

ENGR 301/II
Engineering Management Principles and Economics
Tutorial 8 - PW& EUAC (Solutions)

1. Two devices are available to perform a necessary function for 3 years. The initial cost for each device at time zero and subsequent annual savings produced by the device are shown in the table below. If the required interest rate is 8%, determine which device should be purchased using present worth analysis?

Year	0	1	2	3
Device A	-\$9,000	\$4,500	\$4,500	\$4,500
Device B	-\$14,500	\$6,000	\$6,000	\$8,000

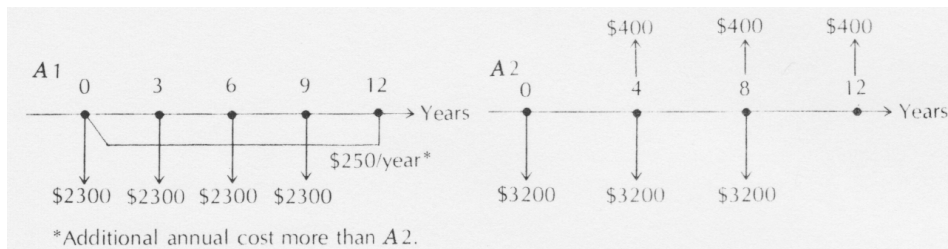
$$PW(\text{device A}) = -\$9000 + \$4500(P/A, 8\%, 3) = -\$9000 + \$4500(2.577) = \$2597$$

$$PW(\text{device B}) = -\$14,500 + \$6000(P/A, 8\%, 2) + \$8000(P/F, 8\%, 3) \\ = -\$14500 + \$6000(1.7832) + \$8000(0.79383) = \$2594$$

Both alternatives meet the minimum acceptable rate of return, because both are positive, and their net present worth are almost equal. In this case other considerations must be involved in the choice, such as availability of the extra \$5500 needed to purchase device B.

2. Assets A_1 and A_2 have the capability of satisfactorily performing the required function. A_2 has an initial cost of \$3200 and an expected salvage value of \$400 at the end of its 4-year economic life cycle. Asset A_1 costs \$900 less initially, with an economic life 1 year shorter than that of A_2 , but it has no salvage value and its annual operating costs exceed those of A_2 by \$250. When the required rate of return is 15%, which alternative is preferred using present worth analysis when compared by:
- The least common-multiple method
 - A 2-year study period (assuming the assets are needed for only 2 years)?

a. The least common multiple of lives is based on the assumption that assets will be replaced by identical models possessing the same costs. Equivalent service results from comparing costs over a period divisible evenly by the economic lives of the alternatives; in this case the least common multiple is 12 years.



$$PW(A_1) = -\$2300 - \$2300(P/F, 15\%, 3) - \$2300(P/F, 15\%, 6) - \$2300(P/F, 15\%, 9) - \\ \$250(P/A, 15\%, 12) \\ = -\$2300 - \$2300(0.6575) - \$2300(0.4323) - \$2300(0.2842) - \$250(5.2406)$$

$$= -\$6816$$

$$\begin{aligned} PW(A_2) &= -\$3200 - \$2800(P/F, 15\%, 4) - \$2800(P/F, 15\%, 8) + \$400(P/F, 15\%, 12) \\ &= -\$3200 - \$2800(0.5717) - \$2800(0.3269) + \$400(0.1869) \\ &= -\$5642 \end{aligned}$$

The present worth advantage of A_2 over A_1 for 12 years of service is $\$6816 - \$5642 = \$1174$

b. $S = 0$ for alternatives A_1 and A_2 after 2 years of service

$$PW(A_1) = -\$2300 - \$250(P/A, 15\%, 2) = -\$2300 - \$250(1.6257) = -\$2707$$

$$PW(A_2) = -\$3200$$

The salvage value of A_2 that would make the $PW(A_1) = PW(A_2)$ is

$$\$2707 = \$3200 - S(P/F, 15\%, 2)$$

$$S = (\$3200 - \$2707)/(P/F, 15\%, 2) = \$493/0.7561 = \$652$$

This means that A_2 is preferred to A_1 when the resale value of A_2 at the end of 2 years is more than \$652 greater than the resale value of A_1 at the same time

3. While in college Candice received \$10,000 in student loans at 5% interest. She will graduate in June and is expected to begin repaying the loans in either 5 or 10 equal annual payments. Compute her yearly payments for both repayment plans.

5 YEARS

$$A = P(A/P, i, n)$$

$$= 10,000(A/P, 5\%, 5) = \$2,310.00$$

10 YEARS

$$A = P(A/P, i, n)$$

$$= 10,000(A/P, 5\%, 10) = \$1,295.00$$

4. What uniform annual payment for 12 years is equivalent to receiving all of these:
- \$3000 at the end of each year for 12 years
 - \$20000 today
 - \$4000 at the end of 6 years
 - \$800 at the end of each year forever
 - \$10,000 at the end of 15 years

Use an interest rate of 8%

$$A_1 = \$3,000$$

$$A_2 = 20,000(A/P, 8\%, 12) = \$2,654$$

$$A_3 = 4,000(P/F, 8\%, 6)(A/P, 8\%, 12) = \$334.51$$

$$A_4 = (800/.08)(A/P, 8\%, 12) = \$1,327$$

$$A_5 = 10,000(P/F, 8\%, 15)(A/P, 8\%, 12) = \$418.27$$

$$\sum A_i = 3,000 + 2,654 + 334.51 + 1,327 + 418.27 = \$7,733.78$$

5. A land surveyor just starting in private practice needs a van to carry crew and equipment. He can lease a used van for \$3,000 per year, paid at the beginning of each year, in which case maintenance is provided. Alternatively, he can buy a used van for \$7,000 and pay for maintenance himself. He expects to keep the van three years at which time he could sell it for \$1,500. What is the most he should pay for uniform annual maintenance to make it worthwhile buying the van instead of leasing it, if his MARR is 20%?

Solution

Lease

$$EAC = 3,000(F/P, 20\%, 1) = 3,000(1.20) = 3,600$$

Buy

$$EAC = 7,000(A/P, 20\%, 3) + M - 1,500(A/F, 20\%, 3)$$

$$M = 3,600 - 2,910.85$$

$$= \$ 689.15$$

6. The town of South Battleford is considering building a bypass for truck traffic around the downtown commercial area. The bypass will provide merchants and shoppers with benefits that have an estimated value of \$500,000 per year. Maintenance costs will be \$125,000 per year. If the bypass is properly maintained, it will provide benefits for a very long time. The actual life of the bypass will depend on factors such as future economic conditions that cannot be forecast at the time the bypass is being considered. It is therefore reasonable to model the flow of benefits as though they will continue indefinitely. If the interest rate is 10%, what is the present worth of benefits minus maintenance costs?

$$\text{For capitalized cost, } P = \frac{A}{i} = \frac{500,000 - 125,000}{0.1} = \$3,750,000$$

7. A mechanical engineer has decided to introduce automated materials-handling equipment for a production line. He must choose between two alternatives: building the equipment or buying the equipment off the shelf. Each alternative has a different service life and a different set of costs.

Alternative 1: build custom automated materials-handling equipment

First cost:	\$15,000
Labour:	\$3300 per year
Power:	\$400 per year
Maintenance:	\$2400 per year
Taxes and Insurance:	\$300 per year
Service life:	10 years

Alternative 2: buy off-the-shelf standard automated materials-handling equipment

First cost:	\$25,000
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Labour:	\$1450 per year
Power:	\$600 per year
Maintenance:	\$3075 per year
Taxes and insurance:	\$500 per year
Service life:	15 years

If the interest rate is 9%, determine which alternative is better using both Present Worth and Annual Cash Flow Analysis.

Using the Present Worth Method

We can apply the least common multiple of lives or repeated lives method. The least common multiple of 10 and 15 is 30 years. Alternative 1 will be repeated twice (after 10 years and 20 years), while alternative 2 will be repeated once (after 15 years) during the 30-year period. At the end of 30 years, both alternatives will be completed simultaneously.

Alternative 1: build custom automated materials-handling equipment and repeat twice.

$$\begin{aligned}
 \text{PW (alternative 1)} &= -15,000 - 15,000(\text{P/F}, 9\%, 10) - 15,000(\text{P/F}, 10\%, 20) - \\
 & (3300+400+2400+300)(\text{P/A}, 9\%, 30) \\
 &= -15,000 - 15,000(0.42241) - 15,000(0.17843) - 6400(10.273) \\
 &= -89760
 \end{aligned}$$

Alternative 2: Buy off-the-shelf standard automated materials-handling equipment and repeat twice

$$\begin{aligned}
 \text{PW (alternative 2)} &= -25,000 - 25,000(\text{P/F}, 9\%, 15) - (1450+600+3075+500)(\text{P/A}, 9\%, 30) \\
 &= -25,000 - 25,000(0.27454) - 5625(10.273) \\
 &= -89,649
 \end{aligned}$$

Since the alternatives have a very similar present worth, it would be wise to consider other factors in making this decision.

Using the Annual Cash Flow Analysis Method

There is no need to give the alternatives equal lives when using the annual cash flow analysis method.

$$\begin{aligned}
 \text{AW (alternative 1)} &= -15,000(\text{A/P}, 9\%, 10) - 6400 \\
 &= -15,000(0.15582) - 6400 \\
 &= -8737
 \end{aligned}$$

$$\begin{aligned}
 \text{AW (alternative 2)} &= -25,000(\text{A/P}, 9\%, 15) - 5625 \\
 &= -25,000(0.12406) - 5625 \\
 &= -8726
 \end{aligned}$$