

## Algorithms and Data Structures

### Session 3 & 4: Problem Solving and Computational Thinking

#### **Define the Problem:**

##### **+ Identify the Problem:**

- Defining the problem is the hardest part. We usually tend to worry about the problem before trying to identify what the problem actually is. We perceive a problem, which might not actually be the problem and start worrying about it. Instead, try to define the problem!

- Defining the Problem with help from others:

- When you are trying to define the problem, you must ask yourself and others involved in the problem the following questions.

1. What are the causes to the problem? Here you might not identify the main causes as such but it is a start. You have to keep in mind that you are not blaming somebody as a cause to the problem right at the beginning. The person might be the cause, but see what led to that person being the cause of the problem.

2. Where is the problem actually occurring?

3. How is the problem occurring?

4. At what times specifically is the problem occurring?

5. Who is the problem happening with?

6. Why is the problem arising? Here you will have to jot down the exact details as to why the problem is occurring.

Finally, you will have to take a sheet of paper and summarize the above answers.

You could begin with "The following is not happening because of \_\_\_\_\_".

##### **- Defining Complex Problems:**

This step also requires you to follow the steps 1-6 that have been stated above.

However, since you find that the problem is overwhelming, you will have to break it down and make it simpler.

Repeat the steps 1-6 for these smaller problems in order to define the complex problem as a whole.

- **Check your understanding of the problem:** Since you are working with other people in identifying the problem, you will find it easy to verify whether your understanding of the problem is the same as your peers.

- Prioritize your problems:
- Identify your role
- Identify Potential Causes for the problem
- Try to identify a strategy and a solution
- Select the most feasible solution: You would have identified a lot of solutions to your problems through the previous step. You will have to now select the best approach to solving your problem.

You will have to consider the following when identifying the best solution to your problem.

1. Which solution will solve the problem for the short term as well as the long term?

2. Are there any risks associated with the solutions?

3. Is it a realistic goal to use the solution to solve the problem?

4. Is it financially viable?

5. Do we have the time to solve the problem through this method?

#### + **Introduction to Problem Solving:**

- Problem Solving:

- In computer science and in the part of artificial intelligence that deals with algorithms ("algorithmics"), problem solving includes techniques of algorithms, heuristics and root cause analysis.

- In these disciplines, problem solving is part of a larger process that encompasses problem determination, de-duplication, analysis, diagnosis, repair, and other steps.

- Other problem solving tools are linear and non-linear programming, queueing systems, and simulation.

- A simulation is an approximate imitation of the operation of a process or system; the act of simulating first.

- Problems can be categorised into

1. Well defined problems
2. Ill-defined problems (not having a clear description or limit).

- When you are faced with a problem in any field, or even in your life, you might either try to solve the problem through logic or by trying to interpret the problem. No matter which method you use, you have to first understand the goal of the problem and also try to identify the different routes you can take to solve the problem. This is the key to problem solving! You might sometimes have to resort to abstract thinking and try coming up with a creative solution.

#### **- Problem Techniques:**

#### **Theory of Evolution:**

- Components involved in evolution:

#### **1. Natural Selection:**

- Natural selection is a process where a design is chosen from a bunch of alternative designs depending on how it helps them reach closer to their goal. It is because of this component that everybody has to adapt to different situations.

- This is a major component in problem solving in which the use of alternate solutions (designs) to help a person achieve the goal.

- which is to solve the problem at hand. If the person finds that the adaptation was useful, it is passed on to the next generation.

- When compared to problem solving, the adaptations are the solutions which are passed down depending on whether or not they have worked well.

#### **2. Sexual Selection:**

- This process has the characteristic that individuals rival against people of the same sex and find themselves attracted immensely to individuals of the opposite sex.

- The concept of rivalry comes very often in problem solving. People might find it difficult to avoid blaming one another when under pressure. However, this problem can be overcome as well.

#### **+ Computer Science and Algorithms:**

- Every software company that develops new software has to troubleshoot and solve problems that the new software might have.

- In the field of computer science and artificial intelligence where algorithms are the methods through

which the programs are designed, problem solving is a hero.

- However, it is not the only process that people working in these fields have to do. They have to first determine the problem that they face, then remove any duplication in the problem, analyze and then solve the problem.

- For instance if the programmers or developers find that there is a bug in the coding of a new app, they will have to first identify the line at which the error occurs.

Once they find the error they will have to check if the error has occurred

anywhere else in the code. After identifying this they can work on solving the issue that is at hand.

- It could be that the programmer did not have enough knowledge and made the error. If that is the case, the supervisor or manager can work on improving the programmer's knowledge or can assign the coding to another programmer.

#### **+ Characteristics of difficult problems:**

- difficult problems are those which are ill-defined problems, they have some characteristics that are typical.

- The following section focuses on those problems.

1. Lack of clarity

2. Multiple goals

3. Multiple items, decisions and relations

4. Time

#### **+ Definition Creativity v/s Innovation:**

##### **Creativity:**

- Creativity is the capability or act of conceiving something original or unusual.

- Creativity is the characteristics of a person to generate new ideas, alternatives, solutions, and possibilities in a unique and different way.

- Creativity is the ability to conceive something unpredictable, original and unique.

- It must be expressive, exciting and imaginative. It is the mirror of how beautifully a person can think in any circumstances.

- It is not genetic but can be developed if someone keeps on learning and comprehending things with a rare and exclusive perception.

- Creativity is a brainstorming and mind-boggling activity in which person has to think beyond his imagination for bringing something which was previously hidden.

### **Innovation:**

- Innovation is an implementation of something new.
- Invention is the creation of something that has never been made before and is recognized as the product.
- Innovation is an act of application of new ideas to which creates some value for the business organization, government and society as well. Better and smarter way of doing anything is innovation.
- It could be the introduction of:
  - New technology
  - New product line or segment
  - A new method of production
  - An improvement in the existing product
- Innovation is closely tied to creativity i.e. putting creative ideas into actions is an innovation, whose consequences should be positive.
- It is the process of doing something better for the first time, which was not previously done by any entity.
- It can also be termed as a change which can bring a new edge to the performance and productivity of the company. It is of two types i.e. **evolutionary** and **revolutionary**.
- If you have a brainstorm meeting and dream up dozens of new ideas then you have displayed creativity but there is no innovation until something gets implemented.
- Somebody has to take a risk and deliver something for a creative idea to be turned into an innovation.
- An invention might be a product or device or method that has never existed before. So every invention is an innovation. But every innovation is not an invention.
- When your company first published its website that was a major innovation for the company even though many other websites already existed.

### **Creativity v/s Innovation:**

1. creativity is an act of creating new ideas, imaginations and possibilities. Whereas an Innovation is an introduction of something new and effective into the market.

2. creativity is an "imaginative process" whereas innovation is a "productive process".
3. creativity is "not quantifiable" i.e. cannot be measured whereas innovation is "quantifiable" i.e. can be measured.
4. there is no money consumption in creativity whereas in innovation money consumption is there.
5. there is "no risk" involved in creativity whereas "risk" is always attached to Innovation.

### **Find Creative Solutions using creativity tools:**

- Effective problem solving approaches: there are seven steps for an effective problem-solving process.

#### **1. Identify the issues:**

- be clear about what the problem is
- remember that different people might have different views of what the issues are.
- separate the listing of issues from the identification of interests.

#### **2. Understands everyone's interests:**

- the best solution is the one that satisfies everyone's interests.

#### **3. List the possible solutions (options)**

#### **4. Evaluate the options**

#### **5. Select an option or options**

#### **6. Document the agreement(s)**

#### **7. Agree on contingencies, monitoring, and evaluation.**

### **Critical Thinking & Information Analysis:**

- Critical thinking refers to the process of actively analyzing, accessing, synthesizing, evaluating and reflecting on information gathered from observation, experience, or communication.
- It is thinking in a clear, logical, reasoned, and reflective manner to solve the problems or make decisions.
- Basically, critical thinking is a taking a hard look at something to understand what it really means.

### **Critical Thinkers:**

- Critical thinkers do not simply accept all ideas, theories, and conclusions as facts. They have the mindset of questioning ideas and conclusions. They make reasoned judgements that are logical and well thought out by

assessing the evidence supports a specific theory or conclusion.

- When presented with a new piece of information critical thinkers asks questions such as:

- what information supports that?
- How was this information obtained?
- Who obtained information?
- How do we know the information is valid?
- Why is that way?
- What makes it do that?
- Are there any other possibilities?

### **Combination of Analytical and Creative Thinking:**

- Critical thinking incorporates both analytical thinking and creative thinking.

- Critical thinking does involves breaking down information into parts and analyzing the parts in a logical, step by step manner. However it also involves challenging consensus to formulate new creative ideas and generate innovative solutions.

- It is critical thinking that helps to evaluate and improve your creative ideas.

### **Elements of Critical Thinking:**

- Critical thinking involves:

- Gathering relevant information
- Evaluating information
- Asking questions
- Assessing bias or unsubstantial assumptions.
- Making inferences from the information and fillings in gaps.
- Using abstract ideas to interpret information.
- Formulating ideas.
- Weighing opinions
- Reaching well-reasoned conclusions.
- Considering alternative possibilities.
- Testing conclusions.
- Verifying if evidence/argument support the conclusions.

### **Developing Critical Thinking Skills:**

- Critical thinking is considered a higher order thinking skills, such as analysis, synthesis, deduction, inference, reason, and evaluation. In order to

demonstrate critical thinking, you would need to develop skills in:

- **Interpreting:** understanding the significance or meaning of information.
- **Analyzing:** breaking information down into parts.
- **Connecting:** making connections between related items or pieces of information.
- **Integrating:** connecting and combining information to better understand the relationship between the information.
- **Evaluating:** judging the value, credibility or strength of something.
- **Reasoning:** creating an argument through logical steps.
- **Deducing:** forming a logical opinion about something based on the information or evidence that is available.
- **Inferring:** figuring something out through reasoning based on assumptions and ideas.
- **Generating:** producing new information, ideas, products, or ways of viewing things.

#### + **Brainstorming:**

- Brainstorming is a perfect strategy to use when there is a group of people involved in solving the problem. This is a great technique since multiple methods to solving a problem come up during discussions. Each member of the group can see how the problem at hand can be solved. Based on their perspectives, they can provide solutions to the problem. These solutions can be combined and developed to form an accurate or optimum solution.
- It is an activity intended to generate new creative ideas to solve specific problem. It is a freewheeling group discussion that attempts to find a solution by gathering numerous ideas from the participants.
- Because of the free-thinking environment, the session helps promote creative out of the box ideas which break free from normal ways of thinking.
- An analysis and critic of the proposed ideas is conducted only after the brainstorming is over.



## **Process:**

- In a brainstorming session, every participant is encouraged to think aloud and spontaneously come up with as many ideas as possible, no matter how outlandish or crazy it may seem.
- The participants shout out ideas as they occur to them. All the ideas are noted and are not criticized or judged. Criticism and judgement of ideas are only allowed when the brainstorming session is over. This is to allow people to think outside the box and freely suggest any idea that may seem remotely possible.
- The purpose of the session is to obtain as many ideas as possible for later analysis. Therefore, people should build on the ideas suggested by other participants.
- The creative potential of mind mapping can be very useful for brainstorming. Mind maps encourage people to generate new ideas and create connections between different ideas or concepts by presenting new ideas in a natural, spontaneous, graphical, and non-linear manner.
- To use the mind mapping approach to brainstorming, start with the basic problem as the center of the paper, and then generate ideas/options to obtain a number of different possible solutions.
- The Mind Map approach allows individuals to connect concepts without forcing them into a specific framework. The ideas often naturally flow in different directions, hence generating a multiplied of options. Using color, symbols, and images can help to stimulate imagination and generate more creative solutions.

## **+ Reverse Brainstorming:**

- It is the process of allowing answers to a negative question to flow out without validation. These ideas are then used to find problem spaces valuable, constraints and solutions. The following are the illustrative examples of reverse brainstorming.

**1. Customer Needs:** identifying customer needs by brainstorming a negative question.

For example, what is the worst thing about this product? This can be used to identify valuable functions, features, quality improvements and customer benefits.

**2. Risks:** Identifying risks with a question such as how can this fail?

**3. Solutions:** Asking -- how could we make this problem worse? This occasionally provides insight into a solution.

**4. Strategy:** Asking -- what is the worst thing our competitor could do to us this year? This is a standard way to identify strategies.

**5. Improvement:** Generating ideas for improvement by beginning with how you could make things worse. For example, how could this process be slower and more expensive?

**6. Icebreaker:** In some cases reverse brainstorming is comical and fun and can serve as an icebreaker for creative processes. For example, asking people to brainstorm a product feature that would drive sales of your product to zero.

#### **+ Imagineering:**

- Imagination is a powerful engine that can drive people to bring their ideas, dreams, and desires to reality. The imagination constructs stories that lead people to create. Combining imagination with engineering knowledge creates inventions which initially might seem fantastic.

- Imagineering is a combination of "imagination" and "engineering". It brings art and science together to turn fantasy into reality and dreams into "magic". Therefore, **"Imagineering" means transforming imagination into concreteness.**

- In other words, it is a procedure of changing ideas into innovative products. The Disney organization's unique strength comes from the dynamic global team of creative and technical professionals, building on the company's heritage of storytelling to pioneer new forms of entertainment through technical innovations and creativity.

#### **+ Mind Mapping:**

- A mind map is a visual representation or diagram of information that has a central idea surrounded by connected branches of associated topics.

- A mind map is a visual representation or diagram used to:

- display connections between concepts.

- generate ideas, or
- classify information

- Mind mapping is a powerful graphic technique which provides a universal key to unlock the potential of the brain. It harnesses the full range of cortical skills - word, image, number, logic, rhythm, color and spatial awareness-allowing you the freedom to roam the infinite expanses of your brain.

- A mind map or concept map is usually a multi colored diagram displayed on a large sheet of paper, containing words and images that are connected in various ways. The information on mind map is arranged intuitively according to the importance of the concepts.

#### + Six Thinking Hats: 6TH

- It is a system developed by internationally respected consultant Edward deBono, which describes a tool for group discussion and individual thinking involving six colored hats.

- De Bono identifies six distinct directions in which the brain can be challenged. In each of these directions the brain will identify and bring into conscious thought certain aspects of issues being considered (e.g. gut instinct, pessimistic judgement, neutral facts). None of these directions is a completely natural way of thinking, but rather how some of us already represent the results of our thinking.

- Six distinct directions are identified and assigned a color. The six directions are:

1. **"Managing Blue"** - what is the subject? what are we thinking about? what is the goal? Can look at the big picture.

2. **"Information White"** - considering purely what information is available, what are the facts?

3. **"Emotions Red"** - intuitive or instinctive gut reactions or statements of emotional feeling (but not any justification).

4. **"Discernment Black"** - logic applied to identifying reasons to be cautious and conservative. Practical, realistic.

5. **"Optimistic response Yellow"** - logic applied to identifying benefits, seeking harmony. Sees the brighter, sunny side of situations.

**6. "Creativity Green"** - statements of provocation and investigation, seeing where a thought goes. Thinks creatively, outside the box.

**1. White Hat thinking:**

- This covers facts, figures, information needs and gaps.

**2. Red Hat thinking:**

- This covers intuition, feelings and emotions.
- The red hat allows the thinker to put forward an intuition without any need to justify it.
- Usually feelings and intuition can only be introduced into a discussion if they are supported by logic. Often the feeling is genuine but the logic is questionable.
- The red hat gives full permission to a thinker to put forward his or her feelings on the subject at the moment.

**3. Black Hat thinking:**

- This is the hat of judgement and caution. It is a most valuable hat. It is not in any sense an inferior or negative hat.
- The black hat is used to point out why a suggestion does not fit the facts, the available experience, the system in use, or the path that is being followed. The black hat must always be logical.

**4. Yellow Hat thinking:**

- This is the logical positive - why something will work and why it will offer benefits.
- It can be used in looking forward to the results of some proposed action, but can also be used to find something of value in what has already happened.

**5. Green Hat thinking:**

- This is the hat of creativity, alternatives, proposals, what is interesting, provocations and changes.

**6. Blue Hat thinking:**

- This is the overview or process control hat. It looks not at the subject itself but at the 'thinking' about the subject.

## **Thinking about the thinking:**

- The six hats represent six modes of thinking and are aids to thinking rather than labels for thinking.
- The method promotes fuller input from more people. In de Bono's words it 'separates ego from performance'.
- Everyone is able to contribute to the exploration without denting egos: they are just using one hat or rather.
- The six hats system encourages performance rather than ego defence. People can contribute under any hat even though they initially support the opposite view. You don't get stuck defending something you said previously.
- The key point is that a hat is a direction to think rather than a label for thinking.
- The key theoretical reasons to use the Six Thinking Hats are to:
  1. encourage parallel thinking (i.e. being able to hold different views while a decision is in the process of being made).
  2. encourage full-spectrum thinking (i.e. the full range of possibilities).
  3. separate ego from performance. (You are communicating about an assignment: it's not personal. This technique keeps the personal out).

## **+ Decision Making Methods:**

- To improve decision making skills one thing that is worth bringing to your notice is that your critical thinking capacity and decision making capability will only improve if you make the most of your brain. And in order to do so, you can apply either a direct or an abstract approach.
- The following are a combination of both these approaches, where some will directly improve your decision-making skills and some will have an indirect bearing upon them. You must practice each one on a daily basis, in order to reap its full benefits.
  1. Distraction
  2. Learn New Languages
  3. Exercise
  4. Diet
  5. Meditate
  6. Social Life
  7. Read

## 8. Explore

### + Force-field Analysis FFA:

- Force-field analysis is a development in social science. It provides a framework for looking at the factors (forces) that influence a situation, originally social situations. It looks at forces that are either driving movement toward a goal (helping forces) or blocking movement toward a goal (hindering forces). The principle, developed by Kurt Lewin, is a significant contribution to the fields of social science, psychology, social psychology, community psychology, communication, organizational development, process management, and change management.
- Kurt Lewin was an American social psychologist and having contributed to science group dynamics and action research, he is regarded one of the founders of modern psychology. But Lewin is perhaps best-known for developing Force-Field Analysis, using **Force Field Diagrams**.
- According to Kurt Lewin, an issue is held in balance by the interaction of two opposing sets of forces, those seeking to promote change (**driving forces**) and those attempting to maintain the status quo (**restraining forces**).
- Lewin viewed organizations as a system in which the present situation was not a static pattern, but a dynamic balance (equilibrium) of forces working in opposite directions. In order for any change to occur, the driving forces must exceed the restraining forces, thus shifting the equilibrium.
- The Force Field Diagram is a model built on this idea that forces - persons, habits, customs, attitudes - both drive and restrain change. It can be used at any level (personal, project, organizational, network) to visualize the forces that may work in favor and against change initiatives. The diagram helps its user picture the "tug-of-war" between forces around a given issue.
- The FFA is a method to:
  - investigate the balance of power involved in an issue.
  - identify the most important players (stakeholders) and target groups for a campaign on the issues.
  - identify opponents and allies
  - identify how to influence each target group

## **How to conduct a FFA?**

- Typically the following steps are taken

**Step-1:** Describe the current situation

**Step-2:** Describe the desired situation

**Step-3:** Identify where the current situation will go if no actions is taken

**Step-4:** List all the forces driving change towards the desired situation

**Step-5:** List all the forces resisting change towards the desired situation

**Step-6:** Discuss and interrogate all of the forces: are they valid? can they be changed? Which are the critical ones?

**Step-7:** Allocate a score to each of the forces using a numerical scale. e.g. 1 = extremely weak and 10 = extremely strong.

**Step-8:** Chart the forces by listing (to strength scale) the driving forces on the left and restraining forces on the right.

**Step-9:** Determine whether change is viable and progress can occur

**Step-10:** Discuss how the change can be affected by decreasing the strength of the restraining forces or by increasing the strength of driving forces.

**Step-11:** Keep in mind that increasing the driving forces or decreasing the restraining forces may increase or decrease other forces or even create a new ones.

## **+ Capability Analysis:**

- Capability analysis is a set of calculations used to assess whether a system is statistically able to meet a set of specifications or requirements. To complete the calculations, a set of data is required, usually generated by a control chart; however, data can be collected specifically for this purpose.

- Specifications or requirements are the numerical values within which the system is

expected to operate, that is, the minimum and maximum acceptable values. Occasionally there is only one limit, a maximum or minimum. Customers, engineers, or managers usually set specifications.

- Specifications are numerical requirements, goals, aims, or standards. It is important to remember that specifications are not the same as control limits.

Control limits come from control charts and are based on the data. Specifications are the numerical requirements of the system.

- All methods of capability analysis require that the data is statistically stable, with no special causes of variation present. To assess whether the data is statistically stable, a control chart should be completed. If special causes exist, data from the system will be changing. If capability analysis is performed, it will show approximately what happened in the past, but cannot be used to predict capability in the future. It will provide only a snapshot of the process at best. If, however, a system is stable, capability analysis shows not only the ability of the system in the past, but also, if the system remains stable, predicts the future performance of the system.

- Capability analysis is an excellent tool to demonstrate the extent of an improvement made to a process. It can summarize a great deal of information simply, showing the capability of a process, the extent of improvement needed, and later the extent of the improvement achieved.

- Use the standard method for calculating capability analysis when you can answer "yes" to all of the following questions:

1. Is it necessary to understand how the system performs in comparison to specification limits?

- Specifications or requirements must be available to complete capability analysis. The system must also be measured in the same way as the specifications, so a direct comparison can be made.

2. Does the specification consist of an upper and lower requirement?

- For processes with one-sided specifications, see the article capability analysis for one-sided specifications.

3. Are no special causes of variation present?

- A system with special causes is unstable and constantly changing. If capability analysis is performed under these circumstances, it will be unreliable. Always construct a control chart and check for special causes before completing capability analysis.



4. Is the data in variables form?

- In order to complete the standard method for capability analysis, the data must be in variables form, that is measured data, such as time, length, weight, or distance.

5. Do the individual values form a normal distribution?

- In order to complete capability analysis using the standard method, a normal distribution is required. Use a histogram to check for normal distribution. If the distribution is not normal, non-normal capability analysis can be used.

6. Has the data been collected over a period of time?

- There are two ways to collect data for capability analysis. The standard method is from a control chart, where the data is collected over a period of time. If data has been collected in this way, the standard method for performing capability analysis is used.

#### **+ Decision Analysis:**

- Decision analysis is a quantitative evaluation of the outcomes that result from a set of choices in a specific clinical situation. With the exception of the word quantitative, this definition is no different from the clinical decision making process conducted by clinicians every day. When faced with a particular problem, clinicians develop an array of possible actions ranging from doing nothing, to obtaining more information by performing diagnostic tests, to recommending various therapeutic strategies. This process is often implicit and occurs in the context of internal algorithms and heuristics (mental shortcuts) that the clinician has developed and acquired over time.

- Decision analysis, by requiring a specific model structure and assessment of the various likelihoods and values of the outcomes, makes the decision process explicit and much more amenable to examination, discussion, and intellectual challenge.

- Decision models are often used as an analytic tool to conduct cost-effectiveness analyses since decision analysis methodology can be used to find the expected value of most any outcome.

### **+ Choosing among alternatives:**

- With the continuing proliferation of decision methods and their variants, it is important to have an understanding of their comparative value. Each of the methods uses numeric techniques to help decision makers choose among a discrete set of alternative decisions. This is achieved on the basis of the impact of the alternatives on certain criteria and thereby on the overall utility of the decision maker(s). The difficulty that always occurs when trying to compare decision methods and choose the best one is that a paradox is reached, i.e. What decision-making method should be used to choose the best decision-making method?

### **- Current assessment:**

Current assessment involves a better understanding of the resources available and the strengths of the business. The potential for the new products need to be understood. Who are the customers and what do they want. Secondly, an assessment of the current resources needs to be made. Does the current business have the land, labor, management, and capital to meet the potential market? Are there financial resources available to get the proposed product to market? These questions as well as others are designed to evaluate any new business or enterprise.

- What alternatives to look at - feasibility and planning. Once a current assessment is completed, alternatives that match up with the assessment can be evaluated.

- According to Joel Salatin there are several factors that will help make the initial choices. Alternatives should have low initial start-up cost and high gross profit margin. They should have relatively low maintenance requirements and high cash flow relative to expenses.

- Alternatives should have a history of high success rates among new enterprises and high demand/low supply in the current marketplace.

- Lastly, alternatives should have high product distinctiveness and be relatively size-neutral regarding profit potential.

- Each of the potential alternatives should be evaluated through a feasibility process. A feasibility study is

intended to look at the multiple alternatives and narrow them down to one.

- The narrowing process should take the following into consideration:

1. the alternative should match the goals and objectives of the business.
2. the alternative should match the current assessment of the strengths of the business.
3. market opportunities need to exist for the products
4. the product should be able to be made efficiently and effectively

### **+ Qualitative Analysis:**

Q. What is Qualitative Analysis?

- Qualitative analysis uses subjective judgment based on non-quantifiable information, such as management expertise, industry cycles, strength of research and development and labor relations.
- Qualitative analysis contrasts with quantitative analysis, which focuses on numbers found in reports such as balance sheets. The two techniques, however, will often be used together to examine a company's operations and evaluate its potential as an investment opportunity.

### **Basics of Qualitative Analysis:**

- The distinction between qualitative and quantitative approaches is similar to the difference between human and artificial intelligence.
- Quantitative analysis uses exact inputs such as profit margins, debt ratios, earnings multiples, and the like. These can be plugged into a computerized model to yield an exact result, such as the fair value of a stock or a forecast for earnings growth. Of course, for the time being, a human has to write the program that crunches these numbers, and that involves a fair degree of subjective judgment. Once they are programmed, though, computers can perform quantitative analysis in fractions of a second, while it might take even the most gifted and highly-trained humans minutes or hours.
- Qualitative analysis, on the other hand, deals with intangible, inexact concerns that belong to the social and experiential realm rather than the mathematical one. This approach depends on the kind of intelligence that machines (currently) lack, since things

like positive associations with a brand, management trustworthiness, customer satisfaction, competitive advantage and cultural shifts are difficult, arguably impossible, to capture with numerical inputs.

### **Understanding People and Qualitative Analysis:**

- Qualitative analysis can sound almost like "listening to your gut," and indeed many qualitative analysts would argue that gut feelings have their place in the process. That does not mean, however, that it is not a rigorous approach. Indeed, it can consume much more time and energy than quantitative analysis.
- People are central to qualitative analysis. An investor might start by getting to know a company's management, including their educational and professional backgrounds. One of the most important factors is their experience in the industry. More abstractly, do they have a record of hard work and prudent decision-making, or are they better at knowing - or being related to - the right people? Their reputations are also key: do their colleagues and peers respect them? Their relationships with business partners are also worth exploring since these can have a direct impact on operations.

### **Company Culture and Qualitative Analysis:**

The way employees view the company and its management is important. Are they satisfied and motivated, or do they resent their bosses? The rate of employee turnover can indicate employees loyalty or lack thereof. What does workplace culture say about the company? Overly hierarchical offices promote intrigue and competition and sap productive energy; a sleepy, unmotivated environment can mean employees are mainly concerned with punching the clock. The ideal is a vibrant, creative culture that attracts top talent.

### **Gathering Data for Qualitative Analysis:**

Admittedly, gathering data for qualitative analysis can be difficult. Fortune 500 CEOs are not known for sitting down with retail investors for a chat or showing them around the corporate headquarters. In part, Warren Buffett can use qualitative analysis so effectively because people are willing to give him access to their time and information. The rest of us have to sift through

news reports and companies filings to get a sense of managers records, strategies and philosophies. The management discussion and analysis (MD&A) section of a company's 10-K filing and quarterly earnings conference calls provide a window into strategies and communication styles. Clear, transparent communication and coherent strategies are useful. Buzzwords, evasiveness and shorttermism, not so much.

### **Qualitative Analysis in Context:**

Customers are the only group more crucial to a company's success than management and employees since they are the source of its revenue. Ironically, if a company places customers' interests before shareholders, it may be a better long-term investment. If feasible, it's a good idea to try being a customer. Say you're considering investing in an airline that has reined in costs, beat earnings estimates in three consecutive quarters and plans to buy back shares.

When you try to actually use the airline, however, you find the website bug-ridden, the customer service representatives cranky, the extra fees petty and your fellow passengers resentful. The negative experience tells you that the company has a lack of priority for its customers and to be careful making an investment in the airline. A company's business model and competitive advantage are a vital component of qualitative analysis. What gives the firm an enduring leg up over its rivals? Has it invented a new technology that competitors will find hard to replicate, or that has intellectual property protection? Does it have a unique approach to solving a problem for its customers? Is its brand globally recognized—in a good way? Does its product have cultural resonance or an element of nostalgia? Will there still be a market for it in twenty years? If you can plausibly imagine another company stepping in and doing what this one does just a little bit better, then the barrier to entry may be too low. Why will an un-established company be the one to create or disrupt its chosen market, and why won't it then be replaced in turn?

## **Real World Example of Qualitative Analysis:**

The idea behind quantitative analysis is to measure things; the idea behind qualitative analysis is to understand them. The latter requires a holistic view and a fact-based overarching narrative. Context is key. For example, a CEO who dropped out of college would be a red flag in some cases, but Mark Zuckerberg and Steve Jobs are exceptions. Silicon Valley is, for better or worse, a different beast. A look at McDonald's Corp's (MCD) financials a few years ago would have told you nothing about a looming backlash against, cheap, unhealthy food. On the other hand, a purely qualitative approach is vulnerable to distortion by blind spots, and personal biases. Quantitative measures can act as a check on these tendencies.

## **+ Establishing Objectives:**

- The major outcome of strategic road-mapping and strategic planning, after gathering all necessary information, is the setting of goals for the organization based on its vision and mission statement.
- A goal is a long-range aim for a specific period. It must be specific and realistic. Long range goals set through strategic planning are translated into activities that will ensure reaching the goal through operational planning.
- An objective is a specific step, a milestone, which enables you to accomplish a goal. Setting objectives involves a continuous process of research and decision making. Knowledge of yourself and your unit is a vital starting point in setting objectives.
- Strategic planning takes place at the highest levels; other managers are involved with operational planning. The first step in operational planning is defining objectives - the result expected by the end of the budget (or other designated) cycle.
- Setting right objectives is critical for effective performance management. Such objectives as higher profits, shareholder value, customer satisfaction may be admirable, but they don't tell managers what to do. "They fail to specify priorities and focus. Such objectives don't map the journey ahead - the discovery of better value and solutions for the customer."

- The objectives must be:
  - be focused on a result, not an activity
  - be consistent
  - be specific
  - be measurable
  - be related to time
  - be attainable
  
- **MBO: Setting Objectives:** In Management by Objective (MBO) systems, objectives are written down for each level of the organization, and individuals are given specific aims and targets. Managers need to identify and set objectives both for themselves, their units, and their organizations. Ensure that you set the right objectives if you want to achieve the right results.
- **Applying Feedback Analysis:** Undertake a feedback analysis to compare actual results with expectations. Whenever you take a decision or action, write down what you expect to happen. Review results at regular intervals, and compare them with expectations. Use this feedback analysis as a guide to reinforce strengths and eliminate weaknesses as well as for the next round of setting objectives.

**+ Assigning weight to objectives in order to make the best decision:**

- Relative Importance of Design Objectives - In the few examples, design objectives have equal importance or equal weight. However, this is generally not the case, as some design objectives are more important than others. So how do we decide on relative weight?
  - Subjective values
  - Client and Designer input
  - Systematic Methods
  
- Systematic Weighting Method: Pairwise Comparison
- When there are many Design Objectives, it becomes more difficult to assign weights. It is even difficult to use systematic methods such as the pairwise comparison method. In order to weight a large number of design objectives, it is much more effective to arrange them into hierarchical groups.

- To use this hierarchy for computing weighting factors, we use a two-stage approach:

1. Perform a pairwise comparison (or other weighting method of your choice) for each group and determine a value, 'k' representing the weight of each category/D.O. box within that group. Note: The total value for k for that group must sum to a value of 1.

2. Establish the relative weight 'w' for each category/D.O. box. Where the relative weight w is the relative importance of that category/D.O. within its own group (i.e. k), multiplied by the relative weight (w) of the category in the next highest level from which it comes.

- Finally, we need to Make a Decision! This is done by "combining" the Evaluation Scale Scores with all the Weighted Design Objectives into a single "Decision Table".

#### **+ Implementing Decisions:**

##### **Develop a plan for implementation:**

- Step-by-step process or actions for solving the problem
- Communications strategy for notifying stakeholders
- Where important or necessary, inform those who care for you and/or will be affected by the change.

Prepare them as necessary about your decision

- Resource identification/allocation
- Timeline for implementation

##### **Monitoring Progress:**

- Your implementation will only be successful if you are monitoring your solution, the effects of it on resources and stakeholders, your timeline, and your progress. As you monitor your progress, if results are not what you expect, review your options and alternatives.

- Whether or not you achieved your goals, it is important to consider what you have learned from your experience: about yourself, about what you consider important.

- Lastly, if you have done your best, you have this as one measure of success.

- A logical and ordered process can help you to do this by making sure that you address all of the critical elements needed for a successful outcome.



- Working through this process systematically will reduce the likelihood of overlooking important factors. Our seven-step approach takes this into account:

1. Create a constructive environment
2. Investigate the situation in detail
3. Generate good alternatives
4. Explore your options
5. Select the best solution
6. Evaluate your plan
7. Communicate your decision, and take action.

**Prioritize actions and assign roles (setting priorities for taking action):**

- To help you manage your team's workload and hit deadlines, here are 6 steps to prioritizing projects that have a lot of moving parts.

**1. Collect a list of all your tasks:** Pull together everything you could possibly consider getting done in a day. Don't worry about the order or the number of items up front.

**2. Identify urgent v/s important:** The next step is to see if you have any tasks that need immediate attention. We're talking about work that, if not completed by the end of the day or in the next several hours, will have serious negative consequences (missed client deadline; missed publication or release deadlines, etc.). Check to see if there are any high-priority dependencies that rely on you finishing up a piece of work now.

**3. Assess value:** Next, look at your important work and identify what carries the highest value to your business and organization. As a general practice, you want to recognize exactly which types of tasks have top priority over the others.

For example, focus on client projects before internal work; setting up the new CEO's computer before re-configuring the database; answering support tickets before writing training materials, and so on. Another way to assess value is to look at how many people are impacted by your work. In general, the more people involved or impacted, the higher the stakes.

**4. Order tasks by estimated effort:** If you have tasks that seem to tie for priority standing, check their estimates, and start on whichever one you think will take the most effort to complete. Productivity experts suggest the tactic of starting the lengthier task first. But, if you feel like you can't focus on your meatier projects before you finish up the shorter task, then go with your gut and do that. It can be motivating to check a small task off the list before diving into deeper waters.

**5. Be flexible and adaptable:** Uncertainty and change are given. Know that your priorities will change, and often when you least expect them to. But—and here's the trick—you also want to stay focused on the tasks you're committed to completing.

**6. Know when to cut:** You probably can't get to everything on your list. After you prioritize your tasks and look at your estimates, cut the remaining tasks from your list, and focus on the priorities that you know you must and can complete for the day. Then take a deep breath, dive in and be ready for anything.

#### **Follow-up at milestones:**

- A milestone is a marker in a project that signifies a change or stage in development.

Milestones are powerful components in project management because they show key events and map forward movement in your project plan.

- Milestones act as signposts through the course of your project, helping ensure you stay on track. Without project milestone tracking, you're just monitoring tasks and not necessarily following the right path in your project.

- Milestones can do more than just show progress – they can help you communicate what's happening with your project. TeamGantt features project milestones in its free project management software, so it seamlessly syncs with all of your gantt chart's moving parts.

- The difference between a task and a milestone You're not building a rocket here—you're building a project plan, and the components aren't that complex. That said, distinguishing between tasks and milestones can be difficult on larger projects, or if the project you're

managing just isn't within the realm of your expertise (yet).

- If you've ever been confused about what is (or isn't) a milestone in your project plan, ask yourself these questions:

1. Is this a task or a deliverable?
2. Will this impact the final deadline?
3. Is this an important moment in the project that will indicate forward progress?
4. Does this need to be reviewed by stakeholders
5. Is this an event that impacts the project?

- Essentially, you want to make the most important events of your project milestones so they can be easily seen and mapped by the project team. Milestones are given additional significance over tasks in a plan so the project manager can track the tasks while the team and stakeholders focus on forward progress.

**- Project management milestone examples:**

Milestones make it easier to keep projects on track by calling out major events, dates, decisions, and deliverables. Here are a few examples of project milestones you might include in your plan:

- Start and end dates for project phases
- Key deliveries
- Client and stakeholder approvals
- Important meetings and presentations
- Key dates or outages that may impact your timeline

- Let's dig a little deeper and explore 3 specific examples of how using project milestones can benefit your projects.

- Monitor deadlines: No plan is ever complete without a list of deadlines! The best way to make them noticeable is to use the project management milestones and deliverables technique. What does this mean? Make the deliverables project milestones.

- Why do this? Well, it's no secret that not everyone wants to pore over your beautiful project plan to find key dates. Most people—your teammates included—want a top-level view of key dates and events. Milestones are great for this purpose because they're called out in a special way—usually with a diamond—in project plans.

- While you should list the tasks and effort leading up to a project milestone, be sure to present the milestone at the end of those tasks to signify a delivery, or even a presentation of, the deliverable.
- Here's an example of a project milestone that's been used to mark the publishing deadline for a blog post.
- Spotlight important dates: Are there days from now until the end of your project that could impact your project in some way? Maybe your team will need to be out of the office for a mandatory training. Maybe there's a board meeting you're expected to attend.
- It's important to keep all of these important events in mind when you're planning project because they could possibly impact your project schedule. So why not include them as project milestones so you can track them all in one place?
- In example the, this team's off-site strat-op meeting has been added to the project plan as a milestone so work can be scheduled around it.

### **Identify potential project bottlenecks:**

- Many projects rely on the work produced by external teams or partners to make forward progress. If you're not tracking those external factors somewhere, there's a great chance you'll forget to follow-up on it.
- That's why it's important to list these deliverables as project milestones if you're working on a project that depends on someone or something outside of your project. Here's an example of what that might look like for a client approval.

### **How to create a project milestone:**

- Creating milestones for your project plan can be simple, especially with TeamGantt. Once you've mapped out your overall process and plan with your team, you can easily add tasks, identify gantt chart milestones, and determine task owners. Adding a milestone (or converting a task to a milestone) is very easy in TeamGantt.
- Project milestones are easy to create and even easier to track because you've called out the most important points in your project.

## **How to share project milestones with clients and stakeholders:**

- Want to give clients and stakeholders a high-level view of the project? Simply follow these steps to share a PDF of key project milestones in your gantt chart.

**1. Filter your project by milestones:** From your gantt chart view, click the All Dates menu at the top of your gantt chart, and select Only Milestones from the drop-down.

**2. Export your filtered project to a PDF file:** Navigate to your project's Menu, and select Print/Export PDF from the drop-down. Customize your PDF settings, then click View PDF to complete the export. From there, you can download and/or print your PDF to share with clients and stakeholders.

## **Hit every project milestone with ease:**

- TeamGantt makes it easy to create, track, and collaborate on all your project milestones so nothing slips through the cracks.

- You'll have all the features you need to ensure projects finish on time and under budget—from drag and drop simplicity and team collaboration to customizable views and workload management.

- Best of all, it's all wrapped up in a simple and intuitive interface your whole team will love.