Annual Worth (AW) Analysis

Annual Worth (AW) Analysis is defined as the equivalent uniform annual worth of all estimated receipts (income) and disbursements (costs) during the life cycle of a project.
Annual Worth (AW) Analysis

Two Cases:

1) Alternatives have the same economic life.
2) Alternatives have different economic lives.

Case 1: No problemo. Compute AW for both alternatives and select alternative that has the highest AW or lowest Annual Cost (AC).

Case 2: The AW or AC has to be calculated for only one life cycle.

Example:
A project engineer with EnvironCare is assigned to start up a new office in a city where a 6-year contract has been finalized to take and to analyze ozone-level readings. Two lease options are available, each with a first cost, annual lease cost, and deposit-return estimates as shown below:

<table>
<thead>
<tr>
<th>Lease Term, years</th>
<th>Location A</th>
<th>Location B</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Cost, $</td>
<td>-$15,000</td>
<td>-$18,000</td>
</tr>
<tr>
<td>Annual lease cost, $ per year</td>
<td>-$3,500</td>
<td>-$3,100</td>
</tr>
<tr>
<td>Deposit Return, $</td>
<td>$1,000</td>
<td>$2,000</td>
</tr>
<tr>
<td>Lease Term, years</td>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>
As you will see when we study Chapter 5, when performing a Present Worth (PW) Analysis the two alternatives must be analyzed over the same number of years.

In this example, Location A has an economic life of 6 years. Its competitor Location B has an economic life of 9 years. The Least Common Multiple (LCM) of years for this example is 18 years. Therefore for Location A the costs must be duplicated for three cycles as shown in the diagram to the right. Two cycles of Location B would have to be used if a PW analysis were required.

An AW approach makes the analysis of these two alternatives easier if we can make the following assumptions:

Assumptions:

1) The services provided are needed for the indefinite future.
2) The selected alternative will be repeated for succeeding life cycles in exactly the same manner as for the first life cycle.
3) All cash flows will have the same estimated values in every life cycle.

Validity of Assumptions:

1) If the services provided are not expected to be needed in the future a common economic life must be determined for the alternatives.
2) If the costs are not expected to change exactly with the inflation or deflation rate then cash flow estimated must be made for each life cycle.

More on this later in Chapter 5!
Capital Recovery

Capital Recovery is defined as the equivalent annual cost of owning the asset plus the return on the initial investment.

\[ CR = -[P(A/P, i\%, n) - S(A/F, i\%, n)] \]

Capital Recovery only includes the initial cost and salvage value!

Relationship between Capital Recovery and AW:

\[ AW = -CR - A \]

Where \( A \) = equivalent annual cost or worth of all costs with the exception of the initial cost and all annual receipts with the exception of the salvage value.

Evaluating Alternatives by Annual Worth (AW) Method

For mutually exclusive alternatives, calculate AW using the MARR value.

One alternative: \( AW \geq 0 \), MARR is met or exceeded.

Two or more alternatives: Choose the lowest cost or highest income AW value using the MARR value.
AW of a Permanent Investment

There are some situations where financial decisions made by engineers assume that the life of a project is long enough to be considered "infinite". Public Works projects are typically assumed to have infinite lives. Dams, Stadiums, Airports, etc. are examples where the economic life of a project is considered infinite. Endowments for universities are also considered to have infinite lives since the money taken from the fund is interest generated by the principal. The principal is left in the fund indefinitely.

\[
A = P \frac{i(1 + i)^n}{(1 + i)^n - 1}
\]

For an infinite life \( n \to \infty \) and using L'Hopital's Rule:

\[
\lim_{n \to \infty} \frac{i(n)(1 + i)^{n-1}}{n(1 + i)^{n-1} - 0} = i
\]

AW of a Permanent Investment

\( A = P(i) \) for a perpetual investment

This equation determines the equivalent annual worth or cost of an investment assuming that the project has an infinite life.

In Chapter 5, we will learn that the Present Worth (PW) of a perpetual investment is given a special name: Capitalized Cost (CC).

\[ CC = \frac{A}{i} \text{ or } CC = \frac{AW}{i} \]