The Effect of the Number of Work Shifts for Erection Box Girder Using Launching Gantry on the Cost and Implementation Time in the Medan-Binjai II Railway Line Project

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Abstract

Resource management strategies in the construction sector play a vital role in achieving cost efficiency and accelerating project execution time. One applicable form of resource management is the implementation of shift work management. In the context of a railway overpass construction project utilizing the erection box girder method with a Launching Gantry and experiencing delays, the configuration of shift schedules becomes a critical variable due to its direct impact on operational costs and project duration. This study was conducted by developing a work schedule for the erection of box girders using Microsoft Project software for two shift work scenarios: a single-shift system and a two-shift system. Subsequent analysis was carried out to evaluate the project duration and calculate the implementation costs for each shift alternative.The analysis results indicate that the implementation of a two-shift work system has a significant impact on time efficiency and cost control. By adopting a two-shift system, the project duration can be accelerated by up to 48 days compared to a single-shift system. In terms of cost, the two-shift system is also able to reduce total project implementation costs by approximately 3.5% compared to the single-shift alternative.

Keywords: Shift Work, Erection Box Girder, Launching Gantry, Time, Cost.

INTRODUCTION

Resource management in construction projects is one of the determining factors for the successful completion of projects on time and at an efficient cost. In the context of large-scale infrastructure projects, human resource and equipment management strategies must be carried out systematically to achieve a balance between accelerating implementation time and operational cost efficiency (Castollani et al., 2020; Massie et al., 2022; Maulidyah et al., 2022). One strategy that is often used is the implementation of shift management. The implementation of different numbers of work shifts can affect the duration of project completion and the total costs incurred. The implementation of a single shift tends to reduce labor and operational costs, but has the potential to prolong the project completion time. Conversely, the implementation of two shifts can accelerate the construction process, but risks significantly increasing operational costs (Akbar & Mulyati, 2024; Puspitasari et al., 2022; Suseno & others, 2021).

In railway construction projects that use the box girder erection method with a launching gantry, shift management is a critical aspect because it directly affects girder installation productivity, implementation costs, and the risk of delays that can result in penalty fees. Therefore, a comprehensive study is needed to assess the optimal number of work shifts to achieve a balance between time, cost, and productivity (Kosim & Supartono, 2020; Provanda et al., 2024; Rizqa et al., 2021). Previous studies have discussed the importance of time and cost management in construction projects. According to several studies, the application of project scheduling network analysis can help identify critical paths and calculate

implementation durations more accurately. Several researchers have also examined project acceleration strategies through the addition of working hours or shifts, which have been proven to increase labor productivity and reduce implementation duration.

Ongkosurya & Supartono (2019) compared the methods of erection box girder using a crane and a launcher, and found that the use of a launcher was more efficient with a significant cost difference and time efficiency of around 32%. Similar research by (A Nur Sayyida, 2024) shows that the crawler crane method is faster and cheaper than the gantry launcher, despite differences in perception among field respondents. Meanwhile, (Maulidyah et al., 2022) reviewed the use of the crashing method with a labor shift system in building construction and found that the implementation of additional shifts can reduce delays with a measurable increase in costs.

In addition, previous studies emphasize that the decision to add shifts is not only related to accelerating work, but also has an impact on increasing direct costs such as overtime wages and heavy equipment operating costs. Several studies on bridge and toll road projects show that calculations between acceleration costs and the risk of delay costs are still often done conventionally, without in-depth quantitative analysis. In projects that use special heavy equipment such as launching gantries, studies highlighting the relationship between the number of work shifts, operational costs, and the risk of penalties due to delays are still very limited (Aisiyah, 2020; Langit & Chandra, 2025).

From the literature review, it can be identified that previous studies generally focused on project acceleration and general cost estimation, but not many focused on quantitative analysis of cost and duration comparisons based on variations in the number of work shifts in box girder erection projects with launching gantries. In fact, this implementation method has specific characteristics that distinguish it from other construction projects, so that the results of previous studies cannot be directly applied (Asri et al., 2024; Sakinah & Mulyati, 2025; Yunus et al., 2024).

Based on this gap analysis, this study aims to analyze the effect of the number of work shifts on the duration of box girder erection using a launching gantry, compare the differences in operational costs for various numbers of work shifts to determine the most efficient alternative, and assess the optimal number of work shifts by considering the balance between project costs and duration. This study on the effect of the number of work shifts on box girder erection using a launching gantry is expected to contribute to the development of construction project management literature, particularly in the aspect of managing work shifts in box girder erection work. In addition, the results of this study are also expected to be useful in practical terms for contractors and project managers in determining more efficient and effective implementation strategies.

METHODS

This study uses a quantitative approach with a correlational study method that aims to analyze the effect of the number of work shifts on the duration of box girder installation, operational costs, and project implementation efficiency. The quantitative method was chosen because this study focuses on numerical measurements, duration calculations, and costs based on shift variations, so that the analysis results can be interpreted objectively.

Research Location and Object

This research was conducted on the Medan–Binjai II Railway Line Project (JLKAMB II) located in North Sumatra Province, focusing on box girder erection work using the launching gantry method.

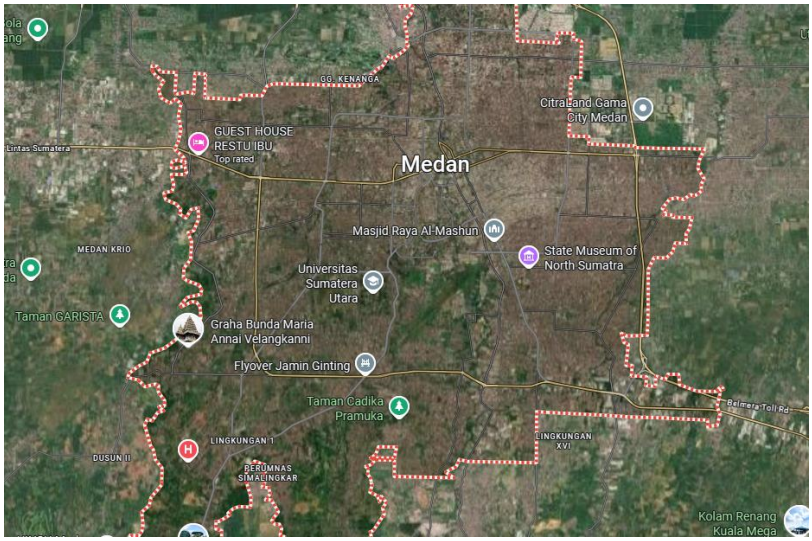

Figure 1. Location of the Medan–Binjai II Railway Line Project (Personal Data, 2025)

This location was chosen because the large-scale project faced delays in implementation, making it relevant to analyze the effect of the number of work shifts on costs and implementation time.

Figure 2. Location of Erection Work Package (Personal Data, 2025)

Types and Sources of Data

The data used in this study consists of :

1. Primary data, in the form of technical field information related to the duration of box girder erection, resource requirements, and implementation costs. This data was obtained through direct observation, interviews with project technical personnel, and collection of internal contractor documents.
2. Secondary data, in the form of project planning documents such as time schedules, budget plans (RAB), and work progress reports. Secondary data was used to supplement and validate the primary data for a more comprehensive analysis.

Data Collection Methods

Data collection was carried out using several techniques, namely :

1. Document study, to obtain technical project data, time schedules, and implementation costs from contractors.
2. Field observation, to record the box girder erection cycle in actual conditions and ensure the conformity of planning data with implementation.

3. Semi-structured interviews with field technical personnel (engineers and launching gantry operators) to confirm work productivity and factors affecting the duration of erection.

Sample Criteria

The unit of analysis in this study is the erection of box girders on a single span. The research sample was determined based on spans that experienced delays and schedule adjustments were made by varying the number of work shifts. The selection of these spans was based on the following criteria :

1. Complete erection technical data.
2. Representative of actual field conditions.
3. Use of the launching gantry installation method.

Table 1. Launching Gantry Technical Specifications (Personal Data, 2025)

Num.	Specification	Value
1	Bridge span length	40m, 35m, 30m, 25m
2	Max segment weight	66 tonnes
3	Max span total weight suspended from the gantry	725 tonnes @40m span
4	Max lift height from the ground to the deck level	15 m
5	Min. radius	R335 m (40 m span) Straight (35 m span) R166 m (30 dan 25 m span)
6	Max longitudinal bridge gradient	±1%
7	Max deck cross fall	±2%
8	Allowable wind pressure (launching)	0,25 kPa
9	Allowable wind pressure (erection)	0,40 kPa
10	Operating air shade temperature range	-
11	All electrical components	-
12	Max humidity	95%
13	Segment delivery	behind or bottom
14	FEM classification	A3-M4
15	Power supply	generator

Data Analysis

The analysis stages were carried out systematically through the following steps:

1. Preparation of network planning to identify critical activities in the box girder erection work.
2. Simulation of work shift scenarios, namely scenario 1 shift (long shift) and scenario 2 shift (double shift) in Microsoft Project.
3. Calculation of implementation duration, by comparing the estimated completion times for erection in both scenarios.
4. Analysis of implementation costs, which includes direct costs (labor, gantry launching operations) and indirect costs (overhead and potential late penalties).
5. Comparison of results, by analyzing the differences in time and costs between scenarios to determine the most optimal number of work shifts.

Method Justification

The selection of a simulation-based quantitative method using Microsoft Project was based on the research need to produce measurable analyses related to time and cost. The case study on the JLKAMB II project was chosen due to the availability of complete data relevant to the research objectives. Meanwhile, the use of 1-shift and 2-shift scenarios is a common strategy in construction management to optimize productivity without sacrificing cost efficiency.

RESULTS AND DISCUSSION

Project Duration in Work Shift Scenarios

Duration analysis shows significant differences between the implementation of 1 shift and 2 shifts. Under normal conditions with 1 shift (8 hours per day), the installation duration for one span of box girder reached 7 days. Meanwhile, the implementation of 2 shifts (16 hours per day) was able to cut the installation time to only 4 days per span.

Table 2. Comparison of Work Shift Duration (Personal Data, 2025)

NO.	Job Description	Duration (hour)	Effective Working Hours Per Day	
			Actual	Accelerated
1	Launching Work	12	Effective Work 8 Hour (1 *Shift*)	Effective Work 16 Hour (2 *Shift*)
2	Box Girder Lifting Work	13		
3	Segment Compaction Work	11		
4	Strand Installation Work	6		
	Stressing Work	7		
5	Load Transfer Work	7		
Total Duration (hours)		**56**	**6 Days**	**4 Days**

Overall, the total project duration was reduced from 344 days on 1 shift to 296 days on 2 shifts.

P35-P36 (30m)	5 days	Sat 20/01/24	Wed 24/01/24	17
P36-P37 (30m)	4 days	Wed 24/01/24	Sat 27/01/24	18
P37-P38 (30m)	5 days	Sun 28/01/24	Thu 01/02/24	19
PAKET 4	**215 days**	**Fri 02/02/24**	**Tue 03/09/24**	
P38-P39 (40m)	14 days	Fri 02/02/24	Thu 15/02/24	20
P39-P40 (30m)	6 days	Thu 15/02/24	Tue 20/02/24	22
P40-P41 (40m)	7 days	Wed 21/02/24	Tue 27/02/24	23
P41-P42 (40m)	6 days	Wed 28/02/24	Mon 04/03/24	24
P42-P43 (40m)	7 days	Thu 02/05/24	Wed 08/05/24	25
P43-P44 (40m)	7 days	Thu 09/05/24	Wed 15/05/24	26
P44-P45 (40m)	7 days	Thu 16/05/24	Wed 22/05/24	27
P45-P46 (40m)	7 days	Thu 23/05/24	Wed 29/05/24	28
P46-P47 (30m)	7 days	Thu 30/05/24	Wed 05/06/24	29
P47-P48 (30m)	7 days	Thu 04/07/24	Wed 10/07/24	30
P48-P49 (30m)	7 days	Thu 11/07/24	Wed 17/07/24	31
P49-P50 (30m)	30 days	Thu 18/07/24	Fri 16/08/24	32
Dismantling & Demob	17 days	Sun 18/08/24	Tue 03/09/24	33

Figure 3a. Comparison of Erection Work Schedule between Plan and Actual (Personal Data, 2025)

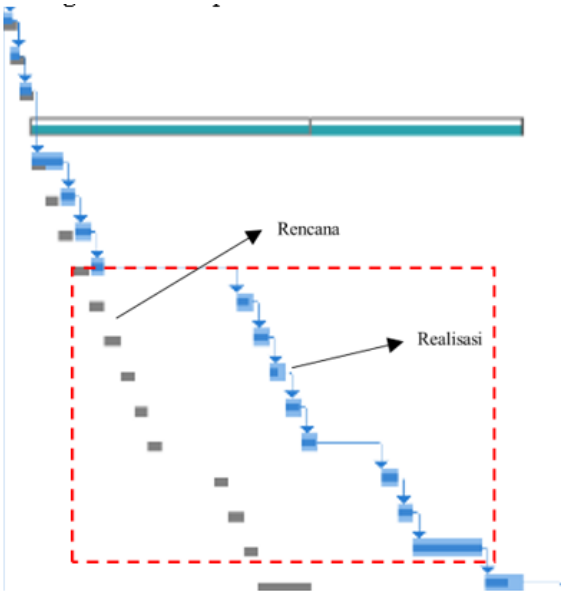

Figure 3b. Graphic of Comparison Erection Work Schedule between Plan and Actual (Personal Data, 2025)

Comparison of Erection Duration

The duration of box girder erection work for each project package was analyzed based on the initial plan, the implementation of 1 shift, and the implementation of 2 shifts. Details of the comparison of the calculation results are presented in Table 4.10. The table shows that the total duration of work under the plan is 251 days, increasing to 344 days in the 1-shift scenario, and decreasing to 296 days in the 2-shift scenario.

Table 3. Comparison of Box Girder Erection Duration (Personal Data, 2025)

Num.	Package	Duration (Days)		
		Plan	1 *Shift*	2 *Shift*
1	Assembly LG	30	30	30
2	Package 3	100	99	99
3	Package 4	121	215	167
4	Package 2	121	107	107
	Total	**251**	**344**	**296**

To provide a clearer visual representation of the differences in duration between scenarios, a comparison of the analysis results is shown in Figure 4.25. The graph clearly shows that implementing two shifts can accelerate the project duration compared to one shift, even though both are longer than the initial plan.

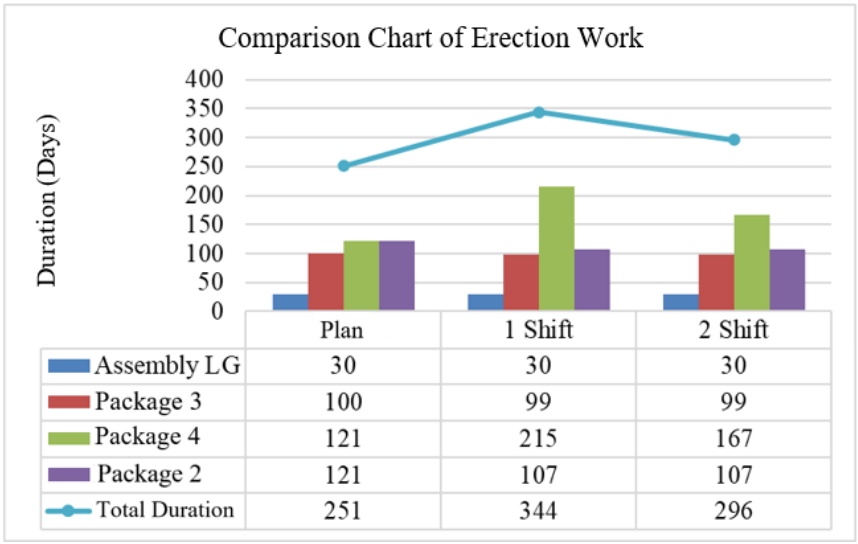

Figure 4. Comparison Chart of Erection Work Duration (Personal Data, 2025)

Comparison of Operational Costs Between Shifts

The cost analysis indicates that implementing two work shifts provides a more economical outcome compared to a single-shift system. Based on the calculation of production cost, the total cost for the 1-shift scenario reaches IDR 38.650 billion, whereas the cost decreases to IDR 37.366 billion when using the 2-shift system. This reduction occurs due to accelerated work progress, which lowers indirect costs and optimizes resource utilization.

When overhead and profit are included, the values represented in the chart (orange bars) illustrate the relationship between operational cost components for each scenario. Meanwhile, the total project cost accounting for a 5% penalty for potential delays shows that the 1-shift scenario increases to IDR 40.678 billion, while the 2-shift scenario reaches only IDR 39.191 billion. This result highlights that the two-shift implementation significantly reduces the risk of additional costs caused by project delays. Overall, considering production cost, overhead & profit, and delay-related risk, the use of a two-shift system provides a more economical and advantageous outcome compared to a single-shift system.

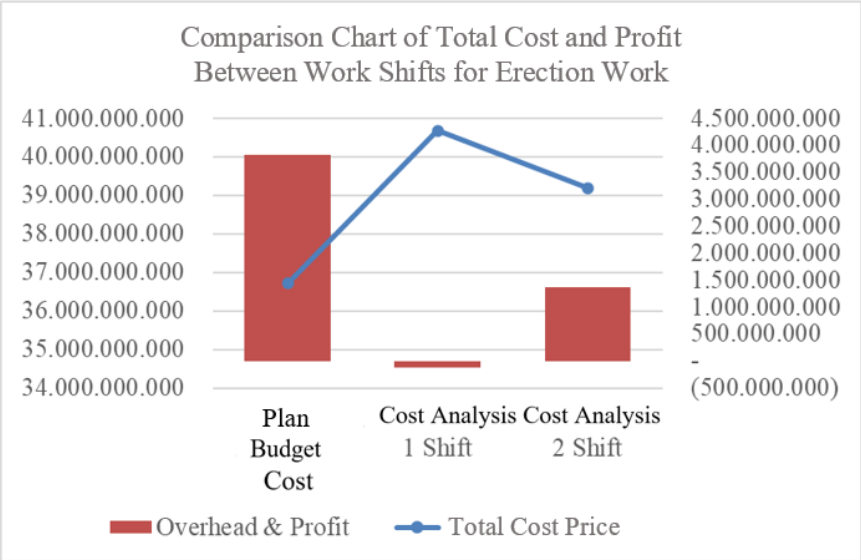

Figure 5. Comparison Chart of Total Costs and Profits Between Work Shifts for Erection Work (Personal Data, 2025)

Time and Total Cost Efficiency

The comparison results show that implementing two shifts not only shortens the project duration by approximately 48 days, but also reduces the total cost. This indicates that despite the additional operational costs incurred by working two shifts, the savings from reduced indirect costs and late penalties result in higher efficiency.

The Effect of Work Shifts on Productivity

The results of the study show that increasing the number of work shifts significantly improves the productivity of box girder installation. With two shifts, the number of effective working hours doubles, so that the speed of completion of each span also increases by almost 40%. This shows that the shift arrangement strategy plays an important role in controlling the critical path of the project.

Table 4. Results of the Analysis of the Effect of Work Shifts (Personal Data, 2025)

Description	Unit	Plan	Analysis Results	
			1 Shift	2 Shift
Total Project Duration	Days	251	344	296
Total Cost	Months	8,4 ≈ 9	11,5 ≈ 12	9,8 ≈ 10
With Late Penalty	Rp	36.723.970.000	40.677.614.900	39.190.956.660
Without Late Penalty		36.723.970.000	38.649.782.500	37.365.907.500
Erection Duration Per Span	Days	7	7	4

Project Time and Cost Acceleration Analysis

Although the implementation of 2 shifts increases daily operating costs, the analysis results show that the total project cost is actually lower than the 1-shift scenario. This is due to the acceleration of the project duration, which reduces potential indirect costs and late penalties. These findings confirm that accelerating work through shift management can be a more efficient solution than relying solely on increasing manpower or additional equipment.

Table 5. Analysis of 2-Shift Costs (Private Data, 2025)

Job Description	Unit	Cost Analysis for 2 Shifts			
		Coeff.	Vol.	Unit Price	Total
Salary & Meal Allowance for Hyap Crane Operator	Hour	128,05	5250	85.000	446.250.000
Solar Crane Hyap Crane	ltr	512,20	21000	19.000	399.000.000
Local Mobile Crane 180 tons	Times	0,10	4	23.500.000	94.000.000

LG Daily Worker	OH	11,71	480	100.000	48.000.000
Expert Labor for Erection Box Girder by LG	Span	1,00	41	320.000.000	13.120.000.000
Expert Consultant for Launching Gantry	Equip.	0,05	2	117.000.000	234.000.000
Pass Trough by LG	Span	0,10	4	41.500.000	166.000.000
Lowbed	Month	0,07	3	52.000.000	156.000.000
Local LG Crane	Times	0,02	1	90.000.000	90.000.000
Other Costs	**Ls**		**1**		**2.027.832.400**
Late Penalty (Max 5% of Project Cost)		0,05	0,05	40.556.648.000	2.027.832.400
Total Production Cost					**40.677.614.900**
					-
Overhead & Profit					**120.966.900**
Grand Total					**40.556.648.000**

Managerial Implications for Project Management

For project managers, the results of this study provide empirical evidence that implementing two shifts can be an optimal strategy for large-scale projects using specialized equipment such as launching gantries. Thus, managerial decisions regarding the number of shifts should consider not only direct costs, but also the risk of indirect costs and penalties due to delays.

CONCLUSION

This study concludes that the number of work shifts has a significant effect on the duration and cost of erecting box girders using a launching gantry in railroad crossing projects. Implementing 1 shift requires 344 days, while 2 shifts only require 296 days, resulting in an acceleration of 48 days. In terms of cost, the 2-shift scenario is more efficient because, despite increasing daily operational costs, the total cost remains lower than that of 1 shift, both with and without considering late penalties. This shows that the implementation of 2 shifts provides a more optimal balance between time and cost and reduces the risk of budget overruns due to late penalties. The main contribution of this study is to provide quantitative evidence on the effectiveness of shift management in box girder erection projects using launching gantries, which has rarely been studied in depth. The limitation of this study lies in the use of secondary data that does not take into account external factors such as weather and worker skills. Therefore, further research is recommended to integrate these variables in order to obtain more comprehensive and applicable results.

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