CE 231
ENGINEERING ECONOMY

PROBLEM SET 6

PROBLEM 1

Considering the great tourism potential in Antalya, the government is thinking about the construction of a second airport at a place located outside the city centre in one of the villages. This project is planned to cost 1.000.000 TL in the design and 50.000.000 TL in the construction phase. The government will have to endow 500.000 TL of maintenance and operating cost with an increasing rate of 100.000 TL/yr. Since the farm lands in the village will be damaged, 250.000 TL/yr profit gained by agriculture will be lost. On the other hand, as an alternative transportation solution and as it gives way to the tourism improvement of the region, it seems to provide 1.500.000 TL/yr to the people living in Antalya region. If the analysis period is defined as 20 years by the government and MARR=10 %, is the airport a feasible investment?

Solution:

AW_{costs}= 51.000.000(A/P, 10%, 20)+500.000+100.000(A/G, 10%, 20)= 7.143.310 TL/yr
0,1175 **6,5081**

$AW_{benefits}$=1.500.000-250.000=1.250.000 TL/yr

B/C= 1.250.000 / 7.143.310

B/C= 0,17 < 1 ⇒ Reject the project!

PROBLEM 2

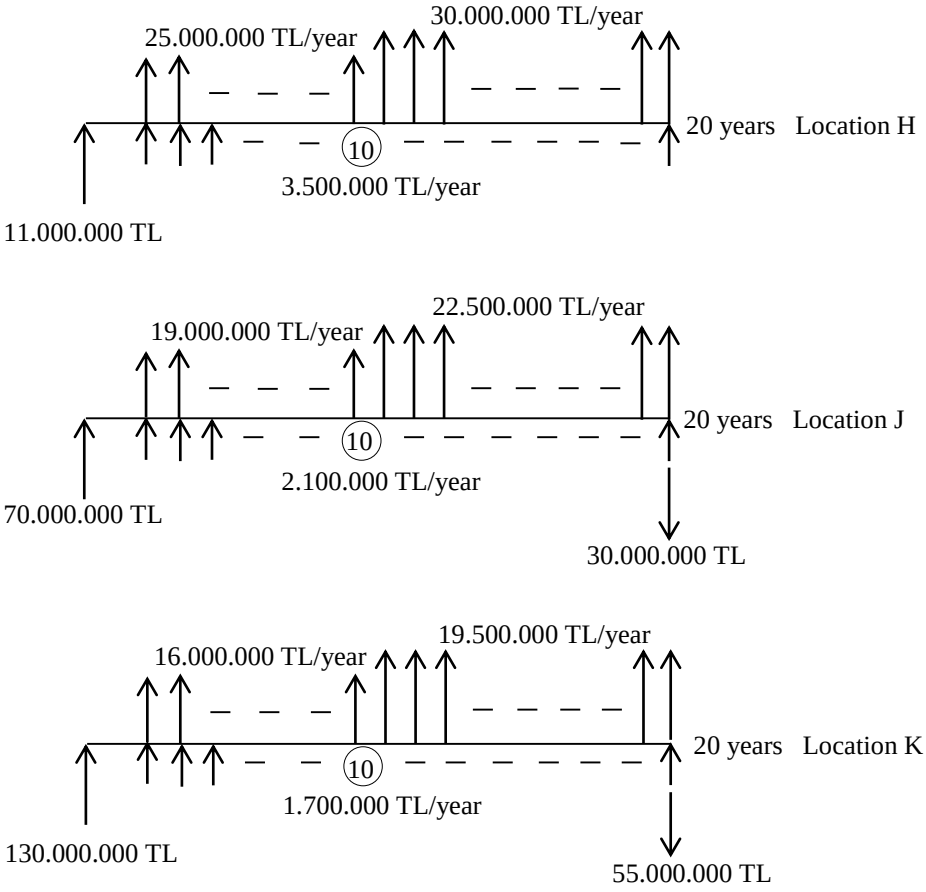
A rural highway is in such a bad condition that its resurfacing or relocation is required. The present location is denoted as H, two possible new locations that will shorten the distance are designated as J and K. Location K is shorter than J but involves a considerably higher investment for grading and structures. An economic study to compare these 3 locations should use a study period of 20 years and a MARR of 7%.

The estimated initial investment to be made by the government would be 11 million TL at location H, 70 million TL at J and 130 million TL at K. If location H is abandoned now, it will have no salvage value, also it will have no residual value at the end of 20 years if the location is kept in service. However, because the estimated useful lives of the works that would be constructed at J or K are longer than the 20 year analysis period, residual values estimated at the end of 20 years are 30 million TL and 55 million TL for J and K respectively. Estimated annual operation and maintenance costs to be paid by government are 3.5 million TL for H, 2,1 million TL for J and 1,7 million TL for K.

It is predicted that the traffic on this section of highway will remain the same for the first 10 years and increase by 20% in the remaining 10 years. It is assumed that volume of the traffic is not affected from choice of location. For location H, annual road user cost is estimated to be 25 million TL for the first 10 years and becomes 30 million TL in the next 10 years. For location J, annual user cost is 19 million TL for the first 10 years and 22,5 million TL for the second 10

years (as it is shorter than location H!). For location K, the corresponding figures are 16 million TL and 19,5 million TL. Carry out an incremental B/C analysis to decide which location to choose.

Solution:



1. Calculate the present worths of all costs and benefits:

Alt-H

$PW_{H\text{-}costs}(7) = 11.000.000 + 3.500.000\ (P/A,7\%,20)$
$= 11.000.000 + 3.500.000 * 10,599$
$= 11.000.000 + 37.079.000$
$= 48.079.000$ TL

$PW_{H\text{-}benefits}(7) = -\ 25.000.000\ (P/A,7\%,10) – 30.000.000\ (P/A,7\%,10)(P/F,7\%,10)$
$= -\ 25.000.000 * 7,024 – 30.000.000 * 7,024 * 0,5083$
$= -\ 175.600.000 – 107.108.976$
$= -\ 282.708.976$ TL

Alt-J

$PW_{J\text{-}costs}(7) = 70.000.000 + 2.100.000\ (P/A,7\%,20) – 30.000.000\ (P/A,7\%,20)$
$= 70.000.000 + 2.100.000 * 10,594 – 30.000.000 * 0,2584$
$= 70.000.000 + 22.247.400 – 7.752.000$
$= 84.495.400$ TL

$PW_{J\text{-}benefits}(7) = -\ 19.000.000\ (P/A,7\%,10) – 22.500.000\ (P/A,7\%,10)(P/F,7\%,10)$
$= -\ 19.000.000 * 7,024 – 22.500.000 * 7,024 * 0,5083$
$= -\ 133.456.000 – 80.331.732$
$= -\ 213.787.732$ TL

Alt-K

$PW_{K\text{-}costs}(7)$ = 130.000.000 + 1.700.000 (P/A,7%,20) – 55.000.000 (P/A,7%,20)
= 130.000.000 + 1.700.000 * 10,594 – 55.000.000 * 0,2584
= 130.000.000 + 18.009.800 – 14.212.000
= 133.797.800 TL

$PW_{K\text{-}benefits}(7)$ = - 16.000.000 (P/A,7,10) – 19.500.000 (P/A,7%,10)(P/F,7%,10)
= - 16.000.000 * 7,024 – 19.500.000 * 7,024 * 0,5083
= - 112.384.000 – 69.620.834
= - 182.004.834 TL

2. Group alternatives in ascending order of their PW costs ⇒ Loc H - Loc J - Loc K

3. Current Best: H
Challenger: J

$PW_{(J\text{-}H)\ costs}$ = 84.495.400 – 48.079.000 = 36.416.400 TL
$PW_{(J\text{-}H)\ benefits}$ = -213.787.732 + 282.708.976 = 68.921.244 TL

B/C = 68.921.244 / 36.416.400 = **1,89 > 1 ⇒ New Current Best is J, Challenger is K.**

$PW_{(K\text{-}J)\ costs}$ = 133.797.800 – 84.495.400 = 49.302.400 TL
$PW_{(K\text{-}J)\ benefits}$ = -182.004.834 + 213.787.732 = 31.782.898 TL

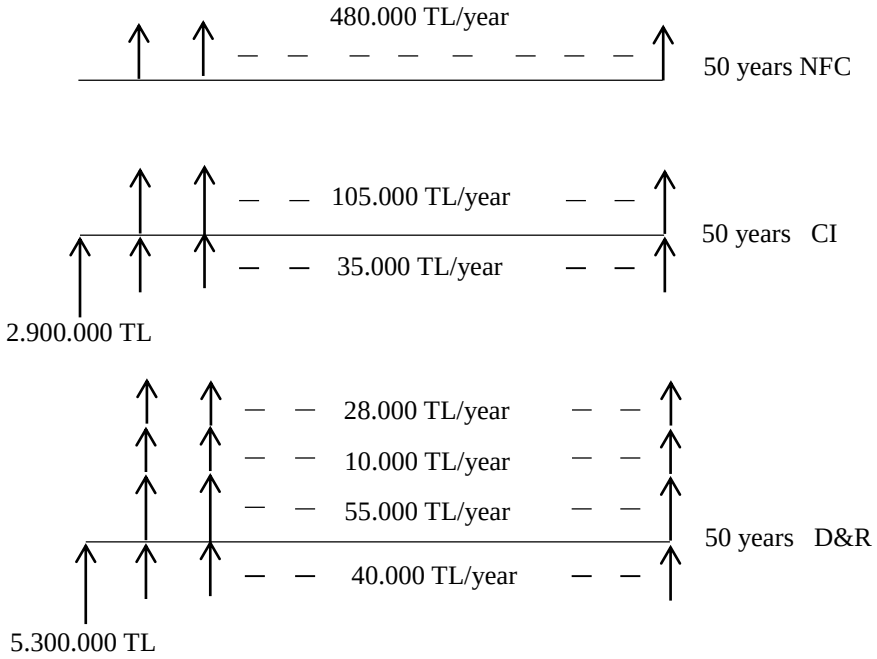
B/C = 31.782.898 / 49.302.400 = **0,65 < 1 ⇒ Select Location J!**

PROBLEM 3

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 4

In order to avoid the contamination of a freshwater wetland from encroaching seawater, the government is considering 2 alternatives, one of which is a 5 km-long set and the other is a channel dredging operation.

In the first alternative, the construction will cost 20.000.000 TL and the maintenance and operating costs are estimated to be 600.000 TL/yr. The new road on the set will provide activities like fishing and it will shorten the travelling distance between 2 towns. These advantages will bring an annual income of 1.500.000 TL/yr.

The second alternative is estimated to cost 12.000.000 TL and its maintenance and operating costs will be 300.000 TL/yr. Total benefits will be negligible compared to the first alternative.

Using a MARR=12% and 20-year life for each method, determine which one would be a better choice? Use B/C ratio method by calculating PW.

Solution:

Calculate PW of costs and benefits of each option.

Alt.1

PW_{costs} = 20.000.000+600.000(P/A, 12%, 20)= 24.481.700 TL

7,4695

$PW_{benefits}$ = 1.500.000(P/A, 12%, 20)= 11.204.250 TL

Alt.2

PW_{costs} = 12.000.000+300.000(P/A, 12%, 20)= 14.240.850 TL

$PW_{benefits}$ = 0

In ascending order of their PW costs, CB is Alt2 and CH is Alt1.

AW_{costs} (Alt1-Alt2)= 10.240.850 TL/yr

$AW_{benefits}$ (Alt1-Alt2)=11.204.250 TL/yr

$B/C= [\Delta B/\Delta C]_{Alt1-Alt2}=1,09 > 1 \Rightarrow$ Alt2 is eliminated, CB is Alt1.

Select Alt1!

PROBLEM 5

An area on Ceyhan River is subject to flood damage occurring every 4 years on the average. Flood causes a damage which has a cost of 1.200.000 TL. The government is thinking about a solution to prevent this loss.

One of the proposals is to deepen the river channel at a cost of 900.000 TL which will reduce loss due to damage by 600.000 TL (damage cost is 600.000 TL every 4 year period). The system will work for a period of 20 years. Maintenance and operating costs will be about 20.000 TL/yr.

Another alternative is to construct a control dam at a cost of 2.900.000 TL. This method will reduce the flood damage by 950.000 TL (damage cost is 250.000 TL every 4 year period). Since this project will provide irrigation water, an income of 150.000 TL/yr in addition to recreational activities that worth 50.000 TL/yr can be achieved. Maintenance and operating costs will be about 50.000 TL/yr.

The third option is establishing both methods at a cost of 3.800.000 TL and reducing the flood damage by 1.100.000 TL (damage cost is 100.000 TL every 4 year period). Benefits due to agricultural and recreational activities will be as much as in the second alternative. Maintenance and operating costs will be about 60.000 TL/yr.

Considering that MARR=10% which alternative would you recommend to be adopted? Carry out B/C analysis.

Solution:

Calculate PW of costs and benefits of each option.

NFC

$PW_{costs} = 0$

$PW_{benefits}$=-1.200.000[(P/F,10%,4)+(P/F,10%,8)+(P/F,10%,12)+(P/F,10%,16)+(P/F,10%, 20)]

0,6830 0,4665 0,3186 0,2176 0,1487

$PW_{benefits}$ = -2.201.280 TL

Alt1

PW_{costs} = 900.000+20.000(P/A,10%,20) = 1.070.272 TL

8,5136

$PW_{benefits}$ = -600.000[(P/F,10%,4)+(P/F,10%,8)+(P/F,10%,12)+(P/F,10%,16)+(P/F,10%, 20)]

0,6830 0,4665 0,3186 0,2176 0,1487

$PW_{benefits}$ = -1.100.640 TL

Alt2

PW_{costs} = 2.900.000+50.000(P/A,10%,20)

8,5136

PW_{costs} = 3.325.680 TL

$PW_{benefits}$ = -250.000[(P/F,10%,4)+(P/F,10%,8)+(P/F,10%,12)+(P/F,10%,16)+(P/F,10%, 20)]
0,6830 0,4665 0,3186 0,2176 0,1487
+200.000(P/A,10%,20)
8,5136
$PW_{benefits}$ = 1.244.120 TL

Alt3

PW_{costs} = 3.800.000+60.000(P/A,10%,20)
8,5136
PW_{costs} = 4.310.816 TL

$PW_{benefits}$ = -100.000[(P/F,10%,4)+(P/F,10%,8)+(P/F,10%,12)+(P/F,10%,16)+(P/F,10%, 20)]
0,6830 0,4665 0,3186 0,2176 0,1487
+200.000(P/A,10%,20)
8,5136
$PW_{benefits}$ = 1.519.280 TL

Alt.	Initial cost	Main.&op.	Benefit	Disbenefit	PW_{costs}	$PW_{benefits}$
NFC	-	-	-	-1.200.000 TL/4yr	-	-2.201.280 TL
Alt1	900.000 TL	20.000 TL/yr	-	-600.000 TL/4yr	1.070.272 TL	-1.100.640 TL
Alt2	2.900.000 TL	50.000 TL/yr	200.000 TL/yr	-250.000 TL/4yr	3.325.680 TL	1.244.120 TL
Alt3	3.800.000 TL	60.000 TL/yr	200.000 TL/yr	-100.000 TL/4yr	4.310.816 TL	1.519.280 TL

In ascending order of their PW costs, CB= NFC and CH= Alt1.
$B/C = [\Delta B/\Delta C]_{Alt1-NFC}$ = (-1.100.640+2.201.280)/(1.070.272) =1,03 > 1⇒ NFC is eliminated.

The new CB=Alt1, CH=Alt2.
$B/C = [\Delta B/\Delta C]_{Alt2-Alt1}$ = (1.244.120+1.100.640)/(3.325.680-1.070.272) = 1,04 > 1⇒ Alt1 is eliminated.

The new CB=Alt2, CH=Alt3.
$B/C = [\Delta B/\Delta C]_{Alt3-Alt2}$ = (1.519.280-1.244.120)/(4.310.816-3.325.680) = 0,28 < 1⇒ Alt3 is eliminated.

Select Alt2!

PROBLEM 6

General Directorate of Highways is considering the construction of a new highway through a scenic rural area. The road is expected to cost 6 million TL, with annual maintenance cost estimated at 20.000 TL per year. The improved accessibility is expected to result in additional income from tourists of 350.000 TL per year. Contrary to this income, the highway would cause agricultural income losses of TL15.000 for the first year, 16.000 TL for the second, and amounts increasing by 1.000 TL per year. Also there will be 650.000 TL resurfacing cost every 6 years. If the road is expected to have a useful life of 30 years, apply the B/C method at a MARR of 6% by using Annual Equivalent Values to determine if the road should be constructed. If not, in order to make highway economically feasible by how much would the tourist income have to increase each year (starting in year two)?

Solution:

AE_{costs}= (6.000.000-650.000) * (A/P, 6%, 30) + 200.000 + 650.000 * (A/P, 6%, 6)
0,0726 **0,2034**
= **540.620 TL/yr**

$AE_{benefits}$=3,500,000 – 15,000 – 1,000 * (A/G, 6%, 30) = **324.658 TL/yr**
10,3422

B/C = 324.658/540.620 = **0,6<1 Not feasible!!!**

To make highway economically feasible;

$$B/C = \frac{350.000 + X*(A/P, 6\%, 30) – 15.000 – 1.000 * (A/G, 6\%, 30)}{(6.000.000-650.000) * (A/P, 6\%, 30) + 200.000 + 650.000 * (A/P, 6\%, 6)} >= 1$$

$$B/C = \frac{350.000 + X*10,3422- 15.000 – 1.000 * 10,3422}{(6.000.000-650.000) * 0,0726 + 200.000 + 650.000 * 0,2034} >= 1$$

540.620 – 324.658 >= 10,3422* X

X >= 20.882 TL/year

PROBLEM 7

Due to the increasing complaints, the government of Dubai is considering a project to extend irrigation canals into a desert area. The initial cost of the project is expected to be 2 million TL, with the maintenance cost of 35.000 TL per year. Also the channel must be dredged every 4 years at a cost of 75.000 TL and there is a 20.000 TL per year disbenefit associated with the project. If the agricultural revenue is expected to be TL180.000 per year, make a B/C analysis on the basis of PW analysis to determine whether the project should be undertaken, using a 20 year study period and an interest rate of 7% per year.

Solution:

PW_{costs} = 2.000.000+75.000* [(P/F,7%,4)+(P/F,7%,8)+(P/F, 7%, 12) + (P/F, 7%, 16)] +
0,7629 0,5820 0,4440 0,3387
35.000 * (P/A, 7%, 20) = **2.530.360 TL**
10,5940

$PW_{benefits}$ = 180.000 * (P/A, 7%, 20) -20.000 * (P/A, 7%, 20)
10,5940 10,5940
$PW_{benefits}$ = **1.695.040 TL**

B/C = 1.695.040 / 2.530.360 = **0,67 < 1** **Project is rejected!!!**

PROBLEM 8

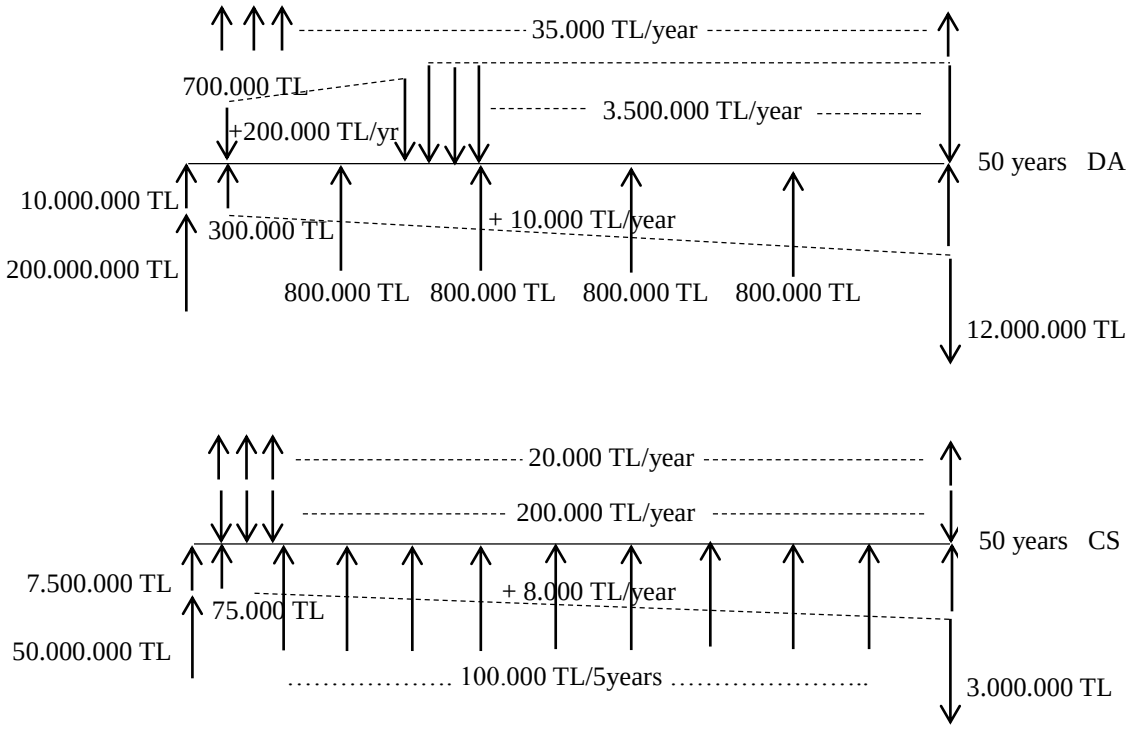
İzmir city will be hosting the next European Football Championship games. Within this context, two alternatives are being considered. First alternative is to construct a domed playing arena and the second one is to construct a conventional stadium.

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.

PROBLEM 9

Highway department officials are considering the economics of either resurfacing an existing highway or constructing one of two new alternatives.

The existing highway is 20 km long and would cost 2,5 million TL to resurface. Annual maintenance cost is expected to be 6.000 TL for the first year, 11.000 TL for the second, and amounts increasing by 5.000 TL per year until year 10, at which time the road would have to be resurfaced again.

If **first alternative** is constructed, the initial cost would be 15 million TL for a road 16 km long. The maintenance is expected to cost 6.000 TL for the first year, 8.000 TL for the second, and amounts increasing by 2.000 TL per year until year 10, after which the cost will be 24.000 TL per year.

The second alternative, which is 10 km long, has an initial cost of 30 million TL because it is shorter and its construction methods require extensive drilling and blasting work. The maintenance cost is estimated as 18.000 TL per year.

If one of the new roads is constructed, the cost of traffic accidents is expected to decrease by 500.000 TL per year. The benefits of the new road users due to time savings and increased income are expected as 3 million TL per year for the first alternative and 5,5 million per year for the second alternative.

Due to the agricultural loss during the construction and adverse environmental impact, there will be additional cost of 100.000 TL per year for the first and 130.000 TL per year for the second alternative. Vehicle operating cost is assumed to be 0,20 TL per km and 600.000 vehicles per year travel road. Both roads are estimated to have a 30 year life with no salvage value. Using Annual Equivalent Values, carry out a benefit cost analysis to determine which road should be constructed. MARR is 7%.

Solution:

Calculate AE of costs and benefits of each option.

Existing Highway

AE_{costs} = 2.500.000 * (A/P, 7%, 10) + 6.000 + 5.000 * (A/G, 7%, 10) = **381.731TL**
0,1424 **3,9461**
$AE_{benefits}$ = -20 * 0,2 * 600.000 = **- 2.400.000TL**

First Alternative

AE_{costs} = 15.000.000 * (A/P, 7%, 30) + [6.000 + 2.000 * (A/G, 7%, 10)] * (P/A, 7%, 10) *
0,0806 **3,9461** **7,0236**
(A/P, 7%, 30) + 24.000 * (P/A, 7%, 20) * (P/F, 7%, 10) * (A/P, 7%, 30) = **1.222.160TL**
0,0806 **10,5940** **0,2584** **0,0806**
$AE_{benefits}$ = -16 * 0,2 * 600.000 + 500.000 + 3.000.000 – 100.000 = **1.480.000TL**

Second Alternative

AE_{costs} = 30.000.000 * (A/P, 7%, 30) + 18.000 = **2.436.000TL**
0,0806
$AE_{benefits}$ = -10 * 0,2 * 600.000 + 500.000 + 5.500.000 – 130.000 = **4.670.000TL**

In ascending order of their AE costs, Current Best is the existing highway and Challenger is the first alternative.

$B/C = [\Delta B/\Delta C]_{CH-CB}$ =[1.480.000 - (-2.400.000)] / [1.222.160 – 381.731]

B/C = 3.880.000 / 840.429 = **4,62 > 1 Current Best is eliminated, First Alternative is new CB.**

New **CB** is the First Alternative, new **CH** is Second Alternative.

$B/C = [\Delta B/\Delta C]_{CH-CB}$ =[4.670.000 – 1.480.000] / [2.436.000 – 1.222.160]

B/C = 3.190.000 / 1.213.840 = **2,62 > 1 Current Best, First Alternative, is eliminated.**

Second Alternative is selected!!!!!

PROBLEM 10

State Airport Authority (DHMİ) is considering extending the runways of Trabzon Airport so that commercial jets can use the facility. The land necessary for the runway extension is currently farmland, which can be purchased for 400.000 TL. Construction cost for the runway extension is estimated to be 750.000 TL, and the additional annual maintenance cost for the extension is estimated to be 25.000 TL for the first year, increasing 2.000 TL per year. Thereafter if the runways are extended, a small terminal will be constructed at a cost of 300.000 TL. The annual operating and maintenance costs for the terminal are estimated at 75.000 TL. Finally, the projected increase in flights will require the addition of three air traffic controllers, at an annual cost 180.000 TL. Annual benefits of the runway extension to public have been estimated as follows;

325.000 TL rental incomes from airlines renting space at the airport
65.000 TL airport tax charged to passengers
50.000 TL transportation convenience benefit for Trabzon city residents
50.000 TL additional tourism benefits for the Trabzon city

Since a farmland is used for this project, it will cause a loss of land for agricultural purposes, priced at 18.000 TL per year. Apply the B/C ratio method with a study period of 25 years and a MARR of 10% to determine whether the runways at Trabzon Airport should be extended or not (Use Annual Equivalent Values).

Solution:

AE_{costs}= [(400.000+750.000+300.000)*(A/P,10%,25)] + 25.000 + 2.000 * (A/G, 10%, 25) +
0,1102 **7,4580**
75.000 + 180.000 = **454.706TL**

$AE_{benefits}$ = 325.000 + 65.000 + 50.000 + 50.000 – 18.000 = **472.000TL**

B/C = 472.000 / 454.706 = **1,04 > 1** **Project is accepted!!!!!**