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An Overview on Decision Making Under Risk & Uncertainty Associated with Project

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Abstract
Decision is nothing but a conclusion reached after consideration. Whereas decision making is a process of selecting the best among the different alternatives. Decision making involves the selection of a course of action from among two or more possible alternatives in order to arrive at a solution for a given problem. Risk and uncertainty is incorporated during the decision making. Also the uncertainty is the lack of certainty, a state of having limited or incorrect knowledge where it is impossible to exactly describe the existing state, a future outcome. The sources of risk and uncertainty in decision making are discussed, emphasizing the distinction between uncertainty and risk. This paper introduces concepts, principles and approaches for addressing rick & uncertainty in decision making.

Keywords—Decision Making Risk, Uncertanities, Township

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1. INTRODUCTION

In our daily life we take many decisions, like purchasing any object & to do investment for that object. In these decisions some are simple in the manner but when there are many possibilities to take the decision at that time risk and uncertainty occurs that which possible condition I should take for the better output. Today by experience we know that few people make decisions after the well deliberated calculations. We also know that during decision making under risky situation, people often neglect the normative rules and that they often make decisions by intuition or on "a hunch" that seems correct. The descriptive theory gives us some explanations that why people make decisions the way they actually do by neglecting suggested normative rules for decision-making under risk and uncertainty and for simplicity and instance people often use well-known paths for decision making.
Risks and uncertainties of project developments arises from various sources of errors including data, model errors and forecasting errors. The most powerful factors affecting risk and uncertainty were resulted from forecasting errors. Also data errors and model errors were found to have insignificant effects.

1.2 Risk

A lot of opportunities might be there to try and overcome the challenges that uncertainty poses for decision makers. On one end of the spectrum are probabilistic risk and decision analysis methods. On the other end of the spectrum are ad-hoc methods and even intuition, if that can be called method. In Contrast to probabilistic risk and decision analysis, ad-hoc methods and intuition are unlikely to provide a defensible basis for decision making. This is particularly true in cases where decision makers hold the public trust, which is the case when potential losses would be distributed across a population that may have had little or no input into a decision process. In such cases, the use of a rational and rigorous approach to decision making is needed both to protect the decision maker and to protect the public. Decision having Probabilistic risk and the decision analysis is the most rigorous engineering approach to difficult decision-making problems involving uncertainty.
A township can be defined as a large scale development to create a self -sustaining neighborhood within it. A township also enables the area around its location, to develop rapidly. The main advantage that a township project has over community living, is that it facilitates modern and cosmopolitan living. Township projects are self -sufficient units with well-designed structures with top class amenities, to provides enjoyable residential

solutions. Risk and uncertainty can be effectively carried out by investigating and identifying the sources of risks associated with each activity of the residential township project.

2. THEORETICAL ASPECT

2.1 Risk

Risk is defined as the probability or threat of quantifiable damage, injury, liability, loss or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through pre-emptive action. The objective of risk assessment is to conduct an assessment to foresee negative effects or risk so that adverse consequences can be minimized. Most literature on this subject defines the word "risk" as comprising two elements as follows:

1)The likelihood (or probability) of occurrence of a negative event during the lifetime of operation of a facility
2)The resultant consequence when a negative event has taken place.

The first term involves risk assessment and the second term is risk management. Risk assessment is a scientific task and risk management is the subject of finding out regulatory measures based on risk assessment and considerations of a legal, political, social, economic, environmental and engineering nature risk issues.
where the outcome is unknown to the decision maker, that means decision-maker is not sure which outcome will occur, is called as a risky situation.

2.2Uncertainty

Uncertainty is the lack of certainty. In residential township project uncertainties may arises due to failure of planning, implementing and monitoring systems. Climate change is introducing many uncertainties into the management and planning of township infrastructure project. The word "uncertainty" emphasizes that choice of decision-making must be made on the basis of incomplete knowledge about projects that do not yet physically exist. Uncertainties arise from three sources of errors, which is as follows:

1)Data errors
2)Forecasting errors
3)Model errors

1. Data Errors

The errors related with the technical problems are known as the data error. Data errors stem from measurement errors, sampling errors and simple human errors. Uncertainties due to data error can be measured by using statistical techniques. Data errors can be reduced by collecting more past data.

2. Forecasting Errors

Forecasting error is related with the uncertainty about "future events". As we know economic evaluation of the future is questionable. There is a limit to our ability to reduce forecasting errors. No matter how hard we tried and used advanced techniques the reason is the future is unknowable.

3. Model Errors

Model errors represents the residual error which is output of difference between observed and model values. Model error may occurs due to the impossibility towards perfectly representing the real world in a mathematical model. Quantifications of economic benefits involves the use of forecast traffic speeds and delays, fuel prices, national income and time valuation, and etc. contain model errors.

2.3 Risk and Uncertainty Assessment

It was found that many European countries use scenarios for the investigation of the effect risk and uncertainty of project investments which include scenario investigation, sensitivity assessment and probability-based assessment. Current practices for the assessment of risk and uncertainty states on scenario analyses. The methodologies are briefly discussed below.

2.3.1 Scenario Analyses

Scenarios analyses is related with investigating the different alternatives for the option which can performs well with minimum risk. Currently, scenario assessment is a basic tool used to assess risk and uncertainty about

future. Since the future is uncertain with involvement of risk one way we can deal with this uncertainty and assess risk is to constructing possible scenarios and looking for the options which performed well with minimum risk. Scenario analysis can begin with defining alternative scenarios, its criteria, impacts and risks. Assessment impacts and risks may involve creating scorecard for each scenario. Decision-making may be done based on the scenarios that possess the most benefit cost effective, minimum risks and impacts. Scenario assessments do not forecast probability of occurrence they indicate what can happen from different given alternative.

2.3.2 Sensitivity Analyses

Sensitivity analyses are the identification of main sources of uncertainty. It is conducted to identify whether there are some variables which contribute greater uncertainty to the forecasted other. Input variables which have high susceptibility for future forecasts may need to be measured first with more analyses and the uncertainties of highly susceptible factors may be considered in decision making. The main objective of sensitivity analysis is to identifying main effects and interaction effects of input variables. The uncertainties arises due to data errors and forecasting errors were considered in the sensitivity analysis.

2.3.3 Probability-based Assessment (Monte Carlo Simulation)

Probability-based assessment is the identification of various uncertainties and it is purely statistical method. As probability-based assessment is the statistical method then mathematical functions of related decision-making factors established first then uncertainties of input variables of that functions are quantified and modeled by probability distribution and its statistical parameters (i.e. mean and coefficient of variation). The outcome from the analysis is the probability distributions of output parameters.

Figure A shows schematic chart of probability-based assessment.

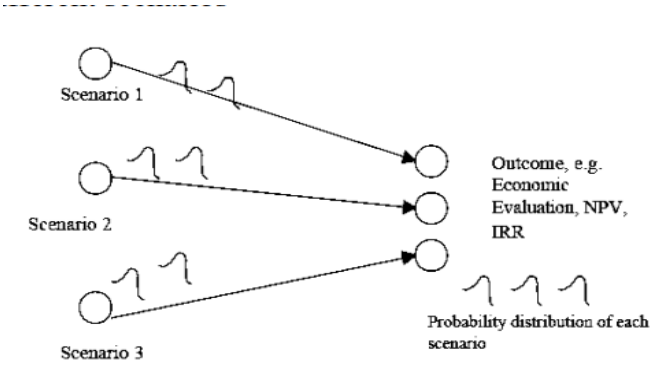

Figure A: schematic chart of probability-based assessment

2.3.4 Decision Tree:

A decision tree like a decision support tool that used a tree like graph or model of decision and their possible consequences, including chance event outcomes, resource costs, and utility and it is one way of showing an algorithm. The most basic technique in decision theory is the decision tree. A decision tree enables the decision maker to view all important aspects of the problem at once the decision alternatives, the uncertain outcomes and their probabilities, the economic consequences, and the chronological order of events. Here as an example, the question of whether to regulate air pollution to improve forest health. Suppose you are asked to provide an opinion on whether or not air pollution should be regulated to improve forest health. Three responses are possible:
1)Pollution is affecting forest health and should be regulated. 2)Pollution is not affecting forest health and should not be regulated.
3)The evidence is inconclusive

Of course, inattentive of your opinion about whether pollution is affecting forest health, pollution either is having an effect or it is not having an effect and their decision is informed by the advice we give them, but their decision on whether to regulate or not depends on whether they think that pollution is affecting forest health, and just as our opinion can be wrong, their decision can be wrong too.6Notice that there are 12 possible

outcomes: 3 answers we might give to the question, 2 possible states of the world, and 2 possible decisions by the regulator. These possibilities and their consequences can be summarized in a decision tree.
Figure B: Decision Tree For Analysis Of Regulation On Air Quality Intended to Improve Forest-Health.

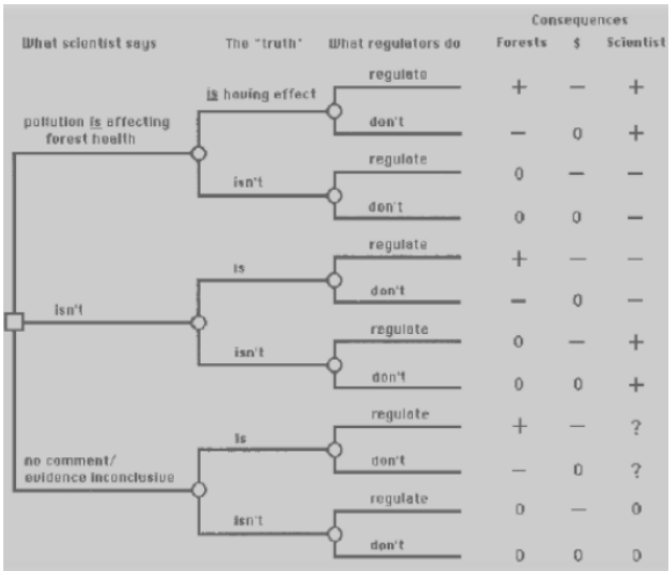

Figure B: Decision tree for analysis of regulation on air quality intended to improve forest-health.

- The squares represent points in the tree over which you have control as a decision maker, i.e., they represent the decisions you can make. In this case our decision is what to tell the person who asked for our opinion.
- The circles represent points in the tree over which you have no control.
- Along each branch of the tree, all possibilities are considered.

2.4 Identification of Various Risks

Risks have always been a part of life. For getting the possible outcome with minimum risk identification of risk is necessary. Here some types of risks are given which is mostly related to infrastructure asset. When investments are done for infrastructure asset investment, political, social and environmental and other related risk issues may not be avoided in decision-making. Risk levels were based on five different risk scales namely rare, unlikely, moderate, likely and almost certain and its consequences are classified into five categories namely insignificant, minor, moderate, major and catastrophic. The identification and classification of the risk related issues are as follows. Details of these risks are given in Table A.1

Table A.1: classification of risks and consequences (Australian Defense Organization2002)

Risk Category	Causes	Consequences	Consequence Rating	Likelihood Rating	Risk Rating
Political Risk	Government policy changes, i.e. Taxation, privatisation and competition	Reduced spending on maintenance and trend toward development of only commercially viable infrastructure projects	Major	Unlikely	Significant
Economic Risk	Reduced access to government funds, providing transport infrastructure in key locations, rationalization of industry players as escalating fixed costs lead to smaller margins and intense competition	Reduction in maintenance / development of infrastructure, increased usage charges, reduced efficiency of infrastructure and greater of total funds invested on maintenance rather than new development	Major	Unlikely	Significant
Social/I Environmental / Cultural Risk	Increased demands by society to reduce environmental damage, increase public awareness of life, civil rights issues, expectation of fast service	Greater costs for infrastructure projects may be incurred in order to satisfy environmental, social criteria and constraints	Minor	Almost Certain	Significant
Technology Risk	Increasing reliance on the use to IT and communications to design, operate and manage transport infrastructure and collect revenue	Interdependency results in greater vulnerability to any IT interruption of services	Major	Almost Certain	High

2.5 Distinction between Risk and Uncertainty

As we know that risk is the situation where outcome is unknown to decision maker or that may or may not be realized in the future. An adverse effect is a loss of some sort. A decision maker faces a risk if the outcome of a decision is uncertain and may be adverse. Risk can be fully defined by a set of three things, including:

1) a set of mutually exclusive and collectively exhaustive scenario conditions under which the possible outcomes may be realized, 2) a set of outcomes for each possible scenario, and 3) a probability of occurrence for each possible scenario. Using this definition, risk can be described using a loss exceedance curve in which scenario outcomes involving potential losses are plotted on the x axis and the probability of exceeding those losses is plotted on the y axis. The loss exceedance curve is sometimes called a risk curve.

Figure C: illustrates three risk curves, which could represent the potential losses associated with three decision alternatives (A, B, and C). The y intercept gives the probability that the costs associated with choosing an alternative will exceed the benefits of that alternative. In Figure 2.2, Alternative C entails the largest potential losses.

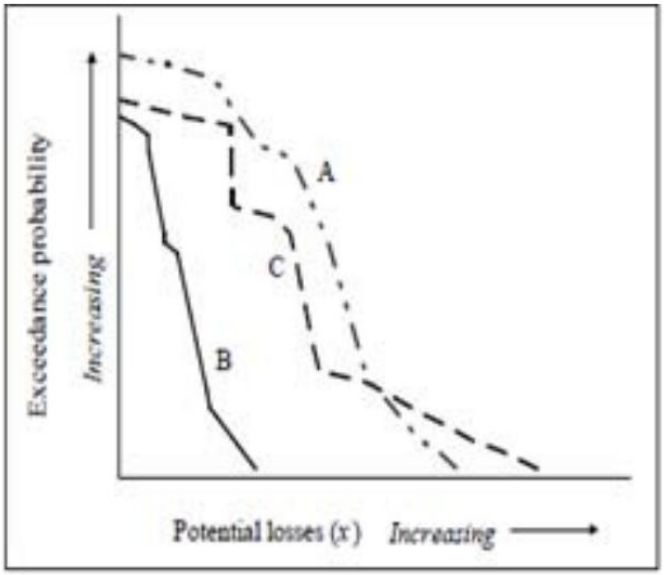

Figure C: Three risk curves

Alternatives A and C are riskier than Alternative B because these alternatives lead to larger losses with higher probabilities. It is important to note that these risk curves by themselves do not provide sufficient information to decision maker to choose among the three alternatives. A decision maker also needs information on the potential benefits of each alternative and their probabilities. An understanding of the decision maker's attitudes toward accepting risks is also important need.

2.5 Risk Assessment Frame Work

Proper assessment and management of risk is necessary and for that a necessary frame work is should be there. This framework includes both quantitative and qualitative risks in the assessment and is shown in Figure D Risk analysis is the quantitative technical assessment and can be estimated by the probability (P) of an event of occurrence over a specified period of time and its related consequences. Risk is a function of the probability of occurrence and the magnitude of consequences (M), R=f (P, M). Public Risk Perception is the measure of public reactions to risk and. Public risk perception can be quantified qualitatively and quantitatively. Perception is a judgment of the degree to which some one likes or dislikes some objects, concepts, projects or persons it means risk perception describes people's feelings about risk. Objective and Subjective data is the behavior data that reflect agreement or opposition to a project introduced.

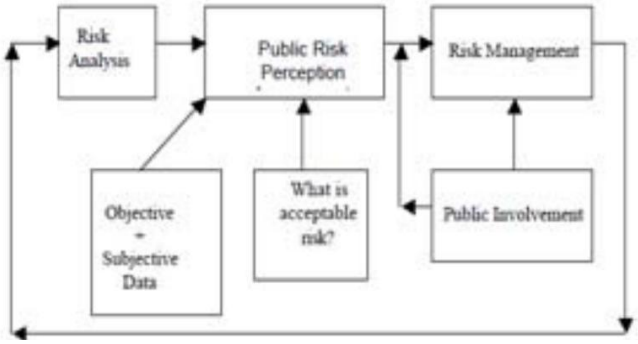

Figure D: Framework for risk assessment

Acceptable risk is the degree of risk to be accepted and in many instances, the public decided which levels of potential risks are acceptable.
Risk Management is the final process to be implemented in the process of risk assessment to ensure that risks are kept at minimum and do not have adverse effects to the public. It is a part of a decision-making process that

entails consideration of political, social, economic, engineering information and cost-benefit with risk related information to develop analyses and compare and make a decision on appropriate solutions.
Figure E step-by-step implementation of risk assessment.

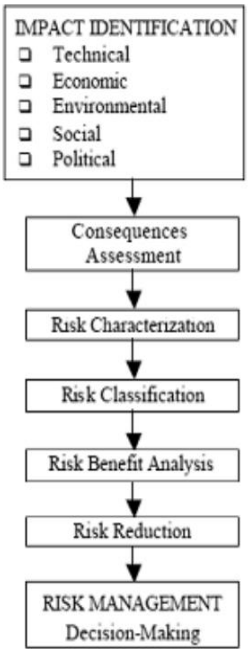

Figure E: Step by step risk assessments

2.6 Rules for Decision under Risk

The decision situations where the decision-maker chooses to consider a several possible outcomes and the probabilities of their occurrence can be stated are called decision under risk. The possibilities of various outcomes may be determined objectively from the past records. Under condition of risk there are generally two criteria to choose from.

2.6.1 Maximum Likelihood Principle

Under this principle, the decision-maker first considers the event that is most likely to occur. He then decides for the course of action which has the maximum conditional payoff, corresponding to this event (of course, when the pay-off matrix is in terms of costs, then the action with the least conditional pay-off would be chosen.)

2.6.2 Expectation Principle

In this principle, the decision-making is done on the basis of the expectation principle when there is a risky situation. With the event probabilities assigned, objectively or subjectively as the case may be, the expected pay-off for each strategy is calculated by multiplying the pay-off values with their respective probabilities and then adding up these products.

2.7 Rules for Decision under Uncertainty

A situations where there is no way in which the decision maker can assess the probabilities of the various states of nature are called decision under uncertainty. The several principles which may be employed for taking decision in such condition are as follows.

2.7.1 Laplace principal

The Laplace principle is based on the simple philosophy that if we are uncertain about the various events then we may treat them as equally probable. Under this assumption, the expected (mean) value of pay-off for each

strategy is determined and the strategy with highest mean value is adopted. Of course, if the pay-off are in terms of costs, we choose the strategy with the lowest average cost.

2.7.2 Maximin or Minimax Principle

This principle is adopted by pessimistic decision-maker who are conservative in their approach. Using this principle, the minimum pay-offs resulting from adoption of various strategies are considered and among these values the maximum one is selected. It involves, therefore, choosing the maximum profit from the set of worst or the minimum profits. **2.7.3 Maximax or Minimum Principle**
The Maximax principle is optimist's principle of choice. This principle suggests that for each strategy, the maximum profit should be considered and the strategy with which the highest of these values is associated should be chosen. The optimist obviously desires a chance for the maximum pay-off in the decision matrix.

2.7.4 Hurwicz Principle

The Hurwicz principle of decision-making stipulates that a decision-maker's view may fall somewhere between the extreme pessimism of the maximin principle and the extreme optimism of the maximax principle. This principle provides a mechanism by which different levels of optimism and pessimism may be shown. For this, an index of optimism, α, is defined on scale ranging from 0 to 1. An $\alpha = 0$ indicates extreme pessimism while $\alpha = 1$ represents extreme optimism.

2.7.5 Savage Principle

The savage principle is based on the concept of regret and calls for selecting the course of action that minimizes the maximum regret. It is alternatively known as the principle of minimax regret. The regret matrix is derived from the pay off matrix then the maximum regret value corresponding of each of the strategies is determined and the strategy which minimizes the maximum regret is chosen.

3.Conclusions

This paper is an attempt to highlight the information, methods of decision making under risk and uncertainty associated with residential township project. From the study the important points observed are as follows.

I. The words "risk" and "uncertainty" emphasize that the decision-making must be made on the basis of incomplete information and the outcome is unknown to decisionmaker.
II. As we know township is a large scale development to create a self-sustaining neighborhoods within it and it offers lifestyle advantages, but have certain limitations or risks such as the problems related to land acquisition and the long list of approvals that are required slow the pace of development. Construction period of township project is also large and might delayed due to funding or regulatory issues.
III. A risk management framework needs to be formulated to minimize or eliminate adverse consequences that may arise.
IV. In the most of countries decision making scenarios i.e. different possibilities are adopted for a project development. To avoid risky situation decisions should be made after the proper investigation.

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