Six Ways to Perform Economic Evaluation of Projects

An Online Continuing Education Course for Engineers

Course Number: BS-3011

Credit: 3 Hours / 3 PDH / 3 CPD

Six Ways to Perform Economic Evaluation of Projects

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Investment in any project entails significant capital and associated costs over the economic life of the project. It is usually possible to accomplish the same result with a variety of means, and there are numerous examples of engineering systems that have a great physical design but little economic worth (i.e., it may simply be too expensive!).

For instance, a proposal to invest in an automated machine for a welding operation on an automotive assembly line could trigger many questions:

1. Will the machine expand capacity (and thus permit us to exploit demand beyond our current limits)?

2. Will the machine reduce costs (at the current level of demand) and thus permit us to operate more efficiently than before we had the machine?

3. Will the machine create other benefits (e.g., higher quality, more operational flexibility)?

4. And finally, if the investment is worth undertaking!

The key economic question asked of project proposals should be, “How will things change (i.e., be better or worse) if we undertake the project?”

Engineers must decide if the benefits of a project exceed its costs and must make this comparison in a unified framework. The framework within which to make this comparison is the field of engineering economics, which strives to answer exactly these questions, and perhaps more. The Accreditation Board for Engineering and Technology (ABET) states that engineering “is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind.”

Economic analyses may be based on a number of cost classifications:

1. **First (or initial) Cost:** Cost to get the activity started, such as property improvement, transportation, installation, and initial expenditures.

2. **Operation and Maintenance Cost:** They are experienced continually over the useful life of the activity.

3. **Fixed Cost:** Fixed costs arise from making preparations for the future and include costs associated with ongoing activities throughout the operational lifetime of that concern. Fixed costs are relatively constant; they are decoupled from the system input/output, for example.

4. **Variable Cost:** Variable costs are related to the level of operational activity (e.g., the cost of fuel for construction equipment will be a function of the number of days of use).

5. **Incremental or Marginal Cost:** Incremental (or marginal) cost is the additional expense that will be incurred from the increased output in one or more system units (i.e., production increase). It is determined from the variable cost.

6. **Sunk Cost:** It cannot be recovered or altered by future actions. Usually, this cost is not a part of engineering economic analysis.

7. **Life-Cycle Cost:** This is the cost for the entire life-cycle of a product and includes feasibility, design, construction, operation, and disposal costs.

All costs which may occur at various times, such as installation costs, maintenance costs, and any miscellaneous expenditure such as replacement of components, should also be treated as capital investment. Bringing all of these costs, which occur at different times, to a common point in time, allows the analyst to compare various design alternatives and select the alternative with the lowest total cost.

The principle underlying all types of investment is the net return expected from the proposed investment. This net return must be evaluated and compared with the overall investment in the project. An economic technique used to compare various design alternatives by projecting (discounting or compounding) associated costs over the economic life of the project is known as "**Life Cycle Analysis (LCA)**."

Mode of Analysis

Payback period and **Return on investment** are two modes of analysis frequently used by plants that do not involve major capital investments. They are not fully consistent with the life cycle cost (LCC) approach in that they do not take into account all relevant values over the entire life period and discount them to a common time basis. Despite their disadvantages, these methods can provide a first-level measure of profitability that is, relatively speaking, quick, simple, and inexpensive to calculate. Therefore, they may be useful as initial screening devices for eliminating more obvious poor investments.

The additional four modes of analysis that follow are fully consistent with the LCC approach:

- Total life cycle cost (present value method)
- Profitability index or benefit/cost ration method
- Net present Value (NPV)
- Internal rate of return (IRR)

Each of the six modes of analysis just mentioned is presented with illustrations in the following sections. But before that, let's understand the concept of money:

Interest Rate

Interest is a rental amount charged by financial institutions for the use of money.

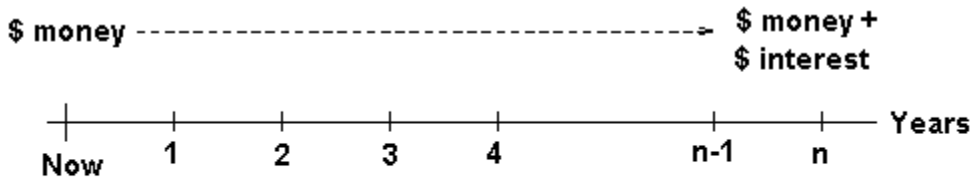
- Called also the rate of capital growth, it is the rate of gain received from an investment.
- It is expressed on an annual basis.
- For the lender, it consists, for convenience, of (1) risk of loss, (2) administrative expenses, and (3) profit or pure gain.
- For the borrower, it is the cost of using capital for immediately meeting his or her needs.

The interest rate can be simple interest or compound interest. Simple interest is computed only on the original amount borrowed. It is the return on that principal for one time period. In contrast, compound interest is calculated each period on the original amount borrowed plus all unpaid interest accumulated to date.

Time Value of Money (TVM)

Money has time value because the purchasing power of a dollar changes with time.

The time-value of money is the relationship between interest and time, i.e.



Time Value of Money

The time-value of money analysis begins with the present value concept—the idea that money you have now is worth more today than an identical amount you would receive in the future.

Why?

There are at least three reasons:

1. **Opportunity.** The money you have now could be (in principle) invested now for a gain in return or interest between now and the future. Money you will not have until a future time cannot be used now.

2. **Risk.** Money you have now is not at risk. Money predicted to arrive in the future is less certain.

3. **Inflation.** A sum you have today will very likely buy more than an equal sum you will not have until years in the future. Inflation over time reduces the buying power of money.

Earning Power of Money

The earning power of money represents funds borrowed for the prospect of gain.

Often, these funds will be exchanged for goods, services, or production tools, which in turn can be employed to generate and economic gain.

Purchasing Power of Money

The prices of goods and services can go upward or downward, and therefore, the purchasing power of money can change with time.

- **Price Reductions:** Caused by increases in productivity and availability of goods.
- **Price Increases:** Caused by government policies, price support schemes, and deficit financing.

Simple Payback Analysis

The payback, also known as the payout or the payoff method, determines the number of years for the invested capital to be offset by resulting benefits. The required number of years is termed as the payback, recovery, or break-even period. The measure is popularly calculated on a before-tax basis, without discounting, i.e., neglecting the opportunity cost of the capital. Investment costs are usually defined as first costs that often neglect the salvage value. Benefits are usually defined as the resulting net change in income cash flow, or, in the case of a cost-reducing investment like energy-efficient devices, as the reduction in net outgoing cash flow.

The simple payback period is usually calculated as follows:

$$\text{Simple Payback Period (SPP)} = \frac{\text{First Cost}}{\text{Yearly Benefits} - \text{Yearly Costs}}$$

All other things being equal, the better investment is the one with the shorter payback period.

For example, if a project costs $100,000 and is expected to return $20,000 annually, the payback period will be $100,000 / $20,000, or five years.

There are two main problems with the payback period method:

1. *It ignores any benefits that occur after the payback period and, therefore, does not measure profitability. The method does not give consideration to cash flows beyond the payback period and thus, does not measure the efficiency of an investment over its entire life.*

2. *It ignores the time value of money. The neglect of the opportunity cost of capital, or failing to discount costs occurring at different times to a common base for comparison, results in the use of inaccurate measures of benefits and cost to calculate the payback period, and hence, results in the determination of an incorrect payback period.*

Because of these reasons, other methods of capital budgeting like net present value, internal rate of return, or discounted cash flow are generally preferred. Despite its limitation, there are several situations in which the payback method might be particularly appropriate:

1. *A rapid payback may be a prime criterion for judging an investment when financial resources are available to the investor for only a short period of time.*

2. *The speculative investor who has a very limited time horiz… will usually desire rapid recovery of the initial investment.*

3. *When the … mination of the break-even life, i… ood of achieving a successful …*

Example (SPP):

Find the SPP for prc… osts $100,000 to install and $5,000 pe… rity system is expected to yield a sa… staff.

Simple Payback Peri…

In other words, the cos… system will be recovered in 1.82 years, or around 22 months.