CE 231 ENGINEERING ECONOMY

STUDY QUESTIONS ABOUT B/C ANALYSIS

1. CALCULATION OF AN INDIVIDUAL B/C RATIO

From the following data, determine the B/C ratio at i=7% per year for a new road project which has a 20 year life. **Use Annual Equivalent values.**

Benefits for road-users in year 0: 50.000 TL

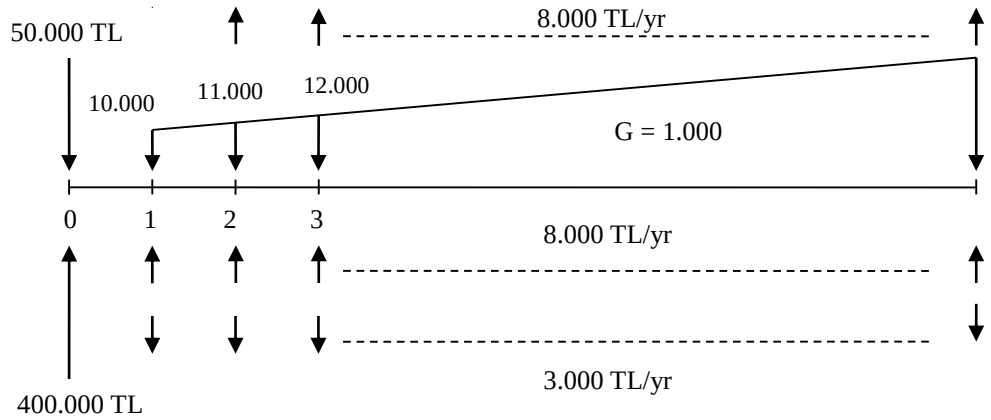
Benefits for road-users in years 1-20 (due to time savings): 10.000 TL in year 1 and increases by 1.000 TL each year.

Loss of income by local businesses because of rerouting of traffic: 8.000 TL/year (disbenefit)

First cost of project: 400.000 TL

Annual operating and maintenance cost of the road: 8.000 TL/year

Annual savings of the government: 3.000 TL/year



Solution:

AE of benefits to public = 50.000(A/P,7%,20) + 10.000 + 1000(A/G,7%,20) = 22.036 TL/yr

AE of disbenefits to the public = 8.000 TL/yr

AE of costs to the government = 400.000(A/P,7%,20) + 8.000 = 45.756 TL/yr

AE of savings to the government = 3.000 TL/yr

B/C = (22.036 – 8.000) / (45.756 – 3.000)

B/C = 0,33 < 1

Reject the new road project

PROCEDURE FOR INCREMENTAL B/C ANALYSIS

STEP 1: Put the alternatives in ascending equivalent cost order where the alternative with least cost becomes the first, and so on.

STEP 2: Select "Current Best" the alternative with least equivalent cost, and as the "Challenger" the next in line.

STEP 3: Find B/C ratio $_{\text{challenger-current best}}$ by subtracting the cost of the current best from the cost of the challenger; and the benefit of the current best from the benefit of the challenger.

If B/C ratio $_{\text{challenger-current best}} > 1$

Accept the "Challenger" as the new "Current Best". The old "Current Best" is eliminated.

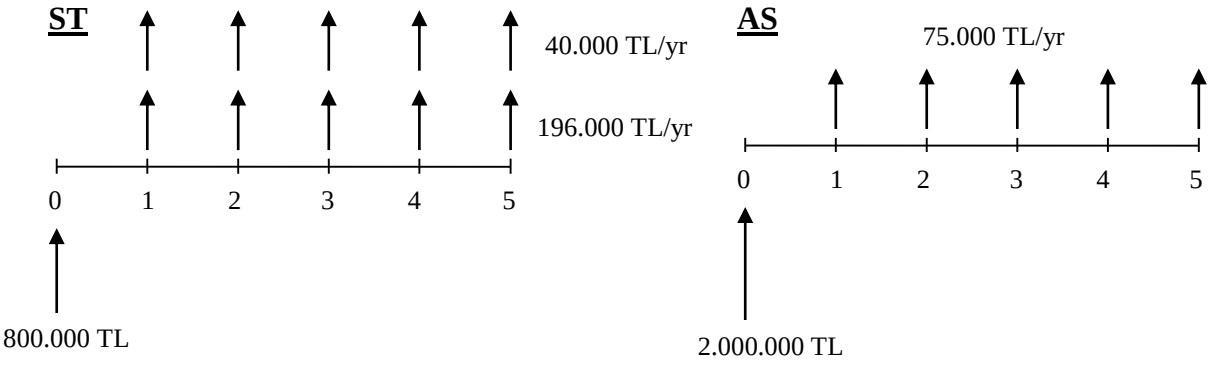
If B/C ratio $_{\text{challenger-current best}} \leq 1$

The "Challenger" is eliminated. The "Current Best" remains the "Current Best".

STEP 4: This is repeated until all alternatives except the first one has become a "Challenger". The last alternative which is the "Current Best" is selected.

2. INCREMENTAL B/C ANALYSIS

A state highway department is considering two types of surface coatings for a new road. Surface treatment alternative will cost only 800.000 TL to install but because of its relatively rough surface, the road users have to spend more money for gasoline, tire wear and vehicle maintenance. The annual cost for these items is estimated to be 196.000 TL/year. Additionally, disbenefits of 40.000 TL per year have been identified for this alternative. A smooth asphalt coating is an alternative also under consideration. This surface would have an initial cost of 2 million TL, but the annual road-user cost will be only 75.000 TL/year. If the life of the either surface is expected to be 5 years, determine which one should be selected on the basis of a B/C analysis using an interest rate of 9% per year compounded annually. **Use Annual Equivalent values**.



Solution:

For surface treatment: (ST)

AE (costs) = 800.000 (A/P,9%,5) = 205.672 TL/yr

AE (benefits) = -196.000 – 40.000 = - 236.000 TL/yr

For smooth asphalt coating: (AS)

AE (costs) = 2.000.000 (A/P,9%,5) = 514.180 TL/yr

AE (benefits) = - 75.000 TL/yr

Ranking of alternatives: ST, AS

Current Best: ST

Challenger: AS

B/C (AS-ST) = (-75.000 – (-236.000)) / (514.180 – 205.672) = 161.000 / 308.508

B/C = 0,52 < 1 AS (challenger) is eliminated, ST stays as current best.

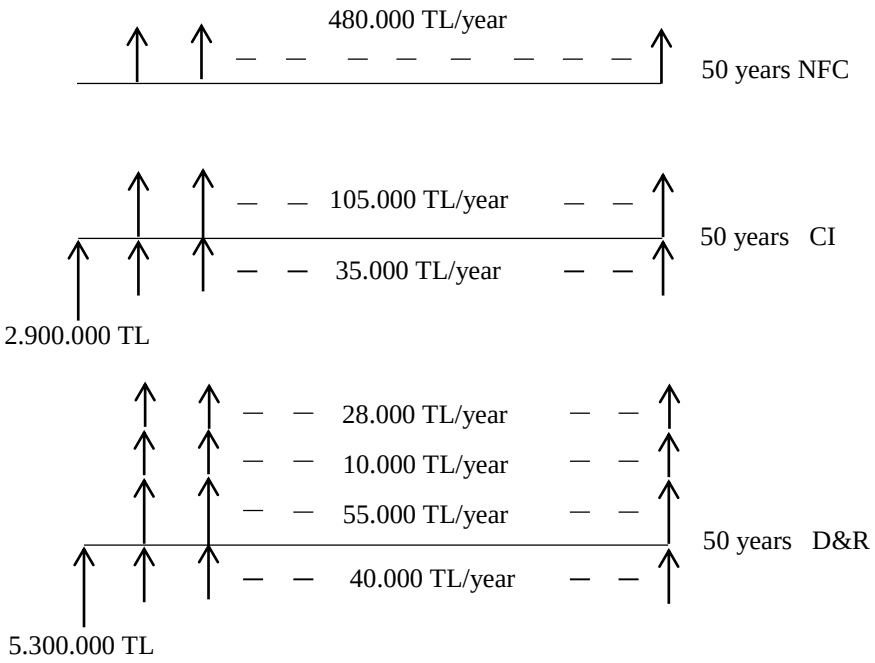
Choose ST (surface treatment)

PROBLEM 1

Billur Çayı goes through an urban area. Because there have been occasional floods that have caused damage to property in this area, a flood control project has been proposed. Estimates have been made for two alternative designs, one involving channel improvement (CI) and the other involving a dam and reservoir (DR). The estimated project life is 50 years and MARR is 6%.

Flood damages are expected to be 480.000 TL per year if the present condition of no flood control (NFC) is continued. The alternative CI will reduce this figure to 105.000 TL and DR will reduce it to 55.000 TL. The initial cost of CI is 2,9 million TL and estimated annual maintenance cost is 35.000 TL. The initial cost of DR is 5,3 million TL and estimated annual maintenance cost is 40.000 TL. DR alternative has also two types of adverse consequences for the public related to the conservation of natural resources. These negative benefits are as follows: The dam will cause a damage to nearby fisheries; priced at 28.000 TL per year. The reservoir will cause a loss of land for agricultural purposes, priced at 10.000 TL per year. Decide which alternative to choose by B/C analysis.

Solution:



1. Calculate the annual equivalents of all costs and benefits:

$AE_{NFC\text{-}Costs} = 0$
$AE_{NFC\text{-}Benefits} = -\ 480.000\ TL/yr$

$AE_{CI\text{-}Costs} = 35.000 + 2.900.000(A/P,6\%,50)$
$= 35.000 + 2.900.000 * 0{,}06344$
$= 35.000 + 183.976$
$= 218.976\ TL/yr$
$AE_{CI\text{-}Benefits} = -\ 105.000\ TL/yr$

$AE_{D\&R\text{-}Costs} = 40.000 + 5.300.000(A/P,6\%,50)$
$= 40.000 + 5.300.000 * 0{,}06344$
$= 40.000 + 336.232$
$= 376.232\ TL/yr$
$AE_{D\&R\text{-}Benefits} = -\ 55.000 - 10.000 - 28.000 = -\ 93.000\ TL/yr$

2. Group alternatives in ascending order of their AE costs $\Rightarrow$ NFC - CI - D&R

3. Current Best: NFC
Challenger: CI

$B/C = AE_{CI\text{-}BEN} - AE_{NFC\text{-}BEN} / AE_{CI\text{-}COST} - AE_{NFC\text{-}COST}$
$= -\ 105.000 + 480.000 / 218.976 - 0$
$=$ **$1{,}71 > 1 \Rightarrow$ New Current Best is CI, Challenger is D&R.**

$B/C = AE_{D\&R\text{-}BEN} - AE_{CI\text{-}BEN} / AE_{D\&R\text{-}COST} - AE_{CI\text{-}COST}$
$= -\ 93.000 + 105.000 / 376.232 - 218.976 =$ **$0{,}076 < 1 \Rightarrow$ Select CI.**

PROBLEM 2

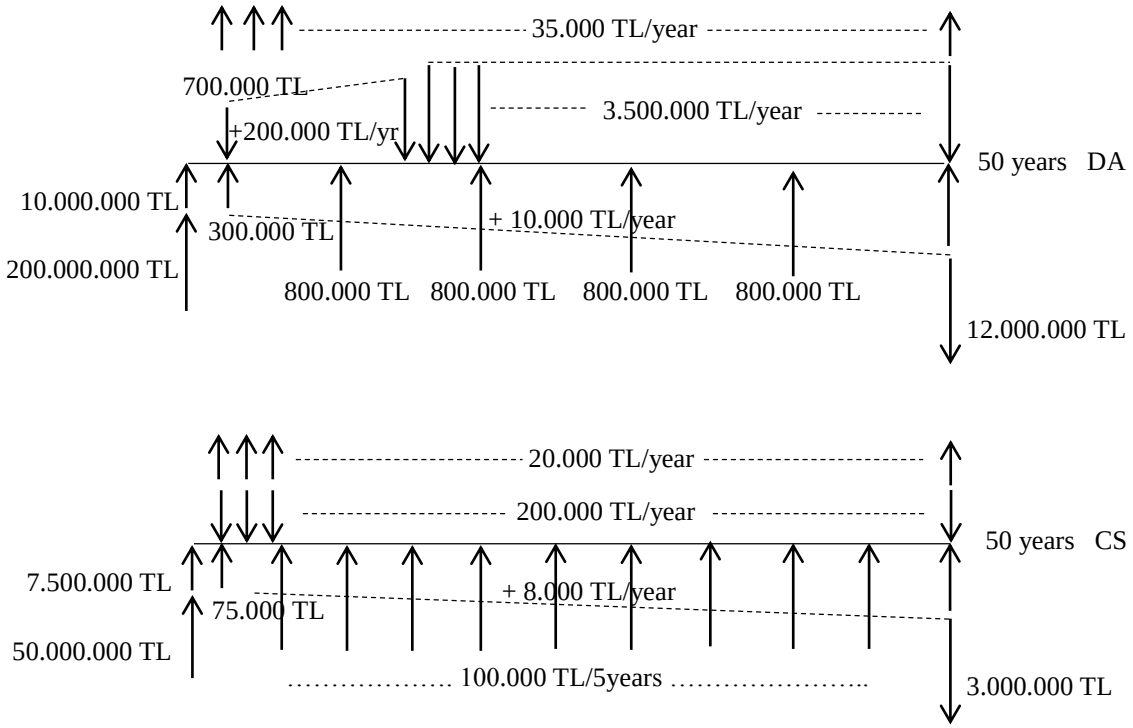
İzmir city will be hosting the next European Football Championship games. Within this context, two alternatives are being considered. First alternative is to construct a domed playing arena and the second one is to construct a conventional stadium.

The domed arena requires the purchase of land at an amount of 10 million TL. It would cost 200 million TL to construct and would have a useful life of 50 years. The maintenance and operation would be 300.000 TL for the first year, with costs increasing by 10.000 TL per year. Every 10 years, an expenditure of 800.000 TL would be required for the refurbishment of the interior design.

The conventional stadium needs to purchase only ¾ of the land. It would cost only 50 million TL to construct and would also have a useful life of 50 years. The cost of maintenance would be TL75.000 for the first year, increasing by 8.000 TL per year. Periodic costs for repainting, resurfacing, etc., would be 100.000 TL every 5 years.

Tourism income from the domed arena is expected to be 700.000 TL for the first year, with amounts increasing by 200.000 TL per year until year 15. Thereafter, the extra income from the domed arena would remain the same at 3,5 million TL per year. Annual tourism income from the conventional stadium is expected to be 200.000 TL for 50 years. As a result of adverse consequences for the public related to conservation of natural resources and environmental impact, there will be an additional annual cost of 35.000 TL and 20.000 TL due to the construction of domed playing arena and conventional stadium, respectively. Assuming that the domed arena and conventional stadium would have a salvage value of 12 million TL and 3 million TL, respectively; considering MARR= 8% per year, make a B/C analysis by calculating PW to determine which structure should be built.

Solution:



1. Calculate the PW of all costs and benefits:

The Domed Arena

PW_{costs} = 200.000.000+10.000.000+[300.000+10.000*(A/G,8%,50)] * (P/A, 8%, 50)
11,4107 **12,2335**

+ 800.000 *[(P/F,8%,10) + (P/F,8%,20) + (P/F, 8%, 30) + (P/F, 8%, 40)]
0,4632 **0,2145** **0,0994** **0,0460**

–12.000.000 * (P/F, 8%, 50)
0,0213

PW_{costs} = **215.468.858 TL**

$PW_{benefits}$ = [700.000+200.000*(A/G,8%,15)] * (P/A, 8%, 15) + 3.500.000 * (P/A, 8%, 35) *
5,5945 **8,5595** **11,6546**

(P/F, 8%, 15) – 35.000 * (P/A, 8%, 50)
0,3152 **12,2335**

$PW_{benefits}$ = **27.998.057 TL**

The Conventional Stadium

PW_{costs} = 10.000.000*3/4 + 50.000.000+[75.000 + 8.000 * (A/G, 8%, 50)] * (P/A, 8%, 50) +
11,4107 **12,2335**

100.000 * [(P/F, 8%, 5) + (P/F, 8%, 10) + (P/F, 8%, 15) + (P/F, 8%, 20) + (P/F, 8%, 25) +
0,6806 **0,4632** **0,3152** **0,2145** **0,1460**

(P/F,8%,30)+(P/F,8%,35) + (P/F,8%,40)+(P/F,8%,45)]+200.000*3/4*(P/A,8%,50) –
0,0994 **0,0676** **0,0460** **0,0313** **12,2335**

3.000.000 * (P/F, 8%, 50)
0,0213

PW_{costs} = **59.677.635 TL**

$PW_{benefits}$ = (200.000- 20.000) * (P/A, 8%, 50) = **2.202.030 TL**
12,2335

2. Group alternatives in ascending order of their PW costs ⇒ CS - DA

3. Current Best: CS
Challenger: DA

$B/C = [\Delta B/\Delta C]_{CH-CB}$ =[27.998.057 – 2.202.030] / [215.468.858 – 59.677.635]

B/C = 25.796.027 / 155.791.223 = **0,165 < 1 Challenger, Domed Arena, is eliminated.**

Conventional Stadium is selected.