



EFFICIENCY OF CRITICAL PATH METHOD (CPM) AND PERT TECHNIQUE FOR YACHT CONSTRUCTION

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ABSTRACT

According to the scientific developments in all sectors around the world, there is needs of using the technique of operation research and its implementation that help the manufacturers to draw their work policy and making future planning to achieve their goals. However, the complexity of industrial projects comprise a lot of activities, which needs to be controlled and scheduled in scientific ways, in according with the availabilities of equipment's and efforts of manufacturer. This research goal is to reduce the completion time and cost of constructing a yacht by using critical bath method and pert techniques. Results showed that the efficiency of using scientific critical path method and pert reduce the time of yacht construction. Also, the receiving and distribution of raw materials leads to minimize the completion job. Therefore, making training programs to the manufacturer employees to process the job in perfect performance.

Key words: Critical Path Method, CPM, PERT, Industrial management, Yacht Construction.

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1. INTRODUCTION

According to the huge and fast scientific development in all sectors around the world, we come to real needs of using the technique of operation research and its implementation which help the manufacturers to draw their work policy and making future planning to achieve their goals with reasonable using of available efforts and resources, the most important factor is time , meaning whenever finishing project with a minimum completion time will give you the chance to make profit and starting with another project.

From the above, it's very important to adopt the modern planning techniques along with the scientific development and its complexity; therefore, it comes the needs to use the following techniques in all successful sectors:

- The critical path method (CPM).
- Program evaluation and review technique (PERT).

These both techniques considered the most important ways for project time planning's to achieve project completion in short time. The manufacturing company (privet sector) doesn't have any scientific planning technique therefore the completion time of manufacturing yacht was 2 years (730 days). Therefor the researcher suggest to adopt a new procedure by using CPM & PERT techniques that may help the manufacturing company in their future projects for the same yacht.

2. METHODOLOGY

The concept network job is a group of activities and events having one start point and one end point [1]. Thus, the network job including all activities and represented on the network [2] as follows:

Activity (\rightarrow) it's consuming time and cost.

Event (O) it's have point of start and end of certain activity.

Dummy activity ($- \rightarrow$) it's a dotted arrow and it's not real activity, doesn't consume time or cost.

After implementing all activities on job network we can use the techniques to calculate the time needed for completion the project.

3. THE "CRITICAL PATH METHOD (CPM)"

The year 1957 has witnessed developing the critical path method (CPM) as a network model for project management (PM). CPM is a deterministic method that uses a fixed time estimation to evaluate each individual activity. It is featured by ease of use and simple to understand, the potential large impact of time variations is not considered at the time on which a complex project is completed.

The path of longest duration though a given network is referred as the critical path [3]. The activities that depend on this path can't be delayed without slowing the project. Hence, critical path has a specific significance for the assessment. Therefore, the analysis of critical path is an essential aspect in the project planning-phase due to its impact on the entire project duration.

The following four parameters define the critical path:

- ES – Early start time: the early time at which the activity can start taking into consideration that its precedent activities must be finished first.
- EF – Early finish time: equal to the earliest start time for the activity added to the time needed to finish the activity.
- LF – Late finish time: the minimum duration at which the activity can be accomplished without causing a delay in the total project duration.
- LS – Late start time: equal to the pessimistic finish time minus the usual duration to accomplish the activity.

For any activity the slack time represents the time between its earliest and latest start time, or between its earliest and latest finish time. Slack is how much time that an activity can be delayed past its earliest start or earliest finish without causing a delay to the project.

Therefore, in general, the critical path represents the path through the project network in which none of the activities have slack time, that is, the path for which $ES=LS$ and $EF=LF$ for

all activities in the path. Any delay in the critical path causes an equivalent increment in the total project duration [4].

CPM Provides the following Merits

- It can provide an illustrative representation of the project plan.
- It can provide a prediction of the minimum time-cost needed to finish the project.
- It can provide a list of the activities that prejudiced the schedule and a list of activities which are not.

Steps in CPM Planning Project

The following are the steps taken for CPM planning project:

- Specifying the activities on an individual base.
- Directing the sequence of activities specified in step-1 taking into account all the possible probabilities.
- Establishing a network diagram to plan the activities based on the possibilities determined in step-2.
- Assessing the time-cost required to complete each individual activity.
- Finding the "critical path" (the most time consuming path through the network).
- Adjusting the CPM diagram as the project processes, by updating the CPM diagram during the project development and implementation phases.

4. THE PROGRAM EVALUATION AND REVIEW TECHNIQUE (PERT)

PERT is a network model that permits the randomness in activity completion time. Late in 1950, PERT was developed for the U.S. Navy. The path time and the cost required to finish a project can be reduced by PERT.

Steps in the PERT planning process

PERT planning involves the following steps:

- Identifying the specifically important activities that can be reported as millstones to the whole project.
- Determining the usual sequence of the project activities that are properly undertaken for similar projects.
- Constructing a network diagram based on the information obtained in the first two steps.
- Estimating the time required for each individual activity in the network.
- Determining the critical path in a similar way to the CPM critical path identifying.
- Updating the PERT chart as the project progress.

Advantages of using PERT over CPM

The following information is provided by the PERT that cannot be obtained with CPM:

- The prediction of project completion time.
- Completion probability before specified date.

- The critical path activities that directly affect the completion time.

Estimate Activity Times in PERT

Three time estimations are usually included by model for each activity including [5]:

- The optimistic time, which is the minimum time in which the activity can be accomplished.
- The most likely time: the completion time having the highest probability, this time is longer than the expected time and shorter than the pessimistic time.
- Pessimistic time, which is the maximum time-cost that any activity can take to be accomplished.

The following average can be used to approximate the expected time for each activity:

$$\text{Expected time} = (\text{Optimistic} + 4 * \text{Most likely} + \text{Pessimistic}) / 6$$

This expected time may be shown on the network diagram.

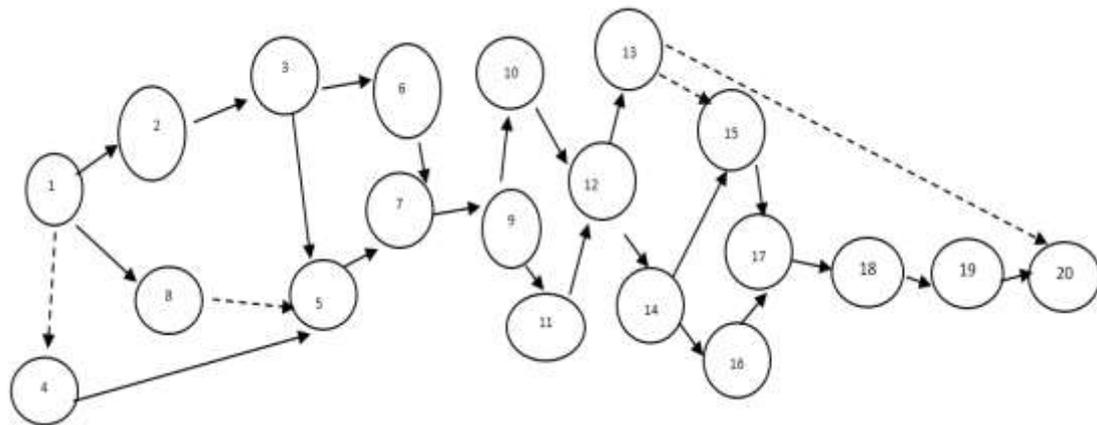
5. ACTIVITIES OF YACHT CONSTRUCTION ON NETWORK

The use of job network for construction planning we should list the activities by order and according to the information, the activities will be as follow:

Table 1 Activities Description

Activity	Description of activity	Previous activity
1	Steel structure	-
2	Roof steel sheets	1
3	Cross Steel support	2
4	Steel frame	-
5	Water and fuel tanks	3,4
6	Steel sheet covering the yacht	3
7	Wrapping both sides yacht with steel sheet	5,6
8	Steel welding	7
9	Fixing the seats on the yacht roof	9
10	Fixing and supporting engines base	9
11	Setting and fixing engines	10,11
12	Fixing the muffler around the yacht	12
13	Fixing the roof aluminum works	12
14	Roof accessories	14
15	Mechanical systems	14
16	Electrical systems	14
17	Power system	16
18	Navigation system	17
19	Painting work inside and outside the yacht	18
20	Yacht assembly and finishing	19

From the table above we can calculate the time needed to finish the job after estimating the duration for each activity and the early time + the late time for every activity as detailed in the table below:



- (O) Event
- (→) Activity
- Dummy Activity

Figure 1 The network activities

To calculate the finishing time by using the critical bath methods as in the table below:

Table 1 Calculating the completion time by CPM

Activity	Duration /day (1)	Early time		Late time		Slack time (4-2)
		Start (2)	Finish (3)	Start (4)	Finish (5)	
1	19	0	19	0	19	0
2	19	19	38	19	38	0
3	15	40	55	40	55	0
4	58	0	58	0	58	0
5	10	58	68	58	68	0
6	35	57	92	57	92	0
7	58	94	152	94	152	0
8	19	19	38	19	19	0
9	3	154	157	154	157	0
10	35	159	194	169	204	10
11	45	159	204	159	204	0
12	28	206	234	206	234	0
13	15	236	251	277	292	41
14	58	236	294	236	294	0
15	49	296	345	317	369	21
16	73	296	369	296	369	0
17	23	371	394	371	394	0
18	15	396	411	396	411	0
19	19	413	432	413	432	0
20	15	434	449	434	449	0

From the table it's obviously the longest bath is shown in the following activities which it's as follow (1, 2, 3, 6, 7, 9, 11, 12, 14, 16, 17, 18, 19, and 20) with total of (449) days, because the critical path method is the longest bath always.

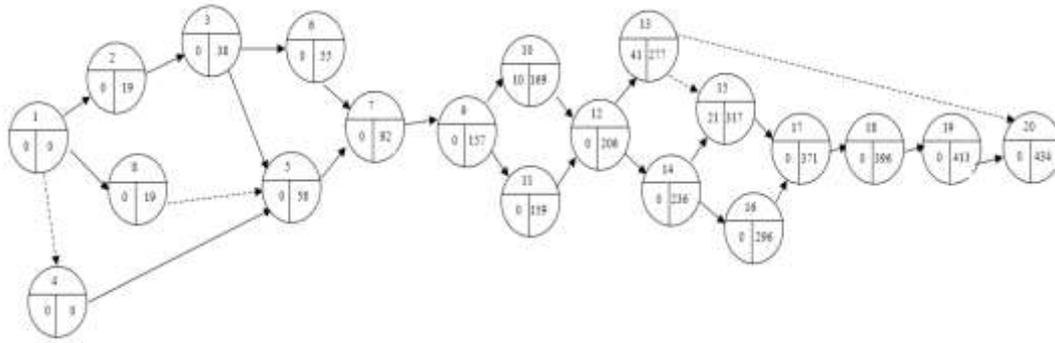


Figure 2 The critical path method (CPM) times and activities network

According to PERT technique we can calculate the expected time by using the following formula: $(\text{Optimistic} + 4 * \text{Most likely} + \text{Pessimistic}) / 6$

Table 2 Calculating the completion time by PERT technique

Activity	Optimistic time (a)	Most likely (m)	Pessimistic time (b)	Previous activity	Et= expected time/day
1	12	19	28	-	19
2	12	19	28	1	19
3	12	15	20	2	15
4	43	58	73	-	58
5	8	10	12	3,4	10
6	20	35	50	3	35
7	43	58	73	5,6	58
8	12	19	28	1	19
9	2	3	4	7	3
10	20	35	50	9	35
11	30	45	60	9	45
12	24	28	32	10,11	28
13	12	15	20	12	15
14	43	58	73	12	58
15	40	49	59	14	49.1
16	65	73	81	14	73
17	18	23	28	16	23
18	12	15	20	17	15
19	12	19	28	18	19
20	12	15	20	19	15

From the table the longest bath of the activities is (1, 2, 3, 6, 7, 9, 11, 12, 14, 16, 17, 18, 19, and 20) with total period of (425) days to complete the job. Thus from the above tow techniques it shows that critical path method is the longest bath which is 449 days.

6. CONCLUSIONS

- The efficiency of using scientific critical path method and pert techniques reduce the time of yacht construction.
- Depending on the self-experience without using the scientific accurate ways lead to delay in time of yacht construction.
- The receiving and distribution of raw materials leads to minimize the completion job.

- Beside the two techniques the distribution of responsibilities for each employee will give accurate ways to execute the job in perfect performance.

RECOMMENDATIONS

- It's very important to use the scientific ways like CPM and PERT in planning and scheduling projects to reduce time and cost.
- Making training programs to the manufacturer employees to process the job in perfect performance.
- Provide the employees with suitable space to do their jobs because the small spaces limited their efforts.
- Providing the raw materials in factory places in time will lead to finish the job in time without any delay.
- Making activity reports to avoid any delay that causing the manufacturer and lose in his profits.

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