LAMPIRAN

Lampiran 1 : data *demand* masing-masing produk.

Tabel 1.

Data *demand* masing-masing produk

Periode	*Bathubs fiber*	*Bathubs marbel*	*Corner bathubs*	*Hanging soap*	Kloset	*Shower trays*	Wastafel
1	90	76	40	45	85	60	98
2	87	78	46	42	83	62	97
3	96	84	44	38	82	61	95
4	89	79	50	40	79	65	99
5	80	81	52	41	81	60	101
6	75	85	48	39	84	57	96
7	81	72	46	37	82	56	91
8	81	68	47	40	77	59	93
9	73	72	49	44	75	62	97
10	76	74	51	46	79	58	98
11	68	70	53	41	78	55	92
12	75	72	54	42	76	56	87
13	80	72	51	37	79	55	89
14	83	68	47	39	85	57	86
15	87	65	42	38	81	58	82
16	79	61	43	40	77	61	84
17	76	64	41	43	79	59	79
18	77	66	39	41	80	63	81
19	72	61	40	39	76	62	83
20	67	59	44	36	73	60	80
21	68	54	46	40	75	64	77
22	71	52	45	41	74	61	78
23	73	57	49	46	81	57	76
24	69	61	49	37	80	58	75
25	68	65	47	41	67	51	79
26	65	59	45	43	69	48	76
27	66	57	44	39	70	49	77
28	71	59	48	37	73	52	79
29	73	66	52	38	71	50	80
30	69	63	55	35	76	47	83
31	70	61	51	40	73	46	84
32	66	58	49	38	69	43	81
33	65	62	46	41	70	41	79
34	69	61	40	41	70	39	76
35	67	61	38	36	74	40	74
36	68	61	35	31	75	37	75
37	65	53	36	35	73	39	71
38	63	56	37	33	71	37	72
39	59	58	34	37	68	40	68
40	64	61	38	38	65	41	74
41	58	64	43	41	69	39	76
42	69	62	45	43	68	43	73
43	70	59	41	39	65	45	80
44	67	56	40	42	71	44	77
45	62	55	44	40	72	46	74
46	59	57	42	39	77	45	79
47	56	60	37	36	79	47	81
48	61	54	34	41	76	41	76

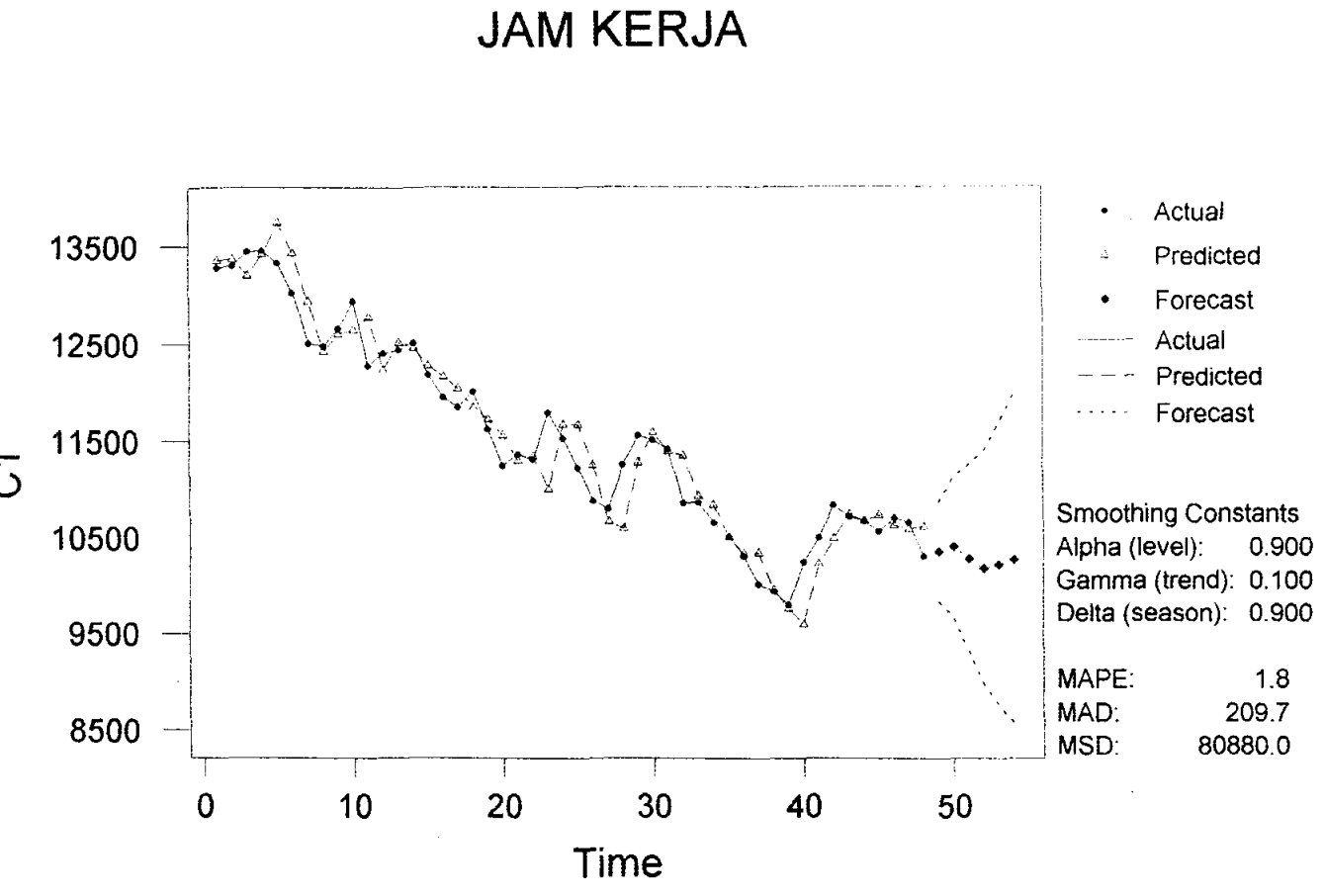
Lampiran 2 : Konversi jam kerja masing-masing produk.

Tabel 2.

Konversi jam kerja masing-masing produk

Periode	Jam *fiber*	Jam *marbel*	Jam *hanging soap*	Jam kloset	Jam *shower trays*	Jam wastafel	Jam *corner batubs*	Total jam
1	2430	2128	1170	2422.5	1515	2548	1060	13273.5
2	2349	2184	1092	2365.5	1565.5	2522	1219	13297
3	2592	2352	988	2337	1540.25	2470	1166	13445.25
4	2403	2212	1040	2251.5	1641.25	2574	1325	13446.75
5	2160	2268	1066	2308.5	1515	2626	1378	13321.5
6	2025	2380	1014	2394	1439.25	2496	1272	13020.25
7	2187	2016	962	2337	1414	2366	1219	12501
8	2187	1904	1040	2194.5	1489.75	2418	1245.5	12478.75
9	1971	2016	1144	2137.5	1565.5	2522	1298.5	12654.5
10	2052	2072	1196	2251.5	1464.5	2548	1351.5	12935.5
11	1836	1960	1066	2223	1388.75	2392	1404.5	12270.25
12	2025	2016	1092	2166	1414	2262	1431	12406
13	2160	2016	962	2251.5	1388.75	2314	1351.5	12443.75
14	2241	1904	1014	2422.5	1439.25	2236	1245.5	12502.25
15	2349	1820	988	2308.5	1464.5	2132	1113	12175
16	2133	1708	1040	2194.5	1540.25	2184	1139.5	11939.25
17	2052	1792	1118	2251.5	1489.75	2054	1086.5	11843.75
18	2079	1848	1066	2280	1590.75	2106	1033.5	12003.25
19	1944	1708	1014	2166	1565.5	2158	1060	11615.5
20	1809	1652	936	2080.5	1515	2080	1166	11238.5
21	1836	1512	1040	2137.5	1616	2002	1219	11362.5
22	1917	1456	1066	2109	1540.25	2028	1192.5	11308.75
23	1971	1596	1196	2308.5	1439.25	1976	1298.5	11785.25
24	1863	1708	962	2280	1464.5	1950	1298.5	11526
25	1836	1820	1066	1909.5	1287.75	2054	1245.5	11218.75
26	1755	1652	1118	1966.5	1212	1976	1192.5	10872
27	1782	1596	1014	1995	1237.25	2002	1166	10792.25
28	1917	1652	962	2080.5	1313	2054	1272	11250.5
29	1971	1848	988	2023.5	1262.5	2080	1378	11551
30	1863	1764	910	2166	1186.75	2158	1457.5	11505.25
31	1890	1708	1040	2080.5	1161.5	2184	1351.5	11415.5
32	1782	1624	988	1966.5	1085.75	2106	1298.5	10850.75
33	1755	1736	1066	1995	1035.25	2054	1219	10860.25
34	1863	1708	1066	1995	984.75	1976	1060	10652.75
35	1809	1708	936	2109	1010	1924	1007	10503
36	1836	1708	806	2137.5	934.25	1950	927.5	10299.25
37	1755	1484	910	2080.5	984.75	1846	954	10014.25
38	1701	1568	858	2023.5	934.25	1872	980.5	9937.25
39	1593	1624	962	1938	1010	1768	901	9796
40	1728	1708	988	1852.5	1035.25	1924	1007	10242.75
41	1566	1792	1066	1966.5	984.75	1976	1139.5	10490.75
42	1863	1736	1118	1938	1085.75	1898	1192.5	10831.25
43	1890	1652	1014	1852.5	1136.25	2080	1086.5	10711.25
44	1809	1568	1092	2023.5	1111	2002	1060	10665.5
45	1674	1540	1040	2052	1161.5	1924	1166	10557.5
46	1593	1596	1014	2194.5	1136.25	2054	1113	10700.75
47	1512	1680	936	2251.5	1186.75	2106	980.5	10652.75
48	1647	1512	1066	2166	1035.25	1976	901	10303.25

Lampiran 3 : hasil peramalan metode *winter*



Worksheet size: 100000 cells

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Winters' multiplicative model

Data C1
Length 48.0000
NMissing 0

Smoothing Constants
Alpha (level): 0.9
Gamma (trend): 0.1
Delta (seasonal): 0.9

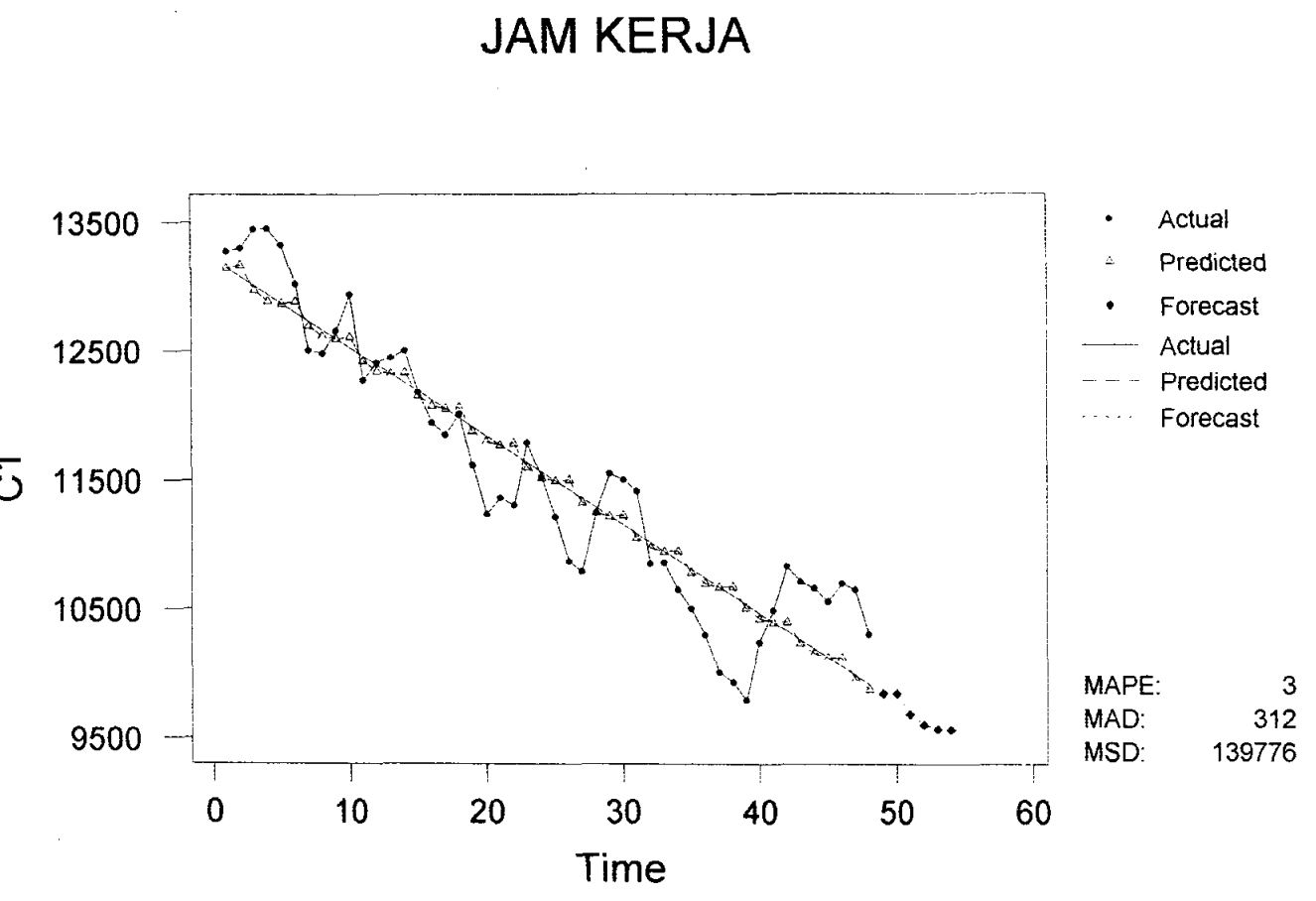
Accuracy Measures
MAPE: 1.8
MAD: 209.7
MSD: 80880.0

Row	Time	C1	SMOO2	FITS2	RESI2
1	1	13273.5	13281.8	13349.1	-75.562
2	2	13297.0	13301.1	13361.6	-64.564
3	3	13445.3	13145.1	13199.2	246.061
4	4	13446.8	13342.8	13418.5	28.219
5	5	13321.5	13657.7	13737.2	-415.712
6	6	13020.3	13384.2	13426.4	-406.139
7	7	12501.0	12932.4	12938.0	-436.960
8	8	12478.8	12453.7	12420.2	58.532
9	9	12654.5	12633.3	12604.7	49.754
10	10	12935.5	12669.5	12645.4	290.116
11	11	12270.3	12775.2	12777.1	-506.897
12	12	12406.0	12275.2	12231.7	174.291
13	13	12443.8	12547.1	12518.9	-75.130
14	14	12502.3	12491.8	12456.7	45.547
15	15	12175.0	12299.9	12269.4	-94.410
16	16	11939.3	12199.8	12160.8	-221.507
17	17	11843.8	12092.5	12032.9	-189.190
18	18	12003.3	11911.6	11834.7	168.566
19	19	11615.5	11784.6	11723.8	-108.348
20	20	11238.5	11629.7	11559.2	-320.671
21	21	11362.5	11396.8	11296.3	66.205
22	22	11308.8	11433.6	11338.4	-29.674
23	23	11785.3	11097.9	11001.9	783.347
24	24	11526.0	11690.1	11664.6	-138.648
25	25	11218.8	11705.2	11666.7	-447.961
26	26	10872.0	11332.0	11252.7	-380.735
27	27	10792.3	10770.8	10658.8	133.492
28	28	11250.5	10687.4	10588.2	662.305
29	29	11551.0	11316.1	11276.0	274.957
30	30	11505.3	11598.6	11583.2	-77.959
31	31	11415.5	11414.6	11392.4	23.119
32	32	10850.8	11364.0	11343.9	-493.124
33	33	10860.3	10993.7	10928.6	-68.381
34	34	10652.8	10907.9	10836.4	-183.660
35	35	10503.0	10588.3	10501.0	2.007
36	36	10299.3	10413.0	10326.7	-27.406
37	37	10014.3	10427.0	10337.1	-322.857
38	38	9937.3	10074.3	9955.0	-17.761
39	39	9796.0	9877.4	9757.2	38.799
40	40	10242.8	9705.9	9590.3	652.451
41	41	10490.8	10273.7	10216.2	274.506
42	42	10831.3	10521.0	10488.0	343.203

43	43	10711.3	10735.5	10733.5	-22.211
44	44	10665.5	10676.6	10672.6	-7.125
45	45	10557.5	10730.5	10725.9	-168.352
46	46	10700.8	10637.9	10618.0	82.780
47	47	10652.8	10599.3	10586.9	65.826
48	48	10303.3	10610.9	10604.5	-301.209

Row	Period	FORE2	LOWE2	UPPE2
1	49	10347.7	9833.90	10861.5
2	50	10398.1	9663.36	11132.9
3	51	10272.4	9302.90	11241.9
4	52	10172.4	8962.35	11382.4
5	53	10212.8	8759.38	11666.3
6	54	10262.2	8563.62	11960.8

Lampiran 4 : hasil peramalan metode dekomposisi



Worksheet size: 100000 cells

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Time Series Decomposition

Data C1
Length 48.0000
NMissing 0

Trend Line Equation

Yt = 13209.6 - 68.5326*t

Seasonal Indices

Period	Index
1	0.999917
2	1.00666
3	0.997239
4	0.996183

Accuracy of Model

MAPE: 3
MAD: 312
MSD: 139776

Row	C1	TREN1	SEAS1	DETR1	DESE1	FITS1	RESI1
1	13273.5	13141.1	0.99992	1.01007	13274.6	13140.0	133.479
2	13297.0	13072.6	1.00666	1.01717	13209.0	13159.6	137.353
3	13445.3	13004.0	0.99724	1.03393	13482.5	12968.1	477.107
4	13446.8	12935.5	0.99618	1.03952	13498.3	12886.1	560.606
5	13321.5	12867.0	0.99992	1.03532	13322.6	12865.9	455.587
6	13020.3	12798.4	1.00666	1.01733	12934.1	12883.7	136.560
7	12501.0	12729.9	0.99724	0.98202	12535.6	12694.8	-193.770
8	12478.8	12661.4	0.99618	0.98558	12526.6	12613.1	-134.309
9	12654.5	12592.8	0.99992	1.00490	12655.5	12591.8	62.695
10	12935.5	12524.3	1.00666	1.03283	12849.9	12607.7	327.766
11	12270.3	12455.8	0.99724	0.98510	12304.2	12421.4	-151.146
12	12406.0	12387.3	0.99618	1.00151	12453.5	12340.0	66.025
13	12443.8	12318.7	0.99992	1.01015	12444.8	12317.7	126.053
14	12502.3	12250.2	1.00666	1.02058	12419.5	12331.8	170.472
15	12175.0	12181.7	0.99724	0.99945	12208.7	12148.0	26.978
16	11939.3	12113.1	0.99618	0.98565	11985.0	12066.9	-127.641
17	11843.8	12044.6	0.99992	0.98333	11844.7	12043.6	-199.839
18	12003.3	11976.1	1.00666	1.00227	11923.8	12055.8	-52.571
19	11615.5	11907.5	0.99724	0.97548	11647.7	11874.6	-259.148
20	11238.5	11839.0	0.99618	0.94928	11281.6	11793.8	-555.306
21	11362.5	11770.5	0.99992	0.96534	11363.4	11769.5	-406.982
22	11308.8	11701.9	1.00666	0.96640	11233.9	11779.9	-471.115
23	11785.3	11633.4	0.99724	1.01305	11817.9	11601.3	183.975
24	11526.0	11564.9	0.99618	0.99664	11570.2	11520.7	5.278
25	11218.8	11496.3	0.99992	0.97586	11219.7	11495.4	-276.624
26	10872.0	11427.8	1.00666	0.95136	10800.1	11503.9	-631.908
27	10792.3	11359.3	0.99724	0.95008	10822.1	11327.9	-535.651
28	11250.5	11290.7	0.99618	0.99644	11293.6	11247.6	2.862
29	11551.0	11222.2	0.99992	1.02930	11552.0	11221.3	329.734
30	11505.3	11153.7	1.00666	1.03152	11429.1	11228.0	277.298
31	11415.5	11085.1	0.99724	1.02980	11447.1	11054.5	360.973
32	10850.8	11016.6	0.99618	0.98495	10892.3	10974.6	-123.803
33	10860.3	10948.1	0.99992	0.99198	10861.2	10947.2	-86.908

34	10652.8	10879.5	1.00666	0.97916	10582.3	10952.0	-299.246
35	10503.0	10811.0	0.99724	0.97151	10532.1	10781.2	-278.153
36	10299.3	10742.5	0.99618	0.95874	10338.7	10701.5	-402.219
37	10014.3	10673.9	0.99992	0.93820	10015.1	10673.1	-658.800
38	9937.3	10605.4	1.00666	0.93700	9871.5	10676.0	-738.789
39	9796.0	10536.9	0.99724	0.92969	9823.1	10507.8	-711.780
40	10242.8	10468.3	0.99618	0.97845	10282.0	10428.4	-185.634
41	10490.8	10399.8	0.99992	1.00874	10491.6	10398.9	91.808
42	10831.3	10331.3	1.00666	1.04839	10759.6	10400.1	431.167
43	10711.3	10262.7	0.99724	1.04370	10740.9	10234.4	476.844
44	10665.5	10194.2	0.99618	1.04623	10706.4	10155.3	510.200
45	10557.5	10125.7	0.99992	1.04265	10558.4	10124.8	432.665
46	10700.8	10057.1	1.00666	1.06400	10630.0	10124.1	576.624
47	10652.8	9988.6	0.99724	1.06649	10682.2	9961.0	691.718
48	10303.3	9920.1	0.99618	1.03863	10342.7	9882.2	421.034

Forecasts

Row	Period	FORE1
1	49	9850.73
2	50	9848.17
3	51	9687.66
4	52	9609.13
5	53	9576.62
6	54	9572.21

Lampiran 5 : perhitungan agregat.

Perhitungan agregat produk *fiber* adalah sebagai berikut :

$Z_1 = c_{01} = 605500 \times 71 = 42990500^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 605500\,(71+69) + 75294\,(69) = 89965286 \\ Z_1^* + C_{12} = 42990500 + 75294\,(69) = 48185786^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 605500\,(71+69+74) + 75294\,(69+74) + 75294\,(74) = 145915798 \\ Z_1^* + C_{13} = 42990500 + 605500\,(69+74) + 75294\,(74) = 135148756 \\ Z_2^* + C_{23} = 48185786 + 623000\,(74) = 94287786^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 605500\,(71+69+74+68) + 75294\,(69+74+68) + 75294\,(74+68) + \\ \qquad 76603\,(68) = 202538786 \\ Z_1^* + C_{14} = 42990500 + 605500\,(69+74+68) + 75294\,(74+68) + 76603\,(68) \\ \qquad = 186651752 \\ Z_2^* + C_{24} = 48185786 + 623000\,(74+68) + 76603\,(68) = 141860790 \\ Z_3^* + C_{34} = 94287786 + 647000\,(68) = 138283786^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 605500\,(71+69+74+68+62) + 75294\,(69+74+68+62) + 75294 \\ \qquad (74+68+62) + 76603\,(68+62) + 78435\,(62) = 259028598 \\ Z_1^* + C_{15} = 42990500 + 605500\,(69+74+68+62) + 75294\,(74+68+62) + \\ \qquad 76603\,(68+62) + 78435\,(62) = 238473336 \\ Z_2^* + C_{25} = 48185786 + 623000\,(74+68+62) + 76603\,(68+62) + 78435 \\ \qquad (62) = 190099146 \\ Z_3^* + C_{35} = 94287786 + 647000\,(68+62) + 78435\,(62) = 183260756 \\ Z_4^* + C_{45} = 138283786 + 651000\,(62) = 178645786^* \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 605500\,(71+69+74+68+62+60) + 75294\,(69+74+68+62+60) + \\ \qquad 75294\,(74+68+62+60) + 76603\,(68+62+60) + 78435\,(62+60) + 78697 \\ \qquad (60) = 318417978 \\ Z_1^* + C_{16} = 42990500 + 605500\,(69+74+68+62+60) + 75294\,(74+68+62+60) \\ \qquad + 76603\,(68+62+60) + 78435\,(62+60) + 78697\,(60) = 293345076 \\ Z_2^* + C_{26} = 48185786 + 623000\,(74+68+62+60) + 76603\,(68+62+60) + \\ \qquad 78435\,(62+60) + 78697\,(60) = 241503246 \\ Z_3^* + C_{36} = 94287786 + 647000\,(68+62+60) + 78435\,(62+60) + 78697\,(60) \\ \qquad = 231508676 \\ Z_4^* + C_{46} = 138283786 + 651000\,(62+60) + 78697\,(60) = 222427606 \\ Z_5^* + C_{56} = 178645786 + 658000\,(60) = 281125786^* \end{cases}$$

$Z_6^* = 218125786$ → membuat 60 unit pada periode 6 untuk periode 6

$Z_5^* = 178645786$ → membuat 62 unit pada periode 5 untuk periode 5

$Z_4^* = 138183786$ → membuat 68 unit pada periode 4 untuk periode 4

$Z_3^* = 94287786$ → membuat 74 unit pada periode 3 untuk periode 3

$Z_2^* = 481185786$ → membuat 69 unit pada periode 2 untuk periode 2

$Z_1^* = 42990500$ → membuat 71 unit pada periode 1 untuk periode 1

Perhitungan agregat produk *bathubs marbel* adalah sebagai berikut :

$Z_1 = C_{01} = 864500 \times 60 = 51870000^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 864500\,(60+62) + 94668\,(60) = 111338416 \\ Z_1^* + C_{12} = 51870000 + 885500\,(62) = 106771000^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 864500\,(60+62+65) + 94668\,(62+65) + 96238\,(65) \\ \qquad = 179939806 \\ Z_1^* + C_{13} = 51870000 + 885500\,(62+65) + 96238\,(65) = 170583970 \\ Z_2^* + C_{23} = 106771000 + 892500\,(65) = 164783500^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 864500\,(60+62+65+60) + 94668\,(62+65+60) + 96238\,(65+60) \\ \qquad + 96762\,(60) = 249069886 \\ Z_1^* + C_{14} = 51870000 + 885500\,(62+65+60) + 96238\,(65+60) + 96762\,(60) \\ \qquad = 235293970 \\ Z_2^* + C_{24} = 106771000 + 892500\,(65+60) + 96762\,(60) = 224139220 \\ Z_3^* + C_{34} = 164783500 + 903000\,(60) = 218963500^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 864500\ (60+62+65+60+63) + 94668\ (62+65+60+63) + 96238 \\ \qquad (65+60+63) + 96762\ (60+63) + 97546\ (63) = 327801868 \\ Z_1^* + C_{15} = 48412000 + 885500\ (62+65+60+63) + 96238\ (65+60+63) + \\ \qquad 96762\ (60+63) + 97546\ (63) = 309384868 \\ Z_2^* + C_{25} = 106771000 + 892500\ (65+60+63) + 96762\ (60+63) + 97546 \\ \qquad (63) = 292608124 \\ Z_3^* + C_{35} = 164783500 + 903000\ (60+63) + 97546\ (63) = 281997898 \\ Z_4^* + C_{45} = 218963500 + 910000\ (63) = 276293500^* \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 864500\ (60+62+65+60+63+67) + 94668\ (62+65+60+63+67) + \\ \qquad 96238\ (65+60+63+67) + 96762\ (60+63+67) + 97546\ (63+67) + 98071 \\ \qquad (67) = 418103463 \\ Z_1^* + C_{16} = 51870000 + 885500\ (62+65+60+63+67) + 96238 \\ \qquad (65+60+63+67) + 96762\ (60+63+67) + 97546\ (63+67) + 98071\ (67) \\ \qquad = 394750707 \\ Z_2^* + C_{26} = 106771000 + 892500\ (65+60+63+67) + 96762\ (60+63+67) + \\ \qquad 97546\ (63+67) + 98071\ (67) = 371995017 \\ Z_3^* + C_{36} = 164783500 + 903000\ (60+63+67) + 97546\ (63+67) + 98071 \\ \qquad (67) = 355605237 \\ Z_4^* + C_{46} = 218963500 + 910000\ (63+67) + 98071\ (67) = 343834257 \\ Z_5^* + C_{56} = 276293500 + 910000\ (67) = 337263500^* \end{cases}$$

$Z_6^* = 337263500$ → membuat 67 unit pada periode 6 untuk periode 6

$Z_5^* = 276293500$ → membuat 63 unit pada periode 5 untuk periode 5

$Z_4^* = 218963500$ → membuat 60 unit pada periode 4 untuk periode 4

$Z_3^* = 164783500$ → membuat 65 unit pada periode 3 untuk periode 3

$Z_2^* = 106783500$ → membuat 62 unit pada periode 2 untuk periode 2

$Z_1^* = 51870000$ → membuat 60 unit pada periode 1 untuk periode 1

Perhitungan agregat untuk produk *hanging soap* adalah sebagai berikut :

$Z_1 = C_{01} = 133000 \times 36 = 4788000^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 133000\ (36+33) + 39949\ (36) = 10495317 \\ Z_1^* + C_{12} = 4788000 + 136500\ (33) = 9292500^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 133000\,(36+33+30) + 39949\,(33+30) + 40211\,(30) = 16890117 \\ Z_1^* + C_{13} = 4788000 + 136500\,(33+30) + 40211\,(30) = 14593830 \\ Z_2^* + C_{23} = 9292500 + 147000\,(30) = 13702500^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 133000\,(36+33+30+31) + 39949\,(33+30+31) + 40211\,(30+31) + \\ \qquad 40997\,(31) = 24768984 \\ Z_1^* + C_{14} = 4788000 + 136500\,(33+30+31) + 40211\,(30+31) + 40997\,(31) \\ \qquad = 21342778 \\ Z_2^* + C_{24} = 9292500 + 147000\,(30+31) + 40997\,(31) = 19530407 \\ Z_1^* + C_{34} = 13702500 + 164500\,(31) = 18802000^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 133000\,(36+33+30+31+32) + 39949\,(33+30+31+32) + 40211 \\ \qquad (30+31+32) + 40997\,(31+32) + 42306\,(32) = 34255800 \\ Z_1^* + C_{15} = 4788000 + 136500\,(33+30+31+32) + 40211\,(30+31+32) + 40997 \\ \qquad (31+32) + 42306\,(32) = 29663226 \\ Z_2^* + C_{25} = 9292500 + 147000\,(30+31+32) + 40997\,(31+32) + 42306\,(32) \\ \qquad = 26900103 \\ Z_3^* + C_{35} = 13702500 + 164500\,(31+32) + 42306\,(32) = 25419792 \\ Z_4^* + C_{45} = 18802000 + 172900\,(32) = 24334800^* \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 133000\,(36+33+30+31+32+31) + 39949\,(33+30+31+32+31) + \\ \qquad 40211\,(30+31+32+31) + 40997\,(31+32+31) + 42306\,(32+31) + 42934\,(31) \\ \qquad = 44777107 \\ Z_1^* + C_{16} = 4788000 + 136500\,(33+30+31+32+31) + 40211\,(30+31+32+31) + \\ \qquad 40997\,(31+32+31) + 42306\,(32+31) + 42934\,(31) = 39054614 \\ Z_2^* + C_{26} = 9292500 + 147000\,(30+31+32+31) + 40997\,(31+32+31) + 42306 \\ \qquad (32+31) + 42934\,(31) = 351370450 \\ Z_3^* + C_{36} = 13702500 + 164500\,(31+32+31) + 42306\,(32+31) + 42934\,(31) \\ \qquad = 33161732 \\ Z_4^* + C_{46} = 18802000 + 172900\,(32+31) + 42934\,(31) = 31025654 \\ Z_5^* + C_{56} = 24334800 + 175000\,(31) = 29759800^* \end{cases}$$

$Z_6^* = 29759800$ → membuat 31 unit pada periode 6 untuk periode 6

$Z_5^* = 24334800$ → membuat 32 unit pada periode 5 untuk periode 5

$Z_4^* = 18802000$ → membuat 31 unit pada periode 4 untuk periode 4

$Z_3^* = 13702500$ → membuat 30 unit pada periode 3 untuk periode 3

$Z_2^* = 9292500$ → membuat 33 unit pada periode 2 untuk periode 2

$Z_1^* = 4788000 \rightarrow$ membuat 36 unit pada periode 1 untuk periode 1

Perhitungan agregat produk kloset adalah sebagai berikut :

$Z_1 = C_{01} = 231000 \times 67 = 15477000^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 231000\,(67+65) + 47280\,(65) = 33565200 \\ Z_1^* + C_{12} = 15477000 + 248500\,(65) = 31629500^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 231000\,(67+65+63) + 47280\,(65+63) + 48539\,(63) = 54154797 \\ Z_1^* + C_{13} = 15477000 + 248000\,(65+63) + 48539\,(63) = 50278957 \\ Z_2^* + C_{23} = 31629500 + 259000\,(63) = 47946500^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 231000\,(67+65+63+60) + 47280\,(65+63+60) + 48589\,(63+60) + \\ \qquad 49374\,(60) = 76732527 \\ Z_1^* + C_{14} = 15477000 + 248500\,(65+63+60) + 48589\,(63+60) + 49374\,(60) \\ \qquad = 71133887 \\ Z_2^* + C_{24} = 31629500 + 259000\,(63+60) + 49374\,(60) = 66448940 \\ Z_3^* + C_{34} = 47946500 + 262000\,(60) = 63666500^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 231000\,(67+65+63+60+63) + 47280\,(65+63+60+63) + 48589 \\ \qquad (63+60+63) + 49374\,(60+63) + 49636\,(63) = 103562904 \\ Z_1^* + C_{15} = 15477000 + 248500\,(65+63+60+63) + 48589\,(63+60+63) + 49374 \\ \qquad (60+63) + 49636\,(63) = 96088124 \\ Z_2^* + C_{25} = 31629500 + 259000\,(63+60+63) + 49374\,(60+63) + 49636\,(60) \\ \qquad = 89003570 \\ Z_3^* + C_{35} = 47946500 + 262500\,(60+63) + 50422\,(63) = 83410586 \\ Z_4^* + C_{45} = 63666500 + 273000\,(63) = 80865500^* \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 231000\,(67+65+63+60+63+67) + 47280\,(65+63+60+63+67) + \\ \qquad 48589\,(63+60+63+67) + 49374\,(60+63+67) + 49636\,(60+67) + 50422\,(67) \\ \qquad = 135475071 \\ Z_1^* + C_{16} = 15477000 + 248500\,(65+63+60+63+67) + 48589\,(63+60+63+67) + \\ \qquad 49374\,(60+63+67) + 49636\,(63+67) + 50422\,(67) = 126005031 \\ Z_2^* + C_{26} = 31629500 + 259000\,(63+60+63+67) + 49374\,(60+63+67) + 49636 \\ \qquad (63+67) + 50422\,(67) = 116338514 \\ Z_3^* + C_{36} = 479[illegible] \\ \qquad = 107[illegible] \\ Z_4^* + C_{46} = [illegible] \\ Z_5^* + C_{56} = [illegible] = 99825500^* \end{cases}$$

$Z_6^* = 99825500$ → membuat 67 unit pada periode 6 untuk periode 6

$Z_5^* = 80865500$ → membuat 63 unit pada periode 5 untuk periode 5

$Z_4^* = 63666500$ → membuat 60 unit pada periode 4 untuk periode 4

$Z_3^* = 47946500$ → membuat 63 unit pada periode 3 untuk periode 3

$Z_2^* = 31629500$ → membuat 65 unit pada periode 2 untuk periode 2

$Z_1^* = 15477000$ → membuat 67 unit pada periode 1 untuk periode 1

Perhitungan agregat Produk *shower trays* adalah sebagai berikut :

$Z_1 = C_{01} = 406000 \times 47 = 19082000^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 406000\,(47+49) + 60370\,(49) = 41934130 \\ Z_1^* + C_{12} = 19082000 + 402500\,(49) = 3[illegible]04500^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 406000\,(47+49+47) + 60370\,(49+47) + 60109\,(47) \\ \qquad = 66678693 \\ Z_1^* + C_{13} = 19082000 + 402500\,(49+47) + 60109\,(47) = 68547123 \\ Z_2^* + C_{23} = 38804500 + 413000\,(47) = 58215500^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 406000\,(47+49+47+50) + 60370\,(49+47+50) + 60109\,(47+50) + \\ \qquad 60894\,(50) = 96047293 \\ Z_1^* + C_{14} = [illegible] \\ \qquad = 86722273 \\ Z_2^* + C_{24} = 38804500 + 413000\,(47+50) + 60894\,(50) = 81910200 \\ Z_3^* + C_{34} = 58215500 + 427000\,(50) = 79565500^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 406000\,(47+49+47+50+46) + 60370\,(49+47+50+46) + 60109\,(47+50+46) + 60894\,(50+46) + 61941(46) = 125915737 \\ Z_1^* + C_{15} = 19082000 + 402500\,(49+47+50+46) + 60109\,(47+50+46) + 60894\,(50+49) + 61941\,(46) = 113652697 \\ Z_2^* + C_{25} = 38804500 + 413000\,(47+50+46) + 60894\,(50+46) + 61941\,(46) = 106558610 \\ Z_3^* + C_{35} = 58215500 + 427000\,(50+46) + 61941\,(46) = 102056786 \\ Z_4^* + C_{45} = 79565500 + 437000\,(46) = 99667500^* \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 406000\,(47+49+47+50+46+45) + 60370\,(49+47+50+46+45) + 60109\,(47+50+46+45) + 60894\,(50+46+45) + 61941\,(46+45) + 62727\,(45) = 157957582 \\ Z_1^* + C_{16} = 19082000 + 402500\,(49+47+50+46+45) + 60109\,(47+50+46+45) + 60894\,(50+46+45) + 61941\,(46+45) + 61727\,(45) = 142820392 \\ Z_2^* + C_{26} = 38804500 + 413000\,(47+50+46+45) + 60894\,(50+46+45) + 61941\,(46+45) + 62727\,(45) = 133493900 \\ Z_3^* + C_{36} = 58215500 + 427000\,(50+46+45) + 61941\,(46+45) + 62727\,(45) = 126881846 \\ Z_4^* + C_{46} = 79565500 + 437000\,(46+45) + 62727\,(45) = 122155215 \\ Z_5^* + C_{56} = 99667500 + 448000\,(45) = 119827500^* \end{cases}$$

$Z_6^* = 119827500$ → membuat 45 unit pada periode 6 untuk periode 6

$Z_5^* = 99667500$ → membuat 46 unit pada periode 5 untuk periode 5

$Z_4^* = 79565500$ → membuat 50 unit pada periode 4 untuk periode 4

$Z_3^* = 58215500$ → membuat 47 unit pada periode 3 untuk periode 3

$Z_2^* = 38804500$ → membuat 49 unit pada periode 2 untuk periode 2

$Z_1^* = 19082000$ → membuat 47 unit pada periode 1 untuk periode 1

Perhitungan agregat produk wastafel adalah sebagai berikut :

$Z_1 = C_{01} = 185500 \times 77 = 14283500^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 185500\,(77+76) + 43876\,(76) = 31716076 \\ Z_1^* + C_{12} = 14283500 + 196000\,(76) = 29179500^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 185500\ (77+76+73) + 43876\ (76+73) + 44662\ (73) = 51720850 \\ Z_1^* + C_{13} = 14283500 + 196000\ (76+73) + 44662\ (73) = 46747826 \\ Z_2^* + C_{23} = 29179500 + 203000\ (73) = 43998500^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 185500\ (77+76+73+75) + 43876\ (76+73+75) + 44662\ (73+75) + \\ \qquad 45185\ (75) = 75662575 \\ Z_1^* + C_{14} = 14283500 + 196000\ (76+73+75) + 44662\ (73+75) + 45185\ (75) \\ \qquad = 63186351 \\ Z_2^* + C_{24} = 29179500 + 203000\ (73+75) + 45185\ (75) = [illegible] \\ Z_3^* + C_{34} = 43998500 + 206000\ (75) = [illegible]^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 185500\ (77+76+73+75+73) + 43876\ (76+73+75+73) + 44662 \\ \qquad (73+75+78) + 45185\ (75+78) + 45447\ (78) = 103917335 \\ Z_1^* + C_{15} = 14283500 + 196000\ (76+73+75+78) + 44662\ (73+75+78) + 45185 \\ \qquad (75+78) + 45447\ (78) = 94027283 \\ Z_2^* + C_{25} = 29179500 + 203000\ (73+75+73) + 45185\ (75+78) + 45447\ (78) \\ \qquad = 85515671 \\ Z_3^* + C_{35} = 43998500 + 206000\ (75+78) + 45447\ (78) = 79061366 \end{cases}$$

$$Z_4^* + C_{45} = 59448500 + 217000\ (78) = 76374500^*$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 185500\ (77+76+73+75+78+76) + 43876\ (76+73+75+78+76) + \\ \qquad 44662\ (73+75+78+76) + 45185\ (75+78+76) + 45447\ (78+76) + 46233\ (78) \\ \qquad = 135335463 \\ Z_1^* + C_{16} = 14283500 + 196000\ (76+73+75+78+76) + 44662\ (73+75+78+76) + \\ \qquad 45185\ (75+78+76) + 45447\ (78+76) + 46233\ (78) = 122719335 \\ Z_2^* + C_{26} = 29179500 + 203000\ (73+75+78+76) + 45185\ (75+78+76) + 45447 \\ \qquad (78+76) + 46233\ (76) = 111345411 \\ Z_3^* + C_{36} = 43998500 + 206000\ (75+78+76) + 45447\ (78+76) + 46233\ (76) \\ \qquad = 101685046 \\ Z_4^* + C_{46} = 59448500 + 217000\ (78+76) + 46233\ (76) = 96380208 \\ Z_5^* + C_{56} = 76374500 + 234000\ (76) = 94158500^* \end{cases}$$

$Z_6^* = 94158500 \rightarrow$ membuat 76 unit pada periode 6 untuk periode 6

$Z_5^* = 76374500 \rightarrow$ membuat 78 unit pada periode 5 untuk periode 5

$Z_4^* = 59448500 \rightarrow$ membuat 75 unit pada periode 4 untuk periode 4

$Z_3^* = 43998500 \rightarrow$ membuat 73 unit pada periode 3 untuk periode 3

$Z_2^* = 29571500$ → membuat 76 unit pada periode 2 untuk periode 2

$Z_1^* = 14283500$ → membuat 77 unit pada periode 1 untuk periode 1

Perhitungan agregat produk *corner bathubs* adalah sebagai berikut :

$Z_1 = C_{01} = 532000 \times 32 = 17024000^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 532000\,(32+36) + 69796\,(36) = 38688656 \\ Z_1^* + C_{12} = 17024000 + 549500\,(36) = 36060000^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 532000\,(32+36+34) + 69796\,(36+34) + 71105\,(34) = 61567290 \\ Z_1^* + C_{13} = 17024000 + 549500\,(36+34) + 71105\,(34) = 57906570 \\ Z_2^* + C_{23} = 36060000 + 546000\,(34) = 54624000^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 532000\,(32+36+34+38) + 69796\,(36+34+38) + 71105\,(34+38) + \\ \qquad 70843\,(38) = 89829562 \\ Z_1^* + C_{14} = 17024000 + 549500\,(36+34+38) + 71105\,(34+38) + 70843\,(38) \\ \qquad = 84181594 \\ Z_2^* + C_{24} = 36060000 + 546000\,(34+38) + 70843\,(38) = 78064034 \\ Z_3^* + C_{34} = 54624000 + 563500\,(38) = 76037000^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 532000\,(32+36+34+38+40) + 69796\,(36+34+38+40) + 71105 \\ \qquad (34+38+40) + 70843\,(38+40) + 72152\,(40) = 122585402 \\ Z_1^* + C_{15} = 17024000 + 549500\,(36+34+38+40) + 71105\,(34+38+40) + \\ \qquad 70843\,(38+40) + 72152\,(40) = 114725594 \\ Z_2^* + C_{25} = 36060000 + 546000\,(34+38+40) + 70843\,(38+40) + 72152\,(40) \\ \qquad = 105623834 \\ Z_3^* + C_{35} = 54624000 + 563500\,(38+40) + 72152\,(40) = 101463080 \\ Z_4^* + C_{45} = 76037000 + 567000\,(40) = 98717000^* \end{cases}$$

$$
Z_6 = \begin{cases}
Z_0^* + C_{06} = 532000\,(32+36+34+38+40+38) + 69796\,(36+34+38+40+38) + \\
\qquad 71105\,(34+38+40+38) + 70843\,(38+40+38) + 72152\,(40+38) + 72414 \\
\qquad (38) = 156221182 \\
Z_1^* + C_{16} = 17024000 + 549500\,(36+34+38+40+38) + 71105\,(34+38+40+38) \\
\qquad + 70843\,(38+40+38) + 72152\,(40+38) + 72414\,(38) = 146401126 \\
Z_2^* + C_{26} = 36060000 + 546000\,(34+38+40+38) + 70843\,(38+40+38) + \\
\qquad 72152\,(40+38) + 72414\,(38) = 134557376 \\
Z_3^* + C_{36} = 54624000 + 563500\,(38+40+38) + 72152\,(40+38) + 72414\,(38) \\
\qquad = 128369585 \\
Z_4^* + C_{46} = 76037000 + 567000\,(40+38) + 72414\,(38) = 123014732 \\
Z_5^* + C_{56} = 98717000 + 574000\,(38) = 120529000^*
\end{cases}
$$

$Z_6^* = 120529000$ → membuat 36 unit pada periode 6 untuk periode 6

$Z_5^* = 98717000$ → membuat 40 unit pada periode 5 untuk periode 5

$Z_4^* = 76037000$ → membuat 38 unit pada periode 4 untuk periode 4

$Z_3^* = 54624000$ → membuat 34 unit pada periode 3 untuk periode 3

$Z_2^* = 36060000$ → membuat 36 unit pada periode 2 untuk periode 2

$Z_1^* = 17024000$ → membuat 32 unit pada periode 1 untuk periode 1

Lampiran 6 : perhitungan kebutuhan *material.*

Perhitungan kebutuhan *material wax* adalah sebagai berikut :

$Z_1 = c_{01} = A_1 + C_1 = 21450 + 78125 = 99575^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 21450 + (78125 \times 2) + 441.5\,(45) = 197\,567.5^* \\ Z_1^* + C_{12} = 21450 + 78125 + 99575 = 199150 \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 21450 + (78125 \times 3) + 441.5\,(45+44) + 441.5\,(44) = 314544.5 \\ Z_1^* + C_{13} = 21450 + (78125 \times 2) + 441.5\,(44) + 99575 = 296701^* \\ Z_2^* + C_{23} = 21450 + 78125 + 197567.5 = 297142.5 \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 21450 + (78125 \times 4) + 441.5\,(45+44+42) + 441.5\,(44+42) + 441.5\,(42) \\ \qquad = 448298.5 \\ Z_1^* + C_{14} = 21450 + (78125 \times 3) + 441.5\,(44+42) + 441.5\,(42) + 99575 = 411912 \\ Z_2^* + C_{24} = 21450 + (78125 \times 2) + 441.5\,(42) + 197567.5 = 393810.5^* \\ Z_3^* + C_{34} = 21450 + 78125 + 296701 = 396276 \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 21450 + (78125 \times 5) + 441.5\,(45+44+42+64) + 441.5\,(44+42+64) + 441.5 \\ \qquad (42+64) + 441.5\,(64) = 611255.5 \\ Z_1^* + C_{15} = 21450 + (78125 \times 4) + 441.5\,(44+42+64) + 441.5\,(42+64) + 441.5\,(64) + \\ \qquad 99575 = 574805 \\ Z_2^* + C_{25} = 21450 + (78125 \times 3) + 441.5\,(42+64) + 441.5\,(64) + 197567.5 = 528447.5 \\ Z_3^* + C_{35} = 21450 + (78125 \times 2) + 441.5\,(64) + 296701 = 502657^* \\ Z_4^* + C_{45} = 21450 + 78125 + 39810.5 = 493385.5 \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 21450 + (78125 \times 6) + 441.5\,(45+44+42+64+45) + 441.5\,(44+42+64+45) + \\ \qquad 441.5\,(42+64+45) + 441.5\,(64+45) + 441.5\,(45) = 816910 \\ Z_1^* + C_{16} = 21450 + (78125 \times 5) + 441.5\,(44+ 42+64+45) + 441.5\,(42+64+45) + 441.5 \\ \qquad (64+45) + 441.5\,(45) + 99575 = 732400 \\ Z_2^* + C_{26} = 21450 + (78125 \times 4) + 441.5\,(42+64+45) + 441.5\,(64+45) + 441.5\,(45) \\ \qquad + 197567.5 = 666175 \\ Z_3^* + C_{36} = 21450 + (78125 \times 3) + 441.5\,(64+45) + 441.5\,(45) + 296701 = 620517 \\ Z_4^* + C_{46} = 21450 + (78125 \times 2) + 441.5\,(45) + 394693.5 = 591378^* \\ Z_5^* + C_{56} = 21450 + 78125 + 493385.5 = 592960.5 \end{cases}$$

$Z_6^* = 591378$ → mengorder 109 Kg pada periode 5 untuk periode 5 dan 6

$Z_4^* = 393810.5$ → mengorder 86 Kg pada periode 3 untuk periode 3 dan 4

$Z_2^* = 197567.5$ → mengorder 91 Kg pada periode 1 untuk periode 1 dan 2

Perhitungan kebutuhan *material gell coat* adalah sebagai berikut :

$Z_1 = c_{01} = A_1 + C_1 = 21450 + 78125 = 99575^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 21450 + (78125 \times 2) + 176.6\,(854) = 328516.4 \\ Z_1^* + C_{12} = 21450 + 78125 + 99575 = 199150^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 21450 + (78125 \times 3) + 176.6\,(854+849) + 176.6\,(849) = 706508.2 \\ Z_1^* + C_{13} = 21450 + (78125 \times 2) + 176.6(849) + 99575 = 427208.4 \\ Z_2^* + C_{23} = 21450 + 78125 + 199150 = 298725^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 21450 + (78125 \times 4) + 176.6\,(854+849+835) + 176.6\,(849+835) + \\ \qquad 176.6\,(835) = 1227016.2 \\ Z_1^* + C_{14} = 21450 + (78125 \times 3) + 176.6\,(849+835) + 176.6\,(835) + 99575 \\ \qquad = 800255.4 \\ Z_2^* + C_{24} = 21450 + (78125 \times 2) + 176.6\,(835) + 199150 = 524311 \\ Z_3^* + C_{34} = 21450 + 78125 + 298725 = 398300^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 21450 + (78125 \times 5) + 176.6\,(854+849+835+842) + 176.6\,(849+835+842) + \\ \qquad 176.6\,(835+842) + 176.6\,(842) = 1899930 \\ Z_1^* + C_{15} = 21450 + (78125 \times 4) + 176.6\,(849+835+842) + 176.6\,(835+842) + 176.6 \\ \qquad (842) + 99575 = 1324472 \\ Z_2^* + C_{25} = 21450 + (78125 \times 3) + 176.6\,(835+842) + 176.6\,(842) + 199150 = 899830.4 \\ Z_3^* + C_{35} = 21450 + (78125 \times 2) + 176.6\,(842) + 298725 = 625122.2 \\ Z_4^* + C_{45} = 21450 + 78125 + 398300 = 497875^* \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 21450 + (78125 \times 6) + 176.6\,(854+849+835+842+848) + 176.6\,(849+835+842+848) + 176.6\,(835+842+848) + 176.6\,(842+848) + 176.6\,(848) = 2726839 \\ Z_1^* + C_{16} = 21450 + (78125 \times 5) + 176.6\,(849+835+842+848) + 176.6\,(835+842+848) + 176.6\,(842+848) + 176.6\,(848) + 99575 = 2001624.2 \\ Z_2^* + C_{26} = 21450 + (78125 \times 4) + 176.6\,(835+842+848) + 176.6\,(842+848) + 176.6\,(848) + 199150 = 1505350.8 \\ Z_3^* + C_{36} = 21450 + (78125 \times 3) + 176.6\,(842+848) + 176.6\,(848) + 298725 = 1002760.8 \\ Z_4^* + C_{46} = 21450 + (78125 \times 2) + 176.6\,(848) + 398300 = 725756.8 \\ Z_5^* + C_{56} = 21450 + 78125 + 497875 = 597450^* \end{cases}$$

$Z_6^* = 597450$ → mengorder 848 Kg pada periode 6 untuk periode 6

$Z_5^* = 497875$ → mengorder 842 Kg pada periode 5 untuk periode 5

$Z_4^* = 398300$ → mengorder 835 Kg pada periode 4 untuk periode 4

$Z_3^* = 298725$ → mengorder 849 Kg pada periode 3 untuk periode 3

$Z_2^* = 199150$ → mengorder 854 Kg pada periode 2 untuk periode 2

$Z_1^* = 99575$ → mengorder 852 Kg pada periode 1 untuk periode 1

Perhitungan kebutuhan *material pigment* adalah sebagai berikut :

$Z_1 = c_{01} = A_1 + C_1 = 21450 + 78125 = 99575^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 21450 + (78125 \times 2) + 883\,(81) = 249223 \\ Z_1^* + C_{12} = 21450 + 78125 + 99575 = 199150^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 21450 + (78125 \times 3) + 883\,(81+81) + 883\,(81) = 470394 \\ Z_1^* + C_{13} = 21450 + (78125 \times 2) + 883\,(81) + 99575 = 448373 \\ Z_2^* + C_{23} = 21450 + 78125 + 199150 = 298725^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 21450 + (78125 \times 4) + 883\,(81+81+80) + 883\,(81+80) + 883\,(80) = 760439 \\ Z_1^* + C_{14} = 21450 + (78125 \times 3) + 883\,(81+80) + 883\,(80) + 99575 = 568203 \\ Z_2^* + C_{24} = 21450 + (78125 \times 2) + 883\,(80) + 199150 = 447490 \\ Z_3^* + C_{34} = 21450 + 78125 + 298725 = 398300^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 21450 + (78125 \times 5) + 883\,(81+81+80+80) + 883\,(81+80+80) + \\ \qquad 883\,(80+80) + 883\,(80) = 1121124 \\ Z_1^* + C_{15} = 21450 + (78125 \times 4) + 883\,(81+80+80) + 883\,(80+80) + 883 \\ \qquad (80) + 99575 = 858248 \\ Z_2^* + C_{25} = 21450 + (78125 \times 3) + 883\,(80+80) + 883\,(80) + 199150 = 666895 \\ Z_3^* + C_{35} = 21450 + (78125 \times 2) + 883\,(80) + 298725 = 547865 \\ Z_4^* + C_{45} = 21450 + 78125 + 398300 = 497875^* \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 21450 + (78125 \times 6) + 883\,(81+81+80+80+81) + 883 \\ \qquad (81+80+80+81) + 883\,(80+80+81) + 883\,(80+81) + 883 \\ \qquad (81) = 1556864 \\ Z_1^* + C_{16} = 21450 + (78125 \times 5) + 883\,(81+80+80+81) + 883\,(80+80+81) + \\ \qquad 883\,(80+81) + 883\,(81) + 99575 = 1222465 \\ Z_2^* + C_{26} = 21450 + (78125 \times 4) + 883\,(80+80+81) + 883\,(80+81) + 883 \\ \qquad (81) + 199150 = 959589 \\ Z_3^* + C_{36} = 21450 + (78125 \times 3) + 883\,(80+81) + 883\,(81) + 298725 = 768236 \\ Z_4^* + C_{46} = 21450 + (78125 \times 2) + 883\,(81) + 398300 = 647523 \\ Z_5^* + C_{56} = 21450 + 78125 + 497875 = 597450^* \end{cases}$$

$Z_6^* = 597450 \rightarrow$ mengorder 81 Kg pada periode 6 untuk periode 6

$Z_5^* = 497875 \rightarrow$ mengorder 80 Kg pada periode 5 untuk periode 5

$Z_4^* = 398300 \rightarrow$ mengorder 80 Kg pada periode 4 untuk periode 4

$Z_3^* = 298725 \rightarrow$ mengorder 81 Kg pada periode 3 untuk periode 3

$Z_2^* = 199150 \rightarrow$ mengorder 81 Kg pada periode 2 untuk periode 2

$Z_1^* = 99575 \rightarrow$ mengorder 81 Kg pada periode 1 untuk periode 1

Perhitungan kebutuhan *material resin* adalah sebagai berikut :

$Z_1 = c_{o1} = A_1 + C_1 = 21450 + 78125 = 99575^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 21450 + (78125 \times 2) + 93.818\,(4266) = 577927.588 \\ Z_1^* + C_{12} = 21450 + 78125 + 99575 = 199150^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 21450 + (78125 \times 3) + 93.818\,(4266+4260) + 93.818\,(4260) = 1455381.948 \\ Z_1^* + C_{13} = 21450 + (78125 \times 2) + 93.818\,(4260) + 99575 = 676939.68 \\ Z_2^* + C_{23} = 21450 + 78125 + 199150 = 298725^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 21450 + (78125 \times 4) + 93.818\,(4266+4260+4141) + 93.818\,(4260+4141) + \\ \qquad 93.818\,(4141) = 2699007.962 \\ Z_1^* + C_{14} = 21450 + (78125 \times 3) + 93.818\,(4260+4141) + 93.818\,(4141) + 99575 \\ \qquad = 1532065.356 \\ Z_2^* + C_{24} = 21450 + (78125 \times 2) + 93.818\,(4141) + 199150 = 765350.338 \\ Z_3^* + C_{34} = 21450 + 78125 + 298725 = 398300^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 21450 + (78125 \times 5) + 93.818\,(4266+4260+4141+4215) + 93.818 \\ \qquad (4260+4141+4215) + 93.818\,(4141+4215) + 93.818\,(4215) = 4358904.442 \\ Z_1^* + C_{15} = 21450 + (78125 \times 4) + 93.818\,(4260+4141+4215) + 93.818\,(4141+4215) + \\ \qquad 93.818\,(4215) + 99575 = 2796518.966 \\ Z_2^* + C_{25} = 21450 + (78125 \times 3) + 93.818\,(4141+4215) + 93.818\,(4215) + 199150 \\ \qquad = 16634361.078 \\ Z_3^* + C_{35} = 21450 + (78125 \times 2) + 93.818\,(4215) + 298725 = 871867.87 \\ Z_4^* + C_{45} = 21450 + 78125 + 398300 = 497875^* \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 21450 + (78125 \times 6) + 93.818\,(4266+4260+4141+4215+4298) + 93.818 \\ \qquad (4260+4141+4215+4298) + 93.818\,(4141+4215+4298) + 93.818\,(4215+4298) \\ \qquad + 93.818\,(4298) = 6453178.262 \\ Z_1^* + C_{16} = 21450 + (78125 \times 5) + 93.818\,(4260+4141+4215+4298) + 93.818 \\ \qquad (4141+4215+4298) + 93.818\,(4215+4298) + 93.818\,(4298) + 99575 \\ \qquad = 4084333.258 \\ Z_2^* + C_{26} = 21450 + (78125 \times 4) + 93.818\,(4141+4215+4298) + 93.818\,(4215+4298) + \\ \qquad 93.818\,(4298) + 199150 = 2922175.37 \\ Z_3^* + C_{36} = 21450 + (78125 \times 3) + 93.818\,(4215+4298) + 93.818\,(4298) + 298725 \\ \qquad = 1756452.389 \\ Z_4^* + C_{46} = 21450 + (78125 \times 2) + 93.818\,(4298) + 398300 = 979229.764 \\ Z_5^* + C_{56} = 21450 + 78125 + 497875 = 597450^* \end{cases}$$

$Z_6^* = 597450$ → mengorder 4298 Kg pada periode 6 untuk periode 6

$Z_5^* = 497875$ → mengorder 4215 Kg pada periode 5 untuk periode 5

$Z_4^* = 398300$ → mengorder 4141 Kg pada periode 4 untuk periode 4

$Z_3^* = 298725$ → mengorder 4260Kg pada periode 3 untuk periode 3

$Z_2^* = 199150$ → mengorder 4266 Kg pada periode 2 untuk periode 2

$Z_1^* = 99575$ → mengorder 4254 Kg pada periode 1 untuk periode 1

Perhitungan kebutuhan *material met* adalah sebagai berikut :

$Z_1 = c_{01} = A_1 + C_1 = 21450 + 78125 = 99575^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 21450 + (78125 \times 2) + 317.88\,(1159) = 546122.92 \\ Z_1^* + C_{12} = 21450 + 78125 + 99575 = 199150^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 21450 + (78125 \times 3) + 317.88\,(1159+323) + 317.88\,(323) = 829598 \\ Z_1^* + C_{13} = 21450 + (78125 \times 2) + 317.88\,(323) + 99575 = 379950.24 \\ Z_2^* + C_{23} = 21450 + 78125 + 199150 = 298725^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 21450 + (78125 \times 4) + 317.88\,(1159+323+327) + 317.88\,(323+327) + \\ \qquad 317.88\,(327) = 1219563.63 \\ Z_1^* + C_{14} = 21450 + (78125 \times 3) + 317.88\,(323+327) + 317.88\,(327) + 99575 \\ \qquad = 665968.76 \\ Z_2^* + C_{24} = 21450 + (78125 \times 2) + 317.88\,(327) + 199150 = 480796.76 \\ Z_3^* + C_{34} = 21450 + 78125 + 298725 = 398300^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 21450 + (78125 \times 5) + 317.88\,(1159+323+327+312) + 317.88 \\ \qquad (323+327+312) + 317.88\,(327+312) + 317.88\,(312) = 1694402.92 \\ Z_1^* + C_{15} = 21450 + (78125 \times 4) + 317.88\,(323+327+312) + 317.88\,(327+312) + 317.88 \\ \qquad (312) + 99575 = 1041629.44 \\ Z_2^* + C_{25} = 21450 + (78125 \times 3) + 317.88\,(327+312) + 317.88\,(312) + 199150 \\ \qquad = 757278.88 \\ Z_3^* + C_{35} = 21450 + (78125 \times 2) + 317.88\,(312) + 298725 = 575603.56 \\ Z_4^* + C_{45} = 21450 + 78125 + 398300 = 497875^* \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 21450 + (78125 \times 6) + 317.88\,(1159+323+327+312+301) + 317.88 \\ \qquad (323+327+312+301) + 317.88\,(327+312+301) + 317.88\,(312+301) + 317.88 \\ \qquad (301) = 2250937.32 \\ Z_1^* + C_{16} = 21450 + (78125 \times 5) + 317.88\,(323+327+312+301) + 317.88\,(327+312+301) \\ \qquad + 317.88\,(312+301) + 317.88\,(301) + 99575 = 1502481.96 \\ Z_2^* + C_{26} = 21450 + (78125 \times 4) + 317.88\,(327+312+301) + 317.88\,(312+301) + 317.88 \\ \qquad (301) + 199150 = 1122449.52 \\ Z_3^* + C_{36} = 21450 + (78125 \times 3) + 317.88\,(312+301) + 317.88\,(301) + 298725 \\ \qquad = 845092.32 \\ Z_4^* + C_{46} = 21450 + (78125 \times 2) + 317.88\,(301) + 398300 = 671681.88 \\ Z_5^* + C_{56} = 21450 + 78125 + 497875 = 597450^* \end{cases}$$

$Z_6^* = 597450$ → mengorder 301 Kg pada periode 6 untuk periode 6

$Z_5^* = 497875$ → mengorder 312 Kg pada periode 5 untuk periode 5

$Z_4^* = 398300$ → mengorder 327 Kg pada periode 4 untuk periode 4

$Z_3^* = 298725$ → mengorder 323 Kg pada periode 3 untuk periode 3

$Z_2^* = 199150$ → mengorder 1159 Kg pada periode 2 untuk periode 2

$Z_1^* = 99575$ → mengorder 312 Kg pada periode 1 untuk periode 1

Perhitungan kebutuhan *material calcium* adalah sebagai berikut :

$Z_1 = c_{01} = A_1 + C_1 = 21450 + 78125 = 99575^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 21450 + (78125 \times 2) + 110.375\,(8430) = 1108161.25 \\ Z_1^* + C_{12} = 21450 + 78125 + 99575 = 199150^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 21450 + (78125 \times 3) + 110.375\,(8430+8550) + 110.375\,(8550) = 3073698.75 \\ Z_1^* + C_{13} = 21450 + (78125 \times 2) + 110.375\,(8550) + 99575 = 1220981.25 \\ Z_2^* + C_{23} = 21450 + 78125 + 199150 = 298725^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 21450 + (78125 \times 4) + 110.375\,(8430+8550+8125) + 110.375\,(8550+8125) + \\ \qquad 110.375\,(8125) = 5842214.375 \\ Z_1^* + C_{14} = 21450 + (78125 \times 3) + 110.375\,(8550+8125) + 110.375\,(8125) + 99575 \\ \qquad = 39092700 \\ Z_2^* + C_{24} = 21450 + (78125 \times 2) + 110.375\,(8125) + 199150 = 1273696.875 \\ Z_3^* + C_{34} = 21450 + 78125 + 298725 = 398300^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 21450 + (78125 \times 5) + 110.375\,(8430+8550+8125+8425) + 110.375 \\ \qquad (8550+8125+8425) + 110.375\,(8125+8425) + 110.375\,(8425) = 9639976.875 \\ Z_1^* + C_{15} = 21450 + (78125 \times 4) + 110.375\,(8550+8125+8425) + 110.375\,(8125+8425) + \\ \qquad 110.375\,(8425) + 99575 = 5960553.125 \\ Z_2^* + C_{25} = 21450 + (78125 \times 3) + 110.375\,(8125+8425) + 110.375\,(8425) + 199150 \\ \qquad = 3211590.625 \\ Z_3^* + C_{35} = 21450 + (78125 \times 2) + 110.375\,(8425) + 298725 = 1406334.375 \\ Z_4^* + C_{45} = 21450 + 78125 + 398300 = 497875^* \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 21450 + (78125 \times 6) + 110.375\,(8430+8550+8125+8425+8910) + 110.375\,(8550+8125+8425+8910) + 110.375\,(8125+8425+8910) + 110.375\,(8425+8910) + 110.375\,(8910) = 14635308.13 \\ Z_1^* + C_{16} = 21450 + (78125 \times 5) + 110.375\,(8550+8125+8425+8910) + 110.375\,(8125+8425+8910) + 110.375\,(8425+8910) + 110.375\,(8910) + 99575 = 9972443.125 \\ Z_2^* + C_{26} = 21450 + (78125 \times 4) + 110.375\,(8425+8125+8910) + 110.375\,(8125+8910) + 110.375\,(8910) + 199150 = 6240039.375 \\ Z_3^* + C_{36} = 21450 + (78125 \times 3) + 110.375\,(8125+8910) + 110.375\,(8910) + 298725 = 3451341.875 \\ Z_4^* + C_{46} = 21450 + (78125 \times 2) + 110.375\,(8910) + 398300 = 1559441.25 \\ Z_5^* + C_{56} = 21450 + 78125 + 497875 = 597450^* \end{cases}$$

$Z_6^* = 597450$ → mengorder 8910 Kg pada periode 6 untuk periode 6

$Z_5^* = 497875$ → mengorder 8925 Kg pada periode 5 untuk periode 5

$Z_4^* = 398300$ → mengorder 8125 Kg pada periode 4 untuk periode 4

$Z_3^* = 298725$ → mengorder 8550 Kg pada periode 3 untuk periode 3

$Z_2^* = 199150$ → mengorder 8430 Kg pada periode 2 untuk periode 2

$Z_1^* = 99575$ → mengorder 8380 Kg pada periode 1 untuk periode 1

Perhitungan kebutuhan *material aceton* adalah sebagai berikut :

$$Z_1 = c_{01} = A_1 + C_1 = 21450 + 78125 = 99575^*$$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 21450 + (78125 \times 2) + 70.64\,(770) = 232092.8 \\ Z_1^* + C_{12} = 21450 + 78125 + 99575 = 199150^* \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 21450 + (78125 \times 3) + 70.64\,(770+764) + 70.64\,(764) = 418155.72 \\ Z_1^* + C_{13} = 21450 + (78125 \times 2) + 70.64\,(764) + 99575 = 331243.96 \\ Z_2^* + C_{23} = 21450 + 78125 + 199150 = 298725^* \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 21450 + (78125 \times 4) + 70.64\,(770+764+758) + 70.64\,(764+758) + 70.64\,(758) = 656916.08 \\ Z_1^* + C_{14} = 21450 + (78125 \times 3) + 70.64\,(764+758) + 70.64\,(758) + 99575 = 516459.2 \\ Z_2^* + C_{24} = 21450 + (78125 \times 2) + 70.64\,(758) + 199150 = 430395.12 \\ Z_3^* + C_{34} = 21450 + 78125 + 298725 = 398300^* \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 21450 + (78125 \times 5) + 70.64\,(770+764+758+761) + 70.64\,(764+758+761) + \\ \qquad 70.64\,(758+761) + 70.64\,(761) = 950069.24 \\ Z_1^* + C_{15} = 21450 + (78125 \times 4) + 70.64\,(764+758+761) + 70.64\,(758+761) + 70.64 \\ \qquad (761) + 99575 = 755855.32 \\ Z_2^* + C_{25} = 21450 + (78125 \times 3) + 70.64\,(758+761) + 70.64\,(761) + 199150 = 616034.2 \\ Z_3^* + C_{35} = 21450 + (78125 \times 2) + 70.64\,(761) + 298725 = 530182.04 \\ Z_4^* + C_{45} = 21450 + 78125 + 398300 = 497875^* \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 21450 + (78125 \times 6) + 70.64\,(770+764+758+761+760) + 70.64 \\ \qquad (764+758+761+760) + 70.64\,(758+761+760) + 70.64\,(761+760) + 70.64 \\ \qquad (760) = 1296626.24 \\ Z_1^* + C_{16} = 21450 + (78125 \times 5) + 70.64\,(764+758+761+760) + 70.64\,(758+761+760) + \\ \qquad 70.64\,(761+760) + 70.64\,(760) + 99575 = 1048725.92 \\ Z_2^* + C_{26} = 21450 + (78125 \times 4) + 70.64\,(758+761+760) + 70.64\,(761+760) + 70.64 \\ \qquad (760) + 199150 = 855218.4 \\ Z_3^* + C_{36} = 21450 + (78125 \times 3) + 70.64\,(761+760) + 70.64\,(760) + 298725 = 715679.84 \\ Z_4^* + C_{46} = 21450 + (78125 \times 2) + 70.64\,(760) + 398300 = 629686.4 \\ Z_5^* + C_{56} = 21450 + 78125 + 497875 = 597450^* \end{cases}$$

$Z_6^* = 597450 \rightarrow$ mengorder 760 Kg pada periode 6 untuk periode 6

$Z_5^* = 497875 \rightarrow$ mengorder 761 Kg pada periode 5 untuk periode 5

$Z_4^* = 398300 \rightarrow$ mengorder 758 Kg pada periode 4 untuk periode 4

$Z_3^* = 298725 \rightarrow$ mengorder 764 Kg pada periode 3 untuk periode 3

$Z_2^* = 199150 \rightarrow$ mengorder 770 Kg pada periode 2 untuk periode 2

$Z_1^* = 99575 \rightarrow$ mengorder 766 Kg pada periode 1 untuk periode 1

Perhitungan kebutuhan *material catalis* adalah sebagai berikut :

$Z_1 = c_{01} = A_1 + C_1 = 21450 + 78125 = 99575^*$

$$Z_2 = \begin{cases} Z_0^* + C_{02} = 21450 + (78125 \times 2) + 79.47\,(43) = 181117.21^* \\ \\ Z_1^* + C_{12} = 21450 + 78125 + 99575 = 199150 \end{cases}$$

$$Z_3 = \begin{cases} Z_0^* + C_{03} = 21450 + (78125 \times 3) + 79.47\,(43+43) + 79.47\,(43) = 266076.63^* \\ Z_1^* + C_{13} = 21450 + (78125 \times 2) + 79.47\,(43) + 99575 = 280692.21 \\ Z_2^* + C_{23} = 21450 + 78125 + 181117.21 = 280692.21 \end{cases}$$

$$Z_4 = \begin{cases} Z_0^* + C_{04} = 21450 + (78125 \times 4) + 79.47\,(43+43+42) + 79.47\,(43+42) + \\ \qquad 79.47\,(42) = 354214.85^* \\ Z_1^* + C_{14} = 21450 + (78125 \times 3) + 79.47\,(43+42) + 79.47\,(42) + 99575 \\ \qquad = 365492.69 \\ Z_2^* + C_{24} = 21450 + (78125 \times 2) + 79.47\,(42) + 181117.21 = 362154.95 \\ Z_3^* + C_{34} = 21450 + 78125 + 280692.21 = 380267.21 \end{cases}$$

$$Z_5 = \begin{cases} Z_0^* + C_{05} = 21450 + (78125 \times 5) + 79.47\,(43+43+42+43) + 79.47\,(43+42+43) + \\ \qquad 79.47\,(42+43) + 79.47\,(43) = 446008.69 \\ Z_1^* + C_{15} = 21450 + (78125 \times 4) + 79.47\,(43+42+43) + 79.47\,(42+43) + 79.47 \\ \qquad (43) + 99575 = 453869.32 \\ Z_2^* + C_{25} = 21450 + (78125 \times 3) + 79.47\,(42+43) + 79.47\,(43) + 181117.21 = 447114.37 \\ Z_3^* + C_{35} = 21450 + (78125 \times 2) + 79.47\,(43) + 280692.21 = 461809.42 \\ Z_4^* + C_{45} = 21450 + 78125 + 380267.21 = 479842.21 \end{cases}$$

$$Z_6 = \begin{cases} Z_0^* + C_{06} = 21450 + (78125 \times 6) + 79.47\,(43+43+42+43+43) + 79.47 \\ \qquad (43+42+43+43) + 79.47\,(42+43+43) + 79.47\,(43+43) + 79.47 \\ \qquad (43) = 541219.74 \\ Z_1^* + C_{16} = 21450 + (78125 \times 5) + 79.47\,(43+42+43+43) + 79.47\,(42+43+43) + \\ \qquad 79.47\,(43+43) + 79.47\,(43) + 99575 = 545663.16 \\ Z_2^* + C_{26} = 21450 + (78125 \times 4) + 79.47\,(42+43+43) + 79.47\,(43+43) + 79.47 \\ \qquad (43) + 181117.21 = 535491 \\ Z_3^* + C_{36} = 21450 + (78125 \times 3) + 79.47\,(43+43) + 79.47\,(43) + 280692.21 = 546768.84^* \\ Z_4^* + C_{46} = 21450 + (78125 \times 2) + 79.47\,(43) + 354214.85 = 535332.06 \\ Z_5^* + C_{56} = 21450 + 78125 + 446008.69 = 545583.69 \end{cases}$$

$Z_6^* = 532232.73 \rightarrow$ mengorder 86 Kg pada periode 5 untuk periode 5 dan 6

$Z_5^* = 266156.1 \rightarrow$ mengorder 172 Kg pada periode 1 untuk periode 1,2,3 dan 4