

Technical Review of Scheduling and Sequence of Overburden Production PT. Tambang Bukit Tambi

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Abstract. Overburden volume at pit 5 PT. Tambang Bukit Tambi site Padang Kelapo is 1,496,925.78 BCM which is located in an area of 10.15 Ha with a disposal distance of 100 – 300 meters. The production target based on the available equipment is 1,483 BCM/hour. The dig-and-load equipment used is the Excavator Komatsu PC-400 LC with equipment productivity of 456.401 BCM/hour with 4 units of equipment, so the productivity of the dig-and-load is 1,825.604 BCM/hour. Then the productivity of the Articulated Dump Truck (ADT) Volvo A40G is 204.248 LCM/hour with 10 units of equipment, so the productivity of the transportation equipment is 2,042.48 LCM/hour. The overburden excavation activity is divided into 4 sequences starting from an elevation of 95–75 in sequence 1 with an overburden production target of 370,008.5 BCM, followed by an elevation of 75–70 in sequence 2 with an overburden production target of 332,933.5 BCM, then from elevation 70–65 in sequence 3 with an overburden production target of 391,512 BCM and the last from an elevation of 65–55 in sequence 4 with an overburden production target of 402,472 BCM. For the overburden excavation activity, 4 units of dig-and-load equipment and 10 units of transportation will be used so that the time needed to carry out mining activities from start to finish is around 83 working days.

Keywords: Scheduling, Sequence, Overburden Production

1. Introduction

PT. Tambang Bukit Tambi is one of the companies engaged in mining in Jambi province. PT. Tambang Bukit Tambi site Padang Kelapo has a Mining Business License Area covering an area of 3,220 Ha located in Maro Sebu subdistrict, Batang Hari regency, Jambi province. Some of these areas have been explored to obtain data on coal reserves in the area and some have been exploited. Before coal mining activities are carried out, it is necessary to schedule (scheduling) and determine the stages (sequence) so that coal mining activities can run effectively and efficiently. The importance of scheduling and determining the stages in coal mine production is based on this research.

Production scheduling serves to create a production plan so that it can run in accordance with a predetermined time. It can be said that production scheduling is done so that the equipment used can work in accordance with the desired production target and in accordance with the specified time.

The plan of the mining design stage is a form of mining that shows how a mine will be mined from the initial form to the final form. This planned mining design phase will facilitate its mining activities by simplifying all existing volumes in the entire mine into smaller units.

2 Research Methods

In carrying out this research, the authors combine the theory of data in the field and interviews so as to obtain an appropriate approach to solving problem. The order of work is:

1. Literature Studies

Literature study is a study of research from existing literature. Literature materials in the form of books and other documentation materials that support research objects. Also planned are work measures that suit the conditions in the field.

2. Research in the Field

Research in the field is conducted through several stages, namely:

- a. Field orientation by looking directly at the condition of the field, for example, data collection of the distribution time of units working in the field.
- b. Determine the locations that must be observed in accordance with the needs of the data so that the appropriate data can be obtained. For example, determining the initial location of mining activities.
- c. Recheck the data taken with the problem formulation that has been created so that the data obtained can be in accordance with the formula that has been discussed.

3. Data Collection

- a. Primary data, namely data obtained from observation and collection of data directly in the field, among others data on the circulation time of the dig-and-load equipment, the time of distribution of the transport equipment and the effectiveness of dig-and-load and transport equipment.
- b. Secondary data, namely supporting and complementary data, such as available working hours data, number of rainy days of research area, volume overburden, sequence map, sediment model of excavated materials and actual situation map (EOM).

4. Data Processing and Analysis

From the results of data collection that has been taken from the field as well as from literature studies, further processing and analysis of existing data is carried out. The data is processed using the formula:

Cycle Time of Mechanical Equipment

Cycle time is the ability of equipment in conducting a single production cycle. The circulation time of dig-and-load equipment and transport equipment is very influential on the production capability of the equipment, where if the circulation time of each large equipment then the production capability will be smaller. Circulation time can be influenced by road conditions, distance, mechanical condition of equipment, operator skills and others (Indonesianto, 2018). To calculate the cycle time of equipment operating in the field, a stopwatch timer tool is used. The collection of cycle time data of each mechanical equipment is carried out as many as 30 observations. This is intended to meet statistical methods so that the data is close to the truth to then be taken into account against a problem. Collection of cycle time data of each type of equipment operated, carried out on each type of material worked. From the overall data obtained in the field, then averaged based on the "Frequency Distribution Method", using the equation:

$$\bar{x} = \frac{\sum Fi \times Xi}{\sum Fi} \quad (1)$$

$$K = 1 + 3,322 \log N \quad (2)$$

$$Ci = \frac{X_{max} - X_{min}}{K} \quad (3)$$

Description:

\bar{X}	= Calculated average value
F_i	= Frequency distribution
X_i	= Midpoint of interval class
N	= Amount of data
C_i	= Interval class
K	= Number of interval classes
X_{max}	= Largest data value
X_{min}	= Smallest data value

Mechanical Equipment Production

1. Production of Dig-and-Load Equipment

The production capability of excavators is strongly influenced by operator skills, available stock materials and uniformity of grains. The production capability of the dig-and-load equipment can be calculated using the following equation (Indonesianto, 2018):

$$P = \frac{3600}{CT} \times KB \times FF \times EK \quad (4)$$

Description:

P	= Dig-and-load equipment production capability (BCM/hr)
CT	= Cycle time (seconds)
KB	= Bucket capacity (m^3)
FF	= Bucket fill factor
EK	= Working efficiency (%)

2. Production of Transport Equipment

To calculate the production capability of the transport equipment, dump truck is considered the combination of loading of the dig-and-load equipment. The ability of transport can be calculated using the following equation (Indonesianto, 2018):

$$Pa = \frac{60}{CT} \times KB \times FF \times SF \times EK \times n \quad (5)$$

Description:

Pa	= Transport equipment production capability (LCM/hr)
CT	= Cycle time (minutes)
KB	= Bucket capacity (m^3)
FF	= Fill factor
SF	= Swell factor
EK	= Working efficiency (%)
n	= Number of fills

Mine Scheduling

Mine scheduling is one part of mine planning. After modeling geology, block modelling levels, determination of SR or COG, to the design of pit-limit, scheduling becomes very

important to determine mining activities in the following year. The main purpose of scheduling is to get the NPV (net present value) as optimally as possible. In a similar way, the purpose of scheduling is to make the most of the profits as much as possible with the smallest operating costs (Hustrulid and Kuchta, 1995). To calculate the length of time overburden stripping itself can use the formula:

$$\text{Stripping time} = \frac{\text{Volume Sequence}}{\text{Productivity equipment}} \quad (6)$$

3. Results and Discussion

A. Volume Overburden

Volume overburden in pit 5 PT. Tambang Bukit Tambi site Padang Kelapo amounted to 1,496,925.78 BCM and coal amounted to 1,144,367.80 tons in an area of 10.15 Ha with a stripping ratio of 1.3. Overburden contained in pit 5 PT. Tambang Bukit Tambi site Padang Kelapo is clay with a density of 2.2 tons/m³, while coal contained in PT. Tambang Bukit Tambi site Padang Kelapo has a caloric value ranging from 3,000 – 3,500 kcal.

B. Effective Working Time

Working hours available at PT. Tambang Bukit Tambi site Padang Kelapo is 10 hrs/day with the number of shifts that is 1 shift. As for the effective working time in 1 month varies depending on the time of obstacles that exist each month as shown in Table 1 – Table 4.

Table 1. Effective Working Time April 2020

<i>DESCRIPTION</i>	<i>Plan</i>	<i>Unit</i>	<i>Monthly</i>
Total Days and Shift :			
<i>Calendar Days</i>		<i>days</i>	30
<i>Over Shift</i>		<i>days</i>	0
<i>Ramadhan Day</i>		<i>days</i>	7
<i>Holiday</i>		<i>days</i>	0
<i>Friday Praying (hr/week)</i>		<i>days</i>	4
<i>Safety Talk Schedule</i>		<i>days</i>	2
<i>Shifts/day</i>			1
<i>Hrs/shift</i>			10
Machine Onhand Hours		<i>(hrs)</i>	300
Lost Time	<i>(Lost)</i>	<i>(hrs)</i>	50,5
	<i>% Lost</i>	<i>%</i>	16,83%
1. <i>Rainy</i>	6 <i>days</i>	<i>(hrs)</i>	6
2. <i>Slippery</i>	50% <i>% of rainy</i>	<i>(hrs)</i>	3
3. <i>Over Shift</i>	0 <i>hrs/day</i>	<i>(hrs)</i>	-
4. <i>Fasting (Ramadhan)</i>	1 <i>hrs/day</i>	<i>(hrs)</i>	7
5. <i>Meal and Rest</i>	1 <i>hrs/day</i>	<i>(hrs)</i>	30
6. <i>Holiday</i>	0 <i>day</i>	<i>(hrs)</i>	-
7. <i>Shift Change</i>	0 <i>hrs/day</i>	<i>(hrs)</i>	-
8. <i>Safety Talk</i>	15 <i>min/week</i>	<i>(hrs)</i>	0,5
9. <i>Friday Praying (hr/week)</i>	1 <i>hrs/week</i>	<i>(hrs)</i>	4
10. <i>Working Hours/Month</i>			249,5

Table 2. Effective Working Time May 2020

<i>DESCRIPTION</i>	<i>Plan</i>	<i>Unit</i>	<i>Monthly</i>
Total Days and Shift :			
<i>Calendar Days</i>		<i>days</i>	31
<i>Over Shift</i>		<i>days</i>	0
<i>Ramadhan Day</i>		<i>days</i>	23
<i>Holiday</i>		<i>days</i>	0

	Friday Praying (hr/week)		days	5
	Safety Talk Schedule		days	2
	Shifts/day			1
	Hrs/shift			10
	Machine Onhand Hours		(hrs)	310
	Lost Time		(Lost) (hrs)	85,5
			% Lost	27,58%
1.	Rainy	4	days	4
2.	Slippery	50%	% of rainy	2
3.	Over Shift	0	hrs/day	-
4.	Fasting (Ramadhan)	1	hrs/day	23
5.	Meal and Rest	1	hrs/day	31
6.	Holiday	2	day	20
7.	Shift Change	0	hrs/day	-
8.	Safety Talk	15	min/week	0,5
9.	Friday Praying (hr/week)	1	hrs/week	5
10.	Working Hours/Month			224,5

Table 3. Effective Working Time June 2020

	DESCRIPTION	Plan		Unit	Monthly
	Total Days and Shift :				
	Calendar Days			days	30
	Over Shift			days	0
	Ramandhan Day			days	0
	Holiday			days	0
	Friday Praying (hr/week)			days	4
	Safety Talk Schedule			days	2
	Shifts/day				1
	Hrs/shift				10
	Machine Onhand Hours			(hrs)	300
	Lost Time		(Lost) (hrs)		36
			% Lost	%	12%
1.	Rainy	1	days	(hrs)	1
2.	Slippery	50%	% of rainy	(hrs)	0,5
3.	Over Shift	0	hrs/day	(hrs)	-
4.	Fasting (Ramadhan)	0	hrs/day	(hrs)	-
5.	Meal and Rest	1	hrs/day	(hrs)	30
6.	Holiday	0	day	(hrs)	-
7.	Shift Change	0	hrs/day	(hrs)	-
8.	Safety Talk	15	min/week	(hrs)	0,5
9.	Friday Praying (hr/week)	1	hrs/week	(hrs)	4
10.	Working Hours/Month				264

Table 4. Effective Working Time July 2020

	DESCRIPTION	Plan		Unit	Monthly
	Total Days and Shift :				
	Calendar Days			days	31
	Over Shift			days	0
	Ramandhan Day			days	0
	Holiday			days	0
	Friday Praying (hr/week)			days	5
	Safety Talk Schedule			days	2
	Shifts/day				1
	Hrs/shift				10
	Machine Onhand Hours			(hrs)	310
	Lost Time		(Lost) (hrs)		38

		% Lost	%	12,26%
1.	Rainy	1	days	(hrs)
2.	Slippery	50%	% of rainy	(hrs)
3.	Over Shift	0	hrs/day	(hrs)
4.	Fasting (Ramadhan)	0	hrs/day	(hrs)
5.	Meal and Rest	1	hrs/day	(hrs)
6.	Holiday	0	day	(hrs)
7.	Shift Change	0	hrs/day	(hrs)
8.	Safety Talk	15	min/week	(hrs)
9.	Friday Praying (hr/week)	1	hrs/week	(hrs)
10.	Working Hours/Month			272

C. Estimated Productivity of Dig-and-Load Equipment

The estimate for excavator productivity Komatsu PC-400 LC is approximately 456,401 BCM/hour or 136,920.3 BCM/month. Because the equipments used there are 4 units, the production is 547,681.2 BCM/month.

D. Stages of Mining Activities

Coal mining at PT. Tambang Bukit Tambi site Padang Kelapo is planned to start from the west side to the east side. The mining site is a relatively narrow area, with such conditions it is planned that the disposal of overburden material is carried out in the pit. In pit 5 this will be divided into 4 sequences that are adjusted to the production scheduling (Figure 1).

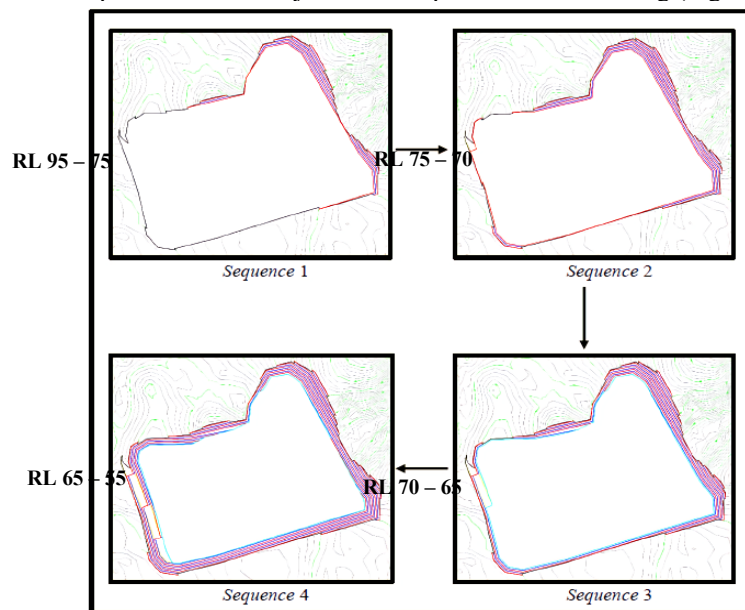


Fig 1. Sequence of Overburden Mining

This overburden excavation activity starts from elevation 95–75 on sequence 1, followed by sequence 2 at elevation 75–70, then sequence 3 at elevation 70–65 and finally sequence 4 at elevation 65–55. All overburden materials will be transported and stockpiled at disposal located on the west side of the pit. For this overburden excavation activity will be used 4 units of digging equipment and 10 units of transport.

E. Production Scheduling

Overburden stripping activities at PT. Tambang Bukit Tambi site Padang Kelapo will be conducted using Excavator Komatsu PC-400 LC and Articulated Dump Truck (ADT) Volvo A40G. The planned overburden production target in pit 5 is 1,483 BCM/hour with a stripping ratio of 1.3. Based on the production target, it is estimated that the length of overburden stripping time on pit 5 is for 83 working days. For more details on the production target of overburden pit 5 PT. Tambang Bukit Tambi site Padang Kelapo is shown in Table 5 below.

Table 5. Overburden Production Target in Pit 5 PT. Tambang Bukit Tambi site Padang Kelapo

Month	Production Target (BCM)
1	370,008.5
2	332,933.5
3	391,512
4	402,472
Total	1,496,926

1. First Month Overburden Stripping

In the first month of overburden stripping, Excavator Komatsu PC-400 LC will be served with 10 ADT Volvo A40G. In the first month, mining activities will start from an elevation of 95–75 with a total volume of 397,221.89 BCM and takes 22 working days.



Fig 2. Sequence 1

2. Second Month Overburden Stripping

In the second month of overburden stripping, Excavator Komatsu PC-400 LC will be served with 10 ADT Volvo A40G. In the second month, mining activities will start from an elevation of 75–70 with a total volume of 418,276.18 BCM and takes 23 working days.



Fig 3. Sequence 2

3. Third Month Overburden Stripping

In the third month of overburden stripping, Excavator Komatsu PC-400 LC will be served with 10 ADT Volvo A40G. In the third month, mining activities will start from an elevation of 70–65 with a total volume of 410,962.89 BCM and takes 23 working days.



Fig 4. Sequence 3

4. Fourth Month Overburden Stripping

In the fourth month of overburden stripping, Excavator Komatsu PC-400 LC will be served with 10 ADT Volvo A40G. In the fourth month, mining activities will start from an elevation of 65–55 with a total volume of 270,464.85 BCM and takes 15 working days.

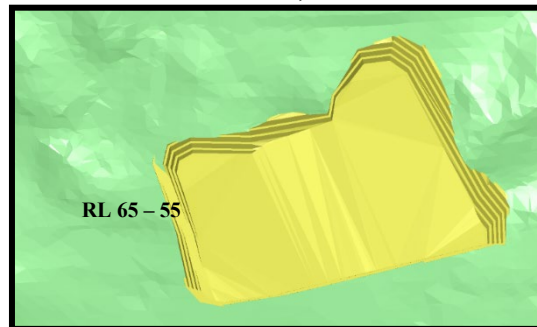


Fig 5. Sequence 4

From the discussion above, the total estimated time for overburden stripping is takes 22 days + 23 days + 23 days + 15 days = **83 working days** with the total volume of overburden that must be peeled as much as **1,496,925.81 BCM**.

The amount of equipment production must be sufficient for the size of the production target that has been set. The amount of equipment production against the overburden production target is shown in Table 6.

Table 6. Comparison of Equipment Production Size to Overburden Production Target

Month	Production Target (BCM)	Excavator Production/Unit (BCM)	Number of Excavators	Excavator Production (BCM)
1	370,008.5	136,920.3	4	547,681.2
2	332,933.5	136,920.3	4	547,681.2
3	391,512	136,920.3	4	547,681.2
4	402,472	136,920.3	4	547,681.2

From the table above can be seen that the productivity of the equipment can meet the desired production target every month.

In the activity of stripping activities of overburden at PT. Tambang Bukit Tambi site Padang Kelapo used pair of Excavator Komatsu PC-400LC with bucket capacity of 2.2 m³ and Articulated Dump Truck (ADT) Volvo A40G with a body capacity of 24 m³. The match factor between the use of the two equipments is shown in the formula below.

$$MF = \frac{\text{Number of ADT} \times \text{Number of fills} \times \text{CT Excavator}}{\text{Number of Excavators} \times \text{CT ADT}}$$

$$MF = \frac{10 \text{ unit} \times 5 \times 0,41 \text{ minutes}}{4 \text{ unit} \times 4,18 \text{ minutes}}$$

$$MF = 1,23$$

From the above results can be known for the stripping activities of overburden has a harmony of equipments (match factor) of 1.23 with the number of excavators as much as 4 units and articulated dump truck (ADT) as much as 10 units. This indicates that the excavator is fully working while the dump truck has a waiting time. This is considered effective because the dig-and-load equipments will always be served to the maximum by the dump truck so that the desired production target can be met.

4 Conclusion

Based on the above discussion on the scheduling of production stripping overburden at PT. Tambang Bukit Tambi site Padang Kelapo, then it can be concluded: Volume overburden in pit 5 PT. Tambang Bukit Tambi site Padang Kelapo amounted to 1,496,925.78 BCM which is in an area of 10.15 Ha based on exploration data that has been done. Productivity of Excavator Komatsu PC-400 LC of 1,825,604 BCM/hour or 18,256.04 BCM/day or 547,681.2 BCM/month for each equipment. Then for productivity of Articulated Dump Truck (ADT) Volvo A40G of 204,248 LCM/hour or 2,042.48 LCM/day or 61,274.4 LCM/month for each equipment. As for the production target of stripping overburden of 1,483 BCM/hour which for the desired production target has been achieved. Time required for stripping activities overburden in pit 5 PT. Tambang Bukit Tambi site Padang Kelapo is takes 83 working days divided into 4 sequences. Scheduling production of overburden in pit 5 PT. Tambang Bukit Tambi site Padang Kelapo in the first month amounted to 370,008.5 BCM, the second month amounted to 332,933.5 BCM, the third month amounted to 391,512 BCM and for the fourth month amounted to 402,472 BCM. Advice that can be given to mining activities at PT. Tambang Bukit Tambi site Padang Kelapo is as follows: It is necessary to have a good monitoring system in the activity of scheduling overburden so that the predetermined production targets can be met. Perform maintenance on heavy equipment, both excavators and mining activities at PT. Tambang Bukit Tambi site Padang Kelapo is running effectively. Appeal to all employees to work on time according to a predetermined schedule in order to reduce working hours and to always maintain work health and safety.

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