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Applications of Decision Theory in Real Life and Business Statistics Problems

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ABSTRACT

The Success or failure for any individual organization experiences depends to large extent on the ability of making positive and acceptable decisions at right time. To obtain such decision in result oriented approach different components of Decision Theory provides the direction to finalize the correct approach in Tree method. We can easily identify the problem and also the events and courses of action available to the decision maker. Provides the proper Payoff matrix through Decision Theory. We will compute the optimum stock to minimize expected cost using decision theory and tree method. It also provides the Under certainty and decision making under risk factors. Decision making under certainty and decision making under uncertainty will also decided in this study of manuscript. Maximax or Minimin Criterion, Pessimism Criterion as Maximin or Minimax also evaluated through Decision Theory approach. The entire Research Manuscript provides the Significance Decision Theory. We can understand the complete scope of Decision Theory in real life problems, we can understand the marginal analysis can solve the uncertainty problems, It also explains the Decision Tree approach in graphic representation of the decision process indicating decision alternatives.

KEYWORDS: *Certainty, Criterion, Decision, Payoff matrix, maximax, minimin, Pessimism, Tree method*

INTRODUCTION

Older days scientific aids to business Statistics were used only when dealing with selective situational problems such as inventory control. Recently, however, decision theory has been developed and has been shown to have rather wide application to business management problems. This is wide applicability that has made decision theory so attractive to managers.

With due respect to its complexities the basic of the managerial process is decisionmaking. Decision theory is a tool in Business Statistics written in mathematical terms which represents management process. It is valuable aid to scientific management. It simplifies application and understating. The Success or failure for anyindividual organization experiences depends to large extent on the ability of making positive and acceptable decisions at right time.To declare positive decision making situation,decision-maker needs to enumerate feasible and viable courses of action, the projection of consequences associated with each course of action.

Decision TheoryApproach is both descriptive and prescriptive decision modeling approach to classify the knowledge and expected outcomes due to several courses decisions.

Decision Theory provides a process, which results in the selection of the systematic managerial action from relevant the alternatives.

In terms of Statistical Approach Decision making is the selection of the best alternative.

In Business Decision policy it follows the basic factors such as :

- Explaining the Problem
- Solution of the Problem
- Development of the decision process
- Description of all alternative managerial actions.
- Accurate determination of the environmental situation
- Establishment of the appropriate decision criteria.
- Making the decision

The manager must analyze each problem in terms of each of the characteristics as mentioned above. A solution is always more accessible when the manager has a more through understanding of the problem which he conform.

DECISION MAKING OBJECTIVES

Decision theory explains that the human decision maker brings to the resolution of a decision problem beliefs and preferences. Specifically, the theory presumes that the decision maker possesses a probability system that captures his or her beliefs about natures selection of states, a belief system about the outcomes.

Decision Making is two stage process.In first stage action in A are ordered and second the best act is selected.

Typically, the first step is completed by assigning a serial number, and then using the complete ordering properly of the real numbers to order the acts.

Decision rules are composed of two commands. First command provides the knowledge on assigning the order of action and the second command tells the user how to choose among the numbers assigned by the first command.

Decision rules are designed to reflect some human attitude towards decision making.

CHARACTERISTICS OF THE SOLUTION

- The problem situation was characterized as a risk environment and empirical probabilities were used.
- The decision criterion selection was based on a value judgment of long run profit needs, short-run cash needs, firm objectives,etc.
- The decision process was merely a conceptualization of the appropriate relationship between environment and managerial actions.
- If the manager can live with each of the above, then one can safely say that statistical decision theory proved to be of vital importance in determining the best answer.

DECISION MAKING ENVIRONEMNTS

In General Decision making in environment depends on three strategies – mentioned below:

- Only one state of nature exists. It is mandatory to analyses the situation and make good decisions. This strategy is purely depends on conditions of certainty.
- More than one states of nature exist but the decision maker lacks sufficient knowledge to allow him assign probabilities to the various states of nature. This depends under conditions of uncertainty.
- More than one states of nature exist but the decision maker has sufficient information to allow him assign probabilities to each of these states.

Under conditions of uncertainty, the decision maker has knowledge about the states of nature that happen but not on occurrence probability. The unrelavantinformationlead to a more complex decision model and a less satisfactory solution.

The decision under uncertainty, situations exist in which two or more appointments with conflicting objectives try to make decisions with each trying to gain at the cost of the other(s).

These situations are different since the decision maker is working against an intelligent appointment.

MAXIMAX ANDMAXMINCRITERION

Maximax Criterion provdes the decision maker with optimistic criterion.We can find the maximum possible pay off for each possible alternative and then chooses the alternative with maximum pay off with in the given data.

Exampl-1:

Alternatives	Product Demand				Max
	High	Moderate	Low	Nil	
Expand	55000	27500	-27500	-45000	55000

Construct	65000	25000	-40000	-80000	65000
Sub contract	35000	17500	-1000	-10000	35000

The Maximax payoff is Rs.65000.

Maximin Criterion provides the decision maker with pessimistic criterion. In this criterion, the decision maker maximizes his minimum possible pay offs. We can find minimum possible pay off for each laternative and then chooses the alternative with maximum payoff within this group.

Example-2:

Alternatives	Product Demand				Min
	High	Moderate	Low	Nil	
Expand	55000	27500	-27500	-45000	-45000
Consruct	65000	25000	-40000	-80000	-80000
Sub contract	35000	17500	-1000	-10000	-10000

The maximum payoff to the company as obtained in the table isRs. 10000/-

MINIMAX REGRET CRITERION

In this method the decision maker might experience regret after the decision has been made and the states of nature. The decision maker must attempt minimize regret before selecting a particular alternative strategy.

Exampl-3:

Alternatives	Product Demand				Max
	High	Moderate	Low	Nil	
Expand	10000	5000	24000	15000	24000
Construct	0	0	39000	65000	65000
Sub contract	30000	5000	0	0	30000

Amount of regrets are represented . Company will minimize tis regret to Rs. 24000/- by selecting alternative expand.

CRITERION OF RATIONALITY

In criterion of rationality we can observe that equal probabilities to all the events of each alternative decision and selects the alternative associated with the maximum expected pay off in given decision problem. The Expected value of strategy is

= (1/n) [P1+P2+P3+....+Pn].

Example-4:

Alternatives	Product Demand				Exp. Pay Off
	High	Moderate	Low	Nil	
Expand	55000	27500	-27500	-45000	2500
Construct	65000	25000	-40000	-80000	-7500
Sub contract	35000	17500	-1000	-10000	10375

The alternative sub contract results in maximum average pay off of Rs.10375/- .

Example-5:

The following matrix gives the pay off of different strategies S_1 to S_3against eventsN_i for I = 1,2,3,4.

Using the table values indicate the decision taken under the following conditions

a) Pessimistic b) Optimistic

c) Regret and d) Equal probability

	N_1	N_2	N_3	N_4
S_1	4000	- 100	6000	18000
S_2	20000	5000	400	0
S_3	20000	15000	- 2000	1000

Sol:-

	Pessimistic (Maxmin value)	Optimistic(Maximax value)	Equal Probability Value
S1	-100	18000	6975
S2	0	20000	6350
S3	- 2000	20000	8500

S1 = (1/4) [4000 – 100 +6000+18000] = Rs.6975.

S2 = (1/4) [20000 +5000 +400+0] = Rs.6350.

S3 = (1/4) [20000+15000-2000+1000] = Rs.8500.

If we Consider a situation called pessimistic approach then S_2 is the optimal decision, under optimistic approach. S_2 or S_3 are the alternativechoices and under equal probabilities approach and S_3 is the alternative for further selection.

The following Simplified table represents the regret for every event and for each alternative calculated by the expression.

i^{th} regret can be computed using

=(maximum pay off X i^{th} pay off) for the jth event.

	N_1 Regret	N_2 Regret	N_3 Regret	N_4 Regret	Maximum Regret
S1	16000	15100	0	0	16000
S2	0	10000	5600	18000	18000
S3	0	0	8000	17000	17000

The decision alternative S_1 would be Selected.

DECISION UNDER CONDITIONS OF RISK

Majority of Business decisions are under the Risk factor unless we take proper decision in critical strategies. These probabilities could be obtained from the pre recordeddata orpre recorded judgments of the decision maker.

The criterion requires the computation of the expected value of each decision alternative which is the total of the weighted payoffs.

Construct a payoff table listing the alternative decisions and the various stats of nature. Consider the conditional probabilities along with the other decision out comes.

Calculate the EMV for each decision by multiplying the conditional profits by given probabilities and adding the outcomes. From the table after computation Choose the best alternative that yields the highest EMV.

Example-6 :

A merchant has the following probabilities of selling a product. Cost of the product is 250 paisa and sale price is 300 paisa. He cannot return unsold product. How many products should be order ?

No.of Products Sold	Probability
10	0.10
11	0.15
12	0.20
13	0.25
14	0.30
TOTAL	1.00

Sol:-

The No. of products for purchases and for sales which have meaning to the merchant are 10,11,12,13 and 14. These are his sales magnitudes.

There is no reason for him to buy less than 10 or more than 14 products. The conditional profit table below shows the profit resulting from any possible combination of supply and demand.

Conditional Profit Table (paisa)						
Demand	Prob.	QTY 10	QTY 11	QTY 12	QTY 13	QTY 14
10	0.10	500	470	440	410	380
11	0.15	500	552	520	490	460
12	0.20	500	550	600	570	540
13	0.25	500	550	600	650	620
14	0.30	500	552	600	650	700

Stocking of 10 products each day will always result in a profit of 500 paise irrespective of the demand. For instance, even if the demand on some day is 13 products, he can sell only 10 and hence his conditional profit is 500 paisa.

When he stocks 11 copies, his profit will be 550 paisa on days when buyers request 11,12,13 or 14 products. But one days when he has 11 products on stock and buyers buy only 10 products,his profit decreases to 470 paisa.

The profit of 500 paisa on the 10 products sold must be reduced by 30 paisa, the cost of one copy left unsold.

The profit of 500 paisa on the 10 products sold must be reduced by 30 paisa, the cost of one product left unsold. The same will be true when he stocks 12,13 or 14 products.

The ConditionalProfit Pay off :

= 50 * Products sold – 30 * Product unsold.

Each decision alternative is obtained by multiplying its conditional profit by the corresponding probability and adding the outcome values.

Expected Profit Table (paisa)						
Demand	Prob.	QTY 10	QTY 11	QTY 12	QTY 13	QTY 14
10	0.10	50	47	44	41	38
11	0.15	75	8205	78	73.5	69
12	0.20	100	110	120	114	108
13	0.25	125	137.5	150	162.5	155
14	0.30	150	165	180	195	210
Total Profit		500	542	572	586	580

The merchant must, therefore order 13 products to earn the highest possible average daily profit of 586 paisa. There is no guarantee that he will make a profit of 586 paisa next day. If he stocks 13 products each day under the condition given, he will have average profit of 586 paisa per day.

MARGINAL ANALYSIS DECISION

In any decision making problems, the use of conditional profit and expected profit tables would be quite cumbersome because of the large number of communications required. The expected marginal profit in the given problem and selling an additional unit in stock is the marginal profit of the unit multiplied by the probability. i.e, P(MP)

The expected marginal loss from stocking and not selling an additional unit is the marginal loss incurred if the unit remains unsold multiplied by the probability that the unit would not be sold that is (1-P)(ML).

(1-P)(ML) = P(MP)

Example-7 :

A shop keeper buys product at Rs.2/- and sells for R.2.50. Unsold product has to be thrown away. Daily demand distribution is given in the below table.Assuming that day to day demand is independent and no where it is depends on previous days demand in such conditions how many products should be ordered every day ?

Demand	46	48	50	52	54
Probability	0.01	0.03	0.06	0.10	0.20
Demand	56	58	60	62	64
Probability	0.25	0.15	0.10	0.05	0.05

Sol:- MP = (2.50 – 2.00) = 0.50

ML = Rs. 2.00

The shopkeeper should stock additional quantity products so long as the probability of selling at least an additional product is greater than P where,

P = [ML / (MP + ML)] = 0.80

∴ There must be at last 0.80 cumulative probability of selling that unit.

Sales	Probability	Cumulative Probability level
46	0.01	1.00
48	0.03	0.99
50	0.06	0.96
52	0.10	0.90
54	0.20	0.80
56	0.25	0.60
58	0.15	0.35
60	0.10	0.20
62	0.05	0.10
64	0.05	0.05

Expected marginal Profit P = 0.8

P(MP) = 0.80 * 0.50 = 0.40

Expected marginal Loss

= (1-P)(ML) = 0.2*2.0 = 0.40

For 56 quantity of stock level expected marginal loss will be more than expected marginal gain.

DECISION TREE

Graphical representation of the decision process indicting decision alternatives, probabilities attached to the states of nature and conditional benefits and losses, is known as Decision Tree. It consists of network of nodes and branches. Nodes

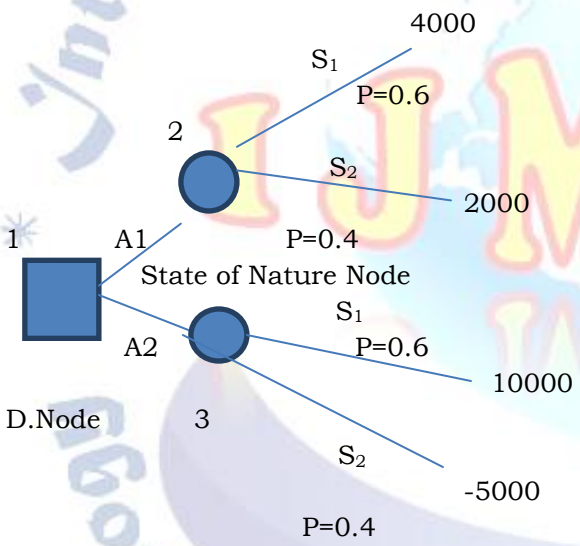
are used in graphical representation for easy understanding and decision process.

The respective pay offs and the probabilities associated with alternative courses and events are shown these branches. At the terminal of the chance branches are shown the expected values of the out come.

Example-8:

CONDITIONAL PROFITS			
States of Nature	Probability	Alternative actions	
		A1-25 Units	A2=75 Units
S1:High Demand	0.6	4000	10000
S2: Low Demand	0.4	2000	-5000

Consider the Decision Tree :



EMV for decision alternative A(node 2) is

= Rs. (4000*0.3 + 2000*0.4) = Rs.3200/-

Decision trees are useful for easy representation of data relation and multi-dimensional aspects of a given decision making problem.

The following are the major steps in Decision Tree:

- Identify the decision points and the alternative courses of action at each decision point systematically.
- At each decision point determine the probability and the payoff associated with each course of action.
- Commencing from the extreme right end, compute the expected payoffs (EMV) for each course of action.
- Choose the course of action that yield the best payoff for teach of the decision.
- Proceed backwards to the next stage of decision points.
- Repeat above steps till the first decision point is reached.
- Finally, identify the courses of action to the adopted from the beginning to the end under different possible outcomes for the situation as a whole.

Advantages :

- It structures the decision process and helps making in an orderly, systematic and sequential manner.
- It requires the decision maker to examine all possible out comes, whether desirable or undesirable.
- It communicates the decision making process to others in an easy and clear manner, illustrating each assumption about the future.
- It displays the logical relationship between the parts of a complex decision and identifies the time sequence in which various actions and subsequent events would occur.
- It is especially useful in situations where in the initial decision and its out come affects the subsequent decisions.

Limitations of Decisions Tree Method :

- Decision tree diagrams become more complicated as the number of decisionalternatives increases and more variables are introduced.
- It becomes highly risk factor when interdependent alternatives and dependent variables are given in the problem.
- It assumes that utility of money is linear with money.
- It analyses the problem in terms of expected values and thus yields an average valued solution.
- There is often inconsistency is assigning probabilities for different events.

CONCLUSION

Business or Quantitative Statistical decision theory is applicable to decision making illustrations within an environment of uncertainty. The Quantitative Decision Theory process leads the decision maker if the given parameters/facts

are favorable to the data sources. These value judgments must be made in light of a through understanding of the problem. Decision theory explains that the human decision maker brings to the resolution of a decision problem beliefs and preferences. Specifically, the theory presumes that the decision maker possesses a probability system that captures his or her beliefs about natures selection of states, a belief system about the outcomes. Graphical representation of the decision process indicting decision alternatives, probabilities attached to the states of nature and conditional benefits and losses, is known as Decision Tree. It consists of network of nodes and branches. Nodes are used in graphical representation for easy understanding and decision process.

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