MEDWIN PUBLISHERS
Committed to Create Value for Researchers

Open Access Journal of Data Science & Artificial Intelligence
ISSN: 2996-671X

Establishing a Project Management Framework for Internet Architecture

Aliyu AM[1]* and Abdulaziz MI[2]

[1]Department of Mathematics and Statistics, American University of Nigeria, Nigeria
[2]Department of Mathematics, Universiti Teknologi Malaysia, Malaysia

***Corresponding author:** Ahmad M Aliyu, Department of Mathematics and Statistics, American University of Nigeria, Nigeria, Tel: 09052522645; Email: ahmad.maliyu@aun.edu.ng

Research Article
Volume 2 Issue 1
Received Date: October 18, 2024
Published Date: November 08, 2024
DOI: 10.23880/oajda-16000150

Abstract

This article utilizes the Critical Path Method (CPM) and the Program Evaluation Review Technique (PERT) to plan, schedule, and oversee the building of an online project. PERT and CPM are project management tools that work well. Project managers can anticipate potential issues and delays in project completion by using PERT and CPM to plan ahead of time. To ensure that the project is finished as soon as is practically possible, schedule the jobs to follow the correct work sequence at the appropriate periods. To ensure that the project is finished on schedule, supervise and manage its activities. The methodology can address questions such as how long a project will take to finish. It appears that the project will be finished in fifty-nine days based on the results. Sensitivity analysis shows that if the project is delayed three days earlier than expected, there is an 83.15% chance that it will be completed, and there is a large possibility (66.3%) that it will be completed between 53 and 59 days. The completion time of 53 to 59 days is confirmed with 99% confidence in this outcome. Only buildings with a medium size are appropriate for the task. Additional activities with longer durations might be possible with additional structures incorporated. This is the first time the research has been conducted; it has never been done before.

Keywords: Project Management; Project Evaluation Review Technique; Critical Path Method; Internet Broad Band

Abbreviations

CPM: Critical Path Method; PERT: Program Evaluation Review Technique; IT: Information Technology.

Introduction

Complex planning, scheduling, and control issues arise when managing large projects with lots of activities, particularly when those tasks must be completed in a precise technological order. Project managers can plan ahead and anticipate potential sources of issues and delays in project completion with the aid of PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method). To ensure that the project is finished as quickly as feasible, schedule the activities at the appropriate times to follow the correct work sequence. Manage and oversee the project's activities to ensure that it is completed on time. Thus, instruments for efficient project management include PERT and CPM. Their methods for solving the problem and approaching it vary. The right technique to utilize is usually determined by the nature of the job. PERT was developed in the United States Navy during the late 1950s to accelerate the development of the Polaris Fleet Balistic Missile [1-3]. For a substantial amount of time, software development, research and development, and the introduction of new industries have all employed PERT as a project management technique [4]. PERT was established by the US Navy to supervise the Polaris missile's development [1].

The structure of this document is as follows: The relevant literature on project management applications in internet design is presented in Section 2. Section 3 lists CPM and PERT as tools for project management planning, scheduling, and control. The results of the research are detailed in Section 4. Lastly, Section 5 presents our findings and the study's limitations along with some recommendations for further research.

Related Literature

To offer the required degree of quality service, effective and efficient internet services must be meticulously planned and well-designed from the start. Delivering superior service is a challenging endeavour that involves meticulous preparation, arrangement, and management. The internet design process uses project management techniques like PERT and CPM to enhance bandwidth flow processes. These methods heavily rely on networks to organize and display the flow while helping technicians plan, schedule, and manage the many online setup tasks [5]. The challenge in finding the best cyclic schedule for robot movements that guarantees maximum cell performance is the issue at hand. In response to this problem, Levner E, et al. [6] suggested a more effective iteration of the parametric PERT/CPM project management technique, which is combined with a combinatorial sub-algorithm that can reject unrealistic timelines. The primary finding is that, in strongly polynomial time, the new fast PERT/CPM approach pro- videos optimal robust schedules for addressing large-scale problems, something that is not possible with current techniques.

PERT and CPM were used by Naveenchandra NS, et al. [4] in the creation of several software applications, including Dishansh, Vigat, Starmiti and Kampan. These programs have several applications in the field of geosciences. This article discusses the many uses for these programs as well as the advantages of using PERT.

Bagshaw KB [7] examined PERT and CPM ideas in project management using real-world examples. The review concluded that although both approaches are successful in project management, the interdependence and linkage between the many activities in a project's life cycle are crucial elements. The study comes to the conclusion that the CPM is more effective when the project's end date is known, but the project evaluation review technique is more effective when the project's duration is uncertain.

Cay T, et al. [8] use satellite pictures as one of the data collecting methods for cadastral map creation for Geographic Information Systems using the Program Evaluation and Review Techniques (PERT) method. Mansor and Gopalasamy [9] worked together The initial step in the study process was to determine which project management best practices generally recognized standards and techniques that are especially useful in assisting a business in accomplishing its goals were used. It also calls for the capacity to oversee projects in today's intricate, dynamic organizations, with their people, procedures, and operating systems all interacting in a cooperative, integrated way.

Maroto C, et al. [10] the development of software and hardware that made it possible for project scheduling techniques like the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) to be developed in the early 1950s has been closely linked to the advancement of these techniques in real-world applications. Alongside the general improvements in software and technology capabilities, a number of applications have seen improvements in quality as a result of flaws and faults fixed in previous versions. Programs are becoming more dynamic and intuitive, which facilitates simpler integration with other tools and offers better and more options for managing resource-constrained project scheduling.

Research Methodology

The information is presented as follows:

Overview of PERT and CPM

One advantage of project management is cost-effective, on-time delivery. This can be guaranteed by implementing project management techniques like PERT and CPM. When planning, carrying out, and overseeing a project, PERT and CPM help management find the most time-consuming or consuming way through a network of tasks or activities. In order to reduce the overall cost and time of the project, managers can use these approaches to optimize the longest time duration. By assisting the project manager at each step of the process, these tools are beneficial. The methods are highly helpful in keeping an eye on project expenses, offer project documentation, and provide critical path and slack time through mathematical simplification. But when weighing the benefits of both approaches to project management, PERT is more appropriate for projects with an unclear time horizon since it is event-oriented, probabilistic, and only focused on time. CPM, on the other hand, is a deterministic, activity-oriented paradigm that is employed for small-scale, recurring tasks [7].

The fundamental tasks of scheduling, planning, and controlling are made easier by the PERT and CPM models. The planning stage divides a project's overall requirements for supplies, labour, and machinery into clear categories. Its focus is on allocating clearly defined tasks to a chronological order of completion. An operational network that links every activity to a time dimension, resource requirements, and a way to distinguish between important and non-essential tasks are all provided to management by PERT and CPM.

PERT is frequently used in construction projects to allocate resources, determine the critical path, and schedule and monitor activities. Office buildings, roads, swimming pools, and the development of a countdown and ”hold” mechanism for space mission launch are a few examples of these projects. It can be used by construction managers to identify possible delays and make the necessary adjustments to keep the project on time. PERT is used in the manufacturing industry to assess production procedures, pinpoint areas for enhancement, and finalize corporate mergers, including ship design and the creation and promotion of a completely new product. The method is applied to optimize resource utilization, develop production schedules, and evaluate production capability. PERT is widely used in information technology (IT) projects to assign resources, identify critical routes, and manage complex operations [11].

Method of Data Collection

Data was gathered through interviews with subject-matter experts. The researcher conducts an in-person interview with the expert to obtain the necessary data. The most likely time, the optimistic time, and the pessimistic time are among the details that were gleaned from the interview, together with the activity description and its predecessors. Details of the data are shown in Tables 1 & 2.

S/N.	Activity description	Symbol
1	Needs assessment	a
2	Budgeting	b
3	Site survey	c
4	Procurement	d
5	Setup infrastructure	e
6	Security implementation	f
7	Testing and Validation	g
8	Documentation	h
9	Monitoring and Maintenance	i
10	Scalability and Future planning	j

Table 1: Setting up internet infrastructure.

Row	From Node	To Node	Activity symbol	a	m	b
1	1	2	a	6	7	8
2	2	3	b	5	6	7
3	2	4	c	1	2	2
4	3	5	d	7	14	21
5	5	6	e	7	14	18
6	6	7	f	3	4	7
7	7	9	g	2	2	3
8	4	9	h	3	4	5
9	7	8	i	2	3	4
10	8	9	j	7	8	10

Table 2: Input Grid- PERT (Program Evaluation Review Technique).

Network Diagram

For a graphical depiction of the software, similar to that seen in Figure 1, the project can then be transformed into a network diagram. Each task originates at a starting node and ends at a subsequent node, represented by the arrows.

Results

The following outcome was obtained when the data was processed through the use of Tora Windows version 2.0 [2].

Probabilities of Completing the Project

The total of all the task durations on the critical route equals the project length X. PERT makes the assumption that every activity's time is independent and identically distributed. Therefore, X has a normal distribution with mean EX(X) and variance VAR(X), according to the central limit theorem [12].

$$Z=\frac{\text{X-EX(X)}}{\sqrt{\text{VAR(X)}}}$$

Let X stands for the length of the project. Next, the project's anticipated duration is expected to be as

$$\begin{aligned} EX(X) &= Sum\ of\ the\ expected\ times\ of\ task \\ &= EX(a)+EX(b)+EX(d)+EX(e)+EX(f)+EX(i)+EX(j) \\ &= 7+6+14+13.5+4.33+3+8.17 \\ &= 56 \end{aligned}$$

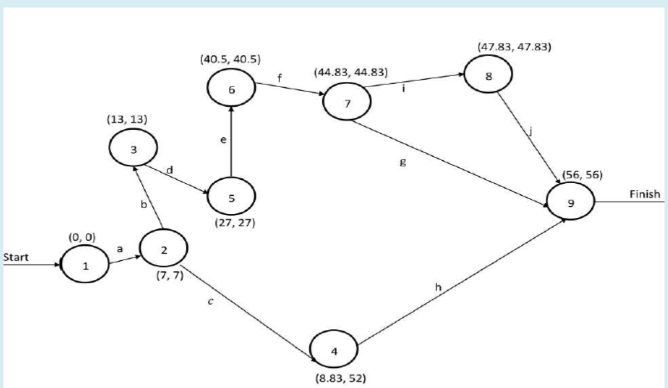

Figure 1: Network diagram for internet set up.

The variance of the project duration is

$$\begin{aligned} VAR(X) &= Sum\ of\ the\ variances\ of\ task \\ &= \sigma_{12}^2+\sigma_{23}^2+\sigma_{35}^2+\sigma_{12}^2+\sigma_{56}^2+\sigma_{67}^2+\sigma_{78}^2+\sigma_{89}^2 \\ &= 0.11+0.11+5.44+3.36+0.44+0.11+0.25 \\ &= 9.82 \end{aligned}$$

The standard deviation of the project duration is

$$\begin{aligned} STD &= \sqrt{VAR(X)} \\ &= \sqrt{9.82} \\ &= 3.13 \end{aligned}$$

A normal distribution with mean μ and variance σ^2 is shown in Figure 2. With a mean of 56 and a standard deviation of 3.13, X has a normal distribution. For every given normal distribution, the probability that a random variable would lie between one standard deviation and the mean is 0.68. Consequently, the project has a 68% chance of taking 50 to 62 days to finish. In contrast, there is a 95% chance that X will fall within two standard deviations, or between 44 and 68 days. Moreover, the X has a 99.7% chance of falling within the range of 38 to 74 days, or three standard deviations.

Additionally, we are able to compute the likelihood of completing the project by the deadline. For example, the client would like to know the likelihood that the project would be finished three days earlier than anticipated. The calculation looks like this:

$$\begin{aligned} Probability(X \le 53) &= Probability\left(Z \le \frac{53-56}{3.13}\right) \\ &= Probability\ (Z \le -0.96) \\ &= 0.3315 \end{aligned}$$

There is a 33.15% chance that the project will be finished three days sooner than anticipated.

$$\begin{aligned} Probability(X \le 59) &= Probability\left(Z \le \frac{59-56}{3.13}\right) \\ &= Probability\ (Z \le -0.96) \\ &= 0.8315 \end{aligned}$$

The project has an 83.15% chance of being finished in less than 59 days. The following formula determines the likelihood that the project will be finished in 53 to 59 days.

$$\begin{aligned} Probability\left(\frac{53-56}{3.13} < Z < \frac{59-56}{3.13}\right) &= Probability\,(-0.96 < Z < 0.96) \\ &= 0.3315+0.3315 \\ &= 0.663 \end{aligned}$$

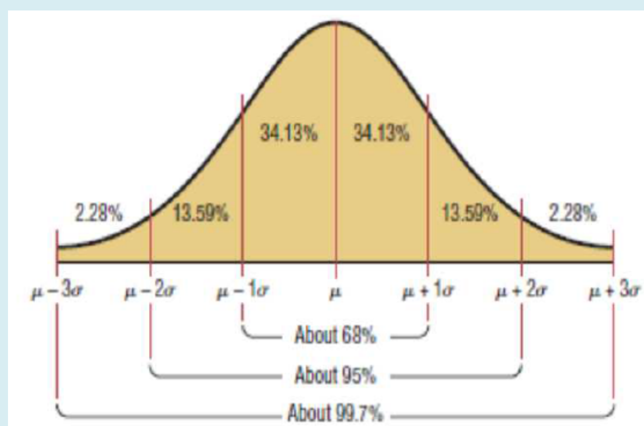

Figure 2: Normal distribution.

There is a 66.3% chance that the project will be completed in 53-59 days [13].

Confidence Interval for the Project Completing Time

If X represents the actual project completion time, then calculate an approximate 99% confidence interval for the project completion time.

$$\bar{X} - t_{\alpha/2}\left(\frac{s}{\sqrt{n}}\right) \le \mu \le \bar{X} + t_{\alpha/2}\left(\frac{s}{\sqrt{n}}\right)$$

Hence,

$$56-(3.25)\left(\frac{3.13}{\sqrt{10}}\right) \le \mu \le 56+(3.25)\left(\frac{3.13}{\sqrt{10}}\right)$$

$$56-(3.25)(0.990) \le \mu \le 56+(3.25)(0.990)$$

$$56-3.22 \le \mu \le 56+3.22$$

$$52.78 \le \mu \le 59.22$$

As a result, based on ten tasks, we can be 99% positive that the completion time will fall between 53 and 59 days.

The project network's activity duration means and variations are displayed in Table 3.

Activity	Activity symbol	Mean	Variance
(1,2)	a	7	0.11
(2,3)	b	6	0.11
(2,4)	c	1.83	0.03
(3,5)	d	14	5.44
(5,6)	e	13.5	3.36
(6,7)	f	4.33	0.44
(7,9)	g	2.17	0.03
(4,9)	h	4	0.11
(7,8)	i	3	0.11
(8,9)	j	8.17	0.25

Table 3: Activity Mean and Variance.

Table 4 shows the longest path mean and standard deviation for the project.

Node	Longest path Based on Mean durations	Mean duration	Std deviation
2	1 - 2	7	0.33
3	1 - 2 - 3	13	0.47
4	1 - 2 - 3 - 4	8.83	0.37
5	1 - 2 - 3 - 4 - 5	27	2.38
6	1 - 2 - 3 - 4 - 5 - 6	40.5	3
7	1 - 2 - 3 - 4 - 5 - 6 - 7	44.83	3.08
8	1 - 2 - 3 - 4 - 5 - 6 - 7 - 8	47.83	3.1
9	1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9	56	3.14

Table 4: Path Mean and Standard deviation.

Floats Determination

For every task, the latest start and earliest completion times are specified as follows:

$LS_{ij} = LC_j - D_{ij}$

$EC_{ij} = ES_i + D_{ij}$

$TF_{ij} = LC_j - ES_i - D_{ij}$

$= LC_j - EC_{ij}$

$= LS_{ij} - ES_i$

$FF_{ij} = ES_j - ES_i - D_{ij}$

$ES_j - ES_i = LC_j - LC_i = D_{ij}$

Where:

D_{ij} = Activity duration

LS_{ij} = Latest Start time

LC_{ij} = Latest completion time

EC_{ij} = Earliest completion time

TF_{ij} = Total float

FF_{ij} = Free float

Activity (ij) 1	Activity Duration D_{ij} (2)	Earliest Start ES_i (3)	Earliest Completion Ec_{ij} (4)	Latest Start LS_{ij} (5)	Latest Completion LC_j (6)	Total Float TF_{ij} (7)	Free Float FF_{ij} (8)
(1,2)	7	0	7	0	7	0	0
(2,3)	6	7	13	7	13	0	0
(2,4)	1.83	7	8.83	50.17	52	43.17*	0
(3,5)	14	13	27	13	27	0	0
(5,6)	13.5	27	40.5	27	40.5	0	0
(6,7)	4.33	40.5	44.83	40.5	44.83	0	0
(7,9)	2.17	44.83	47	53.83	56	9*	9
(4,9)	4	8.83	12.83	52	56	43.17*	43.17
(7,8)	3	44.83	47.83	44.83	47.83	0	0
(8,9)	8.17	47.83	56	47.83	56	0	0

*Non -critical activity

Table 5: Summary

Table 5 provides a handy summary of the critical path estimates along with the floats for the non-critical activities. The network computations are the source of columns (1), (2), (3), (4), (5), (6), (7) and (8). The algorithms above can be used to determine the remaining data. A representative summary of the critical path calculations is shown in Table 4. Observe that the total float of a crucial activity (and only a critical activity) must be zero. When the total float is zero, the free float likewise needs to be zero. However, the opposite is not true in that a non-critical activity can have zero free float [14].

Conclusion

The project should be completed in fifty-nine days based on the findings. Sensitivity analysis indicates that if the project is completed three days earlier than anticipated, there is an 83.15% chance that it will be finished, and there is a substantial probability (66.3%) that it will be completed in 5359 days. It is verified that the completion time is between 53 and 59 days with 99% confidence.

References

1. Winston WL (2004) Operations Research: Applications and Algorithms. Thomson Brooks/Cole Learning, USA.
2. Taha HA (2017) Operations Research: An Introduction. Pearson.
3. Ravindran A, Philips DT, Solberg JJ (2014) Operations Research Principles and Practices. John Wiley.
4. Naveenchandra NS, Thakor RU, Patel SV, Viroja SG, Chetta US (2017) Application of PERT in geo-scientific software development projects few case studies. Triple A Res J Multidisci 1(1): 36-47.
5. Singh S (2017) Project Management and Strategic Objectives of the Organization. Universal J Industrial and Business Management 5(1): 10-12.
6. Levner E, Kats V, Yan P, Che A (2024) Fast Algorithm for High- Throughput Screening Scheduling Based on the PERT/CPM Project Management Technique. Algorithms 17(3): 127.
7. Bagshaw KB (2021) PERT and CPM in Project Management with Practical Examples. Am J Operations Res 11(1): 215-226.
8. Cay T, Iscan F, Durduran S (2024) The Cost Analysis of Satellite Images for using in GIS by the PERT. International Society for Photogrammetry and Remote Sensing.
9. Gopalasamy P, Mansor Z (2013) An Investigation on Project Management Standard practices in IT Organization. International Journal of Computer Engineering Science 3(3): 1-12.
10. Maroto C, Tormos P, Lova A (1999) The Evolution of Software Quality in Project Scheduling. In: J Weglarz (Edn.), Springer Science, Business Media, USA.
11. Aliyu AM, Sabo SA (2024) Project Management: An Objective Assessment of Activity Duration. Open Access J Data Sci Artificial Int 2(1): 1-9.
12. Mood AM, Boes DC, Graybills FA (1974) Introduction to the Theory of Statistics 3rd (Edn.). McGraw- Hill College, USA.
13. Bluman AG (2009) Elementary Statistics: A Step by Step Approach 7th (Edn.). McGraw-Hill Companies, USA.
14. Fogiel M (1985) The Operations Research Problem Solver 12th (Edn.). Research and Education Association, USA.