



## SOME DECISION-MAKING PROBLEMS UNDER UNCERTAINTY ENVIRONMENT

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**Abstract:** *Scientific decision making process is by following systematic, logical reasoning of the understanding of the problem and to arrive at the best possible decision. It can be achieved by observation, investigation and analysis if data.*

*Key words: Decision Making, Pay off, Uncertainty, Maximin Principle.*

### Introduction:

The Managerial activity of management are Planning, organization, direction, supervision and control. While performing these activities the management has to choose a best choice among the number of alternative sources available to them.

The making of choice is known a decision making. It may be defined as a process which decides the selection from a set of alternative course of action, which is considered to achieve the objective of decision problem by the executive of management.

Scientific decision-making process is by following systematic, logical reasoning of the understanding of the problem and to arrive at the best possible decision. It can be achieved by observation, investigation and analysis if data. There are various stages in decision making:

- Understanding the need and opportunity for decision on a problem
- Objective of the solution of the problem
- Collection of suitable information relating to the given problem
- Evaluation of alternative courses of action
- Selection of the bet course of action

### Process of Decision Making:

The decision problem understudy represented by the following

**1. Decision Maker:** The decision maker may be an individual or a group of individuals is responsible for making decision on selection of one choice among the set of possible courses of action.

**2. States of Nature or Outcomes:** The uncontrollable occurrences are called states of Nature or Outcomes and their existence create difficulties and interest in decision making under these circumstances. The decision maker has no control over the outcomes and he can identify the probability of its occurrence of each of these events. The States of Nature or Outcomes are denoted by  $S_1, S_2, \dots, S_n$ .

**3. Payoff:** Each combination of a course of action and state of nature is associated with payoff which gives the net benefit to the decision maker. These are also known as Conditional profit values or Conditional economic consequences. The various payoff elements are summarized in a table which is known as Payoff table. If there are 'n' States of Nature represented by  $S_1, S_2, \dots, S_n$  and 'm' courses of action by  $A_1, A_2, \dots, A_m$ .

Then the Payoff table is as follows:

State of Nature	Courses of action			
	A1	A2	-----	Am
S1	P11	P12	-----	P1m
S2	P21	P22	-----	P2m
S3	P31	P32	-----	
:			-----	
Sn	Pn1	Pn2	-----	Pnm

Here  $p_{11}$  is the payoff resulting from the combination  $i$ th element and  $j$ th action. In general the payoffs are measured in terms of monetary events. The larger the payoff the more desirable is the strategy to the decision maker.

**Payoff = Sales Revenue from estimated demand – total variable cost – fixed cost**

**4. Opportunity Loss or Regret:** The opportunity loss is the loss incurred because of failure to take the best possible action. These opportunity losses are calculated separately for each state of nature that might occur.

Consider a Fixed state of Nature  $S_i$ , the payoffs corresponding to the ‘n’ strategies are given by  $p_{i1}, p_{i2}, p_{i3}, \dots, p_{in}$ . Let  $M_i$  be the maximum of these quantities. Then A1 is used by the decision maker then there is a loss of opportunity  $M_i - p_{i1}$  and so on. The opportunity loss can be obtained in the following table which is known as a Regret Table

**OPPORTUNITY LOSS/REGRET TABLE**

Outcomes	Conditional Opportunity Loss Alternative Strategies			
	A1	A2	-----	An
S1	(M1-P11)	.	-----	(M1-P1n)
S2	(M2-P21)		-----	(M2-P2n)
S3	(M3-P31)		-----	(M3-P3n)
:	:		-----	:
Sn	(Mn-Pm1)		-----	(Mn-Pmn)

**Various steps in solution:**

**Step 1:** Take the highest possible profit of an event

**Step 2:** Take the actual profit obtained from actual action

Step 3: Obtain the opportunity loss on regret by following rule

$$\text{Opportunity loss} = \text{Value of Step 1} - \text{Value of Step 2}$$

**5. Decision Making Environment:** He may have to make decision under different situations which are as follows

**a. Decision under certainty (Deterministic situation):** Whenever there is only one outcome for decision maker, then he has to take that No alternative is available. This situation we can observe in linear Programming Transportation .

**b. Decision under Conflict:** In many situations, we don't have complete knowledge about the states of nature and they are not completely uncertain. We have only partial information about the state of nature hence we are supposed to take decision under Conflict. These situations we can observe in Competitive Game theory

**c. Decision under Risk :** In some situations, the decision maker has to make decisions from

various possible outcomes based on the past data with some probability associated with it.

**d. Decision under Uncertainty:** The situation in which we get more than one occurrence possible from a Single decision.

**Decision making under Uncertainties:** Decision making under uncertainty condition, we don't have the probability of occurrence in each state of Nature. We have only payoffs. In this situation the decision maker has to elect first a criteria and compare the alternative choices with the taken criteria for the best. We have different criterion for decision making under this category. Some of them are :

- Laplace Criterion
- Maximum or Minimum Criterion
- Maxmini or Minimax Criterion

**Laplace Criterion:** Under this situation of Uncertainty, when there is no knowledge about the probability of occurrence of each state of nature, it is assumed that the probabilities of occurrence of each state of nature is same. The decision maker will find out the expected payoffs of all the strategies. After this the strategies which maximizes the expected payoffs is chosen.

The basic steps of this Criterion may be as follows:

Step 1: Assign equal probabilities (1/n) to each payoff of a strategies having 'n' payoffs.

Step 2: Determine the expected payoff value for each alternative

Step 3: Select the alternative which corresponds to the maximum of the expected payoffs.

**PROBLEM:** A business organization must decide on the level of supplies it must stock to the needs of its customers in festival days. The exact number of customer is not known but it is expected to be in one of the four categories-300,350, 400 and 450 customers. Four levels of supplies are thus suggested with the level J being ideal ( from the view point of incurred cost ) if the number of customers falls in J category, Deviations from the ideal levels results in additional cost either because extra supplies or stocked needlessly or because demand cannot be satisfied . The table below provides these costs in thousands of rupees.

Supplier level				
Customer category	A1	A2	A3	A4
E1	7	12	20	27
E2	10	9	10	25
E3	23	20	14	23
E4	32	24	21	17

**SOL :** As per Laplace criterion it is assumed that E1, E2, E3 and E4 are equally likely.

As per Step 1 we assign equal probabilities 1/4 to each payoff of a strategy. Therefore the associated probabilities are given by P(E1) = P(E2) = P(E3) = P(E4) = 1/4

Step 2: The expected costs due to deviations from the best level for different categories of customers are

$$E(A1)=1/4 *(7+10+23+38)= 72/4 =18$$

$$E(A2)=1/4 *(12+9+20+24) =65/4 =16.25$$

$$E(A3)=1/4 *(20+10+14+21)= 65/4 = 16.25$$

$$E(A4)= 1/4 *(27+25+23+17) =98/4 =23$$

Hence the best level of inventory is specified by supply level A2 or A3.

**2. Maximin or Minimax Criterion:** The Maximum or Minimum criterion is based on the assumption that the worst possible is going to happen. Then the decision makers observe each strategy and locate the minimum payoff for each and then selects that alternative which maximizes the minimum payoffs.

The Basic steps of this Criterion are as follows:

Step 1: Determine the minimum expected payoff for each alternative

**PROBLEM:** A business man has 3 alternatives open to him each of which can be followed by way of the 4 possible events . The conditional payoff (in rupees) for each action event combination are given below

Alternatives	Payoff conditional events			
	A	B	C	D
X	8	0	-10	6
Y	-4	12	18	-2
Z	14	16	0	8

Determine which alternative should the businessman choose if he adopts the maximin criteria

Sol: For the give payoff matrix , the minimum assured payoff for each alternative are

$$X \rightarrow -10$$

$$Y \rightarrow -4$$

$$Z \rightarrow 0$$

Since the maximum of these minimum payoffs is 0 ,The alternative Z is selected according to maximin principle.

The maximum payoff associated with the different strategies are

$$X \rightarrow 8$$

$$Y \rightarrow 18$$

$$Z \rightarrow 14$$

The Highest payoff is 18. The strategy Y I selected corresponding to the maximum principle

When dealing with the costs, In this context the criterion used in the Minimum Criterion and it is as follows

Step 1: Determine the Maximum possible cost in each alternative

Step 2: Choose that alternative which corresponds to the minimum of the above cos.

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E4	32	24	21	17

Sol: Since the payoff numbers designate the cost we use the minimum criterion . The maximum possible costs for each alternatives are

$$A1 \rightarrow 32$$

$$A2 \rightarrow 24$$

$$A3 \rightarrow 21$$

$$A4 \rightarrow 27$$

Since the minimum of these costs is 21 So A3 is chosen.

**3. Maximax or Minimin Criterion:** In this the decision maker selects that particular strategy

which corresponds to the maximum of maximum payoff for each strategy. This method consists the following steps:

Step 1: Determine the maximum possible payoff for each alternative

Step 2: Select the alternative which corresponds to the maximum of the maximum payoffs.

**PROBLEM:** A business man has 3 alternatives open to him each of which can be followed by way of the 4 possible events . The conditional payoff (in rupees) for each action event combination are given below

Alternatives	Payoff conditional events			
	A	B	C	D
X	8	0	-10	6
Y	-4	12	18	-2
Z	14	16	0	8

Determine which alternative should the businessman choose if he adopts the maxmimum criteria

**Solution:**

The maximum payoff associated with the different strategies are

$$X \rightarrow 8$$

$$Y \rightarrow 18$$

$$Z \rightarrow 14$$

The Highest payoff is 18. The strategy Y I selected corresponding to the maximum principle

In decision problems, dealing with costs, the minimum for each alternative is considered and then the alternatives which minimizes the above

minimum costs is selected. This is termed as minimin principle.

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