

## Lecture 3,4

### Comparison of alternatives for Water Resources Projects

For most of the engineering projects, equipments etc., there are more than one feasible alternative. It is the duty of the project management team (comprising of engineers, designers, project managers etc.) of the client organization to select the best alternative that involves less cost and results more revenue. For this purpose, the economic comparison of the alternatives is made. The different cost elements and other parameters to be considered while making the economic comparison of the alternatives are initial cost, annual operating and maintenance cost, annual income or receipts, expected salvage value, income tax benefit and the useful life. When only one, among the feasible alternatives is selected, the alternatives are said to be mutually exclusive.

As already mentioned in module-1, the cost or expenses are generally known as cash outflows whereas revenue or incomes are generally considered as cash inflows. Thus in the economic comparison of alternatives, cost or expenses are considered as negative cash flows. On the other hand the income or revenues are considered as positive cash flows. From the view point of expenditure incurred and revenue generated, some projects involve initial capital investment i.e. cash outflow at the beginning and show increased income or revenue i.e. cash inflow in the subsequent years. The alternatives having this type of cash flow are known as investment alternatives. So while comparing the mutually exclusive investment alternatives, the alternative showing maximum positive cash flow is generally selected. In this case, the investment is made at the beginning to gain profit at the future period of time. Example for such type alternatives includes purchase of a dozer by a construction firm. The construction firm will have different feasible alternatives for the dozer with each alternative having its own initial investment, annual operating and maintenance cost, annual income depending upon the production capacity, useful life, salvage values etc. Thus the alternative which will yield more economic benefit will be

selected by the construction firm. There are some other projects which involve only costs or expenses throughout the useful life except the salvage value if any, at the end of the useful life. The alternatives having this type of cash flows are known as cost alternatives. Thus while comparing mutually exclusive cost alternatives, the alternative showing minimum negative cash flow is generally selected. Example for such type alternatives includes construction of a government funded national highway stretch between two regions. For this project there will be different feasible alternatives depending upon length of the stretch, type of pavement, related environmental, social and regulatory aspects etc. Each alternative will have its initial cost of construction, annual repair and maintenance cost and some major repair cost if any, at some future point of time. The alternative that will exhibit lowest cost will be selected for the construction of the highway stretch.

The differences in different parameters namely initial capital investment, annual operation cost, annually generated revenue, expected salvage value, useful life, magnitude of output and its quality, performance and operational characteristics etc. may exist among the mutually exclusive alternatives. Thus the economic analysis of the mutually exclusive alternatives is generally carried out on the similar or equivalent basis since each of the feasible alternatives will meet the desired requirements of the project, if selected.

The economic comparison of mutually exclusive alternatives can be carried out by different equivalent worth methods namely present worth method, future worth method and annual worth method. In these methods all the cash flows i.e. cash outflows and cash inflows are converted into equivalent present worth, future worth or annual worth considering the time value of money at a given interest rate per interest period.

### **Comparison of alternatives by present worth method:**

In the present worth method for comparison of mutually exclusive alternatives, the future amounts i.e. expenditures and incomes occurring at future periods of time are converted into equivalent present worth values at a certain rate of interest per interest period and are added to present worth occurring at „0“ time. The converted equivalent present worth values are always less than the respective future amounts since the rate of interest is normally greater than zero. The cash flow of the mutually exclusive alternatives may consist of future expenditures and incomes in different forms namely randomly placed single amounts, uniform amount series commencing from end of year 1, randomly placed uniform amount series i.e. commencing at time period other than end of year 1, positive and negative uniform gradient series starting either from end of year 1 or at different time periods and geometric gradient series etc. The different compound interest factors namely single payment present worth factor, uniform series present worth factor and present worth factors for arithmetic and geometric gradient series etc. will be used to convert the respective future amounts to the equivalent present worth values for different alternatives.

The methodology for the comparison of mutually exclusive alternatives by the present worth method depends upon the magnitude of useful lives of the alternatives. There are two cases; a) the useful lives of alternatives are equal and b) the useful lives of alternatives are not equal. The alternatives having equal useful lives are designated as equal life span alternatives whereas the alternatives having unequal life spans are referred as different life span alternatives.

#### **a.Equal life span alternatives**

The comparison of mutually exclusive alternatives having equal life spans by present worth method is comparatively simpler than those having different life spans. In case of equal life span mutually exclusive alternatives, the future amounts as already stated are converted into the equivalent present worth values and are added to the present worth occurring at time zero. Then the alternative that exhibits maximum positive equivalent present worth or minimum negative equivalent present worth is selected from the considered feasible alternatives.

### **a. Different life span alternatives**

In case of mutually exclusive alternatives, those have different life spans, the comparison is generally made over the same number of years i.e. a common study period. This is because; the comparison of the mutually exclusive alternatives over same period of time is required for unbiased economic evaluation of the alternatives. If the comparison of the alternatives is not made over the same life span, then the cost alternative having shorter life span will result in lower equivalent present worth i.e. lower cost than the cost alternative having longer life span. Because in this case, the cost of the short span alternative is considered only for a shorter period of time, even though this alternative may not be economical. In case of mutually exclusive investment alternatives, the alternative with longer life span will result in higher equivalent present worth i.e. higher positive equivalent worth, as the costs, revenues, savings through reduced costs is considered over a longer period of time than the alternative with shorter life span. Thus in order to minimize the effect of such kind of discrepancy on the selection of best alternative from the considered feasible alternatives, the comparison is made over the same life span.

The two approaches used for economic comparison of different life span alternatives are as follows;

- i. Comparison of mutually exclusive alternatives over a time period that is equal to least common multiple (LCM) of the individual life spans
- ii) Comparison of mutually exclusive alternatives over a study period which is not necessarily equal to the life span of any of the alternatives.

In the first approach the comparison is made over a time period equal to the least common multiple of the life spans of mutually exclusive alternatives. The cash flow of the alternatives i.e. cash flow of the first cycle is repeated and the number of repetitions depends upon the value of least common multiple of life spans between the mutually exclusive alternatives. It may be noted here that the cash flow i.e. all the costs and revenues of the alternatives in the successive cycle will be exactly same as that in the first cycle. For example if there are two alternatives with useful lives of 4 years and 5 years.

Then the alternatives will be compared over a period of 20 years (least common multiple of life spans) at the given rate of interest per year. Thus the cash flow of the alternative having the life span of 4 years will be repeated 5 times including the first cycle whereas the cash flow of the alternative with life span of 5 years will be repeated 4 times including the first cycle. After that the most economical alternative will be selected.

Taking another example, there are two alternatives with life spans of 5 years and 10 years. In this case the alternatives will be compared over a period of 10 years (LCM). Thus the alternative with life span of 5 years will be analyzed for 2 cycles whereas the alternative with 10 year life span will be analyzed for one cycle only at the given rate of interest per year.

In the second approach, a study period is selected over which the economic comparison of mutually exclusive alternatives is carried out. The length of the study period will depend on the overall benefit of the project i.e. it may be shorter or longer (as compared to useful lives of the individual alternatives) depending upon the short-term or long-term benefits as desired for the project. Thus the cash flows of the alternatives occurring during the study period are only considered for the economic comparison. However if any alternative possesses salvage value at the end of its useful life and that occurs after the study period, then its equivalent value must be included in the economic analysis. The values of equivalent present worth of the mutually exclusive alternatives are calculated over the selected study period and the alternative showing maximum positive equivalent present worth or minimum negative equivalent present worth is selected.

## Lecture 5,6,7 (Tutorials)

### Comparison by present worth method:- (EXAMPLES)

Now some examples showing the use of present worth method for comparison of mutually exclusive alternatives are presented. First the comparison of equal life span mutually exclusive alternatives by present worth method will be illustrated followed by comparison of different life span alternatives. The following examples are formulated only to demonstrate the use of different methods for comparison of alternatives. The values of different cost and incomes mentioned in the examples are not the actual ones pertaining to a particular item.

**Q1.** There are two alternatives for purchasing a concrete mixer. Both the alternatives have same useful life. The cash flow details of alternatives are as follows;

**Alternative-1:** Initial purchase cost = Rs.3,00,000, Annual operating and maintenance cost = Rs.20,000, Expected salvage value = Rs.1,25,000, Useful life = 5 years.

**Alternative-2:** Initial purchase cost = Rs.2,00,000, Annual operating and maintenance cost = Rs.35,000, Expected salvage value = Rs.70,000, Useful life = 5 years.

Using present worth method, find out which alternative should be selected, if the rate of interest is 10% per year.

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