

CHAPTER 5 – CONCLUSIONS AND RECCOMENDATIONS

5.1 Conclusions

There are 2 objectives of the research, namely to design, develop and evaluate Six Sigma in Remanufacturing Companies, as well as to reduce failure of remanufactured products with a target of less than 2.5%. Six Sigma can be implemented well in Remanufacturing Companies with the DMAIC methodology, and it has been proven that the implementation of Six Sigma has had a positive impact on improving product quality, namely reducing the Failure In Process (FIP) ratio from 8% to 2%, improving the Sigma level from 3.75 to 4.365, and reduction in Cost of Poor Quality (COPQ) from 1,125 Bio Idr to 360 Mio Idr.

Based on the entirety of this research, it can be inferred that implementing the Six Sigma methodology can enhance the quality of the study, resulting in a reduction of product failures during the assembly and performance test process. Consequently, this improvement can lead to increased corporate profitability owing to the decrease in product failures.

5.2 Recommendations

This study supports previous research that demonstrates the effectiveness of the Six Sigma technique in finding and evaluating product failures, hence increasing the sigma level and improved product quality. Given the positive results observed in this study, it is recommended to conduct further research on the use of the Six Sigma methodology alongside other quality tools to enhance the quality of various other remanufacturing product or companies. The utilization of the Six Sigma approach is boosted by research diversification.

ATTACHMENT

SIPOC REMANUFACTURE

Supplier	Input	Process	Output	Customer
Principle	Genuine Parts	Pre Washing	Ready Core	TRIATRA
Outsource	Fabrication Parts	Dis Assembly	Surcharge	
Vendor	OEM Parts, Consumable	Washing	Service	
TRIATRA	Damage Core	Measurement & Inspection Fabrication & Parts Fulfilments Assembly Performance Test Completing Painting Wrapping & Packaging		

**SIGMA CALCULATION JANUARY TO MAY 2023
(BEFORE IMPROVEMENT)**

Product	Assembly	Defect	Opportunity	Total Opportunity	DPMO
	Qty				
Cylinder	775	50	32	24.800	2.016
Engine	125	25	39	4.875	5.128

Product	Performance Test	Defect	Opportunity	Total Opportunity	DPMO
	Qty				
Cylinder	775	50	11	8.525	5.865
Engine	125	25	14	1.750	14.286

Product	Assembly	Performance Test	Total DPMO	Tabel Z	Ketentuan Sigma	Total Sigma
	DPMO	DPMO				
Cylinder	2.016	5.865	7.881	2,42	1,5	3,92
Engine	5.128	14.286	19.414	2,07	1,5	3,57
						3,745

TABEL KONVERSI NILAI (Z) KE DPMO										
Z	0,00	0,01	0,02	0,03	0,04	0,05	0,06	0,07	0,08	0,09
- 1,50	933.200	934.500	935.700	937.000	938.200	939.400	940.600	941.800	942.900	945.100
- 1,40	919.200	920.700	922.200	923.600	925.100	926.500	927.900	929.200	930.600	931.900
- 1,30	903.200	904.900	906.600	908.200	909.900	911.500	913.100	914.700	916.200	917.700
- 1,20	885.000	887.000	889.000	891.000	893.000	894.000	896.000	898.000	900.000	901.500
- 1,10	864.000	867.000	869.000	871.000	873.000	875.000	877.000	879.000	821.000	823.000
- 1,00	841.000	844.000	846.000	848.000	851.000	853.000	855.000	858.000	860.000	862.000
- 0,90	816.000	819.000	821.000	824.000	826.000	829.000	831.000	834.000	836.000	839.000
- 0,80	788.000	791.000	794.000	797.000	800.000	802.000	805.000	808.000	811.000	813.000
- 0,70	758.000	761.000	764.000	767.000	770.000	773.000	776.000	779.000	782.000	785.000
- 0,60	726.000	729.000	732.000	736.000	739.000	742.000	745.000	749.000	752.000	755.000
- 0,50	691.000	695.000	698.000	702.000	705.000	709.000	712.000	716.000	719.000	722.000
- 0,40	655.000	659.000	663.000	666.000	670.000	673.000	676.000	679.000	682.000	685.000
- 0,30	618.000	622.000	626.000	629.000	633.000	637.000	641.000	644.000	648.000	652.000
- 0,20	579.000	583.000	587.000	591.000	595.000	599.000	603.000	606.000	610.000	614.000
- 0,10	540.000	544.000	548.000	552.000	556.000	560.000	564.000	567.000	571.000	575.000
- 0,00	500.000	504.000	508.000	512.000	516.000	520.000	524.000	528.000	532.000	536.000
0,00	500.000	496.000	492.000	488.000	484.000	480.000	476.000	472.000	468.000	464.000
0,10	460.000	456.000	452.000	448.000	444.000	440.000	436.000	433.000	429.000	425.000
0,20	421.000	417.000	413.000	409.000	405.000	401.000	397.000	394.000	390.000	386.000
0,30	382.000	378.000	374.000	371.000	367.000	363.000	359.000	356.000	352.000	348.000
0,40	345.000	341.000	337.000	334.000	330.000	326.000	323.000	319.000	316.000	312.000
0,50	309.000	305.000	302.000	298.000	295.000	291.000	288.000	284.000	281.000	278.000
0,60	274.000	271.000	268.000	264.000	261.000	258.000	255.000	251.000	248.000	245.000
0,70	242.000	239.000	236.000	233.000	230.000	227.000	224.000	221.000	218.000	215.000
0,80	212.000	209.000	206.000	203.000	200.000	198.000	195.000	192.000	189.000	187.000
0,90	184.000	181.000	179.000	176.000	174.000	171.000	169.000	166.000	164.000	161.000
1,00	159.000	156.000	154.000	152.000	149.000	147.000	145.000	142.000	140.000	138.000
1,10	136.000	133.000	131.000	129.000	127.000	125.000	123.000	121.000	119.000	117.000
1,20	115.000	113.000	111.000	109.000	107.000	106.000	104.000	102.000	100.000	98.500
1,30	96.800	95.100	93.400	91.800	90.100	88.500	86.900	85.300	83.800	82.300
1,40	80.800	79.300	77.800	76.400	74.900	73.500	72.100	70.800	69.400	68.100
1,50	66.800	65.500	64.300	63.000	61.800	60.600	59.400	58.200	57.100	55.900
1,60	54.800	53.700	52.600	51.600	50.500	49.500	48.500	47.500	46.500	45.500
1,70	44.600	43.600	42.700	41.800	40.900	40.100	39.200	38.400	37.500	36.700
1,80	35.900	35.100	34.400	33.600	32.900	32.200	31.400	30.700	30.100	29.400
1,90	28.700	28.100	27.400	26.800	26.200	25.600	25.000	24.400	23.900	23.300
2,00	22.800	22.200	21.700	21.200	20.700	20.200	19.700	19.200	18.800	18.300
2,10	17.900	17.400	17.000	16.600	16.200	15.800	15.400	15.000	14.600	14.300
2,20	13.900	13.600	13.200	12.900	12.500	12.200	11.900	11.600	11.300	11.000
2,30	10.700	10.400	10.200	9.900	9.640	9.390	9.140	8.890	8.600	8.420
2,40	8.200	7.980	7.760	7.550	7.340	7.140	6.950	6.760	6.570	6.390
2,50	6.210	6.040	5.870	5.700	5.540	5.390	5.230	5.080	4.940	4.800
2,60	4.660	4.530	4.400	4.270	4.150	4.020	3.910	3.790	3.680	3.570
2,70	3.470	3.360	3.260	3.170	3.070	2.980	2.890	2.800	2.720	2.640
2,80	2.560	2.480	2.400	2.330	2.260	2.190	2.120	2.050	1.990	1.930
2,90	1.870	1.810	1.750	1.690	1.640	1.590	1.540	1.490	1.440	1.390
3,00	1.350	1.310	1.260	1.220	1.180	1.140	1.110	1.070	1.040	1.000
3,10	968	935	904	874	845	816	789	762	736	711
3,20	687	664	641	619	598	577	557	538	519	501
3,30	483	466	450	434	419	404	390	376	362	349
3,40	337	325	313	302	291	280	270	260	251	242
3,50	233	224	216	208	200	193	185	178	172	165
3,60	159	153	147	142	136	131	126	121	117	112
3,70	108	104	100	96	92	88	85	82	78	75
3,80	72	70	67	64	62	59	57	54	52	50
3,90	48	46	44	43	41	39	38	36	35	33
4,00	31,7	30,4	29,1	27,9	26,7	25,6	24,5	23,5	22,5	21,6
4,10	20,7	19,8	18,9	18,1	17,4	16,6	15,9	15,2	14,6	13,9
4,20	13,3	12,8	12,2	1,7	11,2	10,7	10,2	9,77	9,34	8,93
4,30	8,54	8,16	7,8	7,46	7,12	6,81	6,5	6,21	5,93	5,67
4,40	5,41	5,17	4,94	4,71	4,5	4,29	4,1	3,91	3,73	3,56
4,50	3,4	3,24	3,09	2,95	2,81	2,68	2,56	2,44	2,32	2,22
4,60	2,11	2,01	1,92	1,83	1,74	1,66	1,58	1,51	1,43	1,37
4,70	1,3	1,24	1,18	1,12	1,07	1,02	0,968	0,921	0,876	0,834
4,80	0,793	0,755	0,718	0,683	0,649	0,617	0,587	0,558	0,53	0,504
4,90	0,479	0,455	0,433	0,411	0,391	0,371	0,352	0,335	0,318	0,302
5,00	0,287	0,272	0,258	0,245	0,233	0,221	0,21	0,199	0,189	0,179
5,10	0,17	0,161	0,153	0,145	0,137	0,13	0,123	0,117	0,111	0,105
5,20	0,0996	0,0944	0,0895	0,0848	0,0803	0,076	0,072	0,0682	0,0646	0,0612
5,30	0,0579	0,0548	0,0519	0,0491	0,0465	0,044	0,0416	0,0394	0,0372	0,0352
5,40	0,0333	0,0315	0,0298	0,0282	0,0266	0,0252	0,0238	0,0225	0,0213	0,0201
5,50	0,019	0,0179	0,0169	0,016	0,0151	0,0143	0,0135	0,0127	0,012	0,0114
5,60	0,0107	0,0101	0,00955	0,00901	0,0085	0,00802	0,0757	0,00714	0,00673	0,00635
5,70	0,00599	0,00565	0,00533	0,00502	0,00473	0,00446	0,00421	0,00396	0,00374	0,00352
5,80	0,00332	0,00312	0,00294	0,00277	0,00261	0,00246	0,00231	0,00218	0,00205	0,00193
5,90	0,00182	0,00171	0,00161	0,00151	0,00143	0,00134	0,00126	0,00119	0,00112	0,00105

**SIGMA CALCULATION AUGUST TO NOVEMBER 2023
(AFTER IMPROVEMENT)**

Product	Assembly				
	Qty	Defect	Opportunity	Total Opportunity	DPMO
Cylinder	620	8	32	19.840	403
Engine	100	4	39	3.900	1.026

Product	Performance Test				
	Qty	Defect	Opportunity	Total Opportunity	DPMO
Cylinder	620	8	11	6.820	1.173
Engine	100	4	14	1.400	2.857

Product	Assembly	Performance Test	Total DPMO	Tabel Z	Ketentuan Sigma	Total Sigma
	DPMO	DPMO				
Cylinder	403	1.173	1.576	3,01	1,5	4,51
Engine	1.026	2.857	3.883	2,72	1,5	4,22

4,365

PATRIA		FINAL INSPECTION SHEET		Disetujui	Diperiksa	Dibuat oleh					
ASSEMBLY & TEST PERFORMANCE ENGINE											
QUALITY CONTROL DEPT. PLANT 2		Dok No: S/CQ/005/005	Revisi: 01 / 24-09-2023	Inspector	Quality Officer	Production Head					
MODEL		KETERANGAN									
PRODUCTION NO : PRC00000001		TANGGAL INSPEKSI : 07 April 2022									
UNIT MODEL WISMA : ENGINE DESK-2		NAMA Mekanik : Pky									
ENGINE MODEL : SMC225 SERIES		NAMA INSPEKTOR : Agus Wijaya									
TANDA PERUBAHAN : V = OK X = NOT GOOD + = TIDAK DIJALAKAN ⊗ = OK UTUK PERUBAHAN											
URUTAN	ITEM INSPEKSI	NO	STANDARD	HASIL	URUTAN	ITEM INSPEKSI	STANDARD	HASIL			
ASSEMBLY	PROSES PENYIMPANAN	1	TIDAK ADA KOROSI / CRACKS / DEFORMASI / WEAR	V	CONVERSION TEST	1	SUMPAH DI ENJEKSI DALAM OIL PAN DENGAN DEEP STICK	ANTARA 1 DAN 4 PADA SURFACE	V		
	CYLINDER BLOCK	2	FRESH, TIDAK DAMAGED, CRACK, WORK	V		2	EROSI CORAN AIR	NO LEAK	V		
		3	CHECK CONTACT SURFACE CYL BLOCK	V		3	EROSI CORAN FUEL	NO LEAK	V		
	CYLINDER LINER	4	FRESH, TIDAK DAMAGED, CRACK, WORK	V	4	EROSI CORAN GAS BUKAN / ESKALAT PIPE	NO LEAK	V			
		5	FACTURION LINE	V	5	ABNORMAL NOISE	NO ABNORMAL NOISE	V			
	CRANKSHAFT	6	FRESH, TIDAK DAMAGED, CRACK, WORK	V	PUMP CRANKS TEST	6	ENGINE SPEED (RPM)	ENGINE LOW & HIGH OIL (OAR)	V		
		7	NOT KETING TORQUE CRANKSHAFT	-		7	BLOW BY PRESSURE (psi/PC)	REFER ITO GAS	V		
		8	MANAGE TORQUE MAIN CAP BOLT	V		8	OIL PRESSURE (kg/cm²)	AT MAXED OUTPUT & LOW OILS (OAR)	V		
	CAMSHAFT	9	END PLAY CRANKSHAFT	V	9	WATER TEMPERATURE (°C)	ENGINE LOW & HIGH OIL / (OAR)	V			
		10	FRESH, TIDAK DAMAGED, CRACK, WORK	V	10	EXHAUST GAS TEMPERATURE (°C)	ENGINE LOW & HIGH OIL / (OAR)	V			
		11	END PLAY CAMSHAFT	V	11	HOSE POWER (HP)	REFER ITO GAS	V			
	TIMING GEAR	12	NOT KETING TORQUE CAMSHAFT	V	12	MAX TORQUE (kgm)	REFER ITO GAS	V			
		13	FRESH, TIDAK DAMAGED, CRACK, WORK	V	AFTER TEST	13	CHECK CONDIT FILTER DAN OIL PADA OIL PAN TERDAPAT MUKA ISIAN	TIDAK ADA GEMUK	V		
		14	END PLAY TIMING GEAR	V		14	LAST JENJAN MEASUREMENT ENJOPLAY CRANKSHAFT AFTER TEST BENCH	REFER ITO GAS	V		
	15	BACKLASH TIMING GEAR	V	CATATAN LAINNYA							
	16	CLASH TIMING GEAR	V								
	17	DEFORMASI, TIDAK BUNTU	⊗								
	18	BACKLASH OIL PUMP DRIVE TERKAP GEAR	V								
	OIL PUMP GEAR	19	FRESH, TIDAK DAMAGED, CRACK, WORK	V							
		20	PERMASANGAN TIDAK TERBALEK	V							
		21	MANAGE TORQUE BOLT CAP CONNECTING ROD	V							
	PISTON & CONNECTING ROD	22	SCR CLAMANCE CONNECTING ROD	V							
		23	MANAGE TIMING	V							
	FUEL SUPPLY PUMP / FIP	24	FRESH, TIDAK DAMAGED, CRACK, WORK	V							
	FLYWHEEL HOUSING	25	MAX RADIAL OUT/ FACE RUN OUT FLYWHEEL HOUSING	V							
		26	FRESH, TIDAK DAMAGED, CRACK, WORK	V							
	FLYWHEEL	27	MAX RADIAL OUT/ FACE RUN OUT FLYWHEEL	V							
		28	FRESH, TIDAK DAMAGED, CRACK, WORK	V							
	CYLINDER HEAD	29	SCISSOR GASKET (G/L) KEMBALAN	V							
		30	MANAGE (TIDAK PERAKURUN BOLT) CYLINDER HEAD	V							
31		TORQUE & ADJUSTMENT CYLINDER HEAD	V								
CRACK HEAD	32	ADJUSTMENT VALVE CLEARANCE	V								
VALVE CLEARANCE	33	TORQUE INJECTOR HOLDER BOLT & HARNESS	V								
NOZZLE HOLDER / INJECTOR & HARNESS	34	SPRINK CLAMP, RUBBER ASSI, YAKI ADA WASE	V								
HIGH PRESSURE TUBE & COMMON RAIL	35	PERMANEN (JERUAN PARTS/BOOK)	V								
EXHAUST MANIFOLD	36	MANAGE TORQUE SEQUENCE EXHAUST MANIFOLD	V								
TURBO CHARGER	37	PERMANEN PELUMAS PRE LUBE LUBRICATING	V								
BELT TENSION	38	ADJUSTMENT BELT TENSION	V								
RPL (Reassemble Parts Use)	39	TIDAK ADA REORDER PARTS	⊗								
TRIMULAN MINOR	40	TIDAK ADA TRIMULAN MINOR (PROCCURE/TORQUE)	V								
NO				PROBLEM & TINDAKAN PERUBAHAN		HASIL		TANGGAL		KETERANGAN	
1				Piston cooling nozzle abnormal bending, belum ada tools untuk mengukur standart bending dan dimensi -> Reorder piston cooling nozzle, Membuat tools untuk cek piston cooling nozzle (kg/NO GC).		⊗		07-Apr-22 08-Apr-22		Create & Release Pro B, Tools (kg / NO GC)	
2				Connecting Rod bearing tidak ada saat akan di pasang (Midinspection) -> Reorder part, create PRO B.		V		07-Apr-22 08-Apr-22		Create & Release Pro B	
3											
4											
5											
6											

Keterangan : A. Setiap temuan kategori RP (Failure In Process) wajib diberikan langkah preventive action di dalam form PDR (Perbaikan Tindakan Perbaikan & Pencegahan)
B. Temuan yang menimbulkan biaya perbaikan (Parts/Insya/Pelatihan) akan planning produksi.
1. Perbaikan biaya (reorder parts / pelatihan) dengan menggunakan referensi Pro B.
2. Perbaikan lead time max 100% dari 1 hari / 7 hari.

VALIDASI HASIL PERUBAHAN		OK / NOT OK	
START INSP.	FINISH INSP.	DISETJUI	
Tgl. 07/04/22	Tgl. 07/04/22	07/04/2022	
Inspector / QC	Inspector / QC	Supervisor / Dept Head	

Keterangan : Revisi setelah dilakukan perbaikan (Corrective Action) di Internal proses produksi

JUMLAH TEMUAN DEFECT	
ASSEMBLY	2
TEST PERFORMANCE	0

[illegible]

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CURRICULUM VITAE

Erwin Oktariyanto



Education

- ✓ Bachelor's Degree, Swiss German University
Industrial Engineering 2020 – 2022.
- ✓ Diploma Degree, Politeknik Universitas Brawijaya,
Electric Engineering 1994 – 1997.
- ✓ Diploma, PATT Politeknik Malang,
Electric & Computer, 1993 – 1994.

Certificates

- ✓ AGMP, AMDI, Astra Management, 2015.
- ✓ GCG Transformation, Erasmus University, Executive Program,
2013.
- ✓ ASrMP, AMDI, Astra Management, 2012.
- ✓ AMMP, AMDI, Astra Management, 2010.
- ✓ POP, ESDM, Safety & Environment, 2010.
- ✓ POM, ESDM, Safety & Environment, 2008.
- ✓ Coaching Counselling, Fritmandiri Utama, Executive Program,
2008.
- ✓ MMA, AMDI, Astra Management, 2007.
- ✓ Strategic Business, Prasetya Mulya, Executive Program, 2007.

Competition

- ✓ PT United Tractors Tbk., Best Site Manager, 2012, Batukajang.
- ✓ PT United Tractors Tbk., Best Innovation, 2012, Batukajang.
- ✓ PT Astra International Tbk., Best Safety Environment, 2012.

Experience

- ✓ PT United Tractors Pandu Engineering (UTPE), 2022 – Now, Chief of Production, Head Office.
- ✓ PT Triatra Sinergia Pratama (TRIATRA), 2022 – Now, Operation Director, Head Office.
- ✓ PT Universal Tekno Industri (UTI), 2019 – 2022, Sales Director, Head Office.
- ✓ PT Universal Tekno Reksajaya (UTR)
 - 2020 – 2022, GM Sales Production GM, Head Office.
 - 2019 – 2020, Production GM, Head Office.
 - 2018 – 2019, Production Deputy GM, Head Office.
- ✓ PT United Tractors Tbk., (UT)
 - 2017 – 2018, Customer Support Area, Service Division, Head Office.
 - 2016 – 2017, Coordinator Site Area, MSO Division, Head Office.
- ✓ PT Duta Nurcahya (DN)
 - 2014 – 2015, Operation Director, Head Office.
 - 2013 – 2014, Operation Deputy Director, Head Office.
- ✓ PT United Tractors Tbk., (UT)
 - 2011 – 2012, Site Manager, Batukajang, Mining Division.
 - 2009 – 2010, Site Manager, Muara Tae, Mining Division.
 - 2008 – 2009, Deputy Site Manager, Batukajang, Mining Division.
 - 2006 – 2007, Service Dept. Head, Adaro, Service Division.
 - 2005 – 2006, Service Dept. Head, Bandung, Service Division.
 - 2003 – 2004, Workshop Supervisor, Timika, Service Division.
 - 2001 – 2002, Branch Instructor, Freeport, Service Division.
 - 1997 – 2000, Electrician, Freeport, Service Division.