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Analysis Productivity and its Impact on Time and Cost of Implementation of the Private Residence Project Structure Work

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Abstract

The construction project of Mrs. Tiya & Mr. Tom's Private Residence in Kemenuh-Gianyar is a 3-story villa development chosen as a case study due to discrepancies between the consultant's plans and the actual field conditions. This necessitated a method to optimize work completion. One proposed solution for accelerating the project was to add more workers. Based on the initial plan, the project required 104 days (3 months and 2 weeks) for completion, with a total structural work cost of Rp. 703,803,162.24. After analysis with the alternative of adding more workers, the project completion duration could return to the schedule of 90 days (3 months) or be accelerated by 12 days (2 weeks), with a total cost of Rp. 671,298,258.93. This concludes that adding more workers is an effective method to increase time efficiency by 14.29% and decrease costs by 4.6%, or the equivalent of Rp. 32,504,903.31.

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1 Introduction

A construction project can be defined as a single-time activity within a specific timeframe, utilizing various resources. This means that effective utilization of available resources within a limited timeframe is necessary for a construction project to meet its objectives within specified time, cost, and quality constraints (Wibawa et al., 2023). Construction projects always require resources, namely: people, materials, machines, methods, money, management, information, and time. All of these resources are crucial to the success of a construction project. One solution to improve efficiency and achieve desired results is to increase labor productivity (Huemann et al., 2007).

The first step every construction company must take is labor productivity planning to determine the performance of its workforce. The labor coefficient, or labor requirements per unit of work, is a multiplier in determining the number of workers and the unit price of wages (Rabbani et al., 2010). As a result, the difference between the total value and unit price of labor wages calculated in the budget and those used in the field can vary. In other words, whether a construction project will meet the established budget and schedule is greatly influenced by labor productivity (Thapa et al., 2024).

As in the construction project of Mrs. Tiya & Mr. Tom's Private Residence in Kemenuh, Gianyar, in the Main Building area there were several differences between the consultant's plan drawings and the actual conditions in the field as well as the collapse of several excavations on the pile cap foundation caused by the intensity of rainfall which caused re-excavation in the affected area. With the owner's request that the completion time remain following the agreed schedule, this prompted the implementing contractor to make several revisions to the working drawings and analyze the use of human resources to overcome problems that occurred in the field. by analyzing labor productivity. How much labor productivity is in implementing structural work on Mrs. Tiya & Mr. Tom's Private Residence project in Kemenuh, Gianyar?

a) How much did the additional workforce change the implementation time for the structural work on the Mrs. Tiya & Mr. Tom Private Residence project in Kemenuh, Gianyar?
b) How much did the implementation costs change to work productivity, given the planned materials used, for the structural work on the Mrs. Tiya & Mr. Tom Private Residence project in Kemenuh, Gianyar?

2 Materials and Methods

Location and Research Objects

Research on labor productivity and its impact on project costs and implementation time was conducted on the Mrs. Tiya & Mr. Tom Private Residence Development Project, Jln. Ir. Sutami, Kemenuh, Sukawati District, Gianyar Regency - Bali.

Data Collection Techniques

To achieve the objectives of this research, clear data souces are required that align with the facts on the ground. These data sources are as follows.:

1) Primary Data:
   Primary data is data obtained directly by the author from the field using interviews and analysis of the construction project itself. This data will be used to calculate labor productivity and its impact on costs and implementation time. The following data is included in the primary data in this study:
   a) Work Time
   b) Labor Costs
2) Secondary Data:
   Secondary data is data obtained by the author from other parties, in this case, the contractor for the Mrs. Tiya & Mr. Tom Private Residence Construction Project in Kemenuh, Gianyar, Bali. The following is included in the secondary data in this study:
   a) RAB
   b) AHSP (Work Unit Price Analysis)
   c) Schedule (Time Schedule)
   d) Working Drawings
   e) Work Volume
   f) Number of Workers

Variable Identification

1) Independent Variable
   An independent variable is a variable that influences or causes changes in or the emergence of a dependent variable. The independent variable in this study is the productivity of labor use on the project.
2) Dependent Variable
   The dependent variable is a variable that is influenced or becomes a consequence of the presence of the independent variable. The dependent variables in this study are Cost and Implementation Time. The costs referred to are direct costs incurred in the actual project, while implementation time is the length of time required for labor to complete a project on the construction project of the Private Residence of Mrs. Tiya & Mr. Tom in Kemenuh, Gianyar, Bali.

Data Analysis

In analyzing human resource utilization against costs and implementation time delays due to inadequate working drawing planning, this research process focuses on calculating daily labor productivity to determine whether the results are in line with the agreed-upon schedule. This research must be conducted systematically, clearly, and orderly to achieve the desired results.

3 Results and Discussions

Primary Data

Primary data is data obtained by the author directly through interviews with foremen in the field. The primary data obtained by the author in this study include the wages of labor, including foremen, head craftsmen, masons, blacksmiths, carpenters, laborers, heavy equipment operators, overtime costs per hour, and the length of time required for each item reviewed.

Secondary Data

Secondary data that the author obtained from the Private Residence Development Project for Mrs. Tiya & Mr. Tom at Kemenuh, Gianyar, including:

1) Cost Budget Plan (RAB)
   This Cost Budget Plan is necessary for the author to identify the work items to be executed and to determine the volume of work. The author will attach the Cost Budget Plan in Table 4.2. A summary of the Cost Budget Plan and the work reviewed in this research will be included in the appendix.

Material Control

After analyzing labor productivity and implementation time, the next step is to calculate the material requirements for each review work item to ensure that material requirements are in accordance with the plan. Material control in review work has the following calculation steps:

1) Find the volume of each work item by calculating data from the project plan drawings.
2) Find the duration of the work by calculating labor productivity for each work item.
3) Find the coefficient based on the AHSP used.
4) Calculate the amount of material required per day for each work item.

The following is an example of calculating iron requirements for Bore Pile reinforcement work*:*

Table 2
Daily Material Calculation

No	Work Items	Materials	Total Volume	Sat	Koef	Time	Daily Productivity	Sat	Daily Needs	Sat	Conversion	Sat
A.	Bore Pile Work											
1	Reinforcement Work	Iron D13	6448.78	Kg	0.681	9 days	758.29	Kg	516.55	Kg	42.00	btg
		Iron Ø10			0.319				241.74	Kg	33.00	btg
		Bendrat Wire			0.150				113.74	Kg	23.00	gl
2	Reinforcement Work	Ready Mix K-300	37.30	m³	1.020	7 days	5.92	m³	5.92	m³		

Cost Comparison

Based on the analysis, a comparison was obtained between the RAB (Cost Budget Plan) prepared during the project planning stage and the actual costs incurred in the field (Real Costs) during the project implementation. This comparison indicates differences or deviations that can be caused by various factors, such as wages and material prices that reflect local prices, as well as alternatives such as additional labor to meet previously planned deadlines. The following table shows the comparison between the planned RAB and the actual RAP in the field for the review work.

Table 3
Cost Comparison Between RAB and RAP

RAB			RAP		
No.	Work Items	Total price	No.	Work Items	Total price
A.	**Week 1**		**A.**	**Week 1**	
1	Bore Pile Drilling Pack	Rp 7,781,639.25	1	Bore Pile Drilling Pack	Rp 11,363,084.40
2	Bore Pile Supply Pack	Rp 42,458,024.64	2	Bore Pile Supply Pack	Rp 38,200,754.48
Total		**Rp 50,239,663.89**	**Total**		**Rp 49,563,838.88**
B.	**Week 2**		**B.**	**Week 2**	
1	Bore Pile Drilling Pack	Rp 15,563,278.50	1	Bore Pile Drilling Pack	Rp 22,726,168.80
2	Bore Pile Supply Pack	Rp 42,458,024.64	2	Bore Pile Supply Pack	Rp 70,090,383.68
Total		**Rp 58,021,303.14**	**Total**		**Rp 92,816,552.48**
C.	**Week 3**		**C.**	**Week 3**	
1	Bore Pile Drilling Package	Rp 12,969,398.75	1	Bore Pile Drilling Package	Rp 7,907,866.80
2	Bore Pile Reinforcement Package	Rp 35,442,975.27	2	Bore Pile Casting Package	Rp 51,697,800.00
3	Bore Pile Casting Package	Rp 26,810,769.70	3	Pile Cap Reinforcement Package PC1	Rp 9,779,952.00
4	Pile Cap PC2 Reinforcement Package	Rp 14,152,674.88	4	Pile Cap Reinforcement Package PC1.1	Rp 6,287,112.00
			5	Pile Cap Reinforcement Package PC2	Rp 19,100,461.20
Total		**Rp 89,375,818.60**	**Total**		**Rp 94,773,192.00**

RAB			RAP		
No.	Work Items	Total price	No.	Work Items	Total price
D.	**Week 4**		**D.**	**Week 4**	
1	Bore Pile Drilling Package	Rp 6,821,699.50	1	Pile Cap Excavation PC1	Rp 4,533,300.00
2	Bore Pile Casting Package	Rp 26,241,840.90	2	Pile Cap Excavation PC1.1	Rp 2,914,100.00
3	Pile Cap Reinforcement Package PC1	Rp 10,869,822.80	3	Pile Cap Excavation PC2	Rp 10,046,400.00
4	Pile Cap Reinforcement Package PC1.1	Rp 6,987,743.23	4	Pile Cap Reinforcement PC2	Rp 27,182,523.53
5	Pile Cap Reinforcement Package PC2	Rp 21,229,012.32	5	Pedestal Column Reinforcement C1	Rp 19,868,953.17
			6	Pedestal Column Reinforcement C2	Rp 9,550,236.97
Total		**Rp 72,150,118.76**	**Total**		**Rp 74,095,513.66**
E.	**Week 5**		**E.**	**Week 5**	
1	PC1 Pile Cap Excavation	Rp 3,436,438.50	1	Pile Cap Formwork Pack PC1	Rp 3,615,913.00
2	PC1.1 Pile Cap Excavation	Rp 2,209,014.50	2	Pile Cap Formwork Pack PC1.1	Rp 2,324,515.50
3	PC2 Pile Cap Excavation	Rp 5,397,876.00	3	Pile Cap Formwork Pack PC2	Rp 7,115,600.23
4	PC2 Pile Cap Reinforcement	Rp 16,059,039.99	4	Pedestal Column Formwork Pack C1	Rp 11,228,580.00
			5	Pedestal Column Reinforcement Pack C2	Rp 24,813,263.33
			6	Pedestal Column Formwork Pack C2	Rp 9,025,396.50
Total		**Rp 27,102,368.99**	**Total**		**Rp 58,123,268.56**
F.	**Week 6**		**F.**	**Week 6**	
1	Pile Cap Formwork PC1	Rp 3,762,797.50	1	Pile Cap Casting Package PC1	Rp 11,232,375.00
2	Pile Cap Formwork PC1.1	Rp 2,418,941.25	2	Pile Cap Casting Package PC1.1	Rp 7,220,812.50
3	Pile Cap Excavation PC2	Rp 2,217,732.00	3	Pile Cap Casting Package PC2	Rp 31,713,225.00
4	Pile Cap Formwork PC2	Rp 7,404,647.94	4	Pedestal Column Casting Package C1	Rp 5,198,985.00
5	Pedestal Column Reinforcement C1	Rp 14,152,789.87	5	Pedestal Column Formwork Package C2	Rp 8,532,019.50
6	Pedestal Column Reinforcement C2	Rp 14,152,789.87	6	Pedestal Column Casting Package C2	Rp 6,021,720.00
			7	Excavation Package RS1	Rp 3,560,400.00
			8	Excavation Package RS2	Rp 3,560,400.00
Total		**Rp 44,109,698.43**	**Total**		**Rp 77,039,937.00**
G.	**Week 7**		**G.**	**Week 7**	

RAB				RAP			
No.	Work Items	Total price		No.	Work Items	Total price	
1	Pile Cap Casting Package PC1	Rp	11,380,292.00	1	Stone. Excavation RS1	Rp	2,469,510.00
2	Pile Cap Casting Package PC1.1	Rp	7,315,902.00	2	Stone. RS2 Excavation	Rp	7,678,320.00
3	Pile Cap Casting Package PC2	Rp	18,267,585.60	3	Stone. Couple Stone Times RS1	Rp	11,604,600.00
4	Pedestal Column Reinforcement Package C1	Rp	7,930,345.12	4	Stone. Couple Stone Times RS2	Rp	11,604,600.00
5	Pedestal Column Formwork Package C1	Rp	6,260,191.25				
6	Pedestal Column Reinforcement Package C2	Rp	24,040,154.14				
7	Pedestal Column Formwork Package C2	Rp	6,260,191.25				
Total		**Rp**	**81,454,661.35**	**Total**		**Rp**	**33,357,030.00**
H.	**Week 8**			**H.**	**Week 8**		
1	Pile Cap Casting Package PC2	Rp	13,863,264.80	1	Stone. Couple Stone Times RS1	Rp	22,199,599.80
2	Pedestal Column Formwork Package C1	Rp	4,641,461.06	2	Stone. Couple Stone Times RS2	Rp	34,813,800.00
3	Pedestal Column Casting Package C1	Rp	5,267,449.44				
4	Pedestal Column Formwork Package C2	Rp	10,786,028.72				
5	Pedestal Column Casting Package C2	Rp	6,101,018.88				
6	Excavation Package RS1	Rp	2,698,938.00				
7	Excavation Package RS2	Rp	3,598,584.00				
Total		**Rp**	**46,956,744.89**	**Total**		**Rp**	**57,013,399.80**
I.	**Week 9**			**I.**	**Week 9**		
1	RS1 Mining Pack	Rp	1,871,995.95	1	RS2 River Stone Masonry	Rp	18,555,755.40
2	RS1 Stone Installation Pack	Rp	12,375,000.00	2	Sloof Reinforcement Package S1	Rp	19,100,473.93
3	RS2 Mining Pack	Rp	4,920,854.40	3	Sloof Reinforcement Package S2	Rp	11,154,278.19
4	RS2 Stone Installation Pack	Rp	12,375,000.00	4	Sloof Reinforcement Package S3	Rp	12,237,097.77
Total		**Rp**	**31,542,850.35**	**Total**		**Rp**	**61,047,605.29**
J.	**Week 10**			**J.**	**Week 10**		
1	Kali Stone Installation Kit RS1	Rp	23,673,375.00	1	Slope Reinforcement Package S1	Rp	19,635,457.52
2	Kali Stone Installation Kit RS2	Rp	37,125,000.00	2	Slope Excavation Package S1	Rp	2,628,900.00
				3	Slope Excavation Package S2	Rp	760,150.00
				4	Slope Excavation Package S3	Rp	872,850.00
Total		**Rp**	**60,798,375.00**	**Total**		**Rp**	**23,897,357.52**

RAB			RAP		
No.	Work Items	Total price	No.	Work Items	Total price
K.	**Week 11**		**K.**	**Week 11**	
1	RS2 River Stone Installation Package	Rp 19,787,625.00	1	Pek. Formwork Sloof S1	Rp 12,057,507.00
2	Sloof Reinforcement Package S1	Rp 14,152,674.88	2	Pek. Formwork Sloof S2	Rp 3,921,063.30
3	Sloof Reinforcement Package S2	Rp 12,397,302.91	3	Pek. Formwork Sloof S3	Rp 3,603,010.95
4	Sloof Reinforcement Package S3	Rp 13,600,791.13			
Total		**Rp 59,938,393.92**	**Total**		**Rp 19,581,581.25**
L.	**Week 12**		**L.**	**Week 12**	
1	Slope Excavation Site S1	Rp 28,899,960.86	1	Sloof Casting Package S1	Rp 18,526,125.00
2	Slope Reinforcement Site S1	Rp 1,992,820.50	2	Sloof Casting Package S2	Rp 4,819,710.00
3	Slope Excavation Site S2	Rp 576,226.75	3	Sloof Casting Package S3	Rp 6,643,147.50
4	Slope Excavation Site S3	Rp 661,658.25			
Total		**Rp 32,130,666.36**	**Total**		**Rp 29,988,982.50**
M.	**Week 13**				
1	Pek. Formwork Sloof S1	Rp 12,067,984.50			
2	Pek. Formwork Sloof S2	Rp 3,924,470.55			
3	Pek. Formwork Sloof S3	Rp 3,606,141.83			
Total		**Rp 19,598,596.88**			
N.	**Week 14**				
1	Sloof Casting Package S1	Rp 18,770,092.00			
2	Sloof Casting Package S2	Rp 4,883,179.84			
3	Sloof Casting Package S3	Rp 6,730,629.84			
Total		**Rp 30,383,901.68**			
Amount Total		**Rp 703,803,162.24**	**Amount Total**		**Rp 671,298,258.93**
Comparation					
Rp 32,504,903.31					

The table above compares the planned RAB and the actual RAP in the field for the reviewed work, based on the work completed per week. This comparison focuses solely on actual field expenditures. The analysis revealed that the RAP was lower than the RAB by approximately Rp. 32,504,903.31, or approximately 4.6%. This efficiency was achieved through the alternative of adding labor, which successfully accelerated the completion of the work, allowing the originally delayed implementation time to return to the planned schedule.

4 Conclusion

From the results of the analysis of Labor Productivity and its Impact on Implementation Time and Costs for the Private Residence Project Structure Work, Kemenuh - Gianyar, the following conclusions can be drawn:

1) Labor productivity on this project was still inefficient, resulting in work delays from the planned schedule. One of the tasks experiencing the greatest delay was bore pile drilling. With the addition of this workforce, work productivity increased significantly, from 31.75 m^1/day to 47.62 m^1/day.
2) The addition of labor for structural work was proven to accelerate the project's implementation duration by 12 days, or approximately 2 weeks, compared to the previous delay. This acceleration allowed the project to

return to its planned schedule. Thus, it successfully increased completion time efficiency by 14.29% compared to normal conditions.

3) The difference in the RAP value was Rp32,504,903.31, or approximately 4.6% of the RAB value, where this comparison only focused on material and labor costs due to the additional labor.

Conflict of interest statement

The authors declared that they have no competing interests.

Statement of authorship

The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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