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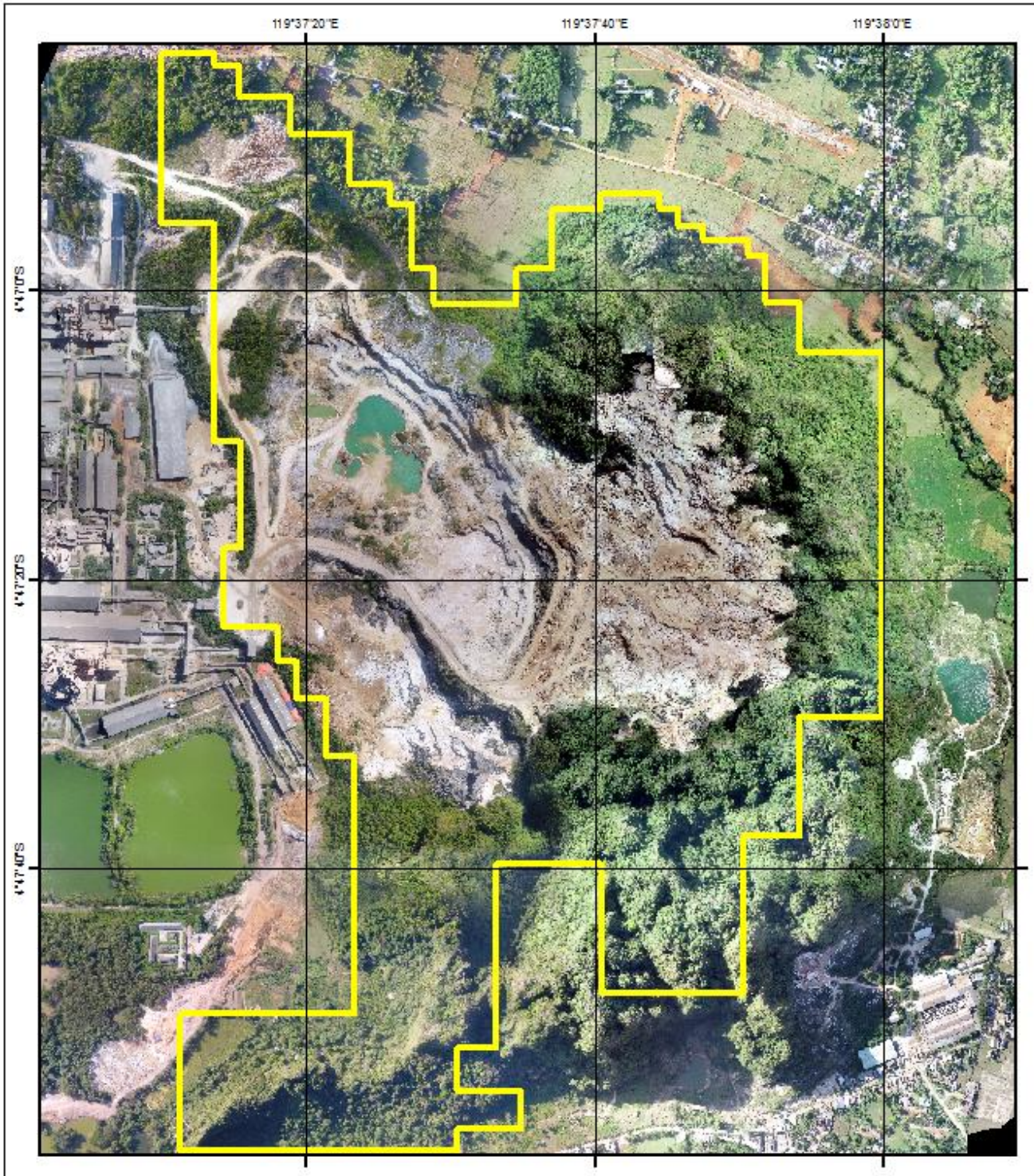
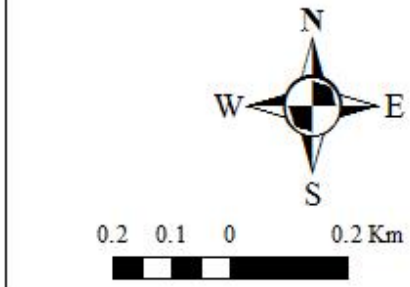
APPENDICES

Appendix A

WIUP Map of PT Semen Tonasa

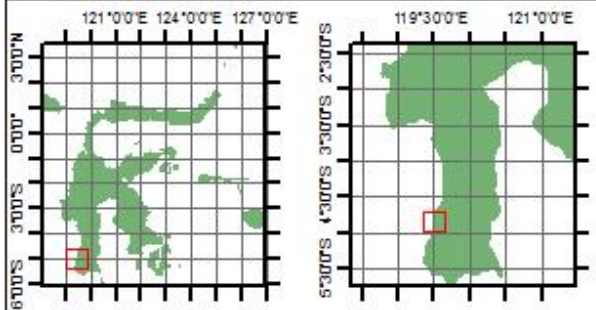




Legend

WIUP

Carographic Informaton
Projection: UTM, Zoe 50S
Datum Unit: WGS-84
Souce: Drone Mapping



MINING ENGINEERING DEPARTMENT
FACULTY OF ENGINEERING
HASANUDDIN UNIVERSITY
2023

BACHELOR THESIS

EVALUATION OF FAILURE IN LIMESTONE PRODUCTION AT PT SEMEN TONASA, PANGKEP REGENCY, SOUTH SULAWESI

DRAWN BY	ANGELIE SANTOSA D111191045
SUPERVISOR	Dr. ARYANTI VIRTANTI ANAS, ST., MT. NIP: 197010052008012026
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WIUP OF PT SEMEN TONASA

Appendix B

Blasting Report

Table 7 Blasting Report

Num	Date	AN Total (Kg)	AN Anfo (Kg)	AN 30% (Kg)	Det (Ea)	Booster (Kg)	Dynamite (Kg)	Inhole (Ea)	Surface (Kg)	Explosives Cost (Rp)	Produksi crusher (Ton)	Emulsion 1 (Kg)	Emulsion 1 Cost (Rp)	Total exp cost (Rp)
1	01 November 2022	4,000	2,500	1,500	109	18.0	21	90	80	46,695,200	31,174	3,500	39,550,000	86,245,200
2	02 November 2022	3,000	1,800	1,200	96	19.0	19	95	90	39,032,550	22,864	3,000	33,900,000	72,932,550
3	03 November 2022	5,000	3,200	1,800	181	24.0	35	120	110	60,393,500	26,469	4,000	45,200,000	105,593,500
4	04 November 2022	3,000	1,500	1,500	120	14.0	30	70	65	36,485,500	26,770	3,000	33,900,000	70,385,500
5	05 November 2022	5,000	3,200	1,800	194	22.0	38	110	100	59,376,100	27,616	4,000	45,200,000	104,576,100
6	06 November 2022	-	-	-	-	-	-	-	-	-	8,366	-	-	-
7	07 November 2022	4,000	2,000	2,000	128	17.0	25	85	80	46,643,250	14,872	4,000	45,200,000	91,843,250
8	08 November 2022	3,000	1,700	1,300	114	18.0	23	90	85	38,776,100	15,936	3,000	33,900,000	72,676,100
9	09 November 2022	3,000	1,500	1,500	187	19.0	37	95	90	40,967,650	16,896	3,500	39,550,000	80,517,650
10	10 November 2022	3,000	1,800	1,200	92	14.0	18	70	65	35,669,100	25,394	3,000	33,900,000	69,569,100
11	11 November 2022	3,000	1,300	1,700	100	17.6	20	88	85	38,284,800	24,977	4,000	45,200,000	83,484,800
12	12 November 2022	3,000	2,000	1,000	140	16.0	28	80	75	38,015,600	22,407	3,000	33,900,000	71,915,600
13	13 November 2022	-	-	-	-	-	-	-	-	-	7,685	-	-	-
14	14 November 2022	4,000	2,500	1,500	147	15.0	30	75	75	45,971,250	22,971	3,500	39,550,000	85,521,250
15	15 November 2022	3,000	2,000	1,000	97	13.0	20	65	65	35,345,750	26,372	3,000	33,900,000	69,245,750

Num	Date	AN Total (Kg)	AN Anfo (Kg)	AN 30% (Kg)	Det (Ea)	Booster (Kg)	Dynamite (Kg)	Inhole (Ea)	Surface (Kg)	Explosives Cost (Rp)	Produksi crusher (Ton)	Emulsion 1 (Kg)	Emulsion 1 Cost (Rp)	Total exp cost (Rp)
16	16 November 2022	4,000	2,000	2,000	134	23.0	26	115	110	50,689,950	25,231	4,000	45,200,000	95,889,950
17	17 November 2022	4,000	2,000	2,000	180	24.0	36	120	110	52,163,200	25,491	4,500	50,850,000	103,013,200
18	18 November 2022	3,000	1,800	1,200	129	7.4	26	37	37	32,351,150	21,503	2,500	28,250,000	60,601,150
19	19 November 2022	2,000	1,000	1,000	119	18.0	24	90	85	30,632,800	26,778	3,000	33,900,000	64,532,800
20	20 November 2022	-	-	-	-	-	-	-	-	--	-	-	-	-
21	21 November 2022	4,000	2,000	2,000	146	25.0	28	125	120	52,240,850	27,432	4,500	50,850,000	103,090,850
22	22 November 2022	4,000	2,000	2,000	94	30.0	18	150	140	54,226,100	27,105	5,000	56,500,000	110,726,100
23	23 November 2022	4,000	2,700	1,300	169	16.0	32	80	70	46,632,900	11,493	3,000	33,900,000	80,532,900
24	24 November 2022	3,000	1,700	1,300	149	18.4	30	92	90	39,898,700	24,942	3,000	33,900,000	73,798,700
25	25 November 2022	3,000	1,500	1,500	152	18.0	30	90	85	39,566,500	23,494	3,000	33,900,000	73,466,500
26	26 November 2022	-	-	-	-	-	-	-	-	-	18,227	-	-	-
27	27 November 2022	-	-	-	-	-	-	-	-	-	-	-	-	-
28	28 November 2022	4,000	2,500	1,500	137	18.0	27	90	80	47,306,400	20,682	3,500	39,550,000	86,856,400
29	29 November 2022	4,000	2,200	1,800	109	27.0	22	135	130	52,807,650	20,426	4,000	45,200,000	98,007,650
30	30 November 2022	3,000	2,000	1,000	144	12.6	28	63	60	35,925,150	21,117	2,500	28,250,000	64,175,150
	TOTAL	88,000	50,400	37,600	3367	464.0	671	2320	2182	1,096,097,700	614,690	87,000	983,100,000	**2,079,197,700**

Appendix C

Explosives COGS

Table 8 Daily explosives COGS of November 2022

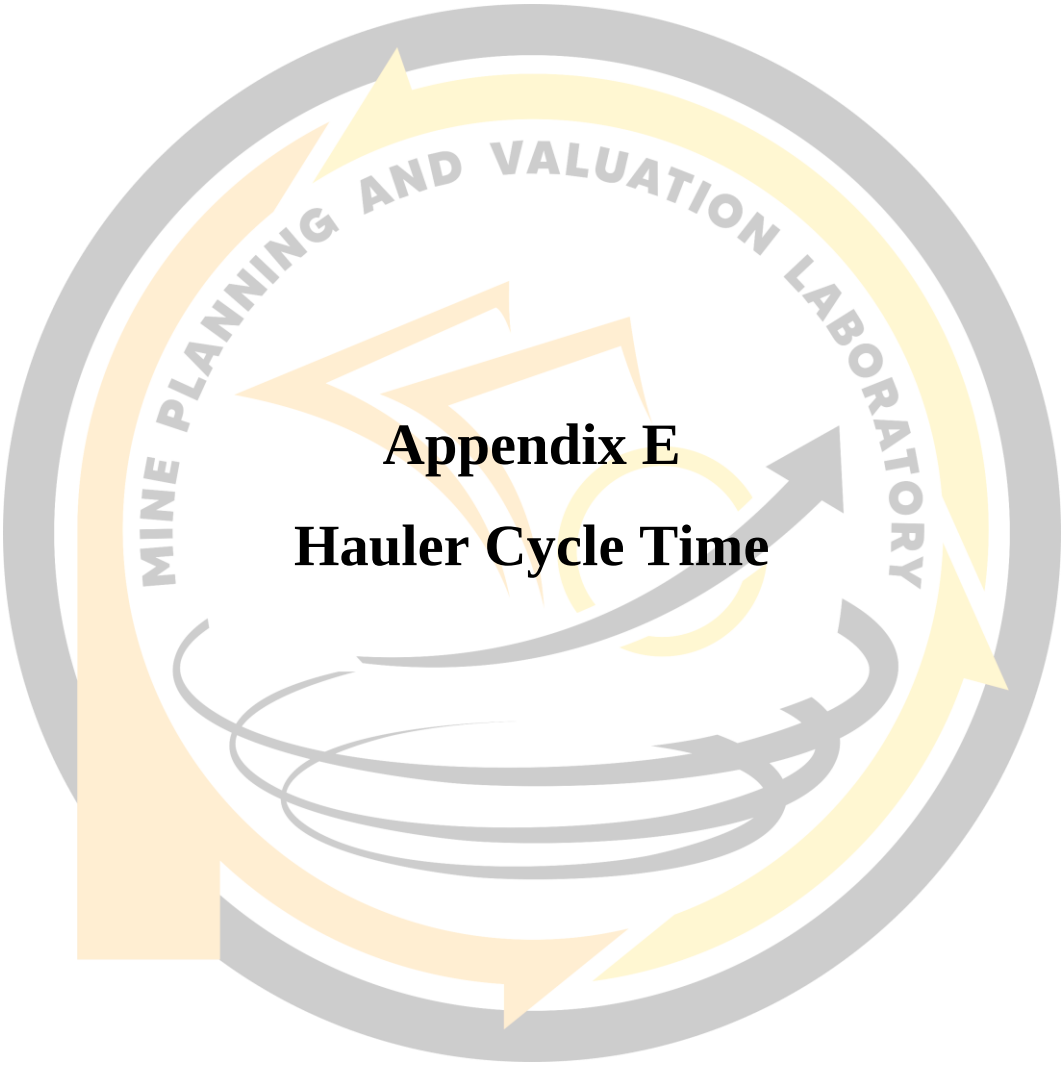
Num	Date	Crusher Production (Tonnage)	Total exp cost (Rp)	COGS (Rp)
1	01 November 2022	31,174	86245200	2,766.57
2	02 November 2022	22,864	72932550	3,189.84
3	03 November 2022	26,469	105593500	3,989.33
4	04 November 2022	26,770	70385500	2,629.27
5	05 November 2022	27,616	104576100	3,786.79
6	06 November 2022	8,366	-	-
7	07 November 2022	14,872	91843250	6,175.58
8	08 November 2022	15,936	72676100	4,560.50
9	09 November 2022	16,896	80517650	4,765.49
10	10 November 2022	25,394	69569100	2,739.59
11	11 November 2022	24,977	83484800	3,342.47
12	12 November 2022	22,407	71915600	3,209.51
13	13 November 2022	7,685	-	-
14	14 November 2022	22,971	85521250	3,723.01
15	15 November 2022	26,372	69245750	2,625.73
16	16 November 2022	25,231	95889950	3,800.48
17	17 November 2022	25,491	103013200	4,041.16
18	18 November 2022	21,503	60601150	2,818.26
19	19 November 2022	26,778	64532800	2,409.92
20	20 November 2022	-	-	-
21	21 November 2022	27,432	103090850	3,758.05
22	22 November 2022	27,105	110726100	4,085.08
23	23 November 2022	11,493	80532900	7,007.13
24	24 November 2022	24,942	73798700	2,958.81
25	25 November 2022	23,494	73466500	3,127.03
26	26 November 2022	18,227	-	-
27	27 November 2022		-	-
28	28 November 2022	20,682	86856400	4,199.61
29	29 November 2022	20,426	98007650	4,798.18
30	30 November 2022	21,117	64175150	3,039.03

Appendix D

Daily Production Report

Table 9 Limestone production report for November 2022

Date	Target	Production for each vendor (ton)			
		Topabiring	Batara	UTSG	Annur
1	30000	7895.12	8192.21	9920.85	5165.93
2	30000	7027.77	6169.13	6361.23	3306.53
3	30000	6333.09	6720.47	8191.54	4328.35
4	30000	5257.35	8000.67	8591.37	4920.75
5	30000	7697.08	6741.97	7812.09	5365.43
6	0	2904.41	1650.25	2261.5	1550.31
7	30000	4586.01	3894.14	3778.17	2614.56
8	30000	4698.88	4183.29	4795.83	2258.54
9	30000	4433.25	5162.73	4300.84	2999.55
10	30000	6605.71	6646.24	7426.98	4715.22
11	30000	7664.31	6103.81	6858.44	4351.04
12	30000	4773.55	5395.3	7903.91	4334.65
13	0	2330.41	2239.67	2330.84	784.51
14	30000	4743.43	6449.85	7245.73	4532.41
15	30000	7299.59	6070.51	7577.69	5425.15
16	30000	5703.11	7608.61	6734.49	5185.43
17	30000	7157.53	6028.28	7466.99	4839.11
18	30000	6314.31	4723.86	6058.23	4406.85
19	30000	6995.29	5003.12	9304.95	5475.04
20	0	0	0	0	0
21	30000	7416.58	6593.07	7465.26	5957.45
22	30000	7309.37	7733.99	6265.29	5796.56
23	30000	3175.51	2664.21	3282.49	2371.18
24	30000	7050.71	6442.08	7085.26	4364.88
25	30000	6526.55	7305.89	6359.26	3302.97
26	30000	5092.83	5083.19	4788.31	3263.19
27	0	0	0	0	0
28	30000	5703.18	5993.29	6186.87	2798.7
29	30000	6217.07	5257.89	5880.45	3073.27
30	30000	6948.03	4747.43	6082.03	3339.74
31	30000	0	0	0	0



Appendix E

Hauler Cycle Time

Table 10 Hauler cycle time for PT Batara Indo Prima

No.	Cycle Time	rate 1	rate 2	rate 1	rate 2	rate 1	rate 2	rate 1	rate 2	average
1	Loading Idle	00:28	02:30	01:53	00:43	01:18	01:40	01:09	01:50	**01:26**
2	Loading	03:08	02:38	02:51	02:55	03:47	03:17	03:22	03:10	**03:09**
3	Loaded Haul	05:50	04:16	06:44	05:49	03:17	03:30	05:11	05:20	**05:00**
4	Weighting	00:34	00:25	00:23	00:25	00:48	01:05	00:26	00:46	**00:36**
5	Dumping Idle	23:43	27:13	02:33	04:00	08:48	06:35	05:11	06:11	**10:32**
6	Dumping (Hopper)	00:21	00:23	00:26	00:20	02:55	00:57	00:36	00:40	**00:50**
7	Empty Haul	04:10	04:20	07:52	05:42	04:03	03:40	05:25	05:20	**05:04**
	TOTAL :	00:38:14	00:41:45	00:22:42	00:19:54	00:24:56	00:20:44	00:21:20	00:23:17	**0:22:18**
	TOTAL :	38.23	41.75	22.70	19.90	24.93	20.73	21.33	23.28	**22.30**
No.	**Description**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	
1	Loading point	B 9 middle		B 9 east		B 9 middle lower		B 10		
2	Loader	B29		B28		B30		B12		
3	Weight (ton)	30.91	28.68	27.89	26.4	24.51	22.06	29.34	31.2	**27.62375**
4	Dumping point	LS CR 5		LS CR 5		LS CR 5		LS CR 5		
5	Distance (km)	2 km		2 km		2 km		2.2 km		

Table 11 Hauler cycle time for CV Annur Abadi

Num.	Cycle Time	rate		rate		rate		rate		
		1	2	1	2	1	2	1	2	average
1	Loading Idle	00:00	00:00	00:00	00:49	00:00	00:00	04:00	00:00	**00:36**
2	Loading	02:25	03:56	02:57	03:09	03:10	02:41	03:59	02:37	**03:07**
3	Loaded Haul	05:57	05:38	06:58	08:05	05:45	05:34	05:07	05:54	**06:07**
4	Weighting	00:48	01:13	00:20	00:14	00:50	00:33	00:41	01:01	**00:42**
5	Dumping Idle	07:45	13:59	10:02	11:02	10:26	02:42	11:54	10:32	**09:48**
6	Dumping (Hopper)	00:51	01:36	00:24	00:35	00:20	00:20	00:31	00:25	**00:38**
7	Empty Haul	05:21	05:20	05:16	05:58	05:54	05:33	06:37	05:34	**05:42**
	TOTAL :	00:23:07	00:31:42	00:25:57	00:29:52	00:26:25	00:17:23	00:32:49	00:26:03	**00:26:40**
	TOTAL :	23.12	31.70	25.95	29.87	26.42	17.38	32.82	26.05	**26.67**
No.	**Description**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	
1	Loading point	B-9		B-9		B-9		B-8		
2	Loader	ANR09		ANR09		ANR09		ANR09		
3	Weight (ton)	34.62	33.62	28.8	29	30	25.17	31.14	32	**30.54375**
4	Dumping point	LS CR 5		LS CR 4		LS CR 4		LS CR 5		
5	Distance (km)	2 km		2 km		2 km		1,5 km		

Table 12 Hauler cycle time for PT Topabiring Trans Logistik

No.	Cycle Time	rate 1	rate 2	rate 1	rate 2	rate 1	rate 2	rate 1	rate 2	average
1	Loading Idle	09:45	06:54	00:57	01:00	00:00	00:00	00:00	00:00	**02:19**
2	Loading	02:12	03:06	02:27	02:32	02:27	02:37	04:30	05:15	**03:08**
3	Loaded Haul	04:56	04:59	04:24	03:55	09:56	11:54	07:49	07:40	**06:57**
4	Weighting	00:36	01:01	00:53	00:52	00:00	00:00	00:00	00:00	**00:25**
5	Dumping Idle	11:14	20:08	46:14	16:59	21:44	23:44	02:37	05:49	**18:34**
6	Dumping (Hopper)	00:56	00:40	00:20	00:30	22:41	23:21	01:06	02:20	**06:29**
7	Empty Haul	04:26	04:12	03:44	04:50	07:11	07:11	05:12	05:12	**05:15**
	TOTAL :	00:34:05	00:41:00	00:58:59	00:30:38	01:03:59	01:08:47	00:21:14	00:26:16	**00:43:07**
	TOTAL :	34.08	41.00	58.98	30.63	63.98	68.78	21.23	26.27	**43.12**
No.	**Description**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	
1	Loading point	B 9 middle		B 9 middle		B9		B-9		
2	Loader	T116		T145		T08		T08		
3	Weight (ton)	23.63	31	33	28	33.85	30.85	30.6	32	**30.36625**
4	Dumping point	LS CR 5		LS CR 5		LS CR 4		LS CR 4		
5	Distance (km)	2 km		2 km		2 km		2 km		

Table 13 Hauler cycle time for PT UTSG

No.	Cycle Time	rate 1	2	rate 1	2	rate 1	2	rate 1	2	average
1	Loading Idle	00:02	00:40	00:50	00:55	01:11	01:30	01:32	01:48	**01:04**
2	Loading	01:29	02:23	02:36	02:20	02:42	02:57	03:59	03:50	**02:47**
3	Loaded Haul	07:42	07:52	07:37	07:41	04:18	04:28	03:27	04:58	**06:00**
4	Weighting	01:26	00:19	00:40	01:09	02:02	01:06	01:10	01:36	**01:11**
5	Dumping Idle	01:07	00:28	01:08	01:06	00:25	00:32	03:09	06:27	**01:48**
6	Dumping (Hopper)	00:33	00:29	00:47	01:01	00:24	00:30	00:29	00:29	**00:35**
7	Empty Haul	06:44	06:50	07:10	06:55	04:08	04:12	04:24	04:20	**05:35**
	TOTAL :	00:19:03	00:19:01	00:20:48	00:21:07	00:15:10	00:15:15	00:18:10	00:21:40	**00:18:47**
	TOTAL :	19.05	19.02	20.80	21+7/60	15.17	15.25	18.17	21.67	**18.78**
No.	**Description**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	
1	Loading point	B 9 north		B 9 north		B 8		B 8		
2	Loader	U26		U23		U51		U30		
3	Weight (ton)	32.24	35.08	34	32.82	23.95	27.43	32.55	30.25	**31.04**
4	Dumping point	LS CR 4		LS CR 4		LS CR 4		LS CR 4		
5	Distance (KM)	2 KM		2 KM		1,5 KM		1,5 KM		

Appendix F

Loader Cycle Time

Table 14 Loader cycle time for PT Batara Indo Prima

No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location
1	Digging	00:04	00:11	00:11	00:12	00:17	00:09	00:09			02:41	00:23	KBC SK480	B18	B 8
2	Swing Loaded	00:05	00:03	00:03	00:04	00:06	00:03	00:06							
3	Dumping	00:02	00:04	00:05	00:05	00:04	00:03	00:05							
4	Swing Empty	00:04	00:07	00:07	00:03	00:03	00:04	00:03							
	TOTAL	00:15	00:25	00:27	00:24	00:30	00:20	00:22							
No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location
1	digging	00:03	00:09	00:07	00:05	00:04	00:04	00:05			01:58	00:17	KBC SK480	B17	B 8
2	Swing Loaded	00:02	00:02	00:05	00:05	00:04	00:02	00:03							
3	dumping	00:02	00:02	00:03	00:05	00:05	00:07	00:05							
4	Swing Empty	00:04	00:04	00:04	00:02	00:05	00:05	00:04							
	TOTAL	00:11	00:18	00:19	00:17	00:18	00:18	00:17							
No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location
1	digging	00:03	00:00:017.84	00:03	00:15	00:22	00:04				02:07	00:15	KBC SK480	B18	B 8
2	Swing Loaded	00:04	00:04	00:00:014.32	00:03	00:06	00:15								
3	dumping	00:03	00:06	00:04	00:03	00:04	00:04								
4	Swing Empty	00:08	00:01	00:02	00:02	00:04	00:08								
	TOTAL	00:19	00:10	00:09	00:23	00:37	00:30								
No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location
1	digging	00:06	00:16	00:03	00:14	00:05	00:14				02:19	00:23		B17	B 8

2	Swing Loaded	00:02	00:04	00:14	00:04	00:10	00:03						KBC SK480		
3	dumping	00:04	00:06	00:04	00:04	00:05	00:02								
4	Swing Empty	00:04	00:01	00:02	00:03	00:06	00:04								
	TOTAL	00:16	00:26	00:23	00:26	00:25	00:23								
No.	**Cycle Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**	**average**	**Unit**	**D.T.**	**Location**
1	digging	00:03	00:04	00:05	00:05	00:05	00:08	00:11			**02:47**	**00:23**	**KBC SK480**	**B17**	**B 8**
2	Swing Loaded	00:04	00:04	00:03	00:02	00:10	00:02	00:06							
3	dumping	00:05	00:08	00:05	00:04	00:05	00:01	00:04							
4	Swing Empty	00:13	00:06	00:14	00:04	00:06	00:12	00:07							
	TOTAL	00:26	00:22	00:27	00:15	00:25	00:23	00:28							
No.	**Cycle Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**	**average**	**Unit**	**D.T.**	**Location**
1	digging	00:18	00:07	00:06	00:10	00:03	00:08	00:08			**02:48**	**00:24**	**KBC SK480**	**B17**	**B 8**
2	Swing Loaded	00:05	00:06	00:03	00:04	00:06	00:06	00:06							
3	dumping	00:04	00:08	00:05	00:05	00:05	00:04	00:03							
4	Swing Empty	00:06	00:05	00:07	00:07	00:03	00:05	00:06							
	TOTAL	00:33	00:26	00:21	00:25	00:17	00:22	00:24							

Table 15 Loader cycle time for CV Annur Abadi

No.	**Cycle Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**	**average**	**Unit**	**D.T.**	**Location**
1	digging	00:10	00:10	00:14	00:05	00:08	00:11	00:09	00:03	00:04	**03:38**	**00:24**	**Dosan 500CV**	**A.11**	**B 9**
2	Swing Loaded	00:07	00:05	00:03	00:03	00:09	00:14	00:06	00:05	00:03					

3	dumping	00:02	00:02	00:03	00:03	00:07	00:11	00:12	00:05	00:05					
4	Swing Empty	00:04	00:04	00:04	00:03	00:04	00:04	00:04	00:09	00:05					
	TOTAL	00:22	00:21	00:23	00:14	00:28	00:40	00:31	00:22	00:17					
No.	**Cycle Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**	**average**	**Unit**	**D.T.**	**Location**
1	digging	00:11	00:13	00:10	00:10	00:15	00:08				**03:21**	**00:34**	**Dosan 500CV**	**A.11**	**B 9**
2	Swing Loaded	00:10	00:09	00:08	00:08	00:06	00:06								
3	dumping	00:02	00:04	00:04	00:04	00:04	00:03								
4	Swing Empty	00:10	00:09	00:10	00:11	00:13	00:13								
	TOTAL	00:33	00:35	00:33	00:33	00:37	00:30								
No.	**Cycle Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**	**TOTAL**	**Unit**	**D.T.**	**Location**
1	digging	00:11	00:05	00:12	00:11	00:11	00:13	00:15			**03:26**	**00:29**	**Dosan 500CV**	**A.11**	**B 9**
2	Swing Loaded	00:05	00:03	00:06	00:07	00:07	00:07	00:07							
3	dumping	00:03	00:03	00:04	00:04	00:04	00:04	00:03							
4	Swing Empty	00:05	00:12	00:09	00:10	00:10	00:08	00:05							
	TOTAL	00:25	00:23	00:32	00:32	00:32	00:33	00:29							
No.	**Cycle Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**	**average**	**Unit**	**D.T.**	**Location**
1	digging	00:08	00:08	00:09	00:06	00:05	00:04	00:05			**02:25**	**00:21**	**Dosan 500CV**	**A.11**	**B 9**
2	Swing Loaded	00:04	00:04	00:04	00:06	00:03	00:04	00:06							
3	dumping	00:08	00:02	00:02	00:02	00:03	00:04	00:07							
4	Swing Empty	00:02	00:05	00:04	00:10	00:08	00:05	00:04							
	TOTAL	00:22	00:20	00:20	00:24	00:19	00:17	00:22							

No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location
1	digging	00:05	00:13	00:10	00:05	00:08	00:22				02:31	00:25	Dosan 500CV	A.11	B 9
2	Swing Loaded	00:08	00:05	00:05	00:05	00:04	00:05								
3	dumping	00:03	00:04	00:03	00:05	00:07	00:04								
4	Swing Empty	00:07	00:06	00:06	00:03	00:04	00:04								
	TOTAL	00:23	00:29	00:24	00:18	00:24	00:35								

Table 16 Loader cycle time for PT Topabiring Trans Logistik

No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location
1	digging	00:09	00:11	00:04	00:11	00:13	00:05				02:09	00:21	PC-500	T.137	B 8
2	Swing Loaded	00:05	00:05	00:04	00:05	00:05	00:00								
3	dumping	00:01	00:02	00:03	00:05	00:04	00:03								
4	Swing Empty	00:04	00:04	00:03	00:06	00:10	00:08								
	TOTAL	00:18	00:22	00:14	00:27	00:31	00:16								
No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location
1	digging	00:03	00:03	00:07	00:04	00:05	00:03				01:31	00:15	PC-500	T.120	B 8
2	Swing Loaded	00:02	00:02	00:03	00:02	00:03	00:03								
3	dumping	00:04	00:04	00:02	00:04	00:04	00:04								
4	Swing Empty	00:05	00:07	00:06	00:05	00:04	00:02								
	TOTAL	00:14	00:16	00:18	00:15	00:16	00:12								
No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location

1	digging	00:04	00:07	00:02	00:05	00:05	00:09				**01:30**	**00:15**	**PC-500**	**T.115**	**B 8**
2	Swing Loaded	00:01	00:04	00:03	00:05	00:03	00:02								
3	dumping	00:02	00:02	00:03	00:03	00:03	00:04								
4	Swing Empty	00:04	00:09	00:03	00:04	00:03	00:02								
	TOTAL	00:11	00:22	00:11	00:16	00:13	00:17								
No.	**Cycle Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**	**average**	**Unit**	**D.T.**	**Location**
1	digging	00:11	00:13	00:11	00:09	00:09	00:06				**02:47**	**00:28**	**PC-500**	**T.115**	**B 8**
2	Swing Loaded	00:03	00:06	00:07	00:08	00:06	00:03								
3	dumping	00:06	00:05	00:04	00:04	00:08	00:02								
4	Swing Empty	00:14	00:08	00:08	00:07	00:09	00:03								
	TOTAL	00:34	00:32	00:29	00:27	00:32	00:13								
No.	**Cycle Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**	**average**	**Unit**	**D.T.**	**Location**
1	digging	00:07	00:13	00:12	00:23	00:19	00:13	00:10			**04:14**	**00:36**	**PC-500**	**T.115**	**B 8**
2	Swing Loaded	00:04	00:06	00:08	00:06	00:12	00:08	00:08							
3	dumping	00:04	00:05	00:12	00:06	00:06	00:07	00:07							
4	Swing Empty	00:14	00:08	00:06	00:07	00:09	00:10	00:04							
	TOTAL	00:29	00:32	00:38	00:43	00:46	00:38	00:29							

Table 17 Loader cycle time for PT UTSG

No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location
1	digging	00:02	00:04	00:04	00:08	00:11	00:03	00:05			01:47	00:15	PC300	Q54	B 8
2	Swing Loaded	00:01	00:04	00:03	00:04	00:06	00:03	00:04							
3	dumping	00:02	00:10	00:01	00:02	00:03	00:02	00:03							
4	Swing Empty	00:02	00:03	00:01	00:02	00:07	00:05	00:02							
	TOTAL	00:07	00:20	00:10	00:16	00:26	00:13	00:14							
No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location
1	digging	00:11	00:09	00:06	00:11	00:06	00:08	00:11			03:03	00:26	PC300	Q25	B 8
2	Swing Loaded	00:48	00:06	00:05	00:05	00:03	00:02	00:06							
3	dumping	00:03	00:02	00:02	00:02	00:05	00:02	00:03							
4	Swing Empty	00:05	00:04	00:03	00:02	00:03	00:04	00:05							
	TOTAL	01:07	00:22	00:17	00:20	00:17	00:16	00:25							
No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location
1	digging	00:02	00:03	00:10	00:13	00:14	00:04	00:08	00:09		02:21	00:18	PC300	Q27	B 8
2	Swing Loaded	00:04	00:05	00:03	00:05	00:04	00:02	00:03	00:02						
3	dumping	00:00:05,64	00:03	00:03	00:02	00:04	00:03	00:02	00:03						
4	Swing Empty	00:03	00:03	00:03	00:02	00:07	00:05	00:04	00:03						
	TOTAL	00:09	00:13	00:20	00:22	00:29	00:14	00:17	00:17						
No.	Cycle Time	1	2	3	4	5	6	7	8	9	TOTAL	average	Unit	D.T.	Location
1	digging	00:06	00:08	00:12	00:11	00:09	00:14	00:07	00:12		02:18	00:17	PC300	Q54	B 8

2	Swing Loaded	00:04	00:02	00:03	00:03	00:02	00:03	00:03	00:02						
3	dumping	00:02	00:01	00:02	00:02	00:02	00:02	00:02	00:02						
4	Swing Empty	00:03	00:04	00:03	00:01	00:03	00:03	00:02	00:03						
	TOTAL	00:15	00:15	00:19	00:17	00:16	00:23	00:14	00:19						

Appendix G

Productivity Rate

Table 18 Loader Productivity

Vendor	Type	Density (ton/m^3)	Fill Factor (%)	Bucket Capacity (m^3)	Swell Factor	Efficiency (%)	Cycle time	Cycle time (s)	Productivity (ton/hour)	Operating units
PT. BATARA INDO PRIMA	KBC SK480	2.3	0.95	1.9	0.95	0.8	02:27	147	77	1
CV. ANNUR ABADI	Dosan 500CV	2.3	0.95	2.91	0.95	0.8	03:02	182	96	1
PT. TOPABIRING TRANS LOGISTIK	PC-500	2.3	0.95	2.7	0.95	0.8	02:27	147	110	1
PT. UTSG	PC-300	2.3	0.95	1.8	0.95	0.8	02:45	165	65	1

Table 19 Hauler Cycle Time

Vendor	Unit	Type	Fill Factor (%)	Weight (ton)	Bucket Capacity (ton)	Swell Factor	Efficiency (%)	Cycle time	Cycle time (s)	rate	Productivity (ton/day)	Operating Units	MF
PT. BATARA INDO PRIMA	B29	ISUZU285TI	0.95	29.795	35	0.95	0.8	00:39:59	2399	9	291	9	0.5
	B28	ISUZU285TI	0.95	27.145	35	0.95	0.8	00:21:18	1278	5	276		0.0
	B30	ISUZU285TI	0.95	23.285	35	0.95	0.8	00:22:50	1370	13	574		0.0
	B12	ISUZU285TI	0.95	30.27	35	0.95	0.8	00:22:18	1338	12	706		0.0
CV. ANNUR ABADI	A 09	HINO260	0.95	34.12	35	0.95	0.8	00:27:25	1645	11	593	6	0.7
	A 16	HINO260	0.95	28.9	35	0.95	0.8	00:27:55	1675	10	448		0.0
	A 21	HINO500	0.95	27.585	35	0.95	0.8	00:21:54	1314	11	600		0.0
	A 04	HINO260	0.95	31.57	35	0.95	0.8	00:29:26	1766	11	511		0.0
PT. TOPABIRING TRANS LOGISTIK	T 116	HINO500	0.95	27.315	35	0.95	0.8	00:37:33	2253	16	504	8	0.4
	T 145	FUSOFIGHTER	0.95	30.5	35	0.95	0.8	00:44:48	2688	7	206		0.0
	T 118	HINO500	0.95	32.35	35	0.95	0.8	01:06:23	3983	17	359		0.0
	T 119	HINO500	0.95	31.3	35	0.95	0.8	00:23:45	1425	7	400		0.0

Vendor	Unit	Type	Fill Factor (%)	Weight (ton)	Bucket Capacity (ton)	Swell Factor	Efficiency (%)	Cycle time	Cycle time (s)	rate	Productivity (ton/day)	Operating Units	MF
PT. UTSG	U26	CWE 370 QUESTER	0.95	33.66	35	0.95	0.8	00:19:02	1142	12	919	7	0.8
	U23	CWE 370 QUESTER	0.95	33.41	35	0.95	0.8	00:20:58	1258	9	621		0.0
	U51	CWE 370 QUESTER	0.95	25.69	35	0.95	0.8	00:15:12	912	8	586		0.0
	U30	CWE 370 QUESTER	0.95	31.4	35	0.95	0.8	00:19:55	1195	11	751		0.0

Appendix H

Equipment Availability

Table 20 Equipment performance November 2022 for PT Topabiring Trans Logistik

Date	TOPABIRING						Dump Truck		Excavator	
	Operating		Standby		Maintenance					
	L	H	L	H	L	H	PA	MA	PA	MA
1	3.0	12.3	-	-	2.0	11.5	52%	52%	60%	60%
2	3.0	11.3	-	-	2.0	13.0	47%	47%	60%	60%
3	3.0	11.3	-	-	1.0	6.0	65%	65%	75%	75%
4	-	-	-	-	5.0	30.0	0%	0%	0%	0%
5	2.0	10.7	-	-	3.0	14.0	43%	43%	40%	40%
6	2.0	10.0	-	-	3.0	15.0	40%	40%	40%	40%
7	2.0	10.7	-	-	2.0	14.0	43%	43%	50%	50%
8	0.3	2.0	0.5	5.5	3.0	9.5	44%	17%	22%	10%
9	1.3	10.0	-	-	3.0	15.0	40%	40%	31%	31%
10	1.3	9.7	-	-	3.0	15.0	39%	39%	31%	31%
11	-	-	-	-	5.0	30.0	0%	0%	0%	0%
12	1.3	10.7	-	-	3.0	14.0	43%	43%	31%	31%
13	1.3	11.3	-	-	3.0	13.0	47%	47%	31%	31%
14	1.3	10.7	-	-	3.0	14.0	43%	43%	31%	31%
15	1.3	10.7	-	-	3.0	14.0	43%	43%	31%	31%
16	1.3	11.0	-	-	3.0	13.5	45%	45%	31%	31%
17	1.0	10.0	-	-	3.0	14.0	42%	42%	25%	25%
18	-	-	-	-	5.0	30.0	0%	0%	0%	0%
19	1.3	9.7	-	-	3.0	15.5	38%	38%	31%	31%
20	1.3	10.3	-	-	3.0	14.5	42%	42%	31%	31%
21	1.3	9.0	-	-	3.0	16.5	35%	35%	31%	31%
22	0.7	9.7	1.0	-	2.5	15.5	38%	38%	40%	21%
23	0.7	6.7	1.0	3.7	2.5	14.5	42%	31%	40%	21%
24	1.3	10.0	-	-	3.0	14.0	42%	42%	31%	31%
25	-	-	-	-	5.0	30.0	0%	0%	0%	0%
26	1.3	9.7	-	-	2.5	15.5	38%	38%	35%	35%
27	1.3	10.3	-	-	2.5	14.5	42%	42%	35%	35%
28	0.7	4.7	-	-	2.5	16.5	22%	22%	21%	21%
29	1.0	8.0	1.0	1.0	2.0	16.5	35%	33%	50%	33%
30	-	-	-	-	5.0	30.0	0%	0%	0%	0%
31	1.4	9.2	0.1	0.4	2.8	14.6	40%	39%	36%	34%

Table 21 Equipment performance November 2022 for PT Batara Indo Prima

Date	BATARA						Dump Truck		Excavator	
	Operating		Standby		Maintenance					
	AM	AA	AM	AA	AM	AA	PA	MA	PA	MA
1	2.0	12.0	-	-	2.0	10.0	55%	55%	50%	50%
2	2.0	15.0	-	-	2.0	7.5	67%	67%	50%	50%
3	1.3	11.3	0.3	-	2.0	11.0	51%	51%	45%	40%
4	-	-	-	-	5.0	30.0	0%	0%	0%	0%

Date	BATARA						Dump Truck		Excavator	
	Operating		Standby		Maintenance					
	AM	AA	AM	AA	AM	AA	PA	MA	PA	MA
5	1.7	10.7	0.3	1.0	2.0	12.5	48%	46%	50%	45%
6	1.7	11.7	-	0.7	2.5	11.5	52%	50%	40%	40%
7	2.0	12.0	-	-	2.0	12.0	50%	50%	50%	50%
8	0.7	5.7	1.0	6.5	2.0	6.0	67%	49%	45%	25%
9	1.3	10.0	0.5	4.5	2.0	6.0	71%	63%	48%	40%
10	2.0	13.7	-	1.5	2.0	6.0	72%	69%	50%	50%
11	-	-	-	-	5.0	30.0	0%	0%	0%	0%
12	1.3	12.0	-	-	3.0	9.5	56%	56%	31%	31%
13	2.0	14.0	-	-	2.0	7.5	65%	65%	50%	50%
14	1.3	9.7	-	-	3.0	12.0	45%	45%	31%	31%
15	1.0	12.3	0.7	-	2.5	10.0	55%	55%	40%	29%
16	1.3	10.3	0.3	3.5	2.5	9.0	61%	53%	40%	35%
17	1.3	9.7	0.5	4.0	2.0	6.0	69%	62%	48%	40%
18	-	-	-	-	5.0	30.0	0%	0%	0%	0%
19	1.3	11.3	-	-	3.0	9.5	54%	54%	31%	31%
20	1.3	12.0	-	-	3.0	8.5	59%	59%	31%	31%
21	1.3	12.7	0.5	-	2.0	10.0	56%	56%	48%	40%
22	1.3	8.3	0.5	2.5	2.0	9.5	53%	47%	48%	40%
23	1.0	6.0	0.3	5.7	3.0	12.5	48%	32%	31%	25%
24	1.3	5.7	-	6.5	3.0	8.0	60%	41%	31%	31%
25	-	-	-	-	5.0	30.0	0%	0%	0%	0%
26	1.3	12.0	-	-	3.0	9.5	56%	56%	31%	31%
27	1.3	11.0	-	-	3.0	11.5	49%	49%	31%	31%
28	0.7	6.3	-	-	3.0	10.5	38%	38%	18%	18%
29	1.0	10.0	-	0.5	3.5	11.0	49%	48%	22%	22%
30	-	-	-	-	5.0	30.0	0%	0%	0%	0%
31	1.3	10.2	0.2	1.4	2.6	10.3	53%	50%	37%	34%

Table 22 Equipment performance November 2022 for PT UTSG

Date	UTSG						Dump Truck		Excavator	
	Operating		Standby		Maintenance					
	AM	AA	AM	AA	AM	AA	PA	MA	PA	MA
1	2.0	7.7	-	4.7	2.0	11.5	52%	40%	50%	50%
2	1.7	7.7	0.7	2.3	1.5	15.0	40%	34%	61%	53%
3	1.3	8.3	1.3	2.3	1.0	10.0	52%	45%	73%	57%
4	-	-	-	-	5.0	30.0	0%	0%	0%	0%
5	2.0	8.3	-	4.0	2.0	11.5	52%	42%	50%	50%
6	2.0	8.3	-	4.0	2.0	11.5	52%	42%	50%	50%
7	1.7	7.7	0.7	4.7	1.5	11.5	52%	40%	61%	53%

Date	UTSG											
	Operating		Standby		Maintenance		Dump Truck		Excavator		EU	
	AM	AA	AM	AA	AM	AA	PA	MA	PA	MA	Dump Truck	Excavator
8	1.0	4.7	1.3	6.7	1.5	13.0	47%	26%	61%	40%	12%	24%
9	1.7	9.0	0.7	2.3	1.5	13.0	47%	41%	61%	53%	19%	32%
10	1.7	8.7	0.7	2.7	2.0	13.0	47%	40%	54%	45%	19%	24%
11	-	-	-	-	5.0	30.0	0%	0%	0%	0%	0%	0%
12	1.3	8.3	1.3	3.0	1.0	13.0	47%	39%	73%	57%	18%	42%
13	1.7	8.7	0.7	2.7	1.5	13.0	47%	40%	61%	53%	19%	32%
14	1.7	9.7	0.7	1.7	1.5	13.0	47%	43%	61%	53%	20%	32%
15	1.7	8.7	0.7	2.7	1.5	13.0	47%	40%	61%	53%	19%	32%
16	1.7	8.3	0.7	3.0	1.5	13.0	47%	39%	61%	53%	18%	32%
17	1.7	8.3	0.3	3.0	2.0	13.0	47%	39%	50%	45%	18%	23%
18	-	-	-	-	5.0	30.0	0%	0%	0%	0%	0%	0%
19	1.3	8.3	1.3	3.0	1.0	13.0	47%	39%	73%	57%	18%	42%
20	1.3	9.3	2.0	2.0	-	13.0	47%	42%	100%	100%	19%	100%
21	1.3	9.0	2.0	2.3	-	13.0	47%	41%	100%	100%	19%	100%
22	0.7	4.0	2.7	7.3	-	13.0	47%	24%	100%	100%	11%	100%
23	1.0	6.0	2.3	5.3	-	13.0	47%	32%	100%	100%	15%	100%
24	2.5	12.0	2.5	5.0	-	13.0	57%	48%	100%	100%	27%	100%
25	-	-	-	-	5.0	30.0	0%	0%	0%	0%	0%	0%
26	1.0	8.0	2.3	3.7	-	12.5	48%	39%	100%	100%	19%	100%
27	1.7	7.3	1.7	4.0	-	13.0	47%	36%	100%	100%	17%	100%
28	1.0	7.7	3.5	5.5	-	13.0	50%	37%	100%	100%	19%	100%
29	0.7	6.0	2.7	5.3	-	13.0	47%	32%	100%	100%	15%	100%
30	-	-	-	-	5.0	30.0	0%	0%	0%	0%	0%	0%
31	1.4	7.7	1.3	3.6	1.2	13.4	46%	37%	70%	55%	17%	39%

Table 23 Equipment performance November 2022 for CV Annur Abadi

Date	ANNUR									
	Operating		Standby		Maintenance		Dump Truck		Excavator	
	L	H	L	H	L	H	PA	MA	PA	MA
1	1.3	5.7	-	-	2.0	15.5	27%	27%	40%	40%
2	0.7	5.7	-	-	3.0	15.5	27%	27%	18%	18%
3	0.7	5.3	-	-	3.0	16.0	25%	25%	18%	18%
4	-	-	-	-	4.0	24.0	0%	0%	0%	0%
5	0.7	6.0	-	-	3.0	15.0	29%	29%	18%	18%
6	0.7	7.3	0.3	-	2.5	13.0	36%	36%	29%	21%
7	1.3	7.3	-	-	2.0	13.0	36%	36%	40%	40%
8	-	-	1.3	5.5	2.0	9.5	37%	0%	40%	0%
9	0.7	8.3	0.3	-	2.5	11.5	42%	42%	29%	21%
10	1.3	8.7	-	-	2.0	11.0	44%	44%	40%	40%
11	-	-	-	-	4.0	24.0	0%	0%	0%	0%
12	1.3	8.7	-	-	2.0	11.0	44%	44%	40%	40%

Date	ANNUR Operating		Standby		Maintenance		Dump Truck		Excavator Operating	
	L	H	L		L	H	L		L	H
13	1.3	8.7	-	-	2.0	11.0	44%	44%	40%	40%
14	1.3	8.7	-	-	2.0	11.0	44%	44%	40%	40%
15	1.3	8.7	-	-	2.0	11.0	44%	44%	40%	40%
16	1.3	8.3	-	-	2.0	11.5	42%	42%	40%	40%
17	1.3	8.7	-	-	2.0	11.0	44%	44%	40%	40%
18	-	-	-	-	4.0	24.0	0%	0%	0%	0%
19	1.3	8.3	-	-	2.0	11.5	42%	42%	40%	40%
20	1.3	8.0	-	-	2.0	12.0	40%	40%	40%	40%
21	1.3	7.0	-	-	2.0	13.5	34%	34%	40%	40%
22	0.7	6.3	0.7	-	2.0	14.5	30%	30%	40%	25%
23	1.0	4.3	0.3	2.7	2.0	13.5	34%	24%	40%	33%
24	1.3	5.7	-	-	2.0	15.0	27%	27%	40%	40%
25	-	-	-	-	4.0	24.0	0%	0%	0%	0%
26	1.3	6.7	-	-	2.0	14.0	32%	32%	40%	40%
27	1.3	7.3	-	-	2.0	13.0	36%	36%	40%	40%
28	1.0	6.0	3.0	14.5	2.0	13.5	60%	31%	67%	33%
29	0.7	7.3	0.7	-	2.0	13.0	36%	36%	40%	25%
30	-	-	-	-	4.0	24.0	0%	0%	0%	0%
31	1.0	6.7	0.3	0.9	2.2	13.2	36%	33%	36%	31%

Appendix I
Haul Road Measurement

Table 24 Haul road segments measurement

Segment	Coordinate		Length	Width	h1	Gradient	
	start	end				deg	%
A-B	S 4° 47’ 21.3” E 119° 37’ 16.7”	S 4° 47’ 19.4 E 119° 37’ 16.9”	34	3.78	59	8	13
B-C	S 4° 47’ 17.1” E 119° 37’ 19”	S 4° 47’ 18.6” E 119° 37’ 24.8”	130	23.75	64	7	14
C-D	S 4° 47’ 18.6” E 119° 37’ 24.8”	S 4° 47’ 22.7” E 119° 37’ 28.3”	90	50	86	8	13
D-E	S 4° 47’ 22.7” E 119° 37’ 28.3”	S 4° 47’ 25.4” E 119° 37’ 30.4”	42	9.2	107	9	20
E-F	S 4° 47’ 25.4” E 119° 37’ 30.4”	S 4° 47’ 27.4” E 119° 37’ 32”	76	12.1	119	8	14
F-G	S 4° 47’ 27.4” E 119° 37’ 32”	S 4° 47’ 26.5” E 119° 37’ 35.8”	144	13.8	131	9	16
G-H	S 4° 47’ 26.5” E 119° 37’ 35.8”	S 4° 47’ 20.4” E 119° 37’ 39.4”	47	15	145	11	19
H-I	S 4° 47’ 21.3” E 119° 37’ 16.7”	S 4° 47’ 21.3” E 119° 37’ 16.7”	59	11.6	151	8	15

Table 25 Road curve measurement

Segment	curve angle (north to east)		angle (degree)	radius (m)	curve width (m)
	curve 1	curve 2			
B-C	76	115	39	5	20.2
C-D	137	42	95	5.6	29.1
E-F	95	71	24	6	17
I-J	286	93	193	5.3	19.57

Appendix J

Haul Road Measurement Map

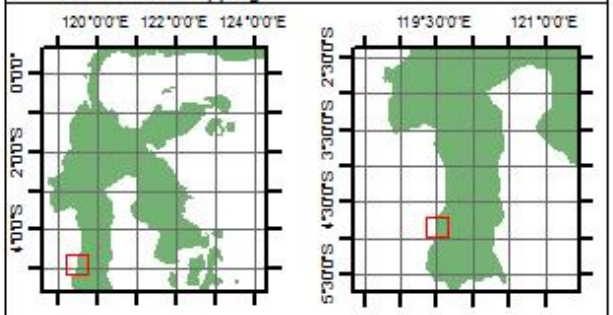
N
W E
S

0.1 0.05 0 0.1 Km

Legend

Segment
Contour

Carographic Information
Projection: UTM, Zoe 50S
Datum Unit: WGS-84
Souce: Drone Mapping



MINING ENGINEERING DEPARTMENT
FACULTY OF ENGINEERING
HASANUDDIN UNIVERSITY
2023

BACHELOR THESIS

EVALUATION OF FAILURE IN LIMESTONE PRODUCTION AT PT SEMEN TONASA, PANGKEP REGENCY, SOUTH SULAWESI

DRAWN BY	ANGELIE SANTOSA D111191045
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ROAD MEASUREMENT MAP

APPENDIX J

Appendix K

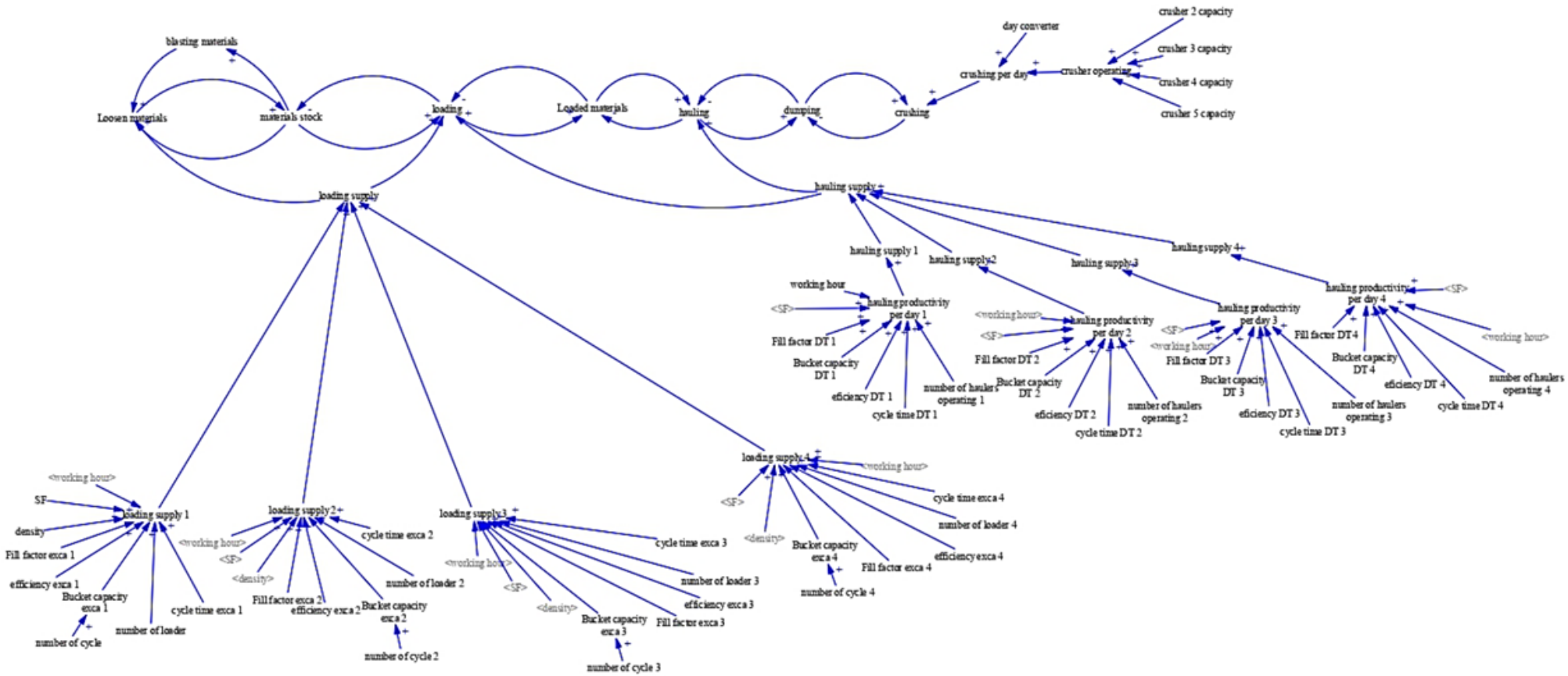
Rainfall Report

Table 26 Rainfall Report November 2022

Date	NOVEMBER	
	DATA (ml)	CH (mm)
1	700	22.29
2	600	19.11
3	500	15.92
4	100	3.18
5	1,100	35.03
6	-	-
7	-	-
8	700	22.29
9	100	3.18
10	800	25.48
11	300	9.55
12	800	25.48
13	-	-
14	200	6.37
15	100	3.18
16	-	-
17	4,000	127.39
18	4,000	127.39
19	1,700	54.14
20	500	15.92
21	-	-
22	1,500	47.77
23	500	15.92
24	200	6.37
25	100	3.18
26	300	9.55
27	350	11.15
28	100	3.18
29	-	-
30	100	3.18
31	-	-
	Total	**616.24**
	Max	**127.39**
	Min	**0.00**
	Average	**11.37**
	Rainy day(s)	**10**
	P	16.50

Appendix L

Causal Loop Diagram



LEGEND

Connector

Loop

Postive effect

Negative effect

CAUSAL LOOP DIAGRAM

APPENDIX L | PAGE 96

MINING ENGINEERING DEPARTMENT
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HASANUDDIN UNIVERSITY
2023

DRAWN BY	Angelie Santosa D111191045
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CO - SUPERVISOR	Dr. Eng. Rini Novrianti Sutardjo Tui, S.T., MT., MBA NIP. 198311142014042001

Appendix M

SFD Equation

Hauling process

Hauling_supply =
hauling_supply_1+hauling_supply_2+hauling_supply_3+hauling_supply_4

loading_supply =
loading_supply_1+loading_supply_2+loading_supply_3+loading_supply_4

MF_1 =
(number_of_haulers_operating_1*cycle_time_exca_1)/(cycle_time_DT_1*numbe
r_of_loader_1)

MF_2 =
(number_of_haulers_operating_2*cycle_time_exca_2)/(number_of_loader_2*cyc
le_time_DT_2)

MF_3 =
(number_of_haulers_operating_3*cycle_time_exca_3)/(cycle_time_DT_3*numbe
r_of_loader_3)

MF_4 =
(number_of_haulers_operating_4*cycle_time_exca_4)/(cycle_time_DT_4*numbe
r_of_loader_4)

dumping(t) = dumping(t - dt) + (hauling - crushing) * dtINIT dumping = hauling
INFLOWS:
hauling = Hauling_supply-crushing
OUTFLOWS:
crushing = crushing_per_day
loaded_materials(t) = loaded_materials(t - dt) + (loading - hauling) * dtINIT
loaded_materials = loading
INFLOWS:

loading = loading_supply-Hauling_supply

OUTFLOWS:

hauling = Hauling_supply-crushing

material_stock(t) = material_stock(t - dt) + (loosen_materials - loading) * dtINIT

material_stock = random(21000,6000)

INFLOWS:

loosen_materials = if blasting_materials<=0 then

blasting_materials*materials_ramp else blasting_materials

OUTFLOWS:

loading = loading_supply-Hauling_supply

blasting_materials = material_stock-loading_supply

crusherr_2 = 1

crusherr_2_capacity = 450*crusherr_2

crusherr_3 = 1

crusherr_3_capacity = 250*crusherr_3

crusher_4 = 1

crusher_4_capacity = 1450*crusher_4

crusher_5 = 1

crusher_5_capacity = 1650*crusher_5

crusher_operating =

crusherr_2_capacity+crusherr_3_capacity+crusher_4_capacity+crusher_5_capacit

y

crushing_per_day = crusher_operating*day_converter

day_converter = 16

materials_ramp = blasting_materials+RAMP(slope_ramp/240,waktu_ramp)

slope_ramp = 61.2

waktu_ramp = 24

Bucket_capacity_DT_1 = 35

cycle_time_DT_1 = random(19.9,41.75)

efficiency_DT_1 = 0.8

Fill_factor_DT_1 = 0.95

hauling_productivity_per_day_1 =
hauling_productivity_per_hour_1*working_hour
hauling_productivity_per_hour_1 =
(SF*Fill_factor_DT_1*efficiency_DT_1*Bucket_capacity_DT_1*SF*number_of
_haulers_operating_1*minute_to_hour)/(cycle_time_DT_1)
hauling_supply_1 = hauling_productivity_per_day_1
minute_to_hour = 60
number_of_haulers_operating_1 = 9
working_hour = 16

Bucket_capacity_exca_1 = 1.9*number_of_cycle
cycle_time_exca_1 = random(1.97,2.8)
density = 2.3
efficiency_exca_1 = 0.8
Fill_Factor_Exca_1 = 0.95
loading_productivity_per_day_1 =
loading_productivity_per_hour_1*working_hour
loading_productivity_per_hour_1 =
(Bucket_capacity_exca_1*density*efficiency_exca_1*Fill_Factor_Exca_1*numb
er_of_loader_1*SF*minute_to_hour)/(cycle_time_exca_1)
loading_supply_1 = loading_productivity_per_day_1
number_of_cycle = random(6,7)
number_of_loader_1 = 2

Bucket_capacity_DT_2 = 35
cycle_time_DT_2 = random(17.383,32.817)
efficiency_DT_2 = 0.8
Fill_factor_DT_2 = 0.95
hauling_productivity_per_day_2 =
hauling_productivity_per_hour_2*working_hour

hauling_productivity_per_hour_2 =
(SF*Fill_factor_DT_2*efficiency_DT_2*Bucket_capacity_DT_2*SF*number_of
_haulers_operating_2*minute_to_hour)/(cycle_time_DT_2)
hauling_supply_2 = hauling_productivity_per_day_2
number_of_haulers_operating_2 = 6

Bucket_capacity_exca_2 = 2.91*number_of_cycle_2
cycle_time_exca_2 = random(2.15,3.63)
efficiency_exca_2 = 0.8
Fill_Factor_Exca_2 = 0.95
loading_productivity_per_day_2 =
loading_productivity_per_hour_2*working_hour
loading_productivity_per_hour_2 =
(Bucket_capacity_exca_2*density*efficiency_exca_2*Fill_Factor_Exca_2*numb
er_of_loader_2*SF*minute_to_hour)/(cycle_time_exca_2)
loading_supply_2 = loading_productivity_per_day_2
number_of_cycle_2 = random(6,9)
number_of_loader_2 = 1

Bucket_capacity_DT_3 = 35
cycle_time_DT_3 = random(21.233,68.783)
efficiency_DT_3 = 0.8
Fill_factor_DT_3 = 0.95
hauling_productivity_per_day_3 =
hauling_productivity_per_hour_3*working_hour
hauling_productivity_per_hour_3 =
(SF*Fill_factor_DT_3*efficiency_DT_3*Bucket_capacity_DT_3*SF*number_of
_haulers_operating_3*minute_to_hour)/(cycle_time_DT_3)
hauling_supply_3 = hauling_productivity_per_day_3
number_of_haulers_operating_3 = 8
SF = 0.95

Bucket_capacity_exca_3 = 2.7*number_of_cycle_3

cycle_time_exca_3 = random(1.5,4.23)

efficiency_exca_3 = 0.8

Fill_Factor_Exca_3 = 0.95

loading_productivity_per_day_3 =

loading_productivity_per_hour_3*working_hour

loading_productivity_per_hour_3 =

(Bucket_capacity_exca_3*density*efficiency_exca_3*Fill_Factor_Exca_3*numb

er_of_loader_3*SF*minute_to_hour)/(cycle_time_exca_3)

loading_supply_3 = loading_productivity_per_day_3

number_of_cycle_3 = random(6,7)

number_of_loader_3 = 2

Bucket_capacity_DT_4 = 35

cycle_time_DT_4 = random(15.167,21.667)

efficiency_DT_4 = 0.8

Fill_factor_DT_4 = 0.95

hauling_productivity_per_day_4 =

hauling_productivity_per_hour_4*working_hour

hauling_productivity_per_hour_4 =

(SF*Fill_factor_DT_4*efficiency_DT_4*Bucket_capacity_DT_4*SF*number_of

_haulers_operating_4*minute_to_hour)/(cycle_time_DT_4)

hauling_supply_4 = hauling_productivity_per_day_4

number_of_haulers_operating_4 = 7

Bucket_capacity_exca_4 = 1.8*number_of_cycle_4

cycle_time_exca_4 = random(1.78,3.05)

efficiency_exca_4 = 0.8

Fill_Factor_Exca_4 = 0.95

loading_productivity_per_day_4 =

loading_productivity_per_hour_4*working_hour

loading_productivity_per_hour_4 = (Bucket_capacity_exca_4*density*efficiency_exca_4*Fill_Factor_Exca_4*number_of_loader_4*SF*minute_to_hour)/(cycle_time_exca_4)

loading_supply_4 = loading_productivity_per_day_4

number_of_cycle_4 = random(7,8)

number_of_loader_4 = 2

Appendix N

FMEA Interview Questionnare

Respondent

Name: Hasbi Afsani Syarif

Position: Mine Planning and Evaluation Staff

Purpose

This questionnaire is used as secondary data for bachelor thesis research of Mining Engineering Study Program Hasanuddin University with title "Evaluation of Failure in Limestone Mining at PT Semen Tonasa, Pangkep Regency, South Sulawesi". In this research, several factors which affect unattainability of limestone production target will be identified and analyzed using Failure Mode Effect Analysis (FMEA) method. These factors are divided into main parameters such as machine, method, environment, measurement, and material. The following questions will be covering each of these aspect.

Instruction

This questionnaire is filled by answering questions that are given by the interviewer. The answer should be in a scale of 1 to 10.

The questions are as follows:

#1 Failure potential: Uncontrolled hauler and loader amount

Based on the observation during November 2022, there are more hauler operated than the loader.

1. How severe does uncontrolled hauler and loader amount affects equipment cycle time?
2. How often did the amount of hauler and loader not match?

#2 Failure potential: Low Effective Usage (EU)

Effective Usage (EU) shows percentage of how effective the usage of equipment during mining process. Physical Availability (PA) and Mechanical Availability (MA) affects the effective usage. Based on equipment availability report, mostly PA and MA for every vendors only reached about 30%.

1. How severe does maintenance affects equipment productivity?
2. How often does the maintenance of an equipment in a month?

#3 Failure potential: High dumping cycle time

Based on observation during November 2022, measured dumping cycle time reached 27 minutes.

1. How severe does dumping idle time affects limestone productivity?
2. How often does dumping idle occurs during November?

#4 Failure potential: Big swing angle

Based on observation during November 2022, swing time for excavator reached 48 seconds.

1. How often does loader position inappropriate for loading process?

#5 Failure potential: Slippery road during rainy season

Based on observation during November 2022, it was found that high rainfall rate caused the haul road to become slippery. This condition requires drivers to lower the speed of equipment.

1. How severe slippery road affects the ease of maneuver?
2. How effective does gridding process prevent slippery road?

#6 Failure potential: Lack of drainage

Based on field observation, there are runoffs which are found on the haul road surface.

1. How much additional drainage needed for the quarry?
2. How often does runoffs flow on haul road surface?

#7 Failure potential: Substandard road design

Based on haul road geometry measurement, it was found that haul road geometry did not satisfy the AASHO standard.

1. How often does the equipment experienced troubles while turning or climbing up on haul road?

#8 Failure potential: Inadequate reserve modelling

Lack of reserve mapping in front area

1. How does avaibility of filler and pile mapping affect productivity?
2. How often does pile material mined?

#9 Failure potential: Inefficient blasting

Based on observation, it was found that blasting fragmentation is varied.

1. How often does blasting material varied?

Monitoring Methods

The following questions is about monitoring methods that are applied, related to issues that tend to happen during mining process.

1. How often does cycle time measurement done in a month?
2. How often does equipment availability reported in a month?
3. How often does road geometry measurement done in a month?
4. How often does mine development mapping done in a month?
5. How often does drainage check in a month?
6. How often does surveying done before blasting?

Respondent

Name: Bahrul

Position: Representative of Blasting Crew

Purpose

This questionnaire is used as secondary data for bachelor thesis research of Mining Engineering Study Program Hasanuddin University with title "Evaluation of Failure in Limestone Mining at PT Semen Tonasa, Pangkep Regency, South Sulawesi". In this research, several factors which affect unattainability of limestone production target will be identified and analyzed using Failure Mode Effect Analysis (FMEA) method. These factors are divided into main parameters such as machine, method, environment, measurement, and material. The following questions will be covering each of these aspect.

Instruction

This questionnaire is filled by answering questions that are given by the interviewer. The answer should be in a scale of 1 to 10.

The questions are as follows:

#8 Failure potential: Inadequate reserve modelling

Lack of reserve mapping in front area

1. How does avaibility of filler and pile mapping affect productivity?
2. How often does pile material mined?

#9 Failure potential: Inefficient blasting

Based on observation, it was found that blasting fragmentation is varied.

1. How often does blasting material varied?

Monitoring Methods

The following questions is about monitoring methods that are applied, related to issues that tend to happen during mining process.

1. How often does surveying done before blasting?

Respondent

Name: Noviyanto Rahmat Zulem, S.T.

Position: Representative of Vendors

Purpose

This questionnaire is used as secondary data for bachelor thesis research of Mining Engineering Study Program Hasanuddin University with title "Evaluation of Failure in Limestone Mining at PT Semen Tonasa, Pangkep Regency, South Sulawesi". In this research, several factors which affect unattainability of limestone production target will be identified and analyzed using Failure Mode Effect Analysis (FMEA) method. These factors are divided into main parameters such as machine, method, environment, measurement, and material. The following questions will be covering each of these aspect.

Instruction

This questionnaire is filled by answering questions that are given by the interviewer. The answer should be in a scale of 1 to 10.

The questions are as follows:

#1 Failure potential: Uncontrolled hauler and loader amount

Based on the observation during November 2022, there are more hauler operated than the loader.

1. How severe does uncontrolled hauler and loader amount affects equipment cycle time?
2. How often did the amount of hauler and loader not match?

#2 Failure potential: Low Effective Usage (EU)

Effective Usage (EU) shows percentage of how effective the usage of equipment during mining process. Physical Availability (PA) and Mechanical Availability (MA) affects the effective usage. Based on equipment availability report, mostly PA and MA for every vendors only reached about 30%.

1. How severe does maintenance affects equipment productivity?
2. How often does the maintenance of an equipment in a month?

#3 Failure potential: High dumping cycle time

Based on observation during November 2022, measured dumping cycle time reached 27 minutes.

1. How severe does dumping idle time affects limestone productivity?
2. How often does dumping idle occurs during November?

#4 Failure potential: Big swing angle

Based on observation during November 2022, swing time for excavator reached 48 seconds.

1. How often does loader position inappropriate for loading process?

#5 Failure potential: Slippery road during rainy season

Based on observation during November 2022, it was found that high rainfall rate caused the haul road to become slippery. This condition requires drivers to lower the speed of equipment.

1. How severe slippery road affects the ease of maneuver?
2. How effective does gridding process prevent slippery road?

#6 Failure potential: Lack of drainage

Based on field observation, there are runoffs which are found on the haul road surface.

1. How much additional drainage needed for the quarry?
2. How often does runoffs flow on haul road surface?

#7 Failure potential: Substandard road design

Based on haul road geometry measurement, it was found that haul road geometry did not satisfy the AASHO standard.

1. How often does the equipment experienced troubles while turning or climbing up on haul road?

#8 Failure potential: Inadequate reserve modelling

Lack of reserve mapping in front area

1. How does avaibility of filler and pile mapping affect productivity?
2. How often does pile material mined?

#9 Failure potential: Inefficient blasting

Based on observation, it was found that blasting fragmentation is varied.

1. How often does blasting material varied