Management for Engineers

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Syllabus (Module 3 – Productivity and Organization)

- Concept of productivity and its measurement; Competitiveness; Decision making process; decision making under certainty, risk and uncertainty; Decision trees; Models of decision making.

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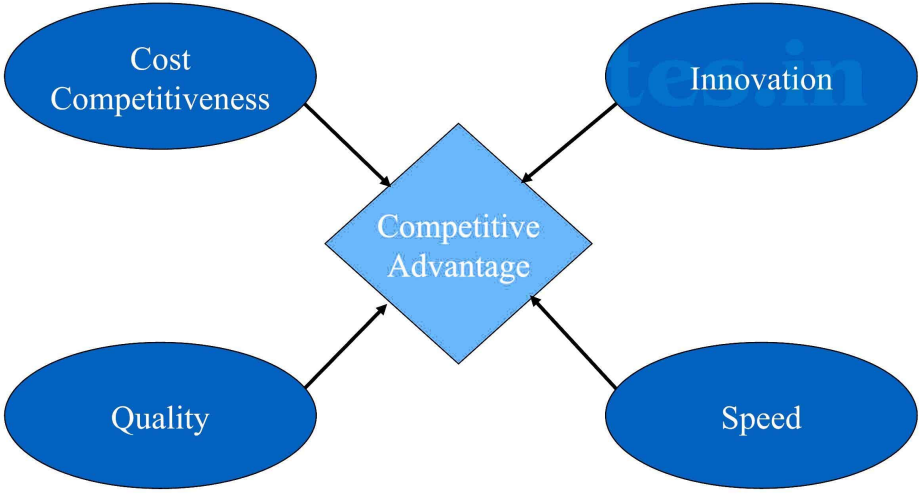
Concept of Productivity and its measurement

Managing for competitive advantage

- Best managers and companies deliver all four



Managing For Competitive Advantage

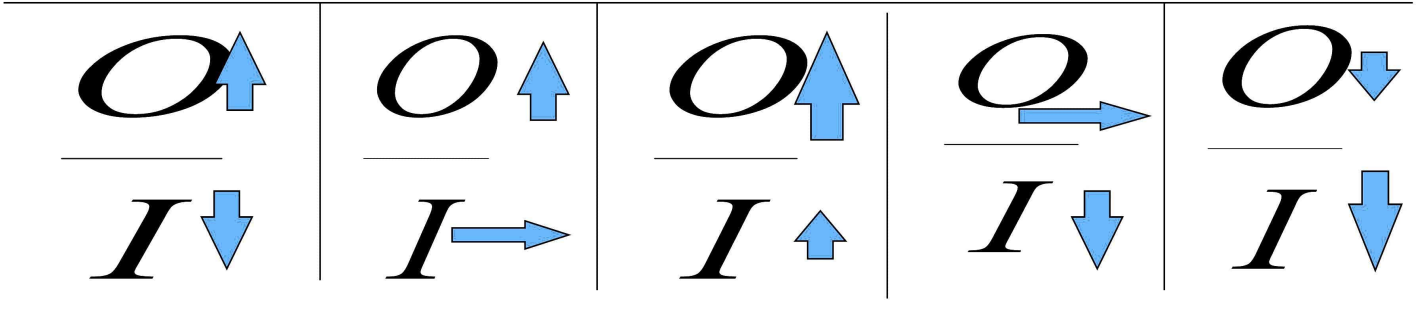
- Innovation
  - the introduction of new goods and services
    - comes from people
    - must be a strategic goal
    - must be managed properly
- Quality
  - excellence of a product, including its attractiveness, lack of defects, reliability, and long-term durability
  - importance of quality has increased dramatically
  - catering to customers' other needs creates more perceived quality

Managing For Competitive Advantage

- Speed
  - fast and timely execution, response, and delivery of results
  - often separates winners from losers in world competition
  - requirement has increased exponentially
- Cost competitiveness
  - costs are kept low enough so that you can realize profits and price your products at levels that are attractive to consumers
  - key is efficiency - accomplishing goals by using resources wisely and minimizing waste
  - little things can save big money
    - cost cuts involve tradeoffs

Productivity

- The output-input ratio within a time period with due consideration of quality.Productivity is the relationship between the outputs generated from a system and the inputs that are used to create those outputs. Mathematically
- Productivity = output/input
- Productivity Improvement (PI) is the result of managing and intervening in transformation or work processes. PI will occur if:



Productivity Examples

Example 1

- a) Let us assume that farmer gets an yield of 25 bags of paddy from his land for which he spends Rs. 1200. Each bag is sold for Rs. 120. Find productivity
- b) By adopting better seeds, fertilizers and methods of cultivation, the yield from his land is increased to 40 bags of paddy. For this he spends Rs. 1600. Find increase in productivity.

Productivity Examples

- Example 1a:
  - Output = 25 x 120
    - = 3000
  - Productivity = (3000 x 100) / 1200 = 250 %
- Example 1b:
  - Output = 40 x 120
    - = 4800
  - Productivity = (4800 x 100)/1600 = 300%
  - Increase in productivity = 50%

Factors affecting productivity in an organization

- Product or System design: through better product design, a product can be simplified.
- Machinery and equipment:
- The skill and effectiveness of the worker: the trained and experienced worker can do the same job in a much shorter time and with far greater effectiveness than a new one.
- Production volume:

Measurement of productivity

Measurement of productivity is difficult in the following cases

- Interdependence of factorial productivities: Productivity of one factor may be affected by the productivity of another.
- General disagreement as to measuring output and input: because of differences in volume of individual products and fluctuations in price level.

Productivity Measurement

Productivity measurement

- a quantitative assessment of productivity changes
- can be actual or prospective
- is forward looking
- serves as input for strategic decision making
- allows managers to compare relative benefits of different input combinations

Productivity Measure

- Individual level
- Group level
- Department level
- Corporate level
- National level
- Global level

Parameters Affecting Productivity Measures

- Efficiency
- Effectiveness
- Quality
- Quality of Work Life
- Innovation

Productivity Measurement

Overall productivity can be measured by the following formula

Value of output = Total cost + net added value = 1 + Net added value

Cost of input Total cost Total cost

Overall productivity is also measured by:

Return on capital employed = Profit x 100

capital employed

= Profit x Sales x 100

sales capital employed

Capital employed = Fixed assets + Current assets – Current liabilities

Productivity Measurement

Total productivity (Craig and Harris model):

$$P_T = \frac{Q_T}{L + C + R + M}$$

Where P_T: Total productivity

L = Labour input

C = Capital input

R = raw material and purchased parts input

M = other miscellaneous goods and services input factors

Q_T = total output

Productivity Measurement

Partial Productivity Measures (PPM):

$$\text{Partial productivity} = \frac{\text{Total Output}}{\text{Individual Input}}$$

$$\text{Labour productivity} = \frac{\text{Total Output}}{\text{Labour Input}}$$

$$\text{Capital productivity} = \frac{\text{Total Output}}{\text{Capital Input}}$$

Productivity Measurement

$$\text{Material productivity} = \frac{\text{Total Output}}{\text{Material Input}}$$

$$\text{Energy productivity} = \frac{\text{Total Output}}{\text{Energy Input}}$$

$$\text{Total Factor Productivity Measure (TFP)} = \frac{\text{Net Output}}{\text{(Labour + Capital)Input}}$$

Productivity Indices Example

- Example 1
- The following information regarding the output produced and inputs consumed for a particular time period for a particular company is given below. Compute various productivity indices

  Output = 10000

  Human input = 3000

  Material input = 2000

  Capital input = 3000

  Energy input = 1000

Other misc. input = 500

Productivity Indices Example

- Example 1
- Labour productivity = 10000/3000 = 3.33
- Capital productivity = 10000/3000 = 3.33
- Material productivity = 10000/2000 = 5
- Energy productivity = 10000/1000 = 10
- Total productivity = 10000/(3000 + 2000 + 3000 + 1000 + 500)
  = 1.053

Total Factor productivity = (Total output – Material and services purchased)/((Labour + capital)Input)
= (10000 – (2000 + 1000 + 500))/(3000 + 3000) = 1.083

Productivity Indices Example

- Example 2
- A hamburger factory produces 50,000 burgers each week. The equipment costs Rs. 5,000 and will remain productive for three years. The annual labor cost is Rs. 8000.
- a) What is the productivity as measured in units of output per rupees of input over a 3-year period?
- b) Management has the option of an equipment cost Rs. 10,000 with an operating life of five years. It would reduce labor costs to Rs. 4,000 per year. Should management purchase the equipment (using productivity arguments alone)?

Productivity Indices Example

- a) Productivity = (Total burgers produced)/ (labor + equipment)
  = (50000 x 52 x 3)/ (8000 x 3 + 5000)
  = 269 burgers / input

b) Productivity = (50000 x 52 x 5)/ (4000 x 5 + 10000)
= 433 burgers/input

This is a good project from a productivity perspective. Although the proposed equipment is expensive, 5 year life and lower labor costs make new machine attractive.

Decision making process

Decision Making

- Decision making can be regarded as the mental processes resulting in the selection of a course of action among several alternatives.
- Every decision making process produces a final choice.
- The output can be an action or an opinion of choice.
- Problem analysis must be done first, then the information gathered in that process may be used towards decision making.
- Decision Making Process: “Decision making is the process of making a choice between a numbers of options and committing to a future course of actions”.

Decision-making

“Efficient decision-making involves a series of steps that require the input of information at different stages of the process, as well as a process for feedback”. - Baker

Decision making

- The decision-making process begins when a manager identifies the real problem. The accurate definition of the problem affects all the steps that follow; if the problem is inaccurately defined, every step in the decision-making process will be based on an incorrect starting point.
- One way that a manager can help determines the true problem in a situation is by identifying the problem separately from its symptoms. The most obviously troubling situations found in an organization can usually be identified as symptoms of underlying problems.

The Ideal Decision-making Process

STEP 1
Define the problem

STEP 2
Determine the requirements that the solution to the problem must meet

STEP 3
Establish goals that solving the problem should accomplish

STEP 4
Identify alternatives that will solve the problem

STEP 5
Develop valuation criteria based on the goals

STEP 6
Select a decision-making Tool

STEP 7
Apply the tool to select a preferred alternative

STEP 8
Check the answer to make sure it solves the problem

The Decision-making Process (adapted from Baker et al, 2001)

Typical problems that require decisions

- A high level of employee turnover.
- A reduction in firm profits.
- Unacceptable levels of “shrinkage” in a store.
- Lower than planned quality of finished goods.
- An unexpected increase in workplace injuries.
- The invention of a new technology that can increase the productivity of the workforce.

Decision making under certainty and risk

Decision Making Criteria

Classifying decision-making criteria

Decision making under certainty.

- in a situation involving certainty, people are sure about the outcome of the decision made.
- The information are available and is considered as reliable and the cause and effect relationships are known.
- The future state-of-nature is assumed known.

Decision Making Criteria

Classifying decision-making criteria

Decision making under risk.

- There is some knowledge of the probability of the states of nature occurring.
- The factual information may exists, but they may be incomplete.
- To improve decision making, one may estimate the objective probability of an outcome by using mathematical models.
- Subjective probability based on judgment and experience may also be used.

Decision making under uncertainity

Decision Making Criteria

Decision making under uncertainty.

- There is no knowledge about the probability of the states of nature occurring.
- Virtually all decisions are made in an environment of some uncertainty.
- The degree varies from relative certainty to uncertainty.
- People only have a meager database, they do not know whether or not the data is reliable and they are unsure about whether or not the situation may change.
- They cannot evaluate the interactions of different variables.
- Consider an organization wants to expand their involvement into another country. In this situation they may not aware about that country's laws, culture, politics etc.
- Managers dealing with uncertainty should know the degree and nature of the risk they are taking in choosing a course of action.

Decision under Uncertainty Criteria

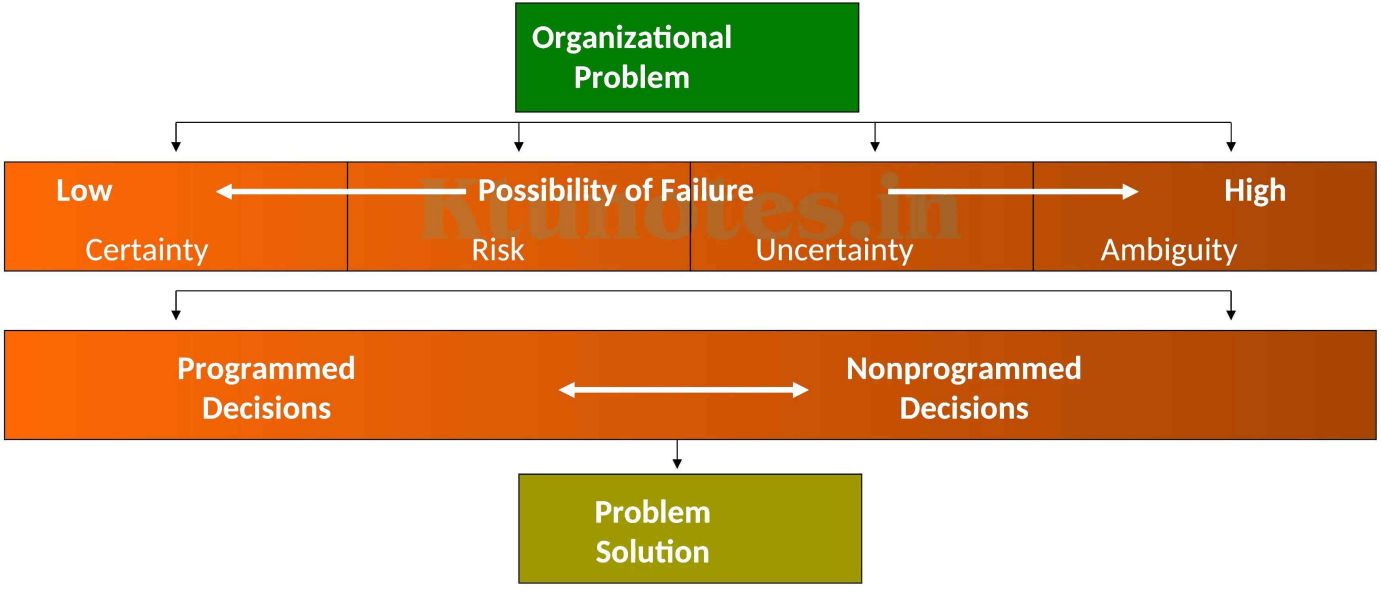
- Laplace Criterion/Equal Probability/ Rationality - Bayes' Criterion
- Criterion of Optimism
  - Maximax Criterion
  - Minimax Criterion
- Criterion of Pessimism (Wald Criterion)
  - Maximax Criterion
  - Minimax Criterion
- Minimax Regret Criterion (Savage Criterion)
  - Maximization Problem
  - Minimization Problem
- Hurwicz Criterion (Criterion of Realism)
  - Maximization Problem
  - Minimization Problem

Decision making criteria

Decision making under Ambiguity

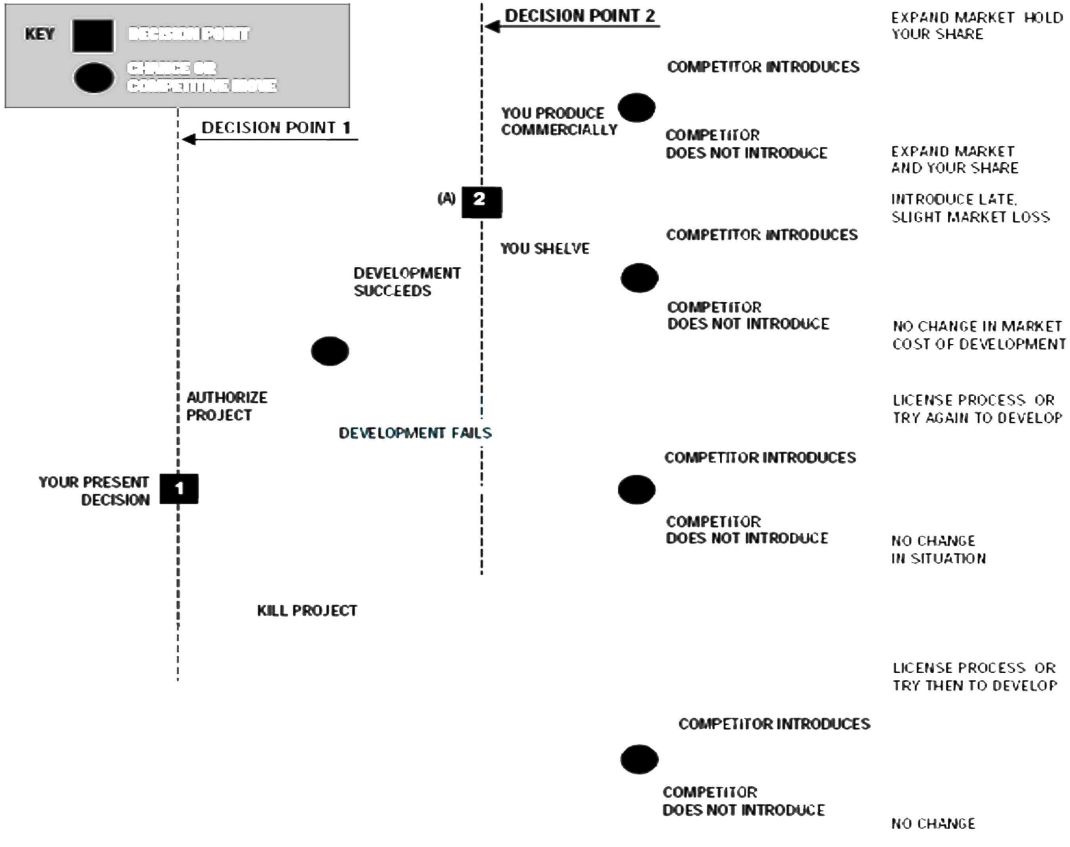
- by far the most difficult decision situation
- goals to be achieved or the problem to be solved is unclear
- alternatives are difficult to define
- information about outcomes is unavailable

Conditions that Affect the Possibility of Decision Failure



Decision trees

EXHIBIT II. Decision Tree with Chains of Actions and Events



Decision Trees

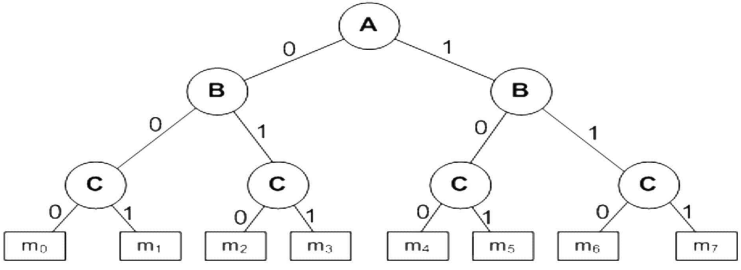
- A **decision tree** is a graphical representation of possible solutions to a decision based on certain conditions.
- it starts with a single box (or root), which then branches off into a number of solutions, just like a tree.
- Decision trees help formalize the brainstorming process so we can identify more potential solutions.
- Decision trees are useful tools, particularly for situations where financial data and probability of outcomes are relatively reliable. They are used to compare the costs and likely values of decision pathways that a business might take.
- They often include decision alternatives that lead to multiple possible outcomes, with the likelihood of each outcome being measured numerically.

Decision Trees

- A Decision Tree is an important data structure known to solve many computational problems

Binary Decision Tree

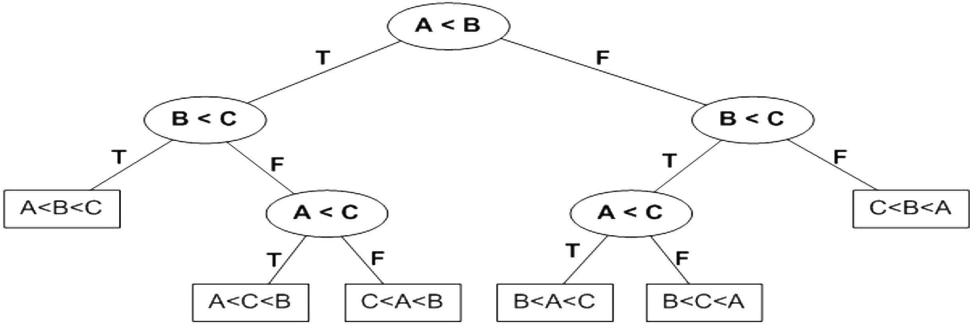
A	*B*	*C*	*f*
0	0	0	m_0
0	0	1	m_1
0	1	0	m_2
0	1	1	m_3
1	0	0	m_4
1	0	1	m_5
1	1	0	m_6
1	1	1	m_7



Decision Trees

- Decision tree is also possible where attributes are of continuous data type

Example 9.2: Decision Tree with numeric data



Decision Trees

- Decision tree may be *n*-ary, $n \geq 2$.
- There is a special node called root node.
- All nodes drawn with circle (ellipse) are called internal nodes.
- All nodes drawn with rectangle boxes are called terminal nodes or leaf nodes.
- Edges of a node represent the outcome for a value of the node.
- In a path, a node with same label is never repeated.
- Decision tree is not unique, as different ordering of internal nodes can give different decision tree.

Decision Trees

- Decision tree helps us to classify data.
  - Internal nodes are some attribute
  - Edges are the values of attributes
  - External nodes are the outcome of classification

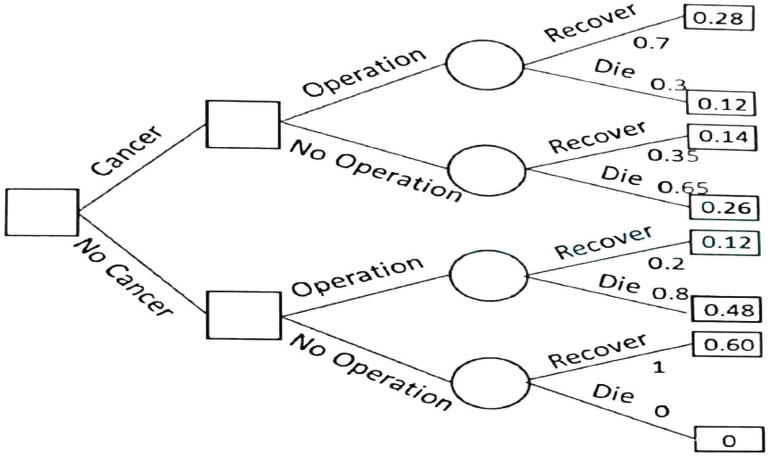
Steps in Decision Tree Analysis

1. The first step is understanding and specifying the problem area for which decision making is required.
2. The second step is to interpreting and chalking out all possible solutions to the particular issue as well as their consequences.
3. The third step is presenting the variables on a decision tree along with its respective probability values.
4. The fourth step is finding out the outcomes of all the variables and specifying it in the decision tree.
5. The last step involves calculating the values for all the chance nodes or options, to figure out the solution which provides highest expected value.

Decision Tree - Example

- There is 40% chance that a patient admitted to the hospital, is suffering from cancer. A doctor has to decide whether a serious operation should be performed or not. If the patient is suffering from cancer, and the serious operation is performed, the chance that he will recover is 70%, otherwise it is 35%. On the other hand, if the patient is not suffering from cancer and the serious operation is performed, the chance that he will recover is 20%, otherwise it is 100%. Assume that recovering and death are the only possible results. Construct an appropriate decision tree. What decision should doctor take?

Decision tree – Example



P_1 = Probability that the patient shall recover after operation = 0.28 + 0.12 =0.4

P_2= Probability that the patient will recover without any operation = 0.14 + 0.60 = 0.74

Since $P_2 > P_1$, doctor should not take a decision for operation to the patient.

Models of decision making

Decision Making Models

- Decision-making models can help teams simplify their decision-making processes and collaborate more effectively.
- They offer different ways to think about a problem and identify potential solutions, which is useful for people with different learning styles or time constraints.
- Models provide useful steps for teams to follow to create solutions and describe their processes clearly to other team members.
- When everyone on a team understands the decision-making model being used, they can more easily contribute to the thinking process for a balanced, successful solution.

Rational Decision Model

- The rational decision-making model focuses on using logical steps to come to the best solution possible.
- This often involves analyzing multiple solutions at once to choose the one that offers the best quality outcome.
- Teams typically use the rational decision model when they have time for meetings and research, which allows them to create a list of potential solutions and discuss the pros and cons of each.

Rational Decision Model

- **Define your goal or obstacle:** First, you must define the goal or obstacle you wish to achieve or overcome. Defining this helps you understand exactly what outcome your solution should produce.
- **Determine the relevant information:** For this step, consider delegating research tasks to your team or brainstorming during a team meeting. Determine what information about your goal or obstacle is relevant to finding a solution.
- **Create a list of options:** Using the relevant information, your team can create a list of potential options for solutions. Try to support your options with evidence for why they would solve achieve your goal or overcome your obstacle.

Rational Decision Model

- **Arrange options by their value:** After creating a list of options, arrange them by their likelihood of success. Options that have a higher chance of success also have a higher value, while options with little evidence may have a lower value.
- **Choose the best option:** Consider the value of each option and how it can help your company succeed. With your team, come to a consensus about the best option for a solution using the information you've gathered.
- **Finalize your decision and take action:** Once your team decides on the best solution, clearly state your commitment to the solution and ask if any team members have concerns. After this, you can implement your solution in your company.

Intuitive Decision Model

- Rather than logical reasoning, the intuitive decision model uses feelings and instinct to make decisions.
- Often, team leaders or managers use this model to make quick decisions when they don't have a lot of time for research or planning.
- The process of an intuitive decision is less structured and may use previous knowledge of similar goals or obstacles to determine a useful solution.

Intuitive Decision Model

- **Define your goal or obstacle:** Even with little time, it's important to define your goal or obstacle clearly, especially if you're making a decision without your team. This can help you explain the decision and its effects later.
- **Identify similar goals or obstacles:** Brainstorm similar goals or obstacles you've encountered before and how you solved them. Use this information as a basis for creating your own solution.
- **Recognize possible biases:** Recognizing your biases is especially important when you don't have input from your team. Consider how your decision may affect yourself, your team and your company as you think of potential solutions.
- **Determine a usable solution:** Determine the best solution using your prior experience and the values of your company. An ideal solution helps your company achieve its goals or overcome an obstacle while also benefitting your team and other employees.
- **Finalize your decision and take action:** After choosing a usable solution, you can alert your company and team of your decision. If you have to make the decision quickly, you may have to put it into action without discussing with your team.

Intuitive Decision Model

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Recognition-primed decision model

- The recognition-primed decision model, created by Gary A. Klein in his book *Sources of Power*, uses quick-thinking and prior experience to make decisions, often in fast-paced environments. Team leaders may use this model to assess the basics of a situation and create a potential solution and then think through the solution to determine if it's usable. This may require you to have a lot of experience with the goal or obstacle for you to create a suitable solution.

Recognition-primed decision model

- **Define your goal or obstacle:** Clearly define the goal or obstacle your team wants to achieve or overcome to make it easier for you to create a solution quickly. While the idea can be broad, try to identify the most important thing you need to decide.
- **Consider relevant information and similar situations:** Using your prior experience, quickly assess the situation and determine what information or prior situations can help you make a usable solution. If you have time, do more research on how to solve your goal or obstacle.
- **Create a potential solution:** Create at least one potential solution using your prior experience or additional knowledge about the situation. To quicken your decision process, try to create a generic solution so you can change or add details as you think through it.

Recognition-primed decision model

- **Consider if the solution works:** Think through your solution to determine if it can really solve your challenge. Start by considering the most obvious issues and then consider the smaller details of the solution.
- **If needed, change the solution:** Your first solution may not produce the best outcomes, so change details about it if you need to. This may involve adding new actions to your solution, making it more specific or changing it altogether.
- **Finalize your decision and take action:** Once you're confident in your solution, finalize the decision with your team and take action. In a fast-paced situation, you may have to change your solution again if you learn new information while taking action.

Creative decision model

- The creative decision model uses original ideas to create innovative solutions that achieve goals or overcome obstacles.
- This involves thinking through a situation and inventing a solution without referencing similar situations.
- Often, you can use this model for situations you haven't experienced before, like new projects or production issues.
- Using the creative decision model typically requires flexible thinking to create successful, unique solutions.

Creative decision model

- **Define your goal or obstacle:** You may not have experience with your goal or obstacle, so it's useful to define it as clearly as possible to help you understand what you need to do. This may involve meetings with your team or other colleagues, like business partners or managers.
- **Consider relevant information:** Do research on the challenge you need to solve to learn everything you can about it. This includes trying to find any similar projects, reports or companies that may inspire your ideas.
- **Consider the information over time:** You can choose how long to consider the information, but it's helpful to take at least a day to think about your challenge passively. To do this, you may brainstorm ideas, talk with colleagues or make a word-association list.

Creative decision model

- **Create a usable solution:** With the creative decision model, your idea may come naturally after a period of thinking about your goal or obstacle and the information relevant to it. Think through your solution logically to make sure it's usable for your situation.
- **Finalize your decision and take action:** After considering the details of your solution, you may finalize your decision with your team and take action to solve your challenge. It's helpful to have a draft or presentation of your creative solution to explain it to your team more easily.