

Study of Network Systems in Practice and Developing an Effective Network to Reduce the Project Duration

Khaidem Rosaline, S.Kesavan

Department of Civil Engineering, SRM University, Chennai, India

Department of Civil Engineering, SRM University, Chennai, India

ABSTRACT: Network analysis is used for planning and controlling projects in construction and many other fields. Dijkstra's algorithm used for finding shortest path from a vertex to any other vertex. Critical Path Method (CPM) is to identify critical activities on the critical path so that resources may be concentrated on these activities in order to reduce project length time. To identify the critical path, two parameters such as earliest event time, latest event time for each of its activities are determined. This paper presents Dijkstra's algorithm to find the path to reduce the project duration and also used for critical path method to find the latest and earliest times .

KEYWORDS: Dijkstra's Algorithm, Critical path method

I. INTRODUCTION

CONSTRUCTION of project on time and within the specified budget is a difficult task. Project management is the overall planning ,control and coordination of building project from the inception to completion stage .A large number of factors contribute in delaying the work that comprises of contractor delays, client delays, consultant delays, labor related delays and various other external delays. These delays in longrun causes time overrun, cost overrun , dispute, arbitration, total abandonment. This is because some project activities are critical in the sense that delay in their commencement will delay the overall project completion time . Therefore planning and scheduling of the every project is important to face the problem . Network models are conventional way of finding the most skillfull way to link a number of activities directly or indirectly in order to satisfy supply and demand requirements at different activity locations and project scheduling.

II. OBJECTIVES OF THE STUDY

The main objective of this project is to find the shortest possible time for the completion of the project and to reduce the project duration which will provide an effective strategy for the clients' objective as well as construction industry.

III. ADVANTAGES OF NETWORK

It identifies various activities that need to be accomplished for the project completion and helps in the planning and scheduling of the activities needed for the activities. It specifies the part of the project that are crucial which if delayed beyond the normal time would increase the completion time of the project as a whole. It further assists in allocating resources, such as labor and equipment and thus helps to make the total cost of the building project a minimum by finding the optimal trade-off between various costs and time involved.

IV. METHODOLOGY

At First literature review was done then construction of buildings site were visited and few data's was collected. On the

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

basis of that a list of equipments were made and data's were collected for them and it was been analyzed

V.INTRODUCTION TO NETWORK SYSTEMS

Network is the diagrammatic representation of a work plan showing the activities, step by step, leading to the established goal arranged in a logical and sequential order.

Network systems is a set of hardware or software tools that allow an Information Technology professional to supervise the individual work components of a network within a larger network management framework.

CRITICAL PATH METHOD (CPM)

PROGRAMME EVALUATION REVIEW TECHNIQUE(PERT)

LINE OF BALANCE(LOB)

BAR CHART OR GANTT CHART

DIJKTRA'S ALGORITHM

1.CRITICAL PATH METHOD

CPM is a management tool that has been used from the mid 50s. The main objective of the CPM isto determine the projecttime required to perform activities and repetitive tasks that are needed to finish off the project .It is the most popular network analysis technique used in assisting managers in planning and controlling large scale projects. Initially this methodology was identified to conduct routine tasks such as plant overhaul, maintenance and construction. (Moder and Phillips, 1964) Critical path analysis is an extension of the bar chart. The CPM uses a work breakdown structure where all projects are divided into individual tasks or activities. For any project there is a sequence of events that have to be undertaken. Some tasks might be dependent on the completion of the previous tasks while other might be independent of the tasks ahead and can be undertaken at any given time. (Lowe, 1966) Job durations and completion times also differ significantly. CP analysis helps decision makersand project execution members to identify the best estimates (based on accurate information) of the time that is needed to complete the project.

1.1 CRITICAL PATH METHOD CALCULATION OF THE NETWORK

LIST OF ACTIVITIES

TABLE 1List of activities

Activity No	Activity	Expected completion time	Dependency
1.	excavation	4	-
2.	Line cement concrete	6	1
3.	RCC work in foundation	7	1
4.	Reinforced cement concrete in columns ,roof ,floors	8	2,3
5.	Brick work	5	3,
6.	flooring	3	5
7.	plastering	2	5
8.	Laying of ceramic tiles	1	7,6
9.	Marble slab flooring	4	4
10.	painting	2	9,8

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

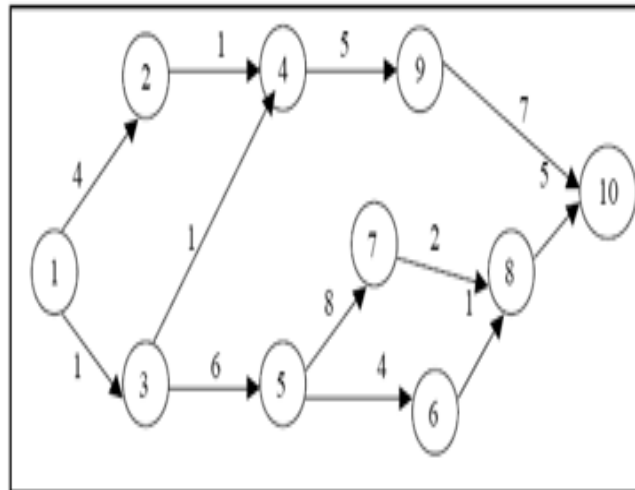


FIGURE 1 Fig showing network diagram

To determine the critical path, compute the earliest, time TE and latest time TL for each of the activity of the project. The calculations of TE and TL are as follows:

TO CALCULATE TE FOR ALL ACTIVITIES

$$TE_1=0$$

$$TE_2=TE_1+t_{1,2}=0+4=4$$

$$TE_3=TE_1+t_{1,3}=0+1=1$$

$$TE_4=\max(TE_2+t_{2,4} \text{ and } TE_3+t_{3,4}) \\ =\max(4+1 \text{ \& } 1+1)=\max(5,2)=5 \text{ days}$$

$$TE_5=TE_3+t_{3,5}=6+1=7$$

$$TE_6=TE_5+t_{5,6}=7+4=11$$

$$TE_8=\max(TE_6+t_{6,8} \text{ \& } TE_7+t_{7,8}) \\ =\max(12,17)=17 \text{ days}$$

$$TE_9=TE_4+t_{4,9}=5+5=10 \text{ days}$$

$$TE_{10}=\max(TE_9+t_{9,10} \text{ \& } TE_8+t_{8,10}) \\ =\max(17,22)=22 \text{ days}$$

TO CALCULATE TL FOR ALL ACTIVITIES

$$TL_{10}=TE_{10}=22$$

$$TL_9=TE_{10}-t_{9,10}=22-7=15$$

$$TL_8=TE_{10}-t_{8,10}=22-5=17$$

$$TL_7=TE_8-t_{7,8}=17-2=15$$

$$TL_6=TE_8-t_{6,8}=17-1=16$$

$$TL_5=\min(TE_6-t_{5,6} \text{ \& } TE_7-t_{5,7}) \\ =7 \text{ days}$$

$$TL_4=TL_9-t_{4,9}=15-5=10$$

$$TL_3=1 \text{ day}$$

$$TL_2=9$$

$$TL_1=0$$

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

TABLE 2 Calculation of cpm

ACTIVITY	NORMAL TIME	START	FINISH	START	FINISH	FLOAT
1-2	4	0	4	5	9	5
1-3	1	0	1	0	1	0
2-4	1	4	5	9	10	5
3-4	1	1	2	9	10	8
3-5	6	1	7	1	7	0
4-9	5	5	10	10	15	5
5-6	4	7	11	12	16	5
5-7	8	7	15	7	15	0
6-8	1	11	12	16	17	5
7-8	2	15	17	15	17	0
8-10	5	17	22	19	22	0
9-10	7	10	17	15	22	15

The critical path for the above network is 1-3,3-5,5-7,7-8 and 8-10.

2. DIJKSTRA'S ALGORITHM

Dijkstra's Algorithm computes the shortest paths from a source vertex to every other vertex the so called single shortest path (SSSP). This Algorithm remains the best for computing single shortest path problem with non negative weighted graphs. Dijkstra's Algorithm is the method used to find the shortest path. Shortest path is that of finding a path of minimum weight connecting two specified vertices in a weighted graph. There are different types of shortest path algorithm to find the shortest path of any graph. Most frequently encountered are the following

- i. Shortest path between two specified vertices
- ii. Shortest path between all pairs of vertices
- iii. Shortest path from a specified vertex to all others.

The most efficient algorithm used to find the shortest path between two known vertices is Dijkstra's algorithm (shortest path between two specified vertices). The problem of finding the shortest path from a specified vertex s to another vertex t , can be stated as follows :

A simple weighted digraph G of n vertices is described by a n by n matrix $D = [d_{ij}]$, where, d_{ij} = length (or distance or weight) of the directed edge from vertex i to vertex j .

$d_{ij} \geq 0$

$d_{ii} = 0$,

If there is no edge from i to j (in carrying out a program we replace infinity by larger value) Dijkstra's algorithm labels the vertices of the given digraph. At each stage in the algorithm some vertices have permanent labels and others temporary labels. The algorithm begins by assigning a permanent label 0 to the starting vertex s , From then on, in each iteration another vertex gets a permanent label, according to the following rules :

Step 1 : Every vertex j that is not yet permanently labelled gets a new temporary label whose value is given by $\min[\text{old label of } j, (\text{old label of } i + d_{ij})]$, where i is the latest vertex permanently labelled in the previous iteration and d_{ij} is using Modified Dijkstra's Algorithm for Critical Path Method the direct distance between vertices i and j . If i and j are not joined by an edge,

then $d_{ij} = 0$.

Step 2 : The smallest value among all the temporary labels is found, and this becomes the permanent label of the corresponding vertex. In case of a tie, select anyone of the candidates for permanent labeling,

Steps 1 and 2 are repeated alternately until the destination vertex t gets a permanent label. The first vertex to be permanently labeled is at a distance of zero from s . The second vertex to get a permanent label (out of the remaining $n-1$ vertices) is the vertex closest to s .

Step 3: From the remaining $n-2$ vertices, the next one to be permanently labeled is the second closest vertex to s . And so on. The permanent label of each vertex is the shortest distance of that vertex from s . This statement can be

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

proved by induction. All steps are easily programmed except for the job of distinguishing the permanently labeled vertices from the temporarily labeled ones, which is slightly tricky. An efficient method of accomplishing this is to associate indices $1, 2, \dots, n$ with the vertices and keep a binary vector $VECT$ of order n . When the i th vertex becomes permanently labeled, the i th element in this binary vector changes from 0 to 1.

CALCULATION FOR DIJKSTRA'S ALGORITHM

TABLE 3 Table showing calculation of shortest path

1	2	3	4	5	6	7	8	9	10
0(P)	-	-	-	-	-	-	-	-	-
0(p)	4	1	-	-	-	-	-	-	-
0(p)	4	1(P)	-	-	-	-	-	-	-
0(p)	4	1(p)	2	7	-	-	-	-	-
0(p)	4	1(p)	2(P)	7	-	-	-	-	-
0(p)	4	1(p)	2(p)	7	-	-	-	7	-
0(p)	4	1(p)	2(p)	7	-	-	-	7(P)	-
0(p)	4	1(p)	2(p)	7	-	-	-	7(p)	14(P)

3. Modified Dijkstra's algorithm for critical path method

An activity network is an acyclic digraph N of n vertices and directed edges $a_{ij}=(v_i, v_j)$ of activities performed in the project. It is described by a n by n matrix $T = \{t_{ij}\}$, where, t_{ij} = time required for the completion of each activity a_{ij} . $t_{ij} \in 0$, $t_{ii}=0$, $t_{ij} = \infty$, if there is no activity from i to j (in carrying out a program we replace infinity by larger value). Let v_1 and v_n be initial and terminal vertices of the activity network diagram. Modified Dijkstra's algorithm labels the vertices of the given digraph. At each stage in the algorithm some vertices have permanent labels and others temporary labels.

Forward pass algorithm

Step 1: Assign the n vertices in the order $v_1 = 1, v_2 = 2, v_3 = 3, \dots, v_n = n$

Step 2: Assign a permanent label $E_1 = 0$ to the initial vertex $v_1 = 1$, and temporary label 0 to the remaining $n-1$ vertices.

Step 3: Every vertex j that is not yet permanently labeled gets a new temporary label whose value is given by $E_j = \max[\text{old label of } i, (\text{old label of } i + t_{ij})]$, where i is the latest vertex permanently labeled and t_{ij} ($t_{ij} = t_{ji}$) is the activity time between vertices i and j . If i and j are not joined by an edge, then $t_{ij} = 0$

Step 4: The next vertex becomes the permanent label. Step 3 and Step 4 are repeated until the destination vertex $v_n = n$ gets a permanent.

TABLE 4 Labelling to find earliest time

1	2	3	4	5	6	7	8	9	10
0(P)	0	0	0	0	0	0	0	0	0
0(p)	4	1	0	0	0	0	0	0	0
0(p)	4	1(P)	0	0	0	0	0	0	0
0(p)	4	1(p)	2	7	0	0	0	0	0
0(p)	4	1(p)	2	7(P)	0	0	0	0	0
0(p)	4	1(p)	2	7(p)	11	15	0	0	0
0(p)	4	1(p)	2	7(p)	11	15(P)	17	0	0
0(p)	4	1(p)	2	7(p)	11	15(p)	17(P)	0	0
0(p)	4	1(p)	2	7(p)	11	15(p)	17(p)	0	22(P)

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

VI. RESULTS AND DISCUSSION

Normal duration for completing the project was 43 days for completing the construction of building headquarter .Using CPM method ,the duration got reduced to 22 days. Using dijkstra's algorithm , the shortest distance or path of the network frame from the source to origin to destination is 14.Using modified dijkstra's algorithm for critical path method the earliest time is 22 days.

VII. CONCLUSION

Dijkstra's Algorithm is more effective method to reduce the project duration to complete the work.Modified Dijkstra's algorithm can calculate the latest times and earliest times for critical path but it does have some disadvantages that may skip an activity inorder to reach the destination and useof additional resources to cover all the important activities and it cannot handle negative values .

REFERENCES

1. H.N.Ahuja, S.P. Dozzi, and S.M. Abourizk, Project Management, New York: Wiley, 1994.
2. W.J. Stevenson, Operation Management, seventh edition, McGraw-Hill, 2002.
3. E.W.Dijkstra, A Note in Connectin with Graphs, Numerische Mathematik, Vol.1, pp. 269-271,1959.
4. M.Barbehenn, A Note on the Complexity of Dijkstra's Algorithm for Graphs with Weighted Vertices, IEEE Transactions on Computers, Vol. 47, No.2, 1998.
5. S.Pettie and V. Ramachandran, Minimizing Randomness in Minimum Spanning Tree, Parallel Connectivity, and Set Maxima Algorithms, UTCS Technical Report TR-01- 25,2001.
6. L.Bing, C. Siew-Hwee, L. Shee-Ling, L.Sing-Meng, L.Soo-Chee, P.Foong-Ping, and T.Hwee-Har, Integrating Case-based Reasoning, Knowledge-Based Approach and Dijkstra's Algorithm for Route Finding, Proceeding of the conference on Artificial Intelligence Applications, pp. 149-155, 1994.
7. D.Geiger and L.Tyang-Luh, Recognizing Articulated Objects with information Theoretic Methods, Proceeding of the Second International Conference on Automatic Face and Gesture Recognition, pp. 45-50, 1996.
8. L.Tyang-Luh, D.Geiger, and A.L.Yville, Segmenting by seeking the symmetry axis, 14th International Conference on Patten Recognition, Vol.2, pp.994-998, 1998.
9. W.L. Schiele, T.Kruger, K.M.Just, and F.H. Kirsch, A Gridless Router for Industrial Design Rules, 27th ACM/ IEEE Design Automation Conference, pp. 626-631,1990.
10. M.Noto and H.Soto, A Method for the Shortest Path search by Extended Dijkstra's Algorithm, IEEE International Conference on Systems, Man, and Cybernetics, Vol.3, pp.2316-2320,2000.
11. A.V. Goldberg and C. Silverstein, Implementations of Dijkstra's Algorithm Based on Multi-Level Buckets, Technical Report 95-187, NEC Research Institute.