Analysis of Worker Productivity with Time Study Method on Column Work

(Case Study: Pamulang University Development Project Serang City)

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ABSTRACT

This research discusses the value of worker productivity in building column work, there are several factors that affect the value of worker productivity, the value of productivity will affect various aspects of construction projects, including completion time, cost, and quality, therefore the organizers of construction projects must know the value of worker productivity when doing work. The research was conducted by conducting field observations to obtain column work time which was then analyzed using the Time Study method to determine the value of worker productivity and work costs. The results showed that the productivity value of Pamulang University column work was obtained in column reinforcement work of 544.07 kg/OH, in column formwork work of 42.01 m^2/OH, in column casting work of 57.05 m^3/OH, and in formwork dismantling work of 170.38 m^2/OH. Factors that hinder productivity in Pamulang University column work, namely in column reinforcement work is the number of workers, in column formwork work is the number of workers and the position of workers, in column casting work is the number of workers, and in column formwork dismantling work is the position of workers and the number of workers. The cost required per column in the Pamulang University Development project is Rp6,727,870.00.

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1. INTRODUCTION

The average number of years of schooling in Serang City which increases every year reflects the progress of education and the commitment of the community and local government to improve access and quality of education. According to BPS Serang City, (2022) the average number of years of schooling in Serang City has increased from 8.67% in 2019 to 8.9% in 2022 [1].

The construction of university buildings is very important in Serang City because the average number of years of schooling in Serang City is increasing. One of the universities that is undergoing development in Serang City is Pamulang University which is located on Jl. Raya Jakarta Km 5 No.6, Kalodran, Kec. Walantaka, Serang City. Soehendradjati (1987) defines construction management as a group that

performs management functions in the construction process (implementation stage), which is a function that occurs in every construction project [2].

The selection of appropriate resources affects the productivity of construction implementation, which has an impact on the quality of the results produced and the Company's profits [3]. Worker production in column manufacturing greatly affects various aspects of construction projects, including completion time, cost, quality, and safety. Poor productivity can cause projects to be delayed, increase costs, and disrupt schedules [4]. In addition, the quality of reinforced concrete structures can be affected by poor productivity, which can cause problems.

The author found a problem in the construction project in the form of the absence of an s-curve to monitor the work of construction workers in the field, therefore the author made a research on analyzing worker productivity with the time study method because the time study method is a method for calculating the value of worker productivity with a simple that can be done by anyone.

2. METHODS

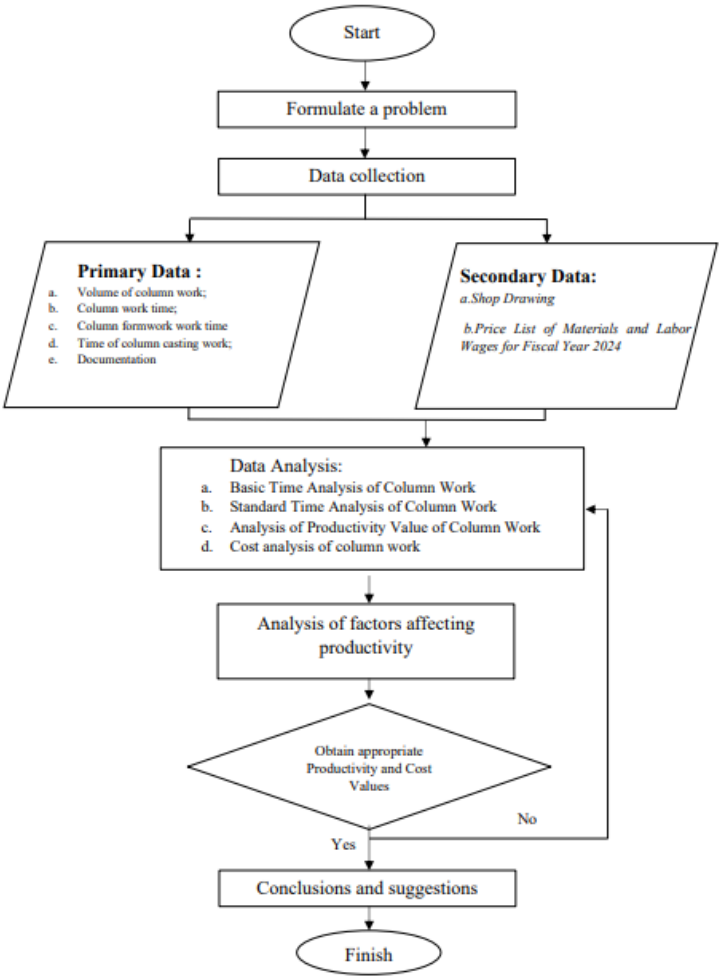


Figure 1. Research Flow Chart

Based on the research flow chart, the data analysis stage is carried out by field observation using the Time Study method. The analysis is done by analyzing the Basic Time of column work, Standard Time of column work. The results of the analysis are used to calculate the value of worker productivity in

column work. Then analyze the factors that affect the value of worker productivity. After that, the cost analysis of column work is carried out using ms.project software to get the cost of materials and workers in making columns.

2.1 Productivity

Productivity value is a value used to evaluate the work efficiency of a construction project [5]. Some reference books define productivity as follows:

- Diposuhudo (1996)

Using resources efficiently is an important component in improving the capability and utilization of relatively limited resources. Efficient use of resources will, presumably, lead to increased labor productivity [6].

$$Productivity = \frac{Work\ Results}{Working\ Hour} \quad (1)$$

- Bartol dan martin (1998)

Productivity is the ratio between the results of activities in the form of outputs, outputs and all costs required to realize the results in the form of inputs, inputs [7].

$$Productivity = \frac{goods\ and\ services\ produced}{worker+capital+power+technology+materials} \quad (2)$$

2.2 Basic Time Analysis

Basic Time Measurement is the process of measuring the time required to complete a specific construction task or activity. It includes the identification of activities, determination of the duration of each activity, and estimation of the time required to complete them. Time measurement is done using a stopwatch [8].

According to Santoso and Chandra (2006), basic time is the time required for labor to perform work and work at a normal rate (100). To get the basic time can be obtained by the formula below [9]:

$$BT = Observed\ time \times \frac{Observed\ rating}{Standard\ rating} \quad (3)$$

2.3 Rate

Rate or job weight refers to how quickly or slowly a worker can complete a particular task. It involves determining the amount of work a worker can complete in a unit of time, such as hours or days. This process involves direct observation of workers to understand their level of productivity in completing a particular job [10].

Several factors, such as age and gender, affect the level or weight of a person's work. In addition, a person's level of work can also differ from time to time throughout the day. Since a worker's work ability or efficiency also affects time, basic time measurements alone are not sufficient to produce an assessment of the effort required to complete a job [11].

Table 1. Work Rate Value [11]

Rate	Description
0	No activities
50	Very slow, lazy, no skills, unmotivated
75	Not fast, average ability, not interested
100	Fast, qualified ability, motivated, professional looking
125	Very fast, dexterous work and efficient movement.
150	Very fast, very trying and concentrated, highly capable.

2.4 Standard Time

Standard time is a measure of time used as a standard for the duration of construction operations [12]. It can be different for each project due to differences in field conditions, management conditions, and labor capabilities [13]. In addition, relaxation time, and contingency time, should be taken into account when determining the standard time.

2.5 Relaxation Allowance

Relaxation Allowance is additional time given over and above the standard time that would otherwise be required to complete a job. It is given as additional time to address delays or uncertainties that may occur during a construction project. The aim is to provide flexibility in the schedule so that the project can be completed on time. Relaxation permits help manage the risk of delay and increase the likelihood that the project will be completed on time [14].

Table 2. Effect of Relaxation on Basic Time [14]

Condition/Cause	Description	Basic Time Percentage
Standard	Personal needs (toilet, drinking, washing hands, etc.) and normal fatigue	8
Working position	Standing	2
	Quite a difficult position	2 – 7
	Very difficult position (lying down, maximum hand reach, etc.)	2 – 7
Concentration	Ordinary attention, looking at pictures	0 – 5
	Extra attention, complicated and lengthy explanations	0 – 8
Environment	Lighting: fair to dim	0 – 5
	Ventilation: fair to dusty then extreme/very dusty conditions	0 – 10
	noise : quiet to noisy	0 – 5
	heat: cool to 35°C humidity 95%	0 – 70
Power used	Lightweight: up to 5 kg	1
	Medium: loads up to 20 kg	1 – 10
	Weight: loads up to 40 kg	10 – 30
	Very heavy: loads up to 50kg	30 – 50
Monotony/Boredom	Mentally	0 – 4
	Physically	0 – 5

2.6 Contigency Allowance

Contingency Allowance is an additional allocation of time granted to deal with uncertainties or risks that may arise during project execution. These risks could include technical risks, changes in planning, or unpredictable external factors. It helps projects avoid delays or excessive costs due to unexpected changes, providing flexibility for the project team to adapt to changes [15].

According to Trisiany and Halim (2006) Contigency Allowance due to unexpected things in construction projects is usually sufficient with a value of 5% [15].

2.7 Construction Cost

Construction cost is the total expenditure required to plan, build and complete a construction project. Construction costs can vary depending on the size and complexity of the project, geographic location, local regulations, and market and economic conditions at the time of the project. Careful and accurate construction cost planning is important to ensure the project can be completed within the set budget. Project construction costs need to be grouped in order to analyze earned value calculations. According to Asiyanto (2005), construction costs have main elements and factors that need to be considered in control activities. The main elements of construction costs are material costs, wage costs and tool costs [16].

3. RESEARCH RESULTS AND DISCUSSION

This research stage consists of analyzing the Basic Time of column work, Standard Time of column work, analyzing factors that affect the value of worker productivity, and analyzing the cost of column work.

3.1 Basic Time Analysis

In the Basic Time analysis, field observations are made to obtain Observed Time or observation time in the field which is then calculated using the following formula:

$$\text{BT} = Observed\ time \times \frac{Observed\ rating}{Standard\ rating} \quad (4)$$

Table 3. Column Reinforcement Data at Observation 1

Basic Time Value								Type of Work: Column reinforcement Date: 8-February-2024 No. Observation: 1
No	ACTIVITY ELEMENT	R	Start (min)	Finish (min)	OT	OT (min)	BT (min)	Description Number of Workers
1	Install the main reinforcement	75	0:00:00	0:22:31	0:22:31	23.4	17.55	2
2	Inserting stirrups	75	0:22:31	0:35:40	0:13:09	13.1	9.825	2
3	Set stirrup spacing and tying	75	0:35:40	1:19:24	0:43:44	43.5	32.625	2
	OT Total					80		
	Total BT without Idle Time						60	

Table 4. Basic Time Value of Each Job

Reinforcement Work	Observation Number	Total Basic Time (minutes)
COLUMN	1	60
COLUMN	2	54.075
COLUMN	3	37.95
COLUMN	4	51.375
COLUMN	5	42.675
Formwork Work	**Observation Number**	**Total Basic Time (minutes)**
COLUMN	6	47.1
COLUMN	7	36.675
COLUMN	8	29.8875
COLUMN	9	47.475
COLUMN	10	51.15
Casting Work	**Observation Number**	**Total Basic Time (minutes)**
COLUMN	11	7.5
COLUMN	12	9.3
COLUMN	13	9.6
COLUMN	14	9.45
COLUMN	15	10.125
Formwork dismantling work	**Observation Number**	**Total Basic Time (minutes)**
COLUMN	16	8.1
COLUMN	17	7.875
COLUMN	18	7.65
COLUMN	19	8.85
COLUMN	20	10.725

3.2 Standard Time Analysis

The Standard Time analysis is carried out by summing up the Basic Time with Relaxation and Contigency Allowance which is determined according to the conditions in the field and adjusted to the percentage determined in the book Improving Site Productivity in the Construction Industry, Alan Heap, 1987.

Table 5. Standard Time Value for Column Work

Reinforcement Work	Observation	Total Standard Time (minutes)
COLUMN	1	62.58
COLUMN	2	56.655
COLUMN	3	40.53
COLUMN	4	53.955
COLUMN	5	45.285
Formwork Work	**Observation**	**Total Standard Time** (minutes)
COLUMN	6	48.92
COLUMN	7	38.535
COLUMN	8	31.7475
COLUMN	9	49.295
COLUMN	10	52.97
Casting Work	**Observation**	**Total Standard Time** (minutes)
COLUMN	11	8.41
COLUMN	12	10.21
COLUMN	13	10.51
COLUMN	14	10.36
COLUMN	15	11.035
Formwork dismantling work	**Observation**	**Total Standard Time** (minutes)
COLUMN	16	9.92
COLUMN	17	9.735
COLUMN	18	9.51
COLUMN	19	10.67
COLUMN	20	12.545

3.3 Analysis of Worker Productivity Value

Analysis of Productivity Value is done by comparing the work output with the Standard Time that has been analyzed.

Table 6. Productivity Value of Time Workers on Column Work

Reinforcement Work	Observation	Number of Workers	Productivity	
			(kg/day)	(kg/person/day)
COLUMN	1	3	1318.35	439.45
COLUMN	2	3	1456.22	485.41
COLUMN	3	3	2035.59	678.53
COLUMN	4	3	1529.10	509.70
COLUMN	5	3	1821.85	607.28

Formwork Work	Observation	Number of Workers	Productivity	
			(m2/day)	(m2/person/day)
COLUMN	6	2	91.84	45.92
COLUMN	7	2	116.59	58.30
COLUMN	8	3	141.52	47.17
COLUMN	9	3	91.14	30.38
COLUMN	10	3	84.82	28.27
Casting Work	**Observation**	**Number of Workers**	**Productivity**	
			(m3/day)	(m3/person/day)
COLUMN	11	2	86.81	43.41
COLUMN	12	2	71.51	35.75
COLUMN	13	1	69.47	69.47
COLUMN	14	1	70.47	70.47
COLUMN	15	1	66.16	66.16
Formwork dismantling work	**Observation**	**Number of Workers**	**Productivity**	
			(m2/day)	(m2/person/day)
COLUMN	16	3	452.90	150.97
COLUMN	17	3	461.51	153.84
COLUMN	18	3	472.43	157.48
COLUMN	19	2	421.07	210.53
COLUMN	20	2	358.13	179.07

Table 7. Productivity Value of Time Workers on Column Work

Work	Number of Workers	Average Productivity	
		day	person/day
Column Reinforcement	3	1632.22	544.07
Column Formwork	3	105.18	42.01
Column Casting	1	72.88	57.05
Formwork Dismantling	3	433.21	170.38

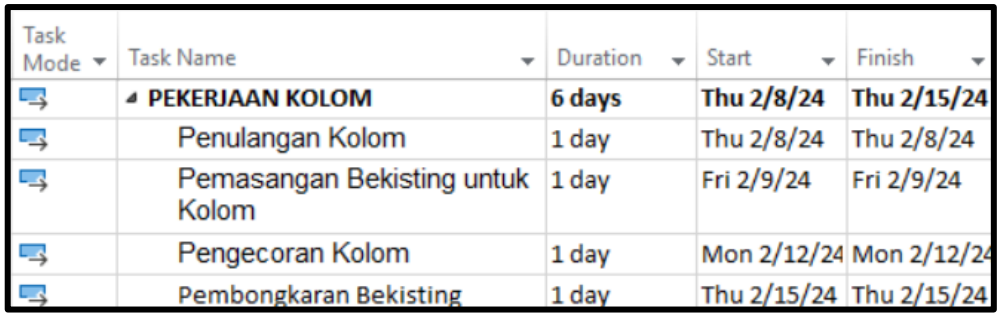
3.4 Analysis of Factors Affecting Worker Productivity

The analysis was carried out by comparing the field observation form of each job with other jobs, after analyzing it, it was found that the smaller number of workers and difficult job positions caused the small productivity figures when compared to jobs that had high productivity figures.

3.4 Column Manufacturing Cost Analysis

The analysis was carried out by calculating the cost of materials and workers using Ms. Project software, while the unit costs were obtained from the List of Material Prices and Worker Wages

for the 2024 Budget Year of Banten Province. The calculation is done by multiplying the unit price by the volume of work in the field.



Task Mode	Task Name	Duration	Start	Finish
	PEKERJAAN KOLOM	**6 days**	**Thu 2/8/24**	**Thu 2/15/24**
	Penulangan Kolom	1 day	Thu 2/8/24	Thu 2/8/24
	Pemasangan Bekisting untuk Kolom	1 day	Fri 2/9/24	Fri 2/9/24
	Pengecoran Kolom	1 day	Mon 2/12/24	Mon 2/12/24
	Pembongkaran Bekisting	1 day	Thu 2/15/24	Thu 2/15/24

Figure 2. Column Job Task Manager

Table 8. Unit Price [17]

Component Code	Component Description	Specifications	Unit	Unit Price
1.1.12.01.01.0001.06659	Building and Construction Materials	Multiplek 12 mm 120 x 224	Sheet	Rp 214,000.00
1.1.12.01.01.0001.07059	Building and Construction Materials	Readymix Concrete K-350 Slump 12+ 2	M3	Rp 1,611,000.00
1.1.12.01.01.0001.05757	Building and Construction Materials	Threaded Rebar	Kg	Rp 19,000.00
8.1.02.02.01.0016.00031	Charges for Labor Services for Handling Public Infrastructure and Facilities	Workers of Serang City	person/day	Rp 164,000.00
8.1.02.02.01.0016.00007	Charges for Labor Services for Handling Public Infrastructure and Facilities	Foreman of Serang City	person/day	Rp 270,000.00

Table 9: Column Manufacturing Price

Work	Biaya Material Dan Upah Pekerja
Column Reinforcement	Rp17,090,600.00
Formwork Installation for Columns	Rp2,765.040.00
Column Casting	Rp13,021,710.00
Formwork Dismantling	Rp762,000.00
Total	**Rp33,639,350.00**
Cost Per Column	**Rp6,727,870.00**

4. CONCLUSIONS

The productivity value of the Pamulang University column work, obtained in the column reinforcement work of 544.07 kg / OH, in the column formwork work of 42.01 m2 / OH, in the column casting work of 57.05 m3 / OH, and in the formwork dismantling work of 170.38 m2 / OH.

Factors that hinder productivity in Pamulang University column work, namely in column reinforcement work is the number of workers, in column formwork work is the number of workers and the position of workers, in column casting work is the number of workers, and in column formwork dismantling work is the position of workers and the number of workers.

The cost required per column in the Pamulang University Development project is Rp6,727,870.00.

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