

**CMA+CEA – problems for practice**

1. Rank the projects according to CEA and CMA, for CMA is the required output 10 units.

Project	Output in units	Total costs
A	11	230
B	16	240
C	8	150
D	10	200

(Solution: CEA – B-C-D-A; CMA – D-A-B, C not acceptable)

2. Based on expert evaluation choose appropriate location for new landfill. Three municipalities came up with the projects: Adamov, Blučina a Čejkovice. Lifetime of the landfill is 20 years.

Location	$k_1$	$k_2$	$k_3$	$k_4$	$k_5$	$k_6$
A	79	86	2.2	31	4	160
B	73	90	2	46	5	161
Č	71	75	1.7	36	5	131

$k_1$  – amount of required employees to operate

$k_2$  – total volume of the landfill

$k_3$  – investment costs in billions

$k_4$  – running costs in millions/year

$k_5$  – cost for waste collection in millions/year

$k_6$  – revenues of projects in millions/year

Choose the best project according to CMA, NPV and CEA with output of amount of required employees, resp. total volume of the landfill.

(Solution: CMA – A = 2 900; B = 3 020; Č = 2 520

NPV – A = 300; B = 200; Č = 100

CEA –  $A_{Req.Emp} = 36.71$ ;  $B_{Req.Emp} = 41.37$ ;  $Č_{Req.Emp} = 35.49$ ;  $A_{Vol} = 33.72$ ;  $B_{Vol} = 33.56$ ;  $Č_{Vol} = 33.60$ )

3. Municipality chooses between 3 projects that meet the required criteria. Which project would you choose according to the CMA with  $r = 1\%$  and  $r = 7\%$ ? Costs are in the table below.

	0	1	2	3	4	5
A	200	30	40	50	40	30
B	10	60	70	80	110	90
C	100	60	60	60	60	60

(Solution: A – 384.4/355.7; B – 407.0/340.6; C – 391.2/346.0; A with  $r = 1\%$  and B with  $r = 7\%$ )

4. Municipality chooses between 2 companies providing waste management. Company A) offers collection every 7 days with annual cost per person 550 CZK, company B) offers collection every 14 days with annual costs per person 450 CZK. Municipality has 3000 inhabitants, according to the research it is estimated that with weekly frequency a person would on average produce 7 kg waste per collection, with bi-weekly frequency 12 kg waste per collection. Which company would you choose based on costs per collected ton of waste?

(Solution: B collects ton for 1442 CZK, A for 1511 CZK;

Partial results: A) 1092 tons of waste, costs 1 650 000; B) 936 tons, costs 1 350 000)

5. Municipality chooses between: A) building a traffic light with a button; B) illuminated pedestrian crossing; and C) pedestrian overpass. Investment costs are: A – 1800; B – 800; C – 3900. Running costs are: A – 60; B – 30; C – 10. Lifetime is 10 years (discount rate is not important, impact on the results would be marginal). Currently there are 1.8 fatal accidents per year (calculated from various severities of the occurred injuries and their long-term impacts). Variant A) would lower this rate, based on expert estimation, to 1.0; B) to 1.4; and C) to 0.2. Which project would you choose according to the CEA with output of decreased amount of fatal accidents?

*(Solution: C – 2500/unit of fatal accident; B – 2750/accident; A – 3000/accident)*

### CUA – problems for practice

1. We are choosing between 2 types of treatment, first extends life by 7.2 years with quality 64%, second by 4.9 years with quality 79%. Unit QALY\* means 1 additional life year with 100% quality. Costs of treatment are 80k CZK for the first and 65k CZK for the second type. Which treatment would you prefer according to the CUA with QALY\* utility unit?

*(Solution: second – 16 792 CZK/QALY\*; first – 17 361 CZK/QALY\*)*

2. Social security service office wants to employ an officer for the next 3 years. There are 3 candidates. Training costs 50k CZK/person. Total costs per year for first candidate are 340k CZK and the office know that he would complete 15 standardized tasks per day with error rate of 9.4%, (1 error bears additional costs of 400 CZK); costs per year for the second candidate are 400k CZK and he would complete 17 tasks per day with 7.7% error rate, and the third candidate costs 470k CZK per year, would complete 20 tasks per day with error rate of 7.1%. We consider 220 working days per year. Discount rate is 3%. Which candidate should be chosen in order to have lowest costs per task (not including costs of errors corrections)? And which candidate if including costs of errors corrections?

*(Solution: A – 102.19 CZK/137.65 CZK; B – 105.3 CZK/134.34 CZK; C – 104.5 CZK/131.28 CZK;*

*Partial results: A) costs 1 011 728 w/o errors, 1 362 702 including errors;*

*B) costs 1 181 445 w/o errors, 1 507 278 including errors;*

*C) costs 1 379 447 w/o errors, 1 732 911 including errors)*

3. Department is deciding between 3 types of courses – week (5 days) course in Křtiny, standard semester course, or e-learning course. Estimated attendances are 27, resp. 36, resp. 51 participants. Success rates of turning student into an expert in the studied field (based on historical experience) are 82, resp. 61, resp. 42% of participants. Costs related to the courses are: course preparation 80k CZK, total personal costs per hour of lecturer 500 CZK (weekly course consists of 8 hours per day, standard course 4 per week over 13 weeks + 2 weeks of examination period and consultations), accommodation of the lecturer in Křtiny + food 4000 CZK/week, renting room and equipment in Křtiny 2000 CZK/day, correction of homework and consultation as a part of the e-learning course approximately 1.5 hours per student per course with costs of 400 CZK/hours of lecturer. Decide which course to run according to the costs per success turning student into an expert.

*(Solution: Křtiny 5149 CZK/expert; semester 5009 CZK/expert; e-learning 5163 CZK/expert)*

**CBA – problems for practice**

1. A municipality wants to separate waste and earn from selling sorted paper, plastics and tetra-pak to EKO-KOM. There are two options, 1) setting-up 5 drop-off sites, or 2) curbside collection from individual households. Each drop-off site consists of 2 containers for plastics (each 7000 CZK), 2 for paper (each 6000 CZK) and 1 for tetra-pak (each 8000 CZK). For curbside collection municipality has to purchase sacks for 9 CZK a piece with approximately 1.2 sack per household per collection per each type of waste. Municipality has 140 households. In both cases the collection will occur biweekly, in case of drop-off sites it would take 5 hours, in case of curbside collection 9. We consider rate for renting appropriate vehicle 400 CZK/hour. With drop-off sites you need 3 employees (driver+2), with curbside collection 2 (driver+1). Driver costs 220 CZK/hour, helpers 120 CZK/hour (here total costs = net wage, no additional taxes apply here). With drop-off sites a household will produce 5 kg paper, 4 kg plastics and 3 kg tetra-pak per week, with curbside collection 6 kg paper, 5 kg plastics and 4 kg tetra-pak. Buying prices are 1800 CZK per ton of paper, 1400 CZK per ton of plastics, and 2000 CZK per ton of tetra-pak. As social benefits consider positive effect from availability of separated collection 7000 CZK per year for each drop-off site, resp. 600 CZK per year per each household in case of curbside collection. As social costs households consider decreased aesthetics of 13 CZK/household/each curbside collection (the waste has to be on the street at the time for the pick-up). Which variant would prefer based on CBA according to the NPV and according to the  $R_i$  with project lifetime of 5 years and  $r = 4\%$ , resp.  $5\%$ ?

(Solution:  $NPV_{EA} A = 146\ 779$  CZK;  $NPV_{EA} B = 104\ 357$  CZK;  $R_i A = 0.86$ ;  $R_i B = 0.88$ ;  
 Partial results: A)  $CF_0 (FA) = -170\ 000$ ;  $CF_{1...n} (FA) = (-111\ 800 + 149\ 968)$ ;  $NPV_{FA} = -83$ ;  
 $CF_0 (EA) = -170\ 000$ ;  $CF_{1...n} (EA) = 73\ 168$ ;  
 B)  $CF_0 (FA) = -117\ 936$ ;  $CF_{1...n} (FA) = (-173\ 160 + 187\ 824)$ ;  $NPV_{FA} = -52\ 654$ ;  
 $CF_0 (EA) = -117\ 936$ ;  $CF_{1...n} (EA) = 51\ 344$ )

2. Municipality Horní Lhotice wants to cultivate a pond:  
 Project A – De-mudding and cultivation with building outdoor swimming pool in one part (open June-September), free of charge. Second part will serve as a fishing pond (expected amount of sold fishing permits is 500) Project B – De-mudding and cultivation. Whole pond will be used for fishing purposes (expected amount of sold fishing permits is 2000)

Costs and benefits:

- 1) costs of de-mudding and cultivation – 1.5 mil. CZK;
  - 2) costs for building outdoor swimming pool – 1 mil. CZK;
  - 3) gross wage for 2 persons maintaining swimming pool, employed only during the season – 15 thousands CZK/person/months (net wage 12 750 CZK);
  - 4) costs for project documentation of cultivation – 150 000 CZK;
  - 5) revenues from private stands selling ice-cream on swimming pool – 300 000 CZK/month;
  - 6) negative impacts due to the noise from swimming pool – 150 000 CZK per season;
  - 7) fishing permit – 200 CZK/person;
  - 8) subvention from the region for cultivation (in year 1) – 50% costs of cultivation
- \*tax corrections for wages are (gross wage)\*1.34 minus (net wage)

Expected lifetime of the project is 3 years and discount rate is 0.08 for FA and EA.

- Calculate simple CMA
- Calculate financial and economic analysis in CBA and choose a better project
- Calculate CEA (real and simple) and as efficiency criterion select points acquired from public poll – project A got 88 points out of 100, project B 47 points, and as an alternative criterion select amount of sold permits

*(Solution: CMA<sub>p</sub>: A = 3 132.4; B = 1 650*

*CBA: NPV: A<sub>FA</sub> = 980.3; B<sub>FA</sub> = 75.3; A<sub>EA</sub> = 745.2; B<sub>EA</sub> = 75.3*

*R<sub>j</sub>: A<sub>FA</sub> = 0.370; B<sub>FA</sub> = 0.046; A<sub>EA</sub> = 0.281; B<sub>EA</sub> = 0.046*

*CEA: A<sub>pointsS</sub> = 35.60; B<sub>pointsS</sub> = 35.11; A<sub>pointsR</sub> = 34.82; B<sub>pointsR</sub> = 35.11; A<sub>permitsS</sub> = 6.26; B<sub>permitsS</sub> = 0.83;*

*A<sub>permitsR</sub> = 6.13; B<sub>permitsR</sub> = 0.83*