Fundamentals

January 11, 2021 8:49 AM

Decision making process fundamentals

- Recognize the problem or opportunity
- Define the goal or objective
- Determine and reach consensus on scope
- Select the criteria to determine the best alternative
- Identify feasible alternatives, including the default option
- Assemble relevant data
- Construct physical and economic models
- Predict the outcomes or consequences for each alternative
- Choose and implement the best alternative
- Audit the results

Think about:

- Limitations
- Options
- Pros and cons

Evaluation method example: scoring

- Points assigned. Not science-based (value-based)
- Weightings assigned

Interest and equivalence

January 13, 2021 5:04 PM

Computing cash flow

- Receipts: cash flowing in (benefits)
- Disbursements: cash flowing out (costs)

Time value of money

- Money has value over time, so we cannot simply add up the various sums of money for a project over a period of time.
- Money is a valuable asset that people are willing to pay to have available for use
- Can be rented, the charge is called interest
- Discounting:
  - Money is not as valuable in the future as it is now.
  - Discount rate is denoted r (always positive)
- Present value measures current worth of future benefits and costs
  - $PV(\$_n) = \frac{\$_n}{(1+r)^n}$
  - The future value can be converted equivalently to present value
- Preference for having money now rather than money in the future differs from person to person
- Interests
  - Simple interest: interest that is computed only on the original sum and no compounding
    - Interest does not earn interest
    - Total interest earned $= Pin$, P = present sum, i =interest rate, n =# of time periods
    - Total money after n periods $F = P + Pin$
  - Compound interest (interest on top of interest)
    - Mostly used
    - Total money after n periods $F = P(1+i)^n$
      - Functional notation: $F = P(F/P, i, n)$ which means the future sum F given present sum P at interest rate i per interest period for n periods
      - E.g. $F = P(F/P, 7\%, 4) = 3000(1+0.07)^4$
      - To find present value given a future value, $P = F(1+i)^{-n}$
      - For continuous compounding:
        - Compound amount: $F = P(e^{rn}) = P[F/P, r, n]$
        - Present worth $P = F(e^{-rn}) = F[P/F, r, n]$
  - Interest rate
    - Pay an interest rate of i per time_period1, compounded every time_period2
    - Effective interest rate: when these time periods are both the same
    - Nominal interest rate: when the two time periods don't match
      - Nominal r =declared rate
      - Effective rate=$\frac{declared\ rate}{\#of\ compounding\ periods\ per\ year}$
      - Effective annual rate $i = \left(1 + \frac{r}{m}\right)^m - 1$ (where r is the nominal rate and m is number of compounding periods)
        - This number has limit $e^r - 1$
    - If without period, assume it is annual
  - Note:
    - Not every benefit or cost will involve a real change to the physical system you are making choices about
    - Not every benefit or cost will involve cache flow
- Repaying a debt
  - Constant principal

    - Interest only
    - Constant payments (mortgages, part interest, part principal)

Equivalence

- Equivalence with respect to the time value of money means a sum of money in one time period may have the same value to a different sum in another time period with respect to an interest rate
- Equivalence is dependent on interest rate
- Equivalence is useful when
    - There are cash flows or other benefits or costs in future time periods that need to be compared
    - Alternatives comparisons of multiple cash flows
- Equivalence and sustainability
    - The methods above can be misleading when applied to longer time periods

Assumptions in solving economic analysis problems

- End-of-year convention:
    - all cash flow amounts are calculated as amounts at the end of each period
    - Year 1 means the end of year 1
    - Now = end of period 0 (beginning of period 1)
- No sunk costs
    - Only the current situation and the potential future is considered
    - Past does not affect the future

Electricity pricing structure for commercial

- Blended rate = $\frac{total\ usage\ cost + demand\ charge\ cost}{usage\ amount\ (kWh)}$
    - Can be calculated over any time period of interest
    - Consequent cost per kWh is a blended rate that accounts for all variable costs
    - Fixed administrative costs are not included

Equivalence for repeated cash flows

January 18, 2021 4:52 PM

Annuity: annual payment

Opportunity cost: the net benefit of next best alternative
- Note: it is not the difference between two options. It is only calculating the net cost

Comparing and converting cash flows over time (discrete)
- Uniform series compound interest
  - Uniform series (A): an end-of-period cash receipt or disbursement in a uniform series, continuing for n periods
  - Relation between uniform series and future value
    - In general: $F = A(1+i)^{n-1} + \cdots + A(1+i)^2 + A(1+i) + A$
      So, $F = A\frac{(1+i)^n-1}{i}$
    - Notation: $F = A(F/A, i\%, n)$
      - The part in brackets is called the uniform series compound amount factor
    - Solving for A, $A = F\frac{i}{(1+i)^n-1}$
      - Notation: $A = F(A/F, i\%, n)$
        - The part in brackets is called the uniform series sinking fund
    - Uniform series sinking fund = 1 / uniform series compound factor
  - Relation between uniform series and present value (capital recovery)
    - Since $F = P(1+i)^n$, we have $A = P\frac{i(1+i)^n}{(1+i)^n-1}$
      - Notation: $A = P(A/P, i\%, n)$
        - The part in brackets is called the uniform series capital recovery factor
    - Solving for P, we have $P = A\frac{(1+i)^n-1}{i(1+i)^n}$
      - Notation: $P = A(P/A, i\%, n)$
      - This is called uniform series present worth formula
- Arithmetic gradient
  - A uniformly increasing series consists of two components:
    - Series component (A)
    - Gradient component (G)
  - Can calculate the conversion by splitting up into
    - P'=Present value of uniform payments
    - P''=Present value of increasing payments
    - Then $P = P' + P'' = A\left(\frac{P}{A}, i, n\right) + G\left(\frac{P}{G}, i, n\right) = A\frac{(1+i)^n-1}{i(1+i)^n} + G\frac{(1+i)^n-in-1}{i^2(1+i)^n}$
  - Can convert the linearly increasing series of payments (G) to a uniformly sized series of payments (A)
    - $A = G(A/G, i, n) = G\left(\frac{1}{i} - \frac{n}{(1+i)^n-1}\right)$
- Geometric gradient
  - Period by period change is a uniform rate (g)
  - Geometric series present worth factor notation: $(P/A, g, i, n)$
  - Two cases:
    - $i \neq g$: $P = A_1\frac{1-(1+g)^n(1+i)^{-n}}{i-g}$
    - $i = g$: $P = A_1\, n(1+i)^{-1}$
  - When compounding period and payment period differ, need to adjust
    - Computing the equivalent payment amounts for each compounding period and applying the interest rate
    - Computing an effective interest rate for the payment periods

- Reality and the assumed uniformity of A(uniform annual cost), G(uniform annual gradient) and g(uniform annual rate of increase)
    - Easier to start with simple models
    - These models cash flows are convenient for bounding the problems often encountered in engineering economic analysis
    - Not enough is known about the future and so it is approximated through series and gradients

Continuous compounding at nominal rate r per period

- Sinking fund: $\frac{e^r-1}{e^{rn}-1}$
- Capital recovery: $\frac{e^{rn}(e^r-1)}{e^{rn}-1}$
- Series compound amount: $\frac{e^{rn}-1}{e^r-1}$
- Series present worth: $\frac{e^{rn}-1}{e^{rn}(e^r-1)}$

Core formulas:

to: \ from:	P	F	A
P		$P = F\frac{1}{(1+i)^n}$	$P = A\left[\frac{(1+i)^n-1}{i(1+i)^n}\right]$
F	$F = P(1+i)^n$		$F = A\left[\frac{(1+i)^n-1}{i}\right]$
A	$A = P\left[\frac{i(1+i)^n}{(1+i)^n-1}\right]$	$A = F\left[\frac{i}{(1+i)^n-1}\right]$	

Present worth analysis

January 20, 2021 5:33 PM

Assumptions for solving economic analysis problems

- End of year convention
- No sunk costs: only the current situation and future is considered
- Viewpoint of economic analysis studies
  - Industrial economic analyses: a total firm
  - Public economic analyses: broader society
- Borrowed money
  - Financing: obtaining money
  - Investment: spending money
  - Money required to finance projects is borrowed at interest rate(discount rate) i
- Income Taxes
- Effect of inflation and deflation

Economic criteria:

- Alternatives are judged based on economic efficiency
- To compare alternatives, must move them to the same moment in time
- Each of the method will always give the same recommendation

Present worth technique

- Useful lives equal to the analysis period - NPW, or NPV(net present value)
  - Maximize net present worth(NPW)=present worth (PW) of benefits - present worth of costs
  - Select the alternative with higher NPW
- Useful lives different from the analysis period
  - Examine the alternatives using a LCM of lives
  - Decide on reasonably comparable analysis period if the LCM is too long or doesn't make sense
- Infinite analysis period: capitalized cost
  - The need for large-scale infrastructure projects is considered to be permanent
  - Capitalized cost: present sum that is required to provide the service indefinitely
    - The money set aside that can provide the funds for the project forever
  - For any initial present sum P, there can be an end-of-period withdrawal of A which is equal to $P(i)$
    - Withdrawals never decrease the original principal
    - $A = Pi$ for $n = \infty$
    - Capitalized cost = $P = \frac{A}{i}$

Future worth analysis

- Besides present worth, we can also choose between alternatives by finding their equivalent value at some future date
- More natural way of thinking about some problems

Bond price

- Bond is a way for firms or governments to borrow money from others
- For the buyer:
  - When bonds are purchased, the followings are fixed
    - Face value: amount paid out when the bond matures
    - Nominal interest rate
  - Purchase price can vary depending on the current market interest rate
  - Present worth is fixed (determined by the fixed values above)

Annual cash flow analysis

January 25, 2021 5:18 PM

Salvage value

- When there is a salvage value at the life of an asset, it is represented as a one-time cash flow benefit (revenue) at the end of the asset's life
- It needs to be included in analysis, no matter what method we use

Equivalent uniform annual cost (EUAC) analysis

- Compare alternatives based on annual cash flows by converting present values and one-time values on the timeline to their EUAC
- EUAC is also known as the capital recovery cost
- Salvage value lowers EUAC
  - $EUAC = P(A/P, i, n) - S(A/F, i, n)$ (most commonly used)
  - $EUAC = (P - S)(A/F, i, n) + Pi$
  - $EUAC = (P - S)(A/P, i, n) + Si$
- Relation between EUAC and PW
  - $EUAC = PW\ Cost(A/P, i, n)$
  - $EUAC = PW\ Cost(A/G, i, n)$ for arithmetic gradient
  - Expenditure increases EUAC, receipt decreases EUAC
- Impact of analysis period
  - Alternatives have equal lives: the analysis period is based on the same lifetime
  - Alternatives have unequal lives: the analysis is based on alternate lifetimes
    - No correction is needed
- Infinite analysis period
  - Infinite analysis of finite service lives
    - $EUAC_{infinite\ analysis\ period} = EUAC_{limited\ life\ n}$
  - Alternative with an infinite life evaluated over an infinite analysis period
    - $EUAC_{infinite\ analysis\ period} = P(A/P, i, \infty)$ +other annual costs=Pi +other annual costs
  - Difference in annual cost between a long life and an infinite life is normally small, unless an unusually low interest rate is used

Analysis complexities

- Analysis period can vary
- Costs and revenues, salvage value, operational and maintenance costs (all relevant costs) may need to be considered

Mortgages

- Technically a legal document
  - Outlines terms and conditions for repaying the money borrowed
    - Amount
    - Interest rate
    - First and last payment dates
    - Repayment period
    - Date the balance is due
    - Prepayment and penalties
- Long-term amortized loan that is used for buying real property such as a house or land
  - Amortization: process of paying off a debt over time
  - Amortization period is the length of time it takes to pay off the mortgage, assuming:
    - Payments are made on time with no additional payments
    - Interest rate doesn't change
- In Canada
  - Amortization period:

        - Between 5 and 40 years
        - Norm is 20 or 25 years in Canada
    - Rates:
        - Usually nominal annual rate
- Building an amortization schedule
    - Loan payment
    - Interest paid
        - interest paid = interest rate * balance remaining from the period before
    - Principal paid
        - Principal payment = payment-interest paid
    - Remaining balance
        - Remaining balance = preceding remaining - principal payment
- Types
    - Conventional
        - For 80% or less of the appraised value of the property, make a down payment of at least 20%
    - High-ratio mortgages
        - Higher than 80%, usually require an outside agency to insure the mortgages
    - Others
        - Open, variable rate, ARM(adjustable rate mortgage), capped rate, closed, convertible rate, second, reverse, CHIP mortgage
- Interest rate considerations
    - Fixed mortgage rates are influenced mainly by the bond market, starting with government-issued bonds
        - Less uncertainty, but cost more
    - Variable mortgage rates are tied to lending rates that National banks set, for loaning money to financial institutions
    - Risk averse: prefer less mortgage risk
- Equity: the value remaining in a property after all mortgage and loans registered against the title are subtracted
    - The amount you actually have paid off
    - Equity=appraised value - mortgages

Rate of return analysis

January 27, 2021 5:39 PM

Internal rate of return (IRR)

- A project's rate of return
- Interest rate/discount rate at which the benefits are equivalent to the cost
  - i.e. interest rate at which the present worth and equivalent uniform annual worth are equal to zero
  - Present worth = net present worth = 0
  - PW of benefits - PW of costs = 0
  - PW of benefits / PW of costs = 1
  - EUAW = EUAB-EUAC = 0
  - PW of costs = PW of benefits
- NPV versus interest rate i is non linear, due to non-linearity of discounting
- Purpose: allow us to decide between different possible projects

Minimum attractive rate of return (MARR)

- Is a benchmark: an estimation of how much you think you could earn through other investments
- The average rate at which we have to recompense our creditors and investors sets a lower bound on the rate of return at which a proposed project becomes attractive
  - The highest of these lower bounds is the MARR

Incremental Analysis (ΔIRR)

- Internal rate of return (IRR) can be deceiving, so we need to maximize the return, not the rate of return
- Two or more alternatives can be compared by using IRR analysis on the differences in cost and revenue streams.
- Algorithm
  - Calculate IRR, discard any which IRR<MARR
  - Arrange the remaining alternatives in ascending order of first cost
  - The one with lowest first cost is the current champion
  - Calculate the incremental IRR of upgrading from the current champion to the alternative with next-lowest first cost
  - If incremental IRR>MARR, upgrade; otherwise, stick with the current champion
  - Repeat the last two steps until we run out of alternatives

In rate of return analysis, the analysis period needs to be the same if we are examining the increments between alternatives. It has the same limitations that present worth method has

Sensitivity analysis

- Make tentative conclusions while one or more important parameters remain undetermined. Compute how much an estimate can change and the effect on a particular decision
- General steps
  - Write down an expression for the PW or EUAC of each alternative, with the unknown MARR as a free parameter
  - Plot PW or EUAC versus MARR for each alternative on the same graph
  - Note which alternative gives the maximum PW or minimum EUAC at each value of MARR, and the crossover points between alternatives

Modified Internal Rate of Return (MIRR)

- When the set of costs and revenues become too complex, the IRR function can fail
  - We made assumption that positive cash flows can be reinvested at the IRR rate
- MIRR is a measure of attractiveness of the cash flows, also a function of the two external rate

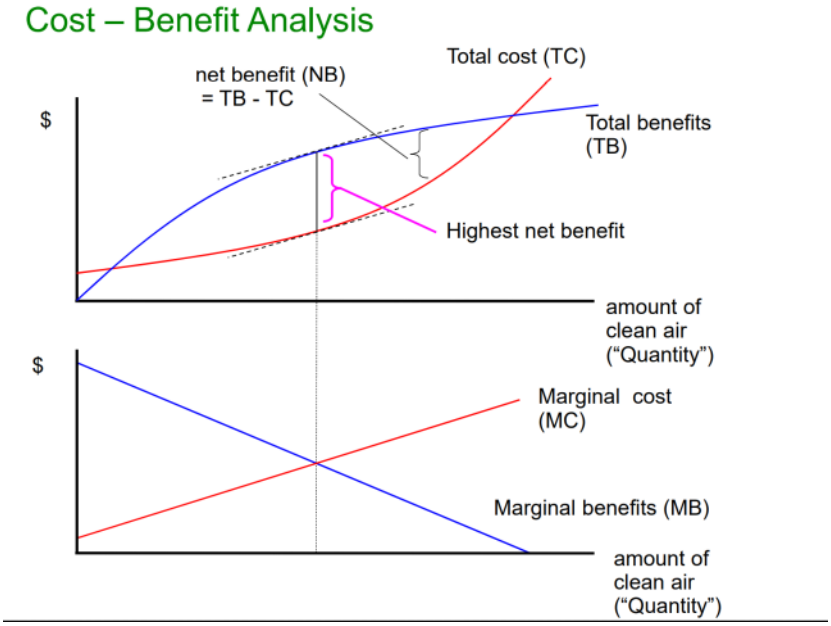
of return

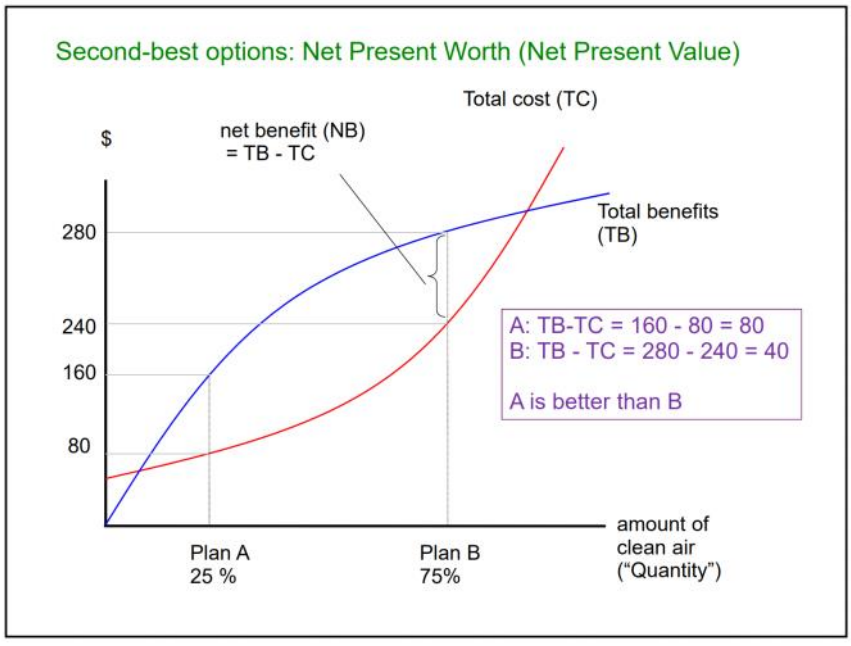
- Use external interest rates to establish a MIRR
  - Investing rate (e_{inv}): positive cash flow
    - Moved to the end of the project's time using $(F/P, e_{inv}, n)$
  - Financing rate (e_{fin}): negative cash flows
    - Moved to the beginning of the project's time using $(P/F, e_{fin}, n)$
  - $0 = (1 + MIRR)^n PW + FW$
- Not used very often

Ideals and second-best solutions

February 1, 2021 5:45 PM

Cost-benefit analysis

- Marginal cost/benefit is the derivative of total cost/benefit
- Ideally: maximize discounted net benefits $\Sigma_n \frac{TB_n - TC_n}{(1+r)^n}$
  - 

- Second best approach: examine several options and choose the best among the set
  - 

Benefit-cost ratio payback period analysis

February 3, 2021 4:53 PM

Benefit cost analysis

- Purpose: to measure a project so that one can determine whether it causes a net increase in economic and social welfare
- $B/C ratio = \frac{Equivalent\ worth\ of\ net\ benefits}{Equivalent\ worth\ of\ costs} = \frac{PW\ benefits}{PW\ costs} = \frac{FW\ b}{FW\ c} = \frac{AW\ b}{AW\ c}$
  - Typically, bring all costs and benefits to today, $B/C\ ratio = \frac{\Sigma_n \frac{TB_n}{(1+r)^n}}{\Sigma_n \frac{TC_n}{(1+r)^n}}$
- Second best analysis:
  - Maximized discounted B/C ratio
  - Examine one option and decide whether to implement or examine several options and choose the best
  - If B/C ratio>1 invest, otherwise don't
  - If ratio close to 1, do sensitivity analysis
  - Choose the one with the highest B/C ratio
- Conventional B/C ratio$= \frac{PW\ of\ all\ benefits}{PW\ of\ all\ costs}$
- Modified B/C ratio$= \frac{PW\ of\ all\ benefits - ongoing\ costs}{Initial\ captial\ costs\ only}$
- Net benefits to users $= expected\ benefits - disbenefits$
  - $disbenefits$ are negative effects on individuals or groups
- For multiple mutually exclusive alternatives, not proper to simply calculate the B/C ratio for each alternatives, we need to use the incremental B/C ratio to compare and select
  - Identify all relevant alternatives
  - Optional: calculate B/C ratio of each alternative
    - If doing nothing is an alternative, and others have B/C ratio less than 1, it must be skipped
  - Rank-order the projects
  - Identify the increment under consideration
  - Calculate B/C ratio for the incremental cash flows
  - Use incremental B/C ratio to decide which alternative is better
  - Iterate to step 4 until all increments have been considered
  - Choose the best alternative from the set of mutually exclusive competing projects

Payback period analysis

- Payback period: period of time required for the profit or other benefits of a project to equal the cost
- Important points
  - This is an approximate calculation
  - All costs/benefits/savings are included with no consideration of timing differences
  - All economic consequences beyond the payback are ignored
  - Due to its approximate nature, it may not select the correct alternative
- Payback period$= \frac{cost}{uniform\ annual\ benefit}$

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Selection of a minimum attractive rate of return

February 8, 2021 4:57 PM

Opportunity cost

- Two independent aspects of investing
  - Source of money available for projects
  - Firm's investment opportunities
- Investments need to be selected
  - Best rejected project is called the opportunity cost
    - cost of best opportunity foregone
    - Cost of next-best opportunity
    - Rate of return on the best rejected project

IRR is commonly used in the private market. May not work well when decisions are being made right at the margin of available funds

Minimum Attractive Rate of Return (MARR):

- Lower boundary must be the cost of the money borrowed to invest in a project
- MARR should not be less than the rate of return on the best opportunity foregone
- Must set a higher MARR than the minimum
- MARR must reflect stockholder expectations of dividends and profits

Uncertainty and risk

- Uncertainty describes the condition when the probabilities are not known
- If the probabilities are known, they are risk
- With normal risk and uncertainty, MARR is used without adjustment
  - Typically 12%-15%
- Higher risk or uncertainty increases the MARR.
  - On average, the set will deliver normal MARR rates

Selecting the best projects

- Rank projects (that exceed the MARR) based on the biggest bang for the buck
  - Measured by $\frac{NPW}{PW\ of\ cost}$
- More common to rank based on rate of return
- Capital budgeting
  - Amount of an investment can change ranking

Public sector analysis

February 8, 2021 6:08 PM

Public sector investment objectives and challenges

- Investment decisions are more difficult in the public sector than in the private sector, for many reasons
  - Broader scope of analysis and of impact
  - Implications of long-lived projects
  - Need to consider social and environmental benefits
  - Conflicting benefits
  - Financial caps and other uniqueness
  - Politics

Scope for analysis

- Economic analysis (governmental, industrial) must be based on a viewpoint
- Possible viewpoints that may be taken include individual, firm, regional municipality, city, province, nations, etc.
- Industry viewpoint consists largely of counting of costs and benefits
- Government generally takes the viewpoint of its constituents
  - Municipality, province, country
- Viewpoint for any problem is to take the viewpoint at least as broad as those who pay the costs and who receive the benefits
- The analysis viewpoint and level of coordinated action should match the scope of the problem

Long-lived projects

- Government projects often have longer lives (20 to 50 years or longer)
  - Usually require substantial funding in the early stages
  - Good to spread the first cost over as many years as possible to reduce annual cost of capital recovery
- In private sector, projects most often have a projected life between 5 an 15 years

Quantifying and valuing benefits and costs

- Many public sector projects have consequences that are difficult to state in monetary terms
  - Usually social and/or environmental impacts
  - Estimated values will have more uncertainty than is typical for private sector projects
  - Broader analysis takes place

Valuing conflicting, mutually exclusive benefits

- Costs and benefits may apply to different groups of businesses and people, with conflicting objectives

Project financing

- Governmental and market-driven firms differ in the way investments in equipment, facilities, and other projects are financed.
- Firms rely on monies from individual investors (through shares and bonds), private lenders, and retained earnings from operations.
- The government sector often uses taxation and bonds as the source of investment capital.
- Municipal and regional governments tend to place a cap on their debt ratio, which constrains borrowing and spending.
- In government, taxation and revenue from operations is adequate to finance only modest projects. However, public projects tend to be large in scale, which means that for many public projects 100% of the investment costs must be borrowed.
  - Smaller projects are fully funded through taxation.
  - Larger projects typically require borrowing through bonds.

- Sometimes P3s - public–private partnerships – are used.
    - Needs identified by the government, who enters into an agreement with private industry to implement a project and meet that need

Politics

- Political influences are felt in nearly every decision made in any organization.
- In government, the effects of politics are felt continuously at all levels due to:
    - The large-scale and multi-purpose nature of projects
    - The use of the citizens' common pool of money
    - The different values and views of individuals and groups (conflicting benefits)
- Politicians are elected for short terms, and can have difficulty balancing short term political needs (including being re-elected) with long-term societal needs.

Discount rates

- No interest rate
    - Time value of money
        - In government, monies are obtained through taxation and spent about as quickly as they are obtained
        - Little or no time lag between collecting and spending tax, so no interest rate should be applied
- Cost of capital
    - Most levels of government borrow money for capital expenditures in addition to collecting taxes
    - Use an interest rate equal to the cost of borrowed money
- Opportunity cost
    - Interest rate on the best opportunity forgone
    - Two forms:
        - Government opportunity cost
            - Interest rate that is based on the opportunity-cost to a government agency or other governing body
            - Set at that of the best prospective project for which funding is not available
            - Disadvantage: different government subdivisions will have different opportunities, inconsistent decisions across government
        - Taxpayer opportunity cost
            - The investment interest rate the taxpayer could have received if the government had not collected the dollars through taxation
            - Taxation takes away the taxpayers' opportunity to use the same dollars for investment
            - The interest rate that the government requires should not be less than what the taxpayer would have received
            - Not very practical, taxpayers can have different earning rates
- To choose a discount rate
    - Apply either government or taxpayer opportunity cost
    - In private sector, no hard and fast rule
    - Setting of an interest rate for use in economic analysis is at the discretion of the government
- In Vancouver, cost-of-capital is used to set the short-term interest rate and discount rate
    - Long term is lower

Cost effectiveness analysis

- Given a standard, we want to find the least expensive option
- Net benefit = total benefit - total cost
- It tells us how we meet the predefined goal most cost effectively, while cost benefit analysis tells us what is the best goal

Scope of analysis

February 10, 2021 5:47 PM

Triple bottom line vs business case analysis

- Not all criteria for success are financial
- Need for decisions and recommendations to consider triple bottom line/sustainability goals
- Comparison with business
- Sustainability concepts
    - Local and global, long term impacts
    - Interconnectedness of systems
    - Collaborative
    - Includes financial impacts
- Business case analysis
    - Local and global; long term impacts
    - Interconnectedness of systems
    - Collaborative
    - Includes financial impacts
- Triple bottom line (TBL) analysis:
    - Environmental, economic (business case), social impacts
    - Environmental, technical, operational, social, financial
    - Measures will not be directly comparable, so subjective comparisons must occur

Categories of benefits

- Market benefits
    - Simpler than other situations, since direct relationship/data exist
    - Such benefits can be transferred, but must control for other factors
- Non-market benefits
    - Indirect use values: proxies exist for estimating value placed on goods that don't have a direct market, by measuring what people do in some other related way
    - Non-use values (passive use)
        - Option value
        - Bequest value
        - Existence value

Methods of measuring benefits

- Complementarity method/surrogate market
    - Can only measure indirect use values
    - The value of an improvement in environmental quality can be inferred from people's expenditures on complementary goods, or goods that tend to be consumed along with the environmental amenity
- Travel cost method
    - Measures benefits that people get from a particular site
    - Can only measure indirect use values
    - The value of a public park or recreational site can be inferred from information about the travel costs people incur to visit the site. People spend money to go to and visit areas because they value them.
- Hedonic price (property value) method
    - Measures benefits that people get from particular environmental goods
    - Can only measure indirect use values
    - The costs associated with avoiding pollution or otherwise undesirable locations (like say, proximity to a landfill, are often reflected in the property values of people living nearby, so comparisons of property values between different locations can provide a proxy value for the benefit.
- Wage/Foregone earnings method

    - Similar to hedonic price method
    - Can only measure indirect use values
    - Differences in wages between a risky occupation and a less risky one can measure
        - the benefits of lower risks.
        - The extra value of living in a more desirable city or region
    - Can be used to estimate the value of statistical life
    - A crucial tool of the insurance industry
- Averting behavior/averting expenditures method
    - Can only measure indirect use value
    - The value of an improvement in environmental quality can be inferred from people's expenditures on other things (such as air conditioning, water filters, or medical care) that help them avoid or cope with environmental problems.
    - Can be used to estimate the value of a statistical life.

Value of a statistical life
- Used to estimate the average value of risk reduction
- Insurance agencies use this method to establish fees

Conjoint analysis
- Advanced analysis is an advanced analysis method that attempts to understand how people make complex choices
- Can only capture indirect use value
- Extract consumer preferences during the purchasing process, and statistically analyzes it to tease out which factors are important and which are not

Cost based methods of estimating use benefits
- Relocation cost: estimates the monetary value of environmental damages based on the potential costs of relocating a physical facility that would be damaged by a change in environmental quality
    - Relies on data on potential expenditures
- Replacement cost: measures the potential expenditures that would be required to replace or restore a productive asset that would be damaged by some project or development
    - Then compared to the costs of preventing the damage from occurring to determine which is more efficient
- Dose-response method: requires information on the effect that a change in a particular chemical or pollutant has on the level of an economic corporate or personal activity

Contingent valuation method (CVM)
- Measures benefits that people get by what they are hypothetically willing to pay to keep a good
- Can be used to estimate indirect use or non-use values
    - The only method that can measure non-use values(existence, option)
- Willingness to pay (WTP)
    - Pay for increase in environmental quality
- Willingness to accept (WTA)
    - Usually $WTA \geq WTP$
    - Pay in compensation to accept a reduction in environmental quality
- Potential biases
    - Strategic
    - Information
        - Impacts identification
        - Impacts description
        - Good and topic familiarity
    - Starting point
    - Hypothetical
- Other difficulties
    - Source of change sometimes matters

- □ Choosing WTP or WTA

Accounting

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The role of accounting

- Engineering economy focuses on the financial aspects of projects, while accounting focuses on the financial aspects of firms
- Three functions within businesses
  - Engineering economics: analyzes economic impact of alternatives and projects over their life cycles
  - Accounting: records the financial impacts of past decisions, reports on the financial state of a unit or firm, and provides info on certain potential funding sources
  - Management: evaluates other potential funding sources, allocates available investment funds to projects, evaluates unit and firm performance, allocates available investment funds to projects, evaluates unit and firm performance, allocates resources, and selects and directs personnel
- Accounting for business transactions
  - Business transaction involves two or more parties and the exchange of dollars for a product or service
  - Accounting functions:
    - Records, analyzes, and reports on transactions
    - Summarizes and analyzes financial data
    - Provides data for general accounting and cost accounting

Primary accounting statements

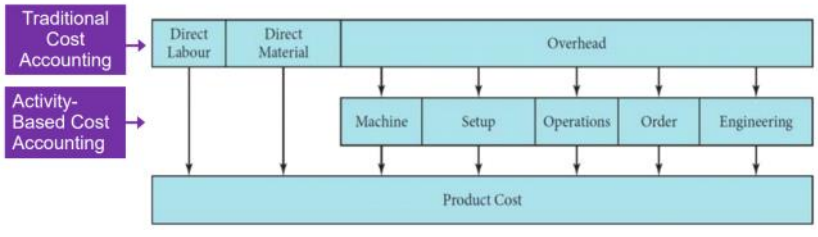
- Balance sheet: a firm's financial condition at one specific time
  - Lists a firm's assets, liabilities, and equity
  - Assets: all thing the firms owns that have monetary value
    - Cash, physical goods and equipment, property, and money owed to the firm
  - Liabilities: all of the money the firm owes to others
    - Short-term (current): due within one year
    - Long-term: due later, mortgages, bond, loans
  - Equity (net worth): value of the firm
    - Represents funding from the firm and its owners (the shareholders)
    - All the money the firm owes to its owners
  - Fundamental accounting equation: assets = liabilities + equity
  - Firms can only make short-term financial decisions if they have cash to support those
  - Some money is tied up in long-term assets or liabilities. That money can't be accessed easily
  - Short-term money: Working capital = current assets - current liabilities
  - Financial ratios
    - $Current\ ratio\ = \frac{\text{current assets}}{\text{current liabilities}}$
      - Shows the ability of a firm to cover current liabilities
      - Usually aim to be at or above 2.0
    - $Acid-test\ ratio\ (quick\ ratio) = \frac{quick\ assets}{current\ liabilities}$
      - Quick assets = current assets - current inventories
      - Shows the ability of a firm to pay debt quickly
      - Inventories excluded because it takes time to sell them to get cash
- Income statement: a firm's performance over a period of time
  - Profit/loss statement
  - Summarizes the firm's revenues and expenses over a period of time
  - Used to evaluate revenue and expenses that occur in the interval between consecutive balance sheet statements
  - Reports the firm's net income or loss by subtracting expenses from revenues

        - Revenues-expenses = profit (if positive) or loss (if negative)
    - Financial ratios
        - $Net\ profit\ ratio\ = \frac{net\ profit}{net\ sales\ revenue}$
            - Indicates cost efficiency of operations and firm's ability to convert sales into profits
            - Net sales revenue = sales - returns and allowances
        - $Interest\ coverage\ ratio\ = \frac{total\ income}{interest\ payments}$
            - Indicates how much revenue must drop to affect the firm's ability to finance its debt
            - Should be at least 3.0 for industrial firms
            - Total income = total revenues - all expenses except interest payments

Using the financial statements

- Need to link the balance sheet, income statement, and capital transactions
- For engineering economic analysis, crucial concepts are
    - Overall profit or loss (income statement) and the starting and ending equity (balance sheet)
    - Acquisition of capital assets
    - Depreciation of capital assets
- Retained earnings (RE)
    - Overall profit or loss during the year is reflected in the change in RE
    - $RE_{end}\ =\ RE_{beg}\ +\ \frac{Net\ Income}{Loss}\ +\ New\ Stock\ -\ Dividends$

Traditional Cost accounting

- Method of assigning costs to products or services
    - Understand the mix of costs involved in a particular product
    - Understand the relative costs, revenues and profits of various products
    - Evaluate outsourcing and subcontracting possibilities
- Direct and indirect costs
    - Ideal method
    - Rationale
    - Real situation
    - Direct: activities directly associated with the final product or service produced (material, labor)
    - Indirect (overhead): costs not easily linked directly to individual products or services (machine depreciation, management, sales, finance/accounting, administration/support)
        - Allocated across projects through absorption costing
        - Allocation based on proxies
            - # of staff in each project group
            - Direct-labor costs by group or possibly by project
            - Direct-materials cost
            - Total direct costs by group or possibly by project
- Problems:
    - Indirect cost allocation can distort product costs and the decisions based on those costs
    - Some firms are shifting to activity-based costing where activities are linked to specific costs. This shifts indirect costs to direct costs
    - 

Accounting/reporting challenges

- Centralized accounting systems have been accuse by project managers of being too slow or untimely
- If an organization establishes numerous files and systems so that stakeholders have the timely data they need, the level of accuracy in one or all systems may be low
- Inventory or land valued too low because its based on acquisition cost
- Capital equipment being valued too high or too low depending on the depreciation methods and company policy