
8 Uncertainty and Risk Analysis

8.1 INTRODUCTION

Initial estimated costs and financial benefits of a project are based on assumptions of expenses and revenues of some quantifiable variables, the values of which are based on the data available at the time of the budget. However, values of these variables are often at variance from the subsequent actual figures. This is mostly due to occurrence of some unexpected events (uncertainty and consequent risks). Possibility of such uncertainty and risk does exist in every project. The various types of uncertainty and risks are illustrated by the following examples:

- Sales of goods or services not as per expectation;
- Costs of goods or services higher or lower than budgeted figures;
- Variation in business environment (change in interest rate, tax structures inflation, government policy, etc.);
- Changes in technologies or project life cycle;
- Industrial relations problems;
- Unavailability of resources.

All uncertainties lead to risks, which may affect the success of the project in terms of:

- Budget;
- Completion date;
- Scope;
- Quality.

Project risk analysis is aimed at removing/reducing the risks that threaten attainment of the success of the project.

8.2 UNCERTAINTY AND RISK

In financial and economic analysis, the word 'uncertainty' is referred to as 'unreliability' of actual values *vis-à-vis* estimated values. The causes of unreliability may be due to errors in estimating due to insufficient information, inability to predict the future, etc. The word 'risk' means volatility of expected returns. Volatility conveys the idea of change from anticipated (estimated) values, which may be due to unplanned causes. Actual values can be known only on completion of a project. Some authorities consider *risk is uncertainty that matters*. Thus, uncertainty appears to be a generic term, while risk is a more specific term. In any case although technical distinction

may exist between the words uncertainty and risk, there is hardly any significant gain for the present text in treating these two words as different. Therefore, these two words are intended to be used synonymously and interchangeably in the present text.

8.3 BENEFITS OF RISK ANALYSIS

Benefits of risk analysis are manifold. The foremost benefit is a better understanding of the project situation leading to appropriate future planning in respect of time frame and costs. It also helps in efficient and effective management of the risk. This results in discouraging acceptance of financially unsound projects. One other use of risk analysis is a better understanding of the risk and, if necessary, the most suitable agency may be engaged to tackle it. Better understanding of the risk may also lead to the incorporation of appropriate clauses in the contract agreement for the project. Risk analysis should be properly documented since the resulting data may be useful for future projects.

8.4 FACTORS CONTRIBUTING TO RISK

There are several factors that may cause uncertainty and risk in a project. Some of the major factors are discussed below.

8.4.1 INACCURACY IN THE INPUT DATA

The first key factor for risks in the analysis is the possibility of inaccuracy in the input data which form the basis of the study. Thus, the level of reliability of the study depends largely on the accuracy of the information available. In cases where the information is based on past experience or adequate market surveys, this may be fairly dependable. On the other hand, if the information is based on mere guesswork, a fair amount of uncertainty is likely to creep in.

8.4.2 TYPE OF THE ACTIVITY AND FUTURE TREND OF ECONOMY

The second factor causing uncertainty is the type of activity involved in the project and the future trend of the economy. While making capital investment in any enterprise, it is imperative to study in advance the nature and background of the enterprise as well as the projected future economic conditions (e.g., interest rates, inflation) and assess the risk involved in the process. However, this may not be easily achievable, since for new enterprises, hardly any past history is available, particularly in the current fast-changing business cycles.

8.4.3 TYPE OF PLANTS AND EQUIPMENT

A third factor causing uncertainty and risk is the type of plants and equipment involved in the project. Some plants have definite economic lives and resale value, while others may not have much resale value. This will have direct bearing on the anticipated income and expenditure. Multipurpose equipment may be very useful in

the workshop, while equipment capable of only limited specialized job would naturally have restricted use. This aspect needs careful examination while studying the investment strategy.

8.4.4 EXTENT OF THE ESTIMATED STUDY PERIOD

If the extent of the estimated study period is too long, it may not be possible to maintain the income/expenditure figures as per the initial estimation. Therefore, a long study period will increase the probability of uncertainty and risk in an investment.

8.5 IDENTIFICATION OF RISKS

It is vital that project risks are identified before the project is implemented, preferably at the appraisal stage itself. This would help in developing appropriate strategy for managing such risks. In this connection, past experience would be the ideal way of identifying the probable risks in the project.

Past experience may be of two categories. First, personal experience of the members of the project needs to be explored. Dialogue with team members seeking their inputs from personal knowledge within their specific field of expertise may help the team in this pursuit. Second, records of past experience of the organization may help in identifying future risks of similar nature and prepare for and/or mitigate the damage.

8.6 ANALYSIS OF RISKS

Analysis of risks is a systematic process for the assessment of identified risks in a project. There are several methods for analyzing risks. Some of the methods are detailed in the succeeding sections.

8.6.1 QUALITATIVE RISK ANALYSIS

Qualitative method of risk analysis is generally used to prioritize the already identified risks by utilizing the data in respect of their impact on the project objectives and the rate of their occurrences. It is often useful for making an estimate of the extent of the risk and can provide useful qualitative assessments to stakeholders. Also, compared to quantitative analysis, this method (qualitative analysis) is often more accessible and more easily understood by the stakeholders. In particular, where sufficient data or mathematical competence and facilities for assessment are not available, qualitative analysis becomes quite a useful and handy method of risk assessment.

8.6.1.1 Probability and Impact Matrix

This method is one of the common methods of qualitative risk assessment. The method is used to evaluate the importance and to prioritize each risk. Risk can be ranked in respect of each of the project objectives. For the purpose of general ranking, the advantage among the several project rankings can be assessed without difficulty. This makes the process easily workable.

TABLE 8.1
Probability and Impact Matrix of Risks

		Impact Severity		
		Low (Insignificant)	Medium (Reasonable)	High (Significant)
Probability of occurrence	Low (unlikely to occur)	5	4	3
	Medium (may occur)	4	3	2
	High (likely to occur)	3	2	1

Actual technique of this method is to allot values for two items.

- Probability of occurrence of each risk;
- Impact of the risks.

Ranges of these values are to be assessed by the project team and stated in a matrix form. A typical probability and impact matrix is illustrated in Table 8.1. In this case, the risk grading is considered in descending order of risk, i.e., '1' is considered to be of highest risk and '5' is considered to be of lowest risk.

8.6.1.2 Brainstorming

Brainstorming may be defined as 'a means of getting a large number of ideas from a group of people in a short time'. It is a simple, yet effective, way to think creatively in a group setting without any emotional blockage or criticism from other members.

The definition embodies three aspects:

- A large number of ideas;
- A group of people;
- A short time.

The intention of brainstorming is to allow all the stakeholders to use their knowledge and experience, and contribute effectively in the generation of ideas for risk analysis within a reasonable time frame. This method, however, cannot provide quantitative results, which is one of its drawbacks.

8.6.1.3 Delphi Method

The basic philosophy of Delphi method is to bring out the consensus of a panel of experts with the help of a mail survey. This method is often used for assessing potential risks in activities where the impact of risk is of prime importance.

First, the group leader selects a panel of experts on the topic being examined. This activity is of great importance as the result of the study would depend on the level of expertise of each and every participant. Once the expert participants are selected, each member of the group is sent a questionnaire by mail and asked to comment on each item based on their personal opinion, experience or previous research. The feedbacks received from the experts are summarized without divulging the identity of the

experts. A copy of the summary of the feedbacks is sent to each participant, for his further comments. The questionnaires are returned to the group leader who prepares a summary and sends this again to the participants for their comments, if any. The questionnaire rounds are repeated till a reasonable consensus emerges.

The advantage of this method is that it attempts to elicit opinions from relevant experts without having to bring them together in a physical meeting. Also, since the names of the experts are kept anonymous, individual panelists are kept free from worrying about repercussions for their opinions. Furthermore, it is less expensive than the conventional face-to-face meetings. While Delphi method is appealing, as this method allows consensus of a diverse panel of experts, it has its disadvantages too. First, it does not provide the same sort of live interactions, which is the essence of traditional face-to-face meetings. Also, response time may be long, and the method is time-consuming. The other disadvantage is that the information received back from the expert panelists may not provide any intrinsic value.

8.6.1.4 Lessons Learnt from Previous Projects

Final reports of previous projects may reveal experiences gathered by earlier project teams in respect of certain risks. The present project team would then save both time and money if the previous experience is utilized in avoiding repetition of the same mistake.

8.6.2 QUANTITATIVE RISK ANALYSIS: SENSITIVITY ANALYSIS

Compared to qualitative risk analysis, quantitative risk analysis includes more sophisticated methods. Currently, computer software is available for such analysis. Quantitative analysis is effectively a continuation of the qualitative analysis. Once the risks are identified by qualitative analysis, a detailed quantitative analysis may be carried out. With this exercise, the impact of the risk may be quantified in respect of the three basic project success yardsticks, viz., cost, time and performance. Several methods have been developed for this purpose, among which sensitivity analysis is the simplest method. It involves changing the value of a few selected variables and calculating the resulting change in the net present value (NPV). In practice, a number of variables are responsible for the economic viability of a project, viz., economic life of the project, change in the interest rate of the borrowed capital, selling price, etc. Any change in these basic parameters will automatically change the NPV of the project. Sensitivity analysis shows the effect of such variations upon the expected return to be achieved in a project. For carrying out sensitivity analysis, the estimated values of the basic variables are considered, taking one factor at a time. The sum total of NPV of the project is then calculated. The effect of the NPV is plotted graphically for examination.

NPV of a project is represented by:

$$NPV = \sum_{n=1}^n \frac{Q(P - V) - F}{(1 + i)^n} + \frac{S}{(1 + i)^n} - I$$

where

n = expected project life in years

Q = number of units sold annually

P = selling price per unit
 V = variable cost per unit
 F = fixed costs, including taxes and liabilities
 i = interest rate
 S = salvage value
 I = initial investment

It may be noted that the basic variables in the above equation are represented by selling price (P), interest rate (i) and the expected project life (n). From the above equation, an idea in the change of NPV can be formed, when one of the variables, say the selling price (P), is changed, keeping the other variables unchanged. Similarly, an idea of the change in the NPV can be obtained, if the interest rate (i) is varied, keeping the other variables unchanged. Figures 8.1 and 8.2 illustrate the visual representation of typical changes in NPV if the selling price (P) or the interest rate (i) is varied. Such visual representations are helpful in identifying variables that are critical to the success of a project. It may be noted from Figures 8.1 and 8.2 that when the selling price is too low or the interest rate is too high, the value of NPV indicates unfavorable investment condition.

Apart from being one of the most appropriate methods for indicating favorable and unfavorable investment condition for appraisal of projects, sensitivity analysis can also help in the initial stages in the design process of a project by:

- Improving the understanding of the effect of change in variable factor(s) on the project;
- Increasing expected NPV by varying the design in the initial stage;
- Reducing risk factor by taking adequate precaution;
- Indicating areas that need more in-depth investigation.

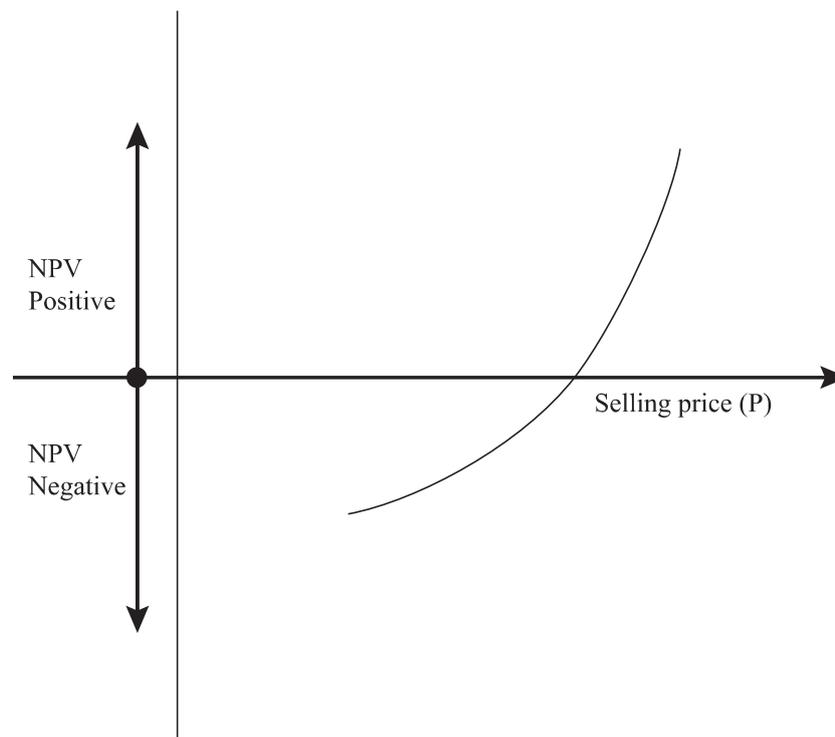


FIGURE 8.1 Relation between P and NPV.

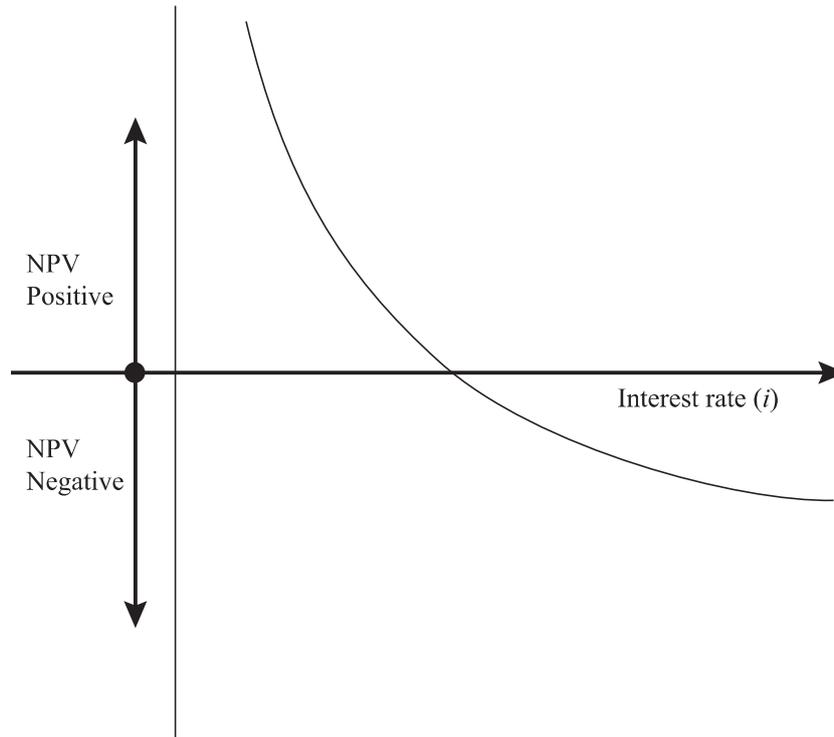


FIGURE 8.2 Relation between i and NPV.

Sensitive analysis is thus not only useful, but also very simple and consequently very popular in analyzing the risk in an investment proposal. However, when more than one variable changes simultaneously at a time, the analysis may not give an authentic representation.

8.7 CONCLUDING REMARKS

The information collected during risk analysis phase is generally used to improve the probability of the project in achieving the targets of its cost, time and performance objectives. This is done by reducing the risk whenever possible, and monitoring the risks where reduction is not possible.

This may involve changing the project schedule by removing high-risk activities or setting up monitoring device for getting early responses to risks. These responses are as follows:

- Eliminating risks whenever possible;
- Decreasing the risks by taking appropriate actions immediately;
- Mitigating the risk by contingency.

The risk management phase begins as soon as the qualitative analysis phase is complete, and proceeds through the quantitative analysis phase (sensitivity analysis). During this phase, the management may take action against the impact of the risk, say by changing the overall time frame or cost plan in order to increase the probability of achieving his project objective.

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