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RESEARCH ARTICLE

APPLICATION OF PRIMAVERA P6 SOFTWARE FOR SCHEDULING SINGLE CONSTRAINED RESOURCE IN SMALL GAS STATION PROJECT

Mabrouka Shahat Younis Elfargani[a*], Ahmed Fthallh Mhmmed[b], Aimen Emragha Abd alati Abd allah[b], Abd aullah Mansor Algedo[b], Hamad Fryaj Hamad Amer[b], Youssf Tiher Abobker Hasan[b],

[a]Civil Engineering Department, Al Gubba, University of Derna, Libya.
[b]Omar AL Mukhtar University, Civil Engineering Dep., AL-Gubba, Libya
***Corresponding Author Email: M.Shahat@uod.edu, mabroukaelshaary@gmail.com**

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ABSTRACT

The Success in the use of the Primavera P6 Software to schedule the project depends on the size of the project, the level of its complexity the time allocated for its execution and the requirements dictated by owner of the project……etc. The basic idea behind the proposed system is the use of software set up for this purpose in order to delineate start- finish time by applying Critical Path Method, the Primavera P6 Software for scheduling single constrained resource in projects. They may only of solutions start by scheduling and analyzing the resource time period by time period, and resource by resource when the amount of the resources available is exceeded the method of tasks is examined and rare resources are then allocated according is the levels of priority. A major position arises then: how to increase the time necessary for the completion of the project with the remaining minimum with due respect to the labor limitations. The answer lies in the application of the Primavera P6 Software which is used in practical situations, so as to avoid mathematical complications which are characteristics of perfect model methods. In order to achieve the best solution, activities are re- scheduled based on labor constraints according to various numerous bases. These were applied on a project for the construction of a small size Gas Station, classified under small construction projects which include 29 activities. The 3 stages of implementation were applied tested to the project mainly planning, scheduling and control. We obtained the desired results with an increase in the time allocated for the completion of the project with strictest minimum possible while respecting labor constraints.

KEYWORDS

Primavera P6, CPM, Resource-Constrained, Project Planning, Project Control, Project Scheduling.

1. Introduction

The scheduling of a construction project is more important today than ever before. Here, we have tested the idea to reduce the increase in the time of completion of the project to the least possible duration, to stress that there is a restriction in terms the size of the available labors (Conclaves et al., 2004). The basic idea in this case depends on the fact that there is a restriction on the size of the available labor which may result in an increase in the minimum time possible to complete the project according to the estimations of regular time. And it lies in some diligence regulation methods, which are often used in practical life in order to avoid the problems of the mathematical complexity in the optimal solution methods using computer programs to test the rescheduling in light of constraint resources based on the many and varied discretionary rules.

Most of the solution methods begin in scheduling and analyzing the resource time by time (Gen et al., 2008). In the period when they are infringed quantity available from the supplier examine how experimental tasks in the period and the distribution of the scare resource sequentially according to some priority rule and the main difference between trials, is the priority rules that you use (Sharma et al., 2004).

The use of computers in project management in highlighted by using Primavera P6 as a distinctive program in project management whereas it allows us to add flexibility to the severe program that is required in project management in terms of how much data you grasp and ease to deal with this data and acceptance of the amendment at any stage of the project (Elmaghraby, 1977).

2. Problem Statement

The problem discussed in this research is that of scheduling the project under single resource constraints (Ismail et al., 2009) The focus of scheduling in these situations is to prioritize and allocate resources in such a manner that there is minimal project delay, An implementation of the computing of the resource-constrained project scheduling (Kim and Ellis 2005). The strategy of activity-shifting was replaced by prolonging duration and dividing it into active and sleeping parts. This makes it possible to apply a simple CPM algorithm.

3. Scope of This Work

In this section the application PrimaveraP6 software as shown to achieve optimal or near optimal solutions for single constrained resource projects is presented (Kim, 2003).

4. Oracle Software Primavera P6

Oracle Primavera P6 Project Management software (P6) is a powerful, interlinked software system designed to create and analyze the CPM schedules used in managing construction projects. P6 is built on SQL, Oracle, and SQL Server express databases, which allows the creation of global codes and resources, and to link multiple schedules together

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(Meredith and Mantel, 1995). P6 uses standard Windows interfaces to make usage easy, and to manage multiple large-scale projects at once.

5. Case Study (Small Gas Stations Project)

In order to illustrate the breakdown of a project into individual work activities for planning consider the small gas station project (Kelley, 1963). This project is typical of a small building.

First, the overall sequence of work must be considered. The first activity will be to mobilize onto the site. Next, the site must be prepared and excavation as required must be undertaken. Following the preparation of the site, the footers and the pier foundations are to be poured (Wiest, 1963). After the footers and pier foundation have reached sufficient strength, the building structure is erected (Wiest, 1964). It should be noted that in this case the floor slabs for the service bays, the show room, and office areas as well as the utility room and toilets are not poured until after the building structure is erected. The roof is then constructed and the building is "closed in" so that work inside the building is protected from the elements (Davis and Patterson, 1975). Once the building is protected from the weather, the work of pouring the interior floor slabs can proceed. Exterior finish items (exterior brick) can proceed at the same time as the interior floors are being cast (Viniotis and Ephremides, 1988). Once the interior floors are complete, other interior finish items can be completed (interior walls, electrical and mechanical systems, etc).

The major groups of activities are:

1. Site preparation and excavation.
2. Construction of footers and pier foundations.
3. Erect structure.
4. Roof construction.
5. Pour interior floor slabs.
6. Exterior finishes.
7. Interior finishes.
8. Electrical and mechanical systems.

A sequential time diagram indicating the order in which these activities will be worked is given in figure 1 (Woodwort and Shanahan, 1988). Typically a required date for the facility is given in the contract documents or directed by the client. The duration of the activities, obviously, must fit into this period of time (Badiru, 1993). The definition of the major work activities is shown in figure 1 and the decisions regarding the sequencing of the work constitutes planning for the job (Bowers, 1995).

Given the eight major work categories defined, the scheduler can now proceed with more detailed planning by breaking the work categories into activities that can be used for time control of the project. The initial category of site preparation can be expanded into the following activities:

1. Mobilization.
2. Permits.
3. Site work (leveling, grading, etc.)
4. Hook- up and connection with exterior utilities.
5. Excavation of catch basin.
6. Excavation of footers.
7. Excavation of pier foundations.

The expansion of the 8 categories into a final set of 22 control activities is given in figure 2 Since no durations of the activities have been assigned at this point, the work accomplished to date can be considered to be planning.

The starting time of the project equals 0 and all times are relative to this start. In practice, the start of the project is given in the form of real dates and times.

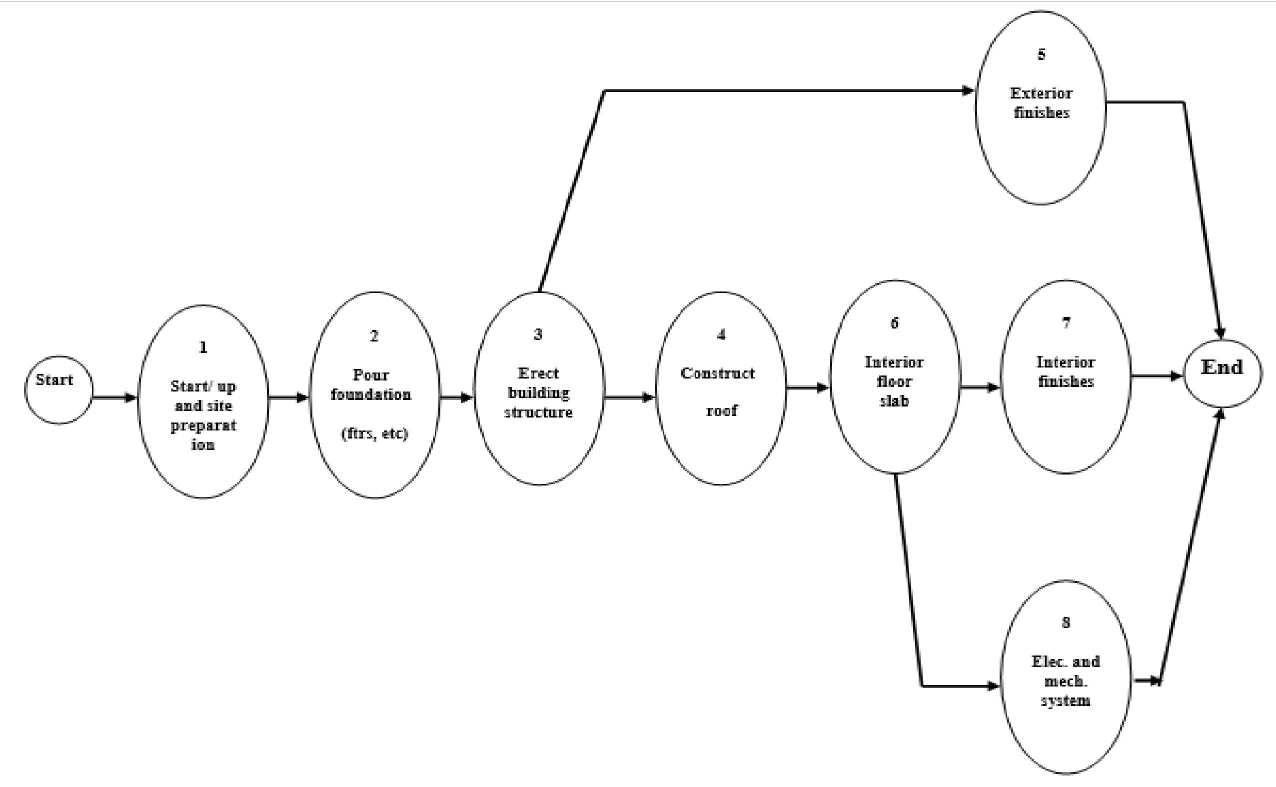

Figure 1: Preliminary Project Breakdown.

The next step in time control is to assign durations to each of the activities. The scheduler must consult with field personnel and get the best estimate of the duration for each activity based on methods selected for accomplishing the work, the resources available, and the experience the field management has in estimating productivity and time durations with these methods and resources. Assume that the durations for the individual activities are given in table 1.

Given this information, we are in a position to determine the minimum project duration for the project and the amount of time any activity might be delayed without impacting the minimum project duration. The method used to establish this information is the critical path method, which has been used widely throughout the construction industry since the mid-1960s

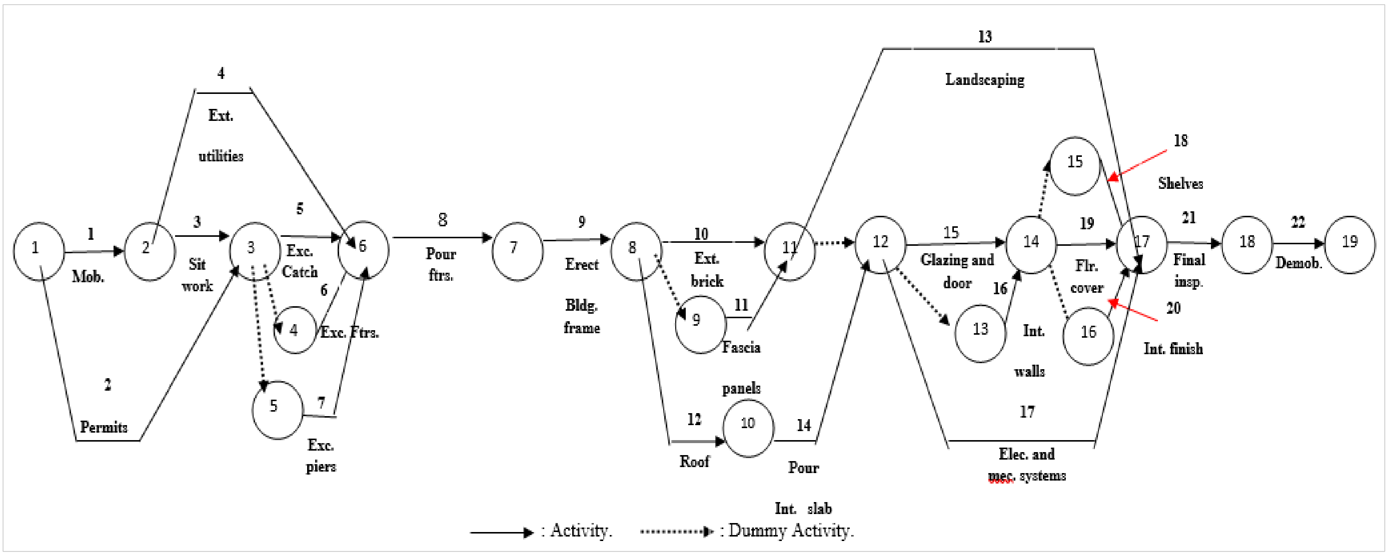

Figure 2: Extended Project Model.

Table 1: Durations of Activities for Small Gas Station			
Activity	Title	Duration (Day)	Resources (Labour)
1	Mobilize	10	12
2	Obtain permits	15	13
3	Site work	8	10
4	Exterior utilities	12	10
5	Excavate catch basin	2	3
6	Excavate footers	5	6
7	Excavate foundation piers	6	7
8	Pour footers, etc.	8	8
9	Erect bldg. frame	10	9
10	Exterior brick façade	14	12
11	Exterior fascia panels	4	4
12	Roof construction	15	14
13	Landscaping	12	10
14	Pour interior slabs	10	8
15	Glazing and doors	6	5
16	Interior walls	10	9
17	Elec. and mech. Systems	25	20
18	Shelves	3	3
19	Floor covering	6	7
20	Interior finishes	8	9
21	Final inspection	1	2
22	Demobilization	3	3

6. Application of Critical Path Method (CPM)

The critical path method, or CPM, approach to scheduling is based on describing the project as a network of activities. A network consists of nodes and links. Depending on the notation used, the nodes may represent events in time or the activities themselves. Depending on the notation, the links may represent the activities of the project or the logical sequence that relates the activities to one another. If we consider the initial eight activities breakdown of the small gas station project shown in figure 1, the activities are shown as large nodes or circles (Bowers, 2000). The sequence of work is shown by arrows connecting the circles. This notation is referred to as circle, or precedence, notation.

In arrow notation networks, it is often necessary to avoid introducing extra relationships like this one, by using a number of dummy arrows. Their sole function is to help avoid introducing extraneous relationships (Lu and Li, 2003). By referring to table 2, it can be seen that a dummy arrow has been introduced between nodes 11 and 12 to avoid relating the 'Pour interior slabs' activity (10-12) with the landscaping activity (11-17). If nodes 11 and 12 were pulled together into a single node, a false relationship would develop.

Precedence diagrams do not have this problem, but as noted they do not allow the definition of the logical sequence form a simple listing of the activity numbers. Precedence notation is also not attractive to some schedulers since the circle representation of the activities dose not impart the "feel" of a length reflecting activity duration.

The expanded diagram showing 22 activities in figure 2 has each activity shown as a link or arrow. The connections between the arrows and thus the element showing the sequence of the activities in a small node or circle (Seda ,2007). In this representation, the roles of the nodes and links have reversed. This way of representing a project is called arrow notation. In both cases, the use of nodes and links gives us a network of lines and points. Therefore, for time control purposes, the project has been reduced to a network. This network is as abstract model of the project plan.

Table 5.2: (i-j) Table for Small Gas Station.				
Activity	i-j	Title	Duration (Day)	Resources (Labour)
1	1-2	Mobilize	10	12
2	1-3	Obtain Permits	15	13
3	2-3	Site work	8	10
4	2-6	Exterior utilities	12	10
5	3-4	Dummy	0	0
6	3-5	Dummy	0	0
7	3-6	Excavate catch basin	2	3
8	4-6	Excavate footers	5	6
9	5-6	Excavate found. Piers	6	7
10	6-7	Pour footers, etc	8	8
11	7-8	Erect bldg. frame	10	9
12	8-9	Dummy	0	0
13	8-10	Roof construction	15	14
14	8-11	Exterior brick façade	14	12
15	9-11	Exterior fascia panels	4	4
16	10-12	Pour interior slabs	10	8
17	11-12	Dummy	0	0
18	11-17	Landscaping	12	10
19	12-13	Dummy	0	0
20	12-14	Glazing and doors	6	5
21	12-17	Elec. and mech. Systems	25	20
22	13-14	Interior walls	10	9
23	14-15	Dummy	0	0
24	14-16	Dummy	0	0
25	14-17	Floor coverings	6	7
26	15-17	Shelves	3	3
27	16-17	Interior finishes	8	9
28	17-18	Final inspection	1	2
29	18-19	Demobilization	3	3

7. Calculating the Schedule

- **Forward Pass**

The forward pass is used to calculate the early dates (day) of each activity in the schedule. Begin moving along the network, from left to right, assuming that the Start milestone has an early start day (ES) set at zero. The early finish day (EF) of every activity is the ES plus the activity duration (D) minus one, shown in figure 3.

- **Backward Pass**

The backward pass is used to calculate the late dates (day) of each activity in the schedule. Begin moving along the network, from right to left, the final activity's (F) late finish day (LF) is the same as the EF of the same activity. The late start day (LS) of every activity is the late finish day (LF) minus the activity duration (D) plus one day, shown in figure

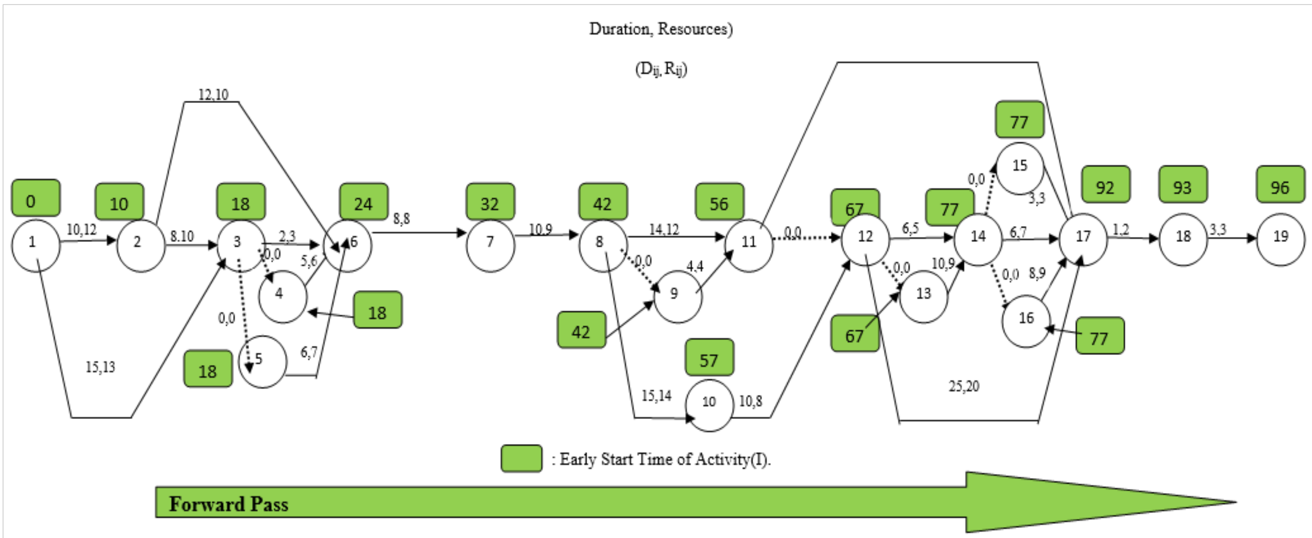

Figure 3: Expanded Project Model with Early Event Times.

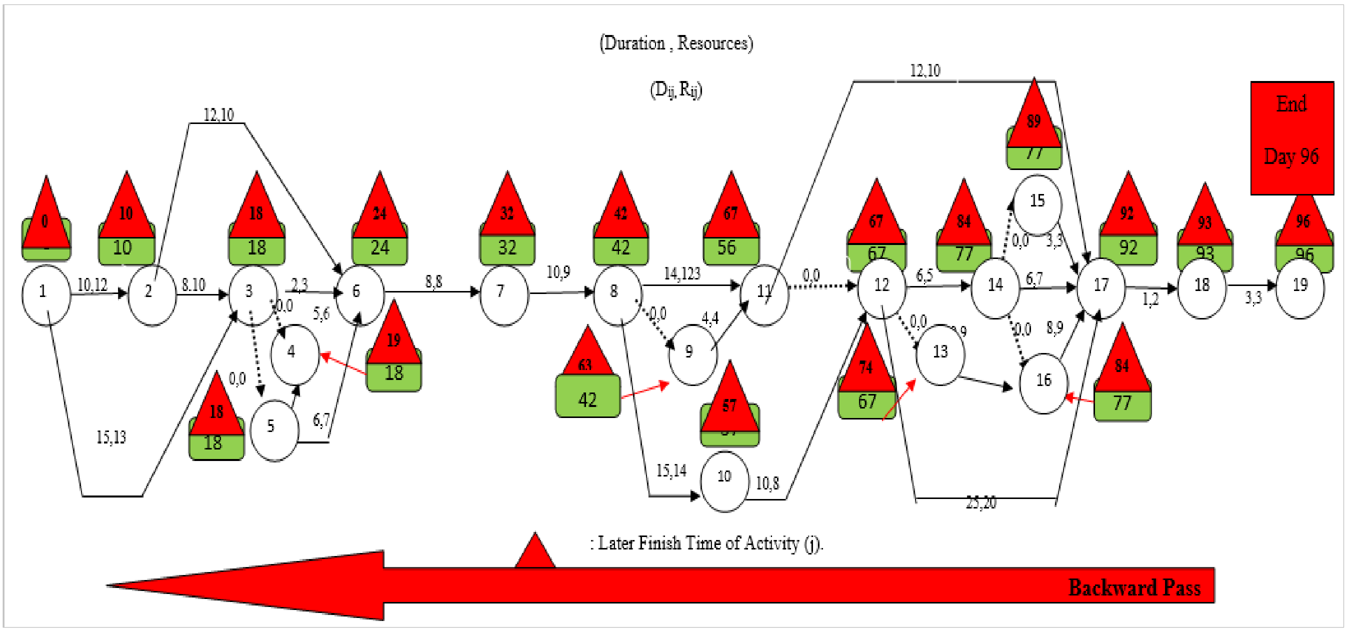

Figure 4: Expanded Project Model with Early and Late Event Times.

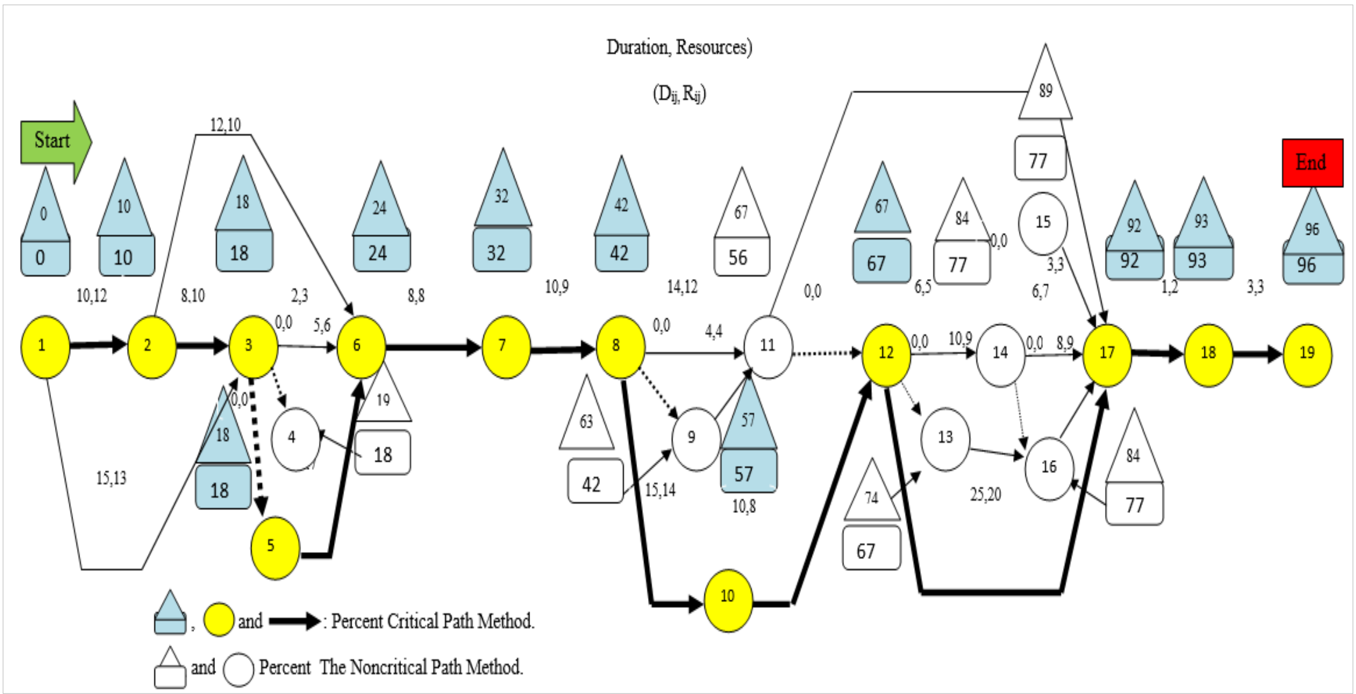

Figure 5: Typical Precedence Notation Network Schedule.

8. Critical Path Calculations

The objective of analyzing a project network is to:

1. Find the critical path that establishes the minimum duration of the project.
2. Calculate the early start times for each activity.
3. Calculate the late start times for each activity.
4. Calculate the float, or time, available for delay for each activity.

In **Fig. 5.** has each activity shown as a link or arrow, and shown Critical Path.

9. Activity Float

All activities that are not on the Critical Path can be delayed a certain number of time units (days) without causing an extension of the project duration. The number of days an activity can be delayed without extending the project minimum duration is referred to as the activity float. The amount of float associated with a critical activity is, by definition, zero. That is, if an activity is critical, it cannot be delayed without causing an extension of the project. Therefore, the float associated with a critical activity is zero.

For noncritical activities four types of float can be defined. Of these four types of float (Total float, Free float, Interfering float, and Independent float), three have a practical interpretation within the context of a construction project. Total float is the total amount of time (number of time units) that an activity can be delayed without causing an extension of the project duration.

The results of the application of CPM are illustrated in table 3, and the calculated characteristics of the network, such as, (Total Float TF, Free

Float FF, and Resource Requirement RR), are tabulated and the Critical Path (CP) is identified.

The network topology is determined and presented in table 4, such as (Critical Path Time, Total no. Critical Paths, Total no. of Critical Activities, Minimum Resources Needed, Maximum Resources Units Available).

Table 3: Calculated Characteristics of the Network.

Activity	i-j	Title	Duration (Day)	Resources (Labour)	EST	EFT	LST	LFT	TF	FF	CP
1	1-2	Mobilize	10	12	0	10	0	10	0	0	C
2	1-3	Obtain Permits	15	13	0	15	3	18	3	3	
3	2-3	Site work	8	10	0	18	10	18	0	0	C
4	2-6	Exterior utilities	12	10	10	22	12	24	2	2	
5	3-4	Dummy	0	0	18	18	19	19	1	0	
6	3-5	Dummy	0	0	18	18	18	18	0	0	C
7	3-6	Excavate catch basin	2	3	18	20	22	24	4	4	
8	4-6	Excavate footers	5	6	18	20	19	24	1	1	
9	5-6	Excavate found. Piers	6	7	18	23	18	24	0	0	C
10	6-7	Pour footers, etc	8	8	24	32	24	32	0	0	C
11	7-8	Erect bldg. frame	10	9	32	42	32	42	0	0	C
12	8-9	Dummy	0	0	42	42	63	63	21	0	
13	8-10	Roof construction	15	14	42	57	42	57	0	0	C
14	8-11	Exterior brick façade	14	12	42	56	53	67	11	0	
15	9-11	Exterior fascia panels	4	4	42	46	63	67	21	10	
16	10-12	Pour interior slabs	10	8	57	67	57	67	0	0	C
17	11-12	Dummy	0	0	56	56	67	67	11	11	
18	11-17	Landscaping	12	10	56	68	80	92	24	24	
19	12-13	Dummy	0	0	67	67	74	74	7	0	
20	12-14	Glazing and doors	6	5	67	73	78	84	11	4	
21	12-17	Elec. and mech. Systems	25	20	67	92	67	92	0	0	C
22	13-14	Interior walls	10	9	67	77	74	84	7	0	
23	14-15	Dummy	0	0	77	77	89	89	12	0	
24	14-16	Dummy	0	0	77	77	84	84	12	12	
25	14-17	Floor coverings	6	7	77	83	86	92	7	0	
26	15-17	Shelves	3	3	77	80	89	92	9	9	
27	16-17	Interior finishes	8	9	77	85	84	92	7	7	
28	17-18	Final inspection	1	2	92	93	92	93	0	0	C
29	18-19	Demobilization	3	3	93	96	93	96	0	0	C

Table 4: The Network Topology

Critical path time	96
Total no. of critical paths	1
Total no. of critical activities	11
Minimum resources needed	20
Maximum resource units available	29

10. APPLICATIONS OF PRIMAVERA P6

Figure 6 shows the application of Primavera P6 before leveling and, figure 7 shows the result of resource constrained scheduling using Primavera P6. The result final schedule of resource constrained of project by application of Primavera P6 after leveling =107 time units with project delay of 11 time units

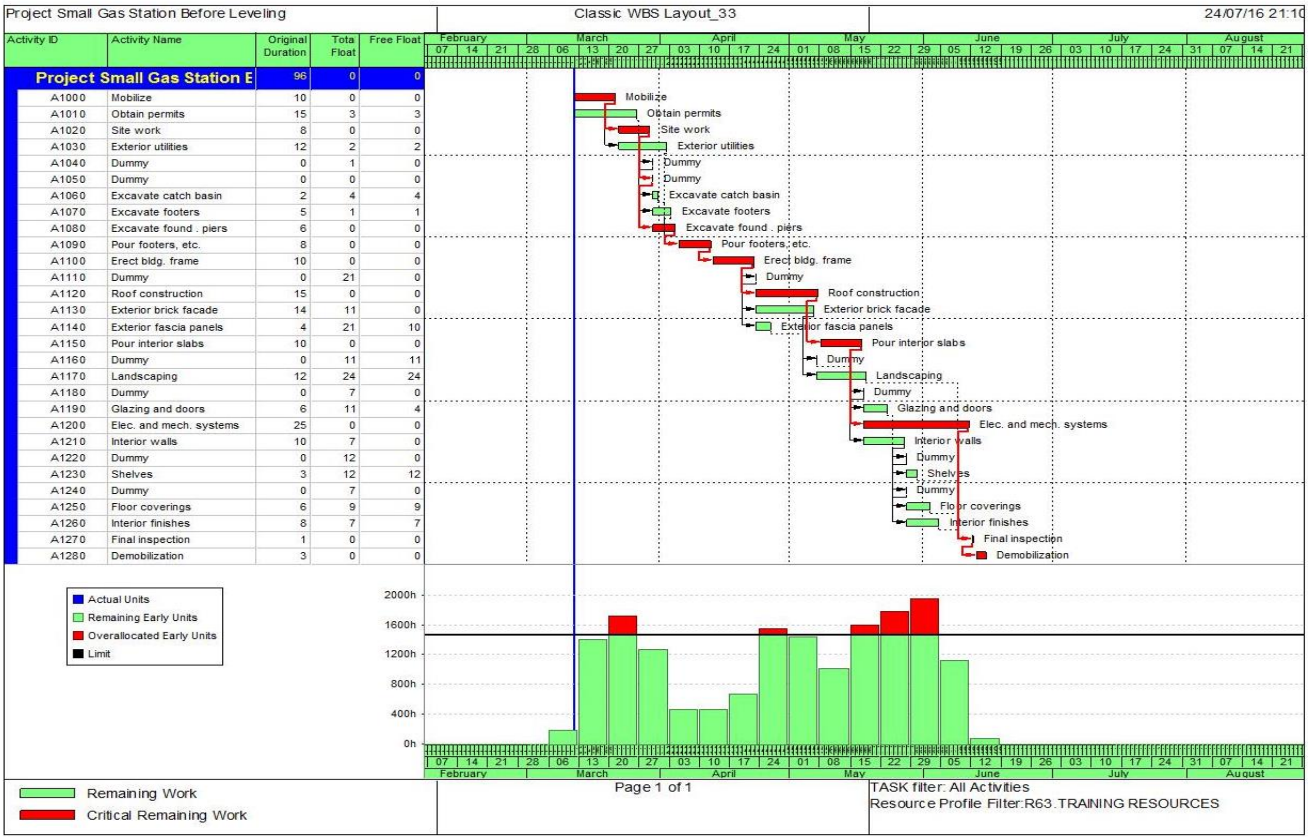

Figure 6: Application of Primavera P6 Before Leveling

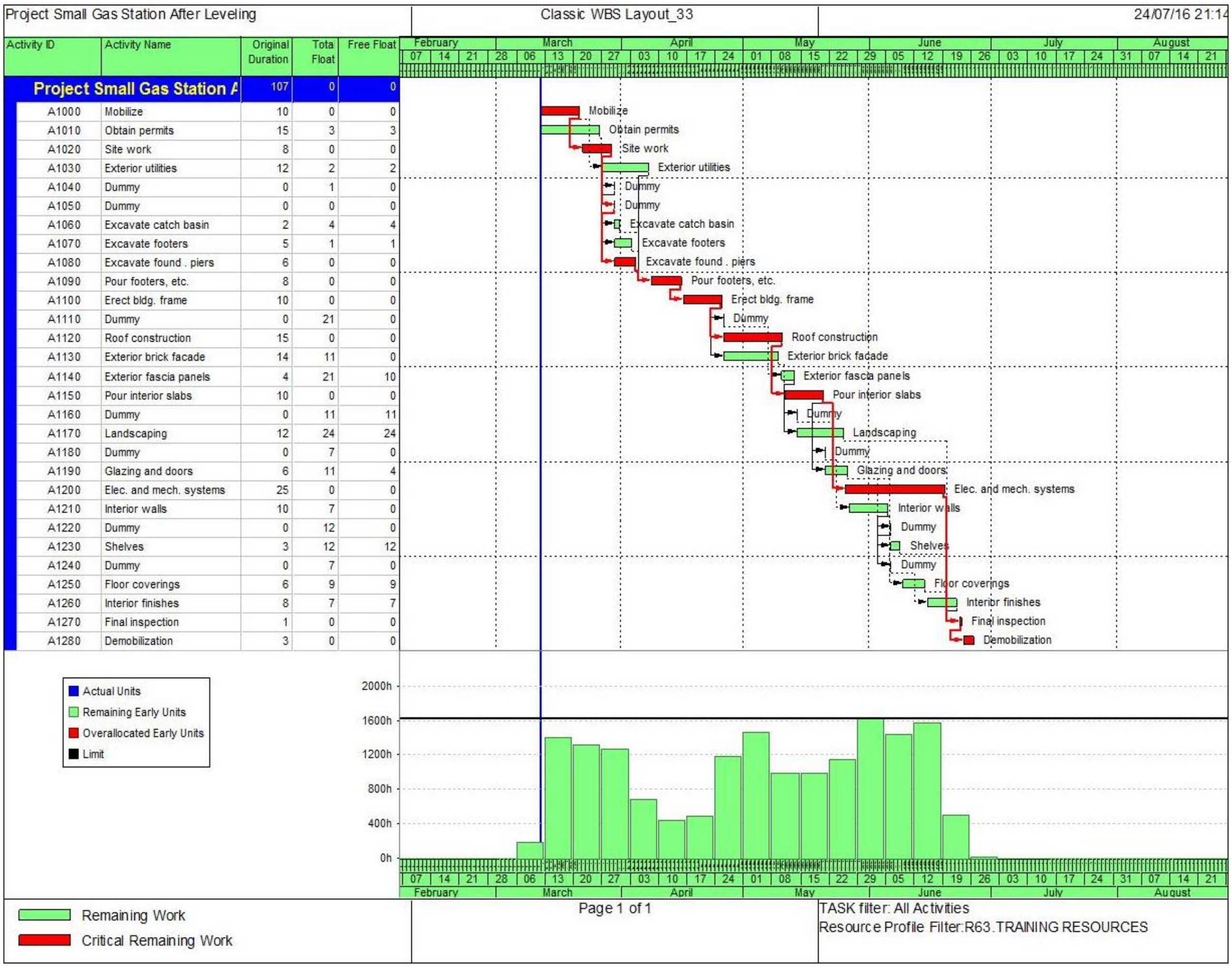

Figure 7: Application of Primavera P6 After Leveling.

11. Conclusions

The Project management is the process of carefully thinking how to accomplish this project and put careful planning for all the implementation steps and to identify the needed resources to complete the project, and then follow-up the actual implementation and compared it with the scheme, whereas in actually performing the project , we find that the actual implementation differs from the planned as a result to many factors which requires severe flexibility in managing the project with accordance to the new conditions.

The scheduling in the light of the limited resources for the purpose of completing the project in the shortest possible time, which is known by the limited resources case.

The applying of computers in project management by using Primavera P6 as a distinctive programs in project management as it allows us flexibility severe program that is required in project management in terms of how much data you grasp and easy to deal with this data and acceptance of the amendment at any stage of the project and the algorithm tested results were for reducing the increase in the time to complete the project better and less of the results of Primavera P6 program.

The result, discussion and analysis of the final configuration for the suggested methodology indicated the following:

- The application of Primavera P6 before leveling= 96 time units.
- The result final schedule of resource constrained of project by application of Primavera P6 after leveling =107 time units with project delay of 11 time units.

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