Welcome

HUT 310 Management for Engineers

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Module III-Topics

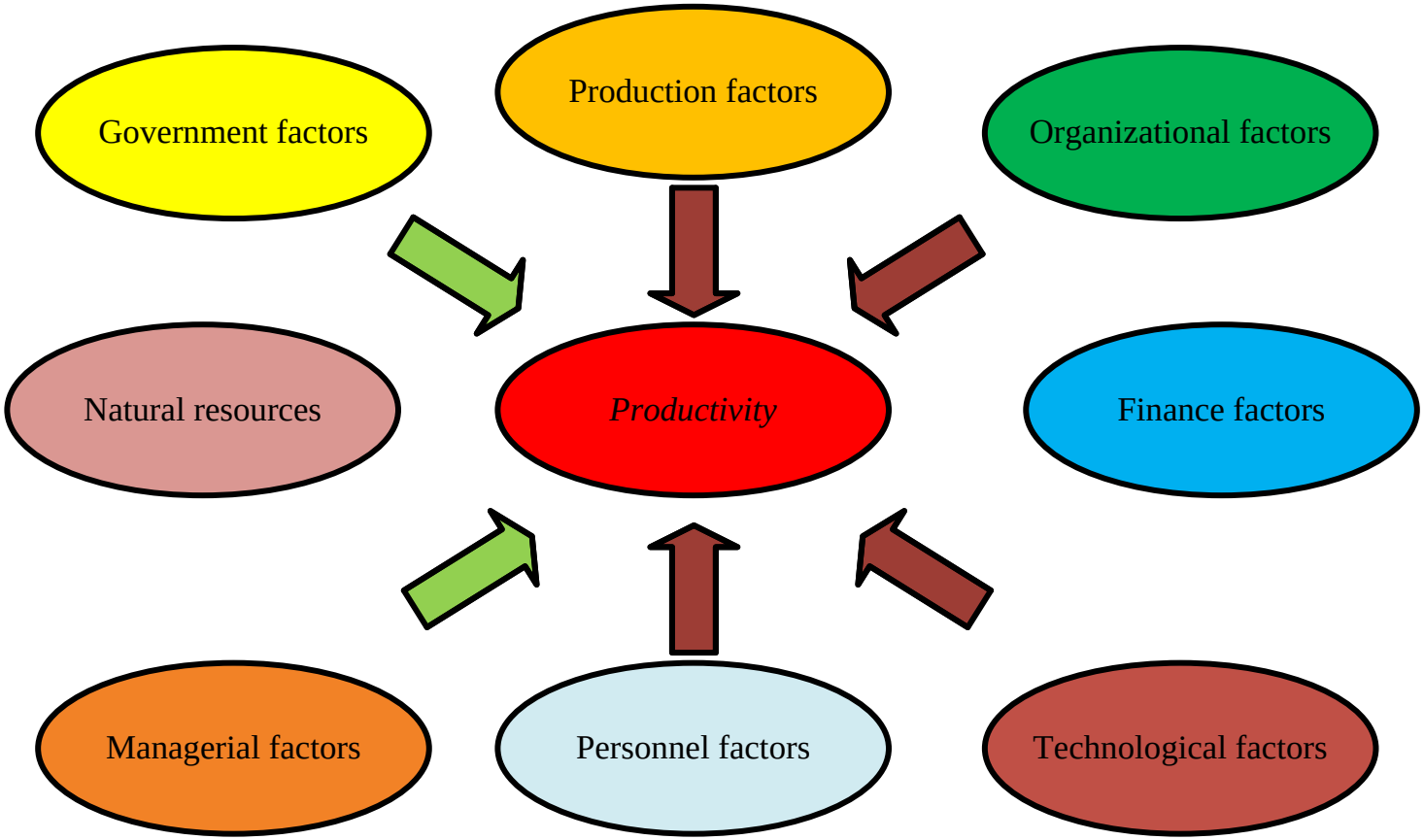
1. Concept of productivity and its measurement
2. Competitiveness
3. Decision making process
4. Decision making under certainty
5. Risk and uncertainty
6. Decision trees
7. Models of decision making

Productivity

- ***Production*** is the manufacturing of desired products with the help of inputs (raw material and utilities), machines, method, and manpower.
- ***Production*** refers to the quantity of the product.
- ***Productivity*** is the manufacturing of desired products with the optimal utilization of inputs(raw material and utilities), machines, method, and manpower.
- Productivity is the ***efficiency of production***.
- Productivity can be defined as the ratio between output and input.

$$Productivity = \frac{Output}{Input}$$

Factors affecting productivity



Factors affecting productivity

Factors affecting productivity can be classified into :-

1. ***Controllable factors***
2. ***Non-controllable factors***

Measurement of productivity

1. ***Single factor productivity***
2. ***Multifactor productivity***,
3. ***Total productivity*** and
4. ***Total Factor productivity***.

Single factor productivity

- Comparison of output with all the input factors (like labour, material, machinery, etc.) taken together is called ***total productivity index***
- Comparison of output with any one of the input factors keeping other factors constant is called ***partial productivity index***.
- *Partial productivity index* is expressed as follows.

$$\textbf{\textit{Single factor productivity}} = \frac{\textbf{\textit{Total output}}}{\textbf{\textit{Individual input}}}$$

$$Capital\ productivity = \frac{Total\ output}{Capital\ input(capital\ employed)}$$

$$Labour\ productivity = \frac{Total\ output}{Labour\ input\ (expenditure\ on\ labour)}$$

$$Material\ productivity = \frac{Total\ output}{Material\ input(cost\ of\ material)}$$

Multifactor Productivity

- A multifactor productivity measure utilizes more than a single factor, for example, both labor and capital.
- The different factors must be measured in the same units, for example dollars or standard *hours*.
- Multifactor productivity measures reflect output per unit of some combined set of inputs.

Total productivity

- Total productivity is defined as the ratio of total output to the sum of all input factors

$$\textit{Total productivity} = \frac{\textit{Total output}}{\textit{Total input}}$$

Total Factor Productivity

- ***Total factor productivity*** can be defined as the ratio of net output to the sum of associated labour and capital (factor) inputs.

$$\textit{Total Factor Productivity}\ (TFP) = \frac{\textit{Net output}}{(\textit{Labour} + \textit{Capital})\ \textit{input}}$$

Net Output = Total Output - Intermediate goods or services purchased

Difficulties or Problems in measuring productivity

1. ***Difficulty in measuring inputs***
2. ***Difficulty in measuring output***
3. ***Factorial productivity***
4. ***Changing conditions Service sector***
5. ***Different periods***
6. ***Difficulty in measuring man-hours***
7. ***Technological change***

Problems on Productivity

1. A company produces 160 *kg* of plastic molded parts of acceptable quality by consuming 200 *kg* of raw materials for a particular period. For the next period, the output is doubled (320 *kg*) by consuming 420 *kg* of raw material and for the third period, the output is increased to 400 *kg* by consuming 400 *kg* of raw material.

Solution :

During the first year, production is 160 kg

$$Productivity = \frac{Output}{Input} = \frac{160}{200} = 0.8 = 80\%$$

For the second year, production is increased by 100%

$$Productivity = \frac{Output}{Input} = \frac{320}{420} = 0.76 \text{ or } 76\% \downarrow$$

For the third period, production is increased by 150%

$$Productivity = \frac{Output}{Input} = \frac{400}{400} = 1.0 = 100\% \uparrow$$

Problems on Productivity

2. At Modem Lumber Company, Kishore the president and a producer of an apple crates sold to growers, has been able, with his current equipment, to produce 240 crates per 100 logs. He currently purchases 100 logs per day, and each log requires 3 labour *hours* to process. He believes that he can hire a professional buyer who can buy a better quality log at the same cost. If this is the case, he can increase his production to 260 crates per 100 logs. His labour *hours* will increase by 8 *hours* per day. What will be the impact on productivity (measured in crates per labour-*hour*) if the buyer is hired? What is the growth in productivity in this case?

Solution :

Labour productivity for the current method:-

$$Productivity = \frac{Output}{Input} = \frac{240 \text{ crates}}{100 \text{ logs} \times 3 \text{ hrs./log}} = 0.8 \text{ crates / labour} - hr$$

The current labour hours is 300 labour *hours*/day. Buying better quality logs will increase the output to 260 crates per 100 logs and increase the labour hours to 308 labour *hours*/day. Labour productivity in this case is calculated as follows.

$$Productivity = \frac{260 \text{ crates}}{(100 \text{ logs} \times 3 \text{ hrs./log}) + 8 \text{ hrs.}} = 0.844 \text{ crates / labour} - hr$$

This means that the labor productivity would increase by 5.5 percent $\left[\left(\frac{0.844 - 0.8}{0.8}\right)\right]$.

Problems on Productivity

3. Long Beach Bank employs three loan officers, each working eight *hours* per day. Each officer processes an average of five loans per day. The bank's payroll cost for the officers is $820 per day, and there is a daily overhead expense of ₹500.

   a) Compute the labor productivity.
   b) Compute the multifactor productivity, using loans per dollar cost as the measure.

Solution :

a) Labor productivity is the ratio of loans to labor-*hours*.

$$\frac{Output(\text{loans})}{Input(\text{Labour } hours)} = \frac{3 \text{ officers} \times 5 \text{ loans/day}}{3 \text{ officers} \times 8 \text{ hours/day}} = 0.625 \; loans \,/\, labour - hour$$

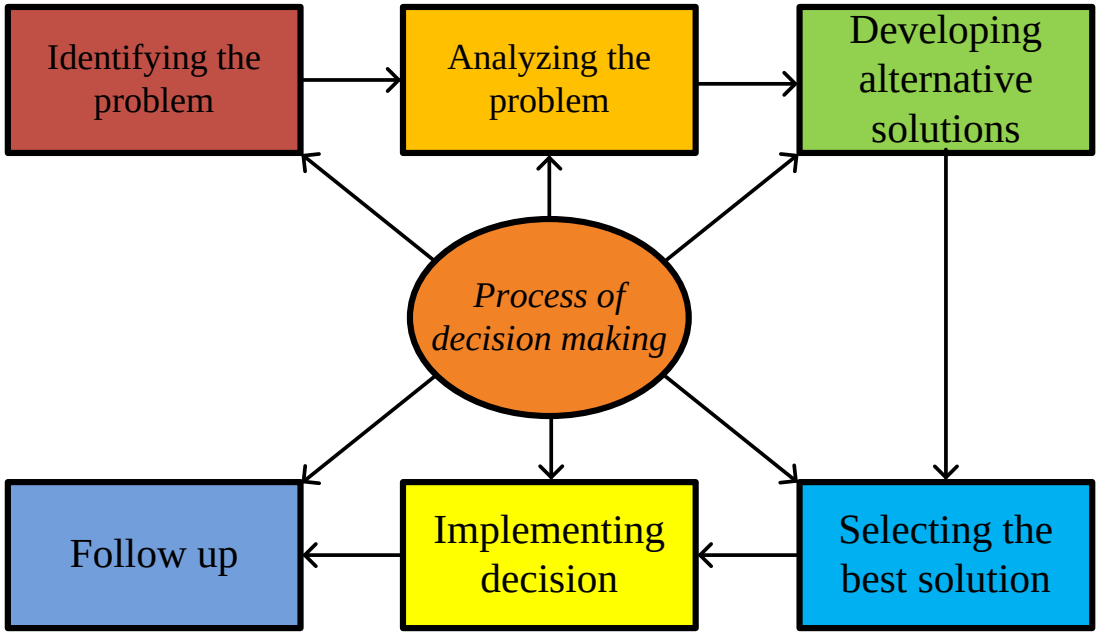
b) Multifactor productivity accounts for both labor cost and overhead.

$$\frac{Output(\text{loans})}{Input(\text{Labour cost} + \text{Overhead})} = \frac{3 \text{ officers} \times 5 \text{ loans/day}}{820 + 500} = 0.0113 \; loans \,/\, dollar$$

Decision making

- *Decision making is a process by which a course of action is consciously chosen from available alternatives for the purpose of achieving desired results.*

Steps in decision making process

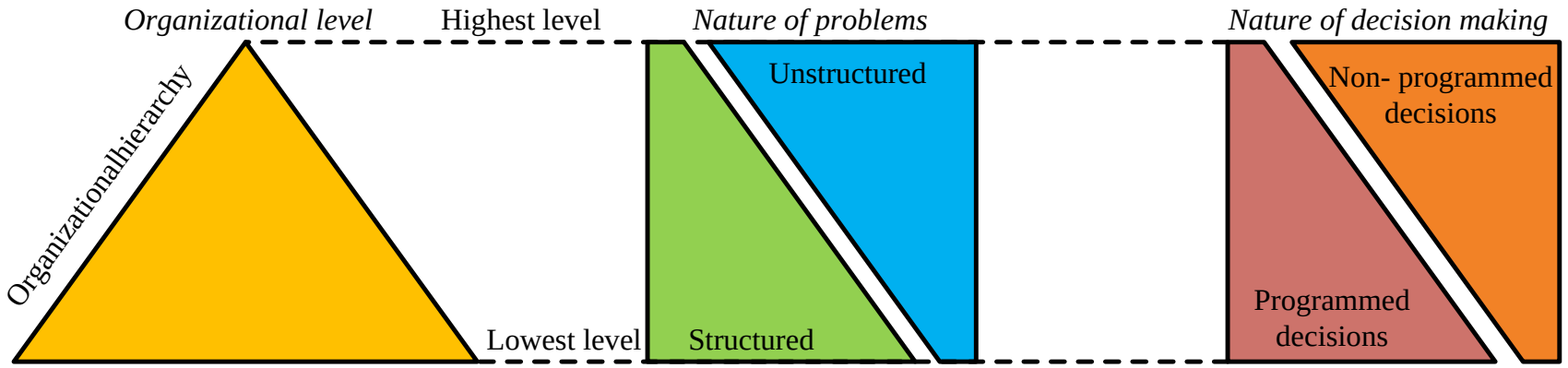


Decision making process

Models of decision making

1. ***Rational decisions*** – The rational decision-making model follow logical steps to find a solution to a problem.
2. ***Intuitive decision model*** – Rather than logical reasoning, the intuitive decision model uses ***feelings and instincts*** to make decisions.
3. ***Recognition-primed decision model*** – This decision model is similar to the intuitive model except that this model is little more structured.

Types of decisions



Nature of problems and decision making in the organizations

1. ***Programmed decisions*** – Decisions following the standard policy, rules or procedures that exist there. These decisions are known as the ***programmed decisions***.

2. ***Non-programmed decisions*** – ***Non-programmed decisions***, on the other hand, are new and non-routine in nature. These decisions are unstructured, non-recurring and ill-defined in nature.

Decision making environments

1. ***Decision making under risk***

   - *Risk refers to a decision-making situation where there are different possible outcomes and the probabilities of these outcomes can be measured in some way.*

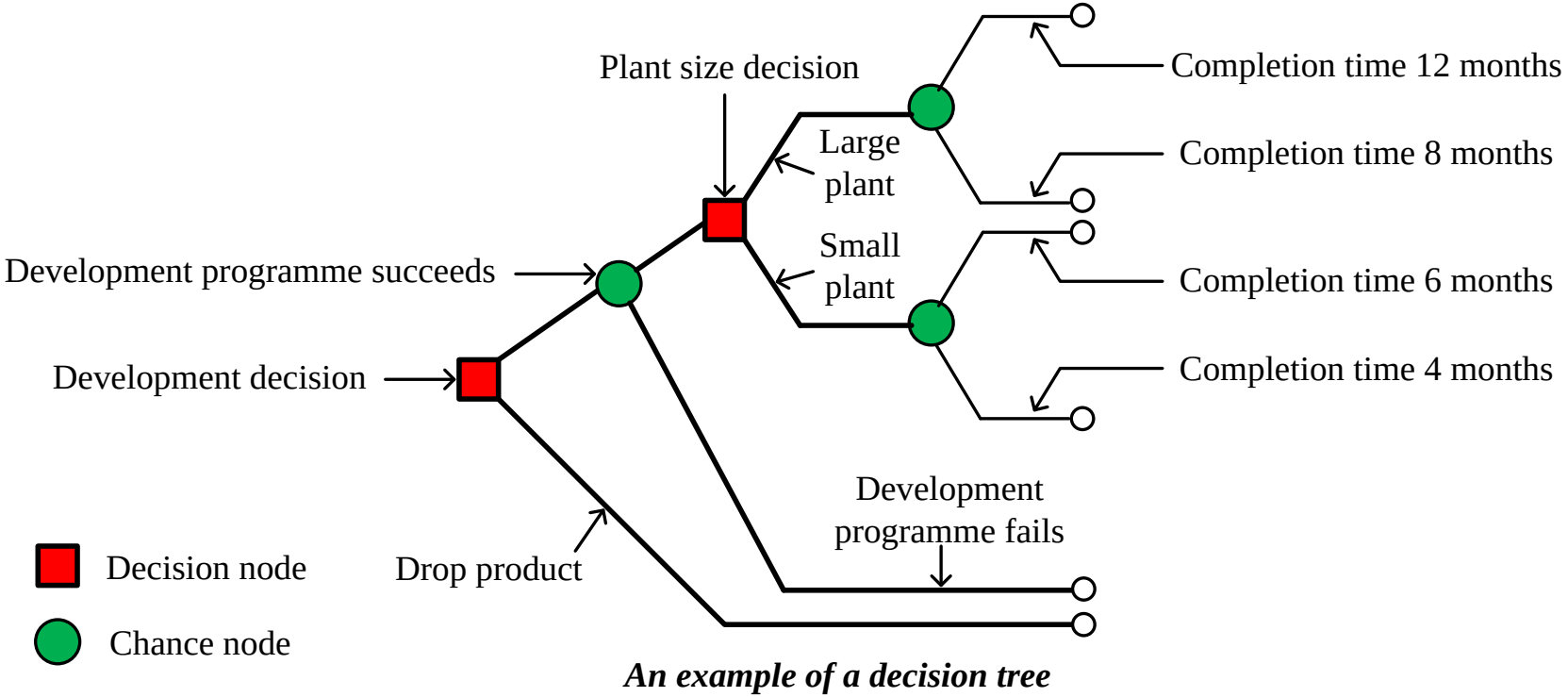
2. ***Decisions making under conditions of certainty***

   - Decision making under certainty implies that we are certain of the future state of nature

3. ***Decision making under conditions of uncertainty***

   - Uncertainty refers to a decision-making situation where there are different possible outcomes and the probabilities of these outcomes cannot be meaningfully measured, sometimes because all possible outcomes cannot be foreseen or specified.

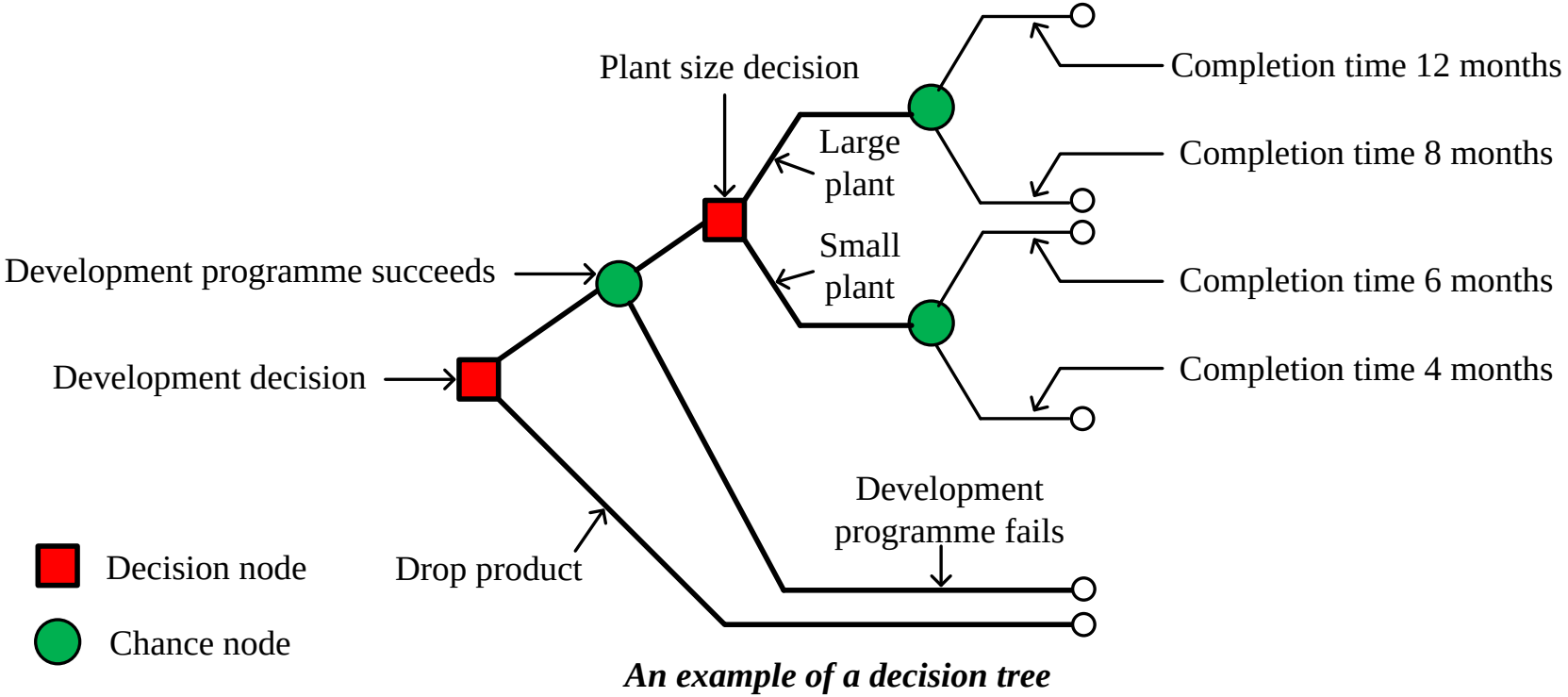
Models of decision making



An example of a decision tree

- A decision tree is a schematic representation of the alternatives available to a decision maker and their possible consequences.
- All decision trees contain ***decision nodes*** and ***state of nature nodes*** (***chance node***). Construction and reading of decision tree is from left to right.

Decision tree analysis



An example of a decision tree

- ***Decision nodes*** (*decision points*) are represented by squares from which one or several alternatives may be chosen.
- ***State-of-nature nodes*** are represented by circles out of which one or more state-of-nature will occur. Branches leaving square nodes represent alternatives; branches leaving circular nodes represent ***chance events*** (i.e., the ***possible states of nature***).

Decision tree analysis -Problems

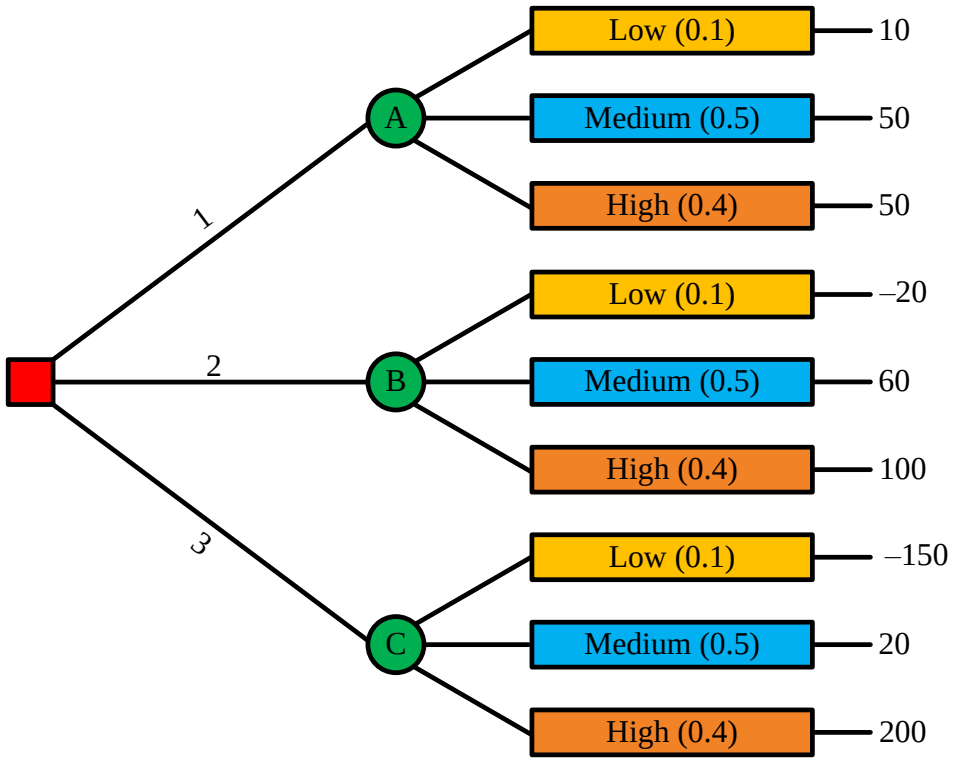
1. A glass firm developing a substantial backlog of orders is considering three courses of action (i) Arrange for subcontracting (ii) Begin overtime production (iii) Construct new facilities. The correct choice depends largely on future demand, which may be low, medium or high. By consensus, management ranks the respective probabilities as 0.10, 0.50 and 0.40. A cost analysis reveals the effect on profits as shown below.

Course of action	Low (P = 0.1)	Medium (P = 0.5)	High (P = 0.4)
1 – Arrange for subcontracting	10	50	50
2 – Begin overtime	– 20	60	100
3 – Construct new facilities	– 150	20	200

Show this decision situation in the form of a decision tree and indicate the most preferred decision and the corresponding expected value.

Decision tree analysis -Problems

Solution :



Expected Monetary Value is calculated for each alternative as below.

EMV of node A = $10 \times 0.1 + 50 \times 0.5 + 50 \times 0.4$ = ₹46

EMV of node B = $-20 \times 0.1 + 60 \times 0.5 + 100 \times 0.4$ = ₹68

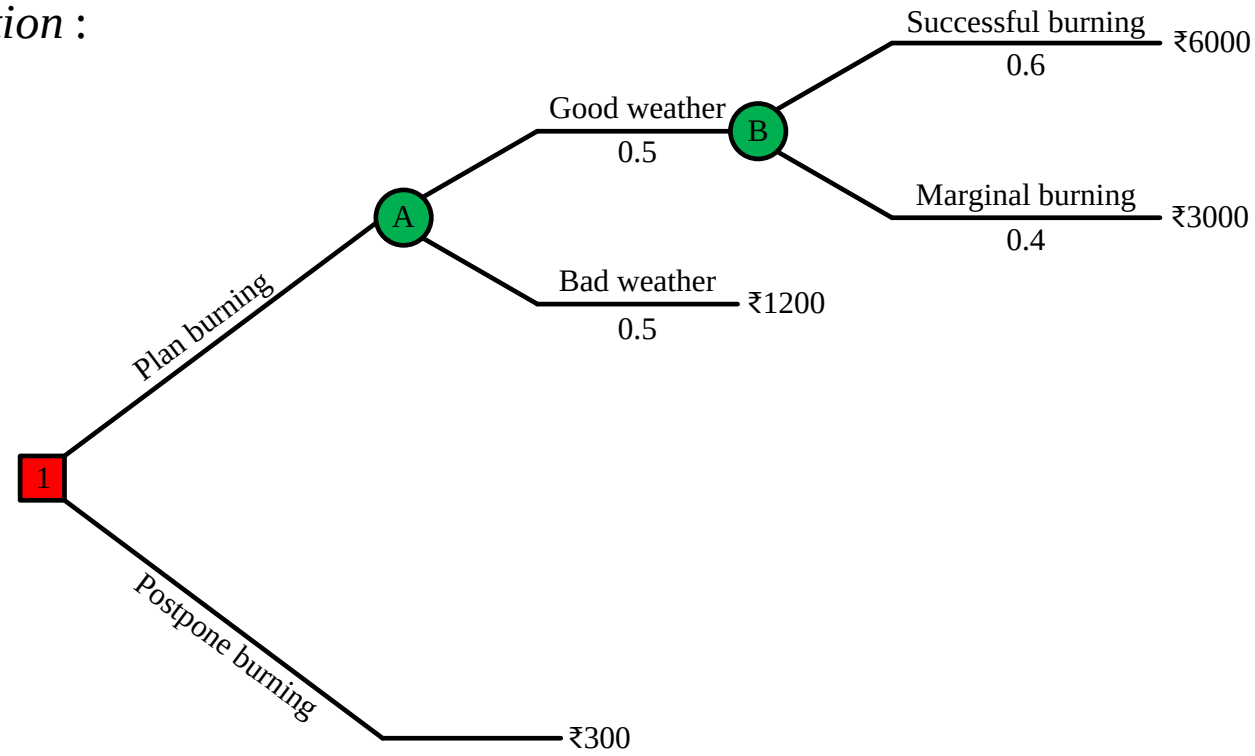
EMV of node C = $-150 \times 0.1 + 20 \times 0.5 + 200 \times 0.4$ = ₹75

Decision tree analysis -Problems

2. Modern forest management uses controlled fires to reduce fire hazards and to stimulate new forest growth. Management has the option to postpone or plan a burning. In a specific forest tract, if burning is postponed, a general administrative cost of ₹300 is incurred. If a controlled burning is planned, there is a 50% chance that good weather will prevail and burning will cost ₹3200. The results of the burning may be either successful with probability 0.6 or marginal with probability 0.4. Successful execution will result in an estimated benefit of ₹6000, and marginal execution will provide only ₹3000 in benefits. If the weather is poor, burning will be cancelled incurring a cost of ₹1200 and no benefit. Develop a decision tree for the problem and analyse the decision tree and determine the optimal course of action.

Decision tree analysis -Problems

Solution :



Expected Monetary Value is calculated for each alternative as below.

EMV of node B =

$= 0.6 \times (₹6000) - ₹3200 + (₹3000) \times 0.4 = ₹1600$ [₹3200 is the burning costs]

EMV of node A =

$= 0.5 \times (₹1600) + - (₹1200 \times 0.5)$ [₹1200 is the burning cost with no benefit]

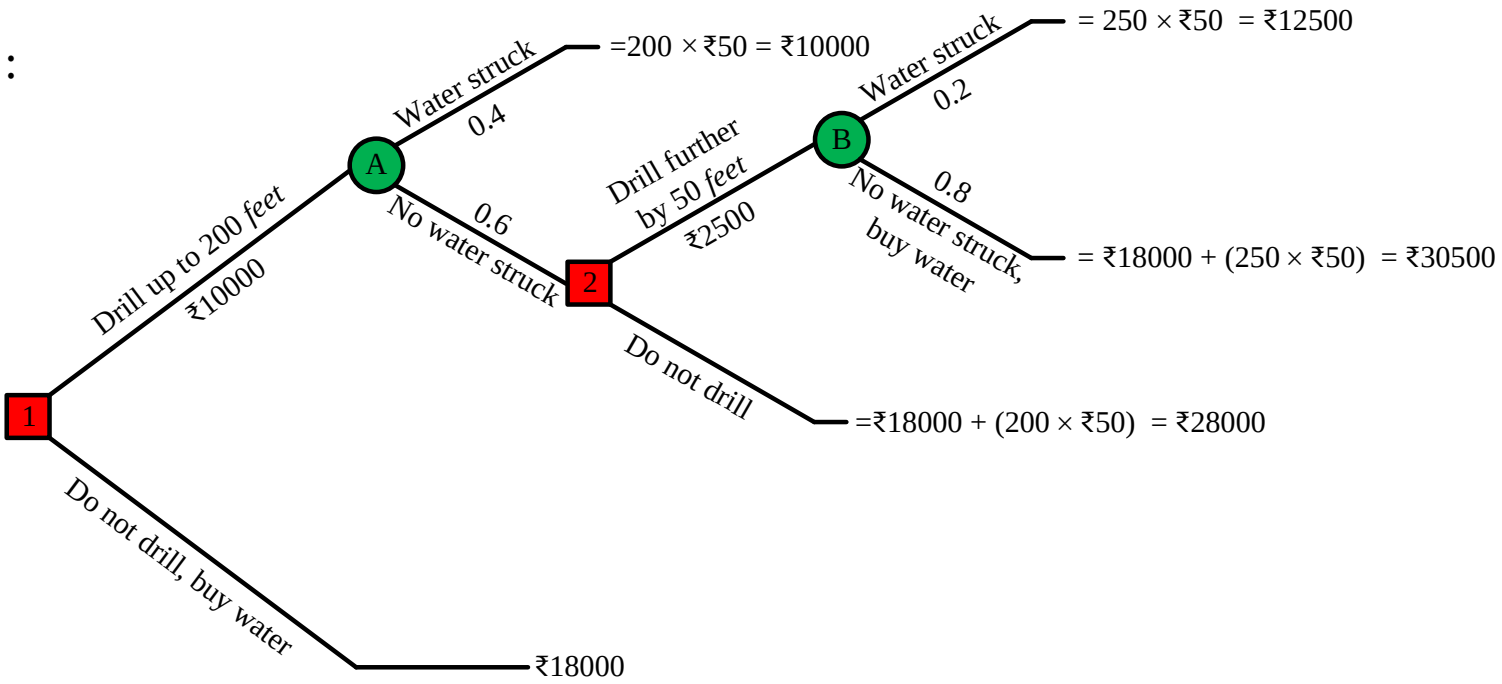
$= ₹800 - ₹600 = ₹200$

Decision tree analysis -Problems

3. Mr.Sinha had to decide whether or not to drill a well on his farm. In his village only 40% of the wells drilled were successful at 200 *feet* of depth. Some of the farmers who did not get water at 200 *feet*, drilled further up to 250 *feet*, but only 20% struck water at 250 *feet*. Cost of drilling is ₹50 per *foot*. Mr.Sinha estimated that he would pay ₹18000 during a five year period in the present value terms, if he continues to buy water from the neighbor rather than go for the well which would have a life of 5 years. Mr.Sinha has three decisions to make, (1) should he drill up to 200 *feet* and (2) if no water is found at 200 *feet*, should he drill up to 250 *feet*? (3) should he continue to buy water from his neighbor? Draw up an appropriate decision tree and determine his optimal decision.

Decision tree analysis -Problems

Solution :



EMV of node B =

$= (₹18000 + 250 \times ₹50) \times 0.8 + (₹50 \times 250) \times 0.2$

$= (₹30500 \times 0.8) + (₹12500 \times 0.2) = ₹26900$

EMV for drilling up to 200 *feet* and not drilling up to 250 *feet* = ₹18000 + (₹50 × 200) = ₹28000

EMV of node 2 = ₹26900 (Lesser of the two values of ₹26900 and ₹28000)

EMV of node A =

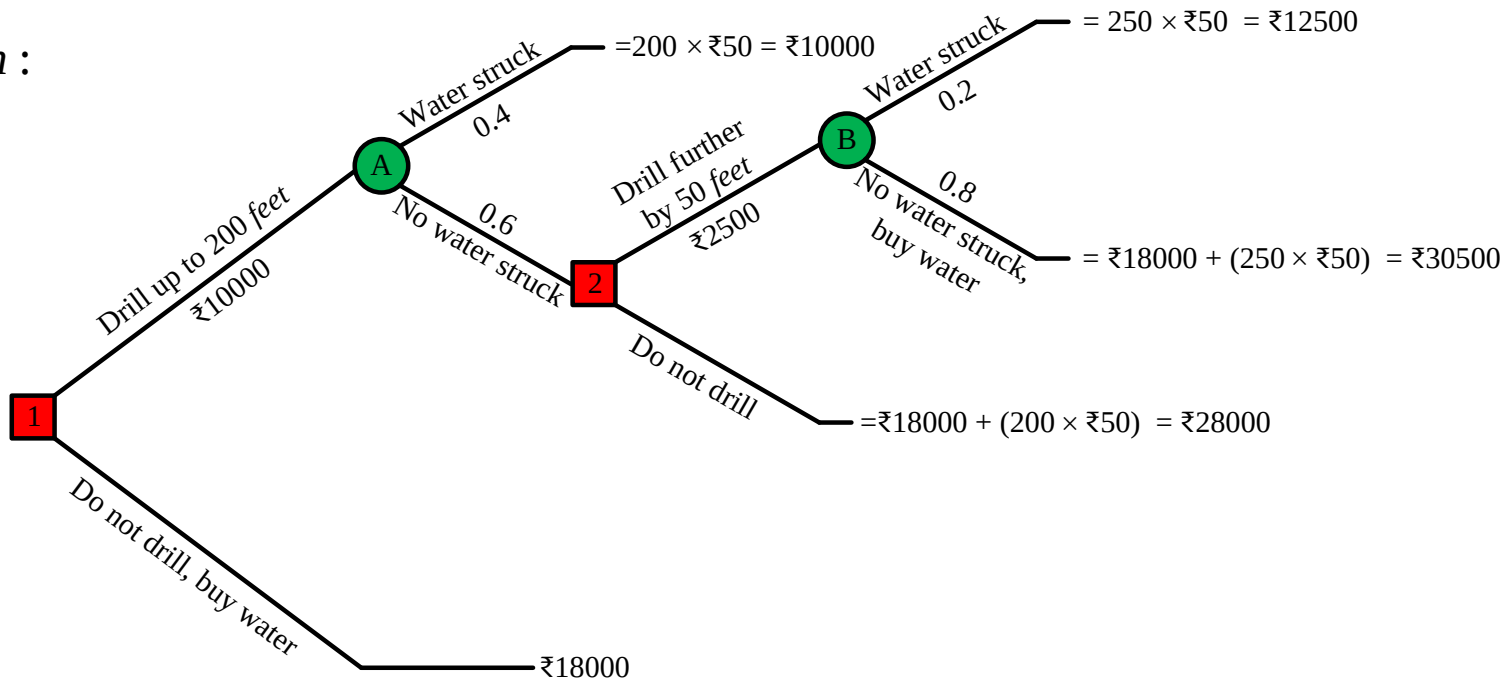
$= (₹26900) \times 0.6 + (₹50 \times 200) \times 0.4$

$= (₹26900 \times 0.6) + (₹10000 \times 0.4) = ₹20140$

EMV of node 1 = ₹18000 (Lesser of the two values of ₹20140 and ₹18000)

Decision tree analysis -Problems

Solution :



EMV of node B =

$= (₹18000 + 250 \times ₹50) \times 0.8 + (₹50 \times 250) \times 0.2$

$= (₹30500 \times 0.8) + (₹12500 \times 0.2) = ₹26900$

EMV for drilling up to 200 *feet* and not drilling up to 250 *feet* = ₹18000 + (₹50 × 200) = ₹28000

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EMV of node A =

$= (₹26900) \times 0.6 + (₹50 \times 200) \times 0.4$

$= (₹26900 \times 0.6) + (₹10000 \times 0.4) = ₹20140$

EMV of node 1 = ₹18000 (Lesser of the two values of ₹20140 and ₹18000)

Decision tree analysis -Problems

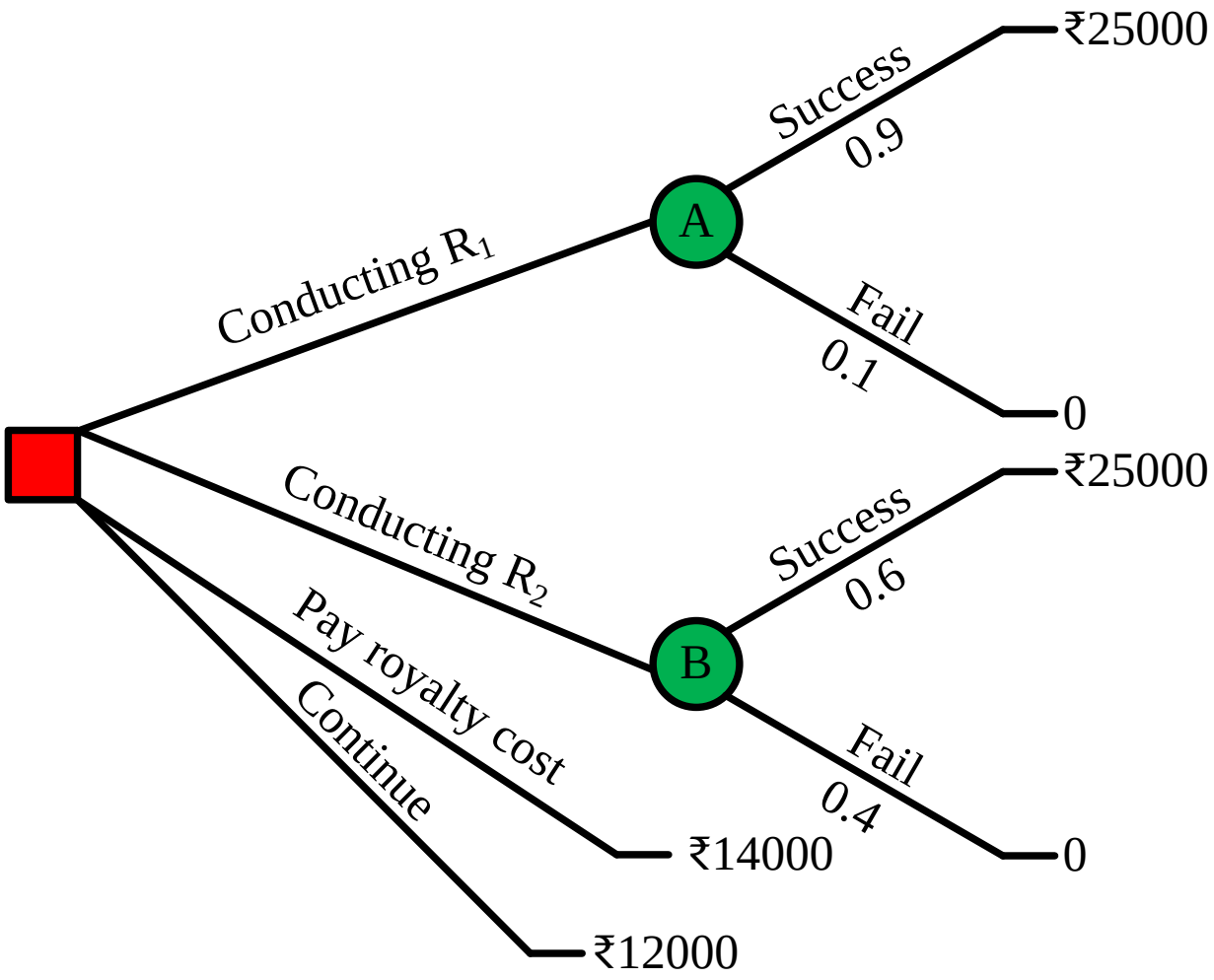
4. Amar company is currently working with a process, which after paying for materials, labour, etc., brings profit of ₹12000. The following alternatives are made available to the company.

   a) The company can conduct research (R_1) which is expected to cost ₹10000 having 90% chance of success. If it proves to be success, the company gets gross income of ₹25000.
   b) The company can conduct research (R_2) which is expected to cost ₹8000 having 60% chance of success. If it proves to be success, the gross income will be ₹25000.
   c) The company can pay ₹6000 as royalty for a new process which will bring a gross income of ₹20000.
   d) The company continues the current process.

   Because of limited resources, it is assumes that only one of the two types of research can be carried out at a time. Use decision tree analysis to locate the optimal strategy of the company.

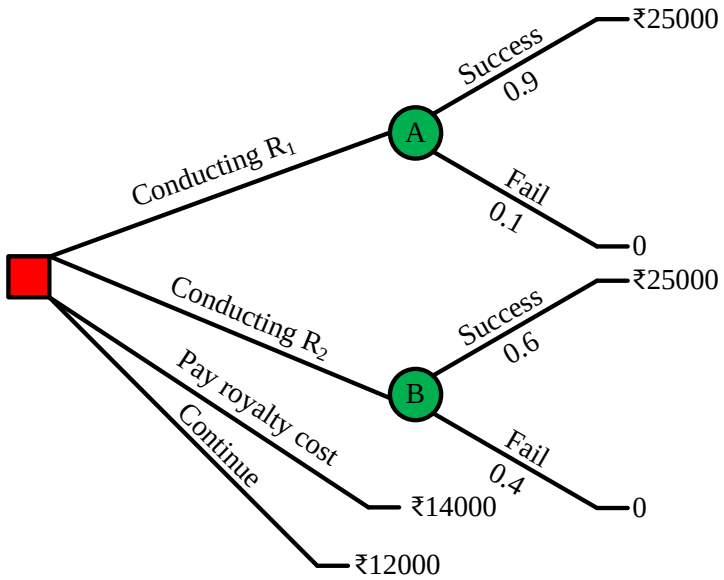
Decision tree analysis -Problems

Solution :



Decision tree analysis -Problems

Solution :



EMV of node A =

= $0.9 \times (₹25000) - ₹10000 + (0) \times 0.1 = ₹11250$ [₹10000 is the expense to conduct research R_1]

= ₹22500 – ₹10000 = ₹12500

EMV of node B =

= $0.6 \times (₹25000) - ₹8000 + (0) \times 0.4 = ₹11250$ [₹8000 is the expense to conduct research R_2]

= ₹15000 – ₹8000 = ₹7000

EMV to pay royalty = ₹20000 – ₹6000 = ₹14000

EMV for the company to continue the current process = ₹12000

As the EMV to pay royalty is highest (i.e., **₹14000**), this is the optimal decision.

Business decisions under uncertainty

- Uncertainty occurs when there exist several future *states of nature* but the probabilities of each of these states occurring are not known.
- *Decision making under uncertainty involves alternative actions whose payoffs depend on the states of nature.*
- In such situations the decision maker can choose among ***alternatives*** (***strategies***) for making the decision.

NB :

States of nature	:	Scenarios that may occur
Alternatives	:	Strategies
Payoff	:	The outcome

Business decisions under uncertainty

- ***The maxi-max criterion*** – This approach taken by the ***optimistic decision maker*** deals with selecting the best possible outcome for each decision and choosing the decision with the maximum payoff for all the best outcomes.
- ***The maxi-min criterion*** – This approach taken by ***pessimist decision maker*** deals with selecting an alternative whose worst outcome is '*least bad*'.
- ***The mini-max criterion*** – When dealing with ***costs***, the maximum cost associated with each alternative is considered and the alternative that minimizes this maximum cost is chosen.
- ***Laplace criterion*** – When decision maker has no definite information about the probability of occurrence of various states of nature, he makes simple assumption that each is equally likely.
- ***Savage principle or minimax regret*** – ***Savage principle*** *suggests that alternative that minimizes the maximum regrets should be selected*.

Business decisions under uncertainty-Problems

1. The following matrix gives the payoff of different strategies (alternatives) S_1, S_2 and S_3 against conditions (events) N_1, N_2, N_3 and N_4.

Alternatives	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

Indicate the decision taken under (a) Pessimistic (b) Optimistic and equal probability approaches.

Solution :

Pessimistic approach (*Maxi-min criterion*)

Minimum payoffs under various alternatives are –100, 0 and –2000. Among them, the alternative with maximum payoff of 0 is S_2, which is chosen.

Optimistic approach (*Maxi-max criterion*)

Maximum payoffs under various alternatives are 18000, 20000 and 20000. Among them, the alternative(s) with maximum payoff of 20000 are S_2 or S_3.

Business decisions under uncertainty-Problems

1. The following matrix gives the payoff of different strategies (alternatives) S_1, S_2 and S_3 against conditions (events) N_1, N_2, N_3 and N_4.

Alternatives	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

Indicate the decision taken under (a) Pessimistic (b) Optimistic and equal probability approaches.

Equal probability approach (*Laplace criterion*)

When decision maker has no definite information about the probability of occurrence of various states of nature, he makes simple assumption that each is equally likely. Therefore the probability of each to occur is $\frac{1}{4}$. The expected payoffs are calculated as follows.

Expected payoff of alternative, $S_1 = \frac{1}{4}(4000 - 100 + 6000 + 18000) = 6975$

Expected payoff of alternative, $S_2 = \frac{1}{4}(20000 + 5000 + 400 + 0) = 6350$

Expected payoff of alternative, $S_3 = \frac{1}{4}(20000 + 15000 - 2000 + 1000) = 8500$

Maximum payoff of 8500 is the alternative S_3 and hence it is chosen.

Business decisions under uncertainty-Problems

A pay off matrix is given below. Which alternative will be selected according to the savage principle or minimax regret?(estimate regrets) (*May*, 2019)

Alternatives	***States of nature***		
	Low	*Medium*	*Failure*
Small facility	15	15	15
Medium facility	14	17	17
Large facility	8	9	19

Solution :

The regret values obtained by subtracting every entry in the original payoff table for the problem from the largest entry in the column is tabulated in the table below (regret table).

Alternatives	***States of nature***		
	Low	*Medium*	*Failure*
Small facility	0	2	**4**
Medium facility	1	0	**2**
Large facility	7	**8**	0

The minimum of these three regret values (4, 2, 8) is 2 with the decision alternative, 'medium facility'.

Discussions

1. Why decision making is a difficult task.
2. List any two methods to deal with decision making under uncertainty.
3. Illustrate the difference between programmed and non-programmed decisions by highlighting suitable examples.
4. What is productivity ? Mention the types of productivity.
5. Discuss the factors influencing productivity.
6. What are the steps involved in decision tree analysis.
7. For what types of projects decision tree is useful.
8. What do you mean by a risky situation in business? How is decision taken under risk?
9. Business always operate in an environment of uncertainty'. Do you agree? Give 3 reasons.
10. Explain the concept of productivity. Bring out its importance.
11. What are the factors affecting productivity?
12. Distinguish between production and productivity.