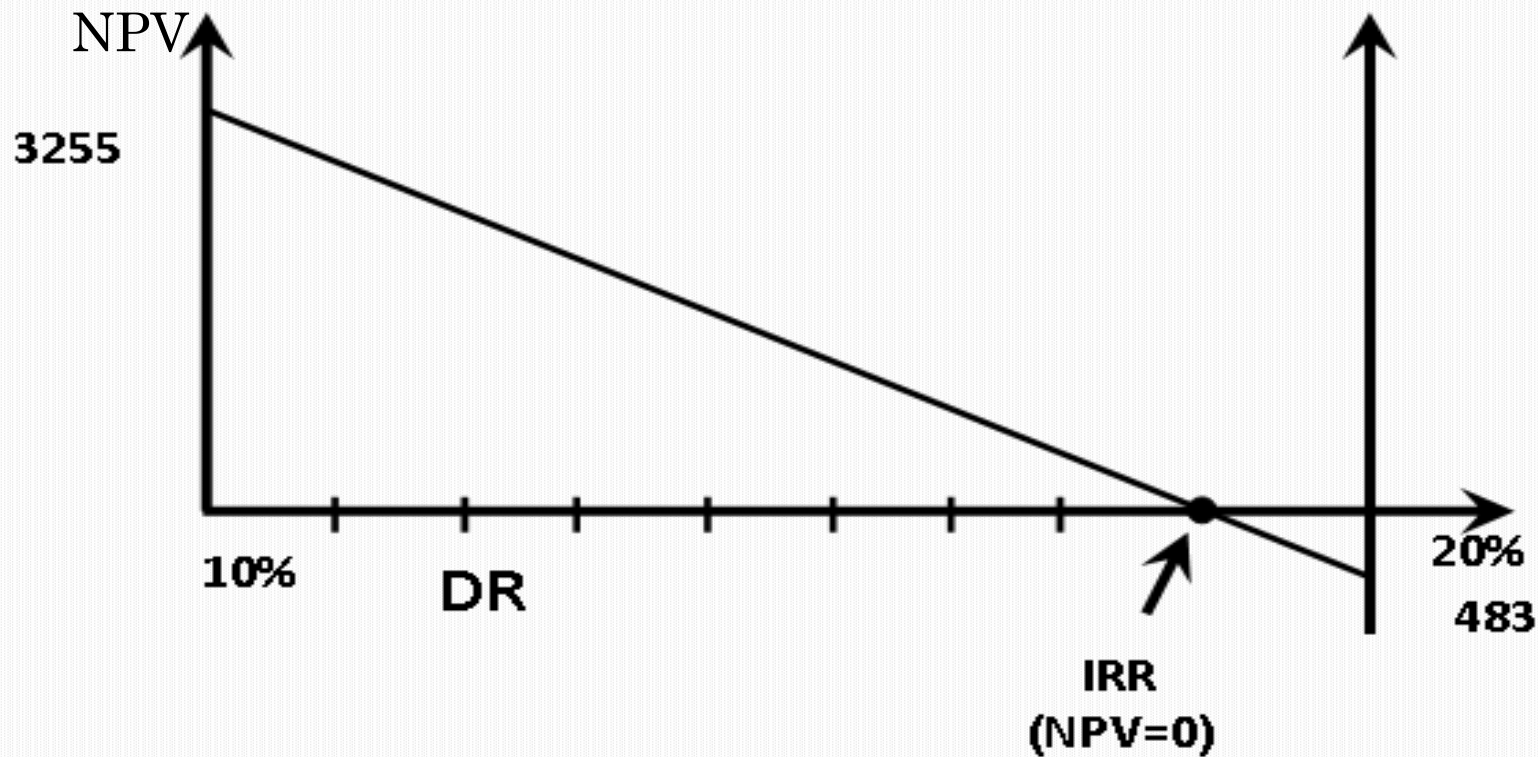
3. **Net Present Worth(NPW) or NPV**

= Present Worth of Total Benefits - Present Worth of Total Costs
= PWB - PWC = 19100 - 15845 = 3255

Project Evaluation

Method of analysis

Computation of IRR (Graphical Method)



Project Evaluation

Method of analysis

4. Internal Rate of Return or Discounted Cash Flow Return, (at NPV=0)

= Lower discount rate + Difference between discount rates
X $\frac{\text{NPV at lower discount rate}}{\text{difference between NPVs rate}}$

$$= 10 + (20 - 10) \left(\frac{3255}{3740} \right)$$

$$= 10 + 8.7$$

$$= 18.7 \approx 19\%$$

IRR = 19%

NPV at 20% → (485)



Project Evaluation

Method of analysis

Algebraically,

$$\begin{aligned}\text{IRR} &= \text{Low DR} + \text{Difference of DR's (NPV at Lower} \\ &\quad \text{DR/Total Difference between NPVs)} \\ &= 10\% / (20\% - 10\%) * (3255 / 3740) \\ &= 10 + 10 (0.87) \\ &= 18.7 \\ &= \mathbf{19\%}\end{aligned}$$



Project Evaluation

Economic Appraisal of Project

In general Five decision criteria are in use

**** Net Present Value (NPV)**

**** Benefit: Cost Ratio (BCR)**

**** Internal Rate of Return (IRR)**

**** Payback period**

**** First Year Rate of Return (FYRRY)**



Project Evaluation

Economic Appraisal of Project

Discussions

NPV Method is recommended as the best of the above five techniques for economic analysis.

It is subjected to the least ambiguity, it produces information which is readily understood.

It is least likely to be affected by assumptions (definition of costs, benefits and is easiest to calculate).

IRR can be compared with yields from investments, and is readily understood by decision markers.

Project Evaluation

Economic Appraisal of Project

Internal Rate of Return (IRR)

Significance

- ❑ Another way of using discounted cash flow for measuring the worth of a project
- ❑ It is the discount rate which just makes the net present worth of the cash flow equal zero.
- ❑ This discount rate is termed the internal rate of return
- ❑ and in a sense, It represents the average earning power of the money used in the project over the project life:

Project Evaluation

Method of analysis

Internal Rate of Return (IRR)

- i.e. at that particular discount rate, the Project just breaks even-i.e. it will earn back all the capital & operating costs expended upon it and pay us that percent (i.e. 12 or 15% etc.) for the use of our money in the project.

Computation:

Use trial or interpolation method illustrated in the example.



Project Evaluation

Equipment Replacement

Replacement Studies

One of the problems which individuals and business encounter frequently is deciding whether existing equipment or property should be replaced with new and more modern facilities.

Wear and tear of equipment, coupled with rapid technological progress which results in new and improved devices, make this an ever present problem.



Project Evaluation

Equipment Replacement

Reasons for Replacement

Four basic reasons for replacement

1. **Physical impairment:** Existing equipment is completely or partially worn out.
2. **Inadequacy:** do not have sufficient capacity.
3. **Obsolescence:** caused either by or lessening in demand or by the availability of more efficient equipment.
4. **Rental possibilities:** to rent identical or comparable equipment; thus freeing capital for other and more profitable use.


Project Evaluation

Equipment Replacement

DIESEL Versus GALOLINE

For your Project you need a piece of equipment (e.g. a truck, generator, bull-dozer, or pump). As you consider what type of equipment to purchase, you realize that you are faced with a choice between gasoline and diesel powered models.

The **diesel model** offers the advantage of longer life and lower operating costs. However, a **gasoline engine** is considerably cheaper to buy. Assume that the work output of both units will be equal, and that the cost and availability of diesel and gasoline will be the same.



Project Evaluation

Equipment Replacement

DIESEL Versus GALOLIN cont.

Given the Following assumptions on costs and the working life of the respective equipment engines, make a decision on which model to purchase

- if you have alternative investment opportunities that yield **10% interest** compounded annually;
- if you have alternative investment opportunities that yield **20% interest** compounded annually.



Project Evaluation

Equipment Replacement

DIESEL MODEL

| | |
|-------------------------------|----------|
| Operating life | 10 years |
| Price per Engine | 100,000 |
| Ann. operating & maint. costs | 10,000 |

GASOLINE MODEL

| | |
|-------------------------------|---------|
| Operating life | 5 years |
| Price per Engine | 50,000 |
| Ann. operating & maint. costs | 15,000 |

Note: There is no salvage value at the end of operating life for either model.

Which Model to Buy?



Project Evaluation

Equipment Replacement

DIESEL Vs. GASOLINE -WORKSHEET

DIESEL:

| End of Year | Annual Outlays | Discount Factor 10% | Present Worth 10% | Discount Factor 20% | Present Worth 20% |
|----------------------------|----------------|---------------------|-------------------|---------------------|-------------------|
| 1 | 110000 | .909 | 99,990 | .833 | 91,630 |
| 2 | 10000 | | | | |
| 3 | 10000 | | | | |
| 4 | 10000 | | | | |
| 5 | 10000 | | | | |
| 6 | 10000 | | | | |
| 7 | 10000 | | | | |
| 8 | 10000 | | | | |
| 9 | 10000 | | | | |
| 10 | 10000 | | | | |
| Total Present Wroth | | PW= | 152,340 | | 125,230 |

Project Evaluation

Equipment Replacement

GASOLINE

| End of Year | Annual Outlays | Discount Factor 10% | Present Worth 10% | Discount Factor 20% | Present Worth 20% |
|----------------------------|----------------|---------------------|--------------------|---------------------|-------------------|
| 1 | 65000 | | | | |
| 2 | 15000 | | | | |
| 3 | 15000 | | | | |
| 4 | 15000 | | | | |
| 5 | 15000 | | | | |
| 6 | 65000 | | | | |
| 7 | 15000 | | | | |
| 8 | 15000 | | | | |
| 9 | 15000 | | | | |
| 10 | 15000 | | | | |
| Total Present worth | | | PW= 165,810 | | 121,295 |

Conclusion: At 10%, **Diesel** is Preferable
At 20%, **Gasoline** is Preferable

Project Evaluation

Equipment Replacement

DIESEL Versus GALOLIN

CROSSOVER DISCOUNT

DISCOUNT
RATE

between

Cross over Discount Rate:

Between 10% and 20% there is a discount rate which will make us indifferent between two alternatives. (Present Worth of costs will be same)

Total Pre
indifferenc

$$= 10\% + (20\%$$

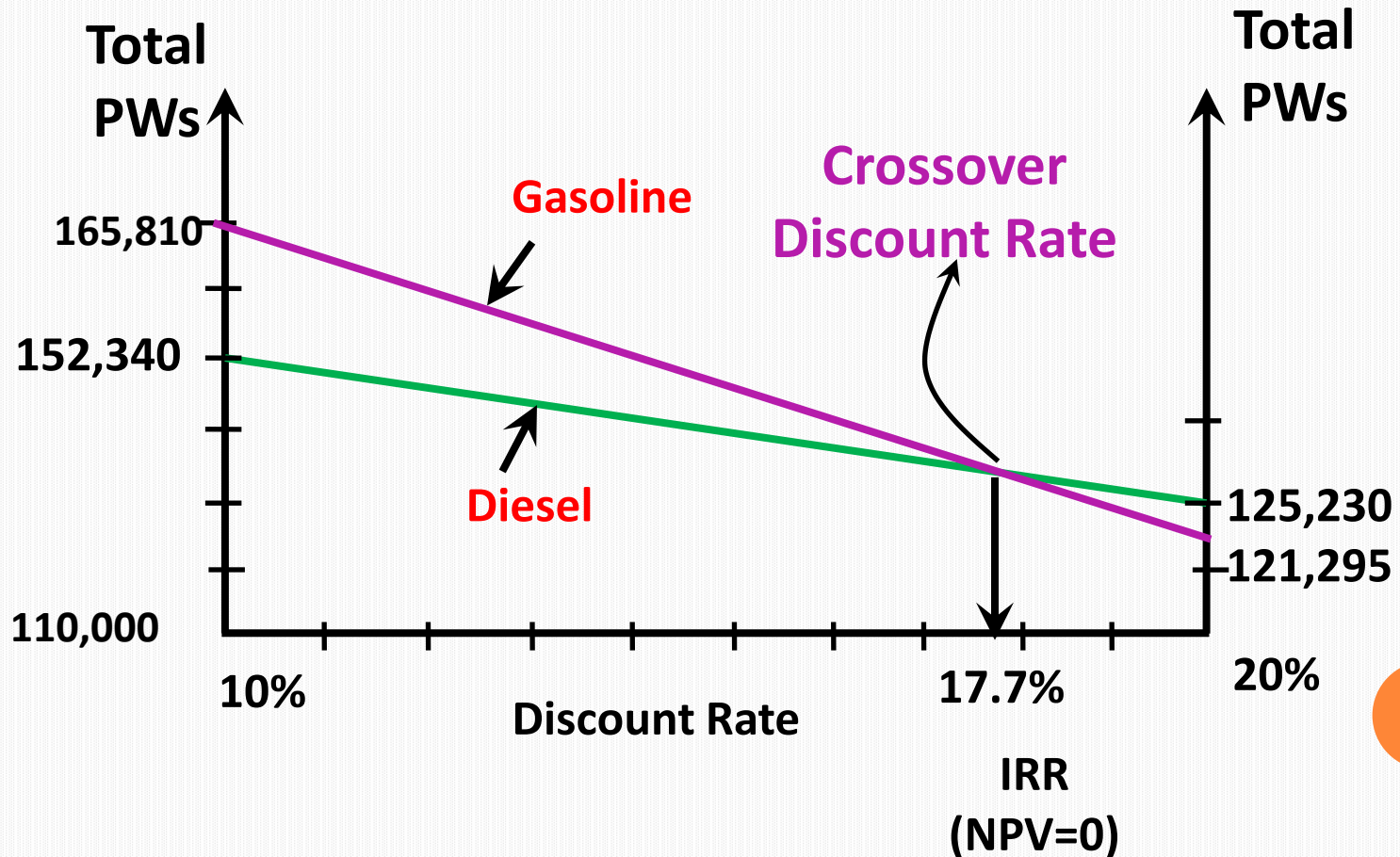
$$= 10\% + 7.7\% = 17.7\% \approx 18\%$$



Project Evaluation

Equipment Replacement

Graphical Solution



Project Evaluation

Equipment Replacement

From the Figure, Crossover Discount Rate = 17.7%

Crossover Discount Rate

- Between 10% and 20%, there is a discount rate which will make us indifferent between two alternatives.



Project Evaluation

Equipment Replacement

Crossover Discount Rate

- ❑ The Preference ranking of the alternatives (indicated by the cost stream with the lowest present worth) may change between lower and higher discount rates.
- ❑ The discount rate at which the preference changes is known as the crossover discount rate.



Project Evaluation

Equipment Replacement

Crossover Discount Rate (contd)

- ❑ This is also called as “equalizing” discount rate, at which the total **Present Worth** of two alternatives will be approximately equal.
- ❑ In the replacement example, between 10% and 20%, there is a discount rate which will make us indifferent between the two alternatives.



Project Evaluation

Exercise- Comparing Alternatives

Compare the economics of two alternative material handling systems. The Pertinent data are as follows:

| System | X | Y |
|------------------------------|----------|-----------|
| First Cost | \$80,000 | \$200,000 |
| Economic life | 20 years | 40 years |
| Annual cash disbursement | \$18,000 | \$6,000 |
| Salvage value at end of life | \$20,000 | \$40,000 |

Assuming a **6% minimum attractive rate of return (MARR)**, show which alternative is the best by the:

- Annual Cost (A.C) Method
- Present Value (PV) Cost Method.
- Internal Rate of Return (IRR) Method

Project Evaluation

Project Analysis

What is a Project?

A Project is an activity or which we spend money in expectation of returns and which logically seems to lend itself to Planning, Financing and Implementing as a unit.

It is the smallest operational element prepared and implemented as a separate entity in a National Plan or Program.

It is a specific activity with a specific starting point and specific ending point intended to accomplish a specific objective.



Project Evaluation

Project Analysis

Plans and Projects Plans: National plan to accelerate economic growth- requires good projects.

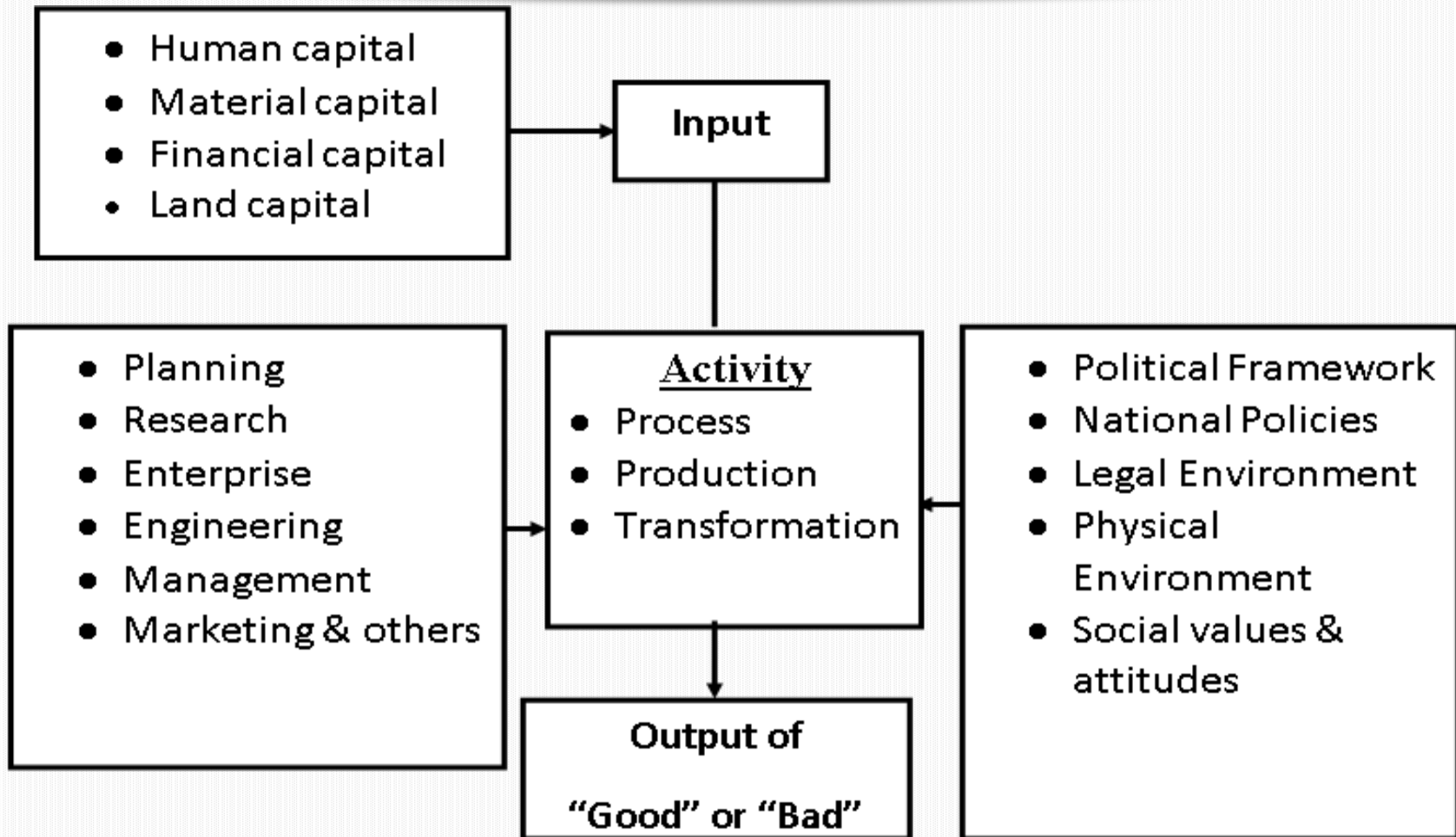
Good Project requires: Sound Planning; sound planning requires considerable information, data.

Project Format: Is the framework for analysis of information from a broad range of sources.



Project Evaluation

Project Activities



Net Social Surplus: = "Good"s - "Bad"s - Inputs

Project Evaluation

Project Analysis

Tools and Techniques for Project management

□ Project Selection:

Cost-benefit analysis

Risk and Sensitivity Analysis

□ Project Execution Planning:

Work break - down structure

Project execution plan

Project responsibility matrix &

Project management manual.



Project Evaluation

Project Analysis

□ Project Scheduling & Coordinating:

Bar charts

Life cycle curves

Line of balance (LOB)

Network techniques (PERT/CPM)



Project Evaluation

Project Analysis

❑ Project Monitoring & Progressing

Progress measurement technique
Value engineering

❑ Project Communication & Clean-up

Control room
Computerized information systems.



Project Evaluation

The Project Cycle

There tends to be a natural sequence in the way projects are planned and carried out – known as Project Cycle.

Identification- To find the potential projects (sources are from technical specialists or social leaders)

Preparation & analysis- First step is to undertake a feasibility study that will provide enough knowledge to help to determine whether or not to proceed with more detailed planning

Project Evaluation

The Project Cycle (Contd)

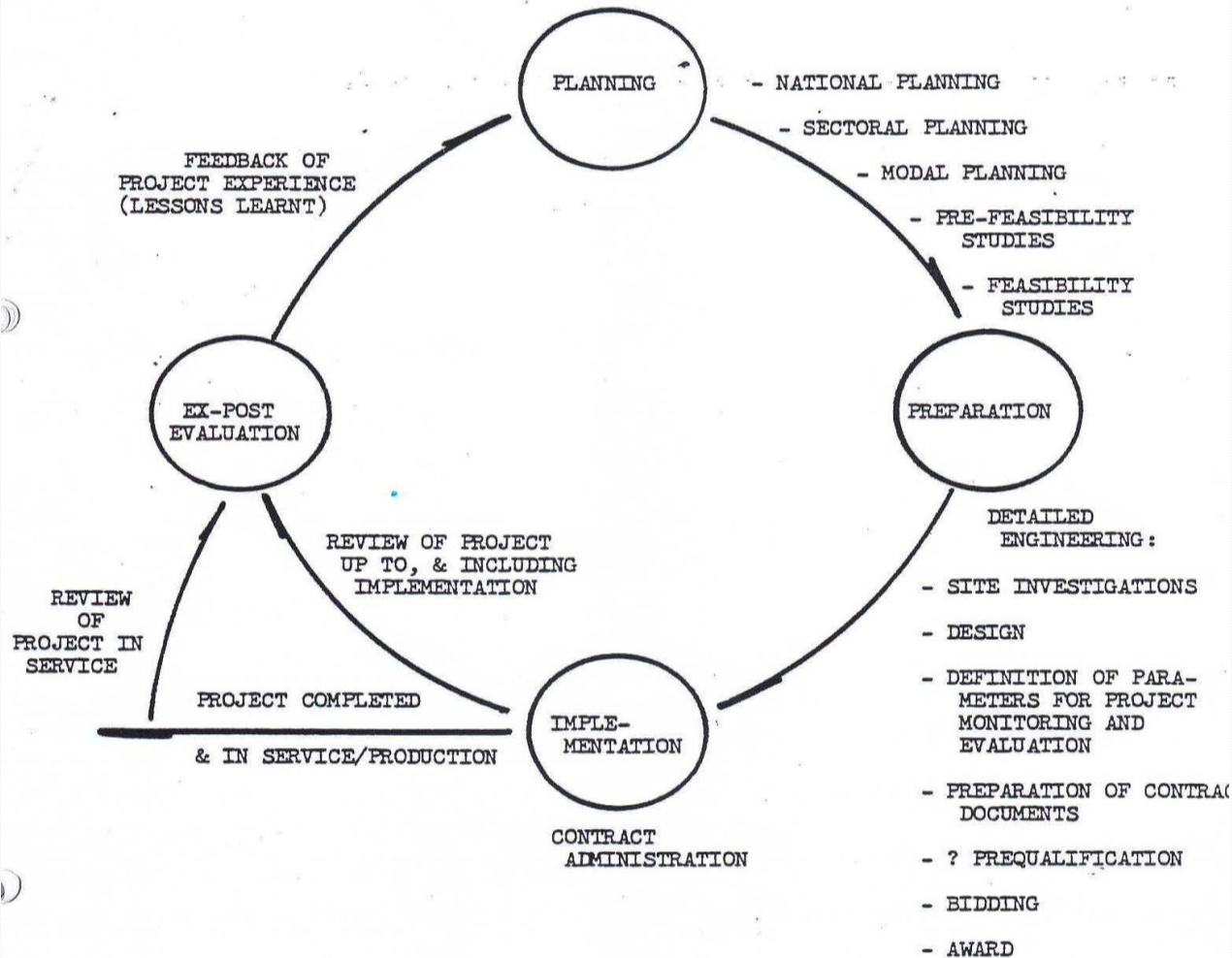
Appraisal- After project has been prepared, it is appropriate for a critical review or an independent appraisal to be conducted.

Implementation- Implementation becomes the most critical/important part of project cycle.

Evaluation- The final phase in the project cycle is evaluation: looks at systematically the elements of success & failure.

Project Evaluation

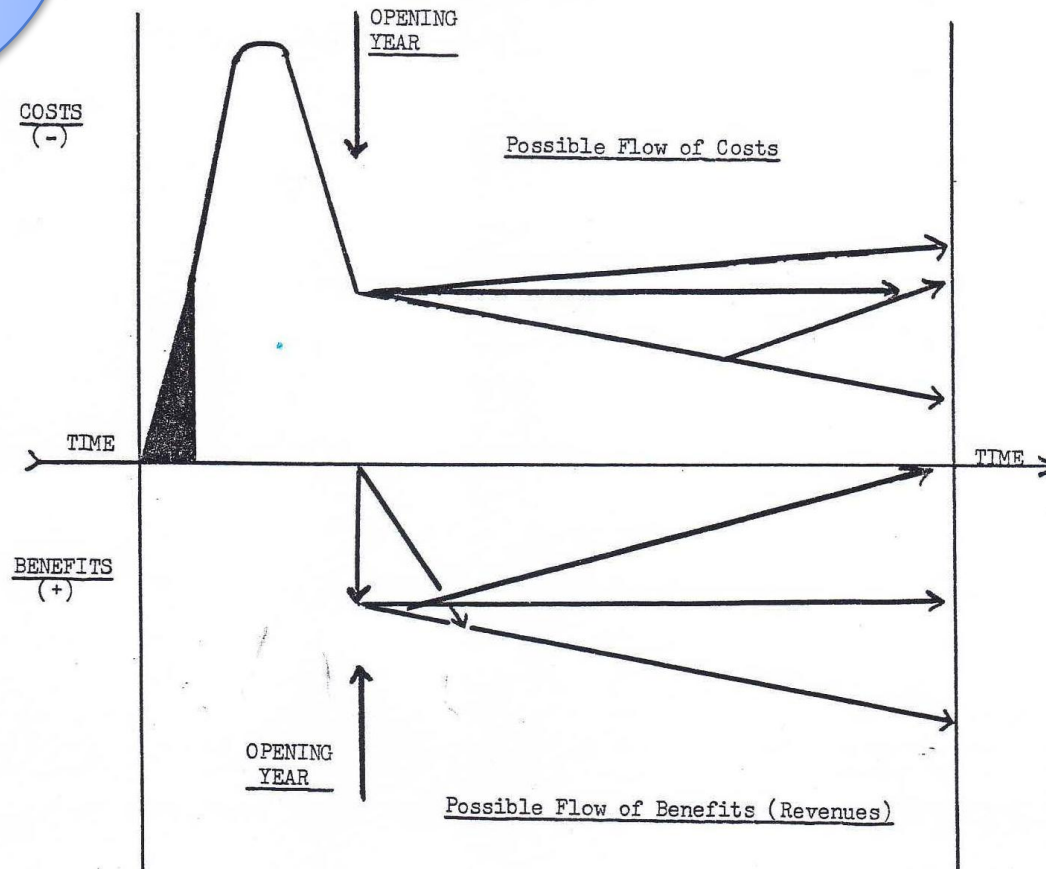
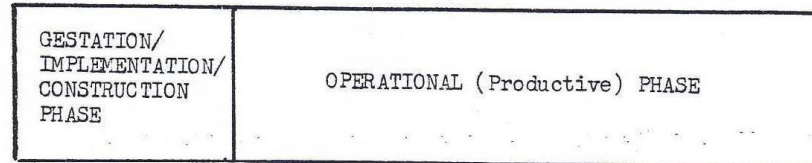
The Project Cycle



Project Evaluation

The Project Cycle

PROJECT LIFE CYCLE



Project Evaluation

Project Analysis

Some Aspects of Project Preparation & Analysis

Technical aspects:

- Concerns the inputs and outputs of real goods and services
- Technical skills and assistance

Institutional Aspects:

- Organizational and Managerial aspects.

Social Aspects:

- Social implications of proposed investments
- i.e. income distribution and others social concerns



Project Evaluation

Project Analysis

Some Aspects of Project Preparation & Analysis

Commercial Aspects:

- Arrangements for marketing outputs produced.
- Supply of materials and services needed etc.

Financial Aspects:

- Financial impacts
- Budgets, Sources etc.

Economic Aspects:

- Contribution to the development of total economy etc.
(National growth).

Project Evaluation

Project Analysis

Determining Economic values

A Project may be analyzed either from “**Financial**” point of view or from “**Economic**” point of view.

Financial Analysis:

Based on “Market” prices of goods and services.

Economic Analysis:

Based on “Economic” value (shadow price - From the view point of entire economy).



Project Evaluation

Project Analysis

When we change the market price of any good or service to make it more nearly represent the opportunity cost to the society, the new value we assign to it becomes its “**Shadow Price**” is not the Market Price but is an estimate of the economic value of the good or service in question.

Example :- Determining the value of Foreign Exchange.

Feasibility Reports

Examine these aspects for preliminary assessment of the project.



Project Evaluation

Feasibility Study

Purpose:

The Feasibility study is an in-depth analysis which is undertaken in order to establish:

- ✓ whether the proposed project will solve the problems which have motivated the identification,
- ✓ whether it has the proper scope and the relevant inputs,
- ✓ whether it is possible to implement and to sustain in the future and
- ✓ whether alternative solutions should be considered.



Project Evaluation

Feasibility Study

Perspectives:

The Feasibility study analyses the proposal from many angles, such as:

- Technical,
- Economic,
- Financial,
- Social,
- Institutional,
- Organizational and
- Environmental.

The feasibility study typically requires a multi-professional team as it address a wide-ranging complex of different and often interlinked issues. The study is normally undertaken by external consultants.



Project Evaluation

Feasibility Report

1. Summary of the Project

- General Presentation of Basic data
- Specialization, Goods/Services
- Capacity; total volume
- Profitability

2. Market Study

- Market problem in relation to specific project (nature of markets)
- Specifications of goods/services
- Type of consumers
- Demand forecasting, projection of demand
- Economic policy



Project Evaluation

Project Analysis

3. Size & Location

- Justification of capacity & location
- Minimum cost & freight
- Availability of resources

4. Project Engineering

- Preliminary research
- Technical alternatives, Efficiency
- Flexibility of productive capacity
- Construction, Work schedule/program



Project Evaluation

Feasibility Study

5. Investments

- Cost Items; Composition & Volume of capital investments
- Cost of organization and equipment
- Investment Program

6. Budget Expenditure & Income Budget

- Annual Cost & Income budgets
- Profits and unit production costs, Selling prices
- Prepare such data (personnel, fuel, materials, depreciation, intangible benefits)



Project Evaluation

Feasibility Study

7. Evaluation

- Issues/Social view points
- Methodologies for evaluation(Economic vs Financial)
- Criteria of evaluation, Net Return, B/C ratio, IRR, Value added etc.

8. Financing & Organization

- (i) **Financing:** Sources, dates of availability of funds, Currency involved.
- (ii) **Organization:** Organizational internal matters; Structure; Legal; Administrative; Decision making; Forecasting; Future development.