Sustainable Civil Building Management and Engineering Journal Vol: 2, No 2, 2025, Page: 1-13

A Comparative Analysis of the CPM and PERT Methods in Project Time Management for a High-Rise Building Construction Project in Yogyakarta

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DOI:
https://doi.org/10.47134/scbmej.v2i2.3927
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Received: 16-02-2025
Accepted: 23-03-2025
Published: 30-04-2025

Abstract: This study examines the comparison of PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method) in time management for construction projects through a case study of a 21-story high-rise building project in Yogyakarta. The research is motivated by the need for effective time management in construction projects to avoid delays that may escalate costs and disrupt project execution. The objectives are to determine the estimated duration for completing the building's structural work, compare the differences between the initial schedule and the results of PERT and CPM analyses. The study employs a case study approach, with primary data collected through direct interviews with project stakeholders regarding activity durations and predecessors, as well as secondary data from project documentation, including schedules and structural drawings. Data analysis involves applying PERT calculations using three-time estimates (optimistic, most likely, and pessimistic) and identifying critical paths through CPM. Data processing and network diagram visualization are conducted using a project management software to comprehensively map critical and non-critical project activities. Results indicate that the CPM method predicts a project duration of 419 days, 237 days shorter than the initial schedule, while the PERT method estimates 580 days, 76 days shorter than the original timeline, with an 82.98% probability of timely completion.

Keywords: Construction Management, CPM, PERT, Scheduling

Introduction

The construction sector in Indonesia has experienced rapid growth, driven by large-scale projects initiated by both government and private entities in urban and rural areas (Toricelli & Budiyanto, 2021). The development of infrastructure such as roads, buildings, and bridges aims to improve societal welfare. The success of these projects relies heavily on an effective management system that spans from planning to completion, ensuring efficiency and alignment with set objectives (Mahyuddin et al., 2023).

Construction project management is characterized by unique challenges, including strict time constraints, necessitating high levels of efficiency (Belferik et al., 2023). Project leaders must be capable of adapting to changing conditions and addressing unforeseen challenges through flexible strategies. Such adaptability is crucial for completing projects on schedule while measuring success based on innovative responses to field dynamics (Pontan, 2024).

Construction project plans are often based on initial assumptions and forecasts, which frequently do not align with actual conditions. This mismatch can lead to delays and cost overruns (Megawati & Lirawati, 2021). Therefore, precision in planning, flexibility, and responsiveness to on-site changes are essential to minimize risks and ensure projects remain within budget (Hanifazaki, 2023).

Project delays often trigger conflicts between owners and contractors regarding additional costs and extended timelines (Rauzana et al., 2022). According to (Saputro & Aufa, 2024), accurate activity duration estimates and clear interactivity relationships in planning significantly influence scheduling accuracy. Continuous monitoring is required to identify early issues and implement corrective actions, enabling projects to achieve time, cost, and resource efficiency (Putra, 2025).

A case study of the 21-story high-rise building construction project in Yogyakarta utilized PERT and CPM methods for scheduling analysis. These methods classify activities into critical and non-critical categories (Oktafiana & Baroroh, 2022). PERT incorporates three-time estimates—optimistic, pessimistic, and most likely—to calculate average durations (Nemaa & Aswed, 2021), while CPM considers a single deterministic duration estimate (Akila, 2023). The application of PERT and CPM methods aims to enhance scheduling accuracy, reduce delay risks, and ensure smooth project execution in line with targets (Nugraha & Waskito, 2023).

Methodology

This study employs a case study approach, collecting primary data through direct interviews with project implementers regarding the duration of each activity for the construction of the 21-story high-rise building and its predecessors. Secondary data were sourced from project documents, including implementation schedules and structural drawings. Data analysis involved applying time estimation calculations using the PERT and CPM methods. The PERT method incorporates three estimates—optimistic, most likely, and pessimistic (Santosa, 2009), making this method probabilistic in nature (Setiawati et al., 2016). In contrast, the CPM method identifies the critical path based on a single deterministic duration (Bagshaw, 2021).

According to Widiasanti & Lenggogeni (2013) the steps for analyzing scheduling using the CPM method are as follows: establishing dependencies between tasks, creating a network diagram, performing forward pass and backward pass calculations, analyzing float values, and determining the critical path.

For PERT scheduling, the analysis follows these steps, as outlined by Soeharto (1999): defining optimistic (a), most-likely (m), and pessimistic (b) durations; calculating the expected time (te); analyzing standard deviation and variance; and determining the probability of completion.

Data processing and network diagram visualization were conducted using a project management software to provide a comprehensive overview of critical and non-critical activities within the project.

Result and Discussion

CPM Method

1. Determining Dependencies Between Tasks

The results of interviews regarding the duration of each activity and their respective predecessors were organized into the software worksheet. This process was conducted to calculate the total duration required for project completion using the CPM Method.

Prior to constructing a project network diagram, tasks must be systematically organized according to their sequence, which is governed by logical dependencies. This methodology ensures that each activity is scheduled only after its preceding task has been finalized. The foundational principle of this framework is that the completion of one activity directly enables the initiation of subsequent tasks. Additionally, certain non-conflicting activities may be executed simultaneously without compromising the integrity of the workflow (Tuanaya et al., 2024).

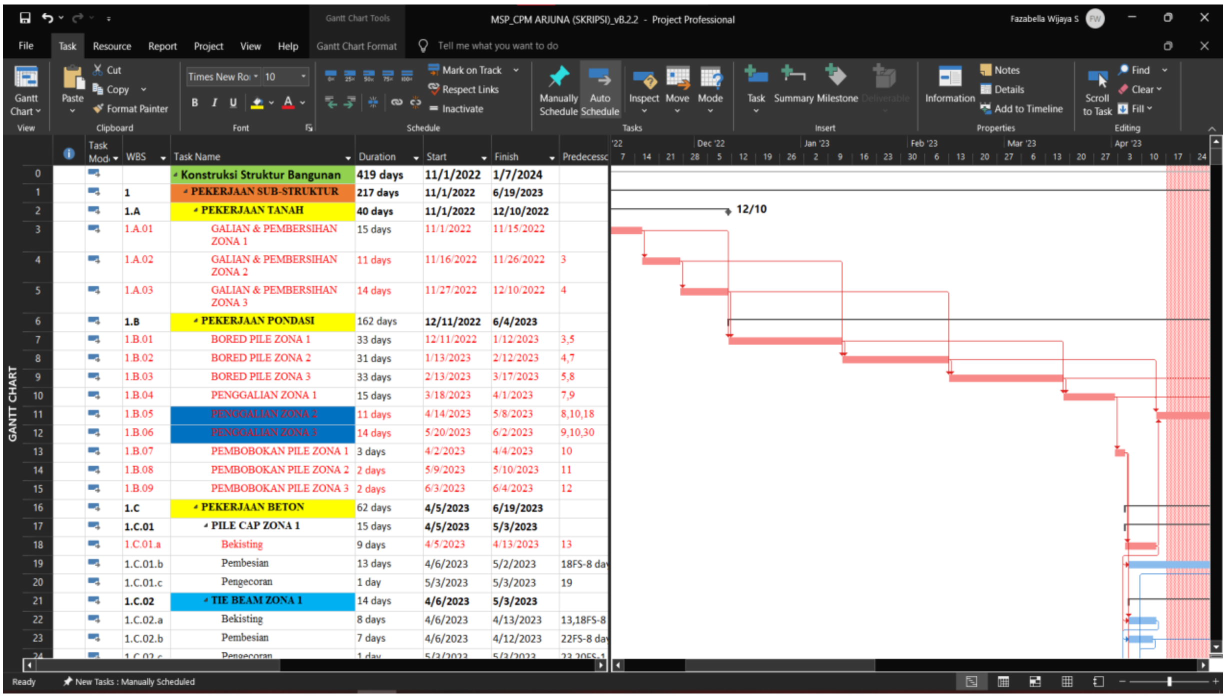

Figure 1. Activity Dependency Relationships Using the CPM Method in the Software Worksheet

2. Creating a Network Diagram

Based on the established dependency relationships, a network diagram was generated using the software, incorporating the results obtained. This is depicted in Figure 2.

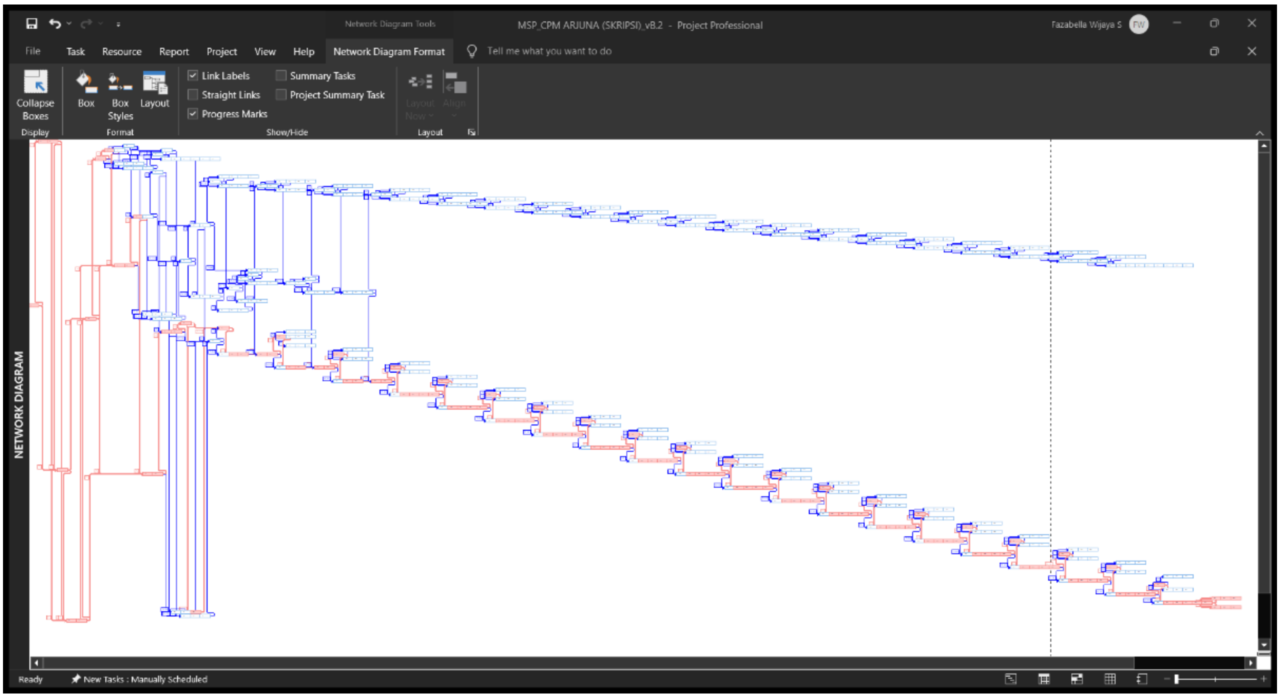

Figure 2. The visualization of CPM Network Diagram

3. Analyzing the Forward Pass

Based on the CPM duration data and tasks dependency relationships from interviews, a forward pass analysis was conducted to determine the Earliest Start (ES) and Earliest Finish (EF) values for each task item. To illustrate the calculation process, an example is provided below.

For the excavation work in zone 3 of the foundation (WBS ID: 1.B.06), the following data were used:

Duration = 14 days
Predecessors = 1.B.03, 1.B.04, 1.C.04.a

a) Earliest Start

The activity begins after the last predecessor (1.C.04.a) is completed, which occurs at 186 days.

ES= max (EF of all predecessors)
= 186 days

b) Earliest Finish

EF= ES + Duration
= 186 + 14
= 200 days

This forward pass analysis was applied to all other task items to estimate the project completion duration, determined by the largest EF value.

4. Analyzing the Backward Pass

Based on the CPM duration data and tasks dependency relationships from interviews, a backward pass analysis was conducted to determine the Latest Start (LS) and Latest Finish (LF) values for each task item. An example is provided below to clarify the calculation process.

For the pile demolition work in zone 1 of the foundation (WBS ID: 1.B.07), the following data were used:

Duration = 3 days
Successors = 1.C.01.a, 1.C.02.a, 1.C.03.a

a) Latest Finish

The activity must be completed before the earliest successor (1.C.01.a) begins, which occurs at 186 days.

LF= min (LS of all successors)
= 155 days

b) Latest Start

LS= ES – Duration
= 155 – 3
= 152 days

This backward pass analysis was applied to all other task items to estimate the project completion duration, determined by the largest LF value.

5. Analyzing Float Calculations

Based on the forward and backward pass analyses, the Total Float (TF) for each task item was calculated. An illustrative example is provided below to clarify the process.

For the excavation work in zone 3 of the foundation (WBS code: 1.B.06), the following values were obtained:

ES = 186 days ; LS = 186 days
EF = 200 days ; LF = 200 days

The Total Float was calculated using either of the following formulas:

TF = LF – EF or TF = LS – ES
TF = 200 – 200 TF = 186 – 186
TF = 0 days TF = 0 days

The result (TF = 0) indicates that this activity has no slack time and is therefore classified as critical task. This float analysis was applied to all task items to identify activities falling within the critical path.

6. Determining the Critical Path

The analysis of the forward and backward passes revealed that the high-rise building construction project is completed in 419 days using the CPM method, as indicated by the largest values of Earliest Finish (EF) and Latest Finish (LF).

Additionally, prior analysis identified activities with Total Float = 0 (indicating no scheduling flexibility) as part of the critical path. These critical activities include: 1.A.01; 1.A.02; 1.A.03; 1.B.01; 1.B.02; 1.B.03; 1.B.04; 1.B.05; 1.B.06; 1.B.07; 1.B.08; 1.B.09; 1.C.01.a; 1.C.04.a; 1.C.07.a; 1.C.07.b; 1.C.07.c; 1.C.08.c; 2.A.05.b; 2.A.06.b; 2.A.06.c; 2.B.07.a; 2.B.07.b; 2.B.07.c; 2.B.12.b; 2.B.12.c; 2.C.06.a; 2.C.06.b; 2.C.06.c; 2.C.09.b; 2.C.09.c; 2.D.05.a; 2.D.05.b; 2.D.05.c; 2.D.08.b; 2.D.08.c; 2.E.04.a; 2.E.04.b; 2.E.04.c; 2.E.07.b; 2.E.07.c; 2.F.04.a; 2.F.04.b; 2.F.04.c; 2.F.07.b; 2.F.07.c; 2.G.04.a; 2.G.04.b; 2.G.04.c; 2.G.07.b; 2.G.07.c; 2.H.04.a; 2.H.04.b; 2.H.04.c; 2.H.07.b; 2.H.07.c; 2.I.04.a; 2.I.04.b; 2.I.04.c; 2.I.07.b; 2.I.07.c; 2.J.04.a; 2.J.04.b; 2.J.04.c; 2.J.07.b; 2.J.07.c; 2.K.04.a; 2.K.04.b; 2.K.04.c; 2.K.07.b; 2.K.07.c; 2.L.04.a; 2.L.04.b; 2.L.04.c; 2.L.07.b; 2.L.07.c; 2.M.04.a; 2.M.04.b; 2.M.04.c;

2.M.07.b; 2.M.07.c; 2.N.04.a; 2.N.04.b; 2.N.04.c; 2.N.07.b; 2.N.07.c; 2.O.04.a; 2.O.04.b; 2.O.04.c; 2.O.07.b; 2.O.07.c; 2.P.04.a; 2.P.04.b; 2.P.04.c; 2.P.07.b; 2.P.07.c; 2.Q.04.a; 2.Q.04.b; 2.Q.04.c; 2.Q.07.b; 2.Q.07.c; 2.R.04.a; 2.R.04.b; 2.R.04.c; 2.R.07.b; 2.R.07.c; 2.S.04.a; 2.S.04.b; 2.S.04.c; 2.S.07.b; 2.S.07.c; 2.T.04.a; 2.T.04.b; 2.T.04.c; 2.T.07.b; 2.T.07.c; 2.U.04.a; 2.U.04.b; 2.U.04.c; 2.U.05.a; 2.U.05.b; 2.U.05.c; 2.U.06.a; 2.U.06.b; 2.U.06.c.

A critical task is defined as an activity with zero total float, indicating no permissible delay in its execution. Such tasks must adhere strictly to their scheduled timelines, as any postponement directly extends the project's completion date. Conversely, non-critical activities—those with total float greater than zero—possess a time buffer that allows for delays up to their specified float value without disrupting the overall project timeline. This distinction ensures that essential tasks are prioritized, while flexible ones accommodate adjustments within predefined limits.

Non-critical tasks should not be conflated with optional or unnecessary work; rather, they represent activities that can be scheduled concurrently with critical tasks while possessing a defined time buffer. This buffer signifies the maximum permissible delay for such activities without jeopardizing the project's overall timeline (Iriyanto & Yommy, 2017). Consequently, the minimum required timeframe for completing the 21-story high-rise building construction project in Yogyakarta is established at 419 days with CPM method.

PERT Method

1. Establishing Optimistic (a), Most-Likely (m), and Pessimistic (b) Durations

   The PERT technique is a project scheduling approach that uses three duration estimates to structure activity timelines. These include the optimistic duration (a) (shortest possible time), most-likely duration (m) (realistic estimate), and pessimistic duration (b) (longest possible time). These estimates enable probabilistic calculation of activity durations, allowing adaptive planning to address uncertainties in project execution (Ardany et al., 2022). Data for these three duration estimates were obtained through direct interviews with project implementers.

2. Calculating the Expected Time (te)

   Using the PERT duration estimates (optimistic, most-likely, and pessimistic) obtained from interviews, the Expected Time (te) was calculated for each task item. For example, the formwork activity for pile cap zone 1 (WBS ID 1.C.01.a) was analyzed with the following averaged data:

   Optimistic duration (a) = 7.67 days
   Pessimistic duration (b) = 14.67 days
   Most-likely duration (m) = 10 days

   $$TE = (a+4m+b)/6 = (7.67 + 4(10) + 14.67)/6 = 10.39 \approx 10 \text{ days}$$

This calculation was applied to all task items to establish a revised schedule based on the derived te values.

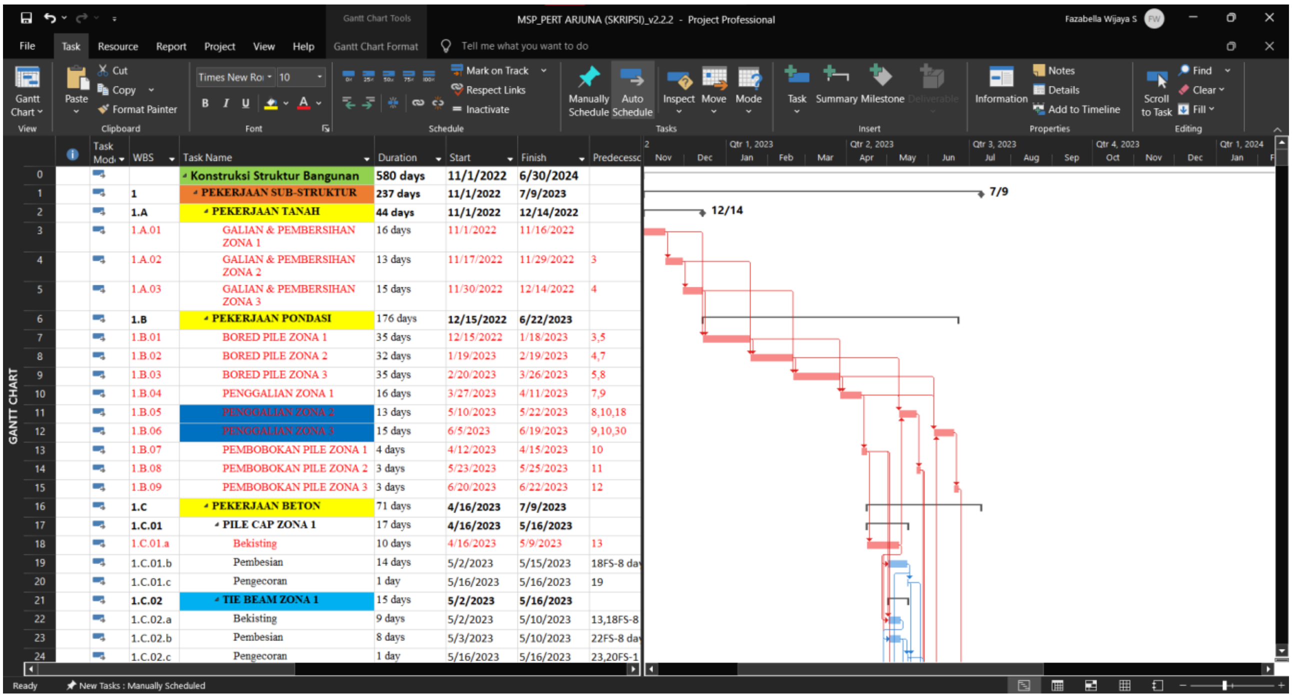

Figure 3. PERT Schedule based on TE Durations in the Software Worksheet

3. Analyzing Activity Standard Deviation and Activity Variance

The PERT method estimates activity durations using a time range rather than a fixed duration, reflecting the uncertainty inherent in project scheduling. This range is quantified by the difference between optimistic and pessimistic estimates. In PERT, standard deviation and variance measure this uncertainty: smaller variance indicates greater predictability in completing an activity, and vice versa (Soeharto, 1999).

For example, the formwork activity for pile cap zone 1 (WBS ID 1.C.01.a) was analyzed with the following averaged data:

Optimistic duration (a) = 7.67 days
Pessimistic duration (b) = 14.67 days

Calculations for standard deviation (S) and variance (V) were performed as follows:

S = (b-a)/6 V = S^2
= (14.67-7.67)/6 = 〖1.667〗^2
= 1.1667 = 1.3611

This analysis was replicated for all other task items to assess variability in activity durations.

4. Analyzing the Critical Path

After determining the expected duration (TE) for each activity, the next step involved analyzing the critical path to calculate the critical path variance and critical path standard deviation. These values are essential for estimating project completion probability and the total expected duration (TE) for PERT scheduling. The critical path analysis in PERT follows the same methodology as the CPM scheduling technique, involving calculations of Earliest Start (ES), Earliest Finish (EF), Latest Start (LS), Latest

Finish (LF), and Total Float (TF) based on predecessor and successor dependencies derived from interview data.

The critical path analysis, using forward and backward pass calculations for all project activities, was visualized via a network diagram with the software, as shown in Figure 4 below.

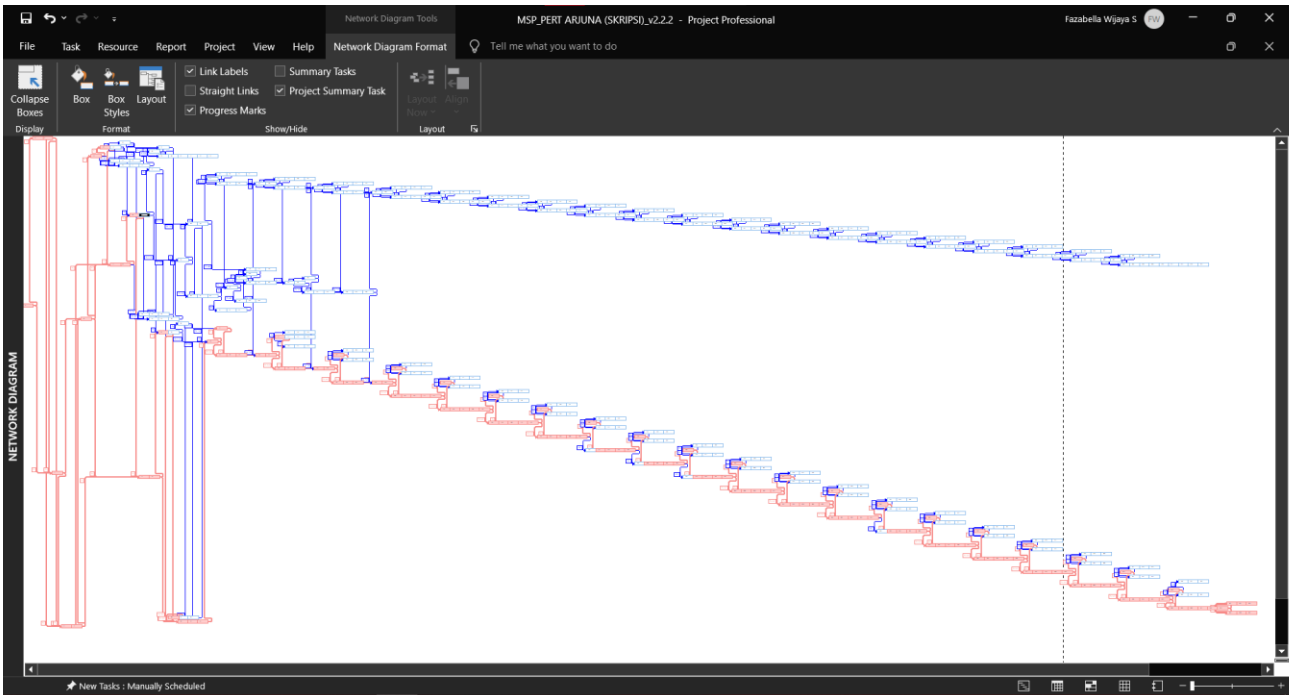

Figure 4. The visualization of PERT Network Diagram

The analysis of the forward and backward passes revealed that the expected total duration (TE) for the high-rise building construction project is 580 days using the PERT method, derived from the largest Earliest Finish (EF) and Latest Finish (LF) values.

Additionally, the results identified activities with Total Float = 0 (indicating no scheduling flexibility) as part of the critical path. These critical activities include: 1.A.01; 1.A.02; 1.A.03; 1.B.01; 1.B.02; 1.B.03; 1.B.04; 1.B.05; 1.B.06; 1.B.07; 1.B.08; 1.B.09; 1.C.01.a; 1.C.04.a; 1.C.07.a; 1.C.08.a; 1.C.09.a; 1.C.09.b; 1.C.09.c; 2.A.05.a; 2.A.05.b; 2.A.06.a; 2.A.06.b; 2.A.06.c; 2.B.07.a; 2.B.07.b; 2.B.07.c; 2.B.12.a; 2.B.12.b; 2.B.12.c; 2.C.06.a; 2.C.06.b; 2.C.06.c; 2.C.09.a; 2.C.09.b; 2.C.09.c; 2.D.05.a; 2.D.05.b; 2.D.05.c; 2.D.08.a; 2.D.08.b; 2.D.08.c; 2.E.04.a; 2.E.04.b; 2.E.04.c; 2.E.07.a; 2.E.07.b; 2.E.07.c; 2.F.04.a; 2.F.04.b; 2.F.04.c; 2.F.07.a; 2.F.07.b; 2.F.07.c; 2.G.04.a; 2.G.04.b; 2.G.04.c; 2.G.07.a; 2.G.07.b; 2.G.07.c; 2.H.04.a; 2.H.04.b; 2.H.04.c; 2.H.07.b; 2.H.07.c; 2.I.04.a; 2.I.04.b; 2.I.04.c; 2.I.07.b; 2.I.07.c; 2.J.04.a; 2.J.04.b; 2.J.04.c; 2.J.07.b; 2.J.07.c; 2.K.04.a; 2.K.04.b; 2.K.04.c; 2.K.07.a; 2.K.07.b; 2.K.07.c; 2.L.04.a; 2.L.04.b; 2.L.04.c; 2.L.07.a; 2.L.07.b; 2.L.07.c; 2.M.04.a; 2.M.04.b; 2.M.04.c; 2.M.07.a; 2.M.07.b; 2.M.07.c; 2.N.04.a; 2.N.04.b; 2.N.04.c; 2.N.07.b; 2.N.07.c; 2.O.04.a; 2.O.04.b; 2.O.04.c; 2.O.07.a; 2.O.07.b; 2.O.07.c; 2.P.04.a; 2.P.04.b; 2.P.04.c; 2.P.07.a; 2.P.07.b; 2.P.07.c; 2.Q.04.a; 2.Q.04.b; 2.Q.04.c; 2.Q.07.a; 2.Q.07.b; 2.Q.07.c; 2.R.04.a; 2.R.04.b; 2.R.04.c; 2.R.07.a; 2.R.07.b; 2.R.07.c; 2.S.04.a; 2.S.04.b; 2.S.04.c; 2.S.07.a; 2.S.07.b; 2.S.07.c; 2.T.04.a; 2.T.04.b; 2.T.04.c; 2.T.07.a; 2.T.07.b; 2.T.07.c; 2.U.03.a; 2.U.03.b; 2.U.03.c; 2.U.04.a; 2.U.04.b; 2.U.04.c; 2.U.05.a; 2.U.05.b; 2.U.05.c.

The identified critical activities above enable the calculation of the total critical path variance and critical path standard deviation by summing the individual activity variances and standard deviations from prior analyses. These aggregated values will be utilized to determine the probability of project completion.

Table 1. Critical Activity Sequence with Critical Path Variance and Critical Path Standard Deviation

WBS ID	V	S	WBS ID	V	S	WBS ID	V	S
1.A.01	0.3086	0.5556	2.F.04.a	0.1512	0.3889	2.N.07.b	0.3086	0.5556
1.A.02	0.8920	0.9444	2.F.04.b	1.3611	1.1667	2.N.07.c	0.3086	0.5556
1.A.03	0.6049	0.7778	2.F.04.c	0.0278	0.1667	2.O.04.a	0.1512	0.3889
1.B.01	0.8920	0.9444	2.F.07.a	0.1111	0.3333	2.O.04.b	1.3611	1.1667
1.B.02	1.0000	1.0000	2.F.07.b	0.3086	0.5556	2.O.04.c	0.0278	0.1667
1.B.03	0.8920	0.9444	2.F.07.c	0.3086	0.5556	2.O.07.a	0.1111	0.3333
1.B.04	0.3086	0.5556	2.G.04.a	0.1512	0.3889	2.O.07.b	0.3086	0.5556
1.B.05	0.8920	0.9444	2.G.04.b	1.3611	1.1667	2.O.07.c	0.3086	0.5556
1.B.06	0.6049	0.7778	2.G.04.c	0.0278	0.1667	2.P.04.a	0.1512	0.3889
1.B.07	0.1111	0.3333	2.G.07.a	0.1111	0.3333	2.P.04.b	1.3611	1.1667
1.B.08	0.0494	0.2222	2.G.07.b	0.3086	0.5556	2.P.04.c	0.0278	0.1667
1.B.09	0.1512	0.3889	2.G.07.c	0.3086	0.5556	2.P.07.a	0.1111	0.3333
1.C.01.a	1.3611	1.1667	2.H.04.a	0.1512	0.3889	2.P.07.b	0.3086	0.5556
1.C.04.a	1.3611	1.1667	2.H.04.b	1.3611	1.1667	2.P.07.c	0.3086	0.5556
1.C.07.a	1.3611	1.1667	2.H.04.c	0.0278	0.1667	2.Q.04.a	0.1512	0.3889
1.C.08.a	1.0000	1.0000	2.H.07.b	0.3086	0.5556	2.Q.04.b	1.3611	1.1667
1.C.09.a	0.3086	0.5556	2.H.07.c	0.3086	0.5556	2.Q.04.c	0.0278	0.1667
1.C.09.b	0.3086	0.5556	2.I.04.a	0.1512	0.3889	2.Q.07.a	0.1111	0.3333
1.C.09.c	0.0278	0.1667	2.I.04.b	1.3611	1.1667	2.Q.07.b	0.3086	0.5556
2.A.05.a	1.3611	1.1667	2.I.04.c	0.0278	0.1667	2.Q.07.c	0.3086	0.5556
2.A.05.b	0.0278	0.1667	2.I.07.b	0.3086	0.5556	2.R.04.a	0.1512	0.3889
2.A.06.a	0.1111	0.3333	2.I.07.c	0.3086	0.5556	2.R.04.b	1.3611	1.1667
2.A.06.b	0.3086	0.5556	2.J.04.a	0.1512	0.3889	2.R.04.c	0.0278	0.1667
2.A.06.c	0.3086	0.5556	2.J.04.b	1.3611	1.1667	2.R.07.a	0.1111	0.3333
2.B.07.a	0.1512	0.3889	2.J.04.c	0.0278	0.1667	2.R.07.b	0.3086	0.5556
2.B.07.b	1.3611	1.1667	2.J.07.b	0.3086	0.5556	2.R.07.c	0.3086	0.5556
2.B.07.c	0.0278	0.1667	2.J.07.c	0.3086	0.5556	2.S.04.a	0.1512	0.3889
2.B.12.a	0.1111	0.3333	2.K.04.a	0.1512	0.3889	2.S.04.b	1.3611	1.1667
2.B.12.b	0.3086	0.5556	2.K.04.b	1.3611	1.1667	2.S.04.c	0.0278	0.1667
2.B.12.c	0.3086	0.5556	2.K.04.c	0.0278	0.1667	2.S.07.a	0.1111	0.3333
2.C.06.a	0.1512	0.3889	2.K.07.a	0.1111	0.3333	2.S.07.b	0.3086	0.5556
2.C.06.b	1.3611	1.1667	2.K.07.b	0.3086	0.5556	2.S.07.c	0.3086	0.5556
2.C.06.c	0.0278	0.1667	2.K.07.c	0.3086	0.5556	2.T.04.a	0.1512	0.3889
2.C.09.a	0.1111	0.3333	2.L.04.a	0.1512	0.3889	2.T.04.b	1.3611	1.1667
2.C.09.b	0.3086	0.5556	2.L.04.b	1.3611	1.1667	2.T.04.c	0.0278	0.1667
2.C.09.c	0.3086	0.5556	2.L.04.c	0.0278	0.1667	2.T.07.a	0.1111	0.3333
2.D.05.a	0.1512	0.3889	2.L.07.a	0.1111	0.3333	2.T.07.b	0.3086	0.5556
2.D.05.b	1.3611	1.1667	2.L.07.b	0.3086	0.5556	2.T.07.c	0.3086	0.5556

WBS ID	V	S	WBS ID	V	S	WBS ID	V	S
2.D.05.c	0.0278	0.1667	2.L.07.c	0.3086	0.5556	2.U.03.a	0.1512	0.3889
2.D.08.a	0.1111	0.3333	2.M.04.a	0.1512	0.3889	2.U.03.b	1.3611	1.1667
2.D.08.b	0.3086	0.5556	2.M.04.b	1.3611	1.1667	2.U.03.c	0.0278	0.1667
2.D.08.c	0.3086	0.5556	2.M.04.c	0.0278	0.1667	2.U.04.a	0.3086	0.5556
2.E.04.a	0.1512	0.3889	2.M.07.a	0.1111	0.3333	2.U.04.b	0.1512	0.3889
2.E.04.b	1.3611	1.1667	2.M.07.b	0.3086	0.5556	2.U.04.c	0.0278	0.1667
2.E.04.c	0.0278	0.1667	2.M.07.c	0.3086	0.5556	2.U.05.a	0.3086	0.5556
2.E.07.a	0.1111	0.3333	2.N.04.a	0.1512	0.3889	2.U.05.b	0.1512	0.3889
2.E.07.b	0.3086	0.5556	2.N.04.b	1.3611	1.1667	2.U.05.c	0.0278	0.1667
2.E.07.c	0.3086	0.5556	2.N.04.c	0.0278	0.1667			
	Σ V(Te) = 59.7253						**Σ S(Te) = 79.7222**	

The calculation results revealed a total critical path variance (V(Te)) of 59.7253, derived from summing individual activity variances, and a critical path standard deviation (S(Te)) of 79.7222, obtained by aggregating activity standard deviations. These values are used to assess the probability of project completion.

5. Analyzing Probability Calculations

Based on the critical path analysis, the expected total duration (TE) for the 21-story high-rise building construction project is 580 days, with a critical path variance (V(Te)) of 59.7253 and a critical path standard deviation (S(Te)) of 79.7222. The relationship between the expected duration (TE) and the target completion time (T(d)) in PERT is expressed using the z-score, calculated as:

$$\text{z-score} = (T(d)-TE)/(S(Te))$$

To determine the probability of completing the project within the planned target duration of T(d) = 656 days, the z-score was computed:

$$z = (T(d)-TE)/(S(Te)) = (656-580)/79.7222= 0.95$$

Using the standard normal distribution table, a z-score of 0.95 corresponds to a probability of 0.8298 (or 82.98%). This indicates an 82.98% likelihood of completing the project within the scheduled timeframe.

Discussion

The analysis demonstrates that the CPM and PERT methods differ in their approaches to project scheduling. The CPM method relies on single deterministic time estimates with Finish-to-Start (FS) logic, while PERT employs three probabilistic time estimates to accommodate uncertainties. Based on the analysis, CPM yields a project duration of 419 days with 125 critical activities, whereas PERT estimates a duration of 580 days with 143 critical activities. Additionally, PERT calculates an 82.98% probability of completing the project within 656 days, reflecting its flexibility in addressing delay risks.

Regarding schedule efficiency, CPM achieves a 36.13% reduction (237 days) from the initial timeline which is 656 days, compared to PERT's 11.59% acceleration (76 days). Both methods highlight that compressing timelines not only affects project duration but also potentially alters cost estimates significantly, emphasizing that method selection depends on project complexity and uncertainty levels.

These findings illustrate the contrasting outcomes of the analysis: CPM's duration is shorter than PERT's due to its reliance on single-activity time estimates, whereas PERT incorporates three-time estimates. To ensure alignment with planned schedules, contractors must prioritize monitoring critical path activities.

Conclusion

CPM employs single deterministic time estimates with Finish-to-Start (FS) logic, resulting in a project duration of 419 days (125 critical activities). In contrast, PERT uses three probabilistic time estimates to accommodate uncertainties, predicting a duration of 580 days (143 critical activities) with an 82.98% probability of completion within 656 days. This highlights CPM's greater efficiency in duration reduction compared to PERT's adaptability to risks.

CPM achieves a 36.13% schedule compression (237 days), significantly outperforming PERT's 11.59% reduction (76 days). However, accelerating timelines in both methods may significantly alter project cost estimates. The choice of method should align with project complexity and uncertainty levels, with a focus on monitoring critical activities to ensure schedule adherence.

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