

Lampiran 1 – Data Persediaan Bahan Baku dan Bahan Bakar

Data persediaan bahan baku dan bahan bakar mulai bulai Desember 2014 sebagai berikut,

1. Trass

Tanggal	Terima	Pakai	Stock
01-Dec	0	3.365	22.924
02-Dec	0	3.869	19.056
03-Dec	5.946	4.177	20.824
04-Dec	7.006	4.497	23.333
05-Dec	6.579	3.770	26.142
06-Dec	6.918	3.673	29.387
07-Dec	0	2.927	26.460
08-Dec	5.751	2.157	30.054
09-Dec	7.752	3.064	34.742
10-Dec	7.521	3.871	38.392
11-Dec	8.328	3.630	43.090
12-Dec	0	3.900	39.190
13-Dec	0	3.651	35.538
14-Dec	0	3.406	32.132
15-Dec	8.503	4.273	36.362
16-Dec	8.439	4.527	40.274
17-Dec	7.442	4.181	43.535
18-Dec	0	4.544	38.991
19-Dec	251	4.461	34.781
20-Dec	7.546	4.588	37.739
21-Dec	0	4.056	33.683
22-Dec	8.965	4.313	38.336
23-Dec	8.559	3.597	43.298
24-Dec	5.507	4.060	44.745
25-Dec	0	4.921	39.825
26-Dec	6.386	5.274	40.937
27-Dec	114	5.518	35.533
28-Dec	0	5.579	29.954
29-Dec	5.798	4.260	31.492
30-Dec	4.483	5.713	30.263
31-Dec	0	5.226	25.037

2. Gypsum

Tanggal	Terima	Pakai	Stock
01-Dec	701	1.352	98.110
02-Dec	841	1.114	97.836
03-Dec	1.950	1.296	98.491
04-Dec	2.120	1.354	99.257
05-Dec	1.487	1.354	99.390
06-Dec	1.251	1.320	99.321
07-Dec	0	1.388	97.933
08-Dec	1.889	1.200	98.622
09-Dec	1.653	1.131	99.143
10-Dec	822	1.290	98.676
11-Dec	1.206	1.360	98.522
12-Dec	1.452	1.376	98.597
13-Dec	1.221	1.303	98.515
14-Dec	0	1.174	97.341

Tanggal	Terima	Pakai	Stock
15-Dec	2.091	1.439	97.994
16-Dec	1.614	1.434	98.174
17-Dec	1.722	1.369	98.527
18-Dec	1.979	1.454	99.053
19-Dec	2.026	1.537	99.541
20-Dec	1.748	1.698	99.592
21-Dec	0	1.725	97.867
22-Dec	2.360	1.670	98.557
23-Dec	1.680	1.600	98.637
24-Dec	1.137	1.673	98.102
25-Dec	1.083	1.793	97.391
26-Dec	1.177	1.838	96.730
27-Dec	1.547	1.890	96.387
28-Dec	0	1.955	94.432
29-Dec	1.974	1.569	94.836
30-Dec	623	1.765	93.695
31-Dec	0	1.805	91.890

3. Pasir Besi (Copper Slag)

Tanggal	Terima	Pakai	Stock
01-Dec	790	841	17.344
02-Dec	1.172	320	18.195
03-Dec	1.317	781	18.732
04-Dec	721	822	18.632
05-Dec	895	587	18.940
06-Dec	410	532	18.818
07-Dec	0	580	18.239
08-Dec	709	481	18.467
09-Dec	1.244	237	19.473
10-Dec	1.309	249	20.534
11-Dec	1.503	330	21.707
12-Dec	1.095	450	22.352
13-Dec	335	771	21.916
14-Dec	57	900	21.072
15-Dec	1.099	917	21.254
16-Dec	1.231	828	21.657
17-Dec	1.311	760	22.208
18-Dec	1.069	784	22.493
19-Dec	1.074	1.063	22.504
20-Dec	458	1.068	21.894
21-Dec	94	1.104	20.884
22-Dec	937	732	21.088
23-Dec	1.513	893	21.708
24-Dec	1.291	752	22.247
25-Dec	322	1.096	21.474
26-Dec	1.111	884	21.700
27-Dec	501	823	21.378
28-Dec	93	1.054	20.417
29-Dec	1.155	737	20.835
30-Dec	1.029	799	21.065
31-Dec	726	836	20.955

4. Pasir Silika

Tanggal	Terima	Pakai	Stock
01-Dec	0	57	18.424
02-Dec	0	9	18.415
03-Dec	0	20	18.395
04-Dec	0	66	18.329
05-Dec	0	34	18.295
06-Dec	0	59	18.235
07-Dec	0	38	18.198
08-Dec	0	4	18.193
09-Dec	0	29	18.165
10-Dec	0	5	18.160
11-Dec	0	4	18.156
12-Dec	0	62	18.094
13-Dec	0	162	17.932
14-Dec	0	63	17.869
15-Dec	0	5	17.865
16-Dec	0	81	17.784
17-Dec	0	115	17.669
18-Dec	0	153	17.516
19-Dec	0	320	17.195
20-Dec	0	230	16.966
21-Dec	0	225	16.741
22-Dec	0	102	16.639
23-Dec	0	84	16.555
24-Dec	0	78	16.477
25-Dec	0	62	16.415
26-Dec	0	107	16.309
27-Dec	0	210	16.098
28-Dec	0	274	15.824
29-Dec	0	192	15.632
30-Dec	0	75	15.557
31-Dec	0	167	15.390

5. Batubara

Tanggal	Terima	Pakai	Stock
01-Dec	13.983	6.433	186.997
02-Dec	7.048	5.918	188.128
03-Dec	10.206	5.853	192.481
04-Dec	4.088	5.933	190.636
05-Dec	2.812	5.063	188.386
06-Dec	6.401	4.454	190.333
07-Dec	8.278	4.221	194.391
08-Dec	8.288	4.830	197.848
09-Dec	8.490	3.561	202.778
10-Dec	7.944	3.218	207.504
11-Dec	8.664	3.952	212.215
12-Dec	7.060	5.082	214.193
13-Dec	7.116	7.128	214.182
14-Dec	8.511	7.544	215.149
15-Dec	9.478	7.642	216.985
16-Dec	5.100	7.804	214.282
17-Dec	5.030	7.389	211.923
18-Dec	5.465	7.268	210.119
19-Dec	4.724	7.556	207.287
20-Dec	6.541	7.537	206.291

Tanggal	Terima	Pakai	Stock
21-Dec	8.073	7.281	207.083
22-Dec	5.354	7.625	204.813
23-Dec	0	7.633	197.180
24-Dec	0	6.807	190.373
25-Dec	0	7.267	183.106
26-Dec	0	6.864	176.242
27-Dec	3.400	7.393	172.249
28-Dec	7.479	7.457	172.271
29-Dec	6.599	6.206	172.663
30-Dec	6.297	7.346	171.614
31-Dec	7.408	7.002	172.020

6. Bahan Bakar Alternatif (BBA)

Tanggal	Terima	Pakai	Stock
01-Dec	79	70	705
02-Dec	197	3	898
03-Dec	261	45	1.114
04-Dec	323	97	1.340
05-Dec	284	13	1.611
06-Dec	245	0	1.856
07-Dec	0	0	1.856
08-Dec	0	203	1.653
09-Dec	185	93	1.745
10-Dec	155	164	1.736
11-Dec	196	259	1.674
12-Dec	186	296	1.564
13-Dec	216	328	1.452
14-Dec	0	226	1.226
15-Dec	29	364	891
16-Dec	147	193	845
17-Dec	178	147	875
18-Dec	211	156	930
19-Dec	277	181	1.026
20-Dec	235	146	1.115
21-Dec	0	239	876
22-Dec	411	234	1.054
23-Dec	309	147	1.216
24-Dec	402	222	1.396
25-Dec	189	240	1.345
26-Dec	347	149	1.543
27-Dec	235	0	1.777
28-Dec	0	12	1.765
29-Dec	365	151	1.979
30-Dec	307	420	1.866
31-Dec	163	486	1.543

Lampiran 2 – Peramalan dengan Metode *Double Exponential Smoothing*

Hasil peramalan lengkap dengan menggunakan metode *Double Exponential Smoothing* sebagai berikut:

Tahun	t	Actual Sales (Yt)	Forecast (Y [^])	Base Level (Et)	Trend (Tt)
2012	1	742.441	-	742.441	0
	2	707.960	742.441	734.038,62	-840,24
	3	787.439	733.198	746.415,81	481,51
	4	788.071	746.897	756930,58	1.484,83
	5	902.139	758.415	793.438,18	4.987,11
	6	867.096	798.425	815.159,06	6.660,49
	7	983.188	821.820	861.142,04	10.592,73
	8	771.001	871.735	847.187,82	8.138,04
	9	1.070.662	855.326	907.799,28	13.385,38
	10	1.054.272	921.185	953.615,57	16.628,47
	11	1.072.763	970.244	995.226,00	19.126,67
	12	1.065.272	1.014.353	1.026.760,77	20.367,48
2013	13	970.919	1.047.128	1.028.557,47	18.510,40
	14	881.926	1.047.068	1.006.825,87	14.486,20
	15	953.665	1.021.312	1.004.827,73	12.837,77
	16	910.916	1.017.666	991.652,63	10.236,48
	17	923.159	1.001.889	982.704,05	8.317,97
	18	961.710	991.022	983.879,23	7.603,69
	19	1.071.632	991.483	1.011.013,76	9.556,78
	20	648.203	1.020.571	929.831,49	482,87
	21	1.122.514	930.314	977.149,84	5.166,42
	22	1.1846.99	982.316	1.031.633,17	10.098,11
	23	1.119.082	1.041.731	1.060.580,22	11.983,01
	24	1.130.422	1.072.563	1.086.662,33	13.392,92
2014	25	1.040.525	1.100.055	1.085.548,83	11.942,27
	26	972.375	1.097.491	1.067.002,64	8.893,43
	27	1.062.110	1.075.896	1.072.536,66	8.557,49
	28	964.852	1.081.094	1.052.768,10	5.724,88
	29	1.100.064	1.058.493	1.068.623,06	6.737,89
	30	1.126.956	1.075.361	1.087.933,71	7.995,17
	31	861.124	1.095.929	1.038.711,29	2.273,41
	32	950.840	1.040.985	1.019.018,11	76,75
	33	1.101.322	1.019.095	1.039.132,09	2.080,47
	34	1.151.856	1.041.213	1.068.174,31	4.776,65
	35	1.176.097	1.072.951	1.098.085,73	7.290,12
	36	1.072.846	1.105.376	1.097.448,93	6.497,43
2015	37	1.105.376	1.103.946	1.104.294,70	6.532,27
	38	1.103.946,363	1.110.827	1.109.150,29	6.364,60
	39	1.110.826,968	1.115.515	1.114.372,53	6.250,36

Tahun	t	Actual Sales (Y _t)	Forecast (Y [^])	Base Level (E _t)	Trend (T _t)
	40	1.115.514,891	1.120.623	1.119.378,17	6.125,89
	41	1.120.622,894	1.125.504	1.124.314,61	6.006,94
	42	1.125.504,058	1.130.322	1.129.147,62	5.889,55
	43	1.130.321,554	1.135.037	1.133.888,06	5.774,64
	44	1.135.037,171	1.139.663	1.138.535,55	5.661,92
	45	1.139.662,704	1.144.197	1.143.092,43	5.551,42
	46	1.144.197,472	1.148.644	1.147.560,35	5.443,07
	47	1.148.643,855	1.153.003	1.151.941,08	5.336,84
	48	1.153.003,425	1.157.278	1.156.236,30	5.232,68



Perhitungan *error* sebagai berikut,

No	Actual Sales (Yt)	Forecast (Y [^])	Error	Kumulatif Error	Absolute Error	Kumulatif Absolute Error	MAD	MAPE	Tracking Signal
1	707.960	742.441	-3.4481	-34481	34.481	34.481	34.481	4,8705	-1
2	787.439	733.198	54.241	19759.62	54.240,6	88.721,62	44.360,81	6,8882	0,44543
3	788.071	746.897	41.173,7	60933.30	41.173,7	129.895,30	43.298,43	5,2246	1,40729
4	902.139	758.415	143.723,6	204656.89	143.723,6	273.618,89	68.404,72	15,9314	2,99185
5	867.096	798.425	68.670,7	273327.60	68.670,7	342.289,60	68.457,92	7,9196	3,99264
6	983.188	821.820	161.368,5	434696.06	161.368,5	503.658,06	83.943,01	16,4128	5,17847
7	771.001	871.735	-100.733,8	333962.29	100.733,8	604.391,83	86.341,69	13,0653	3,86791
8	1.070.662	855.326	215.336,1	549298.42	215.336,1	819.727,97	102.466	20,1124	5,36079
9	1.054.272	921.185	133.087,3	682385.76	133.087,3	952.815,31	105.868,37	12,6236	6,44561
10	1.072.763	970.244	102.519,0	784904.72	102.519,0	1.055.334,27	105.533,43	9,5565	7,43750
11	1.065.272	1.014.353	50.919,3	835824.05	50.919,3	1.106.253,59	100.568,51	4,7799	8,31099
12	970.919	1.047.128	-76.209,2	759614.81	76.209,2	1.182.462,84	98.538,57	7,8492	7,70881
13	881.926	1.047.068	-165.141,9	594472.94	165.141,9	1.347.604,71	103.661,90	18,7251	5,73473
14	953.665	1.021.312	-67.647,1	526825.87	67.647,1	1.415.251,77	101.089,41	7,0934	5,21148
15	910.916	1.017.666	-106.749,5	420076.37	106.749,5	1.522.001,27	101.466,75	11,7189	4,14004
16	923.159	1.001.889	-78.730,1	341346.26	78.730,1	1.600.731,39	100.045,71	8,5283	3,41190
17	961.710	991.022	-29.312,0	312034.24	29.312,0	1.630.043,41	95.884,91	3,0479	3,25426
18	1.071.632	991.483	80.149,1	392183.32	80.149,1	1.710.192,49	95.010,69	7,4792	4,12778
19	648.203	1.020.571	-372.367,5	19815.78	372.367,5	2.082.560,03	109.608,42	57,4461	0,18079
20	1.122.514	930.314	192.199,6	212015.41	192.199,6	2.274.759,66	113.737,98	17,1222	1,86407
21	1.184.699	982.316	202.382,7	414398.14	202.382,7	2.477.142,39	117.959,16	17,0831	3,51306
22	1.119.082	1.041.731	77.350,7	491748.86	77.350,7	2.554.493,11	116.113,32	6,9120	4,23508
23	1.130.422	1.072.563	57.858,8	549607.63	57.858,8	2.612.351,88	113.580,52	5,1183	4,83893
24	1.040.525	1.100.055	-59.530,2	490077.39	59.530,2	2.671.882,13	111.328,42	5,7212	4,40209

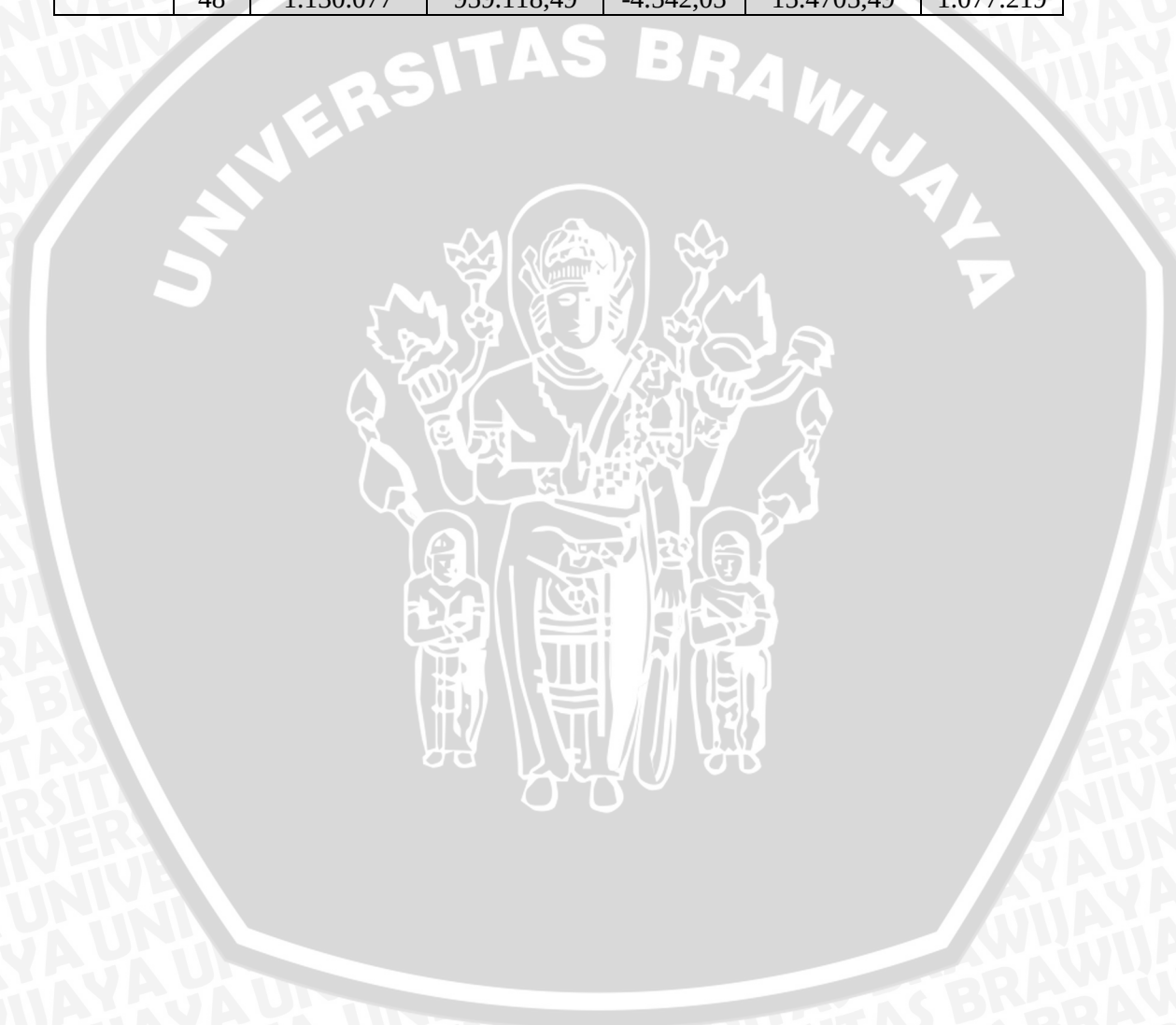
No	Actual Sales (Yt)	Forecast (Y^)	Error	Kumulatif Error	Absolute Error	Kumulatif Absolute Error	MAD	MAPE	Tracking Signal
25	972.375	1.097.491	-125.116,1	364961.28	125.116,1	2.796.998,24	111.879,93	12,8671	3,26208
26	1.062.110	1.075.896	-13.786,1	351175.21	13.786,1	2.810.784,30	108.107,09	1,2980	3,24840
27	964.852	1.081.094	-116.242,1	234933.07	116.242,1	2.927.026,45	108.408,39	12,0477	2,16711
28	1.100.064	1.058.493	41.571,0	276504.09	41.571,0	2.968.597,47	106.021,34	3,7790	2,60800
29	1.126.956	1.075.361	51.595,0	328099.14	51.595,0	3.020.192,52	104.144,57	4,5783	3,15042
30	861.124	1.095.929	-234.804,9	93294.27	234.804,9	3.254.997,39	108.499,91	27,2673	0,85986
31	950.840	1.040.985	-90.144,7	3149.57	90.144,7	3.345.142,09	107.907,81	9,4805	0,02919
32	1.101.322	1.019.095	82.227,1	85376.70	82.227,1	3.427.369,23	107.105,29	7,4662	0,79713
33	1.151.856	1.041.213	110.643,4	196020.15	110.643,4	3.538.012,67	107.212,51	9,6057	1,82833
34	1.176.097	1.072.951	103.146,0	299166.19	103.146,0	3.641.158,72	107.092,90	8,7702	2,79352
35	1.072.846	1.105.376	-32.529,9	266636.34	32.529,9	3.673.688,57	104.962,53	3,0321	2,54030
36	1.105.376	1.103.946	1.429,5	268065.83	1.429,5	3.675.118,05	102.086,61	0,1293	2,62587
37	1.103.946,363	1.110.827	-6.880,6	261185.22	6.880,6	3.681.998,66	99.513,48	0,6233	2,62462
38	1.110.826,968	1.115.515	-4.687,9	256497.30	4.687,9	3.686.686,58	97.018,07	0,4220	2,64381
39	1.115.514,891	1.120.623	-5.108,0	251389.30	5.108,0	3.691.794,59	94.661,40	0,4579	2,65567
40	1.120.622,894	1.125.504	-4.881,2	246508.14	4.881,2	3.696.675,75	92.416,89	0,4356	2,66735
41	1.125.504,058	1.130.322	-4.817,5	241690.64	4.817,5	3.701.493,25	90.280,32	0,4280	2,67711
42	1.130.321,554	1.135.037	-4.715,6	236975.02	4.715,6	3.706.208,86	88.243,07	0,4172	2,68548
43	1.135.037,171	1.139.663	-4.625,5	232349.49	4.625,5	3.710.834,40	86.298,47	0,4075	2,69239
44	1.139.662,704	1.144.197	-4.534,8	227814.72	4.534,8	3.715.369,16	84.440,21	0,3979	2,69794
45	1.144.197,472	1.148.644	-4.446,4	223368.34	4.446,4	3.719.815,55	82.662,57	0,3886	2,70217
46	1.148.643,855	1.153.003	-4.359,6	219008.77	4.359,6	3.724.175,12	80.960,33	0,3795	2,70514
47	1.153.003,425	1.157.278	-4.274,5	214734.28	4.274,5	3.728.449,61	79.328,72	0,3707	2,70689

Lampiran 3 – Peramalan dengan Metode *Holt Winter Additive*

Hasil peramalan dengan menggunakan metode *Holt Winter Additive* adalah sebagai berikut:

Tahun	t	Actual Sales (Yt)	Base Level (Et)	Trend (Tt)	Seasonal Factor (St)	Forecast (Y [^])
2012	1	742.441	901.025,33		-158.584,33	
	2	707.960	901.025,33		-193.065,33	
	3	787.439	901.025,33		-113.586,33	
	4	788.071	901.025,33		-112.954,33	
	5	902.139	901.025,33		1.113,67	
	6	867.096	901.025,33		-33.929,33	
	7	983.188	901.025,33		82.162,67	
	8	771.001	901.025,33		-130.024,33	
	9	1.070.662	901.025,33		169.636,67	
	10	1.054.272	901.025,33		153.246,67	
	11	1.072.763	901.025,33		171.737,67	
	12	1.065.272	901.025,33	0	164.246,67	
2013	13	970.919	988.993,99	8.796,87	-88.329,66	839.207
	14	881.926	1.027.514,60	11.769,24	-169.326,97	846.219
	15	953.665	1.050.051,89	12.846,05	-104.986,61	949.312
	16	910.916	1.047.871,52	11.343,40	-124.954,93	946.261
	17	923.159	1.006.401,85	6.062,10	-41.064,59	1.013.578
	18	961.710	1.005.986,13	5.414,31	-39.102,73	977.471
	19	1.071.632	1.002.956,52	4.569,92	75.419,07	1.089.689
	20	648.203	919.241,64	-4.258,56	-200.531,49	784.959
	21	1.122.514	929.573,14	-2.799,55	181.288,76	1.096.410
	22	1.184.699	967.077,02	1.230,79	185.434,32	1.121.554
	23	1.119.082	960.236,45	423,65	165.291,61	1.132.398
	24	1.130.422	962.783,58	636,00	165.942,54	1.127.666
2014	25	1.040.525	1.027.115,44	7.005,59	-37.460,05	945.791
	26	972.375	1.075.541,87	1.1147,67	-136.246,92	917.363
	27	1.062.110	1.117.647,89	14.243,51	-80.262,25	1.026.905
	28	964.852	1.115.688,02	12.623,17	-137.895,48	1.003.356
	29	1.100.064	1.133.246,15	13.116,67	-37.123,37	1.105.298
	30	1.126.956	1.153.946,14	13.875,00	-33.046,44	1.128.718
	31	861.124	1.020.698,66	-837,25	-42.077,80	1.095.280
	32	950.840	1.070.495,45	4.226,15	-160.093,47	874.190
	33	1.101.322	1.015.163,45	-1.729,66	133.723,66	1.194.723
	34	1.151.856	995.333,18	-3.539,72	170.978,57	1.177.228
	35	1.176.097	999.113,43	-2.807,72	171.137,59	1.161.597
	36	1.072.846	961.884,03	-6.249,89	138.452,26	1.121.577
2015	37	1.121.577	1.033.948,26	1.581,52	25.084,19	918.174
	38	918.174	1.042.803,28	2.308,87	-130.438,06	899.283

Tahun	t	Actual Sales (Yt)	Base Level (Et)	Trend (Tt)	Seasonal Factor (St)	Forecast (Y [^])
	39	899.283	1.019.867,51	-215,59	-100.423,45	964.850
	40	964.850	1.051.644,58	2.983,67	-112.345,08	881.756
	41	881.756	1.002.362,36	-2.242,92	-78.864,64	1.017.505
	42	1.017.505	1.019.536,74	-301,19	-17.539,15	967.073
	43	967.073	1.015.352,71	-689,47	-45.178,75	977.158
	44	977.158	1.061.862,10	4.030,41	-122.398,91	854.570
	45	854.570	933.042,66	-9.254,57	27.625,38	1.199.616
	46	1.199.616	964.157,27	-5.217,65	203.218,73	1.094.767
	47	1.094.767	945.344,35	-6.577,18	160.279,95	1.130.077
	48	1.130.077	959.118,49	-4.542,05	15.4705,49	1.077.219



Perhitungan *error* sebagai berikut,

No	Actual Sales (Yt)	Forecast (Y [^])	Error	Kumulatif Error	Absolut Error	Kumulatif Absolut Error	MAD	MAPE	Tracking Signal
1	970.919	839.207	131.712,5	131.712,48	131.712,48	131.712,48	131.712,5	13,5658	1
2	881.926	846.219	35.707,49	167.419,97	35.707,49	167.419,97	83.709,98	4,0488	2
3	953.665	949.312	4,353,394	171.773,36	4.353,39	171.773,36	57.257,79	0,4565	3
4	910.916	946.261	-3,5344,6	136.428,77	35.344,59	207.117,95	51.779,49	3,8801	2,63480
5	923.159	1.013.578	-90.418,6	46.010,15	90.418,62	297.536,57	59.507,31	9,7945	0,77318
6	961.710	977.471	-15.761,1	30.249,04	15.761,11	313.297,68	52.216,28	1,6389	0,57930
7	1.071.632	1.089.689	-18.057,1	12.191,93	18.057,11	331.354,80	47.336,4	1,6850	0,25756
8	648.203	784.959	-136.756	-124.563,83	136.755,75	468.110,55	58.513,82	21,0977	-2,12879
9	1.122.514	1.096.410	26.103,75	-98.460,08	26.103,75	494.214,30	54.912,7	2,3255	-1,79303
10	1.184.699	1.121.554	63.144,52	-35.315,56	63.144,52	557.358,81	55.735,88	5,3300	-0,63362
11	1.119.082	1.132.398	-13.315,8	-48.631,33	13.315,77	570.674,59	51.879,51	1,1899	-0,93739
12	1.130.422	1.127.666	2.755,752	-45.875,58	2.755,75	573.430,34	47.785,86	0,2438	-0,96002
13	1.040.525	945.791	94.733,64	48.858,06	94.733,64	668.163,97	51.397,23	9,1044	0,95060
14	972.375	9173.63	55.012,43	103.870,49	55.012,43	723.176,40	51.655,46	5,6575	2,01083
15	1.062.110	1.026.905	35.205,22	139.075,70	35.205,22	758.381,62	50.558,77	3,3146	2,75077
16	964.852	1.003.356	-38.504,3	100.571,43	38.504,27	796.885,89	49.805,37	3,9907	2,01929
17	1.100.064	1.105.298	-5.234,22	95.337,21	5.234,22	802.120,11	47.183,54	0,4758	2,02056
18	1.126.956	1.128.718	-1.762,41	93.574,80	1.762,41	803.882,52	44.660,14	0,1564	2,09526
19	861.124	1.095.280	-234.156	-140.581,68	234.156,48	1.038.039,00	54.633,63	27,1920	-2,57317
20	950.840	874.190	76.649,88	-63.931,80	76.649,88	1.114.688,88	55.734,44	8,0613	-1,14708
21	1.101.322	1.194.723	-93.400,6	-157.332,36	93.400,56	1.208.089,44	57.528,07	8,4808	-2,73488
22	1.151.856	1.177.228	-25.371,8	-182.704,13	25.371,77	1.233.461,21	56.066,42	2,2027	-3,25871
23	1.176.097	1.161.597	14.499,68	-168.204,45	14.499,68	1.247.960,89	54.259,17	1,2329	-3,10002
24	1.072.846	1.121.577	-48.730,7	-216.935,14	48.730,68	1.296.691,58	54.028,82	4,5422	-4,01517

Perhitungan *error* sebagai berikut,

No	Actual Sales (Yt)	Forecast (Y [^])	Error	Kumulatif Error	Absolut Error	Kumulatif Absolut Error	MAD	MAPE	Tracking Signal
25	1.121.577	918174	203.402,6	-13.532,54	203.402,59	1.500.094,17	60.003,77	18,1354	-0,22553
26	918.174	899.283	18.891,23	5.358,69	18.891,23	1.518.985,40	58.422,52	2,0575	0,09172
27	899.283	964.850	-65.567	-60.208,35	65.567,04	1.584.552,44	58.687,13	7,2910	-1,02592
28	964.850	881.756	83.093,46	22.885,10	83.093,46	1.667.645,90	59.558,78	8,6121	0,38424
29	881.756	1.017.505	-135.748	-112.863,34	135.748,44	1.803.394,34	62.186,01	15,3952	-1,81493
30	1.017.505	967.073	5.0431,88	-62.431,46	5.0431,88	1.853.826,22	61.794,21	4,9564	-1,01031
31	967.073	977.158	-10.084,8	-72.516,21	10.084,75	1.863.910,97	60.126,16	1,0428	-1,20607
32	977.158	854.570	122.588	50.071,77	122.587,98	1.986.498,95	62.078,09	12,5454	0,80659
33	854.570	1.199.616	-345.046	-294.974,62	345.046,40	2.331.545,35	70.652,89	40,3766	-4,17498
34	1.199.616	1.094.767	104.849,5	-190.125,12	104.849,50	2.436.394,85	71.658,67	8,7403	-2,65320
35	1.094.767	1.130.077	-35.310,5	-225.435,66	35.310,54	2.471.705,40	70.620,15	3,2254	-3,19223
36	1.130.077	1.077.219	52.857,79	-172.577,88	52.857,79	2.524.563,18	70.126,76	4,6774	-2,46094

Lampiran 4 – Peramalan dengan Metode *Holt Winter Multiplicative*

Hasil peramalan lengkap dengan menggunakan metode *Holt Winter Multiplicative* sebagai berikut:

Tahun	t	Actual Sales (Yt)	Base Level (Et)	Trend (Tt)	Seasonal Factor (St)	Forecast (Y [^])
2012	1	742.441			0,82400	
	2	707.960			0,78573	
	3	787.439			0,87394	
	4	788.071			0,87464	
	5	902.139			1,00124	
	6	867.096			0,96234	
	7	983.188			1,09119	
	8	771.001			0,85569	
	9	1.070.662			1,18827	
	10	1.054.272			1,17008	
	11	1.072.763			1,19060	
	12	1.065.272	901.025,33	0	1,18229	
2013	13	970.919	1.067.393,68	30.292,4	0,87537	904.489
	14	881.926	1.112.534,25	32.996	0,78992	900.074
	15	953.665	1.112.949,54	27.063,7	0,86370	996.299
	16	910.916	1.080.891,92	16.298,8	0,85550	959.645
	17	923.159	992.087,94	-2.838,3	0,95881	990.472
	18	961.710	995.304,78	-1.735,8	0,96469	956.155
	19	1.071.632	986.674,56	-2.991,1	1,08814	1.073.383
	20	648.203	847.984,31	-27.699,3	0,80092	701.912
	21	1.122.514	894.911,11	-14.111,3	1,22791	1.046.629
	22	1.184.699	959.816,16	276,0	1,20861	1.123.385
	23	1.119.082	947.994,36	-1926,8	1,18452	1.126.390
	24	1.130.422	952.105,23	-827,4	1,18529	1.124.685
2014	25	1.040.525	1.093.713,83	25107,4	0,92097	979.381
	26	972.375	1.186.114,38	37.360,2	0,80785	966.449
	27	1.062.110	1.227.219,78	38.042,1	0,86476	1.092.811
	28	964.852	1.182.796,53	23.026,8	0,83164	1.031.584
	29	1.100.064	1.170.724,64	16.636	0,94731	1.138.450
	30	1.126.956	1.175.870,72	14.543,9	0,96091	1.148.376
	31	861.124	950.990,14	-29.050,6	0,97856	1.003.197
	32	950.840	1.081.086,77	-73	0,84808	865.805
	33	1.101.322	970.551,74	-20.186	1,17201	1.166.960
	34	1.151.856	951.971,06	-19.893	1,20943	1.126.519
	35	1.176.097	968.561,91	-13.250,6	1,20237	1.131.590
	36	1.072.846	925.205,92	-18.732,2	1,16986	1.074.432
2015	37	1.074.432,02	1.062.569,18	9.689,8	0,97509	987.517
	38	987.516,656	1.162.346,11	26.092,9	0,83289	960.078
	39	960.077,9123	1.141.512,42	17.548,5	0,85054	1.002.306

Tahun	t	Actual Sales (Yt)	Base Level (Et)	Trend (Tt)	Seasonal Factor (St)	Forecast (Y [^])
	40	1.002.306,478	1.186.751,30	22.590,4	0,83941	1.005.741
	41	1.005.741,226	1.120.746,00	6.458,8	0,91735	1.067.811
	42	1.067.811,352	1.117.628,55	4.715,2	0,95762	1.078.477
	43	1.078.476,863	1.110.203,28	2.504,6	0,97428	1.088.848
	44	1.088.847,839	1.215.420,45	21.206,6	0,87675	1.048.760
	45	1.048.760,34	1.031.556,37	-16.132,8	1,07881	1.190.082
	46	1.190.081,891	996.572,72	-19.565,2	1,20028	1.181.618
	47	1.181.618,394	980.446,29	-18.939	1,20406	1.156.090
	48	1.156.090,165	977.540,47	-16.019,7	1,17754	1.124.845



Perhitungan *error* sebagai berikut,

No	Actual Sales (Yt)	Forecast (Y [^])	Error	Kumulatif Error	Absolut Error	Kumulatif Absolut Error	MAD	MAPE	Tracking Signal
1	970.919	904.489	66.430,36	66.430,36	66.430,36	66.430,36	66.430,36	6,84201	1
2	881.926	900.074	-18.148,13	48.282,23	18.148,13	84.578,49	42.289,24	2,05778	-0,42914
3	953.665	996.299	-42.634,26	5.647,97	42.634,26	127.212,75	42.404,25	4,47057	-1,00542
4	910.916	959.645	-48.728,74	-43.080,77	48.728,74	175.941,49	43.985,37	5,34942	-1,10784
5	923.159	990.472	-67.313,31	-110.394,09	67.313,31	243.254,80	48.650,96	7,29163	-1,38360
6	961.710	956.155	5.555,22	-104.838,87	5.555,22	248.810,02	41.468,34	0,57764	0,13396
7	1.071.632	1.073.383	-1.751,50	-106.590,37	1.751,50	250.561,52	35.794,5	0,16344	-0,04893
8	648.203	701.912	-53.709,07	-160.299,43	53.709,07	304.270,59	38.033,82	8,28584	-1,41214
9	1.122.514	1.046.629	75.885,45	-84.413,98	75.885,45	380.156,04	42.239,56	6,76031	1,79655
10	1.184.699	1.123.385	61.314,08	-23.099,90	61.314,08	441.470,12	44.147,01	5,17550	1,38886
11	1.119.082	1.126.390	-7.308,42	-30.408,32	7.308,42	448.778,54	40.798,05	0,65307	-0,17914
12	1.130.422	1.124.685	5.737,09	-24.671,23	5.737,09	454.515,63	37.876,3	0,50752	0,15147
13	1.040.525	979.381	61.144,44	36.473,20	61.144,44	515.660,06	39.666,16	5,87631	1,54148
14	972.375	966.449	5.925,94	42.399,14	5.925,94	521.586,00	37.256,14	0,60943	0,15906
15	1.062.110	1.092.811	-307.00,57	11.698,57	30.700,57	552.286,57	36.819,1	2,89053	-0,83382
16	964.852	1.031.584	-66.732,31	-55.033,74	66.732,31	619.018,88	38.688,68	6,91633	-1,72485
17	1.100.064	1.138.450	-38.385,93	-93.419,66	38.385,93	657.404,80	38.670,87	3,48943	-0,99263
18	1.126.956	1.148.376	-21.419,72	-114.839,38	21.419,72	678.824,52	37.712,47	1,90067	-0,56797
19	861.124	1.003.197	-142.073,5	-256.912,86	142.073,48	820.898,00	43.205,16	16,49861	-3,28835
20	950.840	865.805	85.034,63	-171.878,23	85.034,63	905.932,63	45.296,63	8,94311	1,87728
21	1.101.322	1.166.960	-65.638,15	-237.516,38	65.638,15	971.570,77	46.265,27	5,95994	-1,41873
22	1.1518.56	1.126.519	25.337,23	-212.179,15	25.337,23	996.908,00	45.314	2,19969	0,55915
23	1.176.097	1.131.590	44.506,89	-167.672,26	44.506,89	1041.414,88	45.278,91	3,78429	0,98295
24	1.072.846	1.074.432	-1.586,02	-169.258,28	1.586,02	1043.000,90	43.458,37	0,14783	-0,03650

No	Actual Sales (Y _t)	Forecast (Y [^])	Error	Kumulatif Error	Absolut Error	Kumulatif Absolut Error	MAD	MAPE	Tracking Signal
25	1.074.432,019	987.517	86.915,36	-82.342,92	86.915,36	1.129.916,27	45.196,65	8,08942	1,92305
26	987.516,656	960.078	27.438,74	-54.904,17	27.438,74	1.157.355,01	44.513,65	2,77856	0,61641
27	960.077,9123	1.002.306	-42.228,57	-97132,74	42.228,57	1.199.583,58	44.429,02	4,39845	-0,95047
28	1.002.306,478	1.005.741	-3.434,75	-100.567,49	3.434,75	1.203.018,32	42.964,94	0,34268	-0,07994
29	1.005.741,226	1.067.811	-62.070,13	-162.637,61	62.070,13	1.265.088,45	43.623,74	6,17158	-1,42285
30	1.067.811,352	1.078.477	-10.665,51	-173.303,12	10.665,51	1.275.753,96	42.525,13	0,99882	-0,25080
31	1.078.476,863	1.088.848	-10.370,98	-183.674,10	10.370,98	1.286.124,94	41.487,9	0,96163	-0,24998
32	1.088.847,839	1.048.760	40.087,50	-143.586,60	40.087,50	1.326.212,44	41.444,14	3,68164	0,96727
33	1.048.760,34	1.190082	-141.321,5	-284.908,15	141.321,55	1.467.533,99	44.470,73	13,47510	-3,17786
34	1.190.081,891	1.181.618	8.463,50	-276.444,66	8.463,50	1.475.997,48	43.411,69	0,71117	0,19496
35	1.181.618,394	1.156.090	25.528,23	-250.916,43	25.528,23	1.501.525,71	42.900,73	2,16045	0,59505
36	1.156.090,165	1.124.845	31.245,24	-219.671,18	31.245,24	1.532.770,95	42.576,97	2,70266	0,73385

Lampiran 5 – Rekap Perencanaan Kebutuhan Bahan Baku dan Bahan Bakar

1. Pasir Besi

Gross Requirement

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
3037	1	1	1	1	3036.96	3036.96
3591	2	4	8	16	7182	14364
3789	3	9	27	81	11368.08	34104.24
3406	4	16	64	256	13625.28	54501.12
3406	5	25	125	625	17031.6	85158
3406	6	36	216	1296	20437.92	122627.52
3591	7	49	343	2401	25137	175959
3789	8	64	512	4096	30314.88	242519.04
3406	9	81	729	6561	30656.88	275911.92
3974	10	100	1000	10000	39740.4	397404
3406	11	121	1331	14641	37469.52	412164.72
3406	12	144	1728	20736	40875.84	490510.08
3406	13	169	2197	28561	44282.16	575668.08
3406	14	196	2744	38416	47688.48	667638.72
3974	15	225	3375	50625	59610.6	894159
3406	16	256	4096	65536	54501.12	872017.92
3406	17	289	4913	83521	57907.44	984426.48
3406	18	324	5832	104976	61313.76	1103647.68
3406	19	361	6859	130321	64720.08	1229681.52
3974	20	400	8000	160000	79480.8	1589616
3406	21	441	9261	194481	71532.72	1502187.12
3406	22	484	10648	234256	74939.04	1648658.88
3406	23	529	12167	279841	78345.36	1801943.28
3406	24	576	13824	331776	81751.68	1962040.32
3974	25	625	15625	390625	99351	2483775
3406	26	676	17576	456976	88564.32	2302672.32
3406	27	729	19683	531441	91970.64	2483207.28
3406	28	784	21952	614656	95376.96	2670554.88
3406	29	841	24389	707281	98783.28	2864715.12
3974	30	900	27000	810000	119221.2	3576636
3406	31	961	29791	923521	105595.9	3273473.52
3406	32	1024	32768	1048576	109002.2	3488071.68
3406	33	1089	35937	1185921	112408.6	3709482.48
3406	34	1156	39304	1336336	115814.9	3937705.92
3974	35	1225	42875	1500625	139091.4	4868199
3406	36	1296	46656	1679616	122627.5	4414590.72
3406	37	1369	50653	1874161	126033.8	4663252.08
3406	38	1444	54872	2085136	129440.2	4918726.08
3406	39	1521	59319	2313441	132846.5	5181012.72
3974	40	1600	64000	2560000	158961.6	6358464

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
3406	41	1681	68921	2825761	139659.1	5726023.92
3406	42	1764	74088	3111696	143065.4	6008748.48
3406	43	1849	79507	3418801	146471.8	6298285.68
3406	44	1936	85184	3748096	149878.1	6594635.52
3974	45	2025	91125	4100625	178831.8	8047431
3406	46	2116	97336	4477456	156690.7	7207773.12
3406	47	2209	103823	4879681	160097	7524560.88
3406	48	2304	110592	5308416	163503.4	7848161.28
3406	49	2401	117649	5764801	166909.7	8178574.32
3974	50	2500	125000	6250000	198702	9935100
3406	51	2601	132651	6765201	173722.3	8859838.32
1135	52	2704	140608	7311616	59042.88	3070229.76
JUMLAH						
180733	1378	48230	1898884	79743482	4734614	163633847

$$180733 = 52a + 1378b + 48230c$$

$$4734614 = 1378a + 48230b + 1898884c$$

$$163633847 = 48230a + 1898884b + 79743482c$$

$$a = 3352.86; b = 22.7429; c = -0.517417058$$

$$y = -0.517417058t^2 + 22.7429t + 3352.86$$

Scheduled Receipt

Y	T	t ²	t ³	t ⁴	tY	(t ²)Y
4357	1	1	1	1	4357.08	4357.08
3406	2	4	8	16	6812.64	13625.28
3406	3	9	27	81	10218.96	30656.88
3591	4	16	64	256	14364	57456
3789	5	25	125	625	18946.8	94734
3406	6	36	216	1296	20437.92	122627.52
3406	7	49	343	2401	23844.24	166909.68
3406	8	64	512	4096	27250.56	218004.48
3591	9	81	729	6561	32319	290871
3789	10	100	1000	10000	37893.6	378936
3406	11	121	1331	14641	37469.52	412164.72
3406	12	144	1728	20736	40875.84	490510.08
3406	13	169	2197	28561	44282.16	575668.08
3406	14	196	2744	38416	47688.48	667638.72
3974	15	225	3375	50625	59610.6	894159
3406	16	256	4096	65536	54501.12	872017.92
3406	17	289	4913	83521	57907.44	984426.48
3406	18	324	5832	104976	61313.76	1103647.68
3406	19	361	6859	130321	64720.08	1229681.52

Y	T	t ²	t ³	t ⁴	tY	(t ²)Y
3974	20	400	8000	160000	79480.8	1589616
3406	21	441	9261	194481	71532.72	1502187.12
3406	22	484	10648	234256	74939.04	1648658.88
3406	23	529	12167	279841	78345.36	1801943.28
3406	24	576	13824	331776	81751.68	1962040.32
3974	25	625	15625	390625	99351	2483775
3406	26	676	17576	456976	88564.32	2302672.32
3406	27	729	19683	531441	91970.64	2483207.28
3406	28	784	21952	614656	95376.96	2670554.88
3406	29	841	24389	707281	98783.28	2864715.12
3974	30	900	27000	810000	119221.2	3576636
3406	31	961	29791	923521	105595.9	3273473.52
3406	32	1024	32768	1048576	109002.2	3488071.68
3406	33	1089	35937	1185921	112408.6	3709482.48
3406	34	1156	39304	1336336	115814.9	3937705.92
3974	35	1225	42875	1500625	139091.4	4868199
3406	36	1296	46656	1679616	122627.5	4414590.72
3406	37	1369	50653	1874161	126033.8	4663252.08
3406	38	1444	54872	2085136	129440.2	4918726.08
3406	39	1521	59319	2313441	132846.5	5181012.72
3974	40	1600	64000	2560000	158961.6	6358464
3406	41	1681	68921	2825761	139659.1	5726023.92
3406	42	1764	74088	3111696	143065.4	6008748.48
3406	43	1849	79507	3418801	146471.8	6298285.68
3406	44	1936	85184	3748096	149878.1	6594635.52
3974	45	2025	91125	4100625	178831.8	8047431
3406	46	2116	97336	4477456	156690.7	7207773.12
3406	47	2209	103823	4879681	160097	7524560.88
3406	48	2304	110592	5308416	163503.4	7848161.28
3406	49	2401	117649	5764801	166909.7	8178574.32
3974	50	2500	125000	6250000	198702	9935100
3406	51	2601	132651	6765201	173722.3	8859838.32
1135	52	2704	140608	7311616	59042.88	3070229.76
JUMLAH						
135221	1378	48230	1898884	79743482	3895785	136165094

$$135221 = 52a + 1378b + 48230c$$

$$3895785 = 1378a + 48230b + 1898884c$$

$$136165094 = 48230a + 1898884b + 79743482c$$

$$a = 425.301; b = 223.501; c = -3.531449368$$

$$y = -3.531449368t^2 + 223.501t + 425.301$$

$$GR(t) = \begin{cases} -0.30774719t^2 + 9,7503t + 3.517,17 & ; t \in [1, 52] \\ 0 & ; t \in [0] \end{cases}$$

$$SR(t) = \begin{cases} -3,447233t^2 + 217,65t + 516,703 & ; t \in [1, 52] \\ 0 & ; t \in [0] \end{cases}$$

$$OH = 20.955$$

$$t_0 = 0$$

$$OH(t) + \int_0^t SR(t) - \int_0^t GR(t) = 0$$

$$20955 + \int_0^t (-3,447233t^2 + 217,65t + 516,703) - \int_0^t (-0.30774719t^2 + 9,7503t + 3.517,17) = 0$$

$$20955 + (-1,14908t^3 + 108,825t^2 + 516,703t)$$

$$-(-0,10258t^3 + 4,875015t^2 + 3.517,17t) = 0$$

$$-1,0465t^3 + 103,95t^2 - 3.000,47t + 20955 = 0$$

$$t^*_0 = 10,2454 \text{ (solusi minimum)} ; t = 39,0989 ; t = 49,9868$$

$$SR(t) - GR(t) = 0$$

$$(-3,447233t^2 + 217,65t + 516,703) - (-0.30774719t^2 + 9,7503t + 3.517,17) = 0$$

$$-3,13949t^2 + 207,9t - 3000,47 = 0$$

$$t_1 = 21,2536 \text{ (solusi minimum)} ; t_2 = 44,9673$$

$$\int_{t_1}^t SR(t) - \int_{t_1}^t GR(t) = 0$$

$$\int_{21,2536}^t (-3,447233t^2 + 217,65t + 516,703) - \int_{21,2536}^t (-0.30774719t^2 + 9,7503t + 3.517,17) = 0$$

$$-1,0465t^3 + 103,95t^2 - 3.000,47t + 25.303,8 = 0$$

$$t^*_1 = 55,5585 \text{ (solusi minimum)}$$

$$\int_{t_2}^t SR(t) - \int_{t_2}^t GR(t) = 0$$

$$\int_{44,9673}^t (-3,447233t^2 + 217,65t + 516,703) - \int_{44,9673}^t (-0.30774719t^2 + 9,7503t + 3.517,17) = 0$$

$$-1,0465t^3 + 103,95t^2 - 3.000,47t + 19.884,1 = 0$$

$$t^*_2 = 9,3966 \text{ (tidak feasibel)}$$

$$OH(t) = \begin{cases} \begin{cases} -1,0465t^3 + 103,95t^2 - 3.000,47t + 20955 & 0 \leq t \leq 10,2454 \\ -1,0465t^3 + 103,95t^2 - 3.000,47t + 25.303,8 & 21,2536 \leq t \leq 52 \end{cases} \\ 0 & \text{untuk } t \text{ yang lain} \end{cases}$$

$$\text{Holding Cost} = h \int_0^{10,2454} (-1,0465t^3 + 103,95t^2 - 3.000,47t + 20955) \\ + h \int_{21,2536}^{52} (-1,0465t^3 + 103,95t^2 - 3.000,47t + 25.303,8)$$

Biaya pesan : Rp 1.900.322,00

Biaya simpan per minggu : Rp 27,16,00

Total Inventory Cost =

$$2 \times 1900322 + 27.16 \int_0^{10,2454} (-1,0465t^3 + 103,95t^2 - 3.000,47t + 20955) \\ + 27.16 \int_{21,2536}^{52} (-1,0465t^3 + 103,95t^2 - 3.000,47t + 25.303,8) = \text{Rp } 8.432.260,00$$

2. Gypsum

Gross Requirement

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
13860	1	1	1	1	13860	13860
10800	2	4	8	16	21600	43200
10800	3	9	27	81	32400	97200
11340	4	16	64	256	45360	181440
12060	5	25	125	625	60300	301500
10800	6	36	216	1296	64800	388800
10800	7	49	343	2401	75600	529200
10800	8	64	512	4096	86400	691200
11340	9	81	729	6561	102060	918540
12060	10	100	1000	10000	120600	1206000
10800	11	121	1331	14641	118800	1306800
10800	12	144	1728	20736	129600	1555200
10800	13	169	2197	28561	140400	1825200
10800	14	196	2744	38416	151200	2116800
12600	15	225	3375	50625	189000	2835000
10800	16	256	4096	65536	172800	2764800
10800	17	289	4913	83521	183600	3121200
10800	18	324	5832	104976	194400	3499200
10800	19	361	6859	130321	205200	3898800
12600	20	400	8000	160000	252000	5040000
10800	21	441	9261	194481	226800	4762800
10800	22	484	10648	234256	237600	5227200
10800	23	529	12167	279841	248400	5713200
10800	24	576	13824	331776	259200	6220800

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
12600	25	625	15625	390625	315000	7875000
10800	26	676	17576	456976	280800	7300800
10800	27	729	19683	531441	291600	7873200
10800	28	784	21952	614656	302400	8467200
10800	29	841	24389	707281	313200	9082800
12600	30	900	27000	810000	378000	11340000
10800	31	961	29791	923521	334800	10378800
10800	32	1024	32768	1048576	345600	11059200
10800	33	1089	35937	1185921	356400	11761200
10800	34	1156	39304	1336336	367200	12484800
12600	35	1225	42875	1500625	441000	15435000
10800	36	1296	46656	1679616	388800	13996800
10800	37	1369	50653	1874161	399600	14785200
10800	38	1444	54872	2085136	410400	15595200
10800	39	1521	59319	2313441	421200	16426800
12600	40	1600	64000	2560000	504000	20160000
10800	41	1681	68921	2825761	442800	18154800
10800	42	1764	74088	3111696	453600	19051200
10800	43	1849	79507	3418801	464400	19969200
10800	44	1936	85184	3748096	475200	20908800
12600	45	2025	91125	4100625	567000	25515000
10800	46	2116	97336	4477456	496800	22852800
10800	47	2209	103823	4879681	507600	23857200
10800	48	2304	110592	5308416	518400	24883200
10800	49	2401	117649	5764801	529200	25930800
12600	50	2500	125000	6250000	630000	31500000
10800	51	2601	132651	6765201	550800	28090800
3600	52	2704	140608	7311616	187200	9734400
JUMLAH						
573120	1378	48230	1898884	79743482	15011640	518814720

$$573120 = 52a + 1378b + 48230c$$

$$15011640 = 1378a + 48230b + 1898884c$$

$$518814720 = 48230a + 1898884b + 79743482c$$

$$a = -10645.177 ; b = 71.04294 ; c = -1.62401$$

$$y = -1.62401t^2 + 71.04294t - 10645.177$$

Scheduled Receipt

Y	t	t²	t³	t⁴	tY	(t²)Y
0	1	1	1	1	0	0
0	2	4	8	16	0	0
0	3	9	27	81	0	0
0	4	16	64	256	0	0
0	5	25	125	625	0	0
0	6	36	216	1296	0	0
0	7	49	343	2401	0	0
0	8	64	512	4096	0	0
10710	9	81	729	6561	96390	867510
12060	10	100	1000	10000	120600	1206000
10800	11	121	1331	14641	118800	1306800
10800	12	144	1728	20736	129600	1555200
10800	13	169	2197	28561	140400	1825200
10800	14	196	2744	38416	151200	2116800
12600	15	225	3375	50625	189000	2835000
10800	16	256	4096	65536	172800	2764800
10800	17	289	4913	83521	183600	3121200
10800	18	324	5832	104976	194400	3499200
10800	19	361	6859	130321	205200	3898800
12600	20	400	8000	160000	252000	5040000
10800	21	441	9261	194481	226800	4762800
10800	22	484	10648	234256	237600	5227200
10800	23	529	12167	279841	248400	5713200
10800	24	576	13824	331776	259200	6220800
12600	25	625	15625	390625	315000	7875000
10800	26	676	17576	456976	280800	7300800
10800	27	729	19683	531441	291600	7873200
10800	28	784	21952	614656	302400	8467200
10800	29	841	24389	707281	313200	9082800
12600	30	900	27000	810000	378000	11340000
10800	31	961	29791	923521	334800	10378800
10800	32	1024	32768	1048576	345600	11059200
10800	33	1089	35937	1185921	356400	11761200
10800	34	1156	39304	1336336	367200	12484800
12600	35	1225	42875	1500625	441000	15435000
10800	36	1296	46656	1679616	388800	13996800
10800	37	1369	50653	1874161	399600	14785200
10800	38	1444	54872	2085136	410400	15595200
10800	39	1521	59319	2313441	421200	16426800
12600	40	1600	64000	2560000	504000	20160000
10800	41	1681	68921	2825761	442800	18154800
10800	42	1764	74088	3111696	453600	19051200
10800	43	1849	79507	3418801	464400	19969200

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
10800	44	1936	85184	3748096	475200	20908800
12600	45	2025	91125	4100625	567000	25515000
10800	46	2116	97336	4477456	496800	22852800
10800	47	2209	103823	4879681	507600	23857200
10800	48	2304	110592	5308416	518400	24883200
10800	49	2401	117649	5764801	529200	25930800
12600	50	2500	125000	6250000	630000	31500000
10800	51	2601	132651	6765201	550800	28090800
3600	52	2704	140608	7311616	187200	9734400
JUMLAH						
492030	1378	48230	1898884	79743482	14667840	516993120

$$492030 = 52a + 1378b + 48230c$$

$$14667840 = 1378a + 48230b + 1898884c$$

$$516993120 = 48230a + 1898884b + 79743482c$$

$$a = -38.91176471 ; b = 785.2361906 ; c = -12.1916247$$

$$y = -12.1916247t^2 + 785.2361906t - 38.91176471$$

$$GR(t) = \begin{cases} -0,96824t^2 + 30,42457t - 11158,33 & ; t \in [1, 52] \\ 0 & ; t \in [0] \end{cases}$$

$$SR(t) = \begin{cases} -12,6416t^2 + 822,3491t - 767,708 & ; t \in [1, 52] \\ 0 & ; t \in [0] \end{cases}$$

$$OH = 98.190$$

$$t_0 = 0$$

$$OH(t) + \int_0^t SR(t) - \int_0^t GR(t) = 0$$

$$98190 + \int_0^t (-12,6416t^2 + 822,3491t - 767,708) - \int_0^t (-0,96824t^2 + 30,42457t - 11158,33) = 0$$

$$98190 + (-4,21387t^3 + 411,1746t^2 - 767,708t)$$

$$-(-0,32275t^3 + 15,21229t^2 + 11158,33t) = 0$$

$$-3,89112t^3 + 395,9623t^2 - 11926t + 98190 = 0$$

$$t^*_0 = 13,4347 \text{ (solusi minimum)} ; t = 35,6737 ; t = 52,6520$$

$$SR(t) - GR(t) = 0$$

$$(-12,6416t^2 + 822,3491t - 767,708) - (-0,96824t^2 + 30,42457t - 11158,33) = 0$$

$$-11,6734t^2 + 791,9245t - 11926 = 0$$

$$t_1 = 22,5653 \text{ (solusi minimum)} ; t_2 = 45,2748$$

$$\int_{t_1}^t SR(t) - \int_{t_1}^t GR(t) = 0$$

$$\int_{22,5653}^t (-12,6416t^2 + 822,3491t - 767,708) - \int_{22,5653}^t (-0,96824t^2 + 30,42457t - 11158,33) = 0$$

$$-3,89112t^3 + 395,9623t^2 - 11926t + 108342,8 = 0$$

$$t^*_1 = 55,7283 \text{ (solusi minimum)}$$

$$\int_{t_2}^t SR(t) - \int_{t_2}^t GR(t) = 0$$

$$\int_{45,2748}^t (-12,6416t^2 + 822,3491t - 767,708) - \int_{45,2748}^t (-0,96824t^2 + 30,42457t - 11158,33) = 0$$

$$-3,89112t^3 + 395,9623t^2 - 11926t + 89428,9 = 0$$

$$t^*_2 = 45,6009 \text{ (tidak feasible)}$$

$$OH(t)$$

$$= \begin{cases} \begin{cases} -3,89112t^3 + 395,9623t^2 - 11926t + 98190 & 0 \leq t \leq 13,4347 \\ -3,89112t^3 + 395,9623t^2 - 11926t + 108342,8 & 22,5653 \leq t \leq 52 \end{cases} \\ 0 \end{cases} \text{ untuk } t \text{ yang lain}$$

$$\text{Holding Cost} = h \int_0^{13,4347} (-3,89112t^3 + 395,9623t^2 - 11926t + 98190)$$

$$+ h \int_{22,5653}^{52} (-3,89112t^3 + 395,9623t^2 - 11926t + 108342,8)$$

Biaya pesan : Rp 1.960.356,00

Biaya simpan per minggu : Rp 35,56,00

Total Inventory Cost =

$$2 \times 1960356 + 35.56h \int_0^{13,4347} (-3,89112t^3 + 395,9623t^2 - 11926t + 98190)$$

$$+ 35.56 \int_{22,5653}^{52} (-3,89112t^3 + 395,9623t^2 - 11926t + 108342,8) = \text{Rp } 32.874.132,00$$

3. Trass

Gross Requirement

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
35840	1	1	1	1	35840	35840
26880	2	4	8	16	53760	107520
26880	3	9	27	81	80640	241920
26880	4	16	64	256	107520	430080
31360	5	25	125	625	156800	784000
26880	6	36	216	1296	161280	967680
26880	7	49	343	2401	188160	1317120
26880	8	64	512	4096	215040	1720320
26880	9	81	729	6561	241920	2177280
31360	10	100	1000	10000	313600	3136000
26880	11	121	1331	14641	295680	3252480
26880	12	144	1728	20736	322560	3870720
26880	13	169	2197	28561	349440	4542720
26880	14	196	2744	38416	376320	5268480
31360	15	225	3375	50625	470400	7056000
26880	16	256	4096	65536	430080	6881280
26880	17	289	4913	83521	456960	7768320
26880	18	324	5832	104976	483840	8709120
26880	19	361	6859	130321	510720	9703680
31360	20	400	8000	160000	627200	12544000
26880	21	441	9261	194481	564480	11854080
26880	22	484	10648	234256	591360	13009920
26880	23	529	12167	279841	618240	14219520
26880	24	576	13824	331776	645120	15482880
31360	25	625	15625	390625	784000	19600000
26880	26	676	17576	456976	698880	18170880
26880	27	729	19683	531441	725760	19595520
26880	28	784	21952	614656	752640	21073920
26880	29	841	24389	707281	779520	22606080
31360	30	900	27000	810000	940800	28224000
26880	31	961	29791	923521	833280	25831680
26880	32	1024	32768	1048576	860160	27525120
26880	33	1089	35937	1185921	887040	29272320
26880	34	1156	39304	1336336	913920	31073280
31360	35	1225	42875	1500625	1097600	38416000
26880	36	1296	46656	1679616	967680	34836480
26880	37	1369	50653	1874161	994560	36798720
26880	38	1444	54872	2085136	1021440	38814720
26880	39	1521	59319	2313441	1048320	40884480
31360	40	1600	64000	2560000	1254400	50176000
26880	41	1681	68921	2825761	1102080	45185280

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
26880	42	1764	74088	3111696	1128960	47416320
26880	43	1849	79507	3418801	1155840	49701120
26880	44	1936	85184	3748096	1182720	52039680
31360	45	2025	91125	4100625	1411200	63504000
26880	46	2116	97336	4477456	1236480	56878080
26880	47	2209	103823	4879681	1263360	59377920
26880	48	2304	110592	5308416	1290240	61931520
26880	49	2401	117649	5764801	1317120	64538880
31360	50	2500	125000	6250000	1568000	78400000
26880	51	2601	132651	6765201	1370880	69914880
8960	52	2704	140608	7311616	465920	24227840
JUMLAH						
1429120	1378	48230	1898884	79743482	37367680	1291301760

$$1429120 = 52a + 1378b + 48230c$$

$$37367680 = 1378a + 48230b + 1898884c$$

$$1291301760 = 48230a + 1898884b + 79743482c$$

$$a = 31552.96 ; b = 145.3832 ; c = -3.55495$$

$$y = -3.55495t^2 + 145.3832t + 31552.96$$

Scheduled Receipt

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
10533	1	1	1	1	10533	10533
26880	2	4	8	16	53760	107520
26880	3	9	27	81	80640	241920
26880	4	16	64	256	107520	430080
31360	5	25	125	625	156800	784000
26880	6	36	216	1296	161280	967680
26880	7	49	343	2401	188160	1317120
26880	8	64	512	4096	215040	1720320
26880	9	81	729	6561	241920	2177280
31360	10	100	1000	10000	313600	3136000
26880	11	121	1331	14641	295680	3252480
26880	12	144	1728	20736	322560	3870720
26880	13	169	2197	28561	349440	4542720
26880	14	196	2744	38416	376320	5268480
31360	15	225	3375	50625	470400	7056000
26880	16	256	4096	65536	430080	6881280
26880	17	289	4913	83521	456960	7768320
26880	18	324	5832	104976	483840	8709120
26880	19	361	6859	130321	510720	9703680
31360	20	400	8000	160000	627200	12544000

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
26880	21	441	9261	194481	564480	11854080
26880	22	484	10648	234256	591360	13009920
26880	23	529	12167	279841	618240	14219520
26880	24	576	13824	331776	645120	15482880
31360	25	625	15625	390625	784000	19600000
26880	26	676	17576	456976	698880	18170880
26880	27	729	19683	531441	725760	19595520
26880	28	784	21952	614656	752640	21073920
26880	29	841	24389	707281	779520	22606080
31360	30	900	27000	810000	940800	28224000
26880	31	961	29791	923521	833280	25831680
26880	32	1024	32768	1048576	860160	27525120
26880	33	1089	35937	1185921	887040	29272320
26880	34	1156	39304	1336336	913920	31073280
31360	35	1225	42875	1500625	1097600	38416000
26880	36	1296	46656	1679616	967680	34836480
26880	37	1369	50653	1874161	994560	36798720
26880	38	1444	54872	2085136	1021440	38814720
26880	39	1521	59319	2313441	1048320	40884480
31360	40	1600	64000	2560000	1254400	50176000
26880	41	1681	68921	2825761	1102080	45185280
26880	42	1764	74088	3111696	1128960	47416320
26880	43	1849	79507	3418801	1155840	49701120
26880	44	1936	85184	3748096	1182720	52039680
31360	45	2025	91125	4100625	1411200	63504000
26880	46	2116	97336	4477456	1236480	56878080
26880	47	2209	103823	4879681	1263360	59377920
26880	48	2304	110592	5308416	1290240	61931520
26880	49	2401	117649	5764801	1317120	64538880
31360	50	2500	125000	6250000	1568000	78400000
26880	51	2601	132651	6765201	1370880	69914880
8960	52	2704	140608	7311616	465920	24227840
JUMLAH						
1404083	1378	48230	1898884	79743482	37342643	1291276723

$$1404083 = 52a + 1378b + 48230c$$

$$37342643 = 1378a + 48230b + 1898884c$$

$$1291276723 = 48230a + 1898884b + 79743482c$$

$$a = 26475.36 ; b = 467.3763 ; c = -8.60186$$

$$y = -8.60186t^2 + 467.3763t + 26475.36$$

$$GR(t) = \begin{cases} -2,18864t^2 + 61,30321t + 32779,83 & ; t \in [1, 52] \\ 0 & ; t \in [0] \end{cases}$$

$$SR(t) = \begin{cases} -7,29004t^2 + 386,7722t + 27647,42 & ; t \in [1, 52] \\ 0 & ; t \in [0] \end{cases}$$

$$OH = 25307$$

$$t_0 = 0$$

$$OH(t) + \int_0^t SR(t) - \int_0^t GR(t) = 0$$

$$25307 + \int_0^t (-7,29004t^2 + 386,7722t + 27647,42) - \int_0^t (-2,18864t^2 + 61,30321t + 32779,83) = 0$$

$$25307 + (-2,43001t^3 + 193,3861t^2 + 27647,42t)$$

$$-(-0,72955t^3 + 30,65161t^2 + 32779,83t) = 0$$

$$-1,70046t^3 + 162,7345t^2 - 5132,41t + 25307 = 0$$

$$t_0^* = 6,0011$$

$$SR(t) - GR(t) = 0$$

$$(-7,29004t^2 + 386,7722t + 27647,42) - (-2,18864t^2 + 61,30321t + 32779,83) = 0$$

$$-5,10139t^2 + 325,469t - 5132,41 = 0$$

$$t_1 = 28,5043 \text{ (solusi minimum)}; t_2 = 35,2958$$

$$\int_{t_1}^t SR(t) - \int_{t_1}^t GR(t) = 0$$

$$\int_{28,5043}^t (-7,29004t^2 + 386,7722t + 27647,42) - \int_{28,5043}^t (-2,18864t^2 + 61,30321t + 32779,83) = 0$$

$$-1,70046t^3 + 162,7345t^2 - 5132,41t + 53456,91 = 0$$

$$t_1^* = 38,6932 \text{ (solusi minimum)}$$

$$\int_{t_2}^t SR(t) - \int_{t_2}^t GR(t) = 0$$

$$\int_{35,2958}^t (-7,29004t^2 + 386,7722t + 27647,42) - \int_{35,2958}^t (-2,18864t^2 + 61,30321t + 32779,83) = 0$$

$$-1,70046t^3 + 162,7345t^2 - 5132,41t + 53190,63 = 0$$

$$t_2^* = 35,4259 \text{ (tidak feasibel)}$$

$$OH(t) = \begin{cases} -1,70046t^3 + 162,7345t^2 - 5132,41t + 25307 & 0 \leq t \leq 6,0011 \\ -1,70046t^3 + 162,7345t^2 - 5132,41t + 53456,91 & 28,5043 \leq t \leq 38,6932 \\ & \text{untuk } t \text{ yang lain} \end{cases}$$

$$\text{Holding Cost} = h \int_0^{6,0011} (-1,70046t^3 + 162,7345t^2 - 5132,41t + 25307)$$

$$+h \int_{28,5043}^{38,6932} (-1,70046t^3 + 162,7345t^2 - 5132,41t + 53456,91)$$

Biaya pesan : Rp 1.438.326,00

Biaya simpan per minggu : Rp 21,68,00

Total Inventory Cost =

$$2 \times 1438326 + 21.68 \int_0^{6,0011} (-1,70046t^3 + 162,7345t^2 - 5132,41t + 25307)$$

$$+ 21.68 \int_{28,5043}^{38,6932} (-1,70046t^3 + 162,7345t^2 - 5132,41t + 53456,91)$$

$$= \text{Rp } 4.440.929,00$$

4. Batubara

Gross Requirement

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
60368	1	1	1	1	60368	60368
47040	2	4	8	16	94080	188160
47040	3	9	27	81	141120	423360
49392	4	16	64	256	197568	790272
52528	5	25	125	625	262640	1313200
47040	6	36	216	1296	282240	1693440
47040	7	49	343	2401	329280	2304960
47040	8	64	512	4096	376320	3010560
49392	9	81	729	6561	444528	4000752
52528	10	100	1000	10000	525280	5252800
47040	11	121	1331	14641	517440	5691840
47040	12	144	1728	20736	564480	6773760
47040	13	169	2197	28561	611520	7949760
47040	14	196	2744	38416	658560	9219840
54880	15	225	3375	50625	823200	12348000
47040	16	256	4096	65536	752640	12042240
47040	17	289	4913	83521	799680	13594560
47040	18	324	5832	104976	846720	15240960
47040	19	361	6859	130321	893760	16981440
54880	20	400	8000	160000	1097600	21952000
47040	21	441	9261	194481	987840	20744640
47040	22	484	10648	234256	1034880	22767360
47040	23	529	12167	279841	1081920	24884160
47040	24	576	13824	331776	1128960	27095040
54880	25	625	15625	390625	1372000	34300000
47040	26	676	17576	456976	1223040	31799040
47040	27	729	19683	531441	1270080	34292160

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
47040	28	784	21952	614656	1317120	36879360
47040	29	841	24389	707281	1364160	39560640
54880	30	900	27000	810000	1646400	49392000
47040	31	961	29791	923521	1458240	45205440
47040	32	1024	32768	1048576	1505280	48168960
47040	33	1089	35937	1185921	1552320	51226560
47040	34	1156	39304	1336336	1599360	54378240
54880	35	1225	42875	1500625	1920800	67228000
47040	36	1296	46656	1679616	1693440	60963840
47040	37	1369	50653	1874161	1740480	64397760
47040	38	1444	54872	2085136	1787520	67925760
47040	39	1521	59319	2313441	1834560	71547840
54880	40	1600	64000	2560000	2195200	87808000
47040	41	1681	68921	2825761	1928640	79074240
47040	42	1764	74088	3111696	1975680	82978560
47040	43	1849	79507	3418801	2022720	86976960
47040	44	1936	85184	3748096	2069760	91069440
54880	45	2025	91125	4100625	2469600	1.11E+08
47040	46	2116	97336	4477456	2163840	99536640
47040	47	2209	103823	4879681	2210880	1.04E+08
47040	48	2304	110592	5308416	2257920	1.08E+08
47040	49	2401	117649	5764801	2304960	1.13E+08
54880	50	2500	125000	6250000	2744000	1.37E+08
47040	51	2601	132651	6765201	2399040	1.22E+08
15680	52	2704	140608	7311616	815360	42398720
JUMLAH						
2496256	1378	48230	1898884	79743482	65384032	2259726336

$$2496256 = 52a + 1378b + 48230c$$

$$65384032 = 1378a + 48230b + 1898884c$$

$$2259726336 = 48230a + 1898884b + 79743482c$$

$$a = 46365.62 ; b = 309.4315 ; c = -7.07345$$

$$y = -7.07345t^2 + 309.4315t + 46365.62$$

Scheduled Receipt

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
0	1	1	1	1	0	0
0	2	4	8	16	0	0
0	3	9	27	81	0	0
0	4	16	64	256	0	0
20708	5	25	125	625	103540	517700
47040	6	36	216	1296	282240	1693440
47040	7	49	343	2401	329280	2304960
47040	8	64	512	4096	376320	3010560
49392	9	81	729	6561	444528	4000752
52528	10	100	1000	10000	525280	5252800
47040	11	121	1331	14641	517440	5691840
47040	12	144	1728	20736	564480	6773760
47040	13	169	2197	28561	611520	7949760
47040	14	196	2744	38416	658560	9219840
54880	15	225	3375	50625	823200	12348000
47040	16	256	4096	65536	752640	12042240
47040	17	289	4913	83521	799680	13594560
47040	18	324	5832	104976	846720	15240960
47040	19	361	6859	130321	893760	16981440
54880	20	400	8000	160000	1097600	21952000
47040	21	441	9261	194481	987840	20744640
47040	22	484	10648	234256	1034880	22767360
47040	23	529	12167	279841	1081920	24884160
47040	24	576	13824	331776	1128960	27095040
54880	25	625	15625	390625	1372000	34300000
47040	26	676	17576	456976	1223040	31799040
47040	27	729	19683	531441	1270080	34292160
47040	28	784	21952	614656	1317120	36879360
47040	29	841	24389	707281	1364160	39560640
54880	30	900	27000	810000	1646400	49392000
47040	31	961	29791	923521	1458240	45205440
47040	32	1024	32768	1048576	1505280	48168960
47040	33	1089	35937	1185921	1552320	51226560
47040	34	1156	39304	1336336	1599360	54378240
54880	35	1225	42875	1500625	1920800	67228000
47040	36	1296	46656	1679616	1693440	60963840
47040	37	1369	50653	1874161	1740480	64397760
47040	38	1444	54872	2085136	1787520	67925760
47040	39	1521	59319	2313441	1834560	71547840
54880	40	1600	64000	2560000	2195200	87808000

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
47040	41	1681	68921	2825761	1928640	79074240
47040	42	1764	74088	3111696	1975680	82978560
47040	43	1849	79507	3418801	2022720	86976960
47040	44	1936	85184	3748096	2069760	91069440
54880	45	2025	91125	4100625	2469600	111132000
47040	46	2116	97336	4477456	2163840	99536640
47040	47	2209	103823	4879681	2210880	103911360
47040	48	2304	110592	5308416	2257920	108380160
47040	49	2401	117649	5764801	2304960	112943040
54880	50	2500	125000	6250000	2744000	137200000
47040	51	2601	132651	6765201	2399040	122351040
15680	52	2704	140608	7311616	815360	42398720
JUMLAH						
2324236	1378	48230	1898884	79743482	64974272	2258569456

$$2324236 = 52a + 1378b + 48230c$$

$$64974272 = 1378a + 48230b + 1898884c$$

$$2258569456 = 48230a + 1898884b + 79743482c$$

$$a = 19758.71 ; b = 2209.464 ; c = -36.2401$$

$$y = -36.2401t^2 + 2209.464t + 19758.71$$

$$GR(t) = \begin{cases} -4,21722t^2 + 132,5159t + 48600,73 ; t \in [1, 52] \\ 0 ; t \in [0] \end{cases}$$

$$SR(t) = \begin{cases} -42,20871t^2 + 2623,547t + 13293,58 ; t \in [1, 52] \\ 0 ; t \in [0] \end{cases}$$

$$OH = 172020$$

$$t_0 = 0$$

$$OH(t) + \int_0^t SR(t) - \int_0^t GR(t) = 0$$

$$172020 + \int_0^t (-42,20871t^2 + 2623,547t + 13293,58) - \int_0^t (-4,21722t^2 + 132,5159t + 48600,73) = 0$$

$$172020 + (-14,0696t^3 + 1311,774t^2 + 13293,58t)$$

$$-(-1,40574t^3 + 66,25795t^2 + 48600,73t) = 0$$

$$-12,6638t^3 + 1245,516t^2 - 35307,2t + 172020 = 0$$

$$t^*_0 = 6,1055 \text{ (solusi minimum)}$$

$$SR(t) - GR(t) = 0$$

$$(-42,20871t^2 + 2623,547t + 13293,58) - (-4,21722t^2 + 132,5159t + 48600,73) = 0$$

$$-37,9915t^2 + 2491,031t - 35307,2 = 0$$

$$t_1 = 20,7238 \text{ (solusi minimum)} ; t_2 = 44,8443$$

$$\int_{t_1}^t SR(t) - \int_{t_1}^t GR(t) = 0$$

$$\int_{20,7238}^t (-42,20871t^2 + 2623,547t + 13293,58) - \int_{20,7238}^t (-4,21722t^2 + 132,5159t + 48600,73) = 0$$

$$-12,6638t^3 + 1245,516t^2 - 35307,2t + 287719,5 = 0$$

$$t^*_1 = 55,4819 \text{ (solusi minimum)}$$

$$\int_{t_2}^t SR(t) - \int_{t_2}^t GR(t) = 0$$

$$\int_{44,8443}^t (-42,20871t^2 + 2623,547t + 13293,58) - \int_{44,8443}^t (-4,21722t^2 + 132,5159t + 48600,73) = 0$$

$$-12,6638t^3 + 1245,516t^2 - 35307,2t + 220632,8 = 0$$

$$t^*_2 = 44,8922 \text{ (tidak feasibel)}$$

$$OH(t) = \begin{cases} -12,6638t^3 + 1245,516t^2 - 35307,2t + 172020 & 0 \leq t \leq 6,1055 \\ -12,6638t^3 + 1245,516t^2 - 35307,2t + 287719,5 & 20,7238 \leq t \leq 52 \\ \text{untuk } t \text{ yang lain} \end{cases}$$

$$\text{Holding Cost} = h \int_0^{6,1055} (-12,6638t^3 + 1245,516t^2 - 35307,2t + 172020)$$

$$+ h \int_{20,7238}^{52} (-12,6638t^3 + 1245,516t^2 - 35307,2t + 287719,5)$$

Biaya pesan : Rp 3.588.400,00

Biaya simpan per minggu : Rp 44,72,00

Total Inventory Cost =

$$2 \times 3588400 + 44,72 \int_0^{6,1055} (-12,6638t^3 + 1245,516t^2 - 35307,2t + 172020)$$

$$+ 44,72 \int_{20,7238}^{52} (-12,6638t^3 + 1245,516t^2 - 35307,2t + 287719,5)$$

$$= \text{Rp } 71.778.630,00$$

5. Bahan Bakar Alternatif

Gross Requirement

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
1232	1	1	1	1	1232	1232
960	2	4	8	16	1920	3840
960	3	9	27	81	2880	8640
1008	4	16	64	256	4032	16128
1072	5	25	125	625	5360	26800
960	6	36	216	1296	5760	34560
960	7	49	343	2401	6720	47040
960	8	64	512	4096	7680	61440
1008	9	81	729	6561	9072	81648
1072	10	100	1000	10000	10720	107200
960	11	121	1331	14641	10560	116160
960	12	144	1728	20736	11520	138240
960	13	169	2197	28561	12480	162240
960	14	196	2744	38416	13440	188160
1120	15	225	3375	50625	16800	252000
960	16	256	4096	65536	15360	245760
960	17	289	4913	83521	16320	277440
960	18	324	5832	104976	17280	311040
960	19	361	6859	130321	18240	346560
1120	20	400	8000	160000	22400	448000
960	21	441	9261	194481	20160	423360
960	22	484	10648	234256	21120	464640
960	23	529	12167	279841	22080	507840
960	24	576	13824	331776	23040	552960
1120	25	625	15625	390625	28000	700000
960	26	676	17576	456976	24960	648960
960	27	729	19683	531441	25920	699840
960	28	784	21952	614656	26880	752640
960	29	841	24389	707281	27840	807360
1120	30	900	27000	810000	33600	1008000
960	31	961	29791	923521	29760	922560
960	32	1024	32768	1048576	30720	983040
960	33	1089	35937	1185921	31680	1045440
960	34	1156	39304	1336336	32640	1109760
1120	35	1225	42875	1500625	39200	1372000
960	36	1296	46656	1679616	34560	1244160
960	37	1369	50653	1874161	35520	1314240
960	38	1444	54872	2085136	36480	1386240
960	39	1521	59319	2313441	37440	1460160
1120	40	1600	64000	2560000	44800	1792000
960	41	1681	68921	2825761	39360	1613760

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
960	42	1764	74088	3111696	40320	1693440
960	43	1849	79507	3418801	41280	1775040
960	44	1936	85184	3748096	42240	1858560
1120	45	2025	91125	4100625	50400	2268000
960	46	2116	97336	4477456	44160	2031360
960	47	2209	103823	4879681	45120	2120640
960	48	2304	110592	5308416	46080	2211840
960	49	2401	117649	5764801	47040	2304960
1120	50	2500	125000	6250000	56000	2800000
960	51	2601	132651	6765201	48960	2496960
320	52	2704	140608	7311616	16640	865280
JUMLAH						
50944	1378	48230	1898884	79743482	1334368	46116864

$$50944 = 52a + 1378b + 48230c$$

$$1334368 = 1378a + 48230b + 1898884c$$

$$46116864 = 48230a + 1898884b + 79743482c$$

$$a = 1108.771 ; b = 6.314928 ; c = -0.14436$$

$$y = -0.14436t^2 + 6.314928t + 1108.771$$

Scheduled Receipt

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
0	1	1	1	1	0	0
649	2	4	8	16	1298	2596
960	3	9	27	81	2880	8640
1008	4	16	64	256	4032	16128
1072	5	25	125	625	5360	26800
960	6	36	216	1296	5760	34560
960	7	49	343	2401	6720	47040
960	8	64	512	4096	7680	61440
1008	9	81	729	6561	9072	81648
1072	10	100	1000	10000	10720	107200
960	11	121	1331	14641	10560	116160
960	12	144	1728	20736	11520	138240
960	13	169	2197	28561	12480	162240
960	14	196	2744	38416	13440	188160
1120	15	225	3375	50625	16800	252000
960	16	256	4096	65536	15360	245760
960	17	289	4913	83521	16320	277440
960	18	324	5832	104976	17280	311040
960	19	361	6859	130321	18240	346560

Y	t	t ²	t ³	t ⁴	tY	(t ²)Y
1120	20	400	8000	160000	22400	448000
960	21	441	9261	194481	20160	423360
960	22	484	10648	234256	21120	464640
960	23	529	12167	279841	22080	507840
960	24	576	13824	331776	23040	552960
1120	25	625	15625	390625	28000	700000
960	26	676	17576	456976	24960	648960
960	27	729	19683	531441	25920	699840
960	28	784	21952	614656	26880	752640
960	29	841	24389	707281	27840	807360
1120	30	900	27000	810000	33600	1008000
960	31	961	29791	923521	29760	922560
960	32	1024	32768	1048576	30720	983040
960	33	1089	35937	1185921	31680	1045440
960	34	1156	39304	1336336	32640	1109760
1120	35	1225	42875	1500625	39200	1372000
960	36	1296	46656	1679616	34560	1244160
960	37	1369	50653	1874161	35520	1314240
960	38	1444	54872	2085136	36480	1386240
960	39	1521	59319	2313441	37440	1460160
1120	40	1600	64000	2560000	44800	1792000
960	41	1681	68921	2825761	39360	1613760
960	42	1764	74088	3111696	40320	1693440
960	43	1849	79507	3418801	41280	1775040
960	44	1936	85184	3748096	42240	1858560
1120	45	2025	91125	4100625	50400	2268000
960	46	2116	97336	4477456	44160	2031360
960	47	2209	103823	4879681	45120	2120640
960	48	2304	110592	5308416	46080	2211840
960	49	2401	117649	5764801	47040	2304960
1120	50	2500	125000	6250000	56000	2800000
960	51	2601	132651	6765201	48960	2496960
320	52	2704	140608	7311616	16640	865280
JUMLAH						
49401	1378	48230	1898884	79743482	1332146	46113284

$$49401 = 52a + 1378b + 48230c$$

$$1332146 = 1378a + 48230b + 1898884c$$

$$46113284 = 48230a + 1898884b + 79743482c$$

$$a = 806.6416 ; b = 25.24777 ; c = -0.43929$$

$$y = -0.43929t^2 + 25.24777t + 806.6416$$

$$GR(t) = \begin{cases} -0,08607t^2 + 2,704406t + 1162,221 & ; t \in [1, 52] \\ 0 & ; t \in [0] \end{cases}$$

$$SR(t) = \begin{cases} -0,38973t^2 + 22,13121t + 854,2377 & ; t \in [1, 52] \\ 0 & ; t \in [0] \end{cases}$$

$$OH = 1543$$

$$t_0 = 0$$

$$OH(t) + \int_0^t SR(t) - \int_0^t GR(t) = 0$$

$$1543 + \int_0^t (-0,38973t^2 + 22,13121t + 854,2377) - \int_0^t (-0,08607t^2 + 2,704406t + 1162,221) = 0$$

$$1543 + (-0,12991t^3 + 11,06561t^2 + 854,2377t)$$

$$-(-0,02869 + 1,352203t^2 + 1162,221t) = 0$$

$$-0,10122t^3 + 9,713402t^2 - 307,983t + 1543 = 0$$

$$t^*_0 = 6,1138 \text{ (solusi minimum)}$$

$$SR(t) - GR(t) = 0$$

$$(-0,38973t^2 + 22,13121t + 854,2377) - (-0,08607t^2 + 2,704406t + 1162,221) = 0$$

$$-0,30366t^2 + 19,4268t - 307,983 = 0$$

$$t_1 = 28,9911 \text{ (solusi minimum)} ; t_2 = 34,9844$$

$$\int_{28,9911}^t SR(t) - \int_{28,9911}^t GR(t) = 0$$

$$\int_{28,9911}^t (-0,38973t^2 + 22,13121t + 854,2377) - \int_{28,9911}^t (-0,38973t^2 + 22,13121t + 854,2377) = 0$$

$$-0,10122t^3 + 9,713402t^2 - 307,983t + 3230,972 = 0$$

$$t^*_1 = 37,9543 \text{ (solusi minimum)}$$

$$\int_{34,9844}^t SR(t) - \int_{34,9844}^t GR(t) = 0$$

$$\int_{34,9844}^t (-0,38973t^2 + 22,13121t + 854,2377) - \int_{34,9844}^t (-0,38973t^2 + 22,13121t + 854,2377) = 0$$

$$-0,10122t^3 + 9,713402t^2 - 307,983t + 3220,3 = 0$$

$$t^*_2 = 35,0896 \text{ (tidak feasibel)}$$

$$OH(t)$$

$$= \begin{cases} \begin{cases} -0,10122t^3 + 9,713402t^2 - 307,983t + 1543 & 0 \leq t \leq 6,524 \\ -0,10122t^3 + 9,713402t^2 - 307,983t + 3230,972 & 28,991 \leq t \leq 37,9543 \end{cases} \\ 0 & \text{untuk } t \text{ yang lain} \end{cases}$$

$$\text{Holding Cost} = h \int_0^{6,1138} (-0,10122t^3 + 9,713402t^2 - 307,983t + 1543) \\ + h \int_{28,9911}^{37,9543} (-0,10122t^3 + 9,713402t^2 - 307,983t + 3230,972)$$

Biaya pesan : Rp 1.009.543,00

Biaya simpan per minggu : Rp 19,97,00

Total Inventory Cost =

$$2 \times 1009543 + 19.97 \int_0^{6,1138} (-0,10122t^3 + 9,713402t^2 - 307,983t + 1543) \\ + 19.97 \int_{28,9911}^{37,9543} (-0,10122t^3 + 9,713402t^2 - 307,983t + 3230,972) = \text{Rp } 2.107.659,00$$



Lampiran 6 – Metode Existing

No	Forecast (Y [^])	Actual Sales (Y _t)	Error	Kumulatif Error	Absolut Error	Kumulatif Absolut Error	MAD	MAPE	Tracking Signal
1	1.040.525	1.039.516	1.009	1.009	1.009	1.009	1.009	0,09697	1
2	972.375	942.171	30.204	31.213	31.213	32.222	16.111	3,106209	1,874743964
3	1.062.110	1.134.059	-71.949	-40.736	40.736	72.958	24.319,33	6,774157	-2,95851037
4	964.852	971.469	-6.617	-47.353	47.353	120.311	30.077,75	0,685805	-0,21999650
5	1.100.064	1.104.190	-4.126	-51.479	51.479	171.790	34.358	0,375069	-0,12008848
6	1.126.956	1.126.186	770	-50.709	50.709	222.499	37.083,17	0,068326	0,020764138
7	861.124	943.504	-82.380	-133.089	133.089	355.588	50.798,29	9,566566	-1,62170826
8	950.840	860.233	90.607	-42.482	42.482	398.070	49.758,75	9,529153	1,820925968
9	1.101.322	994.090	107.232	64.750	64.750	462.820	51.424,44	9,736662	2,085234
10	1.151.856	1.181.645	-29.789	34.961	34.961	497.781	49.778,1	2,586174	-0,59843585
11	1.176.097	1.156.466	19.631	54.592	54.592	552.373	50.215,73	1,669165	0,390933301
12	1.072.846	1.135.038	-62.192	-7.600	7.600	559.973	46.664,42	5,796918	-1,33274997
13	974.145	970.919	3.226	-4.374	4.374	564.347	43.411,31	0,331162	0,074312435
14	918.386	881.926	36.460	32.086	32.086	596.433	42.602,36	3,970008	0,85582119
15	1.011.923	953.665	58.258	90.344	90.344	686.777	45.785,13	5,757157	1,272421761
16	835.270	910.916	-75.646	14.698	14.698	701.475	43.842,19	9,056473	-1,72541573
17	914.358	923.159	-8.801	5.897	5.897	707.372	41.610,12	0,962533	-0,21151105
18	974.911	961.710	13.201	19.098	19.098	726.470	40.359,44	1,354072	0,327085771
19	1.011.313	1.071.632	-60.319	-41.221	41.221	767.691	40.404,79	5,964424	-1,49286757
20	786.945	648.203	138.742	97.521	97.521	865.212	43.260,6	17,63046	3,207121492
21	1.122.060	1.122.514	-454	97.067	97.067	962.279	45.822,81	0,040461	-0,00990772
22	1.181.440	1.184.699	-3.259	93.808	93.808	1.056.087	48.003,95	0,27585	-0,06789024

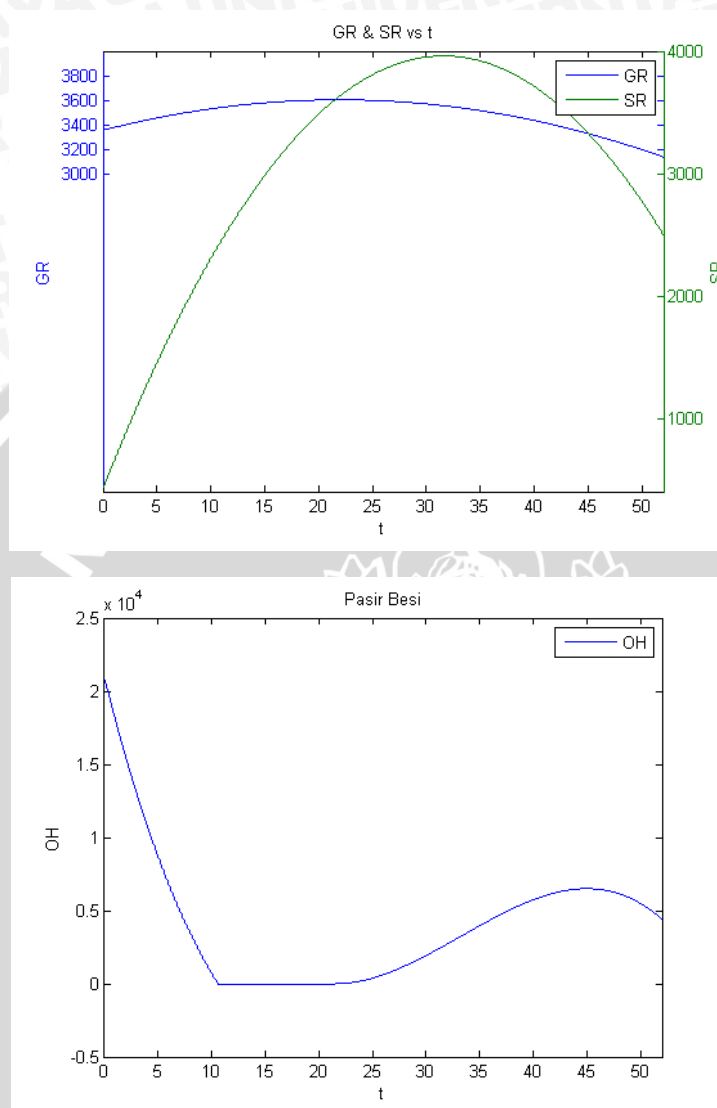
No	Forecast (Y [^])	Actual Sales (Y _t)	Error	Kumulatif Error	Absolut Error	Kumulatif Absolut Error	MAD	MAPE	Tracking Signal
23	1.117.717	1.11.9082	-1.365	92.443	92.443	1.148.530	49.936,09	0,122124	-0,02733494
24	1.136.812	1.130.422	6.390	98.833	98.833	1.247.363	51.973,46	0,562098	0,12294737
25	1.049.850	1.136.812	-86.962	11.871	11.871	1.259.234	50.369,36	8,283279	-1,72648610
26	950.660	1.049.850	-99.190	-87.319	87.319	1.346.553	51.790,5	10,4338	-1,91521611
27	1.094.471	950.660	143.811	56.492	56.492	1.403.045	51.964,63	13,13977	2,76747859
28	981.454	1.094.471	-113.017	-56.525	56.525	1.459.570	52.127,5	11,51526	-2,16808786
29	1.076.195	981.454	94.741	38.216	38.216	1.497.786	51.647,79	8,80333	1,834366859
30	1.076.359	1.076.195	164	38.380	38.380	1.536.166	51.205,53	0,015237	0,003202779
31	968.027	1.076.359	-108.332	-69.952	69.952	1.606.118	51.810,26	11,19101	-2,09093727
32	943.059	968.027	-24.968	-94.920	94.920	1.701.038	53.157,44	2,647554	-0,46969909
33	986.955	943.059	43.896	-51.024	51.024	1.752.062	53.092,79	4,447619	0,826778961
34	1.152.555	986.955	165.600	114.576	114.576	1.866.638	54.901,12	14,36808	3,016332037
35	1.125.985	1.152.555	-26.570	88.006	88.006	1.954.644	55.846,97	2,359712	-0,47576438
36	1.109.012	1.125.985	-16.973	71.033	71.033	2.025.677	56.268,81	1,530461	-0,30164137

Perhitungan biaya persediaan,

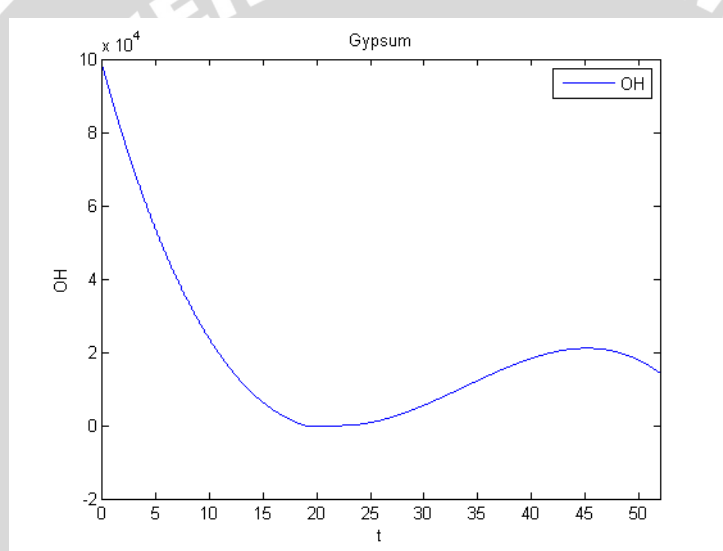
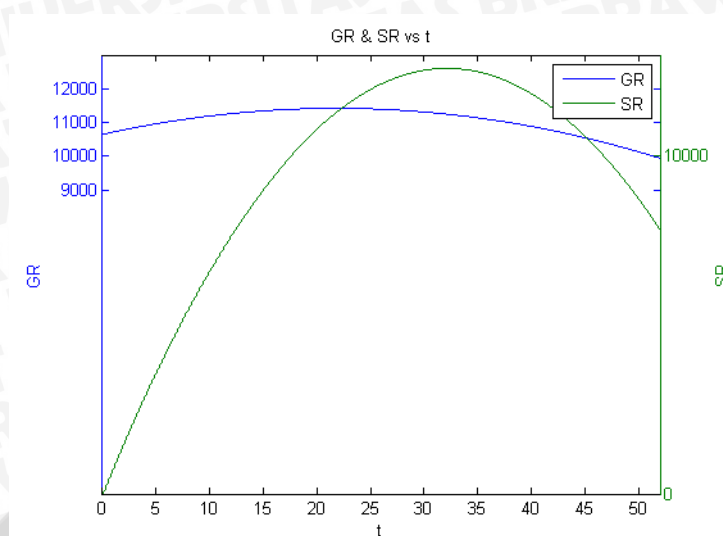
Nama	Biaya Persediaan
Pasir Besi	(Rp 27,16 x 301.136) + Rp 4.750.805,00 = Rp 37.454.174,00
Gypsum	(Rp 35,56 x 564.660) + Rp 4.900.890,00 = Rp 85.218.128,00
Trass	(Rp 21,68 x 1.451.776) + Rp 3.595.815,00 = Rp 129.493.830,00
Batubara	(Rp 44,72 x 2.459.408) + Rp 8.971.000,00 = Rp 448.909.903,00
Bahan Bakar Alternatif	(Rp 19,97 x 79.838) + Rp 2.523.858,00 = Rp 8.901.317,00

Lampiran 7 – Gambar *material requirement planning* (MRP) dengan menggunakan *continous material requirement planning* (CMRP)

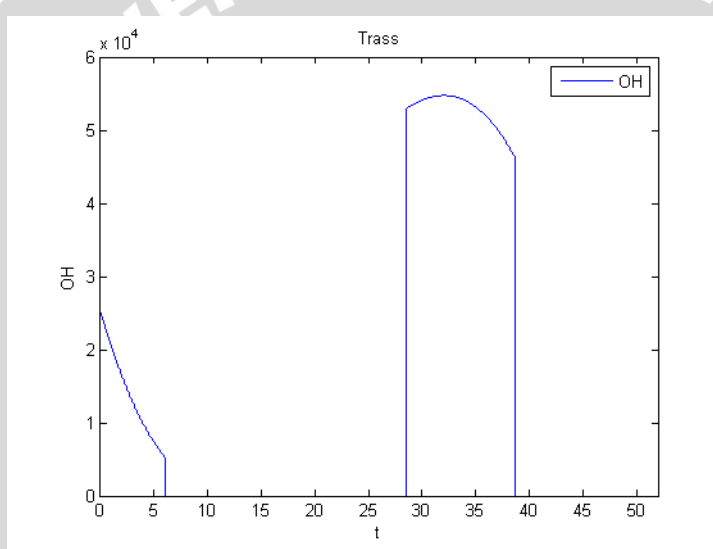
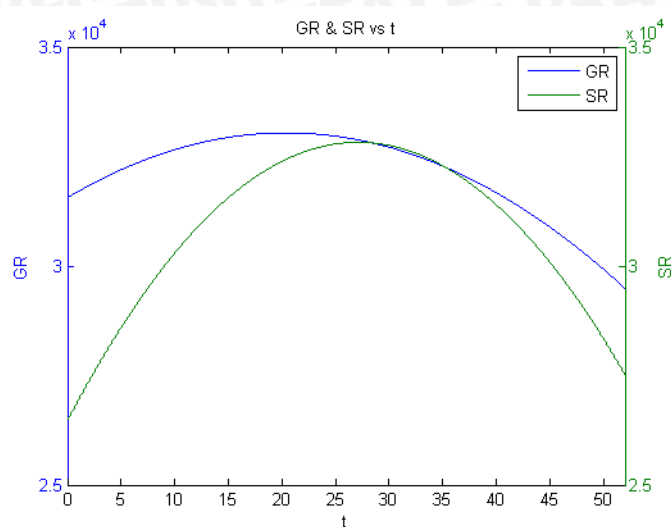
1. Pasir Besi



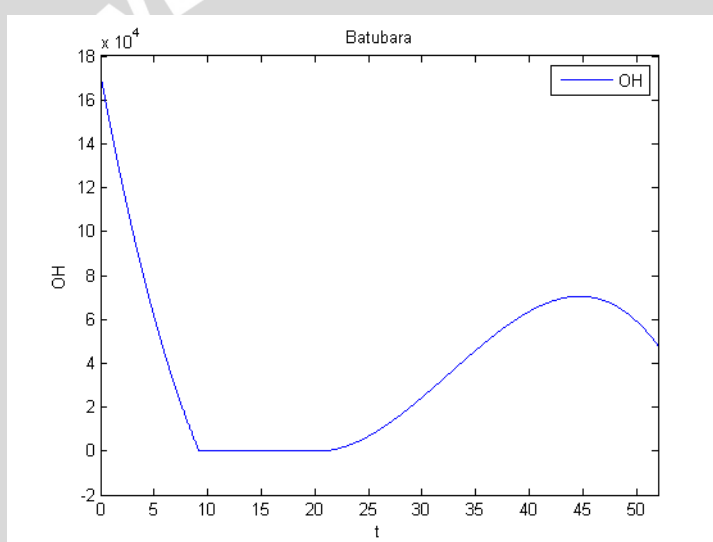
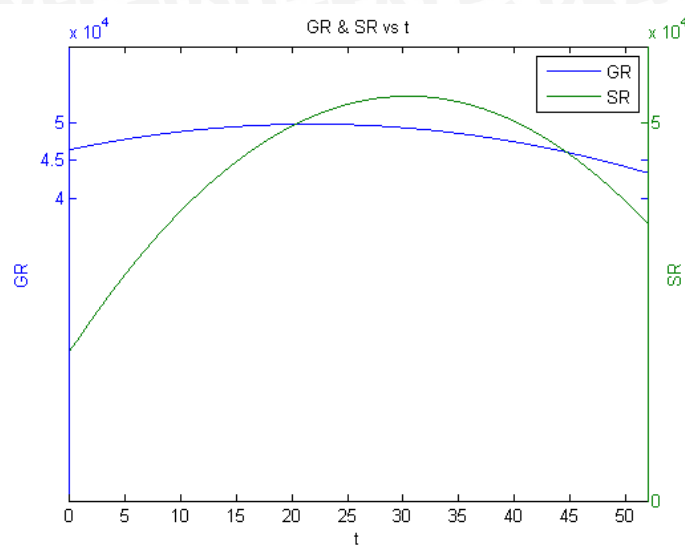
2. Gypsum



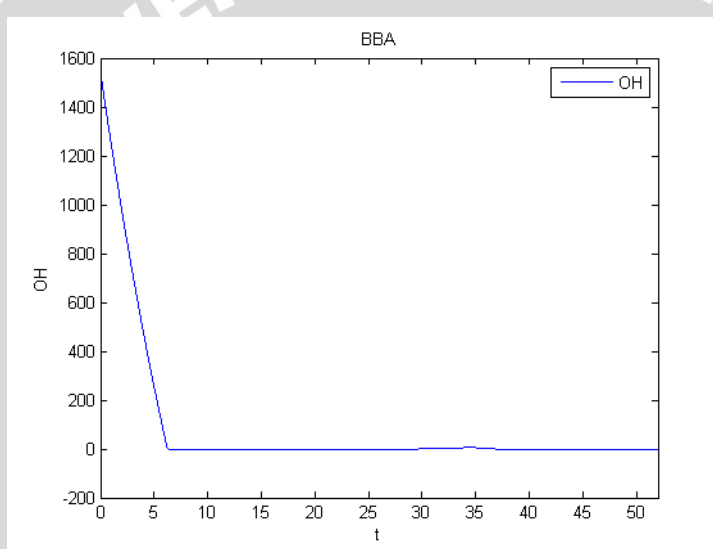
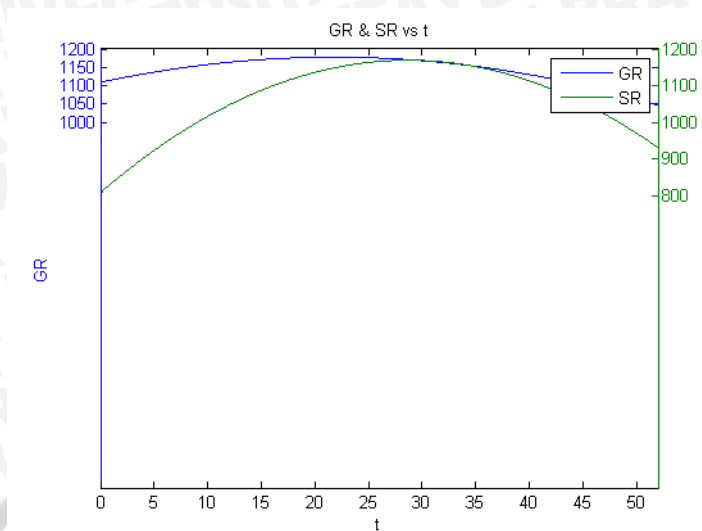
3. Trass



4. Batubara



5. Bahan Bakar Alternatif



Lampiran 8 – Perhitungan Jumlah Produksi Harian Tahun 2015

Produk OPC

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
			45179	10625	10625	10625	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626
29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626
85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626
113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168
10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626
169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196
10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626
197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626
225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252
10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626
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309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336
10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626
337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364
10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10625	10626	10626	10626	10625	10625	10625	10626	10626		

[illegible]

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2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
24793		130398	24793	24793	24793	24793	24793	24793	24793	24794	24794	24794	24793	24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794
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24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794
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24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794
282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307
24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794
310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335
24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794
338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363
24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794	24794	24793	24793	24793	24793	24793	24794	24794	24793	24793	24793	24794	24794	

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