

Geog 469  
GIS Workshop

Benefit-cost analysis for  
GIS project evaluation

# Outline

- Why bother with benefit-cost analysis (BCA)?
- What is the conceptual basis for BCA?
- What are the main types of benefits?
- What are the main types of costs?
- What kinds of difficulties might we face when performing BCA for GIS project?
- How do we perform benefit-cost analysis?
- What is risk analysis in the context of GIS project implementation?

# Context

- Benefit-cost analysis (BCA) and evaluation is one stage of final report
- This lecture provides guidance for performing a BCA

# Why benefit cost analysis?

- Analysis involves weighing the costs of proposed projects against projected benefits.
- It's better to approve projects based on measures (e.g. BC ratio), rather than assertions of needs or problems
- Reduces uncertainty during decision making
- Provides a basis for comparing GIS options
- Assess the advantages of a specific GIS application over competitive solutions, for example not utilizing a GIS
- Public sector considers policy impact as well as financial impact while private sector is most concerned with financial bottom line (although could be triple bottom line)

# BCA is used to...

- Justify investment: GIS vs. non-GIS
- Is it wise to adopt a GIS?
- Compare alternative implementation scenarios: GIS project with different requirements (e.g. s/w, h/w, data....)
- Prioritize information products; which information products should be implemented given resource constraints?

# Pros and Cons of BCA

- Pros
  - Provides an economic rationale for an organization's decision to adopt a GIS or purchase which system; persuasive information
- Cons
  - Very difficult to assess or quantify many of the benefits and costs that are needed to perform the calculation, but particularly the benefits

# Basic Concepts in BCA

- Benefit types
- Cost types
- Benefit/cost ratio
- Life expectancy of investment
- Discounting of value

# Performing BCA

- Identify benefits
- Identify costs
- Compare benefits and costs
- Calculate benefit/cost ratios



# Types of benefit

- How difficult to quantify?
  - Tangible vs. intangible benefits
- Any ripple effect?
  - Internal vs. external benefits
- Consider timeframe of effect?
  - Strategic vs. Tactical vs. Operational benefits

# Types of benefits

- Tangible Benefits: Benefits appraised at actual (or approximate) dollar value
  - Cost reductions
    - Decreased operating costs, staff time savings
  - Cost avoidances
    - Increased efficiency, fast performance
  - Increased revenue
- Intangible Benefits: Benefits for which dollar value is difficult to appraise
  - Improve decision making
  - Better internal communication
  - Decrease uncertainty
  - Improved morale
  - Better public image

# Tangible benefit examples

- Total cost of producing maps by manual means was greater than total cost of making identical maps using GIS
  - tangible benefit
- Use of GIS allows garbage collection company to reduce staff through better scheduling of workload and collection routes
  - Tangible benefit, possible to quantify
- Emergency vehicles reduce average arrival time by using GIS-supplied information on road conditions
  - tangible if we can quantify the increased cost resulting from delayed arrival (fire has longer to burn, heart attack victim less likely to survive, etc.)
- Information from GIS was used to avoid costly litigation in land ownership court case
  - tangible but hard to quantify, implies we can predict the outcome of the case if GIS information had not been available
- Forest Service finds a better location for a campsite through use of GIS
  - tangible, implies we can characterize the decision that would have been made in the absence of GIS

# Intangible benefit example

- Improved information avoided the destruction of archaeological site...
- What would be the dollar amount assigned to benefit generated from this?
- Archaeological society may be able to identify amount of tourism directly attributed to archaeology identified by analysts
- Oil/gas company may be able to identify reduction in fines paid by avoiding damaging archaeological resources

## Benefits based on four perspectives

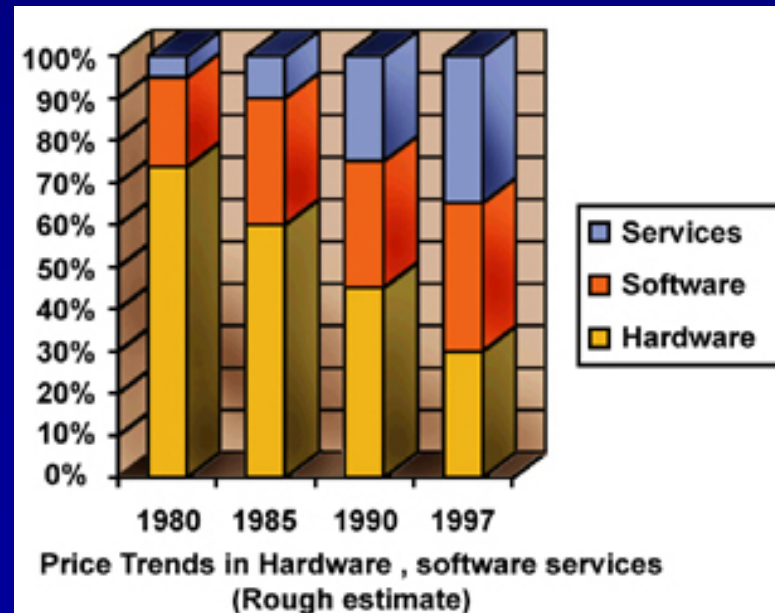
Direct	The savings from using GIS vs. current manual means. Staff savings. Reduced use of outside services. Increased revenues, if the information generates revenue and there's unmet demand for the information.
Departmental (Agency)	Reflects better outcomes from having better (more accurate, complete and timely) information. Increased revenues, if a higher price can be demanded for the information produced. Time savings, because more accurate and complete information avoids waste.
Company-wide (Government-wide)	If better outcomes noted for department/agency above accrue to another department/agency as well, then it's considered a company-wide or government-wide benefit.
External	These benefits accrue to outside entities--other firms, the public and the environment--and thus are most difficult to quantify. They should at least be noted for the qualitative value. Where possible, a proxy for the benefit should be used, and possibly noted in a separate benefit/cost ratio from that for the organization-specific benefits.

# Types of cost

- Start-up (one-time?) cost
  - Hardware, software, data, facility, training
  - Get estimates from vendors
  - For our GIS projects, use an estimate for lease rather than purchase
- Recurring cost
  - Staffing: salary + overheads such as rent, utilities, and supplies
  - Maintenance: database update, service update, ongoing training, etc.
  - For our GIS projects, use standard salary scale

# Types of cost

- Quite often training, consulting, customization, maintenance, data, etc. are grouped into Services, as separate from Software and Hardware
- Proportions have changed over time; and continue as in this chart...



# Benefit/cost ratio

- Calculate the total value of the benefits versus the total costs
- A ratio 1/1 or greater, justifies an expenditure
- $B/C > 1$ , a good investment
- $B/C < 1$ , maybe not such a good investment



# Time

- BCA results must be considered over time
  - Up-front outlays do not produce immediate benefits; benefits begin to accrue over time
- Payback period
  - What time frame (months or years?) would it take to accumulate enough benefits to pay for the cost of the system?

# Discounting

- Deflate the amounts relating to benefits and costs to remove the effects of inflation
  - Benefits realized in the year 2020 are less socially valuable than the same dollar amount of benefit realized in 2014
- Discounting is important...
  - GIS and its applications have multiyear life expectancy
  - GIS costs and benefits are spread over multiple years

# Comparing benefits and costs

- For comparison, benefits and costs must be measured in same units, over same period of time
  - Place them on an equal footing
    - Value should be adjusted for inflation (discount)
  - Cost/benefit ratio changes over time
    - Graph benefit and cost per year over time
- Calculate benefit-to-cost ratio
  - $B/C = PVB / PVC$  where
    - B/C is benefit-to-cost ratio
    - PVB is the present value of benefits and
    - PVC is the present value of costs
  - If a ratio greater than 1, benefits outweighs costs

# Challenges in BCA for GIS

- GIS is new technology to many organizations
- Full benefits might be over- and/or underestimated
- Not well-established market value available as expenditure is unfamiliar
- Benefit and cost extend over time
- BCA based on map output is different from BCA based on spatial analysis
  - The latter is more complex
  - There is a need to understand how decision makers use and value information

# Risk Analysis

- Additional analysis to ensure moving forward in an appropriate manner
- Evaluate the risks associated with project implementation
- **risk** - an uncertain event or condition that, if it occurs, has a positive or negative effect on at least one project objective such as time, cost, scope or quality. (American National Standards Institute, ANSI/PMI 99/001/2008).

# Risk Analysis Method

1. Identify types of risks associated with project
2. Discuss risks in context of planned implementation
3. Describe ways to mitigate risk
4. Assess likelihood & seriousness of each risk by assigning score
5. Summarize risk by summing score

# 1. Identify types of risks associated with project

- Is technology new or mature?
- Does it address need?
- Organizational changes needed to adopt and implement?
- Multiple organizational interaction needed to implement project?
- Budget constraints?
- How complex? Internal regulations, industry regulations, government regulations?
- Project planning, management, scheduling, and human resource constraints?

## 2. Discuss risks in context of planned implementation

- Discuss risks with staff
  - Within team
  - Within department unit
  - Within organization
  - Among organizations



### 3. Describe ways to mitigate risk

- Having identified and discussed risks, what factors can mitigate risks?
- Can staff learn to grow with challenges?
- Work with only “proven” companies for hardware, software, services?

## 4. Assess and score each risk

- Score an organization's (management and staff) ability to address risk using rank, e.g., high, medium, low or 1 – 10
- How important is the risk to overall success of the project?

## 5. Summarize the risk level

- When is it permissible to add ranks?
- The unit metric must be internally consistent
- Compute the average of the risks
- Of course, such numbers can be suspect if the unit of measurement is not logically consistent
- Nonetheless, ordinal risk can provide insight about challenges for a GIS project and an organization within which project is implemented

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