Planning and Scheduling of a School Building by using CPM Network Technique

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Abstract

A building should be planned to make it comfortable, economical and to meet all the requirements. The attempt of the planner should be to attain maximum convenience with the limited money available. Functional utility, cost, habits, taste, requirements, etc., should be considered by the planner. Circulation area should be minimum possible without affecting other requirements and convenience. To start with, all the requirements should be collected and then planning should be taken up and a number of alternative proposals are prepared and comparing their advantages and disadvantages, the best one should be adopted. The engineer and architect shall have to satisfy the owner, for which a number of sitting will be required to finalize the plan. By Scheduling, we assign a particular time for completing a particular job. The main objective of scheduling is to arrive at a position where we will get minimum processing time. The basic principles and mechanics of network technique (CPM/PERT) is the application of planning, analyzing and scheduling and controlling of event and activities involved in a project in relation to time and interdependence of each activity. Therefore, this paper aims at planning and scheduling of a school building by using network technique.

Keywords: CPM, PERT, Activity, Task, Critical Path

I. INTRODUCTION

School building should be planned to have maximum useful area. The carpet area may be 55% to 70% of the plinth area with a target of 70%. The circulation area should be minimum possible to achieve economy, the rooms may be arranged on both sides of the corridor classrooms may be on one side and laboratories on other side.

The floor area of classroom for secondary school may be taken as 1sq. m (10sq. ft) per student and for 60 students a classroom of 60 sq. m (600sq. ft.) may be sufficient. the ratio of dimensions of class room may be taken as 1 ½ :1 for other purpose the area per student may be taken as Library and reading rooms – 0.5 sq. m, office – 0.3sq. m, students common room 0.3 sq. m, examination hall – 0.5sq. m, science laboratory 1.5 sq. m, staff common room 0.15sq. m, store room 0.2 sq. m, principal room total area 30sq. m. Area occupied is about 15% to 20% of the plinth area, and area of verandah and passage may be taken as 15% of the plinth area. the height of room should not be less than 3.6 m it is better to have the height 4.2 m to 4.8 m class rooms should not be placed face to face to avoid disturbance. The class rooms should be well lighted and ventilated. the window area should be placed 1 to 1.2 m height above floor.

The approach centers on the child, the main user of these learning spaces and environments, with the understanding that family and community participation is fundamental for best results. In this regard, the main objectives in school planning are:

- Attract students (increase access)
- Improve attendance rates
- Improve retention and completion rates
- Improve learning achievement
- Provide enabling learning environments
- Build a sense of community within the school (institutional ethos)
- Involve parents and the community (support and participation)
- Cultivate harmony between the school and its community
- Harmonize buildings, school grounds and environment as children interact with them

The main objective of this project is to provide low cost, long life and eco-friendly and good transport and other facility school building to the client.
A. **Low Cost**

Construction of this school building is cheaper than the other conventional building. Therefore, it is economically fit for its owner. We minimize the cost of this project by proper designing, skilled labour, perfect method of working and optimum use of labour, worker, machineries and materials.

B. **Long Life**

The designing of this building is accomplished in such a way that it becomes long lasting. The good quality materials, skilled site engineer, supervisor, labour and appropriate methods make it possible to increase the life time of the building.

C. **Eco Friendly**

For better future it is necessary to save the environment. Many type of pollutions are hurdle which create difficulty to achieve the goal. In this project we seriously focus that it did not harm the environment. Proper plantation is also done to save and make the environment fresh.

D. **Transport and Other Facilities**

School building is located at such a place where transportation facilities and other facilities are easily available.

II. **LITERATURE REVIEW**

Stukhart (1995) and Bernold and Treseler(1991) studied that the materials cost can be around of 50% to 60% of the total of project cost. In addition, unavailability of materials will affect the productivity and cause to the completion of the project.

Nkado R.N, 1995 marked that there is no consensus in the literature on the identification of factors which affect stipulated, planned or achieved construction times of buildings.

Damodara (1999) pointed out that there is obvious that materials can provide saving when it obtained at the lowest price to the company. Also, he studied that more that 40% of the time lost due to bad management in construction site, poor documentation of materials, lack of materials on site when needed and inadequate storage.

Arnold, J. R. and Chapman (2004) studied that materials management can be defined as an organizing function responsible for planning and controlling the materials flow.

Chan et al, (2004) accentuated that accurate construction planning is a key factor in ensuring the delivery of a project on schedule and within budget.

According to Winch, Kelsey 2004, Construction project planning is receiving growing attention as the limitations of formal deterministic planning are becoming more widely recognized.

According to Lock 2007 Project Management has evolved in order to plan, coordinate and control the complex and diverse activities of modern industrial, commercial and management change projects.

Cooke 2008 studied that to allow for effective planning and control of projects, a requirement for systematic and logical methods should be applied along with proven techniques, thus ensuring a successful project outcome for all concerned parties, particularly the client.

A. Russel (2009) presented the network scheduling methods and other family of construction methods in the form of a topology. The network scheduling methods are advancement to bar charts.

III. **PLANNING PHASE**

A. **Features of School Building (G+3)**

School Building is a three storey building with the stilt floor where all offices will be operated and the building is divided into three wings.

1) **Features**

- Total Height - 17mts.
- Built up area - 892sqr. meter
- No. of Classes - 40 Classes
- No. of Labs - 08 labs
- Foundation - Raft Foundation.
- Super structure - Framed Structure.
- No. of stair - 08 nos.

B. **Provisions in School Building**

1) **Ground Floor**

- Parking
- Entrance lobby
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- Canteen
- Generator Room
- Cycle Stand
- Classroom
- Office
- Staff room
- Toilet
- Playground

Ist, IInd and IIIrd Floor
- Classroom
- Labs
- Smart Class
- Staff Room
- Toilet

C. Task or Out-Turn Work

Task: The capacity of doing work by skilled labor in the form of quantity work per day is known as the task-work.

The following may be taken as the approximate quantity of work or out turn of task for a skilled labor per day.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particular of item</th>
<th>Quantity</th>
<th>Per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Earth work</td>
<td>90-120 cum</td>
<td>Per Hydraulic Machine</td>
</tr>
<tr>
<td>2</td>
<td>Earth work</td>
<td>28.0 cum</td>
<td>2 Mazdoor</td>
</tr>
<tr>
<td>3</td>
<td>Brick work in c.m.in foundation, plinth</td>
<td>1.25 cum</td>
<td>Per mason &amp; 1.57 labor</td>
</tr>
<tr>
<td>4</td>
<td>Brick work in c.m.in super str. &amp; plinth</td>
<td>1.00 cum</td>
<td>Per mason &amp; 1.57 labor</td>
</tr>
<tr>
<td>5</td>
<td>Half brick wall in partition</td>
<td>5.00 sq. m</td>
<td>Per mason &amp; 1.57 labor</td>
</tr>
<tr>
<td>6</td>
<td>Cement concrete</td>
<td>5.00 cum</td>
<td>Per mason &amp; 1.57 labor</td>
</tr>
<tr>
<td>7</td>
<td>R.C.C. work</td>
<td>3.00 cum</td>
<td>Per mason &amp; 1.57 labor</td>
</tr>
<tr>
<td>8</td>
<td>Plaster work</td>
<td>8.00 sq. m</td>
<td>Per mason &amp; 1.36 labor</td>
</tr>
<tr>
<td>9</td>
<td>White washing</td>
<td>70.0 sq. m</td>
<td>Per washer &amp; 1.00 labor</td>
</tr>
</tbody>
</table>

IV. Scheduling Phase

A. Duration of Project for a School Building

1) Duration of Project for Substructure Part

- Substructure part: It is a structure which that is completed up to plinth level, or other word substructure is underground structure.
- Activity of completed substructure part: Substructure part involves the activity for completing the substructure part as given below with expected time.
- Activity (1-2): Excavation expected time is 12 days.
- Activity (1-3): Excavation with compaction expected time is 14 days.
- Activity (2-4): Compaction after excavation expected time is 4 days.
- Activity (3-5): P.c.c. after excavation with compaction expected time is 10 days.
- Activity (3-6): P.c.c. with excavation and compaction expected time is 4 days.
- Activity (4-7): P.c.c. after excavation with compaction expected time is 10 days.
- Activity (7-10): Footing after cutting & binding steel expected time is 26 days.
- Activity (5-9): Footing after p.c.c. work expected time is 38 days.
- Activity (6-8): Footing with p.c.c. work expected time is 30 days.
- Activity (8-11): Concreting for column, plinth beam with steel work expected time is 15 days.
- Activity (9-11): Concrete for column, plinth beam with steel work banking expected time is 12 days.
- Activity (10-11): Concrete for column, plinth beam without steel work, banking expected time is 18 days.
- Activity (11-12): Other work expected time is 20 days.

Solution: Computation of $T_E$ is done in tabular form as:

<table>
<thead>
<tr>
<th>Event</th>
<th>Predecessor Event</th>
<th>Activity</th>
<th>$T_E$</th>
<th>$T_{E1}$</th>
<th>$T_{E2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1-2</td>
<td>12</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1-3</td>
<td>14</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>2-4</td>
<td>4</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>3-5</td>
<td>10</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>3-6</td>
<td>4</td>
<td>14</td>
<td>18</td>
</tr>
</tbody>
</table>
2) **Summation of Path**
- 1-2-4-7-10-11-12 = 12+4+10+26+18+20 = 90 days.
- 1-2-4-7-8-11-12 = 12+4+26+10+15+20 = 87 days.
- 1-3-6-8-11-12 = 14+4+30+15+20 = 83 days.
- 1-3-5-9-11-12 = 14+10+38+12+20 = 94 days.

Critical path is that which has maximum \( t_c \).
Hence critical path is that 1-3-5-9-11-12.
Duration of substructure part of Primary School Building is 94 days.

**B. Duration of Project for Superstructure Part**

1) **Superstructure Part**
It is a structure which is completed above plinth level, or other word substructure is above ground structure.

a) Activity of Complete Ground Floor Part:
Ground floor part is involving the activity for completing the superstructure part as given below with expected time.
- Activity (1-2): Concrete such as column, beam, slab expected time is 140 days.
- Activity (2-3): Build wall after 140 days of concrete expected time is 90 days.
- Activity (3-4): Fixed electricity conduit after 80 days of build wall expected time is 10 days.
- Activity (3-5): Plumbing work after 80 days of build wall expected time is 20 days.
- Activity (4-6): Plaster work after plumbing & fixed electricity conduit expected time is 45 days.
- Activity (4-6): Plaster work after plumbing & fixed electricity conduit & other finishing work expected time is 90 days.

b) Activity of Complete First Floor Part
First floor part is involving the activity for completing the superstructure part as given below with expected time.
- Activity (2-7): Concrete such as column, beam, and slab expected time is 140 days.
- Activity (7-8): Build wall after 140 days of concrete expected time is 90 days.
- Activity (8-9): Fixed electricity conduit after 80 days of build wall expected time is 10 days.
- Activity (8-10): Plumbing work after 80 days of build wall expected time is 20 days.
- Activity (9-11): Plaster work after plumbing & fixed electricity conduit expected time is 45 days.
- Activity (10-11): Plaster work after plumbing & fixed electricity conduit & other finishing work expected time is 90 days.

c) Activity of Complete Second Floor Part
Second floor part is involving the activity for completing the superstructure part as given below with expected time.
- Activity (7-12): Concrete such as column, beam, and slab expected time is 140 days.
- Activity (12-13): Build wall after 140 days of concrete expected time is 90 days.
- Activity (13-14): Fixed electricity conduit after 80 days of build wall expected time is 10 days.
- Activity (13-15): Plumbing work after 80 days of build wall expected time is 20 days.
- Activity (14-16): Plaster work after plumbing & fixed electricity conduit expected time is 45 days.
- Activity (15-16): Plaster work after plumbing & fixed electricity conduit & other finishing work expected time is 90 days.

d) Activity of complete third floor part
Third floor part is involving the activity for completing the superstructure part as given below with expected time.
Activity (12-17): Concrete such as column, beam, and slab expected time is 140 days.
Activity (17-18): Build wall after 140 days of concrete expected time is 90 days.
Activity (18-19): Fixed electricity conduit after 80 days of build wall expected time is 10 days.
Activity (18-20): Plumbing work after 80 days of build wall expected time is 20 days.
Activity (19-21): Plaster work after plumbing & fixed electricity conduit expected time is 45 days.
Activity (20-21): Plaster work after plumbing & fixed electricity conduit & other finishing work expected time is 90 days.

2) **Computation of \( T_E \) is done in Tabular Form as**

<table>
<thead>
<tr>
<th>Event</th>
<th>Predecessor Event</th>
<th>Activity</th>
<th>( t_e )</th>
<th>( T_{E(1)} )</th>
<th>( T_{E(2)} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>4-7</td>
<td>10</td>
<td>16</td>
<td>26</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>6-8</td>
<td>30</td>
<td>18</td>
<td>48</td>
</tr>
<tr>
<td>2</td>
<td>7-8</td>
<td>10</td>
<td>26</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>5-9</td>
<td>38</td>
<td>24</td>
<td>62</td>
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<tr>
<td>10</td>
<td>1</td>
<td>7-10</td>
<td>26</td>
<td>26</td>
<td>52</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>8-11</td>
<td>15</td>
<td>48</td>
<td>63</td>
</tr>
<tr>
<td>2</td>
<td>9-11</td>
<td>12</td>
<td>62</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10-11</td>
<td>18</td>
<td>52</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>11-12</td>
<td>20</td>
<td>74</td>
<td>94</td>
</tr>
</tbody>
</table>
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Duration of Project of Primary School Building is 2 year/5 month /4 days. Nearly about 2.5 year.

\[ \text{Total duration} = \text{duration of substructure} + \text{duration of superstructure} \]

Duration of superstructure part of Primary School Building is 790 days.

Hence critical path is critical path is that which has maximum \( t_c \).

Critical path is 1-2-7-12-13-15-16-22 = 790 days.

Duration of project of Primary School Building such as

Total duration = duration of substructure + duration of superstructure

= 94+790 =884 days.

= 2 year-5 month -4 days. Nearly about 2.5 year

Duration of Project of Primary School Building is 2 year/5 month /4 days. Nearly about 2.5 year.

V. CONCLUSION

1) The school building planned is according to the planning done and the facilities are provided as per the plan.
2) The scheduling is done by the CPM network technique.
3) The critical duration of the school building as per the scheduling done is 2 years/5 months and 4 days.
4) All the possibilities of delay in the project are considered.
5) This project use CPM technique which help the client from delay, economical process, properly scheduled and the progress can be checked from time to time according to the scheduling done.

REFERENCES