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Project Management Using Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT)

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ARTICLE INFO	ABSTRACT
Published Online: 06 December 2024 **Corresponding Author:** Ezra, Precious Ndidiamaka	Project delivery within the established time line and project cost is one of the persistent issues in current project management practices. This work therefore aimed at assessing the appropriateness of Project Evaluation Review Technique and Critical Path Method in project management with a case study of a UNN lecture hall construction. Consequently, the research establishes the impact of these quantitative operations research tools on the efficient project management. Both of these project management techniques were explained and used in relation to the data that was obtained from the lecture hall construction project manager, concerning the project activities and the time taken for each of these activities. As indicated by the findings of this study, both the methods were posited to achieve success in project management where by relationship and connectivity of the activities that define a project life cycle persist as the key issues. As such, it was suggested that in view of the project critical activities determined by the CPM and/or PERT analyses, more resources and attention should be directed towards effective management of such activities to avoid the occasion of project delay as well as ensure the successful completion of projects.

KEYWORDS: Project management, Optimization techniques, critical path, Critical activities, Project evaluation

1. INTRODUCTION

Projects are recognized to contain several activities, which can be either sub-tasks and sub-activities or small work-groups. An activity begins when another activity is done or a set of activities are done before the other activity is initiated. Familiarity with the aspect of succession in the context of a task or activity dependency is a core competency a project manager has to possess in view of managing a project. This implies that setting the order of precedence in line with the duration or completion time for each work or sub-project is a prerequisite task in project planning: see Adedeji & Ayo (2018). Coordinating a project that involves coordination of several activities is one of the biggest challenges that a project manager is likely to undertake. Much has to be considered when exercising how to manage all these activities, how to establish feasible time frame, and how to evaluate a project in progress. The role of project manager is to define project duration and the critical activities associated with the project: see Aliyu (2012). The development of a realistic schedule and the progress of the project must be monitored: see Bagshaw (2021). It is however pertinent to know that the traditional approaches of managing projects by the use of Gant chart or other are fatal to the measures of success of the management. It has therefore been seen that management of projects require use of operations research tools. Two similar methods used in operation research are PERT (project evaluation and review technique) and CPM (critical path method) help the project manager and the decision-maker who wishes to undertake a project. These tools assist support the qualitative context of decisions and get a handle on the management of time duration of projects with a view of enhancing the projects' time and cost. These strategies make extensive use of networks to assist in planning and displaying the synchronization of all operations: see Oyeyipo & Adewale (2020). The advantage of these quantitative tools is the optimization of project duration, time minimization and project efficiency: refer to Eshofonie (2020) & Adeboye & Oluwatobi (2021).

Both of these techniques help navigate through a project's activities and determine which activities may be critical. However, Bagshaw (2011) showed that the critical activities actually cumulatively make up the longest duration. The sequence of such activities constitutes the so called critical path in a way, that any delay in the execution of any activity on the critical path also directly influences the planned completion date of the project and there are no float on the critical path.

These methodologies empower project managers to ascertain early and late activity start and finish times, compute activity float (slack), identify critical activities, and assess the impact of changes in duration, logical relations, and cost on overall project duration: see Wallace (2015). PERT is probabilistic, catering to projects with uncertain activity times, and enables the computation of event completion probabilities and expected project completion time: see Surayya & Hendra (2023). Further, PERT has been specifically designed useful for large and complex projects due to its event oriented approach, which is primarily based on time. On the other hand, CPM is based purely on probabilities and anticipated time of an activity which are often extracted from prior project data. CPM is instrumental in determining project completion time and identifying critical activities along the critical path, essential for managerial focus and resource allocation: see Bagshaw (2021).

The aim of this research therefore is to establish the important activities needed in constructing UNN lecture hall and then make use of both PERT and CPM analyses to compare the result gotten in other to know which of them help the project in minimizing its duration effectively for efficient and effective project management.

2. LITERATURE REVIEW

Over the last few years, there has been a number of literature with regard to the implementation of PERT and CPM techniques in project management. These methodologies have been shown to be effective in various project environments in earlier research and have revealed potential to improve project timetables, reduce costs and improve overall project performance. In his study in 2012, Aliyu explored the use of CPM in a building construction project of the Federal University of Technology, Yola, was successful in documenting the efficiency of the method in planning, scheduling and controlling of time and cost of the project. The paper also depicted how CPM contributed towards overcoming challenges of traditional project management including the usage of Gantt charts and eliminating inter departmental communication and frequent crises management. Wallace in his study (2015) uses PERT and CPM to assess the relationship between cost and time in construction of a building construction project. The study applied linear programming approach to crash activity durations, from which the result showed a significant improvement in project time and the feasibility of PERT and CPM in project scheduling and cost control. Lermen (2016) used PERT/CPM on a production project that was a manufacturing one involving horizontal laminator. From their research, they were also able to present clear and dramatic decreases in project time needed to complete a project and cost needed to complete a project due to the scheduling improvements of critical path activities. In the same vein, Hugo (2020) used PERT and CPM for improvement of development process with regards to housing constructions with an objective of achieving highest returns on investment and avoid risks. The analysis established the application of both methodologies in enhancing project management schedules especially the CPM method which was evidently useful in elimination of project time. In Bagshaw (2021) project management in applying numerical decision-making methodologies such as PERT and CPM were assessed and the role of resource allocation and optimization highlighted. The study also established how PERT was particularly suitable for conditions with activities that have unpredictable duration while CPM was more appropriate where activities had to follow fixed project duration. The study by Surayya and Hendra (2022) analyzed the use of PERT and CPM for turn around time and cost reduction based on the shipbuilding industry. From the critical path activities and crashing techniques, the study was able to show a lot of improvement on how PERT and CPM can be used to developed project schedules. Danfulani (2023) used CPM to plan a building construction project to show how the methodology helped to determine the crucial activities and the appropriate duration of the project. CPM was recommended in the study as useful in cutting on labour costs and avoiding time wastage in the project. Altogether, the presented studies demonstrate that PERT and CPM are flexible and efficient tools in project management, which provide essential information regarding their usage in different projects.

Force of this research is indeed, the ability to contrast the findings gotten from each of the two analyses comparing CPM and PERT on a comprehensive basis and to be acquainted with the best approach that could be recommended to the project managers and project decision makers for efficient management of their projects.

3.0 METHODOLOGY

The network based methods which help in planning, scheduling and controlling of project are CPM and PERT. The main purpose of control and project monitoring in both methods are to offer an analytical tool to time the projects with precursive relation activity.

3.1 Critical Path Method (CPM)

While PERT deals with the probability time estimates of the activities in a project; CPM deals with the time estimates of activities in a project. The time estimate put into their decisions is subjective to the decision-maker, thanks to long time experiences over the job. Did this decision-maker have a long experience of similar projects in the past? For each activity, there are four-time estimates:

1) Early Start (ES) time refers to the earliest possible time that an activity may be initiated. We assume that the first activity of every prior activity is at its earliest possible, otherwise, due to delay at start which may come from the start of the prior activity, there will also be a delay at the start of the next activity. The ES of an activity is simply the time addition of all preceding activities for that path. When an activity has more than one preceding activity the ES of that activity depends on the EF of the longest duration or the activity which has longest ES time denoted by t.

2) Delayed Start (DS) is a delayed onset of activity. The last possible time that can be devoted to the start of an activity not to extend the project duration.

3) Early Finish (EF) is an activity which when started early will lead to a early completion of the same activity. It is presumed that activity starts with ES time and extends up to t. EF = ES + t. The early start of an activity can only be possible if the early finish of the activity which comes before it in the network is possible. That is ES + t = EF (Forward induction/movement).

4) Late Finish (LF) time. Habits like leaving something to start very late will lead to the same thing to finish very late. The value being the difference between the early finish of an activity and the late start of that activity should not extend the time needed to complete the project. We presume that for the last activity in the critical path, EF = LF and then if LF − t, it is suggestive of a process known as Backward induction/movement. LS of an activity is dependent on the LF of the immediately preceding activities. When two or more paths converge at a particular activity, then the fastest total LS time is adopted as the LF of the preceding activity(s).

3.1.1 Total slack and Free slack

Float or slack shows how much time an activity can be stretched without actually affecting the overall schedule of the project. This kind of slack is also widely referred to as total slack or total float. For non critical activities, total slack is calculated by subtracting either the late start time from the early start time or the late finish time from the early finish time. Free slack, on the other hand represents the amount of time an activity can be be delayed without causing the start of any preceding activities to be delayed.

3.1.2 Identifying Critical Activities

Bagshaw (2011) defined the critical path as that sequence of activities which takes the longest time to achieve the total job duration. It is the shortest time possible to complete the project such that any delays of an activity on the critical path directly influence the established project completion time. There is no float on the critical path. Occasionally, network diagram in Fig1 used in analyzing helps in identifying these crucial activities. These are the activities that if their start is delayed this will result to generation of longer times in completion of the whole project. For such activities, the early start and late start times, and the early finish and late finish times are the same and therefore the slack for the activity is zero because the time span between the activity start and finish is negligible.

3.1.3 Managerial Use of float (slack)

Specific information about the total, free and interruptive slack of each activity may be beneficial to the management process in project management. Interruptive slack is the difference between free slack and total slack. It reflects the amount of time that can be expended beyond free slack time, if expended will make at least one activity to commence after earliest start time but will not allow the project to be over its earliest finish time. The author suggests that if resources are scarce, then management might want to level resources by starting certain activities later than planned. Hence, while activities on the critical path cannot be rescheduled, they can be ceased. On the use of free slack, it is preferable to centralise the decision making; otherwise, each supervisor might make use of the amount of interruptive slack that actually is not available singly.

3.2 Project Evaluation Review Technique (PERT)

Project managers can obtain information on the time estimates of the activities of a project from service providers. Such information can enable the estimation of a central measure of completion time and a measure of dispersion (variance/standard deviation) for a given project. Given the mean and standard deviation distribution of project completion time, the probabilities of finishing the project at a given due date can be estimated. In PERT, there are three-time estimates for each activity. The expected time for each activity can therefore be estimated using the following weighted averages:

t_o= optimistic time estimate; that is, the minimum reasonable time taken to perform an activity.

t_p = pessimistic time estimate; that is, the maximum reasonable time taken to perform an activity.

t_m = most likely time estimate; that is, the most likely time accepted to perform an activity.

As an estimate of activity completion time, the beta distribution is used, which is a reasonable approximate expression of activity duration. The expected time, T_e which approximates the mean, the standard deviation σ for the beta distribution is given as: $T_e = \frac{t_o+4t_m+t_p}{6}$

Given the mean and standard deviation of the beta distribution, the probability of completing a project at a given time, *D,* may be calculated using the standardized normal distribution as follows: $Z = \frac{D-T_e}{\sqrt{\sigma_{cp}^2}}$

where σ_{cp}^2 is the variance of an individual activity on the critical path

3.3 Definitions of some technical Terms

i. Forward pass: Is used to determine the earliest start and earliest finish or completion time of an activity. The computations start with zero (0) time for the first event and proceeds rightward to the final event. It is one of the methods of obtaining the critical path of a project.

ii. Earliest start time (ES_i): The earliest start time of an activity (*i,j*) is the earliest time an activity can start without affecting the project completion time. It is computed as

$ES_j = ES_i + t_{ij}$

or ES_j = Max ($ES_i + t_{ij}$) if more than one activity enters an event.

where t_{ij} is the activity duration in all cases.

iii. Earliest finish time (EF_{ij}): is the earliest time an activity can be completed without affecting the project completion time. It is computed as

$EF_{ij} = ES_j + t_{ij}$

iv. Backward pass: Is used to determine the latest start and latest completion time of an activity. It is another method of obtaining the critical path of an activity and its computations start from the last activity and moves leftward to the start activity. It is important to note that in using the backward pass method, the forward pass method must have been used to obtain the project completion time through the critical path and hence it begins from the last activity with the already known project completion time and moves the start activity. This method serves as a confirmation of the already computed critical path obtained from the forward pass method.

v. Latest start time (LS_i): is the latest possible time an activity can start without delaying the project completion and computed as

$LS_i = LS_j - t_{ij}$

vi. Latest finishing time (LF_{ij}): is the latest time an activity must finish without affecting the project completion time. It is the minimum of the latest start time of an immediate successor and computed as

LF_j = Min ($LS_j - t_{ij}$)

vii. Dummy activities: These are activities connected to prevent dangling even though they have no duration or resources allocated to them. It is denoted by broken line arrow.

viii. Dangling**:** This occurs when an activity is not connected to any other activity in the network. When an activity has no immediate predecessor, the activity is said to be dangling. Dangling is considered as a dead end in the network as it puts an abrupt stop to a path in the network.

ix. Parallel activities: These are two or more activities in the network having the same head and tail events.

x. Floats or slacks**:** is the amount of time a noncritical activity or event can be delayed without extending the project completion time.

xi. Total float (TF_{ij}): is the length of time a noncritical activity can be delayed beyond its earliest completion time without extending the project completion time. It is computed as

$TF_{ij} = (LF_j - ES_i) - t_{ij} = LS_{ij} - ES_{ij}$

xii. Free float (FF_{ij})**:** is the length of time the completion of a noncritical activity can be delayed beyond the earliest finish time without delaying the earliest start of its preceding activity. It is computed as

$(FF_{ij}) = LF_j - LS_i - t_{ij}$

xiii. Optimistic Time (t_0): Is the minimum time or duration an activity can be completed under the most favourable conditions.

xiv. Most Likely Time (t_m)**:** is the most probable or likely duration or time an activity can be completed under normal circumstances.

xv. Pessimistic Time (t_p)**:** is the maximum time or duration an activity can be completed if significant delays are encountered.

xvi. Expected time (t_e)**:** The expected time of an activity is the mean of the three times estimates and computed as: $t_e = \frac{t_o+4t_m+t_p}{6}$

xvii. Variance time (t_v)**:** measures the dispersion or variation of the times from the mean and computed as: $t_v = \left(\frac{t_p-t_o}{6}\right)^2$

Table 1: **Project Activities with their Precedence relationships and Durations**

Activity code	Activity	Description	IPA	Days
A	1-2	Creation of access road	-	2
B	1-3	Site clearance and excavation	-	3
C	3-4	Erection of site office and stores	B	3
D	2-5	Transportation of materials to site	AC	7
E	5-6	Calibration of foundation pads and trenches	D	2
F	6-9	Digging, excavation of trenches and removal of earth on foundation line	E	9

G	7-8	Casting of concrete strip and reinforcement of column	F	5
H	8-9	Block work to DPC	G	8
I	9-10	Back-filling of excavated materials into foundation	H	8
J	9-11	Consolidated/ imported late-rite filling into foundation	H	5
K	11-12	Compacting and hardcore filling with sand into foundation to required level	J	4
L	12-13	Carpentry work (Site boarding of 150 mm round the building) and laying of DPM and BRC wire mesh	K	4
M	13-14	Casting of over site concrete or German floor	L	6
N	14-15	Installation of extension columns on ground floor	M	1
O	15-16	Casting and hanging of precast lintel	N	20
P	16-17	Block work to final level above lintel	O	12
Q	17-18	Hanging of windows and doors framework	P	5
R	17-19	Carpentry work and reinforcement to beam	P	5
S	19-20	Casting and construction of lintels and beams	R	7
T	20-21	Block work to first floor	S	8
U	21-22	Carpentry form work	T	13
V	22-23	Decking	U	9
W	23-24	Block work on first floor	V	20
X	24-25	Hanging of windows and doors frame	W	4
Y	25-26	Reinforcement of lintel beam	X	5
Z	26-27	Carpentry form work of forms and columns of lintel beam	Y	6
A'	27-28	Casting and block work to lintel level	Z	14
B'	28-31	Block work to roof level	A'	10
C'	31-32	Stairs and pavements construction	B'	8
D'	28-29	Digging of septic tank	A'	6
E'	29-30	Septic tank construction	D'	9
F'	32-33	Roof noggins	C'	11
G'	32-34	Ceiling noggin	C'	3
H'	33-35	Roof covering with aluminium sheet	E'F'	9
I'	31-36	Doors and windows frames fixing	B'	7
J'	34-37	Installation of ceiling sheet	G'	8
K'	37-38	Plastering and wall finishing	J'	10
L'	38-39	Metal works	K'	14
M'	38-40	Floor finishing	K'	21
N'	30-41	Fencing and trench construction	E'	6
O'	41-42	Casting of fence trench	N'	4
P'	36-43	Fixing of doors and windows	I'	7
Q'	42-44	Fence block work	O'	9
R'	38-45	Electrical works	K'	21
S'	44-46	Fence fixing and flooring of the compound	Q'	10
T'	45-47	Final wall finishing: Scree-ding and painting	R'	17
U'	47-48	Connecting building to power supply	T'	17
V'	48-49	Final site clearance	S'	8

W'	48-50	Building inspection	U'	7
X'	50-51	Building handover	W'	1
Y'	49-52	Demobilization	V'	7
	TOTAL			425

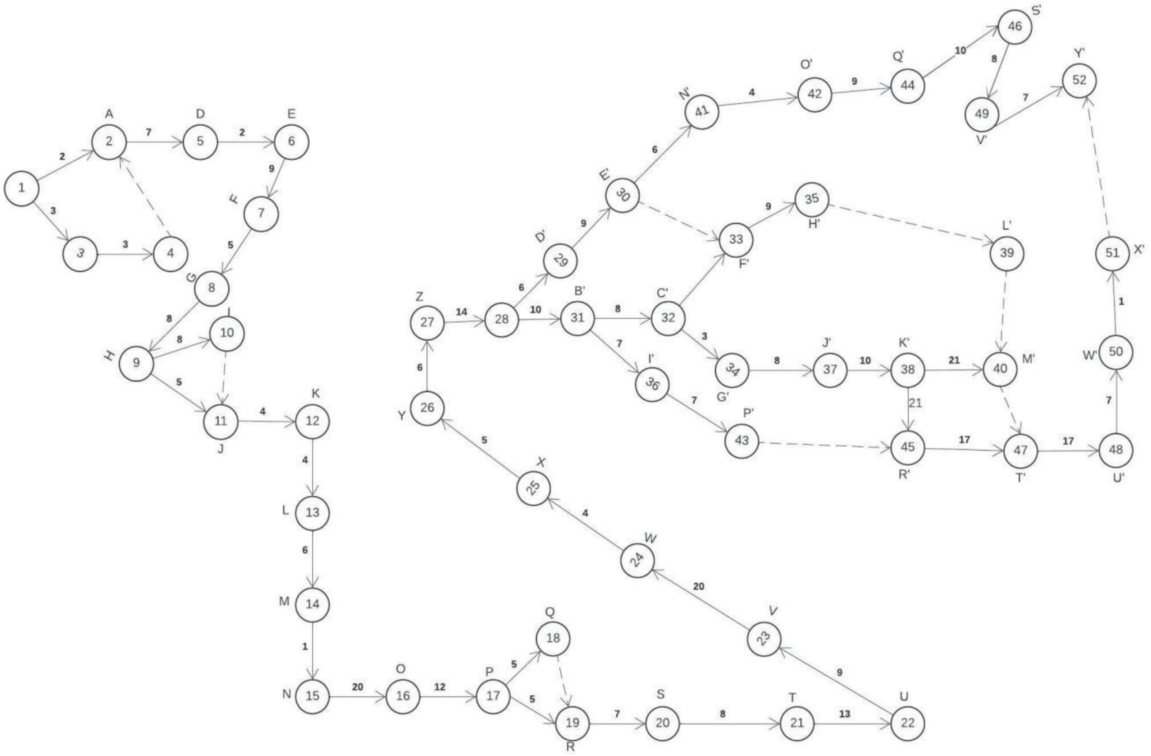

Figure 1: CPM Network Diagram Network diagram.

Table 2: CPM Activity Schedule and necessary computational values

Activity code	Activity	Duration	Earliest Start (ES)	Earliest Finish (EF)	Latest Start (LS)	Latest Finish (LF)	Total float (TF)	Free float (FF)
A	1-2	2	0	2	4	6	4	0
B	1-3	3	0	3	0	3	0	0
C	3-4	3	3	6	3	6	0	0
D	2-5	7	6	13	6	13	0	0
E	5-6	2	13	15	13	15	0	0
F	6-7	9	15	24	15	24	0	0
G	7-8	5	24	29	24	29	0	0
H	8-9	8	29	37	29	37	0	0
I	9-10	8	37	45	37	45	0	0
J	9-11	5	37	42	40	45	3	3
K	11-12	4	45	49	45	49	0	0
L	12-13	4	49	53	49	53	0	0
M	13-14	6	53	59	53	59	0	0
N	14-15	1	59	60	59	60	0	0
O	15-16	20	60	80	60	80	0	0
P	16-17	12	80	92	80	92	0	0
Q	17-18	5	92	97	92	97	0	0

R	17-19	5	92	97	92	97	0	0
S	19-20	7	97	104	97	104	0	0
T	20-21	8	104	112	104	112	0	0
U	21-22	13	112	125	112	125	0	0
V	22-23	9	125	134	125	134	0	0
W	23-24	20	134	154	134	154	0	0
X	24-25	4	154	158	154	158	0	0
Y	25-26	5	158	163	158	163	0	0
Z	26-27	6	163	169	163	169	0	0
A'	27-28	14	169	183	169	183	0	0
B'	28-31	10	183	193	183	193	0	0
C'	31-32	8	193	201	193	201	0	0
D'	28-29	6	183	189	226	232	43	0
E'	29-30	9	189	198	232	241	43	0
F'	32-33	11	201	212	240	251	39	0
G'	32-34	3	201	204	201	204	0	0
H'	33-35	9	212	221	251	260	39	0
I'	31-36	7	193	200	229	236	36	0
J'	34-37	8	204	212	204	212	0	0
K'	37-38	10	212	222	212	222	0	0
L'	38-39	14	222	236	246	260	24	0
M'	38-40	21	222	243	239	260	17	0
N'	30-41	6	198	204	241	247	43	0
O'	41-42	4	204	208	247	251	43	0
P'	36-43	7	200	207	236	243	36	0
Q'	42-44	9	208	217	251	260	43	0
R'	38-45	21	222	243	222	243	0	0
S'	44-46	10	217	227	260	270	43	0
T'	45-47	17	243	260	243	260	0	0
U'	47-48	17	260	277	260	277	0	0
V'	46-49	8	227	235	270	278	43	0
W'	48-50	7	277	284	277	284	0	0
X'	50-51	1	284	285	284	285	0	0
Y'	49-52	7	235	242	278	285	43	43
TOTAL		**425**	**235**	**242**	**278**	**285**		

The (CPM) solution summary from the network and Table 2 reveal the following:
As a result, 35 of the 51 activities of the network and activity schedule were seen as being critical of the project.
(b) The critical path of this project is:
1 → 3 → 4 → 5 and 6 → 7 and 8 → 9 and 10 → 11 and 12 → 13 and 14 → 15 and 16 → 17 → 19 → 20 and 21 → 22 and 23 → 24 and 25 → 26 and 27 → 28 → 31 → 32 → 34 → 37 and

C) The critical activities are B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, A’, B’, C’, G’, J’, K’, R’, T’, U’, W’, X’, Y’, for which cumulative duration is 285 days.
Total resources consumed by all activities in this project take 425 days while at CPM, the latest finishing time state that the project takes 285 days following the critical paths.

Table 3: PERT Activity Schedule and Computational values.

Activity Code	Activity	IPA	t_o	t_m	t_p	$4t_m$	$T_e = \frac{t_o + 4t_m + t_p}{6}$	$t_v = \left(\frac{t_p - t_o}{6}\right)^2$
A	1-2	-	1	2	4	8	2.2	0.250
B	1-3	-	2	3	5	12	3.2	0.250
C	3-4	B	2	3	4	12	3.0	0.111
D	2-5	AC	5	7	12	28	7.5	1.361
E	5-6	D	1	2	4	8	2.2	0.250
F	6-9	E	7	9	11	36	9.0	0.444
G	7-8	F	2	5	8	20	5.0	1.000
H	8-9	G	6	8	10	32	8.0	0.444
I	9-10	H	7	8	10	32	8.2	0.25
J	9-11	H	3	5	7	20	5.0	0.444
K	11-12	J	3	4	5	16	4.0	0.111
L	12-13	K	3	4	5	16	4.0	0.111
M	13-14	L	4	6	10	24	6.3	1.000
N	14-15	M	1	1	3	4	1.3	0.250
O	15-16	N	17	20	25	80	20.3	1.778
P	16-17	O	8	12	15	48	11.8	1.361
Q	17-18	P	5	5	8	20	5.5	0.250
R	17-19	P	2	5	6	20	4.7	0.444
S	19-20	R	5	7	9	28	7.0	0.444
T	20-21	S	8	8	10	32	8.3	0.111
U	21-22	T	10	13	15	52	12.8	0.694
V	22-23	U	6	9	11	36	8.8	0.694
W	23-24	V	12	20	28	80	20.0	7.111
X	24-25	W	4	4	6	16	4.3	0.111
Y	25-26	X	4	5	7	20	5.2	0.250
Z	26-27	Y	5	6	8	24	6.2	0.250
A'	27-28	Z	14	14	16	56	14.3	0.250
B'	28-31	A'	7	10	11	40	9.7	0.444
C'	31-32	B'	6	8	10	32	8.0	0.444
D'	28-29	A'	4	6	9	24	6.2	0.694
E'	29-30	D'	7	9	10	36	8.8	0.250
F'	32-33	C'	9	11	14	44	11.2	0.694
G'	32-34	C'	3	3	5	12	3.3	0.111
H'	33-35	E'F'	7	9	12	36	9.2	0.694
I'	31-36	B'	5	7	10	28	7.2	0.694
J'	34-37	G'	8	8	11	32	8.5	0.250
K'	37-38	J'	6	10	21	40	11.2	6.250
L'	38-39	K'	12	14	16	56	14.0	0.444
M'	38-40	K'	19	21	25	84	21.3	1.000
N'	30-41	E'	4	6	9	24	6.2	0.694

O'	41-42	N'	2	4	7	16	4.2	0.694
P'	36-43	I'	6	7	9	28	7.2	0.250
Q'	42-44	O'	5	9	14	36	9.2	2.250
R'	38-45	K'	15	21	25	84	20.7	2.778
S'	44-46	Q'	8	10	15	40	10.5	1.361
T'	45-47	R'	12	17	23	68	17.2	3.361
U'	47-48	T'	10	17	21	68	16.5	3.361
V'	48-49	S'	6	8	12	32	8.3	1.000
W'	48-50	U'	4	7	8	28	6.7	0.444
X'	50-51	W'	1	1	3	4	1.3	0.250
Y'	49-52	V'	8	7	10	28	7.7	0.250
TOTAL			**321**	**425**	**572**		**429.1**	

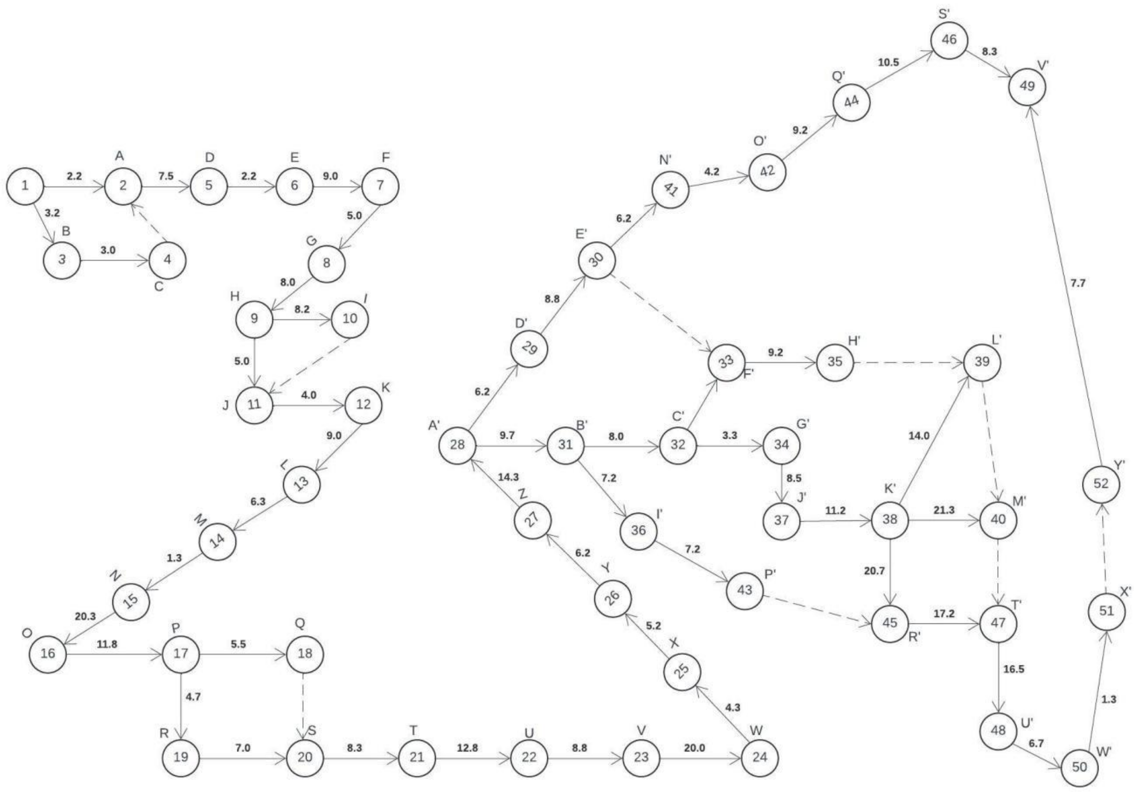

Figure 2. PERT NETWORK DIAGRAM

4. DISCUSSION OF RESULTS

The results of the CPM in table 2 and figure 1 showed that 35 out of the 51 project activities which include: B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, R, S, T, U, V, W, X, Y, Z, A’ ,B’, C’, G’, J’, K’, T’, U’, W’, X’, and Y’ are critical activities, and that the project's duration has been optimized from an initial estimate of 425 days to a significantly reduced timeline of 285 days, resulting in a savings of 133 days. The results from columns 8 and 9 of table 2, where FF = TF, indicate that the associated activities can be scheduled at any point in time in between their early start and latest finish (completion) time with no schedule clash. The relative outcomes derived from FF<TF, indicate that in the initial planning and management of activities, the start of activity (i,j) can be shifted no further than FF earlier in the time line than its initial feasible start.

Further, the activity-on-node method used in the PERT analysis shown in table 2 and the network diagram in figure 2 highlighted the same activities indicated above as being critical. The findings pointed out that the practical project duration time of 433 days had been relatively shrunk to 289 days if the project manager follows strictly the critical path. The use of PERT technique enables constant assessment and activity appraisal of a project. This will ensure that any variance in the expected activity duration is early detected and corrected so that appropriate changes can be made to the project schedules in order to avoid undue prolongation of a project. Therefore the estimate of the expected time to complete the project is also adjusted to a more realistic one. Last but not the least, using PERT, one is able to estimate the likely hood of completing a single activity in a project within a certain time frame.

5. CONCLUSION

PERT and CPM are the most common operational research tools which are used for minimizing the time of completion of project as well as its cost. These techniques are useful in proper timing of individual activities and right people to attend to them as well as management of the whole project right from planning to completion stage. In managing several activities across organization for large scale project management these tools are used to ensure that the step by step activities put in to a precedence relationship to determine critical activities and critical paths. Therefore, they are effective in the coordination simple, complicated, small and medium sized development plans. PERT has a central function of assessing a project that has the uncertain activities or the approximate start and end time on the other hand CPM has a function of providing management with definition of time and cost, an operational network of connecting all activities to time dimension, the resources required and a technique of defining critical and non-critical activities. Irrespective of whether it is found out through pertain or cpm, critical path is important in project management, for decision making and for proper allocation of resources for quick project implementation. Through using the information supplied by CPM and PERT, a project manager is able to competently manage the various aspects of a project in order to achieve the project deliverables on time and efficiently.

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