SECTION-III

Resource Allocation & Monitoring The Control

Introduction:

Resource allocation is the process of assigning and scheduling available resources in the most effective and economical way possible. Projects will always need resources but they can often be scarce. The task, therefore, lies with the project manager to determine the proper timing and allocation of those resources within the project schedule.

So, what is resource allocation in project management? It is the management and delegation of resources throughout a project to ensure that it runs as smoothly and successfully as possible.

Types of Resources:
On an enterprise level, resources can be human and non-human. Some examples of resources for the projects are:

Labor:
They constitute team members or employees and contingent staff with different skill sets and form the backbone of any project.

Equipment/Tools:
It includes everything from software to hardware, depending on the organization's type.

Facilities:
It comprises the environment needed for executing a project, such as a conference room or office space.

Materials:
These are the consumables required to generate outputs. For example, office stationery, raw materials to build a house.

Budget:

Finance needed to purchase any of the above resources.

2. Examples of resource allocation in project management

An efficient resource allocation strategy allows the effective distribution of the available resources to several projects. This activity also requires regular updates to achieve the future goal of the organization.

A project manager often needs to carry out delivery responsibilities with fewer resources. So how to do project resource allocation under these circumstances? Does one identify each resource's primary skill set and assign them to open positions, or is there a better way?

Let's look at some of the specific scenarios in a project:

- Let us take an example of resource allocation in an IT project. Architect positions are critical for delivery. They are expensive and less in numbers. They need to be involved at the beginning of the project for system design related work. In this case, can I afford to dedicate an architect to a specific project, or they need to work on multiple projects?
- The second example could be when a project manager tries to deliver several projects with fewer resources. Should I put some of the low-priority projects on hold or extend its timeline as there is a resource crunch? Shall I allocate my existing resources only for the high priority projects?
- In another resource allocation example, let us assume that one has the required capacity and enough work in hand. But there is a mismatch in the skill set among the available resources. So, how do I effectively utilize the existing resources by building secondary skills? Can I take the risk of allocating a resource that matches approximately 60% of the job description?
- There are many projects. But the tasks do not require full-time involvement of the resources. In this situation, how do I ensure that I do not over/under allocate a resource?

These are all pertinent questions and do not have any standard answers. The decision on resource allocation in a matrix organization depends on its current situation and immediate priorities. At times resources may need to be out rotated from a low-priority project with suitable backfill depending on business priority. These are some of the examples of resource allocation problems in a dynamic business environment.

3. What are common resource allocation problems in project management?

Although resource managers initially conduct the allocation process, continuous change in project demands makes it a daunting task. Let us analyze some of the common resource allocation problems.

A. Use of legacy tools or spreadsheets:

Many organizations are still using homegrown half-baked solutions like spreadsheets for project resource allocation because it is readily available. These legacy tools fail to provide accurate real-time data for resource allocation, leading to discrepancies and double bookings. Spreadsheets are incredibly time-consuming, limiting, and a nightmare to maintain.

B. Frequent changes in project scope:

In an agile world, the project scope can change anytime during its lifecycle. Change in project requirements can lead to fluctuating resource demands. So, without an updated resource schedule, frequent allocations to meet the dynamic demands becomes challenging. Sudden closure of a large project will also increase the bench size that can affect the bottom line.

C. Unable to predict resource availability:

While allocating resources to a project, resource managers typically look at the existing resource pool. Additionally, they need to have a backup contingency resource allocation plan rather than entirely relying on a specific person. Some team members can suddenly fall sick, or it may be difficult to get time out of a shared resource because of other commitments. Since resource availability can suddenly change, it can be a roadblock in project resource allocation.

D. Project uncertainties causing delays:

Even after meticulously ticking all the checkboxes such as project scope and constraints, uncertainties can crop up anytime during the project lifecycle. There could be a delay in the project start date, and you may need to block certain resources without billing. Project managers must promptly respond to these project uncertainties, e.g., dynamic resource allocation, including juggling resources within projects or reassigning them.

E. Limited resources in a multi-project environment:

Some organizations run multiple projects simultaneously, which means sharing limited resources to complete the delivery. Negotiating with other project managers over the same resources could lead to a change in project priorities for one of the projects. It also means that one of the other projects gets stalled and eventually delayed.

F. Lack of knowledge and communication:

Sometimes, project managers lack business knowledge. Due to communication gaps with the team members, they cannot estimate the resource requirements on time. With an incorrect resource demand, the project lands up with either an excess or shortfall of resources. It gets noticed during the execution, and the project can get adversely impacted. Excess resources will blow up the project cost, where fewer resources can cause delivery delays.

G. Location and time zone differences:

Due to globalization, many organizations have implemented an onsite/offshore/nearshore strategy to control cost. Resources are allocated in different geographies covering different time zones for the same project. As a result, there is a lack of coordination between the key members, which can cause project delays. Limited overlapping business hours between the two countries can only provide a small window to hold important meetings and knowledge sharing.

4. Importance of resource allocation in project management

Unavailability of a critical resource can cause project delay and adversely affect overall task dependencies.

According to PMI, "*50% of projects fail to deliver on time out of which 23% cite poor resource allocation as the primary cause*".

A systematic resource allocation process ensures that resources are available when required. Let's look at some of the benefits of resource allocation in project management.

A. Minimize project resource cost significantly:

Resource allocation tool helps you to identify and allocate the best-fit resource instead of first-visible resources. It enables you to deploy cost-effective global resources across matrix boundaries, thereby reducing project resource costs significantly. Resource allocation in project management maintains profitability by uniformly distributing resources across all projects instead of assigning them to a high priority one.

Deloitte Global Cost Survey reveals, "*Cost reduction scores over other business initiatives.*"

B. Maximize profitable resource utilization:

Simply assigning all your resources to projects does not ensure profitability. They could be working on non-billable or mundane operational tasks. Businesses must ensure optimum resource utilization, and resource allocation helps achieve that and more. Using real-time information and forecasting methods, resource managers can take corrective measures to avoid under or overallocation in advance. Mobilizing resources from non-billable work and allocating them to strategic/billable work ensures profitability.

C. Find the right resource using centralized visibility:

A resource allocation tool captures resource-related information in real-time and consolidates them on a centralized platform. 360-degree visibility helps assign resources to projects based on qualifications, skills, experience, availability, costs, and other selection criteria. Centralized visibility and real-time updates avoid data redundancy and discrepancies that could lead to double booking chaos. It is one of the significant benefits of resource allocation.

D. Deliver projects on time and within budget:

Delivering projects on time and within budget ensures project success, increases client satisfaction, and maintains your organization's reputation. Efficient allocation of resources in project management ensures that under or over skilled resources are not assigned to projects. Under skilled resources cause project delays, whereas overqualified team members can spike project resource costs. Therefore, resource allocation is critical to project management.

E. Diversify employee skill sets for increased billability:

Encouraging employees to possess multiple skills enhances their billability. Allocating resources on different projects allow them to build secondary skills in addition to sharpening their primary skills. Focused training programs and on the job-experience further helps them to improve their capabilities. Secondary skills come in handy to make them billable if they are not deployable using primary skills.

F. Solve resource constraints with smart allocation techniques:

In a multi-project environment, intelligent allocation of resources involves generating more ROI using the existing pool. What-if analysis allows you to build different scenarios and simulate each of them using the resource constraints. After comparing and analyzing each

scenario, resource managers can help arrive at the best possible outcome. It can then be applied to the project schedule.

G. Improve employee engagement and productivity:

One of resource allocation best practices involves assigning resources to project tasks based on their skills and interest. Providing an environment for self-development, skill-building, and staying abreast with current technology-trends, motivate them. By giving them the right opportunities, resource managers can effectively manage the bench and improve overall billability. The employees also feel more responsible and take ownership of their job, which increases engagement and productivity.

5. What are the steps of resource allocation in project management?

Resources can be either fully or partially available. Resource managers need to consider this while making allocation decisions that ensure optimum utilization.

So, how do you allocate resources in a complex project environment? In this section, we describe the essential steps of resource allocation in project management.

A. Create a project plan using an appropriate tool

It is necessary to divide each project into several tasks and create their dependencies. This process is known as work break down structure (WBS), and it is the minimum requirement to create a project plan. Two tasks can be executed either sequentially or in parallel based on their relationship.

The critical path within a project plan determines the minimum time required to complete the project. This information can be used within a project management tool to provide a Gantt-chart view. Resource allocation is an integral component of this process because resources are assigned to each task for its completion.

B. Identify resource requirements for project tasks

Once the project is successfully divided into tasks, the resources can be assigned as appropriate. The task may require both human and non-human resources, depending on the nature of the work. For human resources, it is necessary to identify the skills and competencies. For a non-human resource such as machinery, determine the equipment specifications before assigning to a task.

PwC Project Management Insights states, "*30% of project failure results from lack of resources.*"

C. Find available resources with matching skill set

Using resource allocation software, one can easily identify the availability of a resource within the pool for matching skills. It is also possible to search for equipment with matching specifications that can be used for a specific duration. The tool provides a mechanism to update each resource's skills and competencies in real-time with proper verification.

D. Bridge the demand-capacity gap using multiple channels

If a human resource with the matching requirements does not exist, one can hire or use contingency resources. Similarly, if the said equipment is not available, it can be taken on lease or procured depending on the resourcing strategy. All relevant costs need to be factored into project financials. Once the resources are selected for a specific project, the process of allocation of resources begins.

E. Allocate resources as per demand

Once the resources are identified and established, they are assigned to specific tasks. Sometimes the resources may not be available when they are needed to perform the task. If you opt for a new hire for a specific task, the person may decide not to join at the last moment.

It may be necessary to have a backup plan for this resource. For critical positions, the person could be asked to join a little early so that he/she is available when work starts.

F. Re-allocate resources between projects if required

Re-allocation of resources is necessary during the project life cycle for various reasons. A resource may have performance issues which may need replacement. A resource with a niche skill may be required in another high priority project.

So, one needs to out rotate the person with a suitable backfill so that the current project does not suffer. Some of the positions can fall vacant due to attrition and needs replacing. The project manager also can rotate resources within the same project with different roles.

G. Track and monitor resource usage

It is necessary to track the performance of each resource to implement an effective resource allocation process. In an ideal situation, the resource must not be over/under-allocated or over/underutilized.

However, it is very difficult to ensure this for every resource when you have a large pool to manage. The experience of the project manager and some amount of subjectivity plays a big role in deciding this. The dashboards and reports from resource allocation software can help in decision making.

6. How to solve runtime resource allocation challenges?

Most of the allocation of resources related activities take place during the initiation phase of a project. The projects can be short-term or long-term, and resource demand can vary. The project may require additional resources, or some of the existing resources may need to be rolled off. But what happens if the initial resource allocation goes wrong as you have onboarded incompatible resources in a hurry?

It can create a major stumbling block in the delivery and must be course-corrected ASAP. We refer to this situation as a runtime resource allocation challenge. Following techniques can mitigate some of these challenges as a part of a new resource allocation strategy.

Resource Leveling

In this case, the start and finish dates of the projects are adjusted based on resource constraints. One can adjust the project timeline, but it isn't easy to get additional resources. For example, the research projects may have this kind of flexibility. The manager needs to rework and create a revised schedule to identify the new completion date using given resources.

Resource Smoothing

There is no flexibility around the project timeline in resource smoothing, and the work must complete within a specific time. However, the project manager has the flexibility to add and remove resources during the lifecycle as required to deliver the time-bound project.

Availability of resources is assumed.

Additional mentoring using SME

If the existing resources do not meet the 100% requirement, they can be given additional opportunities to learn on the job. Positions requiring multiple skills are challenging to fulfill. A person meeting a certain percentage of the requirement can be given a chance with additional mentoring. It is provided by identified subject matter experts (SMEs) to fast-track his competencies. The SMEs could be either external persons or someone within the project.

Independent Audit

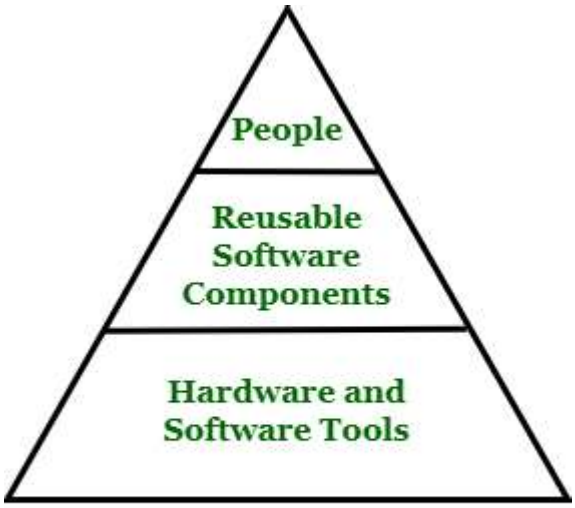
An independent audit can be carried out if there are governance issues that has resulted in an improper allocation of resources. Experienced project managers usually do this within the organization or with the help of consulting firms. The concerned person needs to engage with both the client and the internal team to bring the project back on track.

If the resource allocation strategy is flawed at the beginning of the project, it can derail the overall delivery objective. It is expensive to revisit allocation of resources when the project is in execution mode. Every project manager would like to avoid such a situation. But unfortunately, this can happen due to many factors that are beyond their control.

Nature of Resources:

Project resources simply mean resources that are required for successful development and completion of project. These resources can be capital, people, material, tool, or supplies that are helpful to carry out certain tasks in project. Without these resources, it is impossible to complete project. In project planning phase, identification of resources that are required for completion of project and how they will be allocated is key element and very important task to do. In project management, some resources that are required are assigned to each task of project to get job done.

There are three types of resources that are considered and are very essential for execution of project and completion of project on time and on budget. These resources can be denoted by pyramid which is also known as Resource Pyramid. At base of pyramid i.e. last layer, hardware and software tools are present, then at middle layer, reusable components are present, and at top of pyramid i.e. top layer, human resources are present. This is shown in following diagram :



Resource Pyramid

When software planner wants to specify resources, they specify it using four characteristics :

- Description of resource
- Resource availability
- Time of resource when it will be available
- Duration of resource availability

Types of resources :

1. **Human Resource –**
   Human plays an important role in software development process. No matter what size is and how much complexity is there in project, if you want to perform project task in an effective manner, then human resources are very essential. In software industry, people are assigned some organizational positions such as manager, software developer, software testing, engineer, and so on. These positions are according to their skills and specialty.
   For small project only, single individual can perform all these roles. But for large project, team of people works on it. The total number of people that are required for project is estimated by calculating development effort inters of person-months.
2. **Reusable Components –**
   For bringing ease in software development process or to accelerate development process software, industry prefers to use some ready software components. The components can be defined as the software building blocks that can be created and reused in software development process. Generally, regardless of their type, size, or complexity, all projects need money. Managing budget for project is one of most important tasks that all project managers have to do. The reusable resources also known as cost resources are very helpful as they help in reducing overall cost of development. The use of components emphasizes reusability. This is also termed as Component-Based Software Engineering.
3. **Hardware and Software tools –**
   These are actually material resources that are part of project. This type of resource should be planned before starting development of project otherwise it way causes problems for the project.

For example, if you require certain software elements during performing task and somehow you can't manage to get them on time, even they could take few weeks to ship from manufacturer and this will cause delay to your project.

Identifying Resources Requirement:

The first step in producing a resource allocation plan is to list the resources that will be required along with the expected level of demand. This will normally be done by considering each activity in turn and identifying the resources required. It is likely, however, that there will also be resources required that are not activity specific but are part of the project's infrastructure (such as the project manager) or required to support other resources (office space, for example, might be required to house contract software developers).

Case Study example Amanda has produced a precedence network for the IOE project (Figure 8.2) and used this as a basis for a resource requirements list, part of which is shown in Table 8.1. Notice that, at this stage, she has not allocated individuals to tasks but has decided on the type of staff that will be required. The activity durations assume that they will be carried out by 'standard' analysts or software developers.

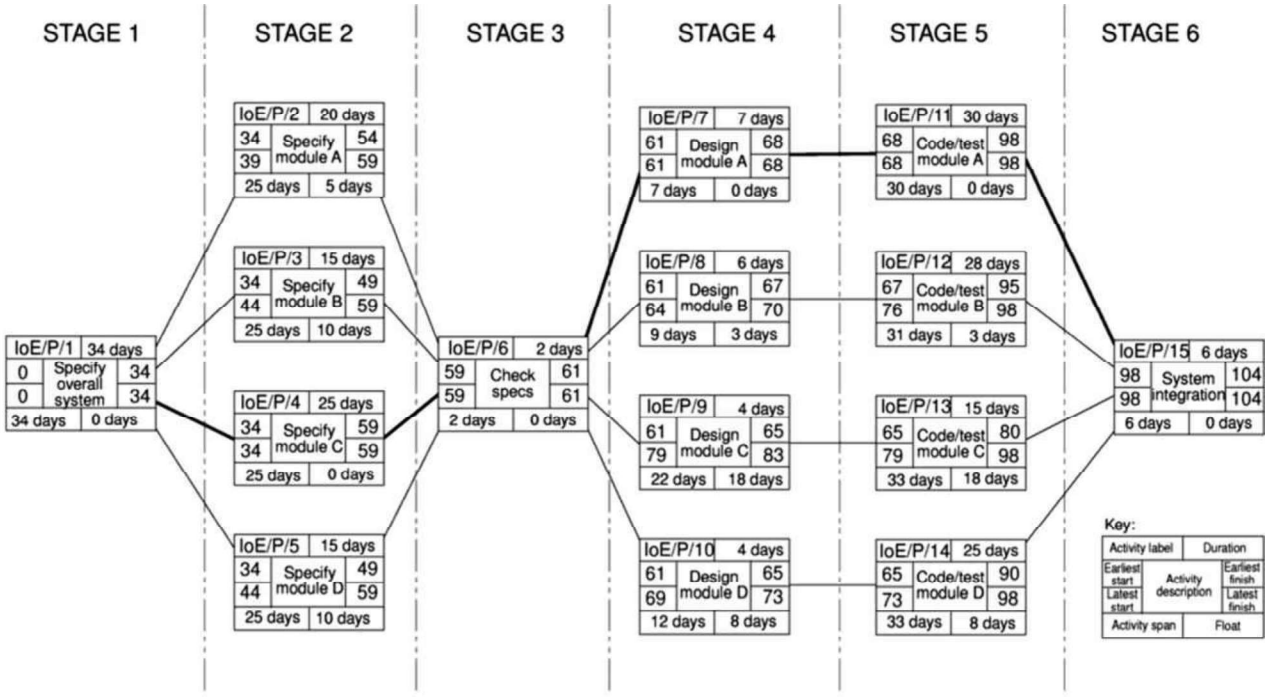


Figure 8.2 *The IOE precedence network.*

At this stage, it is necessary that the resource requirements list be as comprehensive as possible - it is better that something is included that may later be deleted as unnecessary than to omit something essential. Amanda has therefore included additional office space as a possible requirement, should contract software development staff be recruited.

Scheduling Resources Creating Critical Paths:

In project management, the critical path is the longest sequence of tasks that must be completed to complete a project. The tasks on the critical path are called critical activities because if they're delayed, the whole project completion will be delayed.

Finding the critical path is very important for project managers because it allows them to:

Accurately estimate the total project duration

Identify task dependencies, resource constraints and project risks

Prioritize tasks and create realistic project schedules

To find the critical path, project managers use the critical path method (CPM) algorithm to define the least amount of time necessary to complete each task with the least amount of slack.

Once done by hand, nowadays the critical path can be calculated automatically with project scheduling software equipped with Gantt charts, which makes the whole CPM method much easier.

ProjectManager can calculate the critical path for you on our award-winning Gantt charts

What Is the Critical Path Method (CPM)?

The critical path method (CPM) is a technique that's used by project managers to create a project schedule and estimate the total duration of a project.

The CPM method, also known as critical path analysis (CPA), consists in using a network diagram to visually represent the sequences of tasks needed to complete a project. Once these task sequences or paths are defined, their duration is calculated to identify the critical path, which determines the total duration of the project.

CPM History

The critical path method was developed in the late 1950s by Morgan R. Walker and James E. Kelley. The origins of the critical path method are closely related with the Program Evaluation and Review Technique (PERT), a similar method which is commonly used in conjunction with CPM.

Why Is CPM Important in Project Management?

Projects are made up of tasks that have to adhere to a schedule in order to meet a timeline. It sounds simple, but without mapping the work, your project scope can quickly get out of hand and you'll find your project off track.

Using the critical path method is important when managing a project because it identifies all the tasks needed to complete the project, then determines the tasks that must be done on time, those that can be delayed if needed and how much float or slack you have.

When done properly, critical path analysis can help you:

Identify task dependencies, resource constraints and project risks

Accurately estimate the duration of each task

Prioritize tasks based on their float or slack time, which helps with project scheduling and resource allocation

Identify critical tasks that have no slack and make sure those are completed on time

Monitor your project progress and measure schedule variance

Use schedule compression techniques like crash duration or fast tracking

CPM Key Elements

Before we learn the steps to calculate the critical path, we'll need to understand some key CPM concepts.

Earliest start time (ES): This is simply the earliest time that a task can be started in your project. You cannot determine this without first knowing if there are any task dependencies

Latest start time (LS): This is the very last minute in which you can start a task before it threatens to delay your project schedule

Earliest finish time (EF): The earliest an activity can be completed, based on its duration and its earliest start time

Latest finish time (LF): The latest an activity can be completed, based on its duration and its latest start time

Float: Also known as slack, float is a term that describes how long you can delay a task before it impacts its task sequence and the project schedule. The tasks on the critical path have zero float, because they can't be delayed

Let's take a look at some critical path examples to better understand these critical path analysis elements.

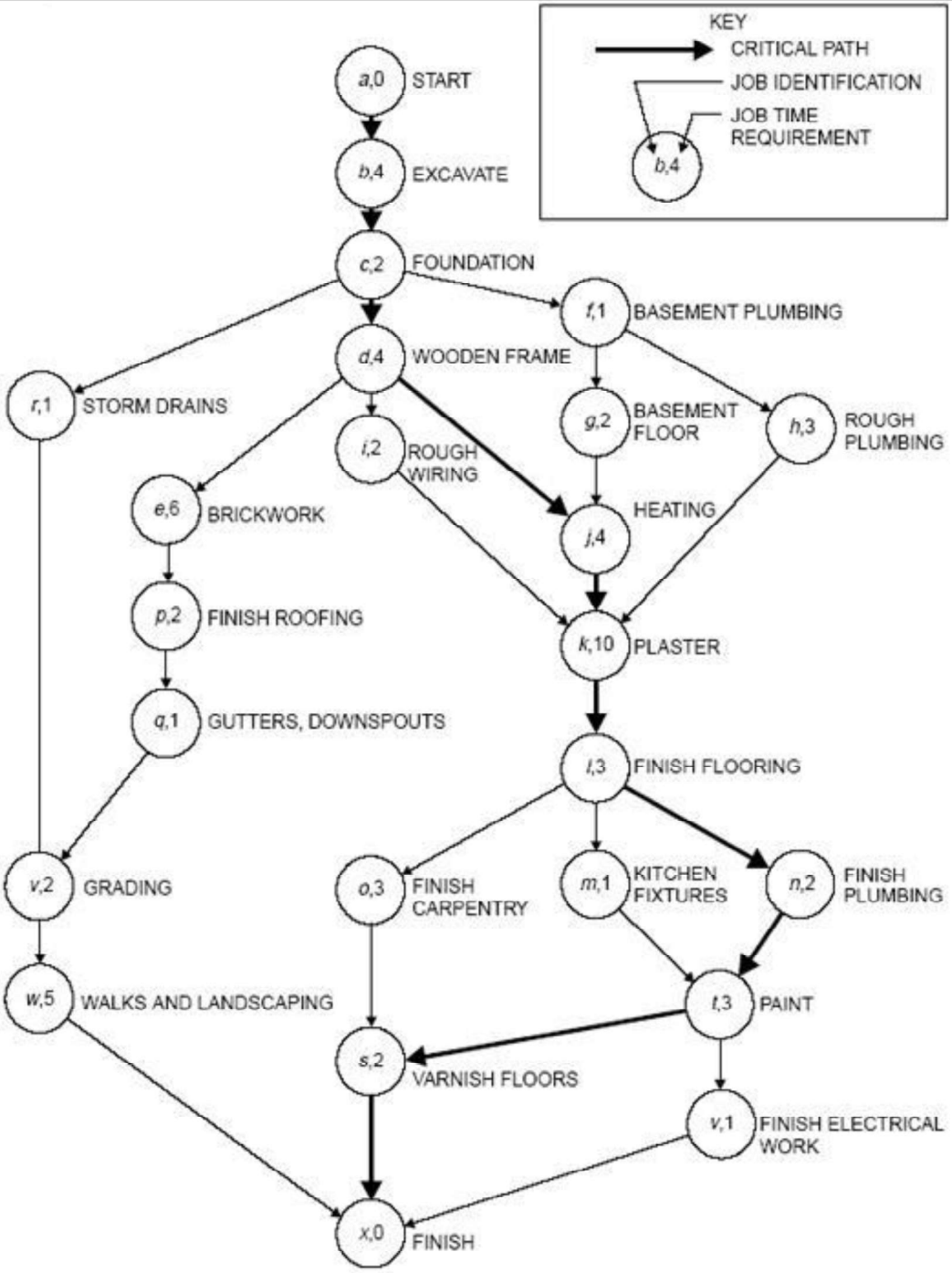
Critical Path Examples

Here's an example of a CPM diagram. Although it's high-level, it can help you visualize the meaning of a critical path for a project schedule. For now, we'll use this critical path diagram to explain the elements that make up the CPM method.

As you can see in this critical path diagram, project activities are represented by letters and the critical path is highlighted in green. Tasks F, G and H are non-critical activities with float or slack. We can also identify task dependencies between the critical path activities, and also between activities (A, F and G) or (A, H and E), which are parallel tasks.

Here's another critical path example from Harvard Business Review, which shows a critical path schedule for the construction of a house. Each circle in the CPM diagram represents a project activity, as well as it's duration, while the bolded arrows link the critical path activities. As projects become more complex, you'll find more parallel tasks, like in this example.

EXHIBIT II
Project Graph



Source:Harvard Business Review

How to Find the Critical Path of a Project in 8 Steps

Now that you know the key concepts of the critical path method, here's how to calculate the critical path in 8 steps.

1.Collect Project Activities

Use a work breakdown structure to collect all the project activities that lead to the final deliverable.

2. Identify Task Dependencies

Figure out which tasks are dependent on other tasks before they can begin. Use your judgement and your team members' feedback. Failing to define task dependencies correctly makes the critical path method useless.

3. Create a Critical Path Diagram

A critical path analysis chart, or network diagram, depicts the order of activities.

4. Estimate Timeline

To use the critical path method, you'll need to estimate the duration of each task. Use data from past projects and other sources of information such as subject matter experts.

5. Use the Critical Path Algorithm

The critical path algorithm has two parts; a forward pass and a backwards pass.

Forward Pass

Use the network diagram and the estimated duration of each activity to determine their earliest start (ES) and earliest finish (EF). The ES of an activity is equal to the EF of its predecessor, and its EF is determined by the formula EF = ES + t (t is the activity duration). The EF of the last activity identifies the expected time required to complete the entire project.

Backward Pass

Begins by assigning the last activity's earliest finish as its latest finish. Then the formula to find the LS is LS = LF – t (t is the activity duration). For the previous activities, the LF is the smallest of the start times for the activity that immediately follows.

6. Identify the Float or Slack of Each Activity

Use this formula to determine the float or slack of each task. Float = LS – ES

7. Identify the Critical Path

The activities with 0 float make up the critical path. All of these critical path activities are dependent tasks except for the first task in your CPM schedule. All project tasks with positive slack are parallel tasks to the critical path activities.

8. Revise During Execution

Continue to update the critical path network diagram as you go through the execution phase.

These critical path analysis steps determine what tasks are critical and which can float, meaning they can be delayed without negatively impacting the project schedule. Now you