

Benefit/Cost Ratio Evaluation:

Benefit (B)- Advantage experienced by the owner.

Disbenefits (D) – disadvantages to the owner when the project under consideration is implemented.

Costs (C) - Anticipated expenditures for construction, operation, maintenance.....etc. Less any salvage values.

Before a B/C ratio can be computed, all the identified benefits and costs must be converted to common dollar units. The unit can be an equivalent PW, AW, or FW.

$$\text{B/C} = \frac{\text{benefits} - \text{disbenefits}}{\text{Costs}} = \frac{\text{B-D}}{\text{C}}$$

A B/C ratio greater than or equal to 1.0 indicates that the project evaluated is economically advantageous. In B/C analyses, costs are not preceded by minus sign.

$$\text{Modified B/C} = \frac{\text{benefits} - \text{disbenefits} - \text{maintenance and operation costs}}{\text{Initial investment}}$$

Any salvage value is included in the denominator as a negative cost.

The benefit and cost difference measure of worth, which does not involve a ratio, that is

$B - C$, if $(B-C) \geq 0$, the project is acceptable.

Example:

Nonprofit research organization is investment of 1.5\$ million in grants to develop new ways to teach people. The grants will extend over a 10 year period and will estimated savings 500.000\$ per year in faculty salaries, student tuition and fees, and other expenses. The organization uses a ROR = 6% per year. Estimated that 200.000\$ per year will be removed from other program funding to support this educational research. The M&O budget equal 50.000\$ per year. Use the following analysis methods to determine if the program is justified over a 10-year period:

- 1) Conventional B/C
- 2) Modified B/C
- 3) $(B - C)$ analysis

Solution:

Benefit = 500.000\$ per year

Disbenefit = 200.000\$ per year

O & M cost = 50.000\$ per year

Investment cost = 1.500.000 (A/P16%, 10) = 203.805 per year

$$1) B/C = \frac{500.000 - 200.000}{203.805 + 50.000} = 1.18$$

The project is justified, since $B/C > 1$.

$$2) \text{ Modified } B/C = \frac{500.000 - 200.000 - 50.000}{203.805} = 1.23$$

The project is also justified

$$3) B - C = (500.000 - 200.000) - (203.805 + 50.000) = 46.195\$ > 0$$

The investment again Justified

The disbenefit $D = 200.000\$$ is not a direct cost to this program and should be subtracted from 6.

Alternative Selection by Benefit/cost Analysis

One the B/C ratio for the difference is computed a $B/C \geq 1$ means that the extra benefits justify the larger – cost alternative. If $B/C < 1$, the extra investment or cost is not justified and the lower cost alternative is selected. The lower-cost project may or may not be the do-nothing alternative.

Ex:

	<u>Present Condition (PC)</u>	<u>Improved condition (IC)</u>
Benefits per year \$	20.000	24.000
Costs per year \$	16.000	8000

Compare between two alternatives by using B/C ratio?

The denominator is always positive value indicating the incremental cost, in this case, the alternative with the larger cost is PC, so it is the base for comparison.

$$\text{The } B/C = \frac{-4000\$}{2000} = -2.0$$

Since the B/C ratio is less than 1, we reject the alternative with the extra cost, which in this case is present condition.

The steps for B/C analysis are summarized below:

- 1- Calculate the total cost of each alternative.
- 2- Subtract the costs of the lower investment alternative from those of the larger cost alternative which we consider the alternative to be justified. Use this value as C in the B/C ratio.
- 3- Calculate the total benefits of each alternative.
- 4- subtract the benefits for the lower-cost alternative from the benefits for the larger-cost alternative, paying attention to algebraic signs. Use this value as B, calculate the B/C ratio.
- 5- If $B/C \geq 1$, the incremental investment is justified, select the larger investment alternative. Otherwise, select the lower-cost alternative.

Selection from alternatives using incremental B/C analysis:

Ex:

Consider the four mutually exclusive alternatives described in ex. A. Apply incremental B/C analysis to select the best alternative for a MARR = 10% per year, use a PW analysis.

Solution:

The alternatives are first ordered from smallest to largest initial investment cost (C, A, B, D) and the PW values of annual cash flows are determined (table), Next calculate the overall B/C ratio and eliminate any alternative that has $B/C < 1$. Location C can be eliminated. All other locations are initially acceptable and are further compared on an incremental basis. The incremental benefits and costs are determined on the basis of present worth.

Incremental benefit – incremental in PW of cash flows between alternatives.

Incremental cost – increment in building cost between alternatives.

