PERT NETWORK ANALYSIS OF INDIAN RAILWAY SYSTEM

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MONTH & YEAR

December, 2017

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1.Abstract

The project is aimed to do the PERT network analysis of indian railway networks. The analysis is done on four regions of india namely North, South, East and West. The critical path, the earliest and latest occurrence time, the earliest and latest expected time are calculated and are confirmed with the C programming. The C program can be used to simplify the process of the time consuming calculations, the complexity of the problem in determining the data for the four regions in indian railways. The problem can be visualized in the networks drawn for each region by analyzing the data from the Indian railways schedule.

2.Introduction

A Project such as setting up of a new milk plant, research and development in an organization, determination of critical path in a railway network, and probability of an occurrence of an event, etc. is a combination of interrelated activities (tasks) which must be executed in a certain order before the entire task can be completed. The activities are interrelated in a logical sequence in such a way that same activities can not start until some others are completed. The objectives of project management can be described in terms of a successful project which has been finished on time, within the budgeted cost and to technical specifications and to the satisfaction level of end users. Normally for any project, one may be interested in answering questions such as

i) What will be the expected time of project completion?
ii) What is the effect of delay of any activity on the overall completion of project?
iii) How to reduce the time to perform certain activities in case of availability of additional funds?
iv) What is the probability of completion of project in time?

The OR techniques used for planning, scheduling and controlling large and complex projects are often referred to as network analysis. A network is a graphical representation consisting of certain configuration of arrows and nodes for showing the logical sequence of various tasks to be performed to achieve the project objectives. Now-a-days we use a technical tool for planning, scheduling and controlling stages of the projects known as Critical Path Method (CPM) and Project Evaluation & Review Technique (PERT). The techniques of PERT and CPM prove extremely valuable in assisting the mangers in handling such projects and thus discharging their project management responsibilities both at planning and controlling stages of the projects. Commonly used project management techniques are:

a) Critical Path Method (CPM) and

b) Project Evaluation and Review Technique (PERT)

Both are basically time oriented methods laid to determination of a time schedule for project. The major difference between these two techniques is that **PERT** is a **Probabilistic** approach for the determination of time estimates of different activities not exactly known to us**.** In the case of **CPM,** different estimates are known as they are **deterministic** in nature. But now a days both these techniques are used for one purpose. Initially the PERT technique was applied to research and development projects while the CPM was used towards construction projects.

3.Literature

1Methodology in CPM/PERT Technique

The methodology involved in network scheduling by CPM/PERT for any project consists of the following four stages:

3.1 Planning

It is started by splitting the total project into small projects. The smaller projects are further divided into different activities and are analyzed by a department or section. The relationship of each activity with respect to other activities are defined and established.

3.2 Scheduling

The objective of scheduling is to give the earliest and the latest allowable start and finish time of each activity as well as its relationship with other activities in the project. The schedule must pinpoint the critical path i.e. time activities which require special attention if the project is to be completed in time.

3.3 Allocation of resources

Allocation of resources is performed to achieve the desired objective. Resource is a physical variable such as labour, finance, space, equipment etc. which will impose a limitation for completion of a project.

3.4 Controlling

The final phase in the project management is controlling. After making the network plan and identification of the Critical path, the project is controlled by checking progress against the schedule, assigning and scheduling manpower and equipment and analyzing the effects of delays. This is done by progress report from time to time and updating the network continuously. Arrow diagram and time charts are used for making periodic progress reports.

4. Basic Terminology used in Network Analysis

Network analysis is the general name given to certain specific techniques which can be used for the planning, management and control of projects. A fundamental method in both PERT and CPM

is the use of network systems as a means of graphically depicting the current problems or proposed projects in network diagram. A network diagram is the first thing to sketch an arrow diagram which shows inter-dependencies and the precedence relationship among activities of the project. Before illustrating the network representation of a project, let us define some basic definitions:

4.1 Activity

Any individual operation, which utilizes resources and has a beginning and an end is called an activity. An arrow is used to depict an activity with its head indicating the direction of progress in the project. It is of four types:

a) **Predecessor activity:** activity that must be completed immediately prior to the start of another activity.

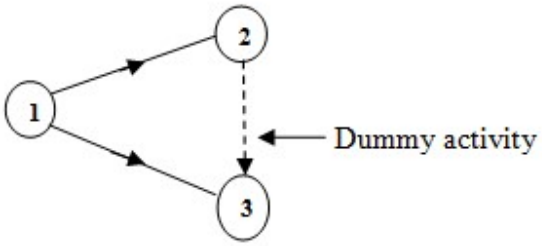
b) **Successor activity:** activity which cannot be started until one or more of other activities are completed but immediately succeed them are called successor activity.

c) **Concurrent:** Activity which can be accomplished concurrently is known as concurrent activity. An activity can be predecessor or successor to an event or it may be concurrent with the one or more of the other activities.

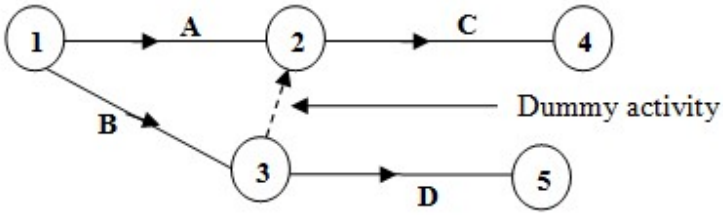
d) **Dummy activity:** An activity which does not consume any kind of resources but merely depicts the technological dependence is called a dummy activity. Dummy activity is inserted in a network to classify the activity pattern in the following situations:

   i) To make activities with common starting and finishing points distinguishable.

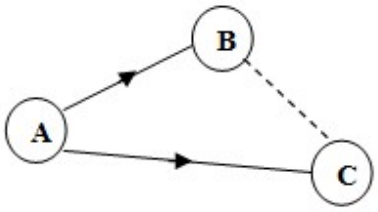
   ii) To identify and maintain the proper precedence relationship between activities those are not connected by events.



Let's consider a situation where A and B are concurrent activities and activity D is dependent on B and C is dependent on both A and B. Such a situation can be handled by use of dummy activity.



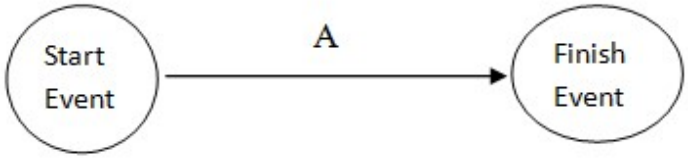
When two or more activities are exactly parallel such that they would start at the same node (event) and finish at the same node. A dummy would be inserted between the end of one of the activities and the common finishing node.



This is to ensure that each activity has a unique description when refer to by its start and finish node number. Dummy are often used to improve the layout of network. When they may not strictly necessary to represents the logic involved. This often happens at the start or finish of a network where a number of activities either start from a certain point or converge to particular point.

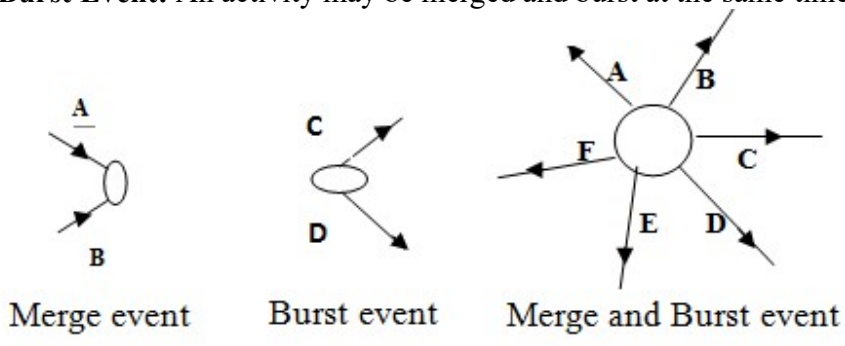
4.2 Event

The beginning and end points of an activity are called events or nodes or connector. This is usually represented by circle in a network.



Here, A is known as the activity.
The events can be further classified into three categories:

a) **Merge Event**: When two or more activities come from an event it is known as merge event.
b) **Burst Event:** When more than one activity leaves an event is known as burst event.
c) **Merge & Burst Event:** An activity may be merged and burst at the same time.



4.3 Difference between event and activity

An event is that particular instant of time at which some specific part of project is to be achieved while an activity is the actual performance of a task. An activity requires time and resources for

its completion. Events are generally described by such words as complete, start, issue, approves, taste etc. while the word like design, process, test, develop, prepare etc. shows that a work is being accomplished and thus represent activity. While drawing networks, it is assumed that

a) The movement is from left to right and
b) Head event has a number higher than the tail event.

Thus the activity (i-j) always means that job which begins at event (i) is completed at event (j).

Network representation is based on the following two axioms.

a) An event is not said to be complete until all the activities flowing into it are completed.
b) No subsequent activities can begin until its tail event is reached or completed.

5. Project Plan

We chose four regions in India that are North, South, East and West. In these four regions we took any two busy stations and found different routes between them and on these different routes we noted the time taken by the train to travel between two consecutive stations including the delay time and following this till the train reaches the destination. Knowing these timings we calculated the E and L values for each station and following this we made the network diagram for each region. After making the pert network diagram we calculated the critical path that is the path at which the train takes the longest time to travel.

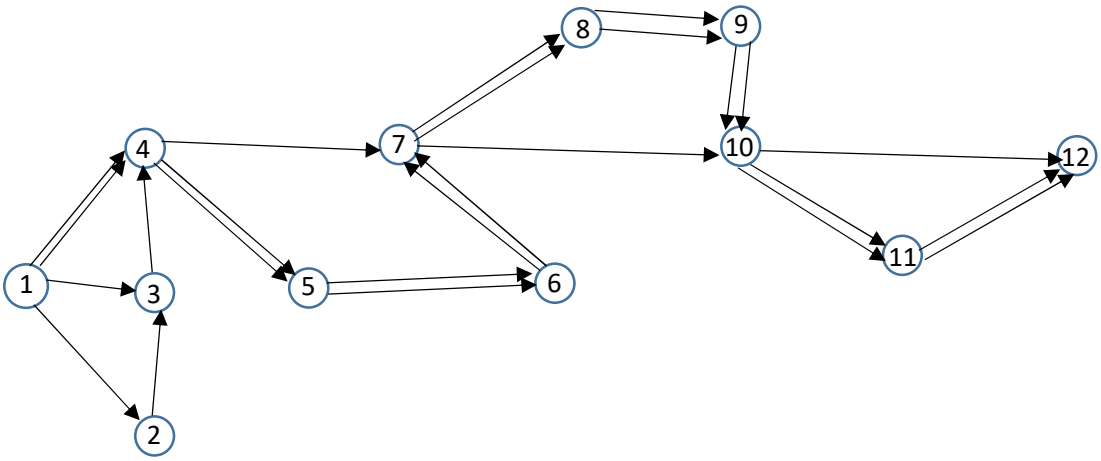
9. Work Done:

1.North Rail

NUMBER ALLOTED	STATIONS
1	NEW DELHI
2	PANIPAT
3	AMBALA
4	LUDHIANA
5	PHILLAUR
6	PHAGWARA
7	JALANDHAR
8	DASUYA
9	MUKERIAN
10	PATHANKOT
11	KATHUA
12	JAMMU

ACTIVITY	DURATION(minutes)
1-4	330
1-3	168
1-2	71
2-3	112
3-4	100
4-5	13
4-7	50
5-6	21
6-7	22
7-8	49
7-10	105
8-9	16
9-10	49
10-11	38
10-12	122
11-12	122

NETWORK DIAGRAM FOR TRAVEL FROM NEW DELHI TO JAMMU



EARLIEST OCCURANCE TIME	LATEST OCCURANCE TIME
E1=0	L1=0
E2=71	L2=118
E3=183	L3=230
E4=330	L4=330
E5=343	L5=343
E6=364	L6=364
E7=386	L7=386
E8=435	L8=435
E9=451	L9=451
E10=500	L10=500
E11=538	L11=538
E12=660	L12=660

The critical path for this diagram is:

1-4-5-6-7-8-9-10-11-12

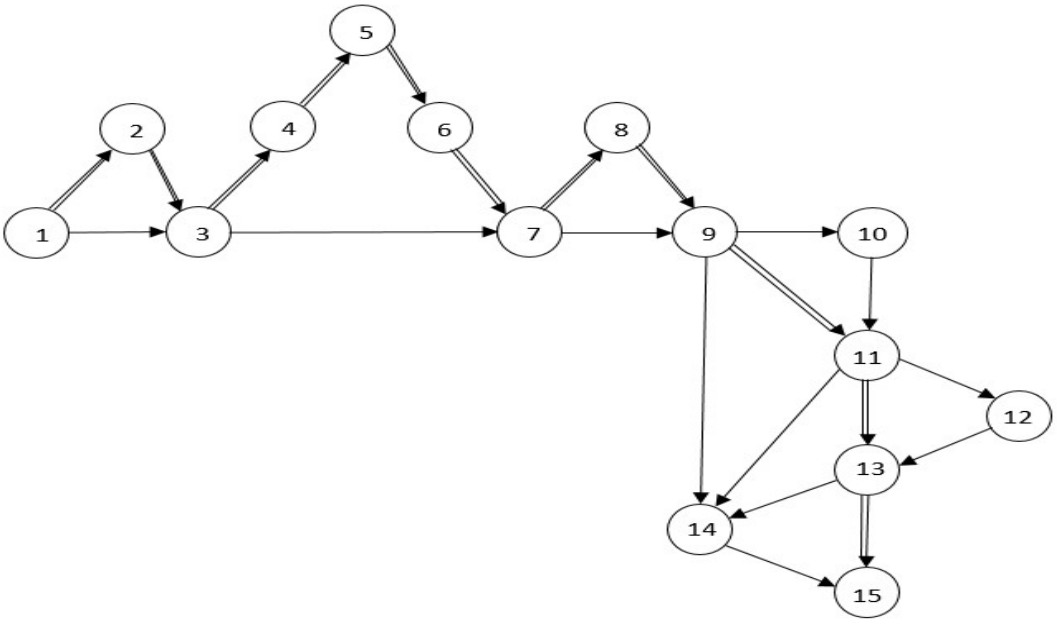
For this if we sum up the duration the total time taken 11 hours.

2. South Rail (Chennai Central To Bengaluru Cantt.)

S.No.	Station
1.	Chennai Central
2.	Tiruvallur
3.	Arakkonam
4.	Anavardikhampettai
5.	Sholinghur
6.	Walajah Road Junction
7.	Katpadi Junction
8.	Ambur
9.	Jolarpettai
10.	Kuppam
11.	Bangarapet
12.	Whitefield
13.	Krishnarajapuram
14.	Bengaluru East
15.	Bengaluru Cantt.

S.No.	Activity	Time (in minutes)
1.	1-2	**34**
2.	1-3	48
3.	2-3	18
4.	3-4	14
5.	3-7	45
6.	4-5	14
7.	5-6	14
8.	6-7	28
9.	7-8	39
10.	7-9	83
11.	8-9	50
12.	9-10	29
13.	9-11	63
14.	9-14	123
15.	10-11	28
16.	11-12	39
17.	11-13	53
18.	11-14	54
19.	12-13	13
20.	13-14	3
21.	13-15	13
22.	14-15	5

Pert Network Diagram:



S.No.	Earliest Occurrence Time E (in minutes)	Latest Occurrence Time L (in minutes)
1.	0	0
2.	34	34
3.	52	52
4.	66	66
5.	80	80
6.	94	94
7.	122	122
8.	161	161
9.	211	211
10.	240	246
11.	274	274
12.	313	314
13.	327	327
14.	334	335
15.	340	340

Hence, the critical path is 1-2-3-4-5-6-7-9-11-13-15.

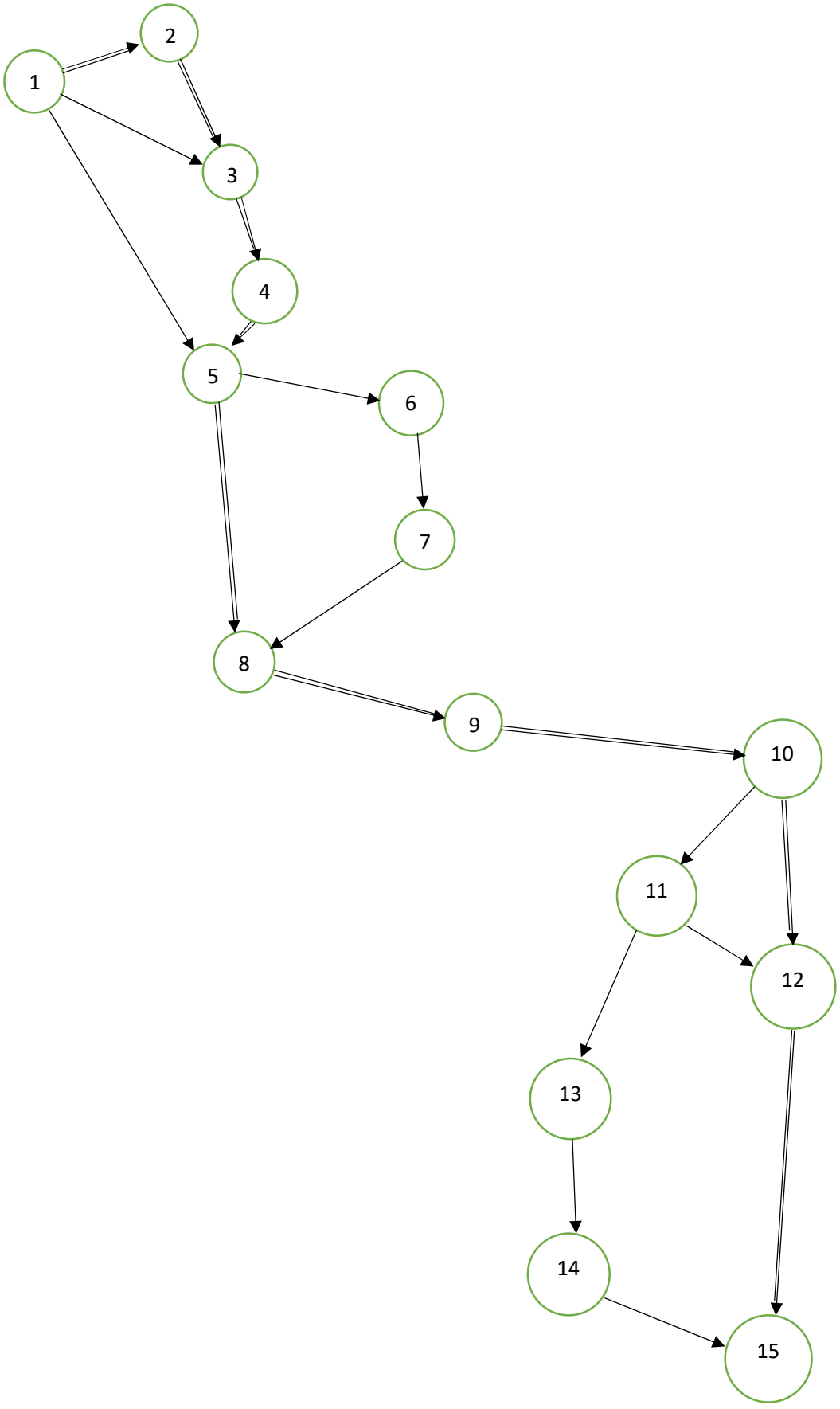
For this if we sum up the duration the total time taken 340 minutes.

3. East Rail (Howrah Jn to Mokama)

S.No.	Activity	Time (in minutes)
1	1-2	65
2	1-3	113
3	1-5	149
4	2-3	51
5	3-4	16
6	4-5	18
7	5-6	18
8	5-8	59
9	6-7	10
10	6-8	39
11	7-8	30
12	8-9	25
13	9-10	20
14	10-11	20
15	10-12	37
16	11-12	16
17	11-13	20
18	12-15	31
19	13-14	16
20	14-15	11

S.No.	Station
1	Howrah Jn
2	Barddhaman Jn
3	Durgapur
4	Raniganj
5	Asansol Jn
6	Chittaranjan
7	Jamtara
8	Madhpur Jn
9	Jisdih Jn
10	Jhajha
11	Jamui
12	Kiul Jn
13	Luckeesarai Jn
14	Hatidah Jn
15	Mokama

Pert Network Diagram:



S.No	Earliest Occurrence Time E (in minutes)	Latest Occurrence Time L (in minutes)
1	0	0
2	65	65
3	116	116
4	132	132
5	150	150
6	168	169
7	178	179
8	209	209
9	234	234
10	254	254
11	274	275
12	291	291
13	294	295
14	310	311
15	322	322

Hence, the critical path is 1-2-3-4-5-8-9-10-12-15.

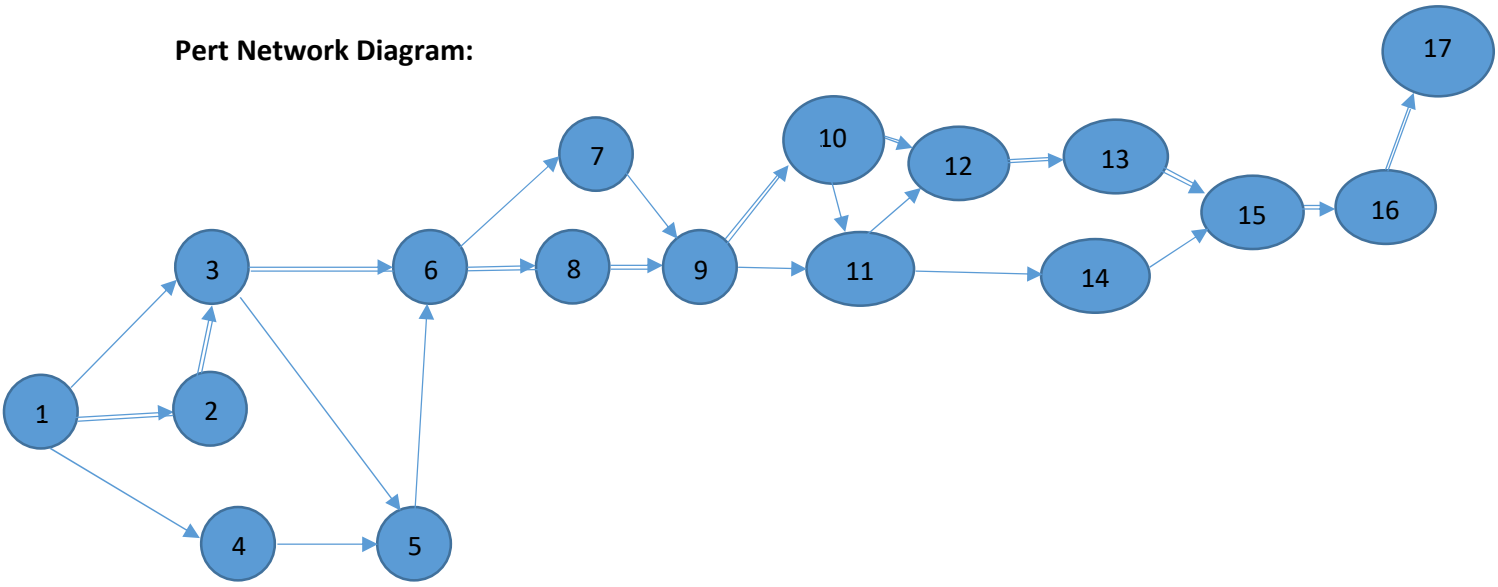
For this if we sum up the duration the total time taken 322 minutes.

4. WEST BLOCK DIAGRAM (MUMBAI CST TO NAGPUR)

1	MUMBAI CST
2	DADAR
3	KALYAN
4	THANE
5	IGATPURI
6	NASHIK
7	JALGAON
8	CHALISGARH
9	BHUSAVAL
10	NANDURA
11	AKOLA
12	SHEGAON
13	MURTAJAPUR
14	BADNERA
15	DHAMANGAON
16	WARDHA
17	NAGPUR

ACTIVITY	TIME (MINUTES)
1-2	14
1-3	60
1-4	38
2-3	46
3-6	160
4-5	65
3-5	90
5-6	58
6-7	183
7-9	27
6-8	118
8-9	95
9-10	83
9-11	135
10-11	55
10-12	18
12-13	64
13-15	91
11-14	70
14-15	32
15-16	51
16-17	87

Pert Network Diagram:



Sr. No.	$E_{i=1-17}$	$L_{i=1-17}$
1	0	0
2	14	14
3	60	60
4	38	97
5	150	162
6	220	220
7	403	406
8	338	338
9	433	433
10	516	516
11	571	587
12	534	534
13	598	598
14	641	657
15	689	689
16	740	740
17	827	827

Hence, the critical path is 1-2-3-6-8-9-10-12-13-15-16-17.

For this if we sum up the duration the total time taken 827 minutes.

8. Timeframe

Gantt chart																							
		Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Sr.No	Task																							
1	Selection of Project																							
2	Collecting relevent data																							
3	Discussing the Scope of Project																							
4	Analysing Problem Statement																							
5	Making the report and presentation																							

9. REFERENCES

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