How Do We Justify a Project?

- Is this project worthwhile?
  
  *Are the benefits greater than the costs?*

- Is this the best way to achieve these benefits (either engineering & institutional options)?
  
  *Can similar benefits be achieved more efficiently by some other approach?*

- Is this the best place to allocate resources?
  
  *Do other projects have greater payoff?*
  
  *Are other types of benefits more important?*
Economic Equivalence

Economic equivalence is established, in general, when we are indifferent between a future payment, or series of future payments, and a present sum of money.

Cashflow of a typical CEE project
Equivalence of Cash Flows

Typical Cash Flows for a CEE Project

Equivalent Present Value

Equivalent Annuity

Equivalent Future Value
Time Value of Money

- $1 today is worth more than $1 dollar next year
- How much more depends upon the opportunities for using or investing that $1
- If we invest in a government bond earning $i\%$ per year, then our $1 will be worth $(1+i)$ at the end of one year and $(1+i)^t$ at the end of $t$ years
- Likewise, earning $1$ at the end of year $t$ is worth $1/(1+i)^t$ today
- We can convert any arbitrary stream of cash flows to various equivalent (but more easily understood) cash flows:
  - $P =$ present value
  - $F =$ future value at time $t$
  - $A =$ annuity of $A$ per period for $N$ periods
Present Value

- The Present Value of receiving cash $C_t$ in a future year $t$ is obtained by discounting the net benefits at an appropriate discount rate:

  \[ PV \text{ of } C_t = \frac{C_t}{(1+i)^t} \]

- The PV for a series of cash flows is obtained by summing the discounted benefits for each year:

  \[ PV \text{ of Project} = \sum \left[ \frac{C_t}{(1+i)^t} \right] \]
**Meaning of NPV**

**NPV > 0, using a discount rate of i%**
This project is better than making an investment at i% per year for the life of the project
   This project is worth further consideration

**NPV < 0, using a discount rate of i%**
This project does not provide enough financial benefits to justify investment, since alternative investments are available that will earn i%
   The project will need additional, possibly non-cash benefits to be justified
Equivalence Factors

Note the timeline of activities. Very Important. Formulae can change!!

\[ [F/P, i, N] = \text{future value } F \text{ after } N \text{ periods given present value } P \text{ and discount rate } i \]

\[ F = P(1+i)^N \]

\[ [P/F, i, N] = \text{present value given future value } F, i, \text{ & } N \]

\[ P = F/ (1+i)^N \]

\[ [F/A, i, N] = \text{"uniform series compound amount factor"} \]

How large will my IRA be after contributing $A$ at $i\%$ for $N$ years?

\[ F = A \left\{ \left(1+i\right)^N-1 \right\}/i \]
\([A/F,i,N] = "sinking fund payment"\)
Annual savings to have a down payment of a house in \(N\) years
\[ A = F \frac{i}{(1+i)^N - 1} \]

\([A/P,i,N] = "capital recovery factor"\)
What will the mortgage payments be?
\[ A = P \frac{i (1+i)^N}{(1+i)^N - 1} \]

\([P/A,i,N] = "uniform series present worth factor"\)
My business makes \(A\) year - should I sell for \(X\)?
\[ P = \frac{(A/i) ((1+i)N-1)/(1+i)^N}{(1+i)^N} \]
Importance of the Discount Rate

Very low rates favor large projects with distant benefits

*Using very low discount rates may lead a country to undertake massive projects while ignoring current needs*

Very high rates favor staged investments with quick payback

*Using very high discount rates may prevent a country from ever undertaking large infrastructure investments*
**What discount rate?**

- The discount rate (i.e. the interest rate that you use in finding equivalent values) should be
  - greater than or equal to your average cost of capital (not necessarily your cost of capital for a particular project)
  - at least as high as your other investment opportunities (OCC) (adjusted for risk)
- The discount rate therefore will equal your "minimum acceptable rate of return"
- The discount rate reflects the *opportunity cost* (?) for the person or organization that will receive the cash flows
- The discount rate is not the same as the interest rate obtained to finance the project
- Higher risks will require a higher discount rate
Importance of the Project Life
Projects need to be evaluated over a reasonable project life (and the economic life will be shorter than physical life)
However, your choice of a project life should NOT determine the outcome of the analysis (if it does, you must show sensitivity of the results to project life)
Because of discounting, the "out years" do not add much to the NPV, so a 20 to 50 year life is usually sufficient for analysis
The proper assumption is that the very long term effects will be positive or neutral - NOT that we can live it up now and let our children and grandchildren worry about the future!
Risks increase with time
So we don't want to be dependent on long-term benefits to recover our investment.
Can We Justify this Project Against Competing Projects?

In principle, any project with NPV > 0 is worth pursuing.

In practice, capital budgets are limited, so that choices must be made: *What set of projects gives the greatest benefits from using the available resources?*

Common approach in private sector: Hurdle rate of return:  
Rank independent projects by rate of return (typically IRR):  
Choose projects (or sets of projects) with highest return subject to a budget constraint
Financial/Economic (Numeric) measures for Project Evaluation

- Net Present Value (NPV) ... mainly financial
- Benefit-cost ratio, Cost and Benefit Analysis (CBA)
- Internal rate of return (IRR) ... \( i \) at point of indifference (when NPV=0)
- Return on Investment (RoI) ... operating cash flow/investment
- Payback period (generally undiscounted, not recommended)
- Cost effectiveness (in Aviation industry in Europe)

**Nonnumeric measures**: Mainly business projects
Sacred cow; Operating necessity; Competitive necessity;
Product line extension; Comparative benefit model (Q-sort)
Problem 1
Once a cement factory is in production, the sixth year of the project, it will produce cement valued Tk. 1,475,000 annually over the economic life of the factory, estimated at 15 years. What is the present value of the cement production, if the discount rate is (a) 12% per annum? (b) 3% per quarter?

Problem 2
For one of your project equipments, you are faced with a choice between a gasoline or a diesel powered model. While the diesel plant offers a longer life and lower operating costs, the gasoline plant has lower capital cost (i.e. initial purchase cost). Given the following information and assuming no other differences in performance, which model would you purchase? i = 10%

**Diesel:** operating life 10 years, price per model Tk. 100,000, Annual M&O Tk. 10,000. **Gasoline:** 5 years, Tk. 50,000, Tk. 15,000
Dealing with Multiple Attributes

<table>
<thead>
<tr>
<th></th>
<th>NPV</th>
<th>Capacity Increase</th>
<th>New Jobs</th>
<th>Decline in Air Quality</th>
<th>Land Required</th>
<th>Effects on Congestion</th>
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<tbody>
<tr>
<td>Project 1</td>
<td>$100</td>
<td>80%</td>
<td>-15%</td>
<td>High</td>
<td>500 acres</td>
<td>Much more</td>
</tr>
<tr>
<td>Project 2</td>
<td>$50</td>
<td>75%</td>
<td>20%</td>
<td>Medium</td>
<td>200 acres</td>
<td>Lower</td>
</tr>
<tr>
<td>Project 3</td>
<td>$20</td>
<td>40%</td>
<td>30%</td>
<td>Medium</td>
<td>250 acres</td>
<td>Moderate</td>
</tr>
<tr>
<td>Project 4</td>
<td>$15</td>
<td>20%</td>
<td>20%</td>
<td>Low</td>
<td>100 acres</td>
<td>None</td>
</tr>
</tbody>
</table>

- Unless one option is the best in all categories, it is impossible to say it is the best overall
- Weighting/Scoring schemes may help, but the weights themselves are inherently a value judgment (avoid value! Let the politicians add that!!)
- Multicriteria analysis; Delphi method
- Selection of the best project in complicated cases will be a political issue rather than an economic issue
Risks and Uncertainty

- **Certainty**: when the probability of the specific outcome is 1.
- **Risk**: when you can assign a probability to the possible outcomes.
- **Uncertainty**: when you cannot assign a probability.

Why risks arise?
- **Project risks** (e.g. can we build this on budget & on schedule?)
- **Market risks** (e.g. will the market for real estate remain strong?)
- **Economy risks** (e.g. will there be a recession?)
- **Country risks** (e.g. will the government remain stable and supportive of new infrastructure projects?)

Higher risk: you would expect higher returns on investment

Return under risk = \( \Sigma p_i \text{NPV}_i \), where \( p_i \) is the probability of event/outcome \( i \) happening. Note: \( \Sigma p_i = 1 \)
Finances Are Important, but They Aren't Everything

Environmental Impact Assessment
  Understand the expected impacts of the major alternatives on the environment

Sustainability
  Can (or should?) this project (or this program) be sustained indefinitely?
  Three sets of concerns
    Financial/ economic
    Social
    Environmental
Broader Economic Issues

Prices of resources may not reflect their true costs
- Local rather than world rates for energy costs
- Natural resources priced at extraction cost rather than at market cost
- Opportunity cost of land may be omitted (build the highway through the park)
- Government may require use of excess labor as a public policy

Generational equity
- Discounting of future costs and benefits may lead to long-term decline in the environment
  "Worry about today and the future will take care of itself": NO!!
Distributional Equity
- Costs and benefits will be unevenly distributed
- If total benefits exceed total costs, there is at least a possibility of compensating the losers
- Pareto optimality - some are better off and none are worse off (after compensation)
- "No one is hurt" (a very strong constraint on development)

Regional Economic Impact
- Multiplier effect of project expenditures on the local economy
- Use of local labor & resources
Non-financial Externalities
- Many impacts - both positive and negative - may be left out of the cash flow analysis
- Environmental impacts & need for remediation

Summary
- For any large project, there will be additional costs & benefits that must be considered in addition to the cash flows directly related to the project
- Some of these costs and benefits cannot readily be reduced to monetary measures
- Distribution of costs & benefits will be a concern
- In some cases, the non-quantifiable items will be the most important items to consider