Performance Measures in Project Management

- Performance Indicators
- Performance Improvement
- Project Management & Environment

- Project may be considered a total failure if:

1. It is abandoned half-way or kept in abeyance or completed with a changed concept
2. It does not produce as specified in terms of quality of produce
3. It becomes sick soon after going into commercial production

- Most projects fall in between a total success or a total failure

Performance Indicators

- Cost over run and time over run
  - These do not enable any comparison with another project
  - Do not convey whether time and cost targets were unrealistic
  - A well managed project may have time and cost over-runs

- **Time Over-run**

➢ Schedule quoted can be far from realistic

➢ Vendors and contractors commit unrealistic delivery time

➢ Defective design and subsequent modification / change to suit the project's requirement increases cost and time

➢ How much time a project actually takes ?

➢ Who is responsible for the over-runs?

➢ Time over-runs cannot be used as true indicators for project management performance

- **Cost Over-run**

- Time can be misquoted, cost cannot
- Any mismanagement will increase cost
- Cost can be used as an indicator for project management performance
- Cost estimates are to be revised at various stages to improve their accuracy – costs increase after each revision
- Cost over-run, the expression which is used to represent the variance between the original sanctioned cost and the final cost incurred, would then provide no indication of managerial performance

- **Project Sickness**

- ➢ An efficient project manager must make the best possible use of the resources given to him for achieving the project objectives
- ➢ A successful project must produce a saleable output
- ➢ The ratio of this output to the cost incurred for setting put the plant, could be an indicator of project management performance
- ➢ Performance of the plant is also dependent on the quality of project management

- Quality of plant and equipment will decide the cost of utilities, repair and maintenance
- Depreciation
- If production cost and installed cost are not managed well a project may fall sick
- It may fall sick because of mismanagement of activities during commercial operation
- Installed cost per capacity is a performance indicator

- **Productivity as Performance Indicator**

➢ Productivity indicator reflects how resources have been utilized either for production of goods and services or for creation of facilities

➢ Productivity at implementation stage will affect the productivity of an operating plant

➢ Ensure profitability of the plant and ward off sickness

➢ A ratio of budgeted and actual expenditure is always a better indicator of performance than deviation figures between budget and actual cost.

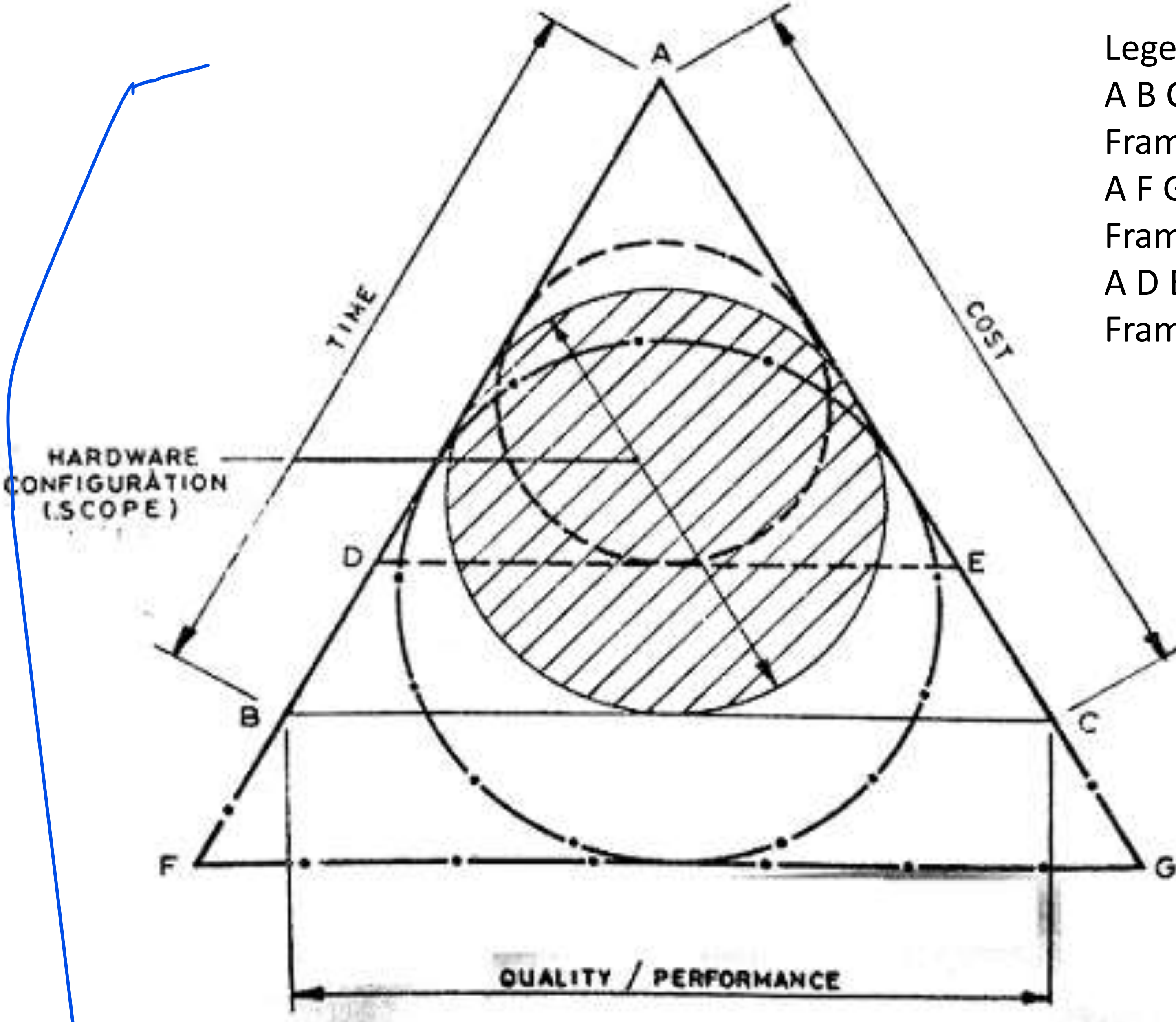
- A ratio of installed cost to completion time can be a better index which can be used to reflect project management's performance
- Computing cost index and schedule index of a completed project and comparing it with the industry average in the same technological area will give a true indication of PM performance

- **Value as Performance Indicator**

- Limitless excellence, without any consideration of time and cost, can lead to project disaster

Task of PM is to

- build a project that works
- To define time-cost-performance frame work and then to ensure, through design of the hardware and management of its implementation
- The scope-time-cost-performance diagram is a symbolic representation of scientific project management and can make a good design for a project management logo
- When the cost of a project is controlled, scope, time, performance are also controlled



Legend:
A B C- Normal Scope & Frame Work
A F G – Enlarged Scope & Frame Work
A D E – Reduced Scope & Frame Work

Project Management Logo

- Value engineering encourages increase in quality if it can be attained at no extra cost

Performance Improvement: Do-it-Yourself Trap

- Imposes tremendous load of coordination
- Lack of experience of working in an uncertain and dynamic environment
- Not equipped with the tools and techniques of PM
- Leads to cost and time overruns
- Unnecessary expansion of scope
- Inability to handle vendors

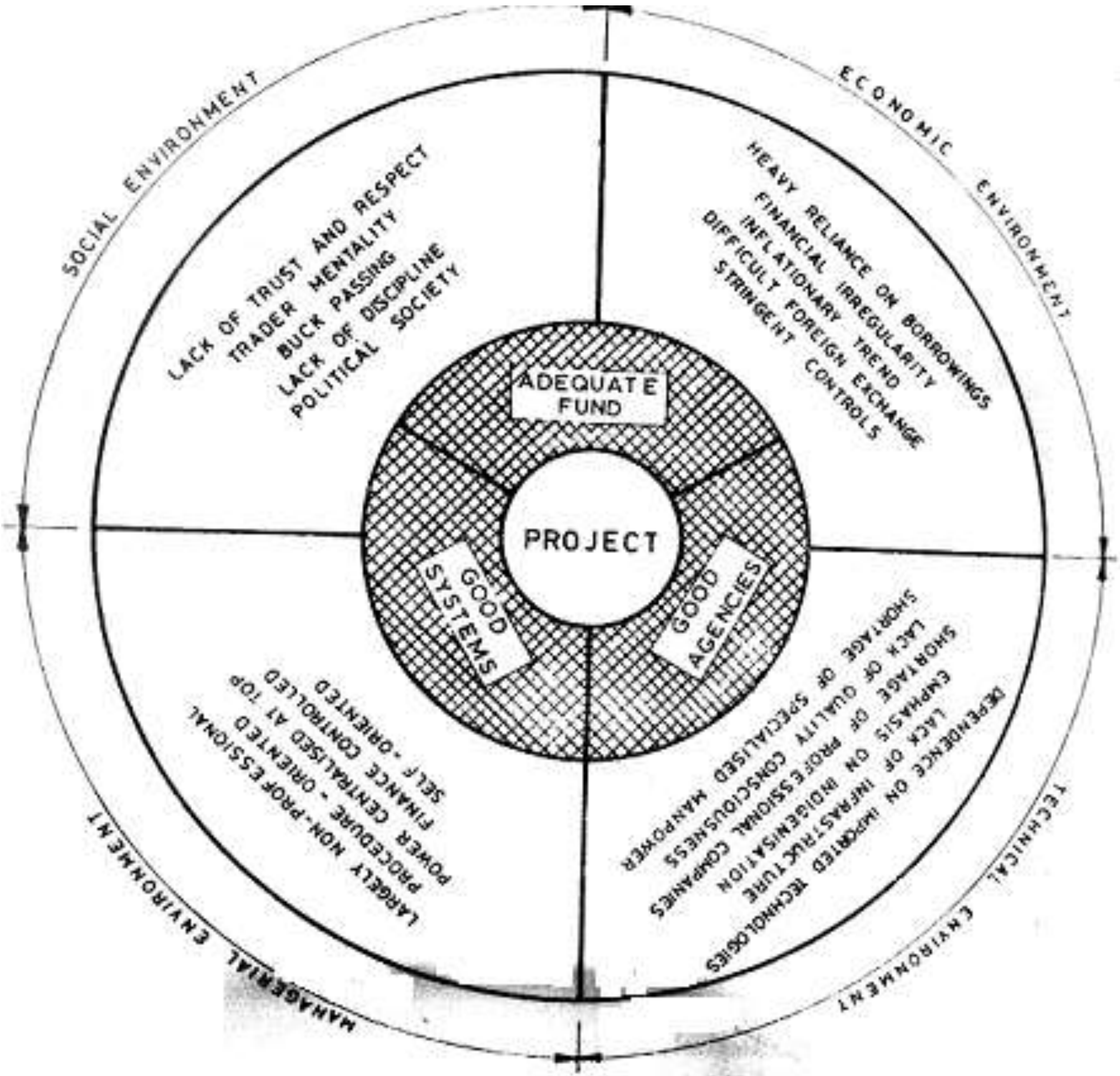
The Turn-key Trap

- Schedule or cost quoted by the turn-key contractor should be of secondary consideration
- Contractor's track record in managing projects
- He will make the tightest possible design and may compromise with quality to earn profit
- Legal consequences may prop up if not handled properly

Project Management Environment

- PM performance largely depends on the real-world environment
- PM environment in India is shown in figure
- Problems specific to country
- Lack of mutual trust and respect amongst the stakeholders: owners, financial institutions, consultants, vendors & contractors
- Traders-turned entrepreneurs or financers handling projects
- Introduction of on going audit system

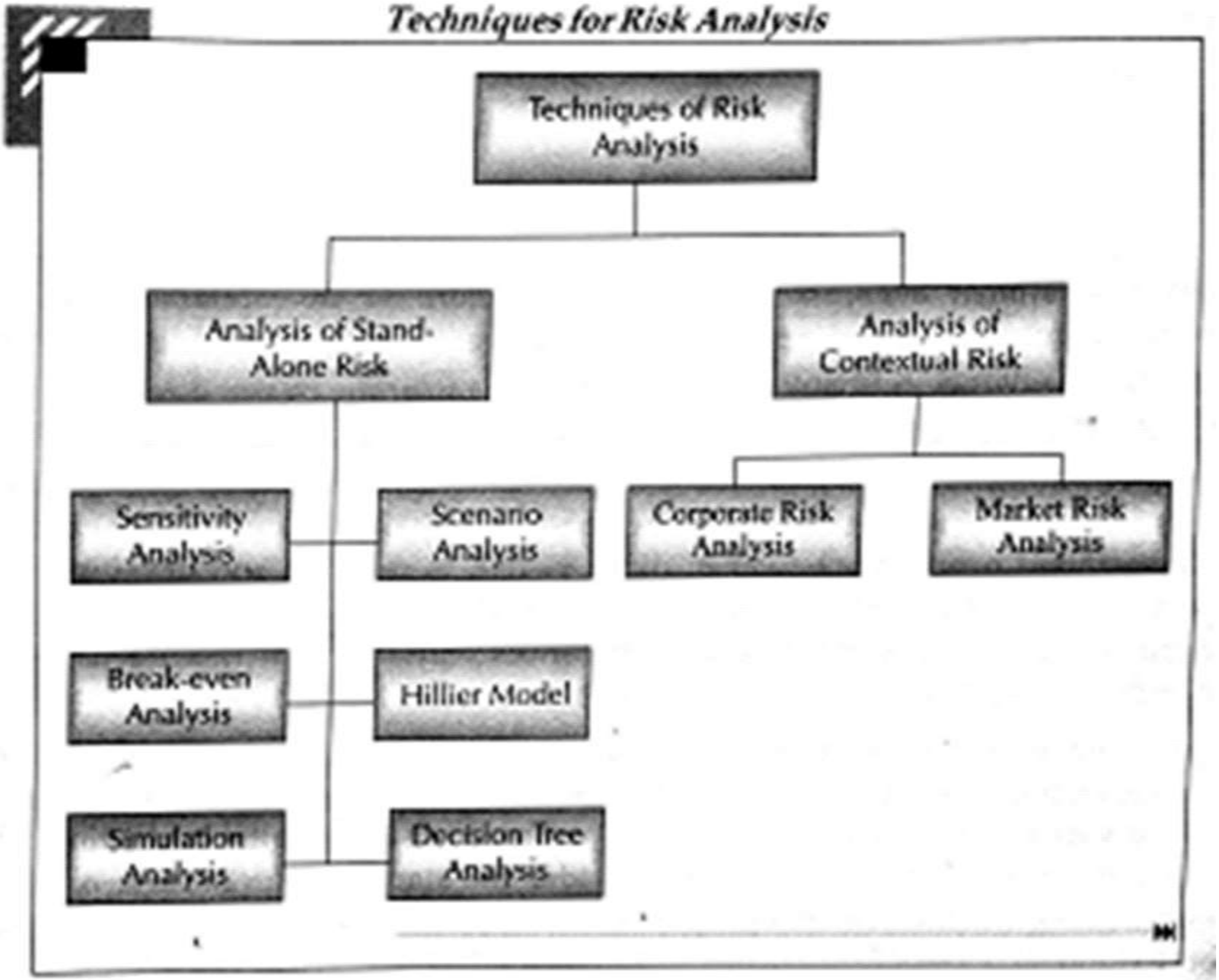
- Financial institutions may not trust the owner/ promoter since an owner may disown a project and the financial institutions have more stake in the project than the owner himself
- Promoter may intentionally underestimate the project cost with the intention of reducing his contribution
- Most vendors and contractors may not trust the owner regarding payment
- Financing cost and inflation overtake the revised cost estimate



Project management environment and the shield

Risk Analysis

- Sources, measures, and perspectives of risk
- Sensitivity analysis
- Scenario analysis
- Break-even analysis
- Hillier model
- Simulation analysis
- Decision tree analysis
- Managing risk
- Project selection under risk
- Risk analysis in practice



Techniques for Risk Analysis
Techniques of Risk Analysis
Analysis of Stand-Alone Risk
Analysis of Contextual Risk
Sensitivity Analysis
Scenario Analysis
Corporate Risk Analysis
Market Risk Analysis
Break-even Analysis
Hillier Model
Simulation Analysis
Decision Tree Analysis

- **Sources of Risk**
  - Project-specific risk
  - Competitive risk
  - Industry-specific risk
  - Market risk
  - International risk

1. Project-specific risk

Risks directly related to the project's internal factors such as scope creep, cost overruns, schedule delays, and resource mismanagement.

Examples:

- Budget overruns
- Delays in delivery
- Inadequate resource allocation
- Poor stakeholder communication

Mitigation Strategies:

- Detailed project planning and scheduling
- Regular progress monitoring
- Risk registers and contingency reserves
- Strong project governance

2. Competitive Risk

Risks arising from actions or innovations by competitors that may impact your project's success or market relevance (e.g., price cuts, new products).

Examples:

- A competitor launches a superior product
- Price wars erode profit margins
- Competitor captures a key client

Mitigation Strategies:

- Market research and competitive analysis
- Innovation and R&D investment
- Building strong customer relationships
- Strategic partnerships or alliances

3. Industry-Specific Risk

Risks tied to the dynamics and trends within a particular industry, such as regulatory changes, labor strikes, or technology shifts.

Examples:

- New regulations impacting operations
- Technological disruption in the sector
- Labor union actions in the industry

Mitigation Strategies:

- Stay updated with industry trends
- Engage in policy and industry groups
- Diversify product/service offerings
- Workforce flexibility and cross-training

4. Market Risk

Risks due to broader market fluctuations, including demand changes, customer preferences, economic downturns, or interest rate changes.

Examples:

- Decline in market demand
- Inflation or interest rate hikes
- Changing consumer preferences

Mitigation Strategies:

- Diversified revenue streams
- Agile marketing strategies
- Hedging against financial risks
- Customer feedback loops for adaptability

5. International Risk

Risks from operating across borders—such as currency exchange volatility, geopolitical instability, trade barriers, and cultural differences.

Examples:

- Currency exchange rate volatility
- Political instability in target countries
- Import/export restrictions or tariffs
- Cultural misunderstandings

Mitigation Strategies:

- Use of foreign exchange hedging tools
- Political risk insurance
- Local partnerships and advisors
- Cultural training for staff

- **Measures of Risk**

- Risk refers to variability
  - Range
  - Standard Deviation
  - Coefficient of variation
  - Semi-variance

1. Range

- **Definition:** The difference between the highest and lowest possible outcomes.
- **Use:** Gives a simple measure of how spread out the possible results are.
- **Limitation:** Doesn’t account for the probability of outcomes or distribution shape.

2. Standard Deviation

- **Definition:** The average amount by which outcomes differ from the expected (mean) value.
- **Use:** A widely used measure of total risk or volatility in finance and project evaluation.
- **Interpretation:** Higher standard deviation = more uncertainty or risk.

3. Coefficient of Variation (CV)

- **Definition:** The ratio of the standard deviation to the mean ($CV = \sigma / \mu$).

- **Use:** Allows comparison of risk across projects or investments with different expected returns.

- **Interpretation:** Lower CV = better risk-return tradeoff.

4. Semi-variance

- **Definition:** Measures only the variation of outcomes that fall **below** the mean.
- **Use:** Focuses on downside risk, which is often more relevant to decision-makers.
- **Interpretation:** Helps investors who are more concerned about losses than variability in general.

- Standard Deviation is the most widely used measure of risk because:

i. If a variable is normally distributed, its mean and standard deviation contain all the information about its probability distribution
ii. If the utility of money is represented by a quadratic function, , then the expected utility is a function of mean and std. deviation
iii. Standard deviation is analytically easily tractable

- Subjective Probabilities

➢ Objective evidence may not be available for defining probability distribution

➢ Probability distribution is defined based on experience and judgment

Perspectives on Risk

➢ Stand-alone risk- Project viewed in isolation

➢ Firm risk or Corporate risk - Contribution of a project to the risk of the firm

➢ Systematic risk or market risk – Risk of the project from the point of view of a diversified investor

Stand alone Risk – Advantages

- Easier to measure
- In most of the cases, stand-alone risk, corporate risk and market risk are highly correlated
- The proponent of capital investment is likely to be judged on the performance of that investment
- In most firms, the capital budgeting committee considers investment proposals one at time

Sensitivity analysis

- To know the viability of the project when some variable like sales or investment deviates in future from its expected value
- Sensitivity analysis means varying the inputs to a model to see how the results change
- Sensitivity analysis is a very important component of exploratory use of models
  - model is not regarded as "correct"
  - sensitivity analysis helps user explore implications of alternate assumptions
  - human computer interface for sensitivity analysis is difficult to design well
- In many models we need to make assumptions we cannot test
- Sensitivity analysis examines dependence of results on these assumptions

Definition:

Sensitivity analysis examines how changes in key project variables (inputs) impact the outcome (e.g., NPV, IRR).

Purpose:

- Identify critical variables
- Understand risk exposure
- Aid in decision-making

Key Variables in Project Analysis

- **Common Variables:**
- Sales volume
- Selling price
- Operating costs
- Initial investment
- Discount rate
- **Example:**
  If sales volume drops by 10%, what is the effect on NPV?

Example – Sales Volume Sensitivity

Base Case:

- NPV = $200,000
- Sales Volume = 10,000 units

Scenario Analysis:

- If volume ↓10%, NPV = $150,000
- If volume ↑10%, NPV = $250,000
- **Conclusion:**
  Project is moderately sensitive to sales volume.

Example – Operating Cost Sensitivity

Base Case:

- Operating cost = $50,000/year

Scenario Analysis:

- If costs ↑20%, NPV drops from $200,000 to $120,000
- If costs ↓20%, NPV increases to $280,000

- **Conclusion:**
  High sensitivity indicates a need for cost control.

Benefits & Limitations

- **Benefits:**
  ✓ Helps prioritize risk mitigation
  ✓ Simple and visual
  ✓ Focuses on key uncertainties

- **Limitations:**
  ✗ One variable at a time
  ✗ Ignores interaction effects
  ✗ Depends on accuracy of base assumptions

- Sensitivity Analysis Answers the question:
  - What does make a difference in the decision?

- Determining what does matters and what does not requires incorporating sensitivity analysis throughout the modeling process.

- No optimal sensitivity analysis procedure exist for decision analysis: Model building is an Art!

- The question that we ask performing SA is: Are we solving the right problem?

- Type III Error: implies that the wrong question was asked or inappropriate decision context was used.

One Way Sensitivity Analysis

- What variables really make a difference in terms of the decision in hand?
  - Do different interest rates really matter?
  - Does it matter that company can set the ticket price?
  - Hours Flown how much impacts on the profit?

Two way sensitivity Analysis

- Suppose we wanted to explore the impact of several variables at one time.
- A graphical technique is available for studying the interaction of two variables.
- For example suppose we want to consider the joint impact of changes in the 2 most crucial variables(Operating cost and Capacity of scheduled flights)

Evaluation and merits of sensitivity analysis

- It shows how robust or vulnerable a project is to changes in values of the underlying variables
- It indicates where future work may be done. If the net present value is highly sensitive to changes in some factor, it may be worthwhile to explore how the variability of that critical factor may be contained
- It is intuitively a very appealing as it articulates the concerns that project evaluators normally have

Drawbacks of Sensitivity Analysis

- It merely shows what happens to NPV when there is change in some variable, without providing any idea of how likely that change will be
- Only one variable is changed at a time. In practical multiple variable move together
- Very subjective analysis. Same analysis may lead one decision maker to accept the project while another may reject

Scenario Analysis

- For interrelated variables, some plausible scenarios are to be looked into
- Each scenario should represent a consistent combination of variables

Procedure

- Select the factor which is the largest source of uncertainty for the success of the project, around which scenarios will be built. Ex: state of the economy, interest rate, technological development, response of the market

- Estimate the values of each of the variables in investment analysis (investment outlay, revenues, costs, project life, and so on) for each scenario
- Calculate the net present value and/or internal rate of return under each scenario

Best and Worst Analysis

- Best Scenario – Ex. High demand, high selling price, low variable cost, etc
- Normal Scenario – Ex. Average demand, average selling price, average variable cost, etc
- Worst Scenario – Ex. Low demand, low selling price, low variable cost, etc

- It's an improvement over sensitivity analysis because it considers variables together

Limitations

- Based on assumption that there are few well-delineated scenarios
- When a continuum is converted into several discrete states, some information is lost
- It expands the concept of estimating the expected values

Break-Even Analysis

A **break-even analysis** is a calculation of the **point** at which revenues equal expenses. In securities trading, the **break-even point** is the **point** at which gains equal losses

Accounting Break-even Analysis:

- Return of original investment but not compensated for the time value of money or the risk taken
- Opportunity cost of the capital is lost
- Will have a negative NPV

Financial Break-even Analysis:

- Focus is on NPV and not on accounting profit
- Financial BeP is significantly higher than Accounting BeP
- Amount of sales to have a zero NPV

Hillier Model

- F.S. Hillier suggested analytical derivation of the expected NPV and Standard deviation of NPV of cash flows

Uncorrelated Cash Flows: Cash flows of different years are uncorrelated.

$$\overline{NPV} = \sum_{t=1}^{n} \frac{\overline{A_t}}{(1+i)^t} - I \qquad \sigma(NPV) = \left[\sum_{t=1}^{n} \frac{\sigma_t^2}{(1+t)^{2t}}\right]^{1/2}$$

Where $\overline{NPV}$ = expected net present value

$\overline{A_t}$ = expected cash flow for year t

i= risk free interest rate

I = Initial outlay

$\sigma(NPV)$ = standard deviation of NPV

σ_t =standard deviation of the cash flow for year t

Perfectively Correlated Cash Flow:

- The behavior of cash flows in all periods is alike
- If the actual cash flow in one year is α standard deviations to the left of its expected value, cash flows in other years will also be α standard deviations to the left of their respective expected values
- Cash flows of all years are linearly related to one another

$$\overline{NPV} = \sum_{t=1}^{n} \frac{\overline{A_t}}{(1+i)^t} - I$$

$$\sigma(NPV) = \sum_{t=1}^{n} \frac{\sigma_t}{(1+i)^t}$$

Simulation Analysis:

- Information generated by simulation analysis may be used for developing the probability profile of a criterion of merit by randomly combining values of variables which have a bearing on the chosen criterion

Procedure:

1) Model the project: shows how the NPV is related to parameters and the exogenous variables
2) Specify the values of parameters and the probability distributions of the exogenous variables

Procedure contd..

3) Select a random value from the probability distributions of each of the exogenous variables
4) Determine the NPV corresponding to the randomly generated values of exogenous variables and pre-specified parameter values
5) Repeat steps (3) and (4) to get a large number of simulated NPVs
6) Plot the frequency distribution of the NPVs

Obtaining Probability Distributions of Basic Variables

- Defining probability distribution is the basic and most important step in simulation
- Often it is impossible to find the true distribution
- Based on judgment of experts
- Certain software packages help to select a right distribution

Obtaining Probability Distributions of Basic Variables

- Portrait Approach:
  - Statistician draws up a standard probability distribution on the basis of the judgment expressed by the expert
  - Drawback: The expert may accept a smooth distribution because s/he may be beguiled (deceived) by the appearance of smooth curves and complicated formulae

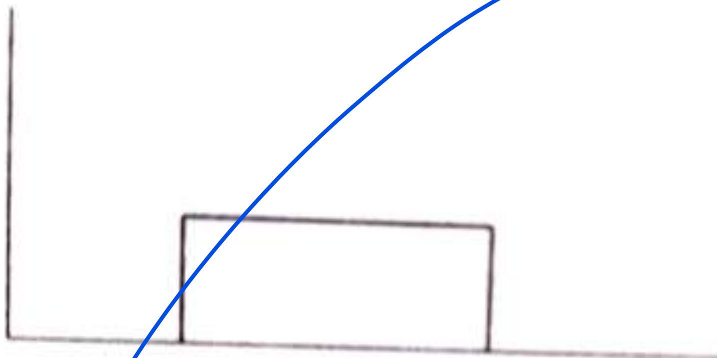
- Building Block Approach:
  - Probability distribution is defined by the expert

Procedure:

- Chooses the range encompassing possible values
- Divides the range into intervals which s/he thinks have different probabilities associated with them
- Assigns probabilities to these intervals and sub-intervals
- Continues this process till s/he arrives at a distribution which represents his/her judgment well

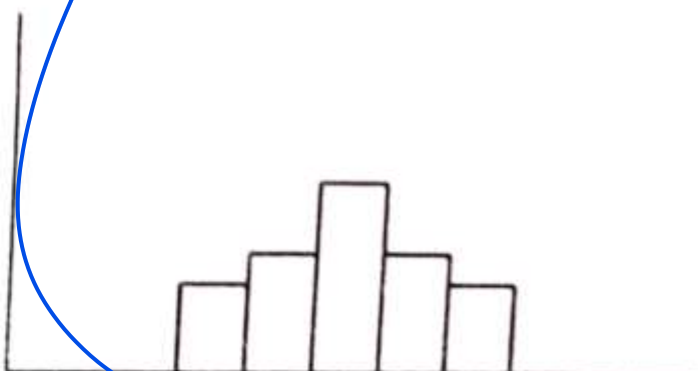
Some commonly used distributions:

- Uniform
- Trapezoidal
- Step rectangular
- Normal

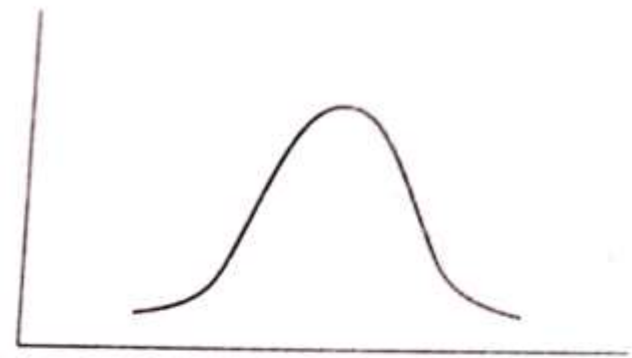


(a) Uniform Distribution

(b) Triangular Distribution



(c) Step Rectangular Distribution



(d) Normal Distribution

Issues in Applying Simulation

- What should the output be?
- Is project variability enough?
- How would the extreme values be used?
- How should the results of simulation be used?

Advantages

- Versatility
- It compels the decision maker to explicitly consider the interdependencies and uncertainties characterizing the project

Shortcomings

- Difficulty in modeling the project
- Inherently imprecise
- A realistic simulation model which is usually complex, may be difficult to understand for the decision maker

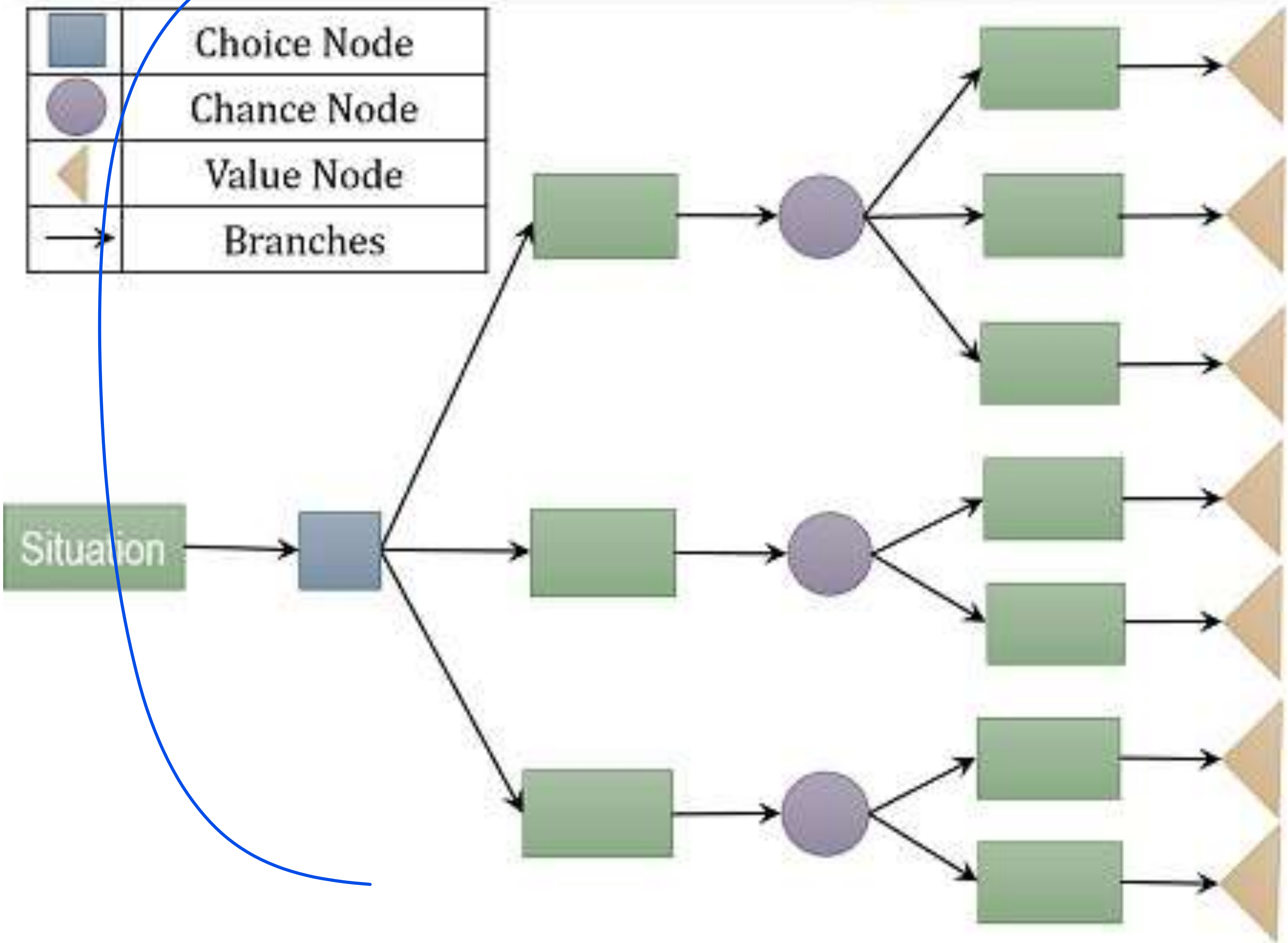
Decision Tree Analysis:

To analyze situations where sequential decision making in the face of risk is involved, decision tree analysis is a useful tool.

Key Steps:

1. Identifying the problems and alternatives
2. Delineating (identifying & indicating the exact position)the decision tree.
3. Specifying probabilities and monetary outcomes
4. Evaluating various decision alternatives

Decision Tree Analysis



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Scenario

- A company is considering launching a new product. They have two choices:
- **Launch the product**
- **Do not launch the product**
- If they **launch**, there's a chance the product will either be a **success** or a **failure**.

Assumptions

Decision/Outcome	Probability	Expected Revenue (if successful)	Cost
Launch → Success	60%	\$500,000	\$200,000
Launch → Failure	40%	\$50,000	\$200,000
Do not launch	-	\$0	\$0

Decision Tree

```
                 [Start]
                    |
     --------------------------------
         |                        |
     [Launch]              Don't Launch]
         |                         |
   -----------------           Payoff: $0]
    |               |
  [Success]     [Failure]
    |                       |
  [$500k-$200k]      [$50k-$200k]
  [$300k]               [-$150k]
```

Expected Monetary Value (EMV) Calculation:

- **EMV for Launch**
  = (0.6 × \$300,000) + (0.4 × -\$150,000)
  = \$180,000 - \$60,000
  = **\$120,000**
- **EMV for Do Not Launch**
  = \$0

Decision:

- Since the **EMV for launching (\$120,000)** is greater than the EMV for not launching (\$0), the recommended decision is to **launch the product**.

What types of projects can be analyzed using decision tree?

- Projects with the following characteristics can be analyzed:
  - Decisions on continuing the project are made in well-defined stages
  - The outcomes at each stage fall into few broad classes
  - The probabilities and the cash flows associated with various outcomes can be specified at the beginning of the project.

- Decision tree analysis requires enormous information before it can be applied
- Difficult to apply for new projects where the organization has very limited information about the project
- Difficult to apply when investments are gradually made over a period of time rather than in a few well-defined stages.

Managing Risk

- Fixed and variable costs
- Pricing strategy
- Sequential investment
- Improving information
- Financial leverage
- Insurance
- Long-term arrangements
- Strategic alliance
- Derivatives : Options (Customers have no obligation to buy/sell assets) and future (Buyers have obligation to buy assets)

Introduction to Managing Project Risk

- **Definition:**
  Managing risk involves identifying, analyzing, and responding to project uncertainties to minimize negative impacts.

- **Goal:**
  Ensure project success by reducing variability in expected outcomes.

Cost Structure – Fixed vs. Variable Costs

- **Fixed Costs:** Stay constant regardless of output (e.g., rent).
- **Variable Costs:** Fluctuate with production (e.g., materials).
- **Risk Strategy:**
- Favor variable costs in uncertain markets to maintain flexibility.
- **Example:**
  A startup opts for contract manufacturing over owning a factory.

Pricing Strategy

- Use **flexible pricing** (e.g., discounts, dynamic pricing) to adapt to demand changes.
- Avoid rigid pricing in volatile markets.
- **Example:**
  Airlines use dynamic pricing to adjust ticket prices based on demand.

Sequential Investment

- Invest in stages, validating assumptions at each phase before committing more capital.
- **Example:**
  A pharmaceutical firm invests in R&D, then testing, then production.

Improving Information

- Use market research, pilot programs, or customer feedback to reduce uncertainty.
- **Example:**
  A tech company releases a beta version of software to collect user data before full launch.

Financial Leverage

- Borrowing increases potential returns **and** risk.
- Use cautiously and only with stable cash flows.
- **Example:**
  A real estate developer uses loans to finance a project with long-term lease guarantees.

Insurance

- Protect against specific risks (e.g., property damage, liability).
- Transfers risk to insurer.
- **Example:**
  A logistics company insures its fleet against accidents and theft.

Long-term Arrangements

- Long-term contracts with suppliers or customers stabilize costs and revenues.
- **Example:**
  A construction firm locks in steel prices with a 5-year supply agreement.

Strategic Alliances

- Share risk and resources by partnering with other firms.
- **Example:**
  An automotive company partners with a battery tech firm to co-develop EVs.

Derivatives – Options and Futures

- **Options:** Right but not obligation to buy/sell (limits downside).
- **Futures:** Obligation to transact at a set price.
- **Example:**
  A coffee exporter uses options to hedge against price drops, and futures to lock in prices.

Project Selection Under Risk

- Judgmental Evaluation
- Payback Period Requirement
- Risk adjusted discount rate method

Judgmental Evaluation

- Relies on managerial intuition, experience, and subjective judgment.
- Often used when quantitative data is limited or uncertain.
- Suitable for high-uncertainty environments.
- Incorporates qualitative factors like strategic alignment and stakeholder preferences.
- Useful in early project screening phases.

Limitations:

- Prone to bias and inconsistency.
- Difficult to replicate or justify analytically.

Payback Period Requirement

- Measures time required to recover initial investment from project cash flows.
- Simple and easy to compute.
- Emphasizes liquidity and risk reduction.
- Projects with quicker payback are often considered less risky.
- Threshold period reflects risk tolerance.
- **Limitations:**
- Ignores cash flows after payback.
- Does not consider the time value of money.

Risk-Adjusted Discount Rate Method

- Applies a higher discount rate to riskier projects in Net Present Value (NPV) analysis.
- Adjusts for risk by increasing discount rate.
- Encourages selection of projects with strong risk-return balance.
- Integrates risk into financial metrics.
- Objective and scalable for multiple projects.
- **Challenges:**
- Selecting the correct risk premium can be complex.
- Assumes risk can be quantified precisely.

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Thank You