# CONSTRUCTION PLANNING AND SCHEDULING

## COTM4221

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# Chapter Four

# Resource Scheduling

# Introduction

- ✓ CPM/PERT ignore resource utilization and availability
- ✓ Schedules need to be evaluated in terms of both time and resources.

Time and resource constraints:

- ✓ Time constraint: A project must be finished by a certain time
- ✓ Resource constraint: A project must be finished without exceeding some specific level of resource usage

# Categories of Resources

I. Material

II. Labor

i. Salaried staff

ii. Hourly workers

III. Equipment

IV. Money

# Influence of resources on schedule

- ✓ Duration of activities are dependent on the usage of resources and their availability.
- ✓ Resources are a significant component of the project cost
- ✓ Proper scheduling of resources will have positive impact on the time as well as cost of the project.
- ✓ Improper scheduling resources will result in cost and time overruns

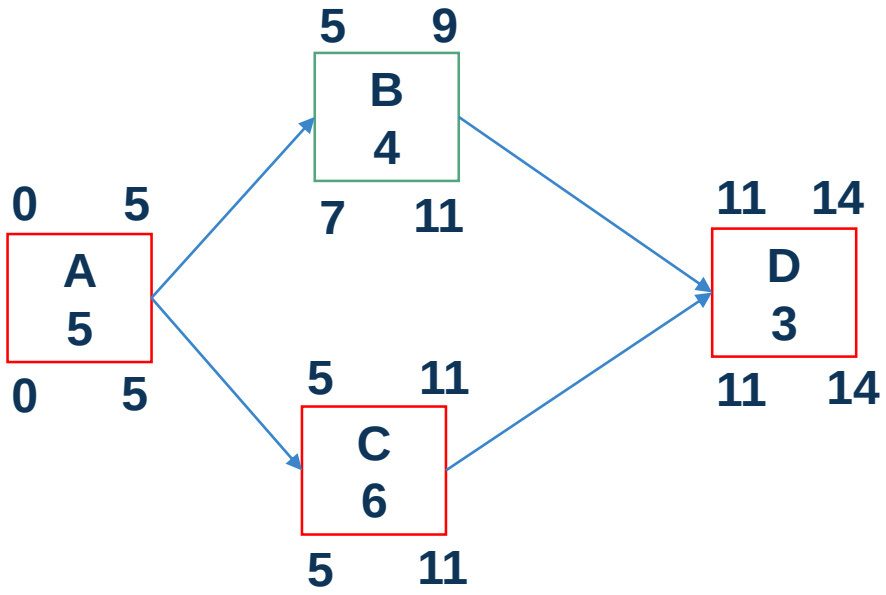
# Resource Allocation and Leveling

## Resource Allocation/Loading:

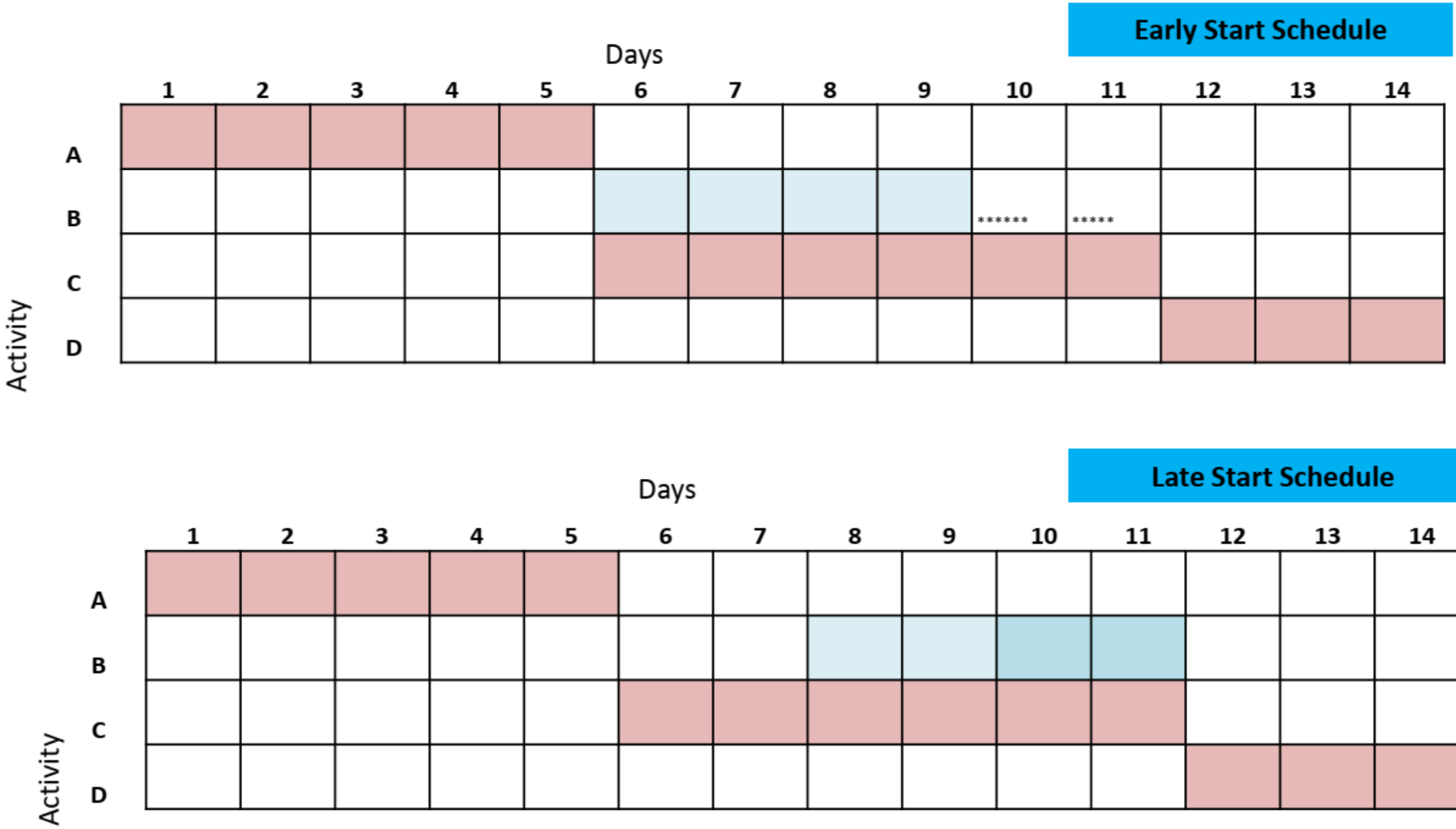
- ✓ **Is the assignment of the required resources to each activity.**

## Example One:

| Activity | Duration | Predecessor |
|---|---|---|
| A | 5 | - |
| B | 4 | A |
| C | 6 | A |
| D | 3 | B,C |



# Result in Bar Chart



# Resource Loading

- ✓ **Assume that 1 manpower resource is required per day for each activity.**

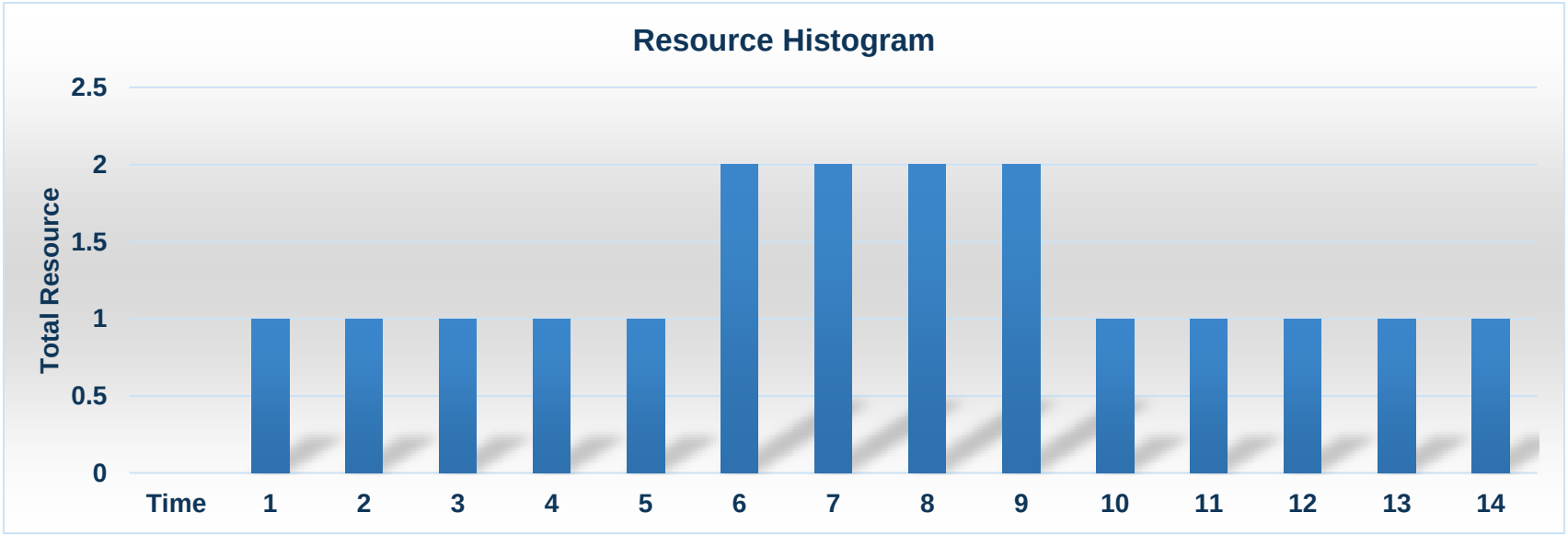
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 1 | 1 | 1 | 1 | 1 | | | | | | | | | |
| B | | | | | | 1 | 1 | 1 | 1 | | | | | |
| C | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| D | | | | | | | | | | | | 1 | 1 | 1 |

- ✓ **Each activity is loaded with one manpower resource based on early start.**

# Resource Loading

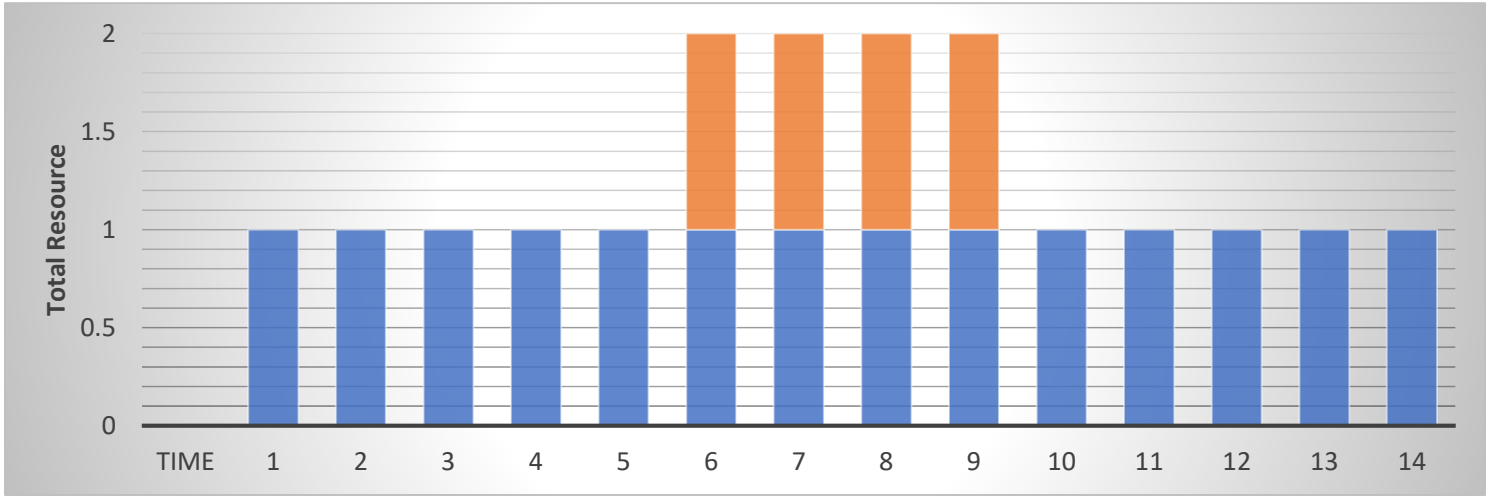
## ✓ Total resource requirement

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 1 | 1 | 1 | 1 | 1 | | | | | | | | | |
| B | | | | | | 1 | 1 | 1 | 1 | | | | | |
| C | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| D | | | | | | | | | | | | 1 | 1 | 1 |
| ∑ | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |



# Resource Over Allocation

- ✓ Resource over allocation occurs when we allocate a specific resource to activities more than the maximum available amount.
- ✓ In the above example, if we consider that there is maximum availability of only one manpower resource on any given day, there is overallocation between day 6 and 9.




- ✓ From the histogram we can understand that the resources allotted on day 6,7,8 & 9 are more than the available limit.

# Resource Leveling

**Resource leveling is performed when :**

- ✓ **There is an over allocation of resource on specific days.**
- ✓ **There is fluctuations in day-to-day resource use throughout the project.**
- ✓ **It attempts to make the daily use of a certain resource as uniform as possible and with in the resource limit.**
- ✓ **It is usually done by shifting or splitting noncritical activities within their available float.**
- ✓ **If shifting noncritical activities doesn't solve the problem specially in over allocations, we can shift or split critical activities.**

**Note: In general, materials do not need to be leveled.**

# Methods

**Heuristic:**

- ✓ **An approach, such as a rule of thumb, that yields a good solution that may or may not be optimal.**

**Optimization:**

- ✓ **An approach, such as linear programming, that yields the one best solution. (Not all projects can be optimized).**

# Heuristic Method

- ✓ Take the CPM/PERT schedule as a baseline
- ✓ They sequentially step through the schedule trying to move resource requirements around to levelized them
- ✓ Resources are moved around based on one or more priority rules
- ✓ Sort : the process of arranging activities in a list to certain specific order/priority.

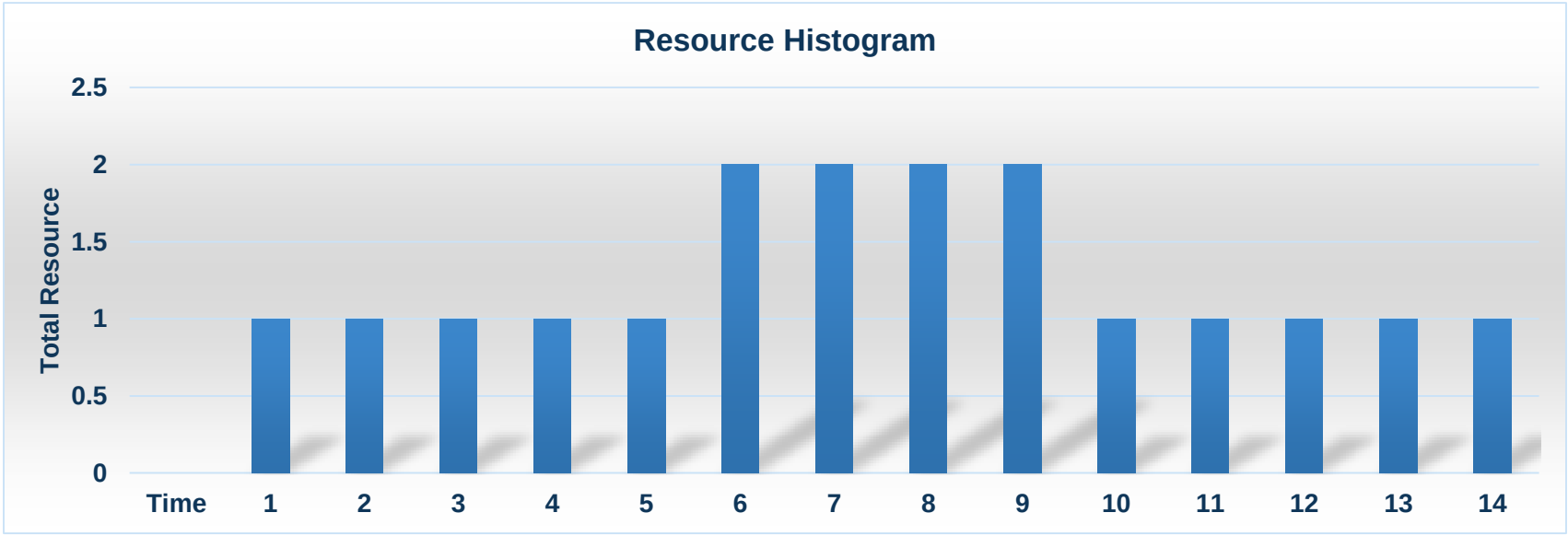
## Common Priority Rules:

- ✓ As soon as possible
- ✓ As late as possible
- ✓ Most resources first
- ✓ Most critical followers
- ✓ Most successors
- ✓ Arbitrary , etc…

# Example One...

- Early start allocation

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 1 | 1 | 1 | 1 | 1 | | | | | | | | | |
| B | | | | | | 1 | 1 | 1 | 1 | | | | | |
| C | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| D | | | | | | | | | | | | 1 | 1 | 1 |
| ∑ | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |



# Example One...

- ✓ **Early start allocation**

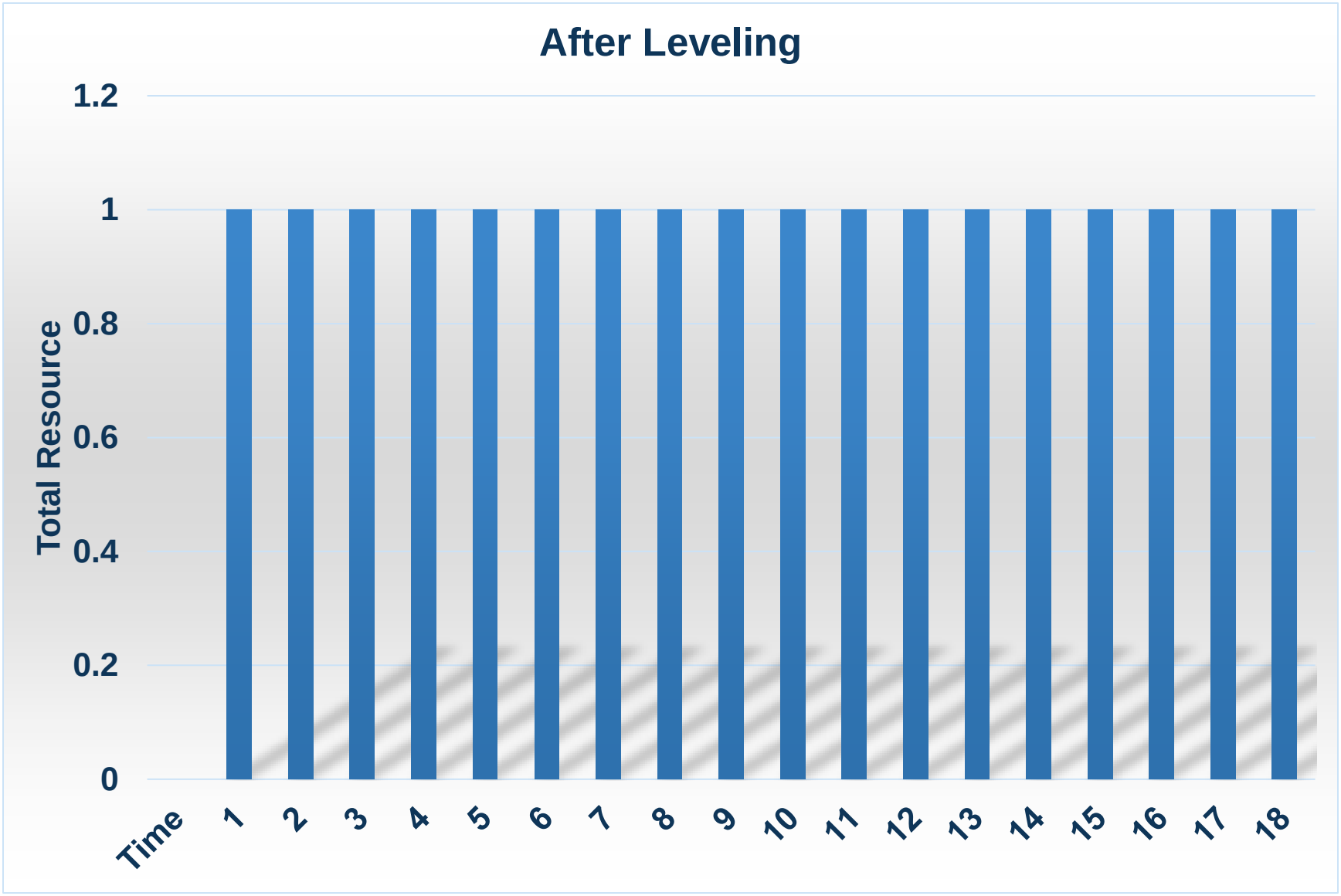
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 1 | 1 | 1 | 1 | 1 | | | | | | | | | |
| B | | | | | | | | 1 | 1 | 1 | 1 | | | |
| C | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| D | | | | | | | | | | | | 1 | 1 | 1 |
| ∑ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |

# Soln.....

- ✓ Both in ES and LS based allocations; there exist an over allocation.
- ✓ In order to level the resource requirement we should either shift Act. B or C so that one should begin after the other one ends.
- ✓ Therefore, move ES of Act. C to day 12. This will affect the ES of Act. D and the total project duration.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | |
| B | | | | | | | | | | | | 1 | 1 | 1 | 1 | | | |
| C | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | |
| D | | | | | | | | | | | | | | | | 1 | 1 | 1 |
| ∑ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

# Soln.....


After Leveling
Total Resource
1.2
1
0.8
0.6
0.4
0.2
0
Time
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

# Example Two

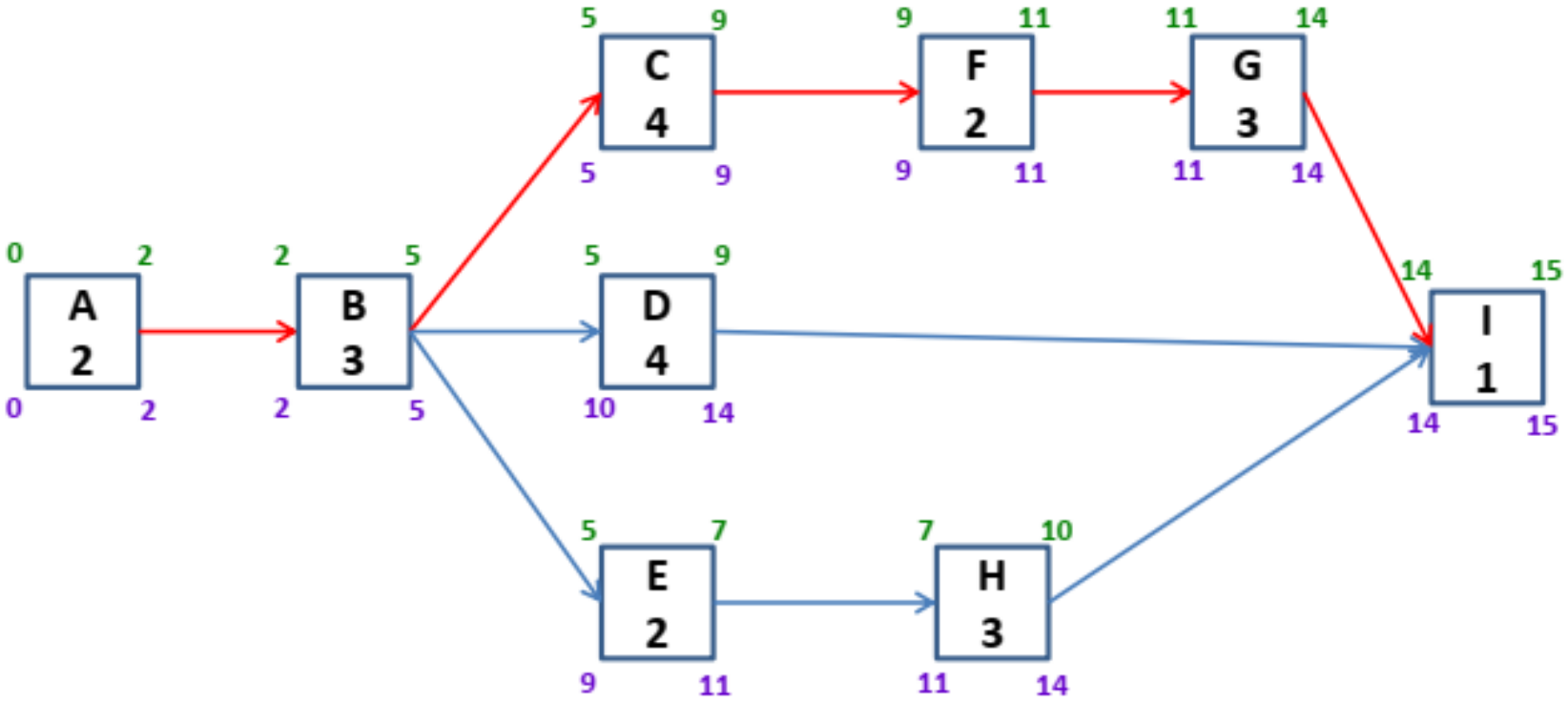
**Consider the following project in which the resource requirement for trucks for each activity is shown in the following Table:**

| Activity | IPA | Duration | Trucks |
|---|---|---|---|
| A | | 2 | 2 |
| B | A | 3 | 1 |
| C | B | 4 | 6 |
| D | B | 4 | 4 |
| E | B | 2 | 4 |
| F | C | 2 | 2 |
| G | F | 3 | 2 |
| H | E | 3 | 1 |
| I | D,G,H | 1 | 1 |

**Assume ten trucks are available for the project. Prepare an activity schedule which satisfies the resources constraints.**

# Resource Leveling

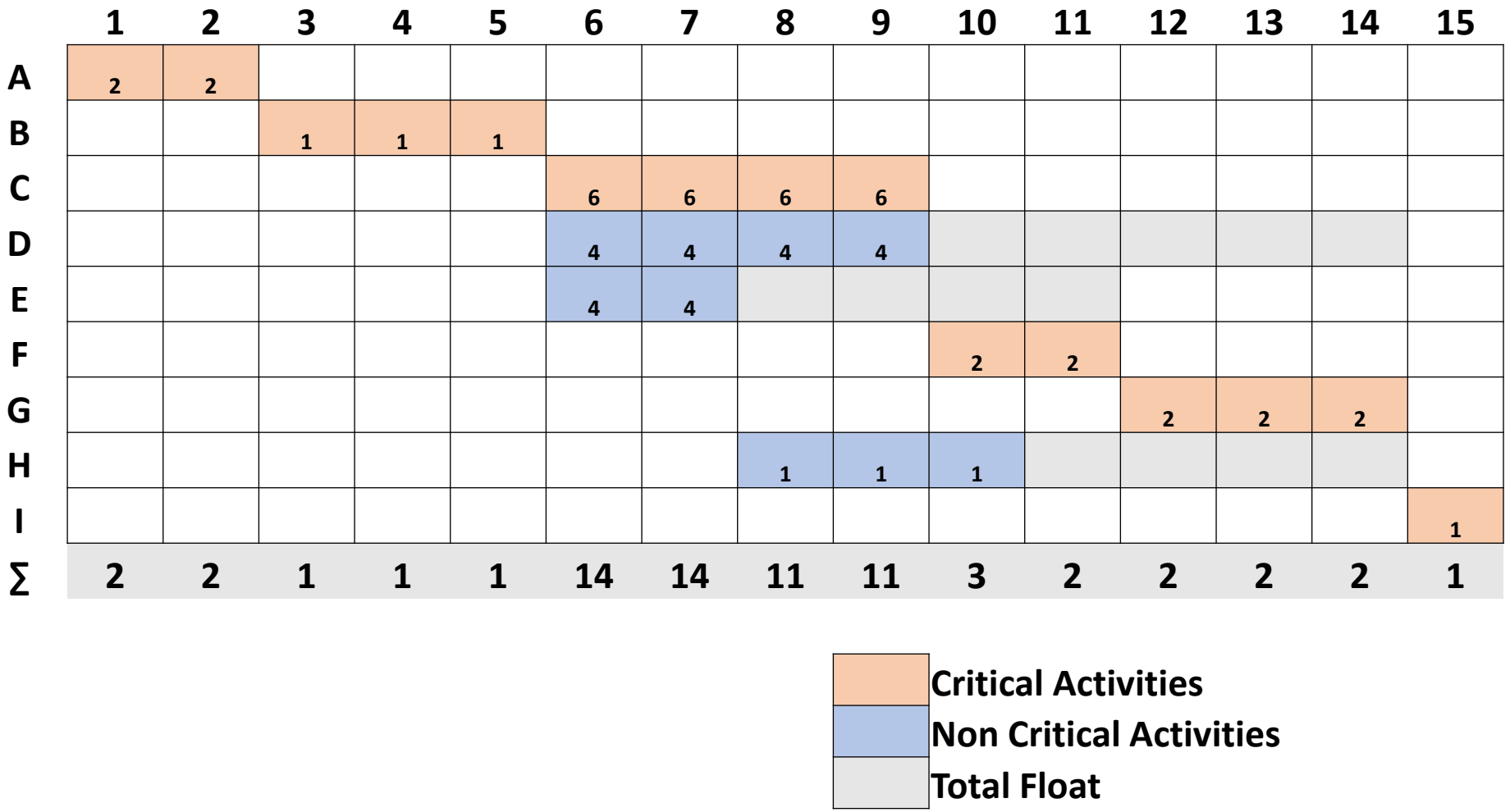
## Network Analysis:



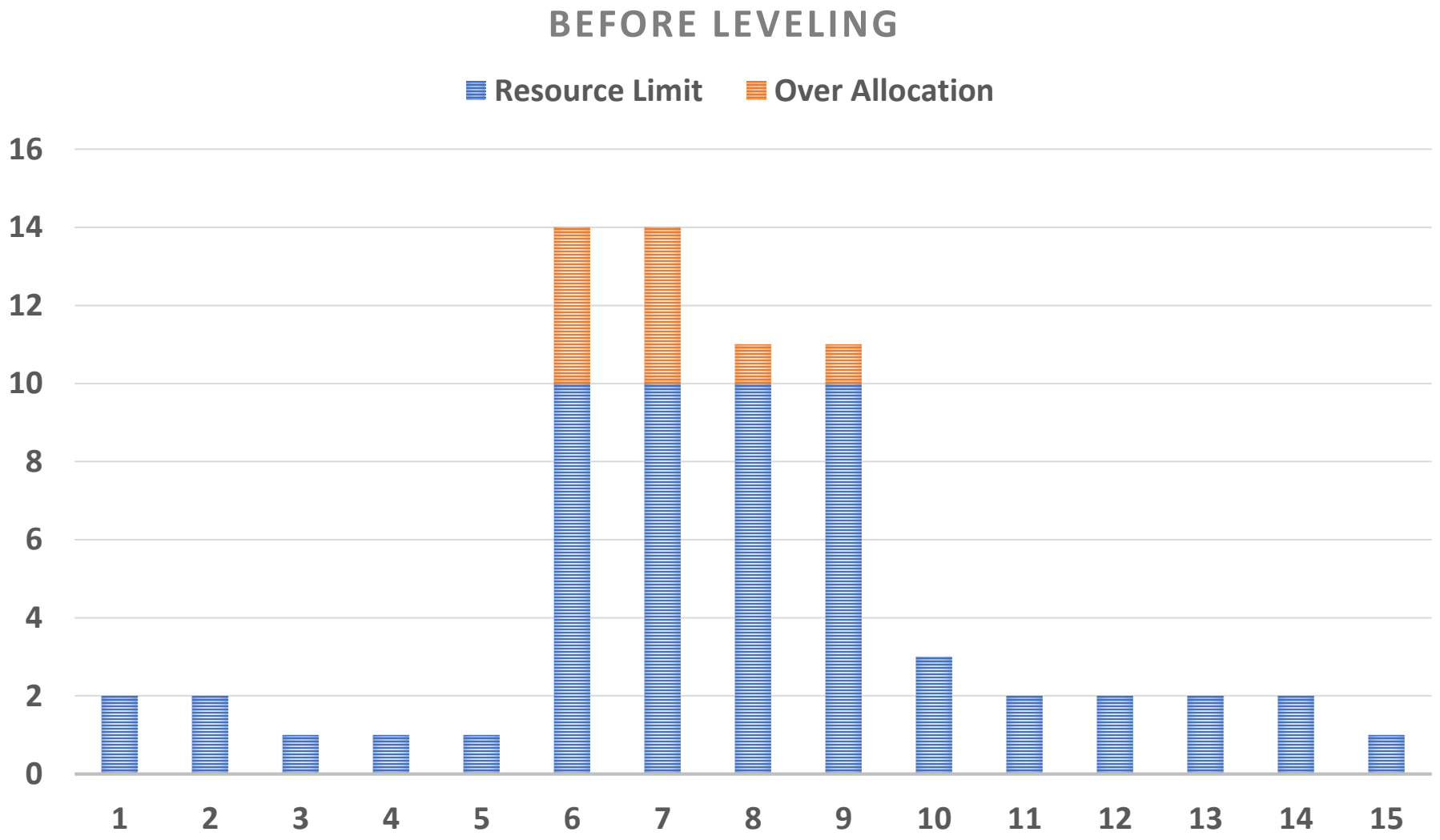

## Critical Activities: A-B-C-F-G-I

# Resource Leveling

## Bar chart based on ES allocation:



# Resource Leveling



# Resource Leveling

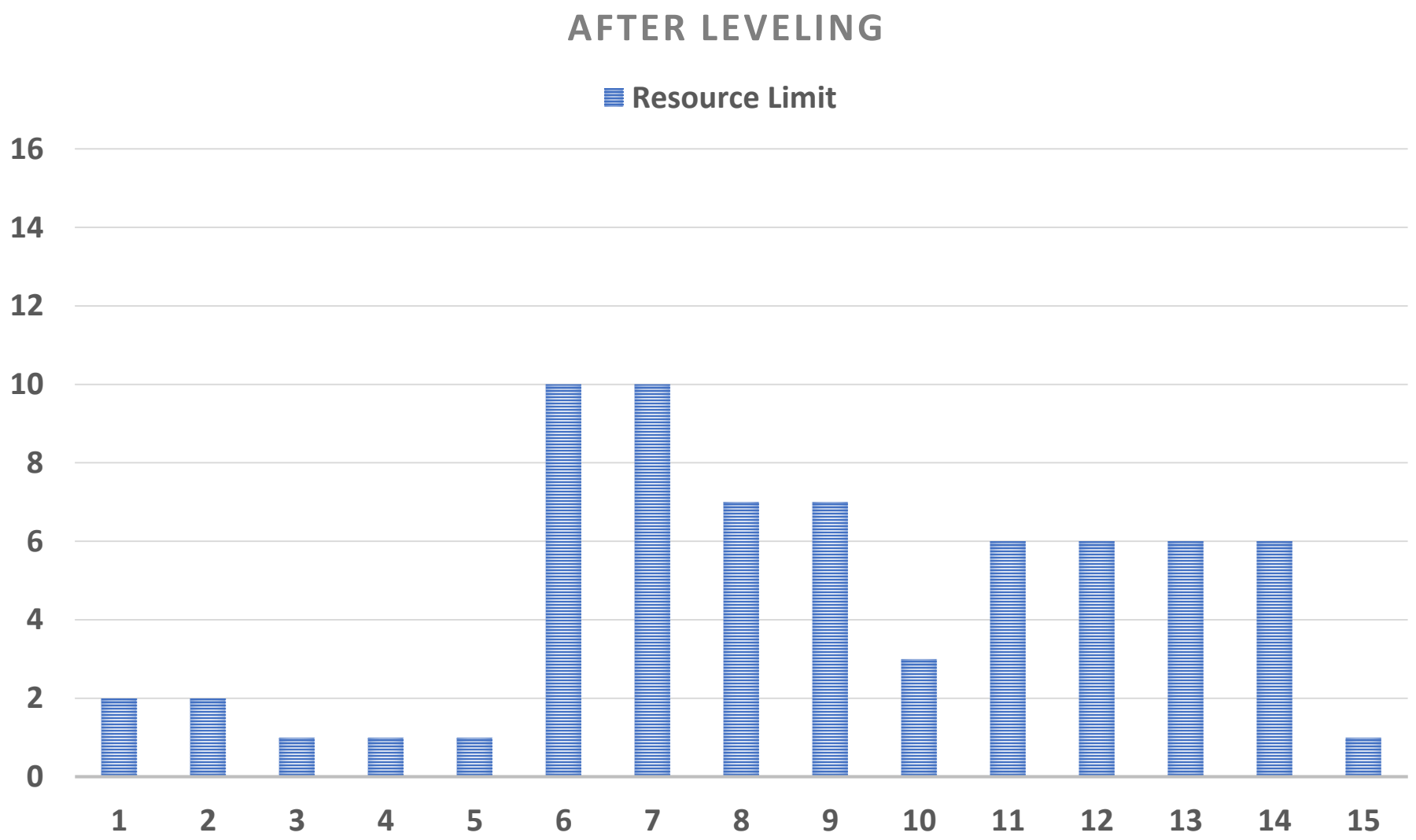
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 2 | 2 | | | | | | | | | | | | | |
| B | | | 1 | 1 | 1 | | | | | | | | | | |
| C | | | | | | 6 | 6 | 6 | 6 | | | | | | |
| D | | | | | | | | | | | 4 | 4 | 4 | 4 | |
| E | | | | | | 4 | 4 | | | | | | | | |
| F | | | | | | | | | | 2 | 2 | | | | |
| G | | | | | | | | | | | | 2 | 2 | 2 | |
| H | | | | | | | | 1 | 1 | 1 | | | | | |
| I | | | | | | | | | | | | | | | 1 |
| ∑ | 2 | 2 | 1 | 1 | 1 | 10 | 10 | 7 | 7 | 3 | 6 | 6 | 6 | 6 | 1 |

Critical Activities

Non Critical Activities

Total Float

# Resource Leveling



# Thank You !