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ASSESSMENT OF SCHEDULE UNCERTAINTY AND RISK MITIGATION IN ACCELERATED BRIDGE CONSTRUCTION USING PERT

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Abstract

Traffic congestion is a critical issue in Indonesia's rapidly urbanizing areas, particularly in regions with high vehicle density such as East Java. To address this, the construction of the Djuanda Flyover in Sidoarjo was initiated as a National Strategic Project (PSN) to alleviate bottlenecks along the Surabaya–Sidoarjo corridor. This study aims to evaluate the probability of successful schedule acceleration in the Djuanda Flyover project using the Program Evaluation and Review Technique (PERT). The research employs a mixed-methods approach, combining quantitative data from weekly and monthly progress reports and PERT-based estimations, with qualitative inputs from expert questionnaires involving 22 project stakeholders, including the owner (BBPJN Jawa-Bali), supervisory consultants, and contractors (PT Wika-Nindya KSO). The analysis focused on the critical path of the project, applying three-point estimates (optimistic, most likely, pessimistic) for activity durations. The initial duration was estimated at 102 days. After applying PERT analysis, the duration was reduced to approximately 95.32 days. With this acceleration, the probability of meeting the 98-day target completion date is 64.8%. These findings reveal a significant risk of failure to meet the targeted acceleration, suggesting the need for enhanced risk mitigation strategies and improved scheduling reliability. The study contributes to infrastructure project management literature by demonstrating how PERT can quantify schedule uncertainty in strategic national infrastructure projects. Recommendations include refining expert judgment techniques, optimizing resource allocation, and implementing real-time performance monitoring to increase schedule confidence beyond 90%. This research may serve as a reference for future accelerated infrastructure projects under similar constraints.

Keywords: Flyover Construction, Schedule Acceleration, PERT Method, Project Risk, Infrastructure Management

Introduction

Population growth is an inevitable phenomenon in the development dynamics of a country (Zhasmukhambetova et al., 2025). In developing nations such as Indonesia, the rate of population increase tends to be rapid, particularly in urban areas and metropolitan buffer zones (Zaneldin & Ahmed, 2024). Traffic congestion is one of the consequences arising from population growth and density that are not adequately addressed by sufficient transportation infrastructure planning (Ashadi et al., 2022). This becomes increasingly relevant when considered within the current context of Indonesia, where urbanization is advancing rapidly and there is a significant rise in economic activity and large-scale mobility (Pradhananga et al., 2023).

The Central Statistics Agency (BPS) recorded that Indonesia's population in 2023 reached 277,534,122 individuals (Sami Ur Rehman et al., 2022). This massive number inevitably implies an increasing demand for both private and public transportation modes (Nabawy & Gouda Mohamed, 2024). It is unsurprising, therefore, that the number of registered motor vehicles in Indonesia has also shown a significant surge. According to BPS data in 2023, the total number of registered motor vehicles in Indonesia reached 152,565,905 units. Of this number, Java Island contributes the largest portion, accounting for 92,036,868 units or approximately 59.67% of the national total. East Java, one of the most populous provinces on the island, recorded 19,382,263 motor vehicles (Y. Chen et al., 2022; Lotfi et al., 2022; Wu & Lu, 2022; X. Zhang et al., 2023).

The rising ownership of private vehicles serves as an indicator of increased pressure on the existing road network, especially in metropolitan regions such as Surabaya and its surrounding areas. The road corridor between Surabaya and Sidoarjo, which forms part of the Gerbangkertosusila metropolitan region, is a major route for the movement of people and goods (Demiss & Elsaigh, 2024; Muhaimin et al., 2021). It not only serves the local population but also functions as a key access route to Juanda International Airport. Unfortunately, this route has also become one of the most chronically congested areas, particularly at the level railway crossings, which frequently cause vehicle queues stretching for several kilometres (Calkin et al., 2021; Nettis et al., 2024).

In response to the long-standing traffic congestion problem, which adversely affects transportation efficiency, the government has sought long-term solutions through structural improvements in infrastructure. One of the strategic initiatives undertaken is the construction of the Djuanda Flyover (FO) in Sidoarjo (Anastasiu et al., 2023; Yu et al., 2021). This flyover is being built above a railway crossing that has long been identified as a primary congestion point along the Surabaya–Sidoarjo corridor. The construction of the flyover aims not only to ease traffic flow but also to modernize the surface transport network toward greater efficiency and sustainability (Sadeghi et al., 2023; Salama et al., 2021).

The Djuanda Flyover project is a collaborative effort between local government authorities and the Ministry of Public Works and Housing (PUPR) through the Java-Bali Regional Directorate of National Road Implementation (BBPJN). The local government is responsible for land acquisition, while BBPJN oversees the technical and administrative aspects of the structural construction (Kaewunruen et al., 2022; Li et al., 2024). This project has been included as part of the National Strategic Projects (PSN), as stipulated in Presidential Regulation (Perpres) No. 80 of 2019. Its inclusion in PSN underlines the critical role of the Djuanda Flyover in improving regional connectivity and mobility and supporting major infrastructure in East Java.

Although the project has been part of the PSN since 2019, its construction was delayed due to the Covid-19 pandemic that hit Indonesia and the global community in early 2020. The pandemic led to budget reallocations, changes in national development priorities, and restrictions on fieldwork (Tang et al., 2025; N. Zhang & Alipour, 2021). As a result, effective construction activities only began in late 2022. Officially, the construction of the Djuanda Flyover commenced on November 1, 2022, and is targeted for completion by April 22, 2024, with a total project cost of IDR 332 billion (Cevikbas et al., 2024; Rezvani et al., 2024).

Technically, the Djuanda Flyover spans a total length of 858 meters, consisting of two sections: FO A (Sidoarjo–Juanda) measuring 435 meters and FO B (Juanda–Surabaya) measuring 423 meters. Both sections are designed to accommodate two lanes of traffic, each with a width of 3.5 meters, including road shoulders and protective parapets (Ghazal & Mwafy, 2022; Ji et al., 2022). The total bridge width is 9 meters. The flyover design adheres to principles of spatial efficiency, traffic safety, and load-bearing capacity for heavy vehicles according to national road standards (Alibrandi, 2022; Bianchi et al., 2022).

To support traffic flow and reduce congestion in the area, the project's timely completion is crucial. Accordingly, BBPJN Java-Bali set an ambitious target for the functional feasibility test (*uji laik fungsi*) to be conducted by December 15, 2023, well ahead of the full completion deadline. This acceleration strategy not only demonstrates the government's commitment to public service in infrastructure provision but also presents significant technical and managerial challenges (Alshboul et al., 2023; Kurino et al., 2021).

In project management, accelerating the completion of construction works is not a straightforward endeavour. It requires appropriate methodologies to predict and evaluate the likelihood of project success, particularly within tight timeframes and budget constraints. One of the relevant approaches in this context is the Program Evaluation and Review Technique (PERT) (Ames et al., 2025; M. Chen et al., 2023a). This method relies on probability theory, where time estimates are calculated using three key values: optimistic time, most likely time, and pessimistic time. The PERT approach is especially useful in projects characterized by uncertainty, such as large-scale infrastructure construction involving numerous variables and risks (Fiorillo & Ghosn, 2022; Sasidharan et al., 2022).

By applying PERT, project managers can identify the critical path, calculate the expected average project duration, and assess the likelihood of meeting specific time targets. It also allows for the identification of key activities that determine overall project success, enabling more effective allocation of resources and informed decision-making. This is highly relevant in the case of the Djuanda Flyover project, which is part of the PSN and carries high public expectations for timely completion (Aramesh et al., 2023; Raza et al., 2023; W. Zhang et al., 2025).

Furthermore, infrastructure projects such as flyovers not only have technical and economic dimensions but also bring social and environmental impacts. In urban transportation studies, traffic congestion is frequently associated with increased vehicle emissions, energy waste, reduced productivity, and declining quality of life. Therefore, efforts to mitigate congestion through infrastructure development must consider sustainability, inclusiveness, and equitable access for all social groups (Bhattacharjee & Baker, 2023).

Conceptually, the construction of the Djuanda Flyover can be seen as the state's response to the increasing demand for infrastructure in line with population growth and economic activity. According to the modernization theory of development (Rostow, 1960), infrastructure is a foundational element enabling countries to transition toward the take-off stage of economic development. Without adequate infrastructure, the mobility of people and goods is hindered, thereby disrupting national productivity (Wang et al., 2022).

Nevertheless, accelerated infrastructure projects must be supported by comprehensive risk management. Delays in material procurement, extreme weather conditions, technical issues in the field, and coordination failures among implementing agencies can be significant obstacles. Therefore, probabilistic evaluation using the PERT method is not only relevant but necessary as a basis for data-driven and empirically grounded decision-making (Abdallah et al., 2022).

Previous studies on infrastructure project management in Indonesia have generally emphasized cost overruns, scheduling delays, and generic risk management frameworks. However, there is still limited empirical evidence on how probabilistic models such as PERT can be applied to assess the success probability of accelerated infrastructure projects, particularly those categorized as National Strategic Projects (PSN). This gap highlights the novelty of the present study.

The research problem in this study is based on the need to assess the level of success in accelerating the project timeline. Accordingly, the central question is: "What is the probability of success in accelerating the construction work of the Djuanda Flyover project?" This study not only provides an estimate of the likelihood of completing the project within the designated timeframe but also contributes to the academic field by demonstrating the application of quantitative methods in infrastructure project management in Indonesia.

The objective of this research is to evaluate the probability of successful acceleration of the Djuanda Flyover construction project, using the PERT approach. The findings are expected to offer constructive insights for policymakers, project implementers, and academics in designing realistic and measurable strategies for accelerating infrastructure development.

Through a systematic and data-based approach, this study is expected to contribute practical value in the field of project management while supporting more efficient, effective, and responsive national infrastructure development. Furthermore, the results may serve as a reference for similar projects that require probabilistic analysis to ensure successful acceleration strategies in public infrastructure projects.

Research Methods

Based on the research problem formulation and objectives that have been established, this study employs a mixed-methods approach, combining both quantitative and qualitative methods. The qualitative approach is used to provide a systematic and accurate description of field facts, particularly regarding the observed phenomena related to the implementation of the Flyover (FO) Djuanda construction project in Sidoarjo Regency. The purpose of the qualitative approach is to understand the real context, actual conditions, and the social and technical dynamics accompanying the project acceleration process. Meanwhile, the quantitative approach is employed to develop and test mathematical models, theories, or hypotheses related to the structure of the project acceleration phenomenon (Chih-Pei & Chang, 2017). Through this approach, numerical data is analyzed to produce categories of acceleration levels, time estimates, and resource efficiency.

The combination of these two approaches aims to generate more comprehensive research results. Quantitative data is presented in the form of figures obtained from measurements of project work items and is analyzed to produce optimal project duration estimates. On the other hand, qualitative data is obtained through field observations, interviews, and documentation (Creswell, 2021), which are then analyzed to provide a realistic depiction of the challenges, obstacles, and acceleration strategies applied in the project. By integrating these two approaches, this study is expected to yield a thorough understanding of the acceleration of flyover construction as a solution to traffic congestion on the Surabaya–Sidoarjo route.

This research was conducted in the area of the Flyover (FO) Djuanda construction project, located in Sidoarjo Regency, East Java Province. The project site is a strategic area that connects the main route between Surabaya and Sidoarjo, which frequently experiences traffic congestion. The Djuanda Flyover is designed as an infrastructure solution to alleviate this congestion, making the project's existence and implementation a significant focus of this study. All data collection processes were carried out on-site, including the areas of FO A (from Sidoarjo to Djuanda) and FO B (from Djuanda to Surabaya), with direct observation of the progress and dynamics of construction activities (Creswell, 2021).

The research was carried out during the project implementation period, specifically from the 46th week until the project's completion. This time frame was chosen because it represents a critical phase in the project's acceleration process, during which several key activities were being executed and strategic acceleration decisions were being implemented (Chih-Pei & Chang, 2017). By selecting this period, the researcher was able to obtain the most relevant and up-to-date data, both from technical and managerial perspectives, which are the main focus in assessing the project's time and cost efficiency and effectiveness.

To address the second research problem, this study employs the Project Evaluation and Review Technique (PERT), which is a project analysis method aimed at estimating completion time more accurately by considering various possible durations for each work item. PERT is highly useful in dealing with uncertainties in work duration, as it facilitates more rational decision-making based on three time estimates: optimistic, most likely, and pessimistic. The use of this method is intended to reduce the uncertainty effects in project acceleration planning and to provide more accurate estimates of time and cost in the construction of the Djuanda Flyover.

The implementation flow for addressing the second research problem begins with the distribution of questionnaires to respondents directly involved in the project, particularly during the 46th week when the project entered a crucial stage of task completion. The questionnaire was only administered to respondents from top project management, such as project leaders, division heads, and technical staff with the authority and direct experience in making decisions related to project acceleration. Respondents were selected using a census sampling technique due to the relatively small population, all of whom were considered relevant and competent to provide accurate information (Creswell, 2021).

Questionnaires were filled out based on the respondents' experiences in handling and completing each work item. Respondents were asked to provide time estimates for each task using the three-point estimation approach: pessimistic (longest time), most likely (normal duration), and optimistic (shortest duration).

All questionnaire data were then analyzed using the PERT formula to obtain more accurate time completion estimates. Additionally, the collected information was also used to develop acceleration scenarios and determine the most effective technical policies to achieve the project completion target optimally.

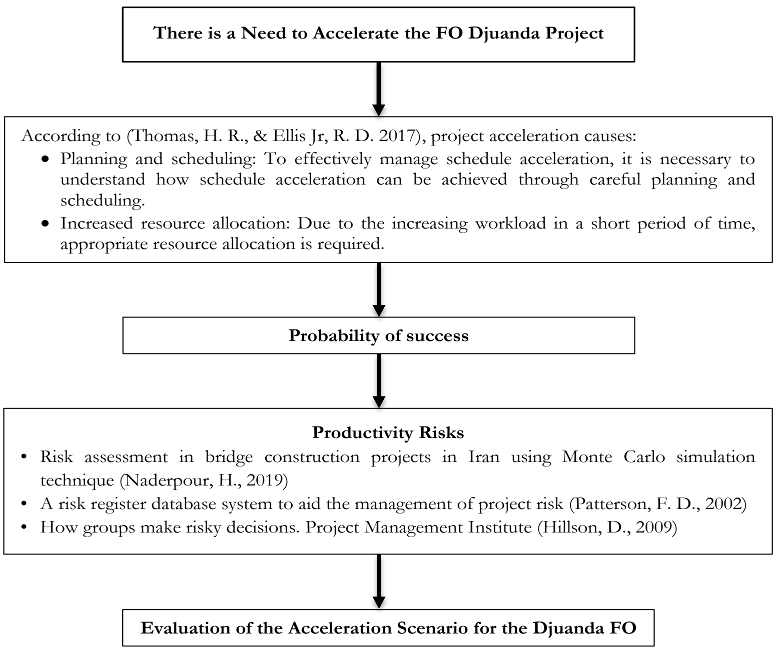


Figure 1. Research Conceptual Framework

Research Results and Discussion

Project Overview

The research focuses on the construction of the Djuanda Flyover at the Aloha Intersection, Waru, Sidoarjo Regency, East Java. The project is owned by the Ministry of Public Works and Public Housing through the East Java–Bali National Road Implementation Agency. It forms part of the government's strategic initiative to reduce traffic congestion, especially along the Surabaya–Sidoarjo route. The contractor, PT Wika–Nindya KSO, is responsible for executing the work under a contract valued at IDR 332,870,053,360.05. Funding is provided by the State Budget (APBN) for the period 2022–2024. The project duration is 540 calendar days, starting on November 1, 2022, with completion scheduled for April 23, 2024.

General Data

The general data for this study were collected through direct field surveys, official documents obtained from the implementing contractor PT Wika–Nindya KSO, and in-depth interviews with key personnel, including the Project Manager and Quantity Surveyor. The data include several essential technical documents for analysis. First, the project schedule, which outlines the overall completion timeline and the duration of each work activity. Second, the Material Take-Off document, detailing the volume of each work item. Third, the S-Curve, which illustrates the relationship between implementation time and accumulated progress from start to finish. Fourth, the detailed Budget Plan (RAB), containing unit prices and work volumes, used to calculate the total project cost based on the 2022 Binamarga standard unit price analysis.

In addition, optimistic and pessimistic time estimates were gathered through questionnaires distributed to experts involved in the project acceleration planning. Risk details were identified to determine potential obstacles to acceleration, while mitigation data were compiled to outline strategic steps for ensuring the flyover's completion effectively and efficiently.

Project Duration Calculation

Preparing a network diagram is the first step in applying time–cost trade-off analysis. This process involves identifying activity relationships and durations based on the project schedule. The review in this study refers to Addendum 03. The project completion time is determined by factors such as work volume, labor and equipment productivity, project location, and resource availability.

Interviews with the team leader, combined with an assessment of early-stage acceleration progress (+22.93% deviation in week 46) and the remaining physical work on-site, indicate that the work originally planned for full completion by April 23, 2024, is now aligned with the timing of the feasibility test.

The PERT Method

The Program Evaluation and Review Technique (PERT) is used to estimate project completion time while accounting for uncertainty in activity durations. Each activity is represented by three-time estimates: optimistic, most likely, and pessimistic. The range between these values reflects uncertainty, which can be quantified through variance and standard deviation. Due to the large number of overlapping activities, PERT calculations in this study were carried out using Excel and Microsoft Project.

Table 1. PERT Calculation

No	Description	Pessimistic	Most-Likely	Optimistic	Expected Duration	Standard Deviation	Activity Variance
			DIVISION 2 – DRAINAGE				
1	Excavation for Drainage Ditch	10.00	8.00	4.00	7.67	1.00	1.00

No	Description	Pessimistic	Most-Likely	Optimistic	Expected Duration	Standard Deviation	Activity Variance
	and Water Channel						
2	Reinforced Concrete Pipe Culvert, Internal Diameter 40 cm	4.00	2.00	1.00	2.17	0.50	0.25
3	Reinforced Concrete Pipe Culvert, Internal Diameter 40 cm	12.00	10.00	5.00	9.50	1.17	1.36
4	Reinforced Concrete Pipe Culvert, Internal Diameter 60 cm	2.00	1.00	1.00	1.17	0.17	0.03
5	Reinforced Concrete Box Culvert, Internal Size 100 cm × 100 cm	2.00	1.00	1.00	1.17	0.17	0.03
6	Reinforced Concrete Box Culvert, Internal Size 150 cm × 100 cm	2.00	1.00	1.00	1.17	0.17	0.03
7	Reinforced Concrete Box Culvert, Internal Size 200 cm × 100 cm	12.00	10.00	5.00	9.50	1.17	1.36
8	Custom-Shaped Channel Type DS 4a (with cover)	16.00	14.00	6.00	13.00	1.67	2.78
9	Custom-Shaped Channel Type DS 5	8.00	5.00	2.00	5.00	1.00	1.00
10	Custom-Shaped Channel Type DS 6a (with cover)	2.00	1.00	1.00	1.17	0.17	0.03
11	Porous Material for Filtering (Filter)	2.00	1.00	1.00	1.17	0.17	0.03
12	Perforated Pipe for Underground Drainage Works, Dia 4 inch	16.00	14.00	6.00	13.00	1.67	2.78
13	Channel Normalization	16.00	14.00	6.00	13.00	1.67	2.78
	DIVISION 3 – EARTHWORK AND GEOSYNTHETICS						

No	Description	Pessimistic	Most-Likely	Optimistic	Expected Duration	Standard Deviation	Activity Variance
14	Common Excavation	14.00	7.00				
15	Structural Excavation, Depth 0–2 meters	3.00	2.00	3.00	7.50	1.83	3.36
16	Asphalt Pavement Excavation without Cold Milling Machine	8.00	5.00	1.00	2.00	0.33	0.11
17	Common Fill from Excavated Source	15.00	8.00	2.00	5.00	1.00	1.00
18	Granular Backfill	4.00	2.00	4.00	8.50	1.83	3.36
19	Roadbed Preparation	8.00	4.00	1.00	2.17	0.50	0.25
20	Cutting Selected Trees, Diameter 15–30 cm	5.00	3.00	2.00	4.33	1.00	1.00
21	Geotextile Filter for Underground Drainage (Class 2)	10.00	5.00	2.00	3.17	0.50	0.25
22	Geotextile Stabilizer (Class 1)	2.00	1.00	2.00	5.33	1.33	1.78
	DIVISION 5 – GRANULAR AND CEMENT CONCRETE PAVEMENT						
23	Drainage Layer	13.00	10.00				
24	Cement Concrete Pavement	16.00	14.00				
25	Lean Concrete Base Layer	10.00	7.00	4.00	9.50	1.50	2.25
	DIVISION 6 – ASPHALT PAVEMENT						
26	Prime Coat – Liquid Asphalt/Emulsion	12.00	10.00	3.00	6.83	1.17	1.36
27	Asphalt Concrete – Wearing Course (AC-WC)	12.00	10.00				
	DIVISION 7 – STRUCTURES						
28	Structural Concrete fc’=35 MPa Pier Head	3.00	1.00	4.00	9.33	1.33	1.78
29	Structural Concrete fc’=30 MPa Slab, Diaphragm, Parapet Side	15.00	10.00	4.00	9.33	1.33	1.78
30	Structural Concrete fc’=30 MPa Abutment,	15.00	12.00				

No	Description	Pessimistic	Most-Likely	Optimistic	Expected Duration	Standard Deviation	Activity Variance
31	Pier Cap, Retaining Wall Structural Concrete fc'=20 MPa	28.00	24.00				
32	Concrete fc'=10 MPa	17.00	14.00	1.00	1.33	0.33	0.11
33	Reinforcing Steel BjTS 420 B	25.00	22.00	6.00	10.17	1.50	2.25
34	Structural Steel Grade 355 (Yield Strength 355 MPa)	16.00	14.00	5.00	11.33	1.67	2.78
35	Structural Steel Installation	25.00	22.00	10.00	22.33	3.00	9.00
36	Bored Pile Foundation, Supply and Installation	28.00	21.00	6.00	13.17	1.83	3.36
37	Dry Stone Masonry	25.00	20.00	9.00	20.33	2.67	7.11
38	Asphaltic Plug Joint, Fixed Type	5.00	4.00	6.00	13.00	1.67	2.78
39	Asphaltic Plug Joint, Movable Type	5.00	4.00	8.00	20.17	2.83	8.03
40	Elastomeric Bearing Pad with Steel Plate, Size 600×600×110 mm	7.00	5.00	8.00	20.00	3.33	11.11
41	Elastomeric Bearing Pad with Steel Plate, Size 250×250×35 mm	7.00	5.00	9.00	19.00	2.67	7.11
42	Bridge Name Plate	2.00	1.00	2.00	3.83	0.50	0.25
43	Demolition of Stone Masonry	14.00	10.00	2.00	3.83	0.50	0.25
44	Concrete Demolition	20.00	14.00	2.00	4.83	0.83	0.69
45	Deck Drain	7.00	5.00	2.00	4.83	0.83	0.69
46	PVC Drainage Pipe Diameter 150 mm	10.00	7.00	1.00	1.17	0.17	0.03
47	PVC Drainage Pipe Diameter 200 mm	11.00	7.00	5.00	9.83	1.50	2.25

No	Description	Pessimistic	Most-Likely	Optimistic	Expected Duration	Standard Deviation	Activity Variance
48	PVC Drainage Pipe Diameter 200 mm	9.00	7.00	6.00	13.67	2.33	5.44
49	Procurement and Installation of Corrugated Plate	13.00	10.00	2.00	4.83	0.83	0.69
50	Bridge Load Testing for Functionality	7.00	7.00	3.00	6.83	1.17	1.36

Based on the Table 1, the estimated time for completing various construction activities in the Flyover Djuanda project was analyzed using the PERT method. Each work item is assessed based on three duration scenarios: pessimistic (Tp), most likely (Tm), and optimistic (To). From these values, the expected duration (Te) is calculated using the formula:

$$\frac{To+4Tm+Tp}{6} \ldots (1)$$

in addition, the standard deviation (S) and variance (Vte) are calculated using the formulas:

$$\frac{To-Tp}{6} \ldots (2)$$

In Division 2: Drainage, tasks such as water channel excavation, pipe and box culvert installation, and channel normalization show varying durations. For example, water channel excavation has an expected duration of 7.67 days with a standard deviation of 1.00. In contrast, installing 60 cm and 100 cm culverts requires only about 1.17 days with a low deviation (0.17), indicating high certainty.

Division 3: Earthwork and Geosynthetics includes general excavation, structural excavation, backfilling, and geotextile installation. High-uncertainty tasks, such as granular backfilling, may take up to 8.50 days with a variance of 3.36, while more predictable activities, like roadbed preparation, have a duration of 2.17 days with low variance.

In Division 5: Granular and Cement Concrete Pavement, activities include drainage layers and lean concrete sub-base. The lean concrete sub-base, for instance, has an expected duration of 9.50 days with a standard deviation of 1.50 and a variance of 2.25, showing a relatively wide execution time range that requires anticipation in planning.

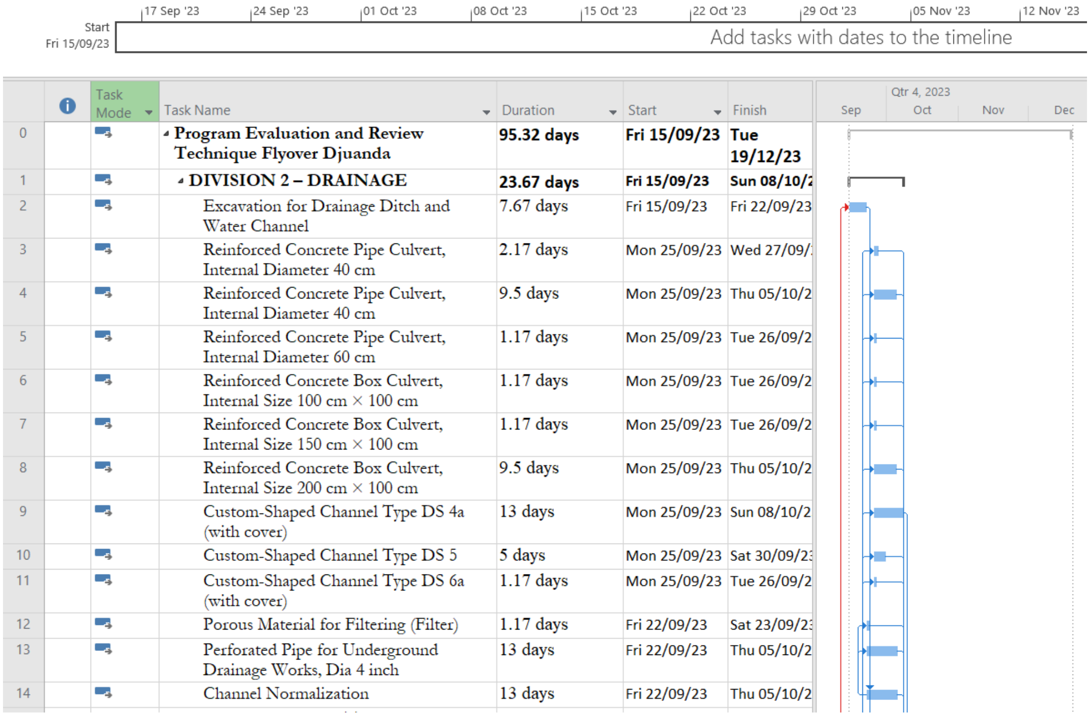
Division 6: Asphalt Pavement covers tasks such as applying liquid/emulsion asphalt and asphalt concrete (laston) layers. Asphalt application has an expected duration of 6.83 days with a standard deviation of 1.17 and a variance of 1.36.

Division 7: Structural Works involves structural concrete, steel installation, foundation works, and bridge joints. Some activities, such as structural steel installation, have a deviation of 3.00 and a variance of 9.00, reflecting high time sensitivity and the need for careful management.

Other tasks such as PVC drainage pipe installation of various diameters, corrugated plate assembly, and bridge load testing have durations that vary based on complexity and field conditions. For example, installing a 200 mm PVC pipe may take up to 13.67 days with a variance of 5.44, indicating significant uncertainty that could affect the project schedule.

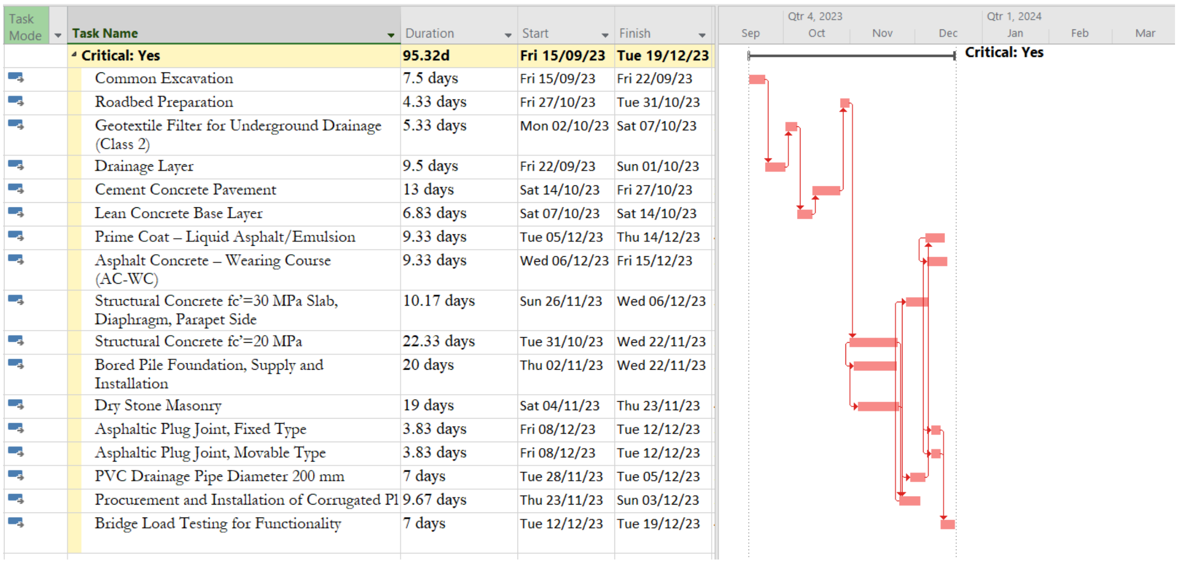
Overall, this analysis helps project management identify activities most at risk of delays and supports decisions on scheduling, resource allocation, and project control to ensure timely completion.

Due to the large number of overlapping tasks with multiple predecessors, critical time calculations under PERT conditions were conducted using Microsoft Project. By inputting the expected time (Te) for each task, the software automatically determines the critical path based on task dependencies and estimated durations. This provides a clear view of which tasks most affect the overall completion time and the causes of potential delays. Moreover, Microsoft Project enables efficient resource management by considering resource limitations. Understanding both the critical path and optimal resource allocation allows the team to address overlapping tasks effectively and keep the project on schedule.



	Task Mode	Task Name	Duration	Start	Finish
0		Program Evaluation and Review Technique Flyover Djuanda	95.32 days	Fri 15/09/23	Tue 19/12/23
1		DIVISION 2 – DRAINAGE	23.67 days	Fri 15/09/23	Sun 08/10/2
2		Excavation for Drainage Ditch and Water Channel	7.67 days	Fri 15/09/23	Fri 22/09/23
3		Reinforced Concrete Pipe Culvert, Internal Diameter 40 cm	2.17 days	Mon 25/09/23	Wed 27/09/
4		Reinforced Concrete Pipe Culvert, Internal Diameter 40 cm	9.5 days	Mon 25/09/23	Thu 05/10/2
5		Reinforced Concrete Pipe Culvert, Internal Diameter 60 cm	1.17 days	Mon 25/09/23	Tue 26/09/2
6		Reinforced Concrete Box Culvert, Internal Size 100 cm × 100 cm	1.17 days	Mon 25/09/23	Tue 26/09/2
7		Reinforced Concrete Box Culvert, Internal Size 150 cm × 100 cm	1.17 days	Mon 25/09/23	Tue 26/09/2
8		Reinforced Concrete Box Culvert, Internal Size 200 cm × 100 cm	9.5 days	Mon 25/09/23	Thu 05/10/2
9		Custom-Shaped Channel Type DS 4a (with cover)	13 days	Mon 25/09/23	Sun 08/10/2
10		Custom-Shaped Channel Type DS 5	5 days	Mon 25/09/23	Sat 30/09/2
11		Custom-Shaped Channel Type DS 6a (with cover)	1.17 days	Mon 25/09/23	Tue 26/09/2
12		Porous Material for Filtering (Filter)	1.17 days	Fri 22/09/23	Sat 23/09/2
13		Perforated Pipe for Underground Drainage Works, Dia 4 inch	13 days	Fri 22/09/23	Thu 05/10/2
14		Channel Normalization	13 days	Fri 22/09/23	Thu 05/10/2

Figure 1. Duration of Ms. Project PERT



Task Mode	Task Name	Duration	Start	Finish
	Critical: Yes	95.32d	Fri 15/09/23	Tue 19/12/23
	Common Excavation	7.5 days	Fri 15/09/23	Fri 22/09/23
	Roadbed Preparation	4.33 days	Fri 27/10/23	Tue 31/10/23
	Geotextile Filter for Underground Drainage (Class 2)	5.33 days	Mon 02/10/23	Sat 07/10/23
	Drainage Layer	9.5 days	Fri 22/09/23	Sun 01/10/23
	Cement Concrete Pavement	13 days	Sat 14/10/23	Fri 27/10/23
	Lean Concrete Base Layer	6.83 days	Sat 07/10/23	Sat 14/10/23
	Prime Coat – Liquid Asphalt/Emulsion	9.33 days	Tue 05/12/23	Thu 14/12/23
	Asphalt Concrete – Wearing Course (AC-WC)	9.33 days	Wed 06/12/23	Fri 15/12/23
	Structural Concrete fc'=30 MPa Slab, Diaphragm, Parapet Side	10.17 days	Sun 26/11/23	Wed 06/12/23
	Structural Concrete fc'=20 MPa	22.33 days	Tue 31/10/23	Wed 22/11/23
	Bored Pile Foundation, Supply and Installation	20 days	Thu 02/11/23	Wed 22/11/23
	Dry Stone Masonry	19 days	Sat 04/11/23	Thu 23/11/23
	Asphaltic Plug Joint, Fixed Type	3.83 days	Fri 08/12/23	Tue 12/12/23
	Asphaltic Plug Joint, Movable Type	3.83 days	Fri 08/12/23	Tue 12/12/23
	PVC Drainage Pipe Diameter 200 mm	7 days	Tue 28/11/23	Tue 05/12/23
	Procurement and Installation of Corrugated Pl	9.67 days	Thu 23/11/23	Sun 03/12/23
	Bridge Load Testing for Functionality	7 days	Tue 12/12/23	Tue 19/12/23

Figure 2. Critical Activities of FO Djuanda's Work

Based on Figures 1 and 2, and the output from Microsoft Project, the expected completion time (Te) for all activities on the critical path is 95.32 days, while the total variance (∑V_te) for each critical activity is 49.61. To calculate the probability of success for the FO Djuanda construction project, the steps are as follows:

$$S_{cr} = \sqrt{\sum V_{te} on\ the\ critical\ path} = \sqrt{49.61} = 7.04 \ldots (3)$$

$$Z(98) = Z\left(\frac{T_d - T_e}{S_{cr}}\right) = Z\left(\frac{98 - 95.32}{7.04}\right) = 0.48 \ldots (4)$$

Referring to the Z-table in Appendix X, the probability for Z = 0.38 is 0.648, or 64.8%. This indicates a relatively high possibility of failure; what can be achieved in this project may not be replicable in other projects, meaning that a probability of 64.8% does not provide strong certainty.

From these results, it appears that the success rate of the FO Djuranda project acceleration has exceeded the threshold for failure. However, to implement the acceleration plan with greater confidence, the confidence level should reach at least within the 90% to 95% interval, which can be achieved through robust statistical validation, increased sample reliability, and cross-verification of findings. Recent studies also highlight that adopting stricter confidence thresholds improves the accuracy and credibility of policy recommendations (e.g., M. Chen et al., 2023). This is essential to give stakeholders the assurance to make decisions without hesitation and ensure that the project acceleration can be executed according to target.

According to statistical concepts, a 95% confidence level with $\alpha = 0.05$ means there is a 95% chance of being correct and a 5% risk of error. In the context of the FO Djuranda development project, although the current probability of success is 64.8%, reaching a higher level of confidence at 95% would require additional acceleration strategies and a more thorough risk evaluation. These steps will help ensure that the project can be completed on target with a higher level of certainty.

Steps to Increase PERT Probability

To enhance the probability of success in the PERT (Program Evaluation and Review Technique) method to above 90–95%, a number of strategic and targeted actions must be taken. First, time estimation accuracy is crucial. Accurate time estimates increase the reliability of PERT analysis results and reduce the risk of errors in project scheduling. Therefore, input from experts with relevant field experience and knowledge is essential. With valid and accountable data, their contributions can reduce uncertainty and improve confidence in the calculation outcomes.

Second, it is important to identify and focus on the project's critical path. The critical path consists of the sequence of activities that determines the overall project duration. By prioritizing acceleration of activities on the critical path, the likelihood of shortening the total project completion time becomes significantly higher.

Third, resource optimization is equally important. The project must ensure that sufficient resources are available and allocated efficiently, particularly for critical path activities. In some cases, this may require rescheduling, adding manpower, or increasing the capacity of tools and materials used. When these three steps are implemented systematically, the probability of success in PERT implementation will increase significantly.

Conclusion

Based on the findings of the study titled "Evaluation of Scheduling and Acceleration Risks in the Djuanda Flyover Construction Project," which employed a mixed-method approach combining both quantitative and qualitative research methods, four main conclusions were formulated to address the research problems and objectives.

First, the analysis results indicate that the probability of successfully accelerating the completion of the Djuanda Flyover construction project by 29 days using the PERT method is

64.8%. This figure reflects a moderate likelihood of achieving the acceleration target, but it also suggests the presence of uncertainties that must be strategically anticipated.

Second, to mitigate potential risks arising from the acceleration of project implementation, this study recommends several mitigation measures categorized into three main aspects. In terms of direct costs, the suggested actions include providing alternative and more competitive resource options, preparing contingency budgets, and ensuring more structured cash flow management. Regarding the work calendar schedule aspect, it is necessary to develop realistic and adaptive timelines, enhance collaboration among project teams, and manage various time constraints that may arise. Lastly, in the logistical aspect, the study recommends selecting reliable and suitable vendors, determining optimal delivery routes to expedite material distribution, and managing inventory efficiently to prevent disruptions in fieldwork execution.

In conclusion, these findings offer a clear, data-driven direction for project managers in formulating acceleration strategies that not only prioritize timely completion but also take into account actual field risks and how their mitigation efforts can be designed in a measurable and effective manner.

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