Module 4 : Planning Projects

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ILOC: Project Management (Autonomy)

Agenda : Planning Projects

- Crashing project time
- Resource loading and leveling
- Goldratt's critical chain
- Project Stakeholders and Communication plan.
- **Software Risk Management:** Identify IT Project Risk
- Risk Analysis and Assessment
- Risk Strategies
- Risk Monitoring and Control
- Risk Response and Evaluation.

Cost Analysis

- The two important components of any activity are the cost and time. Cost is directly proportional to time and vice versa.
- For example, in constructing a shopping complex, the expected time of completion can be calculated using the time estimates of various activities. But if the construction has to be finished earlier, it requires additional cost to complete the project.
- We need to arrive at a time/cost trade-off between total cost of project and total time required to complete it.

What is Project Crashing?

- **Reducing a project's completion time** is called **crashing.**
- Project Crashing is when you shorten the duration of a project by reducing the time of one or more tasks
- Crashing is done by increasing the resources to the project, which reduces the duration of project and the tasks gets completed earlier than planned. This also **adds to the cost of the overall project**
- The primary objective of project crashing is to shorten the project keeping costs at a minimum

Project Crashing

- Crashing a project starts with using the normal time to create the critical path
- The normal cost is the cost for completing the activity using normal procedures
- If the project will not meet the required deadline, extraordinary measures must be taken
- The crash time is the shortest possible activity time and will require additional resources
- The **crash cost** is the price of completing the activity in the earlier-than-normal time.

While crashing, you will monitor other paths as well. It is possible that the duration of other paths could become equal or greater than your critical path.

Project Crashing

- The crashing cost refers to the activity cost under the crashing activity time.
- This relationship is assumed to be linear. Hence for each activity a crash cost per period (eg. per week) can be derived as follows:
- Crash cost per period = (Crash cost - Normal cost) / (Normal time - Crash time)

Cost Analysis

Normal time:

Normal time is the time required to complete the activity at normal conditions and cost.

Crash time:

Crash time is the shortest possible activity time; crashing more than the normal time will increase the direct cost.

Cost Slope

Cost slope is the increase in cost per unit of time saved by crashing. A linear cost curve is shown in Figure 8.27.

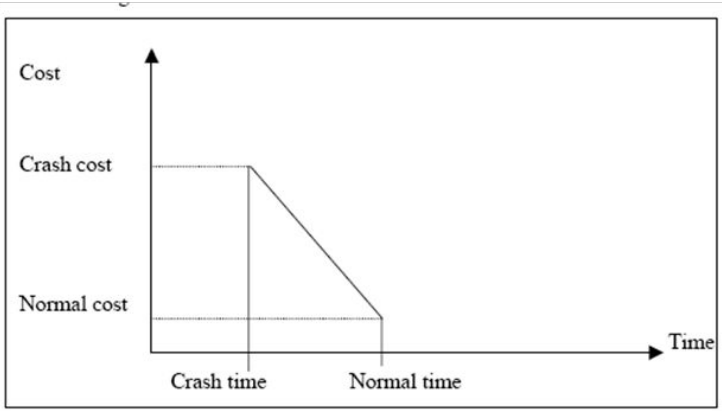


Figure 8.27: Linear Cost Curve

$$\text{Cost slope} = \frac{\text{Crash cost } C_c - \text{Normal cost } N_c}{\text{Normal time } N_t - \text{Crash time } C_t}$$

$$= \frac{C_c - N_c}{N_t - C_t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Project Crashing

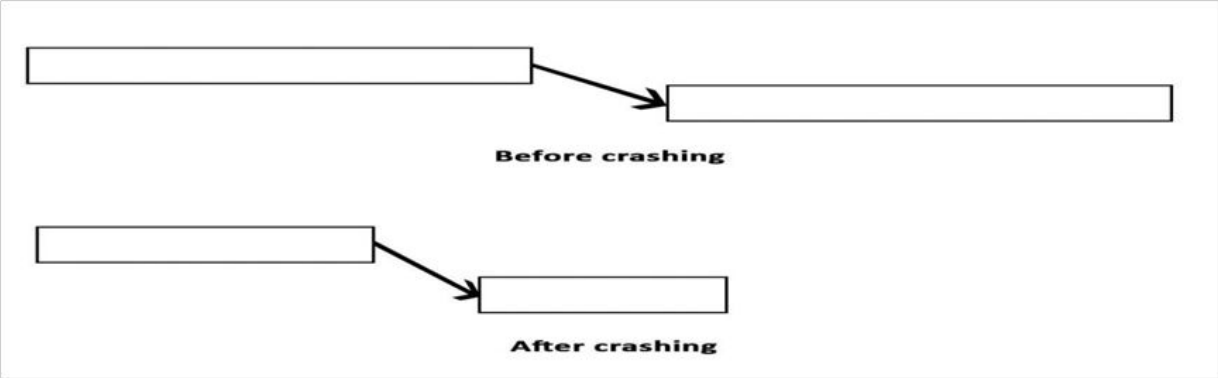
An activity takes 4 days to complete at a normal cost of Rs. 500.00. If it is possible to complete the activity in 2 days with an additional cost of Rs. 700.00, what is the incremental cost of the activity?

Incremental Cost or Cost Slope

$$= \frac{C_c - N_c}{N_t - C_t} \qquad = \frac{700 - 500}{4 - 2} = \text{Rs. } 100.00$$

It means, if one day is reduced we have to spend Rs. 100/- extra per day.

Project Crashing



Eg: Construction of a Room

According to the duration estimate, two masons **will take four days to complete it**.You have to **reduce the duration of this activity by crashing**. You **add two more masons to complete the task in two days.** Sometimes, crashing may not produce the desired result. Getting skilled resources is not easy. and they take time to settle. You cannot bring in a new group of people and expect them to perform immediately. Therefore, it is possible that the cost will increase without any significant gain. Perform due diligence before using crashing.

Project Crashing : Procedure

- **Step1:** Draw the network diagram and mark the Normal time and Crash time.
- **Step2:** Calculate TE (Earliest Expected Time) and TL (Latest Allowable time) for all the activities.
- **Step3:** Find the critical path and other paths.
- **Step 4:** Find the slope for all activities and rank them in ascending order.
- **Step 5:** Establish a tabular column with required field.
- **Step 6:** Select the lowest ranked activity; check whether it is a critical activity. If so, crash the activity, else go to the next highest ranked activity.
- **Note: The critical path must remain critical while crashing.**
- **Step 7:** Calculate the total cost of project for each crashing
- **Step 8:** Repeat Step 6 until all the activities in the critical path are fully crashed.

Project Crashing : Example

If the indirect cost is Rs. 20 per day, crash the activities to find the minimum duration of the project and the project cost associated.

The following Table 8.13 gives the activities of a construction project and other data.

Table 8.13: Construction Project Data

Activity	Normal		Crash	
	Time (days)	Cost (Rs)	Time (days)	Cost (Rs)
1-2	6	50	4	80
1-3	5	80	3	150
2-4	5	60	2	90
2-5	8	100	6	300
3-4	5	140	2	200
4-5	2	60	1	80

Project Crashing : Solution

From the data provided in the table, draw the network diagram (Figure 8.28) and find the critical path.

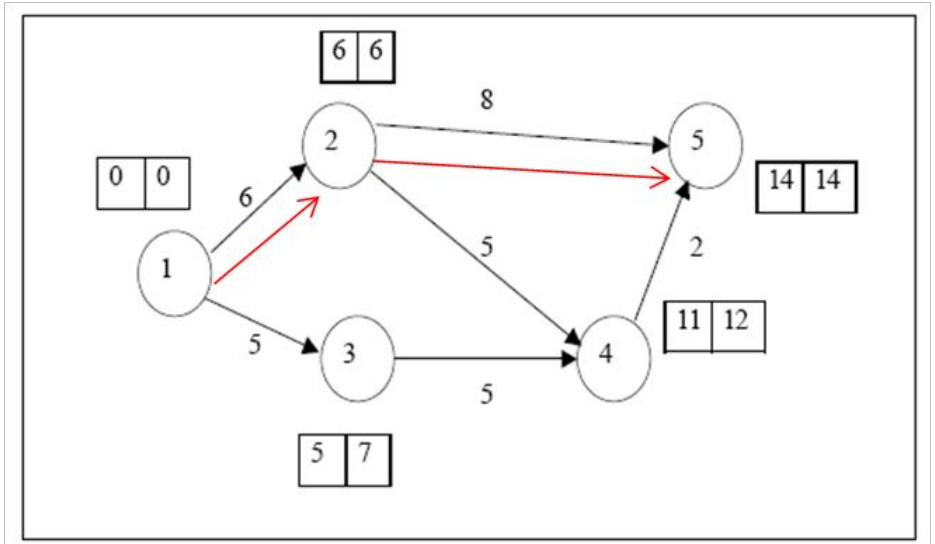


Figure 8.28: Network Diagram

From the diagram, we observe that the critical path is 1-2-5 with project duration of 14 days

The cost slope for all activities and their rank is calculated as shown in Table 8.14

Table 8.14: Cost Slope and Rank Calculated

Activity	Cost Slope	Rank
1-2	15	2
1-3	35	4
2-4	10	1
2-5	100	5
3-4	20	3
4-5	20	3

Project Crashing : Solution

From the data provided in the table, draw the network diagram (Figure 8.28) and find the critical path.

$$\text{Cost slope} = \frac{\text{Crash cost } C_c - \text{Normal cost } N_c}{\text{Normal time } N_t - \text{Crash time } C_t}$$

The cost slope for all activities and their rank is calculated as shown in Table 8.14

$$\text{Cost Slope for activity } 1-2 = \frac{80-50}{6-4} = \frac{30}{2} = 15$$

Table 8.14: Cost Slope and Rank Calculated

Activity	Cost Slope	Rank
1-2	15	2
1-3	35	4
2-4	10	1
2-5	100	5
3-4	20	3
4-5	20	3

Project Crashing : Solution

The available paths of the network are listed down in Table 8.15 indicating the sequence of crashing (see Figure 8.29).

Table 8.15: Sequence of Crashing

Path	Number of days crashed
1-2-5	~~14~~ ~~12~~ ~~11~~ 10
1-2-4-5	~~13~~ ~~11~~ 10
1-3-4-5	~~12~~ ~~11~~ 10

The sequence of crashing and the total cost involved is given in Table 8.16 Initial direct cost

= sum of all normal costs given

= Rs. 490.00

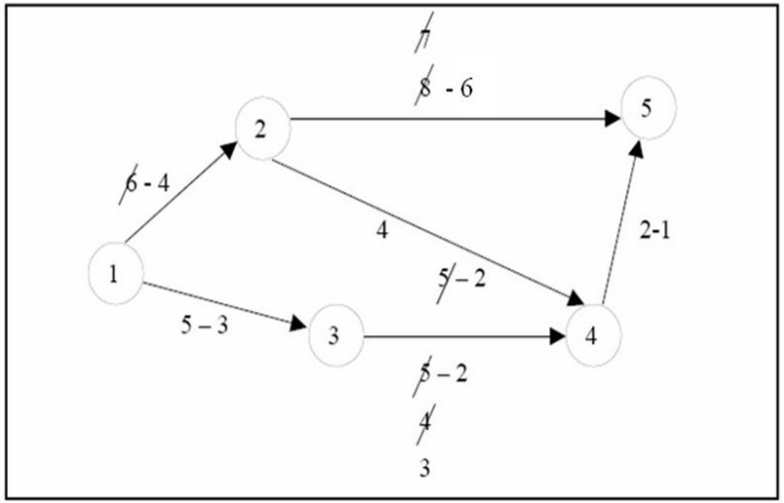


Figure 8.29: Network Diagram Indicating Sequence of Crashing

Project Crashing : Solution

Activity Crashed	Project Duration	Critical Path	Direct Cost in (Rs.)	Indirect Cost in (Rs.)	Total Cost in (Rs.)
-	14	1-2-5	490	14 x 20 = 280	770
1 – 2(2) 2 – 5(2) 2 – 4(1) 3 – 4(2)	10	1 – 2 – 5 1 – 3 – 4 – 5 1 – 2 – 4 – 5	490 + (2 x 15) + (2 x 100) + (1 x 10) + (2 x 20) = 770	10 x 20 = 200	970

It is not possible to crash more than 10 days, as all the activities in the critical path are fully crashed. Hence the minimum project duration is 10 days with the total cost of Rs. 970.00.

Assignment - 1

1. You are required to prepare a network diagram for constructing a 5 floor apartmer
The major activities of the project are given as follows:

Activity	Description	Immediate Predecessor
A	Selection of site	-
B	Preparation of drawings	-
C	Arranging the for finance	A
D	Selection of contractor	A
E	Getting approval from Govt	A
F	Laying the foundation	E
G	Start construction	D, F
H	Advertise in newspaper	B, C
I	Allocation of tenants	G, H

2. For the problem No.1 the time estimates in days are given. Determine the Time earliest and Time latest, and the critical activities

Activity	A	B	C	D	E	F	G	H	I
Time (days)	3	5	7	2	5	20	60	2	10

Assignment - 1

Draw a network diagram for the project:

Activity	A	B	C	D	E	F	G	H	I	J
Predecessor	-	A	B	B	B	C	C	F, G	D, E, F	I

A national conference is planned in a college. The activities are listed down along with their predecessors and time taken. Prepare a network diagram and determine the critical activities.

Activity	Description	Immediate Predecessor	Duration (days)
A	Confirm lead speaker and topic	-	5
B	Prepare brochure	-	1
C	Send letters to other speakers	B	2
D	Get confirmation from speakers	C	5
E	Send letters to participants	C,D	2
F	Obtain travel plans from speakers	D	2
G	Arrange for accommodation for speakers	F	1
H	Get handouts from speakers	F	4
I	Finalize registrations	G,H	10
J	Arrange hall and AV	I	1
K	Conduct of programme	J	1

Assignment - 1

For the PERT problem find the critical path and project duration. What is the probability that the project will be completed in 25 days?

Activity	Predecessor	Time		
		Optimistic	Most likely	Pessimistic
A	-	2	5	14
B	-	1	10	12
C	A	0	0	6
D	A	1	4	7
E	C	3	10	15
F	D	3	5	7
G	B	1	2	3
H	E,F	5	10	15
I	G	3	6	9

Assignment - 1

The following table lists the jobs of a network along with their estimates.

Activity	Time (Weeks)		Cost (Rs)	
	Normal	Crash	Normal	Crash
1-2	9	4	1300	2400
1-3	15	13	1000	1380
2-3	7	4	7000	1540
2-4	7	3	1200	1920
2-5	12	6	1700	2240
3-6	12	11	600	700
4-5	6	2	1000	1600
5-6	9	6	900	1200

Assignment - 1

a.Draw the project network diagram.

b.Calculate the length and variance of the critical path.

c.What is the probability that the jobs on the critical path can be completed in 41 days?

Project Crashing Management Stages

- Critical Path : Analyze the critical path of your project. It helps to determine which tasks can be shortened to bring the project to a close sooner.
- Identify tasks : Get list of all tasks and start looking for ways to tighten up those tasks.
- What's the trade off? : Once tasks are identified, calculate how much adding more resources will cost. Finalize with least amount of strain in the budget.
- Make your choice : Make a wise decision, ensure that getting the most in return for that extra expense.
- Create a Budget : Execute your project crashing plan. Also need to update your baseline. schedule and resource plan as per the new initiative.

Examples : Project Crashing Techniques

.A few examples of crashing techniques are:

- Overtime
- More resources
- Monetary rewards

Crashing cannot be applied to all activities.

What is resource loading?

- **Resource loading** is your total assigned hours of work divided by the number of hours you have to do the work.
- Resource loading is looked at on a per day, per week, per month, or per the **duration of the project** basis.
- Resource loading = hours of work per time period / hours of capacity per time period
- **For Example :** As project managers we expect a resource loaded to 75% to complete 30 hours of planned work each week (40 hours of capacity), or 6 hours a day. The other 10 hours that week is expected to be spent doing other stuff that is not in the plan, or is not related to the project (e.g., training, department meetings, etc.,)

How to calculate resource loading?

There are two options:-

- Estimate all the work needed (each day) and divide by the resource's full capacity(8hrs per day).
- Alternatively, estimate the work needed on the project tasks and divide by the resource's availability to do those project tasks (usually much less than 8hrs per day).

How to calculate resource loading?

Either way, you must account for time that is not available for completing the project tasks in your plan including:

- project-related meetings and ad-hoc discussions (which aren't included in the plan)
- regularly scheduled staff meetings
- work that the person is assigned to other projects
- time spent supporting products that have already launched
- vacation time
- even bathroom breaks,and alot more.

How to calculate resource loading?

- In fact, the more diverse a person's activities are, the more time is added in the form of switching costs which are also quite significant.
- These other activities are largely unavoidable, and often take priority over project tasks.
- The time left for our planned project tasks is almost always a lot less than we planned for.

Resource Leveling

- **Resource leveling** is traditionally defined as: "**The process of using a company's resources in the most efficient way possible.**"
- However, high efficiency is the same as high utilization, which generally results in low throughput, and **throughput is where the profit is .....**
- Project plans must first be based on realistic estimation of work package and time duration required to complete the project
- The most effective plan accounts for foreseeable and unforeseeable work or task emerging out during project execution phase due to fast changing global scenario.
- Resources required in such unforeseeable conditions are also accounted for in the plans to complete the task within the time stipulated.
- Visibility of issues before they occur is critical certainly where people's workloads are concerned

Difference between Resource Leveling & Resource Loading

- Resource loading is the process of assigning resources to tasks in a project.
- It involves determining the number of resources needed to complete a task, the duration of the task, and the cost of the resources.
- Resource leveling is the process of adjusting the resources assigned to tasks in order to ensure that the project is completed on time and within budget.

Resource Loading Chart

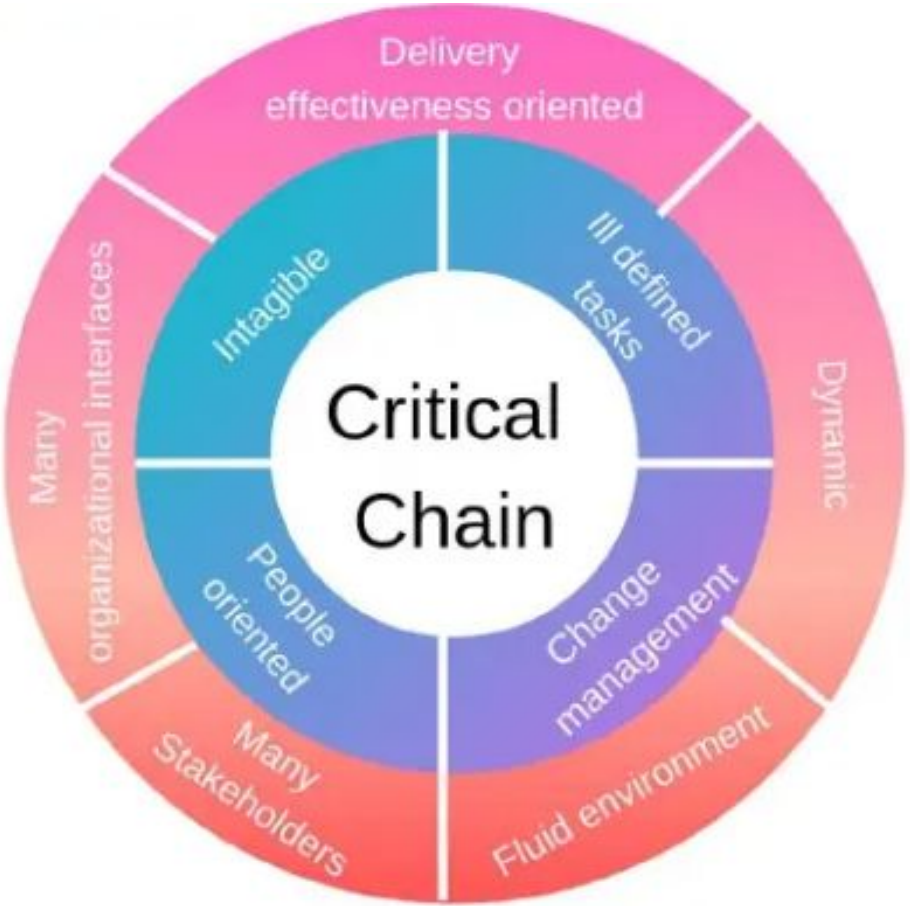
Activity	Resource	Duration	ES	Slack	LF
A	6	4	0	0	4
B	2	1	4	0	5
C	2	3	4	4	11
D	7	4	5	0	9
E	3	2	9	0	11
F	6	1	11	0	12

2. Produce a table that shows the duration, early start, late finish, slack, and resource(s) required for each activity.

Goldratt's Critical Chain

- Dr. Eliyahu Goldratt was Israeli and was known as "a business management guru". He was an educator, a physicist, a theorist as well.
- In 1997,Goldratt Introduced the Critical Chain methodology to apply '**Theory of Constraints**' concepts to manage projects.
- The Critical Chain methodology expands on the notion of a critical path and helps determine where buffers should be placed to prevent unplanned disruptions from delaying project completion.
- To schedule work is also to schedule resource usage. Resource availability constraints all solutions to the scheduling problem.
- Project management is fundamentally concerned with effectively trading off performance, cost, and time.

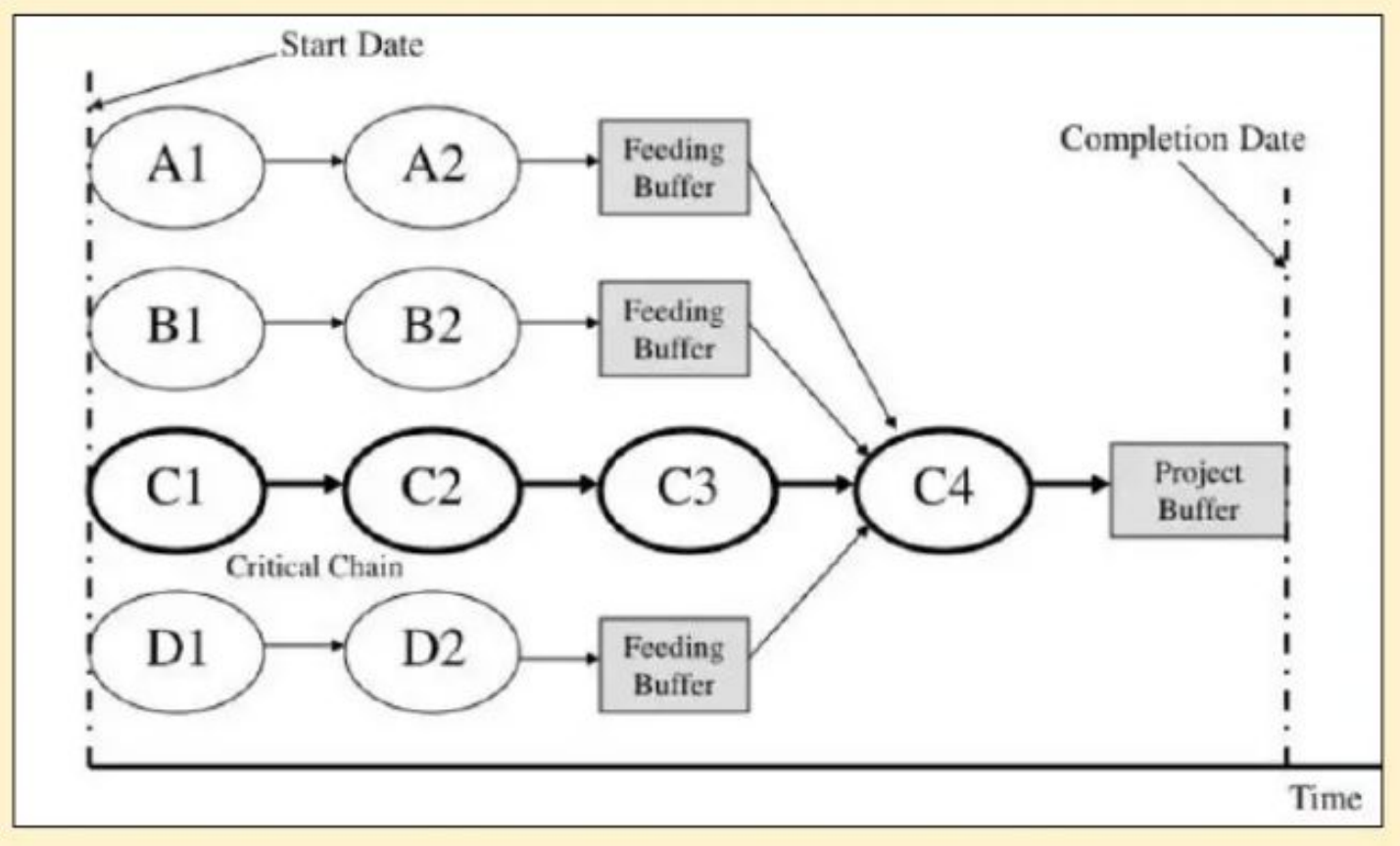
Goldratt's Critical Chain



Goldratt's Critical Chain - Concept

- A **project has four sets of activities** that must be completed before a synchronization operation,represented by 4 can be completed.
- Use historical data to obtain an estimate of the average time for each activity.
- Sum these estimates to obtain the average time it takes each series of activities that must be completed before 4 can begin.
- An analysis reveals that the series of activities with the longest average time is C1-C2-C3
- This is the Critical Chain and the activities along the critical chain are termed critical activities.

Goldratt's Critical Chain - Concept



Buffers and Critical Chain

- In traditional estimates, people often add a buffer to each task and use it if it's needed or not.
- A buffer is additional time to complete a task.
- This time is added to when there is multitasking, distractions, interruptions, fear that estimates will be reduced and Murphy's Law.
- Murphy's Law states that if something can go wrong, it will, Critical chain scheduling removes buffers from individual tasks

Types of Buffers

- **Project Buffer:** The project buffer is placed between the final scheduled task of the critical chain and the estimated project end-date...
- **Feeding Buffer:** Adding such a buffer to the schedule makes it possible to avoid situations when missed completion dates of non-critical chain tasks have an impact to individual tasks of the critical chain...
- **Resource Buffer:** It is a portion of time required by critical resources to complete their critical chain tasks...
- **Capacity Buffer (optional):** This type of buffers assumes that for a multi-project environment there is a need to plan for on-call resources by adding more costs covering the resources to the overall budget

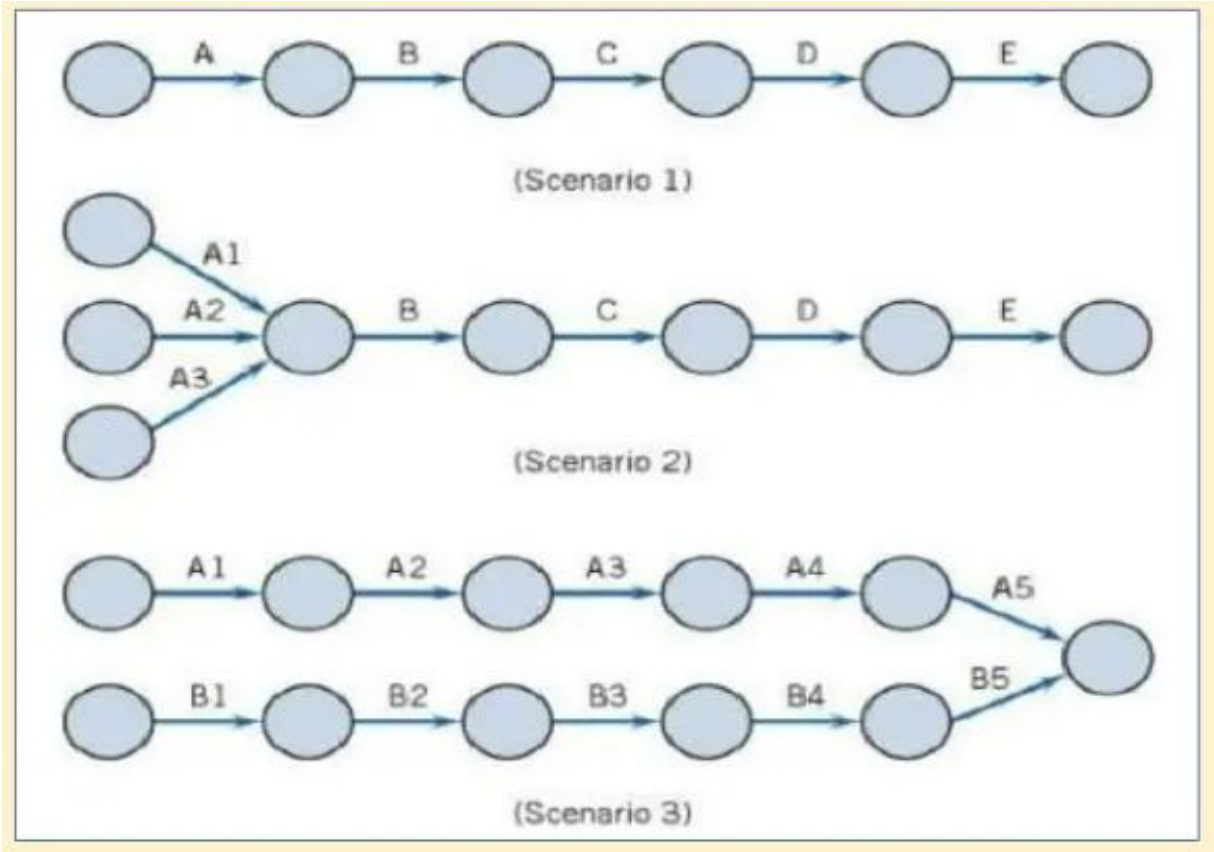
Estimating Task Times - 3 Project Scenario

The primary difference the degree of interdependence across the paths.

- **Scenario 1** : there is only a single path
- **Scenario 2** : the path B-C-D-E is preceded by three activities A1, A2, & A3. The completion of path B-C-D-E depends on which of its three preceding tasks takes the longest
- **Scenario 3** : there are two completely independent paths each consisting of five tasks

- All three tasks require 10 days to complete.

Three Project Scenario



Critical Chain Project Management

- Identify the critical chain: set of tasks that determine the overall duration of the project
- Use deterministic CPM model with buffers to deal with uncertainty
- Remove padding from activity estimates (otherwise, slack will be wasted). Estimate Task durations at median.
- Place project buffer after last task to protect customer's completion schedule
- Exploit Constraining Resource(s)

Critical Chain Project Management

- Avoid wasting slack times by encouraging early task completions
- Have project team focus 100%effort on critical tasks
- Work Your plan and avoid tampering
- Carefully Monitor And Communicate buffer status.

Three Project Scenario

- Project Times are not known with certainty
- Activities that takes less than the expected time tend to cancel out the variability of activities that take more than the expected completion time for the project.

	Scenario 1	Scenario 2	Scenario 3
Average	50.4	51.9	53.4
Std Dev	7.1	6.3	5.3
Max	69.4	72.7	69.3
Min	30.1	36.1	39.3
Median	50.0	51.8	53.1

Project Stakeholders Communication Plan

- A stakeholder communication plan is a strategy developed by an organization to better connect with its stakeholders and to assess their feedback regarding major projects on the company agenda.
- **The primary goals are:**
  - To help the organization meet its goals and achieve its long-term objectives.
  - To maintain or improve relationships with the people who can influence the organization's success , also called key stakeholders or target audience.
  - To improve the effectiveness of the company's operations.

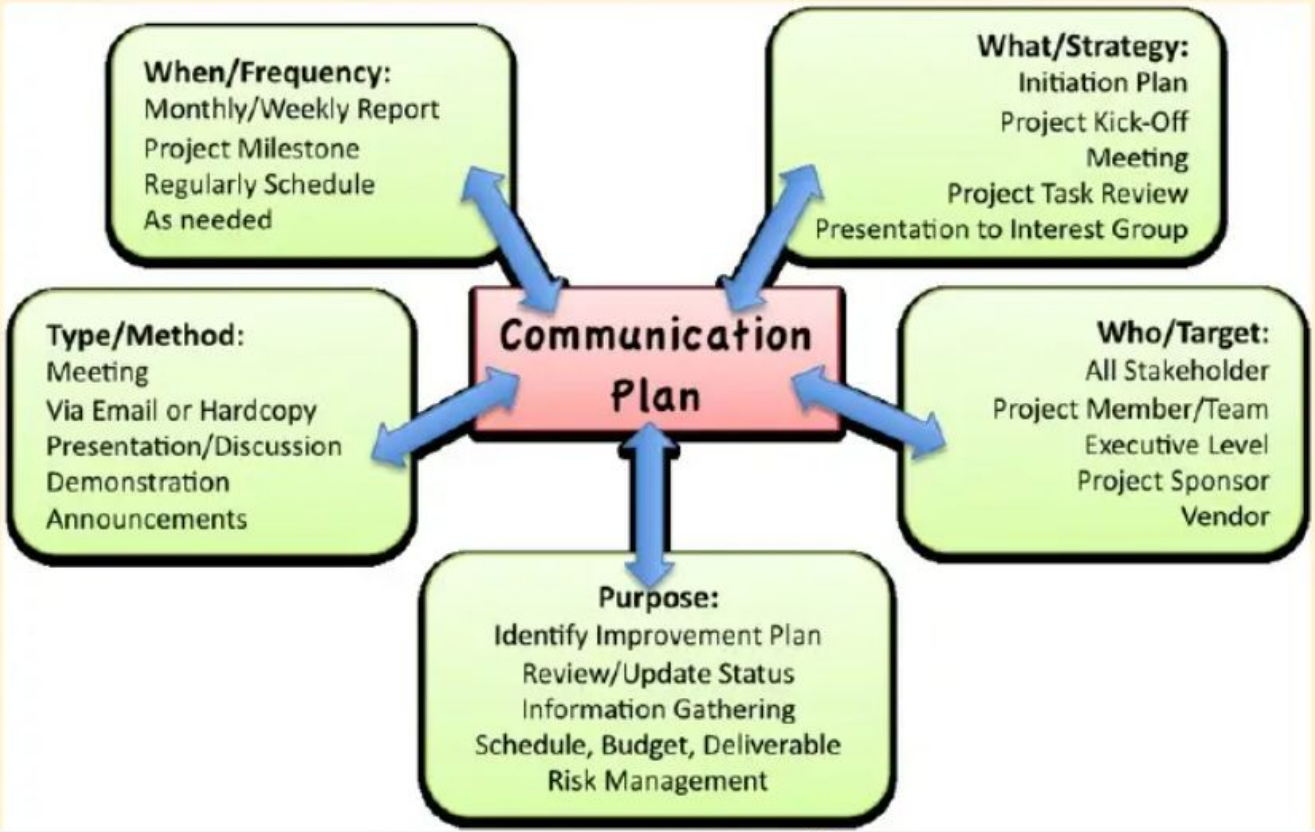
6 Ways to effectively Communicate with stakeholders

- Schedule a meeting
- Send out a newsletter
- Separate online “screen to screen” meetings…
- Project summary report
- Schedule a conference call
- Lunch meetings

7 Ways to effectively Communicate with stakeholders

- Identify key stakeholders and plan communications
- Email and e-Newsletters
- Communication automation
- Presentations..
- Project Summary reports
- Group video call or ‘screen to screen’ meetings..
- Leverage informal stakeholder communications.

Block concept of Project Communication Plan



Sample of project communication plan

	Purpose	Medium	Frequency	Audience
Kickoff meeting	Introduce the project, confirm the project objectives, goals, and deliverables	In-person meeting (don't forget to send the video conference link to remote team members)	A one-off event, at the beginning of the project	Project team, project sponsor, general manager, product manager, senior engineer, additional stakeholders
Project team meetings	Review the status of the project	In-person meeting	Every Monday at 9 A.M.	The project team: project manager, UX designer
Check-ins (meeting recap)	Updates the interested parties on the project status based on the notes from the project team meeting	Email	Every Monday morning	Project sponsor, stakeholders
Project status meetings	Update leadership on the project status and give an opportunity to ask questions.	Video conference call	Monthly	Project manager, project sponsor, stakeholders
UX design review	Give the project sponsor the opportunity to provide feedback on the website design	In-person meeting (email with the design attached, should be sent prior to the meeting)	A one-off event, right after the initial UX design is complete	UX designers, project sponsors