

Lampiran 1.

Lembar kerja FMEA

1. Subsistem Manipulator

RCM II INFORMATION WORKSHEET (FMEA)		SYSTEM ARC ROBOTIC WELDING				Facilitataor		Date:		Sheet No.
		SUB-SYSTEM Manipulator				Auditor:		Date:		1 of 3
NO	FUNCTION	FUNCTIONAL FAILURE (loss of function)		FAILURE MODE (cause of failure)		SEV	OCC	DET	RPN	RANK
1	membantu manusia melakukan proses penyambungan material dengan metode pengelasan.	A	mesin tidak mau melakukan pengelasan dengan baik.	1	motor axis mengalami kegagalan fungsi.	7	8	8	448	1
				2	Nozzle mengalami korosi atau overheat.	7	7	8	392	2
				3	Gear mengalami keausan.	6	5	5	150	6
				4	kontrol program pergerakan pada control unit / PCB bermasalah.	4	2	2	16	7
				5	Wire feeder mengalami kegagalan fungsi yang mengalami over heating pada kabel.	8	5	5	200	4
				6	Inner cable assy mengalami putus.	7	5	5	175	5
		B	Tidak dapat melakukan proses upsetting dengan baik.	1	Limit Switch mengalami kegagalan fungsi karna rusak atau salah setting.	8	7	7	392	2
				2	Setting pada PCB/ control unit bermasalah.	5	2	2	20	8

2. Subsystem Control Unit

RCM II INFORMATION WORKSHEET (FMEA)		SYSTEM ARC ROBOTIC WELDING				Facilitator		Date:		Sheet No.
		SUB-SYSTEM Control Unit				Auditor:		Date:		2 of 3
NO	FUNCTION	FUNCTIONAL FAILURE (<i>loss of function</i>)		FAILURE MODE (<i>cause of failure</i>)		SEV	OCC	DET	RPN	RANK
2	Unit yang digunakan untuk memulai, mengontrol, menghentikan sistem-sistem pada las robot yang dioperasikan oleh operator dan sebagai mengatur suplay daya yang diperlukan dalam pengoperasian mesin-mesin pada las robot	A	Tidak bisa melakukan proses setting pergerakan robot.	1	Ram tidak dapat membaca program karna eror.	6	5	4	120	3
				2	Mainboard atau PCB tidak berfungsi karna overheat.	7	7	6	294	2
				3	Power Unit mengalami kegagalan fungsi.	3	4	4	48	6
				4	Relay unit tidak berfungsi karena coil atau gulungan spull putus.	7	7	7	343	1
		B	Tidak dapat menyuplai daya ke manipulator.	1	Servo drive unit tidak berfungsi karena mengalami overheat.	4	3	3	36	7
				2	Servo power unit mengalami gagal fungsi atau rusak.	3	3	3	27	8
		C	Tidak dapat memback up daya manipulator ketika daya utama mati.	1	Absolute Encoder Batteries tidak berfungsi atau mengalami overheat.	3	4	3	36	7
				2	konsletingnya lilitan pada kawat konduktor yang membuat Auxiliary Transformer terbakar dan tidak dapat menyuplai daya.	8	3	4	96	4

3. Subsystem Teach Pendant

RCM II INFORMATION WORKSHEET (FMEA)		SYSTEM ARC ROBOTIC WELDING			Facilitataor		Date:		Sheet No.	
		SUB-SYSTEM Teach Pendant			Auditor:		Date:		3 of 3	
NO	FUNCTION	FUNCTIONAL FAILURE (<i>loss of function</i>)		FAILURE MODE (<i>cause of failure</i>)		SEV	OCC	DET	RPN	RANK
3	mengatur jalannya sebuah mesin robot sesuai apa yang kita inginkan berdasarkan pengaturan program.	A	Tidak dapat mengatur sistem operasi pada control unit.	1	Tombol unit mengalami kegagalan fungsi atau rusak.	2	2	2	8	4
				2	Baterai tidak dapat menerima daya karena baterai mengalami kerusakan.	4	2	4	32	2
				3	Layar lcd tidak dapat menampilkan program yang terdapat pada teach pendant.	4	2	3	24	3
				4	Inner cable assy mengalami putus.	5	2	4	40	1

Lampiran 2.

Lembar Kerja LTA

1. Subsistem Manipulator

RCM II INFORMATION WORKSHEET (FMEA)		SYSTEM ARC ROBOTIC WELDING				Facilitataor	Date:	Sheet No.	
		SUB-SYSTEM Manipulator				Auditor:	Date:	1 of 3	
NO	FUNCTION	FUNCTIONAL FAILURE (loss of function)		FAILURE MODE (cause of failure)		CRITICAL ANALYSIS			
						Efident	Safety	Outage	Category
1	membantu manusia melakukan proses penyambungan material dengan metode pengelasan.	A	mesin tidak mau melakukan pengelasan dengan baik.	1	motor axis mengalami kegagalan fungsi.	yes	no	no	B
				2	Nozzle mengalami korosi atau overheat.	yes	yes	yes	A/B
				3	Gear mengalami keausan.	yes	no	no	B
				4	kontrol program pergerakan pada control unit / PCB bermasalah.	yes	no	yes	C
				5	Wire feeder mengalami kegagalan fungsi yang mengalami over heating pada kabel.	no	yes	yes	A
				6	Inner cable assy mengalami putus.	yes	yes	yes	A
		B	Tidak dapat melakukan proses upsetting dengan baik.	1	Limit Switch mengalami kegagalan fungsi karna rusak atau salah setting.	yes	yes	yes	A/B
				3	Setting pada PCB/ control unit bermasalah.	yes	no	yes	B

2. Subsystem Control Unit

RCM II INFORMATION WORKSHEET (FMEA)		SYSTEM ARC ROBOTIC WELDING			Facilitator	Date:	Sheet No.		
		SUB-SYSTEM Control Unit			Auditor:	Date:	2 of 3		
NO	FUNCTION	FUNCTIONAL FAILURE (loss of function)		FAILURE MODE (cause of failure)	CRITICAL ANALYSIS				
					Efident	Safety	Outage	Category	
2	Unit yang digunakan untuk memulai, mengontrol, menghentikan sistem-sistem pada las robot yang dioperasikan oleh operator dan sebagai mengatur suplay daya yang diperlukan dalam pengoperasian mesin-mesin pada las robot	A	Tidak bisa melakukan proses setting pergerakan robot.	1	Ram tidak dapat membaca program karna eror.	yes	no	yes	B
				2	Mainboard atau PCB tidak berfungsi karna overheat.	yes	yes	yes	A/B
				3	Power Unit mengalami kegagalan fungsi.	yes	no	yes	B
				4	Relay unit tidak berfungsi karena coil atau gulungan spull putus.	yes	yes	yes	A/B
				5	Inner cable assy mengalami putus.	yes	yes	yes	A/B
		B	Tidak dapat memback up daya manipulator ketika daya utama mati.	1	Servo drive unit tidak berfungsi karena mengalami overheat.	yes	yes	yes	A/B
				2	Servo power unit mengalami gagal fungsi atau rusak.	yes	yes	yes	A/B

		C	Tidak dapat memback up daya manipulator ketika daya utama mati.	1	Absolute Encoder Batteries tidak berfungsi atau mengalami overheat.	yes	yes	yes	A/B
				2	konstelingnya lilitan pada kawat konduktor yang membuat Auxiliary Transformer terbakar dan tidak dapat menyuplai daya.	yes	yes	yes	A/B

3. Subsistem Teac Pendant

RCM II INFORMATION WORKSHEET (FMEA)		SYSTEM ARC ROBOTIC WELDING			Facilitator	Date:	Sheet No.		
		SUB-SYSTEM Teach Pendant			Auditor:	Date:	3 of 3		
NO	FUNCTION	FUNCTIONAL FAILURE (loss of function)		FAILURE MODE (cause of failure)	CRITICAL ANALYSIS				
					Efident	Safety	Outage	Category	
3	mengatur jalannya sebuah mesin robot sesuai apa yang kita inginkan berdasarkan pengaturan program.	A	Tidak dapat mengatur sistem operasi pada control unit.	1	Tombol unit mengalami kegagalan fungsi atau rusak.	yes	no	no	C
				2	Baterai tidak dapat menerima daya karena baterai mengalami kerusakan.	yes	no	yes	C
				3	Layar lcd tidak dapat menampilkan program yang terdapat pada teach pendant.	yes	no	no	C
				4	Inner cable assy mengalami putus.	yes	no	yes	C

Lampiran 3.
Lembar Kerja Decision Worksheet
1. Subsystem Manipulator

RCM II DECISION WORKSHEET			SYSTEM ARC ROBOTIC WELDING										Facilitator:	Date:	Sheet No.		
			SUB-SYSTEM Manipulator										Auditor:	Date:	1 of 3		
FMEA			LTA				PREV.TASK			DEF.TASK			PROPESED TASK			INITIAL INTERVAL	PIC
F	FF	FM	H	S	E	O	H1 S1 O1 N1	H2 S2 O2 N2	H3 S3 O3 N3	H4	H5	S4					
1	A	1	Y	N	N	Y	Y						Melakukan pengecekan dan pembersihan pada gear dan v-belt			30 hari	Divisi Maintenance
1	A	2	Y	Y	N	Y	N	Y					Melakukan pengecekan suhu dan pembersihan pada nozzle			1 hari	Operator
1	A	3	Y	N	N	Y	N	Y					Melakukan sistem lubrikasi terjadwal			8 jam	Divisi Maintenance
1	A	4	Y	N	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal			-	Divisi Maintenance
1	A	5	Y	Y	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal			-	Divisi Maintenance
1	A	6	Y	Y	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal			-	Divisi Maintenance
1	B	1	Y	Y	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal			-	Divisi Maintenance
1	B	2	Y	N	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal			-	Divisi Maintenance

2. Subsystem Control Unit

RCM II DECISION WORKSHEET			SYSTEM ARC ROBOTIC WELDING										Facilitator:		Date:	Sheet No.		
			SUB-SYSTEM Control Unit										Auditor:		Date:	2 of 3		
FMEA			LTA				PREV.TASK			DEF.TASK			PROPESED TASK				INITIAL INTERVAL	PIC
F	FF	FM	H	S	E	O	H1 S1 O1 N1	H2 S2 O2 N2	H3 S3 O3 N3	H4	H5	S4						
2	A	1	Y	N	N	Y	N	Y				Melakukan kegiatan scan virus dan merawat sistem operasionalnya				7 Hari	Divisi Maintenance	
2	A	2	Y	Y	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal				-	Divisi Maintenance
2	A	3	Y	N	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal				-	Divisi Maintenance
2	A	4	Y	Y	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal				-	Divisi Maintenance
2	A	5	Y	Y	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal				-	Divisi Maintenance
2	B	1	Y	Y	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal				-	Divisi Maintenance
2	B	2	Y	Y	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal				-	Divisi Maintenance
2	C	1	Y	Y	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal				-	Divisi Maintenance
2	C	2	Y	Y	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal				-	Divisi Maintenance

3. Subsystem Teach Pendant

RCM II DECISION WORKSHEET			SYSTEM ARC ROBOTIC WELDING									Facilitator:		Date:	Sheet No.	
			SUB-SYSTEM Teach Pendant									Auditor:		Date:	3 of 3	
FMEA			LTA				PREV.TASK			DEF.TASK			PROPESED TASK		INITIAL INTERVAL	PIC
F	FF	FM	H	S	E	O	H1 S1 O1 N1	H2 S2 O2 N2	H3 S3 O3 N3	H4	H5	S4				
3	A	1	Y	N	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal		-	Divisi Maintenance
3	A	2	Y	N	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal		-	Divisi Maintenance
3	A	3	Y	N	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal		-	Divisi Maintenance
3	A	4	Y	N	N	Y	N	N	N				Tidak ada kegiatan perawatan atau perbaikan terjadwal		-	Divisi Maintenance

Lampiran 4.

Uji Distribusi Perhitungan MTTF

1. MOTOR AXIS

a. Distribusi Normal

i	Ti	F(Ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T} i	(Ti- \bar{T} i) ²
1	103	0.0287	-1.9000	10609	3.61	-195.70	-144.79	20964.63
2	115	0.0697	-1.4800	13225	2.19	-170.2	-132.79	17633.63
3	120	0.1107	-1.2200	14400	1.49	-146.4	-127.79	16330.71
4	123	0.1517	-1.0300	15129	1.06	-126.69	-124.79	15572.96
5	127	0.1927	-0.8700	16129	0.76	-110.49	-120.79	14590.63
6	173	0.2337	-0.7300	29929	0.53	-126.29	-420.79	177065.63
7	173	0.2746	-0.6000	29929	0.36	-103.8	-74.79	5593.79
8	175	0.3156	-0.4800	30625	0.23	-84.00	-72.79	5298.63
9	176	0.3566	-0.3600	30976	0.13	-63.36	-71.79	5154.04
10	177	0.3976	-0.2600	31329	0.07	-46.02	-70.79	5011.46
11	197	0.4386	-0.1600	38809	0.03	-31.52	-50.79	2579.79
12	200	0.4796	-0.0500	40000	0.00	-10.00	-447.79	200517.38
13	200	0.5205	0.0500	40000	0.00	10.00	-447.79	200517.38
14	221	0.5615	0.1600	48841	0.03	35.36	-26.79	717.79
15	266	0.6025	0.2600	70756	0.07	69.16	18.21	331.54
16	292	0.6435	0.3600	85264	0.13	105.12	44.21	1954.38
17	295	0.6845	0.4800	87025	0.23	141.6	47.21	2228.63
18	338	0.7255	0.6000	114244	0.36	202.8	90.21	8137.54
19	368	0.7664	0.7300	135424	0.53	268.64	120.21	14450.04
20	389	0.8074	0.8700	151321	0.76	338.43	147.21	21670.29
21	395	0.8484	1.0300	156025	1.06	406.85	147.21	21670.29
22	397	0.8894	1.2200	157609	1.49	484.34	149.21	22263.13
23	440	0.9304	1.4800	193600	2.19	651.20	192.21	36944.04
24	487	0.9714	1.9000	237169	3.61	925.30	239.21	57220.63
Total	5947	12,0012	0	1778367	20,9104	2424,33	0	874418,96
AVG	247,79	0,5	0	74098,63	0,75	65,18	0	35530,36

Index Of Fit

$$\begin{aligned}
 \text{a. } S_{xy} &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\
 &= 24 (2424,33) - (5947)(0) \\
 &= \mathbf{58183,92}
 \end{aligned}$$

$$\begin{aligned}
 \text{b. } S_{xx} &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\
 &= 24 (1778367) - (5947)^2 \\
 &= \mathbf{7313999}
 \end{aligned}$$

$$\begin{aligned}
 \text{c. } S_{yy} &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\
 &= 24 (20,9104) - (0)^2 \\
 &= \mathbf{501,8496}
 \end{aligned}$$

$$\begin{aligned}
 \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\
 &= \frac{58183,92}{\sqrt{7313999 \cdot 501,8496}} = \mathbf{0,96037}
 \end{aligned}$$

b. Distribusi Log Normal

I	t _i	F(T _i)	T _i =LN(t _i)	Y _i	T _i ²	Y _i ²	T _i .Y _i	T _i -T̄ _i	(T _i -T̄ _i) ²
1	103	0.0287	4.6347	-1.90	21.48	3.61	-8.81	-0.74	0.55
2	115	0.0697	4.7449	-1.48	22.51	2.19	-7.02	-0.63	0.40
3	120	0.1107	4.7875	-1.22	22.92	1.49	-5.84	-0.59	0.34
4	123	0.1517	4.8122	-1.03	23.16	1.06	-4.96	-0.56	0.32
5	127	0.1927	4.8442	-0.87	23.47	0.76	-4.21	-0.53	0.28
6	173	0.2337	5.1533	-0.73	26.56	0.53	-3.76	-0.22	0.05
7	173	0.2746	5.1533	-0.60	26.56	0.36	-3.09	-0.22	0.05
8	175	0.3156	5.1648	-0.48	26.68	0.23	-2.48	-0.21	0.04
9	176	0.3566	5.1705	-0.36	26.73	0.13	-1.86	-0.20	0.04
10	177	0.3976	5.1761	-0.26	26.79	0.07	-1.35	-0.20	0.04
11	197	0.4386	5.2832	-0.16	27.91	0.03	-0.85	-0.09	0.01
12	200	0.4796	5.2983	-0.05	28.07	0.00	-0.26	-0.08	0.01
13	200	0.5205	5.2983	0.05	28.07	0.00	0.26	-0.08	0.01
14	221	0.5615	5.3982	0.16	29.14	0.03	0.86	0.02	0.00
15	266	0.6025	5.5835	0.26	31.18	0.07	1.45	0.21	0.04
16	292	0.6435	5.6768	0.36	32.23	0.13	2.04	0.30	0.09
17	295	0.6845	5.6870	0.48	32.34	0.23	2.73	0.31	0.10
18	338	0.7255	5.8230	0.60	33.91	0.36	3.49	0.45	0.20
19	368	0.7664	5.9081	0.73	34.91	0.53	4.31	0.53	0.28
20	389	0.8074	5.9636	0.87	35.56	0.76	5.19	0.59	0.35
21	395	0.8484	5.9789	1.03	35.75	1.06	6.16	0.60	0.37
22	397	0.8894	5.9839	1.22	35.81	1.49	7.30	0.61	0.37
23	440	0.9304	6.0868	1.48	37.05	2.19	9.01	0.71	0.51
24	487	0.9714	6.1883	1.90	38.29	3.61	11.76	0.81	0.66
Total	5460	12	129,7993	0	707,07	20,91	10,08	0	5,07
AVG	247,79	0,50	5,41	0,00	29,46	0,87	0,42	0,00	0,21

Index Of Fit

$$\begin{aligned}
 \text{a. } S_{xy} &= N \sum_{i=1}^N T_i Y_i - (\sum_{i=1}^N T_i)(\sum_{i=1}^N Y_i) \\
 &= 24 (10,08) - (129,7993)(0) \\
 &= \mathbf{241,9906} \\
 \text{b. } S_{xx} &= \sum_{i=1}^N T_i^2 - (\sum_{i=1}^N T_i)^2 \\
 &= 24 (707,07) - (129,7993)^2 \\
 &= \mathbf{121,7604} \\
 \text{c. } S_{yy} &= \sum_{i=1}^N Y_i^2 - (\sum_{i=1}^N Y_i)^2 \\
 &= 24 (20,91) - (0)^2 \\
 &= \mathbf{501,8496} \\
 \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\
 &= \frac{241,9906}{\sqrt{121,7604 \cdot 501,8496}} = \mathbf{0,978946}
 \end{aligned}$$

c. Distribusi Exponensial

i	Ti	F(Ti)	Yi=LN [1-F(Ti)]	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	103	0.0287	-0.0291	10609	0.00085	-3.00	-144.79	20964.63
2	115	0.0697	-0.0722	13225	0.00522	-8.31	-132.79	17633.63
3	120	0.1107	-0.1173	14400	0.01376	-14.08	-127.79	16330.71
4	123	0.1516	-0.1644	15129	0.02703	-20.22	-370.79	137486.46
5	127	0.1926	-0.2140	16129	0.04580	-27.18	-120.79	14590.63
6	173	0.2336	-0.2661	29929	0.07078	-46.03	-74.79	5593.79
7	173	0.2746	-0.3210	29929	0.10306	-55.54	-74.79	5593.79
8	175	0.3156	-0.3792	30625	0.14380	-66.36	-72.79	5298.63
9	176	0.3566	-0.4409	30976	0.19439	-77.60	-71.79	5154.04
10	177	0.3975	-0.5067	31329	0.25671	-89.68	-70.79	5011.46
11	197	0.4385	-0.5772	38809	0.33316	-113.71	-50.79	2579.79
12	200	0.4795	-0.6530	40000	0.42636	-130.59	-47.79	2284.04
13	200	0.5205	-0.7350	40000	0.54024	-147.00	-47.79	2284.04
14	221	0.5615	-0.8243	48841	0.67947	-182.17	-26.79	717.79
15	266	0.6025	-0.9225	70756	0.85101	-245.39	18.21	331.54
16	292	0.6434	-1.0313	85264	1.06358	-301.14	44.21	1954.38
17	295	0.6844	-1.1534	87025	1.33033	-340.25	47.21	2228.63
18	338	0.7254	-1.2925	114244	1.67056	-436.87	90.21	8137.54
19	368	0.7664	-1.4541	135424	2.11441	-535.11	120.21	14450.04
20	389	0.8074	-1.6470	151321	2.71261	-640.68	141.21	19939.79
21	395	0.8484	-1.8863	156025	3.55813	-745.09	147.21	21670.29
22	397	0.8893	-2.2013	157609	4.84572	-873.92	149.21	22263.13
23	440	0.9303	-2.6640	193600	7.09690	-1172.16	192.21	36944.04
24	487	0.9713	-3.5513	237169	12.61173	-1729.48	239.21	57220.63
Total	5947	12	-23,1041	1778367	40,69561	-8001,55	0	426663,46
AVG	247,79	0,50	-0,96	74098,63	1,70	-333,40	0,00	17777,64

Index Of Fit

a. $S_{xy} = N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi)$
 $= 24 (-8001,55) - (5947)(-23,1041)$
 $= -54636,89$

b. $S_{xx} = \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2$
 $= 24 (1778367) - (5947)^2$
 $= 7313999$

c. $S_{yy} = \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2$
 $= 24 (40,69561) - (-23,1041)^2$
 $= 442,8937$

d. $r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$
 $= \frac{-54636,89}{\sqrt{7313999 \cdot 442,8937}} = -0,959972$

d. Distribusi Weibull

i	ti	F(Ti)	Ti=LN(ti)	Yi=LN{-LN [1-F(ti)]}	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	103	0.0287	4.63	-3.5363	21.48	12.51	-16.39	-0.77	0.60
2	115	0.0697	4.74	-2.6276	22.51	6.90	-12.47	-0.66	0.44
3	120	0.1107	4.79	-2.1428	22.92	4.59	-10.26	-0.62	0.39
4	123	0.1516	4.81	-1.8054	23.16	3.26	-8.69	-0.60	0.36
5	127	0.1926	4.84	-1.5421	23.47	2.38	-7.47	-0.56	0.32
6	173	0.2336	5.15	-1.3241	26.56	1.75	-6.82	-0.26	0.07
7	173	0.2746	5.15	-1.1362	26.56	1.29	-5.86	-0.26	0.07
8	175	0.3156	5.16	-0.9697	26.68	0.94	-5.01	-0.24	0.06
9	176	0.3566	5.17	-0.8187	26.73	0.67	-4.23	-0.24	0.06
10	177	0.3975	5.18	-0.6799	26.79	0.46	-3.52	-0.23	0.05
11	197	0.4385	5.28	-0.5497	27.91	0.30	-2.90	-0.13	0.02
12	200	0.4795	5.30	-0.4262	28.07	0.18	-2.26	-0.11	0.01
13	200	0.5205	5.30	-0.3079	28.07	0.09	-1.63	-0.11	0.01
14	221	0.5615	5.40	-0.1931	29.14	0.04	-1.04	-0.01	0.00
15	266	0.6025	5.58	-0.0806	31.18	0.01	-0.45	0.18	0.03
16	292	0.6434	5.68	0.0307	32.23	0.00	0.17	0.27	0.07
17	295	0.6844	5.69	0.1426	32.34	0.02	0.81	0.28	0.08
18	338	0.7254	5.82	0.2565	33.91	0.07	1.49	0.41	0.17
19	368	0.7664	5.91	0.3744	34.91	0.14	2.21	0.50	0.25
20	389	0.8074	5.96	0.4990	35.56	0.25	2.98	0.56	0.31
21	395	0.8484	5.98	0.6347	35.75	0.40	3.79	0.57	0.33
22	397	0.8893	5.98	0.7889	35.81	0.62	4.72	0.58	0.33
23	440	0.9303	6.09	0.9797	37.05	0.96	5.96	0.68	0.46
24	487	0.9713	6.19	1.2672	38.29	1.61	7.84	0.78	0.61
Total	5947	12	129,7993	-13,1667	707,067695	39,45	-59,01	0	5,07
AVG	247,8	0,48	5,41	-0,63	29,46	1,65	-2,91	0,00	0,19

Index Of Fit

$$\begin{aligned} \text{a. } S_{xy} &= N \sum_{i=1}^N T_i Y_i - (\sum_{i=1}^N T_i)(\sum_{i=1}^N Y_i) \\ &= 24 (-59,01) - (129,79932)(-13,1667) \\ &= \mathbf{292,7169} \end{aligned}$$

$$\begin{aligned} \text{b. } S_{xx} &= \sum_{i=1}^N T_i^2 - (\sum_{i=1}^N T_i)^2 \\ &= 24 (707,06769) - (129,79932)^2 \\ &= \mathbf{121,76045} \end{aligned}$$

$$\begin{aligned} \text{c. } S_{yy} &= \sum_{i=1}^N Y_i^2 - (\sum_{i=1}^N Y_i)^2 \\ &= 24 (39,45) - (-13,1667)^2 \\ &= \mathbf{773,34174} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{292,7169}{\sqrt{121,76045 \cdot 773,34174}} = \mathbf{0.9539134} \end{aligned}$$

2. NOZZLE

a. Distribusi Normal

i	Ti	F(Ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	79	0.0287	-1.9000	6241	3.61	-150.10	-181.48	32934.36
2	125	0.0697	-1.4800	15625	2.19	-185	-135.48	18354.36
3	128	0.1107	-1.2200	16384	1.49	-156.16	-132.48	17550.49
4	148	0.1517	-1.0300	21904	1.06	-152.44	-112.48	12651.36
5	170	0.1927	-0.8700	28900	0.76	-147.9	-90.48	8186.32
6	175	0.2337	-0.7300	30625	0.53	-127.75	-435.48	189641.32
7	175	0.2746	-0.6000	30625	0.36	-105	-85.48	7306.53
8	197	0.3156	-0.4800	38809	0.23	-94.56	-63.48	4029.49
9	221	0.3566	-0.3600	48841	0.13	-79.56	-39.48	1558.53
10	224	0.3976	-0.2600	50176	0.07	-58.24	-36.48	1330.66
11	243	0.4386	-0.1600	59049	0.03	-38.88	-17.48	305.49
12	268	0.4796	-0.0500	71824	0.00	-13.40	-528.48	279289.27
13	292	0.5205	0.0500	85264	0.00	14.60	-552.48	305232.23
14	293	0.5615	0.1600	85849	0.03	46.88	32.52	1057.66
15	295	0.6025	0.2600	87025	0.07	76.7	34.52	1191.75
16	298	0.6435	0.3600	88804	0.13	107.28	37.52	1407.88
17	319	0.6845	0.4800	101761	0.23	153.12	58.52	3424.79
18	334	0.7255	0.6000	111556	0.36	200.4	73.52	5405.45
19	340	0.7664	0.7300	115600	0.53	248.2	79.52	6323.71
20	342	0.8074	0.8700	116964	0.76	297.54	156.52	24499.05
21	417	0.8484	1.0300	173889	1.06	429.51	156.52	24499.05
22	445	0.8894	1.2200	198025	1.49	542.9	184.52	34048.27
23	463	0.9304	1.4800	214369	2.19	685.24	202.52	41015.05
Total	5991	11.0298	0	1798109	15.11	808.14	0	980228.03
AVG	260.48	0.5	0	78178.65	0.69	36.73	0	44555.82

Index Of Fit

$$\begin{aligned} \text{a. } X_y &= N \sum_{i=1}^N T_i Y_i - (\sum_{i=1}^N T_i)(\sum_{i=1}^N Y_i) \\ &= 24 (808.14) - (5991)(0) \\ &= \mathbf{19395.36} \end{aligned}$$

$$\begin{aligned} \text{b. } S_{xx} &= \sum_{i=1}^N T_i^2 - (\sum_{i=1}^N T_i)^2 \\ &= 24 (1798109) - (5991)^2 \\ &= \mathbf{7262535} \end{aligned}$$

$$\begin{aligned} \text{c. } S_{yy} &= \sum_{i=1}^N Y_i^2 - (\sum_{i=1}^N Y_i)^2 \\ &= 24 (15.11) - (0)^2 \\ &= \mathbf{362.64} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{19395.36}{\sqrt{7262535 \cdot 362.64}} \\ &= \mathbf{0.377934} \end{aligned}$$

b. Distribusi Log Normal

i	ti	F(Ti)	Ti=LN(ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T} i	(Ti- \bar{T} i) ²
1	79	0.0287	4.3694	-1.90	19.09	3.61	-8.30	-1.08	1.16
2	125	0.0697	4.8283	-1.48	23.31	2.19	-7.15	-0.62	0.38
3	128	0.1107	4.8520	-1.22	23.54	1.49	-5.92	-0.59	0.35
4	148	0.1517	4.9972	-1.03	24.97	1.06	-5.15	-0.45	0.20
5	170	0.1927	5.1358	-0.87	26.38	0.76	-4.47	-0.31	0.10
6	175	0.2337	5.1648	-0.73	26.68	0.53	-3.77	-0.28	0.08
7	175	0.2746	5.1648	-0.60	26.68	0.36	-3.10	-0.28	0.08
8	197	0.3156	5.2832	-0.48	27.91	0.23	-2.54	-0.16	0.03
9	221	0.3566	5.3982	-0.36	29.14	0.13	-1.94	-0.05	0.00
10	224	0.3976	5.4116	-0.26	29.29	0.07	-1.41	-0.03	0.00
11	243	0.4386	5.4931	-0.16	30.17	0.03	-0.88	0.05	0.00
12	268	0.4796	5.5910	-0.05	31.26	0.00	-0.28	0.15	0.02
13	292	0.5205	5.6768	0.05	32.23	0.00	0.28	0.23	0.05
14	293	0.5615	5.6802	0.16	32.26	0.03	0.91	0.23	0.06
15	295	0.6025	5.6870	0.26	32.34	0.07	1.48	0.24	0.06
16	298	0.6435	5.6971	0.36	32.46	0.13	2.05	0.25	0.06
17	319	0.6845	5.7652	0.48	33.24	0.23	2.77	0.32	0.10
18	334	0.7255	5.8111	0.60	33.77	0.36	3.49	0.37	0.13
19	340	0.7664	5.8289	0.73	33.98	0.53	4.26	0.38	0.15
20	342	0.8074	5.8348	0.87	34.05	0.76	5.08	0.39	0.15
21	417	0.8484	6.0331	1.03	36.40	1.06	6.21	0.59	0.35
22	445	0.8894	6.0981	1.22	37.19	1.49	7.44	0.65	0.43
23	463	0.9304	6.1377	1.48	37.67	2.19	9.08	0.69	0.48
Total	5528	11	119.8017	0	656.32	15.11	-10.94	0	3.93
AVG	251.27	0.48	5.45	0.00	29.83	0.69	-0.50	0.00	0.18

Index Of Fit

$$\begin{aligned} \text{a. } S_{xy} &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\ &= 24 (-10,94) - (1119.8017)(0) \\ &= \mathbf{-262,4438} \end{aligned}$$

$$\begin{aligned} \text{b. } S_x &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\ &= 24 (656,32) - (119,8017)^2 \\ &= \mathbf{1399,193} \end{aligned}$$

$$\begin{aligned} \text{c. } S_y &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\ &= 24 (15,11) - (0)^2 \\ &= \mathbf{362,64} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{-262,4438}{\sqrt{1399,193 \cdot 362,64}} \\ &= \mathbf{-0,368434} \end{aligned}$$

c. Distribusi Exponensial

i	T _i	F(T _i)	Y _i =LN [1-F(T _i)]	T _i ²	Y _i ²	T _i ·Y _i	T _i - \bar{T}_i	(T _i - \bar{T}_i) ²
1	79	0.0287	-0.0291	6241	0.00085	-2.30	-172.27	29677.89
2	125	0.0697	-0.0722	15625	0.00522	-9.03	-126.27	15944.80
3	128	0.1107	-0.1173	16384	0.01376	-15.02	-123.27	15196.17
4	148	0.1516	-0.1644	21904	0.02703	-24.33	-399.27	159418.71
5	170	0.1926	-0.2140	28900	0.04580	-36.38	-81.27	6605.26
6	175	0.2336	-0.2661	30625	0.07078	-46.56	-76.27	5817.53
7	175	0.2746	-0.3210	30625	0.10306	-56.18	-76.27	5817.53
8	197	0.3156	-0.3792	38809	0.14380	-74.70	-54.27	2945.53
9	221	0.3566	-0.4409	48841	0.19439	-97.44	-30.27	916.44
10	224	0.3975	-0.5067	50176	0.25671	-113.49	-27.27	743.80
11	243	0.4385	-0.5772	59049	0.33316	-140.26	-8.27	68.44
12	268	0.4795	-0.6530	71824	0.42636	-174.99	16.73	279.80
13	292	0.5205	-0.7350	85264	0.54024	-214.62	40.73	1658.71
14	293	0.5615	-0.8243	85849	0.67947	-241.52	41.73	1741.17
15	295	0.6025	-0.9225	87025	0.85101	-272.14	43.73	1912.07
16	298	0.6434	-1.0313	88804	1.06358	-307.33	46.73	2183.44
17	319	0.6844	-1.1534	101761	1.33033	-367.93	67.73	4586.98
18	334	0.7254	-1.2925	111556	1.67056	-431.70	82.73	6843.80
19	340	0.7664	-1.4541	115600	2.11441	-494.39	88.73	7872.53
20	342	0.8074	-1.6470	116964	2.71261	-563.27	90.73	8231.44
21	417	0.8484	-1.8863	173889	3.55813	-786.59	165.73	27465.53
22	445	0.8893	-2.2013	198025	4.84572	-979.58	193.73	37530.26
23	463	0.9303	-2.2013	214369	4.84572	-1019.20	211.73	44828.44
Total	5528	10.0984	-16.8888	1583740	20.98698	-5449.7627	0	343457.818
AVG	251.27	0.46	-0.77	71988.18	0.95	-247.72	0.00	15611.72

Index Of Fit

$$a \ S_{xy} = N \sum_{i=1}^N T_i Y_i - (\sum_{i=1}^N T_i)(\sum_{i=1}^N Y_i)$$

$$= 24 (-5449,7627) - (-16,8888)(5528)$$

$$= \mathbf{-37432,84}$$

$$b \ S_{xx} = \sum_{i=1}^N T_i^2 - (\sum_{i=1}^N T_i)^2$$

$$= 24 (1583740) - (5528)^2$$

$$= \mathbf{7450976}$$

$$c \ S_{yy} = \sum_{i=1}^N Y_i^2 - (\sum_{i=1}^N Y_i)^2$$

$$= 24 (20,98698) - (-16,8888)^2$$

$$= \mathbf{218,4549}$$

$$d \ r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$$

$$= \frac{-37432,83}{\sqrt{7450976 \cdot 218,4549}}$$

$$= \mathbf{-0,927823}$$

d. Distribusi Weibull

i	ti	F(Ti)	Ti=LN(ti)	Yi=LN{-LN [1-F(ti)]}	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	79	0.0287	4.37	-3.5363	19.09	12.51	-15.45	-1.08	1.16
2	125	0.0697	4.83	-2.6276	23.31	6.90	-12.69	-0.62	0.38
3	128	0.1107	4.85	-2.1428	23.54	4.59	-10.40	-0.59	0.35
4	148	0.1516	5.00	-1.8054	24.97	3.26	-9.02	-0.45	0.20
5	170	0.1926	5.14	-1.5421	26.38	2.38	-7.92	-0.31	0.10
6	175	0.2336	5.16	-1.3241	26.68	1.75	-6.84	-0.28	0.08
7	175	0.2746	5.16	-1.1362	26.68	1.29	-5.87	-0.28	0.08
8	197	0.3156	5.28	-0.9697	27.91	0.94	-5.12	-0.16	0.03
9	221	0.3566	5.40	-0.8187	29.14	0.67	-4.42	-0.05	0.00
10	224	0.3975	5.41	-0.6799	29.29	0.46	-3.68	-0.03	0.00
11	243	0.4385	5.49	-0.5497	30.17	0.30	-3.02	0.05	0.00
12	268	0.4795	5.59	-0.4262	31.26	0.18	-2.38	0.15	0.02
13	292	0.5205	5.68	-0.3079	32.23	0.09	-1.75	0.23	0.05
14	293	0.5615	5.68	-0.1931	32.26	0.04	-1.10	0.23	0.06
15	295	0.6025	5.69	-0.0806	32.34	0.01	-0.46	0.24	0.06
16	298	0.6434	5.70	0.0307	32.46	0.00	0.17	0.25	0.06
17	319	0.6844	5.77	0.1426	33.24	0.02	0.82	0.32	0.10
18	334	0.7254	5.81	0.2565	33.77	0.07	1.49	0.37	0.13
19	340	0.7664	5.83	0.3744	33.98	0.14	2.18	0.38	0.15
20	342	0.8074	5.83	0.4990	34.05	0.25	2.91	0.39	0.15
21	417	0.8484	6.03	0.6347	36.40	0.40	3.83	0.59	0.35
22	445	0.8893	6.10	0.7889	37.19	0.62	4.81	0.65	0.43
23	463	0.9303	6.14	0.9797	37.67	0.96	6.01	0.69	0.48
Total	5528	10.0984	119.80168	-15.41351177	656.318	36.8804	-73.89	0	3.93
AVG	251.27	0.46	5.45	-0.70	29.83	1.68	-3.36	0.00	0.18

Index Of Fit

a. $S_{xy} = N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi)$
 $= 24(-73,9) - (119,802)(-15,4135)$
 $= -73,199$

b. $S_{xx} = \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2$
 $= 24(656,3) - (119,802)^2$
 $= 1399,2$

c. $S_{yy} = \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2$
 $= 24(36,88) - (-15,413512)^2$
 $= 647,55$

d. $r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$
 $= \frac{-37432,84}{\sqrt{7450976 \cdot 218,4549}}$
 $= 0.0769$

3. RELLAY

a. Distribusi Normal

i	Ti	F(Ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti - \bar{T}	(Ti - \bar{T}) ²
1	103	0.0287	-1.9000	10609	3.61	-195.70	-144.21	20796.04
2	115	0.0697	-1.4800	13225	2.19	-170.2	-132.21	17479.04
3	120	0.1107	-1.2200	14400	1.49	-146.4	-127.21	16181.96
4	123	0.1517	-1.0300	15129	1.06	-126.69	-124.21	15427.71
5	127	0.1927	-0.8700	16129	0.76	-110.49	-120.21	14450.04
6	173	0.2337	-0.7300	29929	0.53	-126.29	-420.21	176575.04
7	173	0.2746	-0.6000	29929	0.36	-103.8	-74.21	5506.88
8	175	0.3156	-0.4800	30625	0.23	-84.00	-72.21	5214.04
9	176	0.3566	-0.3600	30976	0.13	-63.36	-71.21	5070.63
10	177	0.3976	-0.2600	31329	0.07	-46.02	-70.21	4929.21
11	197	0.4386	-0.1600	38809	0.03	-31.52	-50.21	2520.88
12	200	0.4796	-0.0500	40000	0.00	-10.00	-447.21	199995.29
13	200	0.5205	0.0500	40000	0.00	10.00	-447.21	199995.29
14	221	0.5615	0.1600	48841	0.03	35.36	-26.21	686.88
15	266	0.6025	0.2600	70756	0.07	69.16	18.79	353.13
16	292	0.6435	0.3600	85264	0.13	105.12	44.79	2006.29
17	295	0.6845	0.4800	87025	0.23	141.6	47.79	2284.04
18	338	0.7255	0.6000	114244	0.36	202.8	90.79	8243.13
19	368	0.7664	0.7300	135424	0.53	268.64	120.79	14590.63
20	389	0.8074	0.8700	151321	0.76	338.43	147.79	21842.38
21	395	0.8484	1.0300	156025	1.06	406.85	147.79	21842.38
22	397	0.8894	1.2200	157609	1.49	484.34	149.79	22437.54
23	440	0.9304	1.4800	193600	2.19	651.20	192.79	37168.63
24	473	0.9714	1.9000	223729	3.61	898.70	225.79	50981.88
Total	5933	12.0012	0	1764927	20.9104	2397.73	0	866578.96
AVG	247.21	0.5	0	73538.63	0.87	99.91	0	36107.46

Index Of Fit

$$\begin{aligned} \text{a. } Xy &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\ &= 24 (2397,73) - (5933)(0) \\ &= \mathbf{57545,52} \end{aligned}$$

$$\begin{aligned} \text{b. } S_{xx} &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\ &= 24 (1764927) - (5933)^2 \\ &= \mathbf{71577559} \end{aligned}$$

$$\begin{aligned} \text{c. } S_{yy} &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\ &= 24 (20,9104) - (0)^2 \\ &= \mathbf{501,8496} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{5745,52}{\sqrt{7157759 \cdot 501,8496}} \\ &= \mathbf{0,960144} \end{aligned}$$

b. Distribusi Log Normal

i	ti	F(Ti)	Ti=LN(ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}	(Ti- \bar{T}) ²
1	103	0.0287	4.6347	-1.90	21.48	3.61	-8.81	-0.77	0.60
2	115	0.0697	4.7449	-1.48	22.51	2.19	-7.02	-0.66	0.44
3	120	0.1107	4.7875	-1.22	22.92	1.49	-5.84	-0.62	0.38
4	123	0.1517	4.8122	-1.03	23.16	1.06	-4.96	-0.59	0.35
5	127	0.1927	4.8442	-0.87	23.47	0.76	-4.21	-0.56	0.32
6	173	0.2337	5.1533	-0.73	26.56	0.53	-3.76	-0.25	0.06
7	173	0.2746	5.1533	-0.60	26.56	0.36	-3.09	-0.25	0.06
8	175	0.3156	5.1648	-0.48	26.68	0.23	-2.48	-0.24	0.06
9	176	0.3566	5.1705	-0.36	26.73	0.13	-1.86	-0.24	0.06
10	177	0.3976	5.1761	-0.26	26.79	0.07	-1.35	-0.23	0.05
11	197	0.4386	5.2832	-0.16	27.91	0.03	-0.85	-0.12	0.02
12	200	0.4796	5.2983	-0.05	28.07	0.00	-0.26	-0.11	0.01
13	200	0.5205	5.2983	0.05	28.07	0.00	0.26	-0.11	0.01
14	221	0.5615	5.3982	0.16	29.14	0.03	0.86	-0.01	0.00
15	266	0.6025	5.5835	0.26	31.18	0.07	1.45	0.18	0.03
16	292	0.6435	5.6768	0.36	32.23	0.13	2.04	0.27	0.07
17	295	0.6845	5.6870	0.48	32.34	0.23	2.73	0.28	0.08
18	338	0.7255	5.8230	0.60	33.91	0.36	3.49	0.42	0.17
19	368	0.7664	5.9081	0.73	34.91	0.53	4.31	0.50	0.25
20	389	0.8074	5.9636	0.87	35.56	0.76	5.19	0.56	0.31
21	395	0.8484	5.9789	1.03	35.75	1.06	6.16	0.57	0.33
22	397	0.8894	5.9839	1.22	35.81	1.49	7.30	0.58	0.33
23	440	0.9304	6.0868	1.48	37.05	2.19	9.01	0.68	0.46
24	473	0.9714	6.1591	1.90	37.93	3.61	11.70	0.75	0.57
Total	5460	12	129.7702	0	706.71	20.91	10.03	0	5.03
AVG	237.39	0.50	5.41	0.00	29.45	0.87	0.42	0.00	0.21

Index Of Fit

a. $S_{xy} = N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi)$
 $= 24 (10,03) - (129,7702)(0)$
 $= \mathbf{240,6605}$

b. $S_{xx} = \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2$
 $= 24 (706,71) - (129,7702)^2$
 $= \mathbf{120,688}$

c. $S_{yy} = \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2$
 $= 24 (20,91) - (0)^2$
 $= \mathbf{501,8496}$

d. $r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$
 $= \frac{240,6605}{\sqrt{120,688 \cdot 501,8496}}$
 $= \mathbf{0,977881}$

c. Distribusi Exponensial

i	Ti	F(Ti)	Yi=LN [1-F(Ti)]	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}	(Ti- \bar{T}) ²
1	103	0.0287	-0.0291	10609	0.00085	-3.00	-144.21	20796.04
2	115	0.0697	-0.0722	13225	0.00522	-8.31	-132.21	17479.04
3	120	0.1107	-0.1173	14400	0.01376	-14.08	-127.21	16181.96
4	123	0.1516	-0.1644	15129	0.02703	-20.22	-370.21	137054.21
5	127	0.1926	-0.2140	16129	0.04580	-27.18	-120.21	14450.04
6	173	0.2336	-0.2661	29929	0.07078	-46.03	-74.21	5506.88
7	173	0.2746	-0.3210	29929	0.10306	-55.54	-74.21	5506.88
8	175	0.3156	-0.3792	30625	0.14380	-66.36	-72.21	5214.04
9	176	0.3566	-0.4409	30976	0.19439	-77.60	-71.21	5070.63
10	177	0.3975	-0.5067	31329	0.25671	-89.68	-70.21	4929.21
11	197	0.4385	-0.5772	38809	0.33316	-113.71	-50.21	2520.88
12	200	0.4795	-0.6530	40000	0.42636	-130.59	-47.21	2228.63
13	200	0.5205	-0.7350	40000	0.54024	-147.00	-47.21	2228.63
14	221	0.5615	-0.8243	48841	0.67947	-182.17	-26.21	686.88
15	266	0.6025	-0.9225	70756	0.85101	-245.39	18.79	353.13
16	292	0.6434	-1.0313	85264	1.06358	-301.14	44.79	2006.29
17	295	0.6844	-1.1534	87025	1.33033	-340.25	47.79	2284.04
18	338	0.7254	-1.2925	114244	1.67056	-436.87	90.79	8243.13
19	368	0.7664	-1.4541	135424	2.11441	-535.11	120.79	14590.63
20	389	0.8074	-1.6470	151321	2.71261	-640.68	141.79	20104.88
21	395	0.8484	-1.8863	156025	3.55813	-745.09	147.79	21842.38
22	397	0.8893	-2.2013	157609	4.84572	-873.92	149.79	22437.54
23	440	0.9303	-2.6640	193600	7.09690	-1172.16	192.79	37168.63
24	473	0.9713	-3.5513	223729	12.61173	-1679.76	225.79	50981.88
Total	5933	12	-23.1041	1764927	40.69561	-7951.8301	0	419866.458
AVG	247.21	0.50	-0.96	73538.63	1.70	-331.33	0.00	17494.44

Index Of Fit

a. $S_{xy} = N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi)$
 $= 24 (-7951,8301) - (5933)(-23,1041)$
 $= -53767,11$

b. $S_{xx} = \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2$
 $= 24 (1764927) - (5933)^2$
 $= 7157759$

c. $S_{yy} = \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2$
 $= 24 (40,69561) - (-23,1041)^2$
 $= 442,8937$

d. $r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$
 $= \frac{-53767,11}{\sqrt{7157759 \cdot 442,8937}}$
 $= -0.954945$

d. Distribusi Weibull

i	ti	F(Ti)	Ti=LN (ti)	Yi=LN{- LN [1- F(ti)]}	Ti ²	Yi ²	Ti.Yi	Ti \bar{T} i	(Ti- \bar{T}) ² i ²
1	103	0.0287	4.63	-3.5363	21.48	12.51	-16.39	-0.77	0.60
2	115	0.0697	4.74	-2.6276	22.51	6.90	-12.47	-0.66	0.44
3	120	0.1107	4.79	-2.1428	22.92	4.59	-10.26	-0.62	0.38
4	123	0.1516	4.81	-1.8054	23.16	3.26	-8.69	-0.59	0.35
5	127	0.1926	4.84	-1.5421	23.47	2.38	-7.47	-0.56	0.32
6	173	0.2336	5.15	-1.3241	26.56	1.75	-6.82	-0.25	0.06
7	173	0.2746	5.15	-1.1362	26.56	1.29	-5.86	-0.25	0.06
8	175	0.3156	5.16	-0.9697	26.68	0.94	-5.01	-0.24	0.06
9	176	0.3566	5.17	-0.8187	26.73	0.67	-4.23	-0.24	0.06
10	177	0.3975	5.18	-0.6799	26.79	0.46	-3.52	-0.23	0.05
11	197	0.4385	5.28	-0.5497	27.91	0.30	-2.90	-0.12	0.02
12	200	0.4795	5.30	-0.4262	28.07	0.18	-2.26	-0.11	0.01
13	200	0.5205	5.30	-0.3079	28.07	0.09	-1.63	-0.11	0.01
14	221	0.5615	5.40	-0.1931	29.14	0.04	-1.04	-0.01	0.00
15	266	0.6025	5.58	-0.0806	31.18	0.01	-0.45	0.18	0.03
16	292	0.6434	5.68	0.0307	32.23	0.00	0.17	0.27	0.07
17	295	0.6844	5.69	0.1426	32.34	0.02	0.81	0.28	0.08
18	338	0.7254	5.82	0.2565	33.91	0.07	1.49	0.42	0.17
19	368	0.7664	5.91	0.3744	34.91	0.14	2.21	0.50	0.25
20	389	0.8074	5.96	0.4990	35.56	0.25	2.98	0.56	0.31
21	395	0.8484	5.98	0.6347	35.75	0.40	3.79	0.57	0.33
22	397	0.8893	5.98	0.7889	35.81	0.62	4.72	0.58	0.33
23	440	0.9303	6.09	0.9797	37.05	0.96	5.96	0.68	0.46
24	473	0.9713	6.16	1.2672	37.93	1.61	7.80	0.75	0.57
Total	5933	12	129.77	-13.166660	706.71	39.4459	-59.0497	0	5.03
AVG	247.21	0.48	5.41	-0.63	29.08	1.65	-2.91	0.00	0.21

Index Of Fit

$$\begin{aligned}
 \text{a. } S_{xy} &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\
 &= 24(-59,04974) - (129,77)(-13,166661) \\
 &= \mathbf{291,445}
 \end{aligned}$$

$$\begin{aligned}
 \text{b. } S_{xx} &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\
 &= 24 (706,70754) - (129,77015)^2 \\
 &= \mathbf{120,68799}
 \end{aligned}$$

$$\begin{aligned}
 \text{c. } S_{yy} &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\
 &= 24 (39,445946) - (-13,16666)^2 \\
 &= \mathbf{773,3417}
 \end{aligned}$$

$$\begin{aligned}
 \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\
 &= \frac{291,445}{\sqrt{120,68799 \cdot 773,3417}} \\
 &= \mathbf{0.9539815}
 \end{aligned}$$

4. LIMIT SWITCH

a. Distribusi Normal

i	Ti	F(Ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}	(Ti- \bar{T}) ²
1	104	0.0287	-1.9000	10816	3.61	-197.60	-119.21	14210.63
2	105	0.0697	-1.4800	11025	2.19	-155.4	-118.21	13973.21
3	122	0.1107	-1.2200	14884	1.49	-148.84	-101.21	10243.13
4	150	0.1517	-1.0300	22500	1.06	-154.5	-73.21	5359.46
5	153	0.1927	-0.8700	23409	0.76	-133.11	-70.21	4929.21
6	168	0.2337	-0.7300	28224	0.53	-122.64	-391.21	153043.96
7	172	0.2746	-0.6000	29584	0.36	-103.2	-51.21	2622.29
8	173	0.3156	-0.4800	29929	0.23	-83.04	-50.21	2520.88
9	174	0.3566	-0.3600	30276	0.13	-62.64	-49.21	2421.46
10	176	0.3976	-0.2600	30976	0.07	-45.76	-47.21	2228.63
11	197	0.4386	-0.1600	38809	0.03	-31.52	-26.21	686.88
12	197	0.4796	-0.0500	38809	0.00	-9.85	-420.21	176575.04
13	199	0.5205	0.0500	39601	0.00	9.95	-422.21	178259.88
14	223	0.5615	0.1600	49729	0.03	35.68	-0.21	0.04
15	246	0.6025	0.2600	60516	0.07	63.96	22.79	519.46
16	246	0.6435	0.3600	60516	0.13	88.56	22.79	519.46
17	267	0.6845	0.4800	71289	0.23	128.16	43.79	1917.71
18	269	0.7255	0.6000	72361	0.36	161.4	45.79	2096.88
19	296	0.7664	0.7300	87616	0.53	216.08	72.79	5298.63
20	317	0.8074	0.8700	100489	0.76	275.79	95.79	9176.04
21	319	0.8484	1.0300	101761	1.06	328.57	95.79	9176.04
22	345	0.8894	1.2200	119025	1.49	420.9	121.79	14833.21
23	367	0.9304	1.4800	134689	2.19	543.16	143.79	20676.04
24	372	0.9714	1.9000	138384	3.61	706.80	148.79	22138.96
Total	5357	12.0012	0	1345217	20.9104	1730.91	0	653427.13
AVG	223.21	0.5	0	56050.71	0.87	72.12	0	27226.13

Index Of Fit

$$\begin{aligned} \text{a. } Xy &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\ &= 24 (1730,91) - (5357)(0) \\ &= \mathbf{41541,84} \end{aligned}$$

$$\begin{aligned} \text{b. } Sxx &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\ &= 24 (1345217) - (5357)^2 \\ &= \mathbf{3587759} \end{aligned}$$

$$\begin{aligned} \text{c. } Syy &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\ &= 24 (20,9104) - (0)^2 \\ &= \mathbf{501,8496} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{Sxy}{\sqrt{Sxx \cdot Syy}} \\ &= \frac{41541,84}{\sqrt{3587759 \cdot 501,8496}} \\ &= \mathbf{0,97901} \end{aligned}$$

b. Distribusi Log Normal

i	t _i	F(T _i)	T _i =LN(t _i)	Y _i	T _i ²	Y _i ²	T _i ·Y _i	T _i -T _i	(T _i -T _i) ²
1	104	0.0287	4.6444	-1.90	21.57	3.61	-8.82	-0.70	0.49
2	105	0.0697	4.6540	-1.48	21.66	2.19	-6.89	-0.69	0.48
3	122	0.1107	4.8040	-1.22	23.08	1.49	-5.86	-0.54	0.29
4	150	0.1517	5.0106	-1.03	25.11	1.06	-5.16	-0.33	0.11
5	153	0.1927	5.0304	-0.87	25.31	0.76	-4.38	-0.31	0.10
6	168	0.2337	5.1240	-0.73	26.26	0.53	-3.74	-0.22	0.05
7	172	0.2746	5.1475	-0.60	26.50	0.36	-3.09	-0.20	0.04
8	173	0.3156	5.1533	-0.48	26.56	0.23	-2.47	-0.19	0.04
9	174	0.3566	5.1591	-0.36	26.62	0.13	-1.86	-0.18	0.03
10	176	0.3976	5.1705	-0.26	26.73	0.07	-1.34	-0.17	0.03
11	197	0.4386	5.2832	-0.16	27.91	0.03	-0.85	-0.06	0.00
12	197	0.4796	5.2832	-0.05	27.91	0.00	-0.26	-0.06	0.00
13	199	0.5205	5.2933	0.05	28.02	0.00	0.26	-0.05	0.00
14	223	0.5615	5.4072	0.16	29.24	0.03	0.87	0.06	0.00
15	246	0.6025	5.5053	0.26	30.31	0.07	1.43	0.16	0.03
16	246	0.6435	5.5053	0.36	30.31	0.13	1.98	0.16	0.03
17	267	0.6845	5.5872	0.48	31.22	0.23	2.68	0.24	0.06
18	269	0.7255	5.5947	0.60	31.30	0.36	3.36	0.25	0.06
19	296	0.7664	5.6904	0.73	32.38	0.53	4.15	0.35	0.12
20	317	0.8074	5.7589	0.87	33.16	0.76	5.01	0.42	0.17
21	319	0.8484	5.7652	1.03	33.24	1.06	5.94	0.42	0.18
22	345	0.8894	5.8435	1.22	34.15	1.49	7.13	0.50	0.25
23	367	0.9304	5.9054	1.48	34.87	2.19	8.74	0.56	0.32
24	372	0.9714	5.9189	1.90	35.03	3.61	11.25	0.58	0.33
Total	4985	12	128.2395	0	688.43	20.91	8.07	0	3.21
AVG	216.74	0.50	5.34	0.00	28.68	0.87	0.34	0.00	0.13

Index Of Fit

$$\begin{aligned} \text{a. } S_{xy} &= N \sum_{i=1}^N T_i Y_i - (\sum_{i=1}^N T_i)(\sum_{i=1}^N Y_i) \\ &= 24 (8,07) - (128,2395)(0) \\ &= \mathbf{193,7991} \end{aligned}$$

$$\begin{aligned} \text{b. } S_{xx} &= \sum_{i=1}^N T_i^2 - (\sum_{i=1}^N T_i)^2 \\ &= 24 (688,43) - (128,2395)^2 \\ &= \mathbf{76,96941} \end{aligned}$$

$$\begin{aligned} \text{c. } S_{yy} &= \sum_{i=1}^N Y_i^2 - (\sum_{i=1}^N Y_i)^2 \\ &= 24 (20,91) - (0)^2 \\ &= \mathbf{501,8496} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{193,7991}{\sqrt{501,8496 \cdot 76,96941}} \\ &= \mathbf{0,986066} \end{aligned}$$

c. Distribusi Exponensial

i	Ti	F(Ti)	Yi=LN [1-F(Ti)]	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	104	0.0287	-0.0291	10816	0.00085	-3.03	-119.21	14210.63
2	105	0.0697	-0.0722	11025	0.00522	-7.59	-118.21	13973.21
3	122	0.1107	-0.1173	14884	0.01376	-14.31	-101.21	10243.13
4	150	0.1516	-0.1644	22500	0.02703	-24.66	-373.21	139284.46
5	153	0.1926	-0.2140	23409	0.04580	-32.74	-70.21	4929.21
6	168	0.2336	-0.2661	28224	0.07078	-44.70	-55.21	3047.96
7	172	0.2746	-0.3210	29584	0.10306	-55.22	-51.21	2622.29
8	173	0.3156	-0.3792	29929	0.14380	-65.60	-50.21	2520.88
9	174	0.3566	-0.4409	30276	0.19439	-76.72	-49.21	2421.46
10	176	0.3975	-0.5067	30976	0.25671	-89.17	-47.21	2228.63
11	197	0.4385	-0.5772	38809	0.33316	-113.71	-26.21	686.88
12	197	0.4795	-0.6530	38809	0.42636	-128.63	-26.21	686.88
13	199	0.5205	-0.7350	39601	0.54024	-146.27	-24.21	586.04
14	223	0.5615	-0.8243	49729	0.67947	-183.82	-0.21	0.04
15	246	0.6025	-0.9225	60516	0.85101	-226.94	22.79	519.46
16	246	0.6434	-1.0313	60516	1.06358	-253.70	22.79	519.46
17	267	0.6844	-1.1534	71289	1.33033	-307.96	43.79	1917.71
18	269	0.7254	-1.2925	72361	1.67056	-347.68	45.79	2096.88
19	296	0.7664	-1.4541	87616	2.11441	-430.41	72.79	5298.63
20	317	0.8074	-1.6470	100489	2.71261	-522.10	93.79	8796.88
21	319	0.8484	-1.8863	101761	3.55813	-601.73	95.79	9176.04
22	345	0.8893	-2.2013	119025	4.84572	-759.45	121.79	14833.21
23	367	0.9303	-2.6640	134689	7.09690	-977.69	143.79	20676.04
24	372	0.9713	-3.5513	138384	12.61173	-1321.08	148.79	22138.96
Total	5357	12	-23.1041	1345217	40.69561	-6734.904	0	283414.958
AVG	223.21	0.50	-0.96	56050.71	1.70	-280.62	0.00	11808.96

Index Of Fit

$$\begin{aligned} \text{a. } S_{xy} &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\ &= 24 (-6734,9043) - (5357)(-23,1041) \\ &= \mathbf{-37868,87} \end{aligned}$$

$$\begin{aligned} \text{b. } S_{xx} &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\ &= 24 (241345217) - (5357)^2 \\ &= \mathbf{3587759} \end{aligned}$$

$$\begin{aligned} \text{c. } S_{yy} &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\ &= 24 (40,69561) - (-23,1041)^2 \\ &= \mathbf{442,8937} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{0337868,87}{\sqrt{3587759 \cdot 442,8937}} \\ &= \mathbf{-0.9499994} \end{aligned}$$

d. Distribusi Weibull

i	ti	F(Ti)	Ti=LN(ti)	Yi=LN{-LN [1-F(ti)]}	Ti ²	Yi ²	Ti.Yi	$\frac{T_i \bar{T}}{i}$	$(T_i - \bar{T}_i)^2$
1	104	0.0287	4.64	-3.5363	21.57	12.51	-16.42	-0.70	0.49
2	105	0.0697	4.65	-2.6276	21.66	6.90	-12.23	-0.69	0.48
3	122	0.1107	4.80	-2.1428	23.08	4.59	-10.29	-0.54	0.29
4	150	0.1516	5.01	-1.8054	25.11	3.26	-9.05	-0.33	0.11
5	153	0.1926	5.03	-1.5421	25.31	2.38	-7.76	-0.31	0.10
6	168	0.2336	5.12	-1.3241	26.26	1.75	-6.78	-0.22	0.05
7	172	0.2746	5.15	-1.1362	26.50	1.29	-5.85	-0.20	0.04
8	173	0.3156	5.15	-0.9697	26.56	0.94	-5.00	-0.19	0.04
9	174	0.3566	5.16	-0.8187	26.62	0.67	-4.22	-0.18	0.03
10	176	0.3975	5.17	-0.6799	26.73	0.46	-3.52	-0.17	0.03
11	197	0.4385	5.28	-0.5497	27.91	0.30	-2.90	-0.06	0.00
12	197	0.4795	5.28	-0.4262	27.91	0.18	-2.25	-0.06	0.00
13	199	0.5205	5.29	-0.3079	28.02	0.09	-1.63	-0.05	0.00
14	223	0.5615	5.41	-0.1931	29.24	0.04	-1.04	0.06	0.00
15	246	0.6025	5.51	-0.0806	30.31	0.01	-0.44	0.16	0.03
16	246	0.6434	5.51	0.0307	30.31	0.00	0.17	0.16	0.03
17	267	0.6844	5.59	0.1426	31.22	0.02	0.80	0.24	0.06
18	269	0.7254	5.59	0.2565	31.30	0.07	1.44	0.25	0.06
19	296	0.7664	5.69	0.3744	32.38	0.14	2.13	0.35	0.12
20	317	0.8074	5.76	0.4990	33.16	0.25	2.87	0.42	0.17
21	319	0.8484	5.77	0.6347	33.24	0.40	3.66	0.42	0.18
22	345	0.8893	5.84	0.7889	34.15	0.62	4.61	0.50	0.25
23	367	0.9303	5.91	0.9797	34.87	0.96	5.79	0.56	0.32
24	372	0.9713	5.92	1.2672	35.03	1.61	7.50	0.58	0.33
Total	5357	12	128.239494	-13.166660	688.43072	39.445945	-60.43368	0	3.21
AVG	223.21	0.48	5.34	-0.63	28.41	1.65	-2.95	0.00	0.13

Index Of Fit

a. $S_{xy} = N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi)$
 $= 24(-60,43368) - (128,23949)(-13,166661)$
 $= \mathbf{238,07751}$

b. $S_{xx} = \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2$
 $= 24(688,43072) - (128,23949)^2$
 $= \mathbf{76,969414}$

c. $S_{yy} = \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2$
 $= 24(39,445945) - (-13,166660)^2$
 $= \mathbf{773,34174}$

d. $r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$
 $= \frac{238,07751}{\sqrt{76,969414 \cdot 773,34174}}$
 $= \mathbf{0.9758286}$

Lampiran 5

Uji Distribusi Perhitungan MTTR

1. MOTOR AXIS

a. Distribusi Normal

i	Ti	F(Ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	20	0.0287	-1.9000	400	3.61	-38.00	-9.75	95.06
2	20	0.0697	-1.4800	400	2.19	-29.6	-9.75	95.06
3	21	0.1107	-1.2200	441	1.49	-25.62	-8.75	76.56
4	22	0.1517	-1.0300	484	1.06	-22.66	-7.75	60.06
5	23	0.1927	-0.8700	529	0.76	-20.01	-6.75	45.56
6	25	0.2337	-0.7300	625	0.53	-18.25	-54.75	2997.56
7	25	0.2746	-0.6000	625	0.36	-15	-4.75	22.56
8	28	0.3156	-0.4800	784	0.23	-13.44	-1.75	3.06
9	28	0.3566	-0.3600	784	0.13	-10.08	-1.75	3.06
10	29	0.3976	-0.2600	841	0.07	-7.54	-0.75	0.56
11	30	0.4386	-0.1600	900	0.03	-4.8	0.25	0.06
12	30	0.4796	-0.0500	900	0.00	-1.50	-59.75	3570.06
13	30	0.5205	0.0500	900	0.00	1.50	-59.75	3570.06
14	30	0.5615	0.1600	900	0.03	4.8	0.25	0.06
15	30	0.6025	0.2600	900	0.07	7.8	0.25	0.06
16	31	0.6435	0.3600	961	0.13	11.16	1.25	1.56
17	31	0.6845	0.4800	961	0.23	14.88	1.25	1.56
18	35	0.7255	0.6000	1225	0.36	21	5.25	27.56
19	35	0.7664	0.7300	1225	0.53	25.55	5.25	27.56
20	35	0.8074	0.8700	1225	0.76	30.45	8.25	68.06
21	38	0.8484	1.0300	1444	1.06	39.14	8.25	68.06
22	39	0.8894	1.2200	1521	1.49	47.58	9.25	85.56
23	39	0.9304	1.4800	1521	2.19	57.72	9.25	85.56
24	40	0.9714	1.9000	1600	3.61	76.00	10.25	105.06
Total	714	12.0012	0	22096	20.9104	131.08	0	11010.00
AVG	29.75	0.5	0	920.67	0.87	5.46	0	458.75

Index Of Fit

$$\begin{aligned}
 \text{a. } S_{xy} &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\
 &= 24 (131.08) - (714)(0) \\
 &= \mathbf{3145.92}
 \end{aligned}$$

$$\begin{aligned}
 \text{b. } S_{xx} &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\
 &= 24 (22096) - (714)^2 \\
 &= \mathbf{20508}
 \end{aligned}$$

$$\begin{aligned}
 \text{c. } S_{yy} &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\
 &= 24 (20.9104) - (0)^2 \\
 &= \mathbf{501.8496}
 \end{aligned}$$

$$\begin{aligned}
 \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\
 &= \frac{3145.92}{\sqrt{20508 \cdot 501.8496}} \\
 &= \mathbf{0.980617}
 \end{aligned}$$

b. Distribusi Log Normal

i	t _i	F(T _i)	T _i =LN(t _i)	Y _i	T _i ²	Y _i ²	T _i .Y _i	T _i -T̄ _i	(T _i -T̄ _i) ²
1	20	0.0287	2.9957	-1.90	8.97	3.61	-5.69	-0.38	0.14
2	20	0.0697	2.9957	-1.48	8.97	2.19	-4.43	-0.38	0.14
3	21	0.1107	3.0445	-1.22	9.27	1.49	-3.71	-0.33	0.11
4	22	0.1517	3.0910	-1.03	9.55	1.06	-3.18	-0.28	0.08
5	23	0.1927	3.1355	-0.87	9.83	0.76	-2.73	-0.24	0.06
6	25	0.2337	3.2189	-0.73	10.36	0.53	-2.35	-0.15	0.02
7	25	0.2746	3.2189	-0.60	10.36	0.36	-1.93	-0.15	0.02
8	28	0.3156	3.3322	-0.48	11.10	0.23	-1.60	-0.04	0.00
9	28	0.3566	3.3322	-0.36	11.10	0.13	-1.20	-0.04	0.00
10	29	0.3976	3.3673	-0.26	11.34	0.07	-0.88	0.00	0.00
11	30	0.4386	3.4012	-0.16	11.57	0.03	-0.54	0.03	0.00
12	30	0.4796	3.4012	-0.05	11.57	0.00	-0.17	0.03	0.00
13	30	0.5205	3.4012	0.05	11.57	0.00	0.17	0.03	0.00
14	30	0.5615	3.4012	0.16	11.57	0.03	0.54	0.03	0.00
15	30	0.6025	3.4012	0.26	11.57	0.07	0.88	0.03	0.00
16	31	0.6435	3.4340	0.36	11.79	0.13	1.24	0.06	0.00
17	31	0.6845	3.4340	0.48	11.79	0.23	1.65	0.06	0.00
18	35	0.7255	3.5553	0.60	12.64	0.36	2.13	0.18	0.03
19	35	0.7664	3.5553	0.73	12.64	0.53	2.60	0.18	0.03
20	35	0.8074	3.5553	0.87	12.64	0.76	3.09	0.18	0.03
21	38	0.8484	3.6376	1.03	13.23	1.06	3.75	0.27	0.07
22	39	0.8894	3.6636	1.22	13.42	1.49	4.47	0.29	0.09
23	39	0.9304	3.6636	1.48	13.42	2.19	5.42	0.29	0.09
24	40	0.9714	3.6889	1.90	13.61	3.61	7.01	0.32	0.10
Total	674	12	80.9256	0	273.90	20.91	4.53	0	1.03
AVG	29.30	0.50	3.37	0.00	11.41	0.87	0.19	0.00	0.04

Index Of Fit

a. $S_{xy} = N \sum_{i=1}^N T_i Y_i - (\sum_{i=1}^N T_i)(\sum_{i=1}^N Y_i)$
 $= 24 (4.53) - (80.9256)(0)$
 $= \mathbf{108.7351}$

b. $S_{xx} = \sum_{i=1}^N T_i^2 - (\sum_{i=1}^N T_i)^2$
 $= 24 (273.90) - (80.9256)^2$
 $= \mathbf{24.69872}$

c. $S_{yy} = \sum_{i=1}^N Y_i^2 - (\sum_{i=1}^N Y_i)^2$
 $= 24 (20.9104) - (0)^2$
 $= \mathbf{501.8496}$

d. $r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$
 $= \frac{108.7351}{\sqrt{24.69872 \cdot 501.8496}}$
 $= \mathbf{0.976665}$

c. Distribusi Exponensial

i	T _i	F(T _i)	Y _i =LN [1-F(T _i)]	T _i ²	Y _i ²	T _i .Y _i	T _i - \bar{T}_i	(T _i - \bar{T}_i) ²
1	20	0.0287	-0.0291	400	0.00085	-0.58	-9.75	95.06
2	20	0.0697	-0.0722	400	0.00522	-1.44	-9.75	95.06
3	21	0.1107	-0.1173	441	0.01376	-2.46	-8.75	76.56
4	22	0.1516	-0.1644	484	0.02703	-3.62	-51.75	2678.06
5	23	0.1926	-0.2140	529	0.04580	-4.92	-6.75	45.56
6	25	0.2336	-0.2661	625	0.07078	-6.65	-4.75	22.56
7	25	0.2746	-0.3210	625	0.10306	-8.03	-4.75	22.56
8	28	0.3156	-0.3792	784	0.14380	-10.62	-1.75	3.06
9	28	0.3566	-0.4409	784	0.19439	-12.35	-1.75	3.06
10	29	0.3975	-0.5067	841	0.25671	-14.69	-0.75	0.56
11	30	0.4385	-0.5772	900	0.33316	-17.32	0.25	0.06
12	30	0.4795	-0.6530	900	0.42636	-19.59	0.25	0.06
13	30	0.5205	-0.7350	900	0.54024	-22.05	0.25	0.06
14	30	0.5615	-0.8243	900	0.67947	-24.73	0.25	0.06
15	30	0.6025	-0.9225	900	0.85101	-27.68	0.25	0.06
16	31	0.6434	-1.0313	961	1.06358	-31.97	1.25	1.56
17	31	0.6844	-1.1534	961	1.33033	-35.76	1.25	1.56
18	35	0.7254	-1.2925	1225	1.67056	-45.24	5.25	27.56
19	35	0.7664	-1.4541	1225	2.11441	-50.89	5.25	27.56
20	35	0.8074	-1.6470	1225	2.71261	-57.65	5.25	27.56
21	38	0.8484	-1.8863	1444	3.55813	-71.68	8.25	68.06
22	39	0.8893	-2.2013	1521	4.84572	-85.85	9.25	85.56
23	39	0.9303	-2.6640	1521	7.09690	-103.90	9.25	85.56
24	40	0.9713	-3.5513	1600	12.61173	-142.05	10.25	105.06
Total	714	12	-23.1041	22096	40.69561	-801.70266	0	3472.5
AVG	29.75	0.50	-0.96	920.67	1.70	-33.40	0.00	144.69

Index Of Fit

a. $S_{xy} = N \sum_{i=1}^N T_i Y_i - (\sum_{i=1}^N T_i)(\sum_{i=1}^N Y_i)$
 $= 24 (-801.70266) - (714)(-23.1041)$
 $= -2744.514$

b. $S_{xx} = \sum_{i=1}^N T_i^2 - (\sum_{i=1}^N T_i)^2$
 $= 24 (22096) - (714)^2$
 $= 20508$

c. $S_{yy} = \sum_{i=1}^N Y_i^2 - (\sum_{i=1}^N Y_i)^2$
 $= 24 (40.69561) - (-23.1041)^2$
 $= 442.8937$

d. $r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$
 $= \frac{-2744.514}{\sqrt{20508 \cdot 442.8937}}$
 $= -0.910655$

d. Distribusi Weibull

i	t _i	F(T _i)	T _i =LN(t _i)	Y _i =LN{-LN [1-F(t _i)]}	T _i ²	Y _i ²	T _i ·Y _i	T _i - \bar{T}_i	(T _i - \bar{T}_i) ²
1	20	0.0287	3.00	-3.5363	8.97	12.51	-10.59	-0.38	0.14
2	20	0.0697	3.00	-2.6276	8.97	6.90	-7.87	-0.38	0.14
3	21	0.1107	3.04	-2.1428	9.27	4.59	-6.52	-0.33	0.11
4	22	0.1516	3.09	-1.8054	9.55	3.26	-5.58	-0.28	0.08
5	23	0.1926	3.14	-1.5421	9.83	2.38	-4.84	-0.24	0.06
6	25	0.2336	3.22	-1.3241	10.36	1.75	-4.26	-0.15	0.02
7	25	0.2746	3.22	-1.1362	10.36	1.29	-3.66	-0.15	0.02
8	28	0.3156	3.33	-0.9697	11.10	0.94	-3.23	-0.04	0.00
9	28	0.3566	3.33	-0.8187	11.10	0.67	-2.73	-0.04	0.00
10	29	0.3975	3.37	-0.6799	11.34	0.46	-2.29	0.00	0.00
11	30	0.4385	3.40	-0.5497	11.57	0.30	-1.87	0.03	0.00
12	30	0.4795	3.40	-0.4262	11.57	0.18	-1.45	0.03	0.00
13	30	0.5205	3.40	-0.3079	11.57	0.09	-1.05	0.03	0.00
14	30	0.5615	3.40	-0.1931	11.57	0.04	-0.66	0.03	0.00
15	30	0.6025	3.40	-0.0806	11.57	0.01	-0.27	0.03	0.00
16	31	0.6434	3.43	0.0307	11.79	0.00	0.11	0.06	0.00
17	31	0.6844	3.43	0.1426	11.79	0.02	0.49	0.06	0.00
18	35	0.7254	3.56	0.2565	12.64	0.07	0.91	0.18	0.03
19	35	0.7664	3.56	0.3744	12.64	0.14	1.33	0.18	0.03
20	35	0.8074	3.56	0.4990	12.64	0.25	1.77	0.18	0.03
21	38	0.8484	3.64	0.6347	13.23	0.40	2.31	0.27	0.07
22	39	0.8893	3.66	0.7889	13.42	0.62	2.89	0.29	0.09
23	39	0.9303	3.66	0.9797	13.42	0.96	3.59	0.29	0.09
24	40	0.9713	3.69	1.2672	13.61	1.61	4.67	0.32	0.10
Total	714	12	80.9255746	-13.1666608	273.901973	39.4459459	-38.795673	0	1.03
AVG	29.75	0.48	3.37	-0.63	11.32	1.65	-1.89	0.00	0.04

Index Of Fit

$$\begin{aligned}
 \text{a. } S_{xy} &= N \sum_{i=1}^N T_i Y_i - (\sum_{i=1}^N T_i)(\sum_{i=1}^N Y_i) \\
 &= 24 (-38.795673) - \\
 &\quad (80.9255746)(-13.1666608) \\
 &= \mathbf{134.4234}
 \end{aligned}$$

$$\begin{aligned}
 \text{b. } S_{xx} &= \sum_{i=1}^N T_i^2 - (\sum_{i=1}^N T_i)^2 \\
 &= 24 (273.901973) - (80.9255746)^2 \\
 &= \mathbf{24.69872}
 \end{aligned}$$

$$\begin{aligned}
 \text{c. } S_{yy} &= \sum_{i=1}^N Y_i^2 - (\sum_{i=1}^N Y_i)^2 \\
 &= 24 (39.4459459) - (-13.1666608)^2 \\
 &= \mathbf{773.3417}
 \end{aligned}$$

$$\begin{aligned}
 \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\
 &= \frac{134.4234}{\sqrt{24.69872 \cdot 773.3417}} \\
 &= \mathbf{0.97264}
 \end{aligned}$$

2. NOZZLE

a. Distribusi Normal

i	Ti	F(Ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	15	0.0287	-1.9000	225	3.61	-28.50	-7.39	54.63
2	16	0.0697	-1.4800	256	2.19	-23.68	-6.39	40.85
3	16	0.1107	-1.2200	256	1.49	-19.52	-6.39	40.85
4	17	0.1517	-1.0300	289	1.06	-17.51	-5.39	29.07
5	17	0.1927	-0.8700	289	0.76	-14.79	-5.39	29.07
6	17	0.2337	-0.7300	289	0.53	-12.41	-39.39	1551.67
7	19	0.2746	-0.6000	361	0.36	-11.4	-3.39	11.50
8	19	0.3156	-0.4800	361	0.23	-9.12	-3.39	11.50
9	19	0.3566	-0.3600	361	0.13	-6.84	-3.39	11.50
10	20	0.3976	-0.2600	400	0.07	-5.2	-2.39	5.72
11	20	0.4386	-0.1600	400	0.03	-3.2	-2.39	5.72
12	20	0.4796	-0.0500	400	0.00	-1.00	-42.39	1797.02
13	20	0.5205	0.0500	400	0.00	1.00	-42.39	1797.02
14	21	0.5615	0.1600	441	0.03	3.36	-1.39	1.94
15	23	0.6025	0.2600	529	0.07	5.98	0.61	0.37
16	25	0.6435	0.3600	625	0.13	9	2.61	6.81
17	25	0.6845	0.4800	625	0.23	12	2.61	6.81
18	30	0.7255	0.6000	900	0.36	18	7.61	57.89
19	30	0.7664	0.7300	900	0.53	21.9	7.61	57.89
20	30	0.8074	0.8700	900	0.76	26.1	7.61	57.89
21	30	0.8484	1.0300	900	1.06	30.9	7.61	57.89
22	31	0.8894	1.2200	961	1.49	37.82	8.61	74.11
23	35	0.9304	1.4800	1225	2.19	51.8	12.61	158.98
Total	515	11.0298	0	12293	15.11	12.89	0	5707.72
AVG	22.39	0.5	0	534.48	0.69	0.59	0	259.44

Index Of Fit

$$\begin{aligned} \text{a. } X_y &= N \sum_{i=1}^N T_i Y_i - (\sum_{i=1}^N T_i)(\sum_{i=1}^N Y_i) \\ &= 24 (12,89) - (515)(0) \\ &= \mathbf{309,36} \end{aligned}$$

$$\begin{aligned} \text{b. } S_{xx} &= \sum_{i=1}^N T_i^2 - (\sum_{i=1}^N T_i)^2 \\ &= 24 (12293) - (515)^2 \\ &= \mathbf{29807} \end{aligned}$$

$$\begin{aligned} \text{c. } S_{yy} &= \sum_{i=1}^N Y_i^2 - (\sum_{i=1}^N Y_i)^2 \\ &= 24 (15,11) - (0)^2 \\ &= \mathbf{362,64} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{309,36}{\sqrt{29807 \cdot 362,64}} \\ &= \mathbf{0,094095} \end{aligned}$$

b. Distribusi Log Normal

i	ti	F(Ti)	Ti=LN(ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T} i	(Ti- \bar{T} i) ²
1	15	0.0287	2.7081	-1.90	7.33	3.61	-5.15	-0.37	0.14
2	16	0.0697	2.7726	-1.48	7.69	2.19	-4.10	-0.30	0.09
3	16	0.1107	2.7726	-1.22	7.69	1.49	-3.38	-0.30	0.09
4	17	0.1517	2.8332	-1.03	8.03	1.06	-2.92	-0.24	0.06
5	17	0.1927	2.8332	-0.87	8.03	0.76	-2.46	-0.24	0.06
6	17	0.2337	2.8332	-0.73	8.03	0.53	-2.07	-0.24	0.06
7	19	0.2746	2.9444	-0.60	8.67	0.36	-1.77	-0.13	0.02
8	19	0.3156	2.9444	-0.48	8.67	0.23	-1.41	-0.13	0.02
9	19	0.3566	2.9444	-0.36	8.67	0.13	-1.06	-0.13	0.02
10	20	0.3976	2.9957	-0.26	8.97	0.07	-0.78	-0.08	0.01
11	20	0.4386	2.9957	-0.16	8.97	0.03	-0.48	-0.08	0.01
12	20	0.4796	2.9957	-0.05	8.97	0.00	-0.15	-0.08	0.01
13	20	0.5205	2.9957	0.05	8.97	0.00	0.15	-0.08	0.01
14	21	0.5615	3.0445	0.16	9.27	0.03	0.49	-0.03	0.00
15	23	0.6025	3.1355	0.26	9.83	0.07	0.82	0.06	0.00
16	25	0.6435	3.2189	0.36	10.36	0.13	1.16	0.14	0.02
17	25	0.6845	3.2189	0.48	10.36	0.23	1.55	0.14	0.02
18	30	0.7255	3.4012	0.60	11.57	0.36	2.04	0.32	0.10
19	30	0.7664	3.4012	0.73	11.57	0.53	2.48	0.32	0.10
20	30	0.8074	3.4012	0.87	11.57	0.76	2.96	0.32	0.10
21	30	0.8484	3.4012	1.03	11.57	1.06	3.50	0.32	0.10
22	31	0.8894	3.4340	1.22	11.79	1.49	4.19	0.36	0.13
23	35	0.9304	3.5553	1.48	12.64	2.19	5.26	0.48	0.23
Total	515	11	70.7810	0	219.22	15.11	-6.40	0	1.17
AVG	22.39	0.48	3.08	0.00	9.53	0.69	-0.29	0.00	0.05

Index Of Fit

a. $S_{xy} = N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi)$
 $= 24 (-6,40) - (70,7810)(0)$
 $= \mathbf{-153,5831}$

b. $S_{xx} = \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2$
 $= 24 (219,22) - (70,7810)^2$
 $= \mathbf{251,4309}$

c. $S_{yy} = \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2$
 $= 24 (15,11) - (0)^2$
 $= \mathbf{362,64}$

d. $r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$
 $= \frac{-153,5831}{\sqrt{251,4309 \cdot 362,64}}$
 $= \mathbf{-0.508623}$

c. Distribusi Exponensial

i	Ti	F(Ti)	Yi=LN [1-F(Ti)]	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	15	0.0287	-0.0291	225	0.00085	-0.44	-7.39	54.63
2	16	0.0697	-0.0722	256	0.00522	-1.16	-6.39	40.85
3	16	0.1107	-0.1173	256	0.01376	-1.88	-6.39	40.85
4	17	0.1516	-0.1644	289	0.02703	-2.79	-39.39	1551.67
5	17	0.1926	-0.2140	289	0.04580	-3.64	-5.39	29.07
6	17	0.2336	-0.2661	289	0.07078	-4.52	-5.39	29.07
7	19	0.2746	-0.3210	361	0.10306	-6.10	-3.39	11.50
8	19	0.3156	-0.3792	361	0.14380	-7.21	-3.39	11.50
9	19	0.3566	-0.4409	361	0.19439	-8.38	-3.39	11.50
10	20	0.3975	-0.5067	400	0.25671	-10.13	-2.39	5.72
11	20	0.4385	-0.5772	400	0.33316	-11.54	-2.39	5.72
12	20	0.4795	-0.6530	400	0.42636	-13.06	-2.39	5.72
13	20	0.5205	-0.7350	400	0.54024	-14.70	-2.39	5.72
14	21	0.5615	-0.8243	441	0.67947	-17.31	-1.39	1.94
15	23	0.6025	-0.9225	529	0.85101	-21.22	0.61	0.37
16	25	0.6434	-1.0313	625	1.06358	-25.78	2.61	6.81
17	25	0.6844	-1.1534	625	1.33033	-28.84	2.61	6.81
18	30	0.7254	-1.2925	900	1.67056	-38.78	7.61	57.89
19	30	0.7664	-1.4541	900	2.11441	-43.62	7.61	57.89
20	30	0.8074	-1.6470	900	2.71261	-49.41	7.61	57.89
21	30	0.8484	-1.8863	900	3.55813	-56.59	7.61	57.89
22	31	0.8893	-2.2013	961	4.84572	-68.24	8.61	74.11
23	35	0.9303	-2.6640	1225	7.09690	-93.24	12.61	158.98
Total	515	10.0984	-16.8888	12293	20.98698	-435.3269	0	2125.10775
AVG	22.39	0.46	-0.77	534.48	0.95	-19.79	0.00	96.60

Index Of Fit

a. $S_{xy} = N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi)$
 $= 24 (-435,32686) - (515) (-16,8888)$
 $= -1750,096$

b. $S_{xx} = \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2$
 $= 24 (12293) - (515)^2$
 $= 29807$

c. $S_{yy} = \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2$
 $= 24 (20,98698) - (-16,8888)^2$
 $= 218,4549$

d. $r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$
 $= \frac{-1750,096}{\sqrt{29807 \cdot 218,4549}}$
 $= -0.685838$

d. Distribusi Weibul

i	ti	F(Ti)	Ti=LN(ti)	Yi=LN{-LN [1-F(ti)]}	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	15	0.0287	2.71	-3.5363	7.33	12.51	-9.58	-0.37	0.14
2	16	0.0697	2.77	-2.6276	7.69	6.90	-7.29	-0.30	0.09
3	16	0.1107	2.77	-2.1428	7.69	4.59	-5.94	-0.30	0.09
4	17	0.1516	2.83	-1.8054	8.03	3.26	-5.12	-0.24	0.06
5	17	0.1926	2.83	-1.5421	8.03	2.38	-4.37	-0.24	0.06
6	17	0.2336	2.83	-1.3241	8.03	1.75	-3.75	-0.24	0.06
7	19	0.2746	2.94	-1.1362	8.67	1.29	-3.35	-0.13	0.02
8	19	0.3156	2.94	-0.9697	8.67	0.94	-2.86	-0.13	0.02
9	19	0.3566	2.94	-0.8187	8.67	0.67	-2.41	-0.13	0.02
10	20	0.3975	3.00	-0.6799	8.97	0.46	-2.04	-0.08	0.01
11	20	0.4385	3.00	-0.5497	8.97	0.30	-1.65	-0.08	0.01
12	20	0.4795	3.00	-0.4262	8.97	0.18	-1.28	-0.08	0.01
13	20	0.5205	3.00	-0.3079	8.97	0.09	-0.92	-0.08	0.01
14	21	0.5615	3.04	-0.1931	9.27	0.04	-0.59	-0.03	0.00
15	23	0.6025	3.14	-0.0806	9.83	0.01	-0.25	0.06	0.00
16	25	0.6434	3.22	0.0307	10.36	0.00	0.10	0.14	0.02
17	25	0.6844	3.22	0.1426	10.36	0.02	0.46	0.14	0.02
18	30	0.7254	3.40	0.2565	11.57	0.07	0.87	0.32	0.10
19	30	0.7664	3.40	0.3744	11.57	0.14	1.27	0.32	0.10
20	30	0.8074	3.40	0.4990	11.57	0.25	1.70	0.32	0.10
21	30	0.8484	3.40	0.6347	11.57	0.40	2.16	0.32	0.10
22	31	0.8893	3.43	0.7889	11.79	0.62	2.71	0.36	0.13
23	35	0.9303	3.56	0.9797	12.64	0.96	3.48	0.48	0.23
Total	515	10.0984	70.781006	-15.4135118	219.224243	36.880440	-42.1044	0	1.17
AVG	22.39	0.46	3.08	-0.70	9.53	1.68	-1.91	0.00	0.05

Index Of Fit

$$\begin{aligned}
 \text{a. } S_{xy} &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\
 &= 24(-42,10444) - (15,413512)(70,781007) \\
 &= \mathbf{80,477414}
 \end{aligned}$$

$$\begin{aligned}
 \text{b. } S_{xx} &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\
 &= 24(219,22424) - (70,781007)^2 \\
 &= \mathbf{251,4309}
 \end{aligned}$$

$$\begin{aligned}
 \text{c. } S_{yy} &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\
 &= 24(36,88044) - (15,413512)^2 \\
 &= \mathbf{647,55422}
 \end{aligned}$$

$$\begin{aligned}
 \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\
 &= \frac{\mathbf{80,477414}}{\sqrt{\mathbf{251,4309} \cdot \mathbf{647,55422}}} \\
 &= \mathbf{0,1994466}
 \end{aligned}$$

3. RELLAY

a. Distribusi Normal

i	Ti	F(Ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T} i	(Ti- \bar{T} i) ²
1	21	0.0287	-1.9000	441	3.61	-39.90	-10.92	119.17
2	25	0.0697	-1.4800	625	2.19	-37	-6.92	47.84
3	25	0.1107	-1.2200	625	1.49	-30.5	-6.92	47.84
4	26	0.1517	-1.0300	676	1.06	-26.78	-5.92	35.01
5	27	0.1927	-0.8700	729	0.76	-23.49	-4.92	24.17
6	27	0.2337	-0.7300	729	0.53	-19.71	-58.92	3471.17
7	28	0.2746	-0.6000	784	0.36	-16.8	-3.92	15.34
8	29	0.3156	-0.4800	841	0.23	-13.92	-2.92	8.51
9	29	0.3566	-0.3600	841	0.13	-10.44	-2.92	8.51
10	29	0.3976	-0.2600	841	0.07	-7.54	-2.92	8.51
11	30	0.4386	-0.1600	900	0.03	-4.8	-1.92	3.67
12	30	0.4796	-0.0500	900	0.00	-1.50	-61.92	3833.67
13	31	0.5205	0.0500	961	0.00	1.55	-62.92	3958.51
14	34	0.5615	0.1600	1156	0.03	5.44	2.08	4.34
15	35	0.6025	0.2600	1225	0.07	9.1	3.08	9.51
16	36	0.6435	0.3600	1296	0.13	12.96	4.08	16.67
17	36	0.6845	0.4800	1296	0.23	17.28	4.08	16.67
18	37	0.7255	0.6000	1369	0.36	22.2	5.08	25.84
19	37	0.7664	0.7300	1369	0.53	27.01	5.08	25.84
20	38	0.8074	0.8700	1444	0.76	33.06	6.08	37.01
21	38	0.8484	1.0300	1444	1.06	39.14	6.08	37.01
22	38	0.8894	1.2200	1444	1.49	46.36	6.08	37.01
23	40	0.9304	1.4800	1600	2.19	59.20	8.08	65.34
24	40	0.9714	1.9000	1600	3.61	76.00	8.08	65.34
Total	766	12.0012	0	25136	20.9104	116.92	0	11922.50
AVG	31.92	0.5	0	1047.33	0.87	4.87	0	496.77

Index Of Fit

$$\begin{aligned} \text{a. } Xy &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\ &= 24 (116,92) - (766)(0) \\ &= \mathbf{2806,08} \end{aligned}$$

$$\begin{aligned} \text{b. } Sxx &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\ &= 24 (25136) - (766)^2 \\ &= \mathbf{16508} \end{aligned}$$

$$\begin{aligned} \text{c. } Syy &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\ &= 24 (20,914) - (0)^2 \\ &= \mathbf{501,8496} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{Sxy}{\sqrt{Sxx \cdot Syy}} \\ &= \frac{2806,08}{\sqrt{16508 \cdot 501,8496}} \\ &= \mathbf{0.974913} \end{aligned}$$

b. Distribusi Log Normal

i	ti	F(Ti)	Ti=LN(ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	21	0.0287	3.0445	-1.90	9.27	3.61	-5.78	-0.40	0.16
2	25	0.0697	3.2189	-1.48	10.36	2.19	-4.76	-0.23	0.05
3	25	0.1107	3.2189	-1.22	10.36	1.49	-3.93	-0.23	0.05
4	26	0.1517	3.2581	-1.03	10.62	1.06	-3.36	-0.19	0.04
5	27	0.1927	3.2958	-0.87	10.86	0.76	-2.87	-0.15	0.02
6	27	0.2337	3.2958	-0.73	10.86	0.53	-2.41	-0.15	0.02
7	28	0.2746	3.3322	-0.60	11.10	0.36	-2.00	-0.12	0.01
8	29	0.3156	3.3673	-0.48	11.34	0.23	-1.62	-0.08	0.01
9	29	0.3566	3.3673	-0.36	11.34	0.13	-1.21	-0.08	0.01
10	29	0.3976	3.3673	-0.26	11.34	0.07	-0.88	-0.08	0.01
11	30	0.4386	3.4012	-0.16	11.57	0.03	-0.54	-0.05	0.00
12	30	0.4796	3.4012	-0.05	11.57	0.00	-0.17	-0.05	0.00
13	31	0.5205	3.4340	0.05	11.79	0.00	0.17	-0.01	0.00
14	34	0.5615	3.5264	0.16	12.44	0.03	0.56	0.08	0.01
15	35	0.6025	3.5553	0.26	12.64	0.07	0.92	0.11	0.01
16	36	0.6435	3.5835	0.36	12.84	0.13	1.29	0.14	0.02
17	36	0.6845	3.5835	0.48	12.84	0.23	1.72	0.14	0.02
18	37	0.7255	3.6109	0.60	13.04	0.36	2.17	0.16	0.03
19	37	0.7664	3.6109	0.73	13.04	0.53	2.64	0.16	0.03
20	38	0.8074	3.6376	0.87	13.23	0.76	3.16	0.19	0.04
21	38	0.8484	3.6376	1.03	13.23	1.06	3.75	0.19	0.04
22	38	0.8894	3.6376	1.22	13.23	1.49	4.44	0.19	0.04
23	40	0.9304	3.6889	1.48	13.61	2.19	5.46	0.24	0.06
24	40	0.9714	3.6889	1.90	13.61	3.61	7.01	0.24	0.06
Total	726	12	82.7636	0	286.13	20.91	3.77	0	0.72
AVG	31.57	0.50	3.45	0.00	11.92	0.87	0.16	0.00	0.03

Index Of Fit

a. $S_{xy} = N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi)$
 $= 24 (3,77) - (82,7636)(0)$
 $= \mathbf{90,43993}$

b. $S_{xx} = \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2$
 $= 24 (286,13) - (82,7636)^2$
 $= \mathbf{17,25681}$

c. $S_{yy} = \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2$
 $= 24 (20,91) - (0)^2$
 $= \mathbf{501,8496}$

d. $r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$
 $= \frac{90,43993}{\sqrt{17,25681 \cdot 501,8496}}$
 $= \mathbf{0,971836}$

c. Distribusi Exponensial

i	Ti	F(Ti)	Yi=LN [1-F(Ti)]	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	21	0.0287	-0.0291	441	0.00085	-0.61	-10.92	119.17
2	25	0.0697	-0.0722	625	0.00522	-1.81	-6.92	47.84
3	25	0.1107	-0.1173	625	0.01376	-2.93	-6.92	47.84
4	26	0.1516	-0.1644	676	0.02703	-4.27	-57.92	3354.34
5	27	0.1926	-0.2140	729	0.04580	-5.78	-4.92	24.17
6	27	0.2336	-0.2661	729	0.07078	-7.18	-4.92	24.17
7	28	0.2746	-0.3210	784	0.10306	-8.99	-3.92	15.34
8	29	0.3156	-0.3792	841	0.14380	-11.00	-2.92	8.51
9	29	0.3566	-0.4409	841	0.19439	-12.79	-2.92	8.51
10	29	0.3975	-0.5067	841	0.25671	-14.69	-2.92	8.51
11	30	0.4385	-0.5772	900	0.33316	-17.32	-1.92	3.67
12	30	0.4795	-0.6530	900	0.42636	-19.59	-1.92	3.67
13	31	0.5205	-0.7350	961	0.54024	-22.79	-0.92	0.84
14	34	0.5615	-0.8243	1156	0.67947	-28.03	2.08	4.34
15	35	0.6025	-0.9225	1225	0.85101	-32.29	3.08	9.51
16	36	0.6434	-1.0313	1296	1.06358	-37.13	4.08	16.67
17	36	0.6844	-1.1534	1296	1.33033	-41.52	4.08	16.67
18	37	0.7254	-1.2925	1369	1.67056	-47.82	5.08	25.84
19	37	0.7664	-1.4541	1369	2.11441	-53.80	5.08	25.84
20	38	0.8074	-1.6470	1444	2.71261	-62.59	6.08	37.01
21	38	0.8484	-1.8863	1444	3.55813	-71.68	6.08	37.01
22	38	0.8893	-2.2013	1444	4.84572	-83.65	6.08	37.01
23	40	0.9303	-2.6640	1600	7.09690	-106.56	8.08	65.34
24	40	0.9713	-3.5513	1600	12.61173	-142.05	8.08	65.34
Total	766	12	-23.1041	25136	40.69561	-836.8563	0	4007.167
AVG	31.92	0.50	-0.96	1047.33	1.70	-34.87	0.00	166.97

Index Of Fit

$$\begin{aligned} \text{a. } S_{xy} &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\ &= 24 (-836,85634) - (766) (-23,1041) \\ &= \mathbf{-2386,787} \end{aligned}$$

$$\begin{aligned} \text{b. } S_{xx} &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\ &= 24 (25136) - (766)^2 \\ &= \mathbf{16508} \end{aligned}$$

$$\begin{aligned} \text{c. } S_{yy} &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\ &= 24 (40,69561) - (-23,1041)^2 \\ &= \mathbf{442,8937} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{-2386,787}{\sqrt{16508 \cdot 442,8937}} \\ &= \mathbf{-0.882707} \end{aligned}$$

d. Distribusi Weibull

i	ti	F(Ti)	Ti=LN(ti)	Yi=LN{-LN [1-F(ti)]}	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T}_i	(Ti- \bar{T}_i) ²
1	21	0.0287	3.04	-3.5363	9.27	12.51	-10.77	-0.40	0.16
2	25	0.0697	3.22	-2.6276	10.36	6.90	-8.46	-0.23	0.05
3	25	0.1107	3.22	-2.1428	10.36	4.59	-6.90	-0.23	0.05
4	26	0.1516	3.26	-1.8054	10.62	3.26	-5.88	-0.19	0.04
5	27	0.1926	3.30	-1.5421	10.86	2.38	-5.08	-0.15	0.02
6	27	0.2336	3.30	-1.3241	10.86	1.75	-4.36	-0.15	0.02
7	28	0.2746	3.33	-1.1362	11.10	1.29	-3.79	-0.12	0.01
8	29	0.3156	3.37	-0.9697	11.34	0.94	-3.27	-0.08	0.01
9	29	0.3566	3.37	-0.8187	11.34	0.67	-2.76	-0.08	0.01
10	29	0.3975	3.37	-0.6799	11.34	0.46	-2.29	-0.08	0.01
11	30	0.4385	3.40	-0.5497	11.57	0.30	-1.87	-0.05	0.00
12	30	0.4795	3.40	-0.4262	11.57	0.18	-1.45	-0.05	0.00
13	31	0.5205	3.43	-0.3079	11.79	0.09	-1.06	-0.01	0.00
14	34	0.5615	3.53	-0.1931	12.44	0.04	-0.68	0.08	0.01
15	35	0.6025	3.56	-0.0806	12.64	0.01	-0.29	0.11	0.01
16	36	0.6434	3.58	0.0307	12.84	0.00	0.11	0.14	0.02
17	36	0.6844	3.58	0.1426	12.84	0.02	0.51	0.14	0.02
18	37	0.7254	3.61	0.2565	13.04	0.07	0.93	0.16	0.03
19	37	0.7664	3.61	0.3744	13.04	0.14	1.35	0.16	0.03
20	38	0.8074	3.64	0.4990	13.23	0.25	1.82	0.19	0.04
21	38	0.8484	3.64	0.6347	13.23	0.40	2.31	0.19	0.04
22	38	0.8893	3.64	0.7889	13.23	0.62	2.87	0.19	0.04
23	40	0.9303	3.69	0.9797	13.61	0.96	3.61	0.24	0.06
24	40	0.9713	3.69	1.2672	13.61	1.61	4.67	0.24	0.06
Total	766	12	82.763618	-13.1666608	286.128053	39.4459459	-40.71082261	0	0.72
AVG	31.92	0.48	3.45	-0.63	11.85	1.65	-1.97	0.00	0.03

Index Of Fit

$$\begin{aligned} \text{a. } S_{xy} &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\ &= 24(-66.854483) - (129.7993)(14.43385) \\ &= \mathbf{112,66074} \end{aligned}$$

$$\begin{aligned} \text{b. } S_{xx} &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\ &= 24(707.067695) - (129.7993)^2 \\ &= \mathbf{17,256818} \end{aligned}$$

$$\begin{aligned} \text{c. } S_{yy} &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\ &= 24(37.8401771) - (14.43385)^2 \\ &= \mathbf{773,34174} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{112,66074}{\sqrt{17,256818 \cdot 773,34174}} \\ &= \mathbf{0.921505} \end{aligned}$$

4. LIMIT SWITCH

a. Distribusi Normal

i	Ti	F(Ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T} i	(Ti- \bar{T} i) ²
1	25	0.0287	-1.9000	625	3.61	-47.50	-8.25	68.06
2	25	0.0697	-1.4800	625	2.19	-37	-8.25	68.06
3	26	0.1107	-1.2200	676	1.49	-31.72	-7.25	52.56
4	26	0.1517	-1.0300	676	1.06	-26.78	-7.25	52.56
5	28	0.1927	-0.8700	784	0.76	-24.36	-5.25	27.56
6	29	0.2337	-0.7300	841	0.53	-21.17	-62.25	3875.06
7	29	0.2746	-0.6000	841	0.36	-17.4	-4.25	18.06
8	30	0.3156	-0.4800	900	0.23	-14.40	-3.25	10.56
9	30	0.3566	-0.3600	900	0.13	-10.8	-3.25	10.56
10	31	0.3976	-0.2600	961	0.07	-8.06	-2.25	5.06
11	31	0.4386	-0.1600	961	0.03	-4.96	-2.25	5.06
12	32	0.4796	-0.0500	1024	0.00	-1.60	-65.25	4257.56
13	32	0.5205	0.0500	1024	0.00	1.60	-65.25	4257.56
14	33	0.5615	0.1600	1089	0.03	5.28	-0.25	0.06
15	34	0.6025	0.2600	1156	0.07	8.84	0.75	0.56
16	35	0.6435	0.3600	1225	0.13	12.6	1.75	3.06
17	37	0.6845	0.4800	1369	0.23	17.76	3.75	14.06
18	38	0.7255	0.6000	1444	0.36	22.8	4.75	22.56
19	38	0.7664	0.7300	1444	0.53	27.74	4.75	22.56
20	39	0.8074	0.8700	1521	0.76	33.93	5.75	33.06
21	39	0.8484	1.0300	1521	1.06	40.17	5.75	33.06
22	43	0.8894	1.2200	1849	1.49	52.46	9.75	95.06
23	43	0.9304	1.4800	1849	2.19	63.64	9.75	95.06
24	45	0.9714	1.9000	2025	3.61	85.50	11.75	138.06
Total	798	12.0012	0	27330	20.9104	126.57	0	13165.50
AVG	33.25	0.5	0	1138.75	0.87	5.27	0	548.56

Index Of Fit

$$\begin{aligned} \text{a. } Xy &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\ &= 24 (126,57) - (798)(0) \\ &= \mathbf{3037,68} \end{aligned}$$

$$\begin{aligned} \text{b. } Sxx &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\ &= 24 (27330) - (798)^2 \\ &= \mathbf{19116} \end{aligned}$$

$$\begin{aligned} \text{c. } Syy &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\ &= 24 (20,9104) - (0)^2 \\ &= \mathbf{501,8496} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{Sxy}{\sqrt{Sxx \cdot Syy}} \\ &= \frac{3037,68}{\sqrt{19116 \cdot 501,8496}} \\ &= \mathbf{0.980746} \end{aligned}$$

b. Distribusi Log Normal

i	ti	F(Ti)	Ti=LN(ti)	Yi	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T} i	(Ti- \bar{T} i) ²
1	25	0.0287	3.2189	-1.90	10.36	3.61	-6.12	-0.27	0.07
2	25	0.0697	3.2189	-1.48	10.36	2.19	-4.76	-0.27	0.07
3	26	0.1107	3.2581	-1.22	10.62	1.49	-3.97	-0.23	0.05
4	26	0.1517	3.2581	-1.03	10.62	1.06	-3.36	-0.23	0.05
5	28	0.1927	3.3322	-0.87	11.10	0.76	-2.90	-0.16	0.02
6	29	0.2337	3.3673	-0.73	11.34	0.53	-2.46	-0.12	0.01
7	29	0.2746	3.3673	-0.60	11.34	0.36	-2.02	-0.12	0.01
8	30	0.3156	3.4012	-0.48	11.57	0.23	-1.63	-0.09	0.01
9	30	0.3566	3.4012	-0.36	11.57	0.13	-1.22	-0.09	0.01
10	31	0.3976	3.4340	-0.26	11.79	0.07	-0.89	-0.06	0.00
11	31	0.4386	3.4340	-0.16	11.79	0.03	-0.55	-0.06	0.00
12	32	0.4796	3.4657	-0.05	12.01	0.00	-0.17	-0.02	0.00
13	32	0.5205	3.4657	0.05	12.01	0.00	0.17	-0.02	0.00
14	33	0.5615	3.4965	0.16	12.23	0.03	0.56	0.01	0.00
15	34	0.6025	3.5264	0.26	12.44	0.07	0.92	0.04	0.00
16	35	0.6435	3.5553	0.36	12.64	0.13	1.28	0.07	0.00
17	37	0.6845	3.6109	0.48	13.04	0.23	1.73	0.12	0.01
18	38	0.7255	3.6376	0.60	13.23	0.36	2.18	0.15	0.02
19	38	0.7664	3.6376	0.73	13.23	0.53	2.66	0.15	0.02
20	39	0.8074	3.6636	0.87	13.42	0.76	3.19	0.17	0.03
21	39	0.8484	3.6636	1.03	13.42	1.06	3.77	0.17	0.03
22	43	0.8894	3.7612	1.22	14.15	1.49	4.59	0.27	0.07
23	43	0.9304	3.7612	1.48	14.15	2.19	5.57	0.27	0.07
24	45	0.9714	3.8067	1.90	14.49	3.61	7.23	0.32	0.10
Total	753	12	83.7431	0	292.91	20.91	3.79	0	0.7042
AVG	32.74	0.50	3.49	0.00	12.20	0.87	0.16	0.00	0.03

Index Of Fit

$$\begin{aligned} \text{a. } S_{xy} &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\ &= 24(3,79) - (83,7431)(0) \\ &= \mathbf{90,93114} \end{aligned}$$

$$\begin{aligned} \text{b. } S_{xx} &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\ &= 24(292,91) - (83,7431)^2 \\ &= \mathbf{16,9017} \end{aligned}$$

$$\begin{aligned} \text{c. } S_{yy} &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\ &= 24(20,91) - (0)^2 \\ &= \mathbf{501,8496} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{90,93114}{\sqrt{16,9017 \cdot 501,8496}} \\ &= \mathbf{-0.987324} \end{aligned}$$

c. Distribusi Exponensial

i	Ti	F(Ti)	Yi=LN [1-F(Ti)]	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T} i	(Ti- \bar{T} i) ²
1	25	0.0287	-0.0291	625	0.00085	-0.73	-8.25	68.06
2	25	0.0697	-0.0722	625	0.00522	-1.81	-8.25	68.06
3	26	0.1107	-0.1173	676	0.01376	-3.05	-7.25	52.56
4	26	0.1516	-0.1644	676	0.02703	-4.27	-59.25	3510.56
5	28	0.1926	-0.2140	784	0.04580	-5.99	-5.25	27.56
6	29	0.2336	-0.2661	841	0.07078	-7.72	-4.25	18.06
7	29	0.2746	-0.3210	841	0.10306	-9.31	-4.25	18.06
8	30	0.3156	-0.3792	900	0.14380	-11.38	-3.25	10.56
9	30	0.3566	-0.4409	900	0.19439	-13.23	-3.25	10.56
10	31	0.3975	-0.5067	961	0.25671	-15.71	-2.25	5.06
11	31	0.4385	-0.5772	961	0.33316	-17.89	-2.25	5.06
12	32	0.4795	-0.6530	1024	0.42636	-20.89	-1.25	1.56
13	32	0.5205	-0.7350	1024	0.54024	-23.52	-1.25	1.56
14	33	0.5615	-0.8243	1089	0.67947	-27.20	-0.25	0.06
15	34	0.6025	-0.9225	1156	0.85101	-31.37	0.75	0.56
16	35	0.6434	-1.0313	1225	1.06358	-36.10	1.75	3.06
17	37	0.6844	-1.1534	1369	1.33033	-42.68	3.75	14.06
18	38	0.7254	-1.2925	1444	1.67056	-49.12	4.75	22.56
19	38	0.7664	-1.4541	1444	2.11441	-55.26	4.75	22.56
20	39	0.8074	-1.6470	1521	2.71261	-64.23	5.75	33.06
21	39	0.8484	-1.8863	1521	3.55813	-73.57	5.75	33.06
22	43	0.8893	-2.2013	1849	4.84572	-94.66	9.75	95.06
23	43	0.9303	-2.6640	1849	7.09690	-114.55	9.75	95.06
24	45	0.9713	-3.5513	2025	12.61173	-159.81	11.75	138.06
Total	798	12	-23.1041	27330	40.69561	-884.019	0	4254.5
AVG	33.25	0.50	-0.96	1138.75	1.70	-36.83	0.00	177.27

Index Of Fit

$$\begin{aligned} \text{a. } S_{xy} &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\ &= 24 (-884,01906) - (798)(-23,1041) \\ &= \mathbf{-2779,36} \end{aligned}$$

$$\begin{aligned} \text{b. } S_{xx} &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\ &= 24 (27330) - (798)^2 \\ &= \mathbf{19116} \end{aligned}$$

$$\begin{aligned} \text{c. } S_{yy} &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\ &= 24 (40,69561) - (-23,1041)^2 \\ &= \mathbf{442,8937} \end{aligned}$$

$$\begin{aligned} \text{d. } r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{-2779,36}{\sqrt{19116 \cdot 441,8937}} \\ &= \mathbf{-0,955205} \end{aligned}$$

d. Distribusi Weibull

i	ti	F(Ti)	Ti=LN(ti)	Yi=LN{-LN [1-F(ti)]}	Ti ²	Yi ²	Ti.Yi	Ti- \bar{T} i	(Ti- \bar{T} i) ²
1	25	0.0287	3.22	-3.5363	10.36	12.51	-11.38	-0.27	0.07
2	25	0.0697	3.22	-2.6276	10.36	6.90	-8.46	-0.27	0.07
3	26	0.1107	3.26	-2.1428	10.62	4.59	-6.98	-0.23	0.05
4	26	0.1516	3.26	-1.8054	10.62	3.26	-5.88	-0.23	0.05
5	28	0.1926	3.33	-1.5421	11.10	2.38	-5.14	-0.16	0.02
6	29	0.2336	3.37	-1.3241	11.34	1.75	-4.46	-0.12	0.01
7	29	0.2746	3.37	-1.1362	11.34	1.29	-3.83	-0.12	0.01
8	30	0.3156	3.40	-0.9697	11.57	0.94	-3.30	-0.09	0.01
9	30	0.3566	3.40	-0.8187	11.57	0.67	-2.78	-0.09	0.01
10	31	0.3975	3.43	-0.6799	11.79	0.46	-2.33	-0.06	0.00
11	31	0.4385	3.43	-0.5497	11.79	0.30	-1.89	-0.06	0.00
12	32	0.4795	3.47	-0.4262	12.01	0.18	-1.48	-0.02	0.00
13	32	0.5205	3.47	-0.3079	12.01	0.09	-1.07	-0.02	0.00
14	33	0.5615	3.50	-0.1931	12.23	0.04	-0.68	0.01	0.00
15	34	0.6025	3.53	-0.0806	12.44	0.01	-0.28	0.04	0.00
16	35	0.6434	3.56	0.0307	12.64	0.00	0.11	0.07	0.00
17	37	0.6844	3.61	0.1426	13.04	0.02	0.51	0.12	0.01
18	38	0.7254	3.64	0.2565	13.23	0.07	0.93	0.15	0.02
19	38	0.7664	3.64	0.3744	13.23	0.14	1.36	0.15	0.02
20	39	0.8074	3.66	0.4990	13.42	0.25	1.83	0.17	0.03
21	39	0.8484	3.66	0.6347	13.42	0.40	2.33	0.17	0.03
22	43	0.8893	3.76	0.7889	14.15	0.62	2.97	0.27	0.07
23	43	0.9303	3.76	0.9797	14.15	0.96	3.68	0.27	0.07
24	45	0.9713	3.81	1.2672	14.49	1.61	4.82	0.32	0.10
Total	798	12	83.7430743	-13.1666608	292.91	39.446	-41.39	0	0.70
AVG	33.25	0.48	3.49	-0.63	12.11	1.65	-2.01	0.00	0.03

Index Of Fit

$$\begin{aligned} \text{a. } S_{xy} &= N \sum_{i=1}^N TiYi - (\sum_{i=1}^N Ti)(\sum_{i=1}^N Yi) \\ &= 24(-41,38825) - (83,743074)(-13,166661) \\ &= \mathbf{109,29876} \end{aligned}$$

$$\begin{aligned} \text{b. } S_{xx} &= \sum_{i=1}^N Ti^2 - (\sum_{i=1}^N Ti)^2 \\ &= 24(291,90851) - (83,743074)^2 \\ &= \mathbf{16,901762} \end{aligned}$$

$$\begin{aligned} \text{c. } S_{yy} &= \sum_{i=1}^N Yi^2 - (\sum_{i=1}^N Yi)^2 \\ &= 24(39,445946) - (-13,166661)^2 \\ &= \mathbf{773,34174} \end{aligned}$$

$$\begin{aligned} \text{d. } R &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{109,29876}{\sqrt{16,901762 \cdot 773,34174}} \\ &= \mathbf{0.921505} \end{aligned}$$

Lampiran 6

1. Perhitungan Parameter dan MTTF Komponen

a. MOTOR AXIS (Distribusi Lognorma)

Diketahui :

$$\sum T_i = 129,7993$$

$$N = 24$$

$$\sum (T_i - \bar{T}_i)^2 = 5,0734$$

$$\bar{T}_i = \frac{\sum T_i}{N} = \frac{129,7993}{24} = 5,4083$$

Maka :

$$\mu = \bar{T}_i = \frac{\sum_{i=1}^N T_i}{N} = \frac{83,741}{24} = 5,4083$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^N (T_i - \bar{T}_i)^2}{N-1}} = \sqrt{\frac{5,0734}{24-1}} = 0,469$$

$$\begin{aligned} \text{MTTF} &= e^{\mu + \frac{1}{2}(\sigma)^2} \\ &= e^{5,4083 + \frac{1}{2}(0,469)^2} \\ &= \mathbf{249,20 \text{ Jam}} \end{aligned}$$

b. NOZZLE (Distribusi Normal)

Diketahui :

$$N = 24$$

$$\sum TiYi = 808.14$$

$$\sum Ti = 5991$$

$$\sum Yi = 0$$

$$\sum Ti^2 = 1798109$$

Maka :

$$\begin{aligned} b &= \frac{\sum_{i=1}^N TiYi - \frac{\sum_{i=1}^N Ti \sum_{i=1}^N Yi}{N}}{\sum_{i=1}^N Ti^2 - \frac{(\sum_{i=1}^N Ti)^2}{N}} \\ &= \frac{808.14 - \frac{(5991)(0)}{23}}{1798109 - \frac{5991^2}{23}} \\ &= 0.0034 \end{aligned}$$

$$\begin{aligned} a &= \frac{\sum_{i=1}^N Yi}{N} - b \frac{\sum_{i=1}^N Ti}{N} \\ &= \frac{0}{23} - (0.0034) \left(\frac{5991}{23} \right) \\ &= -0.8860 \end{aligned}$$

$$\sigma = \frac{1}{b} = \frac{1}{0.0034} = 293.9$$

$$\mu = -a \cdot \sigma = 0.8860 \times 293.9 = 260.3 \text{ Jam}$$

$$\text{MTTF} = \mu = \mathbf{260.3 \text{ Jam}}$$

c. RELLAY (Distribusi Lognormal)

Diketahui :

$$N = 24$$

$$\sum Ti - \bar{T}^2 = 5.0287$$

$$\sum Ti = 129.7702$$

Maka :

$$\mu = \bar{T} = \frac{\sum_{i=1}^N Ti}{N} = \frac{129.7702}{24} = 5.40$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^N (Ti - \bar{T})^2}{N-1}} = \sqrt{\frac{5.0287}{24-1}} = 0.4675$$

$$\begin{aligned} \text{MTTF} &= e^{\mu + \frac{1}{2}(\sigma)^2} \\ &= e^{5.40 + \frac{1}{2}(0.4675)^2} \\ &= \mathbf{246.972 \text{ Jam}} \end{aligned}$$

d. **LIMIT SWITCH (Distribusi Normal)**

Diketahui :

$$\begin{aligned}N &= 24 \\ \sum TiYi &= 1730.91 \\ \sum Ti &= 5357 \\ \sum Yi &= 0 \\ \sum Ti^2 &= 1345217\end{aligned}$$

Maka :

$$\begin{aligned}b &= \frac{\sum_{i=1}^N TiYi - \frac{\sum_{i=1}^N Ti \sum_{i=1}^N Yi}{N}}{\sum_{i=1}^N Ti^2 - \frac{(\sum_{i=1}^N Ti)^2}{N}} \\ &= \frac{1730.91 - \frac{(5357)(0)}{24}}{1345217 - \frac{5357^2}{24}} \\ &= 0.0115\end{aligned}$$

$$\begin{aligned}a &= \frac{\sum_{i=1}^N Yi}{N} - b \frac{\sum_{i=1}^N Ti}{N} \\ &= \frac{0}{24} - (0.0115) \left(\frac{5357}{24} \right) \\ &= -2.58\end{aligned}$$

$$\sigma = \frac{1}{b} = \frac{1}{0.0115} = 86.956$$

$$\mu = - a . \sigma = 2.58 \times 86.956 = 224.3 \text{ Jam}$$

$$\mathbf{MTTF = \mu = 224.3 \text{ Jam}}$$

2. Perhitungan Parameter dan Nilai MTTR

a. MOTOR AXIS (Distribusi Normal)

Diketahui :

$$\begin{aligned} N &= 24 \\ \sum TiYi &= 131.08 \\ \sum Ti &= 714 \\ \sum Yi &= 0 \\ \sum Ti^2 &= 22096 \end{aligned}$$

Maka :

$$\begin{aligned} b &= \frac{\sum_{i=1}^N TiYi - \frac{\sum_{i=1}^N Ti \sum_{i=1}^N Yi}{N}}{\sum_{i=1}^N Ti^2 - \frac{(\sum_{i=1}^N Ti)^2}{N}} \\ &= \frac{131.08 - \frac{(714)(0)}{24}}{22096 - \frac{714^2}{24}} \\ &= 0.1534 \end{aligned}$$

$$\begin{aligned} a &= \frac{\sum_{i=1}^N Yi}{N} - b \frac{\sum_{i=1}^N Ti}{N} \\ &= \frac{0}{24} - (0.1534) \left(\frac{714}{24} \right) \\ &= -4,56 \end{aligned}$$

$$\sigma = \frac{1}{b} = \frac{1}{0.1534} = 6,51$$

$$\mu = -a \cdot \sigma = 4,56 \times 6,51 = 29,67$$

$$\text{MTTR} = \mu = 29,67 \text{ menit}$$

b. NOZZLE (Distribusi Weibull)

Diketahui :

$$\begin{aligned}N &= 23 \\ \sum TiYi &= -42.104436 \\ \sum Ti &= 70.7810068 \\ \sum Yi &= -15.4135118 \\ \sum Ti^2 &= 219.224243\end{aligned}$$

Maka :

$$\begin{aligned}b &= \frac{\sum_{i=1}^N TiYi - \frac{\sum_{i=1}^N Ti \sum_{i=1}^N Yi}{N}}{\sum_{i=1}^N Ti^2 - \frac{(\sum_{i=1}^N Ti)^2}{N}} \\ &= \frac{-42.104436 - \frac{(70.7810068)(-15.4135118)}{23}}{219.224243 - \frac{70.7810068^2}{23}} \\ &= 3.806\end{aligned}$$

$$\begin{aligned}a &= \frac{\sum_{i=1}^N Yi}{N} - b \frac{\sum_{i=1}^N Ti}{N} \\ &= \frac{-15.4135118}{23} - (3.806) \left(\frac{70.7810068}{23} \right) \\ &= -12,3832\end{aligned}$$

Parameter bentuk (β) = $b = 3.806$

Parameter skala (θ) = $\eta = e^{-\frac{a}{b}} = e^{-\frac{(-12.3832)}{3.806}} = 25.883$

$$\begin{aligned}\mathbf{MTTR} &= \eta \Gamma \left(\frac{1}{\beta} + 1 \right) \\ &= 25.883 \Gamma \left(\frac{1}{3.806} + 1 \right) \\ &= 25.883 \Gamma (1,26) \\ &= 25.883 (0.90440) \\ &= \mathbf{23.4 \text{ menit}}\end{aligned}$$

c. RELAY (Distribusi Weibull)

$$\begin{aligned}N &= 24 \\ \sum TiYi &= -40.710822 \\ \sum Ti &= 82.763618 \\ \sum Yi &= -13.1666608 \\ \sum Ti^2 &= 286.128053\end{aligned}$$

Maka :

$$\begin{aligned}b &= \frac{\sum_{i=1}^N TiYi - \frac{\sum_{i=1}^N Ti \sum_{i=1}^N Yi}{N}}{\sum_{i=1}^N Ti^2 - \frac{(\sum_{i=1}^N Ti)^2}{N}} \\ &= \frac{-40.710822 - \frac{(82.763618)(-13.1666608)}{24}}{286.128053 - \frac{82.763618^2}{24}} \\ &= 6.528 \\ \alpha &= \frac{\sum_{i=1}^N Yi}{N} - b \frac{\sum_{i=1}^N Ti}{N} \\ &= \frac{-13.1666608}{24} - (6.528) \left(\frac{82.763618}{24} \right) \\ &= -23.062\end{aligned}$$

Parameter bentuk (β) = b = 6.528

Parameter skala (θ) = $\eta = e^{-\frac{\alpha}{b}} = e - \frac{(-23.062)}{6.528} = 34.219$

$$\begin{aligned}\text{MTTR} &= \eta \Gamma \left(\frac{1}{\beta} + 1 \right) \\ &= 34.219 \Gamma \left(\frac{1}{6.528} + 1 \right) \\ &= 34.219 \Gamma (1,15) \\ &= 25.883 (0.93304) \\ &= \mathbf{24.1 \text{ menit}}\end{aligned}$$

d. **LIMIT SWITCH (Distribusi Lognormal)**

Diketahui :

$$\sum Ti = 83.7431$$

$$N = 24$$

$$\sum(Ti - \bar{T}_i)^2 = 0.7042$$

$$\bar{T}_i = \frac{\sum Ti}{N} = \frac{83.7431}{24} = 3.4892$$

Maka :

$$\mu = \bar{T}_i = \frac{\sum_{i=1}^N Ti}{N} = \frac{83.741}{24} = 3.4892$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^N (Ti - \bar{T}_i)^2}{N-1}} = \sqrt{\frac{0.7042}{24-1}} = 0.174$$

$$\begin{aligned} \mathbf{MTTR} &= e^{\mu + \frac{1}{2}(\sigma)^2} \\ &= e^{3.4892 + \frac{1}{2}(0.174)^2} \\ &= \mathbf{33.25 \text{ Menit}} \end{aligned}$$