



REFERENCES

- Allan, C. Simulation of Manufacturing Systems. New York: John Wiley & Sons, 1988.
- Apple, J.M. Material Handling Systems Design. New York: Ronald Press, 1972.
- Apple, J.M. Plant Layout and Material Handling. 2nd ed. New York: Ronald Press, 1963.
- Chase and Aquilano, Production and Operations Management. 7th ed. New York: Irwin/McGraw-Hill, 1995.
- Dilworth, J.B. Production and Operations Management. 5th ed. New York: Irwin/McGraw-Hill, 1993.
- Gallagher C.C., and Knight, W.A. Group Technology Production method in Manufacturing. New York: John Wiley & Sons, 1986.
- Gelders, L., Mannaerts, P., and Maes, J. Manufacturing Strategy, Performance Indicators and Improvement Programmes. International Journal of Production Research 32 (April 1994): 797-805.
- Hayness, D.O. Materials Handling Applications. Yokyo: Charles E. Tuttle Company, 1962.
- Immer, J.R. Material Handling. New York: McGraw-Hill Book Co., 1950.
- Mallic, R.W., and Gaudreau A.T. Plant Layout Planning and Practice. New York: John Wiley & Sons, 1951.
- Moore, J.M. Plant Layout and Design. New York: The Macmillan Company, 1962.
- Muther, R., and Haganas, K. Systematic Handling Analysis. Kansas City: Management and Industrial Research Publications, 1970.
- Smith, J.M., and Daskalaki, S. Buffer Space Allocation in Automated Assembly Lines. Operation Research 26 (February 1988): 343-358.
- Tersine, R.J. Principles of Inventory and Materials Management. 3rd ed. New York: Elsevier Publishing, 1988.
- Wild R. Mass-Production Management. New York: John Wiley & Sons, 1972.

Appendices

Appendix A

Statistical Test

Appendix A-1

Fitting the Distribution for the number of orders in 1 week.

A-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2/E_i$
at or below	14.1					-2.42406	0.007674		
14.1	19.74	16.92	1	16.92	286.2864	-1.52208	0.05632	1.023906	0.0005582
19.74	25.38	22.56	3	67.68	1526.861	-0.62011	0.203599	3.257586	0.0203681
25.38	31.02	28.2	6	169.2	4771.44	0.281867	0.343384	5.494144	0.0465751
31.02	36.66	33.84	4	135.36	4580.582	1.183842	0.270785	4.332559	0.0255266
above	42.3	39.48	2	78.96	3117.341	2.085818	0.09974	1.595844	0.1023545
	Sum		16	468.12	14282.51				0.1953825

$$\sigma = 6.252 \quad \text{Mean} = 29.25 \quad \chi^2 = 0.195$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

A-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2/E_i$
at or below	9.9					-2.44344	0.007274		
9.9	13.86	11.88	1	11.88	141.1344	-1.55492	0.052709	0.959729	0.0016898
13.86	17.82	15.84	3	47.52	752.7168	-0.66639	0.192597	3.081552	0.0021582
17.82	21.78	19.8	5	99	1960.2	0.222131	0.335314	5.365022	0.0248352
21.78	25.74	23.76	5	118.8	2822.688	1.110654	0.278747	4.459958	0.0653919
above	29.7	27.72	2	55.44	1536.797	1.999177	0.110564	1.769027	0.0301571
	Sum		16	332.64	7213.536				0.1242322

$$\sigma = 4.456 \quad \text{Mean} = 20.79 \quad \chi^2 = 0.124$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

A-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	6					-2.38756	0.00848		
6	8.4	7.2	1	7.2	51.84	-1.5571	0.051243	0.955569	0.0020659
8.4	10.8	9.6	3	28.8	276.48	-0.72665	0.173998	2.783963	0.0167646
10.8	13.2	12	4	48	576	0.103807	0.307618	4.921888	0.172673
13.2	15.6	14.4	5	72	1036.8	0.934262	0.283577	4.537229	0.0472
above	18	16.8	3	50.4	846.72	1.764716	0.136279	2.18046	0.308029
	Sum		16	206.4	2787.84				0.5467324

$$\sigma = 2.889 \quad \text{Mean} = 12.9 \quad \chi^2 = 0.546$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	8.6					-2.55	0.005386		
8.6	12.04	10.32	1	10.32	106.5024	-1.75	0.034673	0.640946	0.2011401
12.04	15.48	13.76	2	27.52	378.6752	-0.95	0.130997	2.095952	0.0043926
15.48	18.92	17.2	3	51.6	887.52	-0.15	0.269326	4.309219	0.3977644
18.92	22.36	20.64	5	103.2	2130.048	0.65	0.301772	4.828347	0.0061025
above	25.8	24.08	5	120.4	2899.232	1.45	0.184317	2.949068	1.4263227
	Sum		16	313.04	6401.978				2.0357224

$$\sigma = 4.3 \quad \text{Mean} = 19.56 \quad \chi^2 = 2.035$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	7.4					-2.65636	0.00395		
7.4	10.36	8.88	1	8.88	78.8544	-1.78897	0.03286	0.58895	0.2868868
10.36	13.32	11.84	2	23.68	280.3712	-0.92159	0.141561	2.264976	0.0309992
13.32	16.28	14.8	3	44.4	657.12	-0.05421	0.300013	4.800207	0.6751259
16.28	19.24	17.76	7	124.32	2207.923	0.81317	0.313557	5.016905	0.7838829
above	22.2	20.72	3	62.16	1287.955	1.680552	0.161635	2.586163	0.0662221
	Sum		16	263.44	4512.224				1.843117

$$\sigma = 3.412 \quad \text{Mean} = 16.46 \quad \chi^2 = 1.843$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	4					-2.53238	0.005665		
4	5.6	4.8	1	4.8	23.04	-1.70548	0.038388	0.704843	0.1235991
5.6	7.2	6.4	2	12.8	81.92	-0.87858	0.145762	2.332192	0.0473166
7.2	8.8	8	4	32	256	-0.05168	0.289577	4.633227	0.0865436
8.8	10.4	9.6	5	48	460.8	0.775217	0.301503	4.824049	0.0064176
above	12	11.2	4	44.8	501.76	1.602115	0.164541	2.632649	0.7101775
	Sum		16	142.4	1323.52				0.9740544

$$\sigma = 1.934 \quad \text{Mean} = 8.9 \quad \chi^2 = 0.974$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2/E_i$
at or below	85.75					-2.59517	0.004727		
85.75	92.75	89.25	1	89.25	7965.563	-1.76472	0.034078	0.620891	0.231480102
92.75	99.75	96.25	2	192.5	18528.13	-0.93426	0.136279	2.18046	0.014935372
99.75	106.75	103.25	3	309.75	31981.69	-0.10381	0.283577	4.537229	0.520818508
106.75	113.75	110.25	6	661.5	72930.38	0.726648	0.307618	4.921888	0.236154464
above	120.75	117.25	4	469.5	4990.25	1.557103	0.173998	2.783963	0.531165736
	Sum		16	1722	186396				1.534554183

$$\sigma = 8.429 \quad \text{Mean} = 107.62 \quad \chi^2 = 1.534$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2/E_i$
at or below	51.45					-2.62461	0.004337		
51.45	55.65	53.55	1	53.55	2867.603	-1.81704	0.030268	0.553688	0.359758546
55.65	59.85	57.75	2	115.5	6670.125	-1.00947	0.12177	1.948321	0.001370771
59.85	64.05	61.95	2	123.9	7675.605	-0.20189	0.263625	4.217993	1.166310961
64.05	68.25	66.15	6	396.9	26254.94	0.60568	0.307636	4.922179	0.23601308
above	72.45	70.35	5	351.75	24745.61	1.413252	0.193573	3.097166	1.169060744
	Sum		16	1041.6	68213.88				2.932514102

$$\sigma = 5.2 \quad \text{Mean} = 65.1 \quad \chi^2 = 2.932$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	34.3					-2.53238	0.005665		
34.3	37.1	35.7	1	35.7	1274.49	-1.70548	0.038388	0.704843	0.123599099
37.1	39.9	38.5	2	77	2964.5	-0.87858	0.145762	2.332192	0.047316615
39.9	42.7	41.3	4	165.2	6822.76	-0.05168	0.289577	4.633227	0.086543564
42.7	45.5	44.1	5	220.5	9724.05	0.775217	0.301503	4.824049	0.006417591
above	48.3	46.9	4	187.6	8798.44	1.602115	0.164541	2.632649	0.710177524
	Sum		16	686	29584.24				0.974054393

$$\sigma = 3.386 \quad \text{Mean} = 42.87 \quad \chi^2 = 0.974$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	30.87					-2.55	0.005386		
30.87	33.39	32.13	1	32.13	1032.337	-1.75	0.034673	0.640946	0.201140101
33.39	35.91	34.65	2	69.3	2401.245	-0.95	0.130997	2.095952	0.004392649
35.91	38.43	37.17	3	111.51	4144.827	-0.15	0.269326	4.309219	0.397764419
38.43	40.95	39.69	5	198.45	7876.481	0.65	0.301772	4.828347	0.006102474
above	43.47	42.21	5	211.05	8908.421	1.45	0.184317	2.949068	1.426322712
	Sum		16	622.44	24363.31				2.035722355

$$\sigma = 3.15 \quad \text{Mean} = 38.9 \quad \chi^2 = 2.035$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	27.93					-2.53238	0.005665		
27.93	30.21	29.07	1	29.07	845.0649	-1.70548	0.038388	0.704843	0.123599099
30.21	32.49	31.35	2	62.7	1965.645	-0.87858	0.145762	2.332192	0.047316615
32.49	34.77	33.63	4	134.52	4523.908	-0.05168	0.289577	4.633227	0.086543564
34.77	37.05	35.91	5	179.55	6447.641	0.775217	0.301503	4.824049	0.006417591
above	39.33	38.19	4	152.76	5833.904	1.602115	0.164541	2.632649	0.710177524
	Sum		16	558.6	19616.16		0.054565	15.12696	0.974054393

$$\sigma = 2.757 \quad \text{Mean} = 34.91 \quad \chi^2 = 0.974$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	14.7					-2.80011	0.002554		
14.7	15.9	15.3	1	15.3	234.09	-1.92165	0.024771	0.437201	0.724478557
15.9	17.1	16.5	1	16.5	272.25	-1.04318	0.121108	1.937721	0.453790943
17.1	18.3	17.7	4	70.8	1253.16	-0.16471	0.286153	4.57844	0.073080122
18.3	19.5	18.9	6	113.4	2143.26	0.713754	0.327725	5.243607	0.109110113
above	20.7	20.1	4	80.4	1616.04	1.592221	0.182022	2.912351	0.406193855
	Sum		16	296.4	5518.8				1.76665359

$$\sigma = 1.366 \quad \text{Mean} = 18.52 \quad \chi^2 = 1.766$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

E-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	135.7					-2.59517	0.004727		
135.7	154.1	144.9	1	144.9	20996.01	-1.76472	0.034078	0.620891	0.23148
154.1	172.5	163.3	2	326.6	53333.78	-0.93426	0.136279	2.18046	0.014935
172.5	190.9	181.7	3	545.1	99044.67	-0.10381	0.283577	4.537229	0.520819
190.9	209.3	200.1	6	1200.6	240240.1	0.726648	0.307618	4.921888	0.236154
above	227.7	218.5	4	874	190969	1.557103	0.173998	2.783963	0.531166
	Sum		16	3091.2	604583.5				1.534554

$$\sigma = 22.156 \quad \text{Mean} = 193.2 \quad \chi^2 = 1.534$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

E-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	94.4					-2.55	0.005386		
94.4	107.2	100.8	1	100.8	10160.64	-1.75	0.034673	0.640946	0.20114
107.2	120	113.6	2	227.2	25809.92	-0.95	0.130997	2.095952	0.004393
120	132.8	126.4	3	379.2	47930.88	-0.15	0.269326	4.309219	0.397764
132.8	145.6	139.2	5	696	96883.2	0.65	0.301772	4.828347	0.006102
above	158.4	152	5	760	115520	1.45	0.184317	2.949068	1.426323
	Sum		16	2163.2	296304.6				2.035722

$$\sigma = 16 \quad \text{Mean} = 135.2 \quad \chi^2 = 2.035$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

E-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	64.9					-2.59808	0.004687		
64.9	73.7	69.3	1	69.3	4802.49	-1.73205	0.036945	0.666116	0.167357
73.7	82.5	78.1	2	156.2	12199.22	-0.86603	0.151606	2.425694	0.074706
82.5	91.3	86.9	4	347.6	30206.44	0	0.306762	4.908191	0.168048
91.3	100.1	95.7	6	574.2	54950.94	0.866025	0.306762	4.908191	0.242869
above	108.9	104.5	3	313.5	32760.75	1.732051	0.151606	2.425694	0.135973
	Sum		16	1460.8	134919.8				0.788952

$$\sigma = 10.16 \quad \text{Mean} = 91.3 \quad \chi^2 = 0.788$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

Appendix A-2

Fitting the Distribution for the processing time of station 2

A-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$	
at or below	4.8					-2.42406	0.007674			
	4.8	6.8	5.8	1	5.8	33.64	-1.52208	0.05632	1.023906	0.0005582
	6.8	8.8	7.8	3	23.4	182.5	-0.62011	0.203599	3.257586	0.0203681
	8.8	10.8	9.8	6	58.8	576.2	0.281867	0.343384	5.494144	0.0465751
	10.8	12.8	11.8	4	47.2	557	1.183842	0.270785	4.332559	0.0255266
above	14.8	13.8	2	27.6	380.9	2.085818	0.09974	1.595844	0.1023545	
	Sum		16	162.8	1730		1		0.1953825	

$$\sigma = 2.217 \quad \text{Mean} = 10.18 \quad \chi^2 = 0.195$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

A-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$	
at or below	5.5					-2.44344	0.007274			
	5.5	7.7	6.6	1	6.6	43.56	-1.55492	0.052709	0.959729	0.0016898
	7.7	9.9	8.8	3	26.4	232.3	-0.66639	0.192597	3.081552	0.0021582
	9.9	12.1	11	5	55	605	0.222131	0.335314	5.365022	0.0248352
	12.1	14.3	13.2	5	66	871.2	1.110654	0.278747	4.459958	0.0653919
above	16.5	15.4	2	30.8	474.3	1.999177	0.110564	1.769027	0.0301571	
	Sum		16	184.8	2226		1		0.1242322	

$$\sigma = 2.476 \quad \text{Mean} = 11.55 \quad \chi^2 = 0.124$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

A-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	8.45					-2.38756	0.00848		
	8.45	10.2	1	10.2	104	-1.5571	0.051243	0.955569	0.0020659
	11.95	13.7	3	41.1	563.1	-0.72665	0.173998	2.783963	0.0167646
	15.45	17.2	4	68.8	1183	0.103807	0.307618	4.921888	0.172673
	18.95	20.7	5	103.5	2142	0.934262	0.283577	4.537229	0.0472
above	25.95	24.2	3	72.6	1757	1.764716	0.136279	2.18046	0.308029
	Sum		16	296.2	5750		1		0.5467324

$$\sigma = 4.215 \quad \text{Mean} = 18.51 \quad \chi^2 = 0.546$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	3.6					-2.55	0.005386		
	3.6	4.3	1	4.3	18.49	-1.75	0.034673	0.640946	0.2011401
	5	5.7	2	11.4	64.98	-0.95	0.130997	2.095952	0.0043926
	6.4	7.1	3	21.3	151.2	-0.15	0.269326	4.309219	0.3977644
	7.8	8.5	5	42.5	361.3	0.65	0.301772	4.828347	0.0061025
above	10.6	9.9	5	49.5	490.1	1.45	0.184317	2.949068	1.4263227
	Sum		16	129	1086		1		2.0357224

$$\sigma = 1.75 \quad \text{Mean} = 8.063 \quad \chi^2 = 2.035$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$	
at or below	8.15					-2.65636	0.00395			
	8.15	11.45	9.8	1	9.8	96.04	-1.78897	0.03286	0.58895	0.2868868
	11.45	14.75	13.1	2	26.2	343.2	-0.92159	0.141561	2.264976	0.0309992
	14.75	18.05	16.4	3	49.2	806.9	-0.05421	0.300013	4.800207	0.6751259
	18.05	21.35	19.7	7	137.9	2717	0.81317	0.313557	5.016905	0.7838829
above	24.65	23	3	3	69	1587	1.680552	0.161635	2.586163	0.0662221
	Sum		16	292.1	5550		1			1.843117

$$\sigma = 3.805 \quad \text{Mean} = 18.26 \quad \chi^2 = 1.843$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$	
at or below	5.65					-2.53238	0.005665			
	5.65	7.95	6.8	1	6.8	46.24	-1.70548	0.038388	0.704843	0.1235991
	7.95	10.25	9.1	2	18.2	165.6	-0.87858	0.145762	2.332192	0.0473166
	10.25	12.55	11.4	4	45.6	519.8	-0.05168	0.289577	4.633227	0.0865436
	12.55	14.85	13.7	5	68.5	938.5	0.775217	0.301503	4.824049	0.0064176
above	17.15	16	4	4	64	1024	1.602115	0.164541	2.632649	0.7101775
	Sum		16	203.1	2694		1			0.9740544

$$\sigma = 2.781 \quad \text{Mean} = 12.69 \quad \chi^2 = 0.974$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

Fitting the Distribution for the processing time of station 1

C-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	12.3					-2.59517	0.004727		
	12.3	12.8	1	12.8	163.84	-1.76472	0.034078	0.620891	0.231480102
	13.3	13.8	2	27.6	380.88	-0.93426	0.136279	2.18046	0.014935372
	14.3	14.8	3	44.4	657.12	-0.10381	0.283577	4.537229	0.520818508
	15.3	15.8	6	94.8	1497.84	0.726648	0.307618	4.921888	0.236154464
above	17.3	16.8	4	67.2	1128.96	1.557103	0.173998	2.783963	0.531165736
	Sum		16	246.8	3828.64		1		1.534554183

$$\sigma = 1.204 \quad \text{Mean} = 15.425 \quad \chi^2 = 1.534$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	12.6					-2.62461	0.004337		
	12.6	13.1	1	13.1	171.61	-1.81704	0.030268	0.553688	0.359758546
	13.6	14.1	2	28.2	397.62	-1.00947	0.12177	1.948321	0.001370771
	14.6	15.1	2	30.2	456.02	-0.20189	0.263625	4.217993	1.166310961
	15.6	16.1	6	96.6	1555.26	0.60568	0.307636	4.922179	0.23601308
above	17.6	17.1	5	85.5	1462.05	1.413252	0.193573	3.097166	1.169060744
	Sum		16	253.6	4042.56		1		2.932514102

$$\sigma = 1.238 \quad \text{Mean} = 15.85 \quad \chi^2 = 2.932$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-3

Lower Limit	Upper Limit	Xi	fi	fX	fX ²	Zi	Relative Frequency	Ei	(O _i -E _i) ² /E _i
at or below	10.1					-2.53238	0.005665		
	10.1	10.5	1	10.5	110.25	-1.70548	0.038388	0.704843	0.123599099
	10.9	11.3	2	22.6	255.38	-0.87858	0.145762	2.332192	0.047316615
	11.7	12.1	4	48.4	585.64	-0.05168	0.289577	4.633227	0.086543564
	12.5	12.9	5	64.5	832.05	0.775217	0.301503	4.824049	0.006417591
above	14.1	13.7	4	54.8	750.76	1.602115	0.164541	2.632649	0.710177524
	Sum		16	200.8	2534.08		1		0.974054393

$$\sigma = 0.967 \quad \text{Mean} = 12.55 \quad \chi^2 = 0.974$$

$$v = 5-3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H₀: Observations conform to Normal Distribution

D-1

Lower Limit	Upper Limit	Xi	fi	fX	fX ²	Zi	Relative Frequency	Ei	(O _i -E _i) ² /E _i
at or below	6.75					-2.55	0.005386		
	6.75	7	1	7	49	-1.75	0.034673	0.640946	0.201140101
	7.25	7.5	2	15	112.5	-0.95	0.130997	2.095952	0.004392649
	7.75	8	3	24	192	-0.15	0.269326	4.309219	0.397764419
	8.25	8.5	5	42.5	361.25	0.65	0.301772	4.828347	0.006102474
above	9.25	9	5	45	405	1.45	0.184317	2.949068	1.426322712
	Sum		16	133.5	1119.75		1		2.035722355

$$\sigma = 0.625 \quad \text{Mean} = 8.343 \quad \chi^2 = 2.035$$

$$v = 5-3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H₀: Observations conform to Normal Distribution

D-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	6.85					-2.37961	0.008665		
	6.85	7.1	1	7.1	50.41	-1.67714	0.038092	0.748116	0.084807191
	7.35	7.6	2	15.2	115.52	-0.90443	0.136127	2.178032	0.014552332
	7.9	8.2	4	32.8	268.96	-0.06147	0.29261	4.681756	0.099277051
	8.5	8.8	5	44	387.2	0.781496	0.307251	4.91601	0.001434958
above	9.7	9.4	4	37.6	353.44	1.624458	0.165116	2.641861	0.69819785
	Sum		16	136.7	1175.53		1		0.898269382

$$\sigma = 0.711 \quad \text{Mean} = 8.543 \quad \chi^2 = 0.898$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	8.65					-2.80011	0.002554		
	8.65	9	1	9	81	-1.92165	0.024771	0.437201	0.724478557
	9.35	9.7	1	9.7	94.09	-1.04318	0.121108	1.937721	0.453790943
	10.05	10.4	4	41.6	432.64	-0.16471	0.286153	4.57844	0.073080122
	10.75	11.1	6	66.6	739.26	0.713754	0.327725	5.243607	0.109110113
above	12.15	11.8	4	47.2	556.96	1.592221	0.182022	2.912351	0.406193855
	Sum		16	174.1	1903.95		1		1.76665359

$$\sigma = 0.796 \quad \text{Mean} = 10.88 \quad \chi^2 = 1.766$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

Fitting the Distribution for the processing time of station 5

A-1

Lower Limit	Upper Limit	Xi	fi	fX	fX ²	Zi	Relative Frequency	Ei	(O _i -E _i) ² /E _i
at or below	2.375					-2.38582	0.00852		
	2.375	2.85	1	2.85	8.1225	-1.5024	0.057977	1.063953	0.003844
	3.325	3.8	3	11.4	43.32	-0.61898	0.201469	3.223499	0.015496
	4.275	4.75	6	28.5	135.375	0.264446	0.336316	5.381054	0.071193
	5.225	5.7	4	22.8	129.96	1.194364	0.27955	4.472808	0.049979
above	7.275	6.75	2	13.5	91.125	2.170778	0.101194	1.619104	0.089606
	Sum		16	79.05	407.9025		1		0.230119

$$\sigma = 1.07 \quad \text{Mean} = 4.94 \quad \chi^2 = 0.23$$

$$v = 5-3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H₀: Observations conform to Normal Distribution

A-2

Lower Limit	Upper Limit	Xi	fi	fX	fX ²	Zi	Relative Frequency	Ei	(O _i -E _i) ² /E _i
at or below	1.725					-2.33895	0.009669		
	1.725	2.05	1	2.05	4.2025	-1.50016	0.057118	1.068592	0.004403
	2.375	2.7	3	8.1	21.87	-0.66136	0.187404	2.998463	7.88E-07
	3.025	3.35	5	16.75	56.1125	0.177438	0.316227	5.059629	0.000703
	3.675	4	5	20	80	1.14528	0.303536	4.856571	0.004236
above	5.275	4.85	2	9.7	47.045	2.242169	0.113571	1.817142	0.018401
	Sum		16	56.6	209.23		1		0.027743

$$\sigma = 0.774 \quad \text{Mean} = 3.53 \quad \chi^2 = 0.027$$

$$v = 5-3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H₀: Observations conform to Normal Distribution

A-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	1					-2.38756	0.00848		
	1	1.4	1	1.2	1.44	-1.5571	0.051243	0.955569	0.002066
	1.4	1.8	3	4.8	7.68	-0.72665	0.173998	2.783963	0.016765
	1.8	2.2	2	4	8	0.103807	0.307618	4.921888	0.172673
	2.2	2.6	5	12	28.8	0.934262	0.283577	4.537229	0.0472
above	3	2.8	3	8.4	23.52	1.764716	0.136279	2.18046	0.308029
	Sum		16	34.4	77.44		1		0.546732

$$\sigma = 0.481 \quad \text{Mean} = 2.15 \quad \chi^2 = 0.546$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	13.3					22.82485	1		
	13.3	14.5	3	41.7	579.63	-1.0245	-0.8472	5.347974	1.030854
	14.5	15.7	4	60.4	912.04	-0.57907	0.128473	4.496555	0.054835
	15.7	16.9	7	114.1	1859.83	-0.13363	0.165575	5.795126	0.250507
	16.9	18.1	9	157.5	2756.25	0.311805	0.175558	6.144537	1.326979
	18.1	19.3	7	130.9	2447.83	0.75724	0.153142	5.359956	0.501822
above	20.5	19.9	5	99.5	1980.05	38.41509	0.224453	7.855852	1.038193
	Sum		35	604.1	10535.63		1		4.203191

$$\sigma = 2.69 \quad \text{Mean} = 17.26 \quad \chi^2 = 4.203$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 7.815$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	8					23.70901	1		
	8	8.7	3	25.05	209.1675	-0.96273	-0.83216	5.874428	1.406492
	8.7	9.4	5	45.25	409.5125	-0.51474	0.135527	4.74346	0.013874
	9.4	10.1	8	78	760.5	-0.06674	0.170025	5.950882	0.70559
	10.1	10.8	9	94.05	982.8225	0.397253	0.181016	6.335563	1.120536
	10.8	11.5	6	67.2	752.64	0.861248	0.15104	5.286395	0.096329
above	12.2	11.9	4	47.6	566.44	39.83684	0.194551	6.809272	1.15901
	Sum		35	357.15	3681.083		1		4.501831

$$\sigma = 1.562 \quad \text{Mean} = 10.2 \quad \chi^2 = 4.501$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 7.815$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	4.3					23.68995	1		
	31.5	5.8	2	11.1	61.605	-1.13861	-0.87257	4.460168	1.356995
	5.8	6.3	4	24.2	146.41	-0.65556	0.128619	4.501682	0.055909
	6.3	6.8	7	45.85	300.3175	-0.17252	0.175463	6.141203	0.120096
	6.8	7.3	10	70.5	497.025	0.31053	0.190405	6.664174	1.669784
	7.3	7.8	8	60.4	456.02	0.793575	0.164358	5.752529	0.878071
above	8.3	8.05	4	32.2	259.21	39.92029	0.213721	7.480244	1.619212
	Sum		35	244.25	1720.588		1		5.700066

$$\sigma = 1.035 \quad \text{Mean} = 6.978 \quad \chi^2 = 5.7$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 7.815$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

Fitting the Distribution for the processing time of station 4

A-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	2.61					-2.42406	0.007674		
	2.61	3.13	1	3.13	9.7969	-1.52208	0.05632	1.023906	0.000558
	3.65	4.17	3	12.51	52.1667	-0.62011	0.203599	3.257586	0.020368
	4.69	5.21	6	31.26	162.8646	0.281867	0.343384	5.494144	0.046575
	5.73	6.25	4	25	156.25	1.183842	0.270785	4.332559	0.025527
above	7.81	7.29	2	14.58	106.2882	2.085818	0.09974	1.595844	0.102355
	Sum		16	86.48	487.3664		1		0.195382

$$\sigma = 1.153 \quad \text{Mean} = 5.405 \quad \chi^2 = 0.195$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

A-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	1.85					-2.44344	0.007274		
	1.85	2.2	1	2.2	4.84	-1.55492	0.052709	0.959729	0.00169
	2.55	2.9	3	8.7	25.23	-0.66639	0.192597	3.081552	0.002158
	3.25	3.6	5	18	64.8	0.222131	0.335314	5.365022	0.024835
	3.95	4.3	5	21.5	92.45	1.110654	0.278747	4.459958	0.065392
above	5.35	5	2	10	50	1.999177	0.110564	1.769027	0.030157
	Sum		16	60.4	237.32		1		0.124232

$$\sigma = 0.787 \quad \text{Mean} = 3.775 \quad \chi^2 = 0.124$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

A-3

Lower Limit	Upper Limit	\bar{x}_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2/E_i$
at or below	1.1					-2.38756	0.00848		
	1.1	1.5	1	1.3	1.69	-1.5571	0.051243	0.955569	0.002066
	1.5	1.9	3	5.1	8.67	-0.72665	0.173998	2.783963	0.016765
	1.9	2.3	4	8.4	17.64	0.103807	0.307618	4.921888	0.172673
	2.3	2.7	5	12.5	31.25	0.934262	0.283577	4.537229	0.0472
above	3.1	2.9	3	8.7	25.23	1.764716	0.136279	2.18046	0.308029
	Sum		16	36	84.48		1		0.546732

$$\sigma = 0.481 \quad \text{Mean} = 2.25 \quad \chi^2 = 0.546$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2/E_i$
at or below	1.6					-2.55	0.005386		
	1.6	2.2	1	1.9	3.61	-1.75	0.034673	0.640946	0.20114
	2.2	2.8	2	5	12.5	-0.95	0.130997	2.095952	0.004393
	2.8	3.4	3	9.3	28.83	-0.15	0.269326	4.309219	0.397764
	3.4	4	5	18.5	68.45	0.65	0.301772	4.828347	0.006102
above	4.6	4.3	5	21.5	92.45	1.45	0.184317	2.949068	1.426323
	Sum		16	56.2	205.84		1		2.035722

$$\sigma = 0.75 \quad \text{Mean} = 3.51 \quad \chi^2 = 2.035$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$	
at or below	1.3					-2.65636	0.00395			
	1.3	1.9	1.6	1	1.6	2.56	-1.78897	0.03286	0.58895	0.286887
	1.9	2.5	2.2	2	4.4	9.68	-0.92159	0.141561	2.264976	0.030999
	2.5	3.1	2.8	3	8.4	23.52	-0.05421	0.300013	4.800207	0.675126
	3.1	3.7	3.4	7	23.8	80.92	0.81317	0.313557	5.016905	0.783883
above	4.3		4	3	12	48	1.680552	0.161635	2.586163	0.066222
	Sum		16	50.2	164.68		1			1.843117

$$\sigma = 0.691 \quad \text{Mean} = 3.13 \quad \chi^2 = 1.843$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$	
at or below	0.75					-2.53238	0.005665			
	0.75	1.05	0.9	1	0.9	0.81	-1.70548	0.038388	0.704843	0.123599
	1.05	1.35	1.2	2	2.4	2.88	-0.87858	0.145762	2.332192	0.047317
	1.35	1.65	1.5	4	6	9	-0.05168	0.289577	4.633227	0.086544
	1.65	1.95	1.8	5	9	16.2	0.775217	0.301503	4.824049	0.006418
above	2.25		2.1	4	8.4	17.64	1.602115	0.164541	2.632649	0.710178
	Sum		16	26.7	46.53		1			0.974054

$$\sigma = 0.362 \quad \text{Mean} = 1.668 \quad \chi^2 = 0.974$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	14.55					-1.46994	0.070789		
	14.55	15.2	3	45.6	693.12	-1.0245	0.08201	5.347974	1.030854
	15.85	16.5	4	66	1089	-0.57907	0.128473	4.496555	0.054835
	17.15	17.8	7	124.6	2217.88	-0.13363	0.165575	5.795126	0.250507
	18.45	19.1	9	171.9	3283.29	0.311805	0.175558	6.144537	1.326979
	19.75	20.4	7	142.8	2913.12	0.75724	0.153142	5.359956	0.501822
above	22.35	21.7	5	108.5	2354.45	1.202676	0.109902	7.855852	1.038193
	Sum		35	659.4	12550.86		1		4.203191

$$\sigma = 2.918 \quad \text{Mean} = 18.84 \quad \chi^2 = 4.203$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 7.815$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	8.85					-1.42629	0.076892		
	8.85	9.2	3	27.6	253.92	-0.9704	0.089032	5.807317	1.357086
	9.55	9.9	5	49.5	490.05	-0.51451	0.137525	4.813379	0.007236
	10.25	10.6	8	84.8	898.88	-0.05861	0.173181	6.061332	0.620067
	10.95	11.3	9	101.7	1149.21	0.397278	0.177789	6.22263	1.239634
	11.65	12	6	72	864	0.853171	0.148799	5.207968	0.120453
above	13.05	12.7	4	50.8	645.16	1.309064	0.101526	6.887374	1.210465
	Sum		35	386.4	4301.22		1		4.554941

$$\sigma = 1.535 \quad \text{Mean} = 11.04 \quad \chi^2 = 4.554$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 7.815$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$	
at or below	5.7					-1.62165	0.052439			
	5.7	6.3	6	2	12	72	-1.13861	0.074995	4.460168	1.356995
	6.3	6.9	6.6	4	26.4	174.24	-0.65556	0.128619	4.501682	0.055909
	6.9	7.5	7.2	7	50.4	362.88	-0.17252	0.175463	6.141203	0.120096
	7.5	8.1	7.8	10	78	608.4	0.31053	0.190405	6.664174	1.669784
	8.1	8.7	8.4	8	67.2	564.48	0.793575	0.164358	5.752529	0.878071
above	9.3	9	4	36	324	1.276621	0.112853	7.480244	1.619212	
	Sum		35	270	2106		1		5.700066	

$$\sigma = 1.242 \quad \text{Mean} = 7.71 \quad \chi^2 = 5.7$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 7.815$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$	
at or below	4.975					-1.67207	0.047255			
	4.975	5.425	5.2	3	15.6	81.12	-1.12655	0.082712	4.548856	0.527376
	5.425	5.875	5.65	3	16.95	95.7675	-0.58102	0.150645	5.272567	0.979515
	5.875	6.275	6.1	8	48.8	297.68	-0.09612	0.181102	6.338576	0.435481
	6.275	6.625	6.45	9	58.05	374.4225	0.328179	0.166898	5.841413	1.707921
	6.625	6.975	6.8	8	54.4	369.92	0.752474	0.145505	5.092682	1.659734
above	7.325	7.15	4	28.6	204.49	1.176768	0.106239	7.905906	1.92971	
	Sum		35	222.4	1423.4		1		7.239737	

$$\sigma = 0.824 \quad \text{Mean} = 6.354 \quad \chi^2 = 7.239$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 7.815$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	5					-1.60262	0.054509		
	5	5.4	2	10.4	54.08	-1.11698	0.077493	4.620061	1.485851
	5.4	5.8	4	22.4	125.44	-0.63134	0.131909	4.616804	0.082405
	5.8	6.2	6	48	288	-0.14569	0.178171	6.236002	0.498988
	6.2	6.6	10	64	409.6	0.33995	0.190971	6.683984	1.645121
	6.6	7	7	47.6	323.68	0.825593	0.16243	5.685039	0.304153
above	7.4	7.2	4	28.8	207.36	1.311236	0.109628	7.158111	1.393337
	Sum		35	221.2	1408.16		1		5.409855

$$\sigma = 0.823 \quad \text{Mean} = 6.32 \quad \chi^2 = 5.409$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 7.815$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	2.5					-1.52402	0.063752		
	2.5	2.7	3	7.8	20.28	-1.04563	0.084115	5.175342	0.914358
	2.7	2.9	4	11.2	31.36	-0.56723	0.13741	4.809361	0.136206
	2.9	3.1	7	21	63	-0.08884	0.179326	6.276397	0.083424
	3.1	3.3	11	35.2	112.64	0.389547	0.186961	6.543645	3.034869
	3.3	3.5	7	23.8	80.92	0.867938	0.155722	5.45026	0.440657
above	3.7	3.6	3	10.8	38.88	1.346329	0.103616	6.744995	2.079317
	Sum		35	109.8	347.08		1		6.688831

$$\sigma = 0.418 \quad \text{Mean} = 3.137 \quad \chi^2 = 6.688$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 7.815$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

Fitting the Distribution for the processing time of station 6

A-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	2					-2.42406	0.007674		
	2	2.4	1	2.4	5.76	-1.52208	0.05632	1.023906	0.0005582
	2.8	3.2	3	9.6	30.72	-0.62011	0.203599	3.257586	0.0203681
	3.6	4	6	24	96	0.281867	0.343384	5.494144	0.0465751
	4.4	4.8	4	19.2	92.16	1.183842	0.270785	4.332559	0.0255266
above	6	5.6	2	11.2	62.72	2.085818	0.09974	1.595844	0.1023545
	Sum		16	66.4	287.36		1		0.1953825

$$\sigma = 0.886 \quad \text{Mean} = 4.15 \quad \chi^2 = 0.195$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

A-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	1.3					-2.44344	0.007274		
	1.3	1.6	1	1.6	2.56	-1.55492	0.052709	0.959729	0.0016898
	1.9	2.2	3	6.6	14.52	-0.66639	0.192597	3.081552	0.0021582
	2.5	2.8	5	14	39.2	0.222131	0.335314	5.365022	0.0248352
	3.1	3.4	5	17	57.8	1.110654	0.278747	4.459958	0.0653919
above	4.3	4	2	8	32	1.999177	0.110564	1.769027	0.0301571
	Sum		16	47.2	146.08		1		0.1242322

$$\sigma = 0.675 \quad \text{Mean} = 2.95 \quad \chi^2 = 0.124$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

A-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	1.85					-2.38756	0.00848		
1.85	2.55	2.2	1	2.2	4.84	-1.5571	0.051243	0.955569	0.0020659
2.55	3.25	2.9	3	8.7	25.23	-0.72665	0.173998	2.783963	0.0167646
3.25	3.95	3.6	4	14.4	51.84	0.103807	0.307618	4.921888	0.172673
3.95	4.65	4.3	5	21.5	92.45	0.934262	0.283577	4.537229	0.0472
above	5.35	5	3	15	75	1.764716	0.136279	2.18046	0.308029
	Sum		16	61.8	249.36		1		0.5467324

$$\sigma = 0.842 \quad \text{Mean} = 3.862 \quad \chi^2 = 0.546$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	1.25					-2.55	0.005386		
1.25	1.75	1.5	1	1.5	2.25	-1.75	0.034673	0.640946	0.2011401
1.75	2.25	2	2	4	8	-0.95	0.130997	2.095952	0.0043926
2.25	2.75	2.5	3	7.5	18.75	-0.15	0.269326	4.309219	0.3977644
2.75	3.25	3	5	15	45	0.65	0.301772	4.828347	0.0061025
above	3.75	3.5	5	17.5	61.25	1.45	0.184317	2.949068	1.4263227
	Sum		16	45.5	135.25		1		2.0357224

$$\sigma = 0.625 \quad \text{Mean} = 2.843 \quad \chi^2 = 2.035$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	2.05					-2.65636	0.00395		
2.05	2.95	2.5	1	2.5	6.25	-1.78897	0.03286	0.58895	0.2868868
2.95	3.85	3.4	2	6.8	23.12	-0.92159	0.141561	2.264976	0.0309992
3.85	4.75	4.3	3	12.9	55.47	-0.05421	0.300013	4.800207	0.6751259
4.75	5.65	5.2	7	36.4	189.28	0.81317	0.313557	5.016905	0.7838829
above	6.55	6.1	3	18.3	111.63	1.680552	0.161635	2.586163	0.0662221
	Sum		16	76.9	385.75		1		1.843117

$$\sigma = 1.037 \quad \text{Mean} = 4.806 \quad \chi^2 = 1.843$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

B-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	1.05					-2.53238	0.005665		
1.05	1.55	1.3	1	1.3	1.69	-1.70548	0.038388	0.704843	0.1235991
1.55	2.05	1.8	2	3.6	6.48	-0.87858	0.145762	2.332192	0.0473166
2.05	2.55	2.3	4	9.2	21.16	-0.05168	0.289577	4.633227	0.0865436
2.55	3.05	2.8	5	14	39.2	0.775217	0.301503	4.824049	0.0064176
above	3.55	3.3	4	13.2	43.56	1.602115	0.164541	2.632649	0.7101775
	Sum		16	41.3	112.09		1		0.9740544

$$\sigma = 0.604 \quad \text{Mean} = 2.581 \quad \chi^2 = 0.974$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-1

Lower Limit	Upper Limit	Xi	fi	fX	fX ²	Zi	Relative Frequency	Ei	(O _i -E _i) ² /E _i
at or below	12.25					-2.59517	0.004727		
12.25	13.25	12.75	1	12.75	162.5625	-1.76472	0.034078	0.620891	0.2314801
13.25	14.25	13.75	2	27.5	378.125	-0.93426	0.136279	2.18046	0.0149354
14.25	15.25	14.75	3	44.25	652.6875	-0.10381	0.283577	4.537229	0.5208185
15.25	16.25	15.75	6	94.5	1488.375	0.726648	0.307618	4.921888	0.2361545
above	17.25	16.75	4	67	1122.25	1.557103	0.173998	2.783963	0.5311657
	Sum		16	246	3804		1		1.5345542

$$\sigma = 1.204 \quad \text{Mean} = 15.375 \quad \chi^2 = 1.534$$

$$v = 5-3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H₀: Observations conform to Normal Distribution

C-2

Lower Limit	Upper Limit	Xi	fi	fX	fX ²	Zi	Relative Frequency	Ei	(O _i -E _i) ² /E _i
at or below	7.35					-2.62461	0.004337		
7.35	7.95	7.65	1	7.65	58.5225	-1.81704	0.030268	0.553688	0.3597585
7.95	8.55	8.25	2	16.5	136.125	-1.00947	0.12177	1.948321	0.0013708
8.55	9.15	8.85	2	17.7	156.645	-0.20189	0.263625	4.217993	1.166311
9.15	9.75	9.45	6	56.7	535.815	0.60568	0.307636	4.922179	0.2360131
above	10.35	10.05	5	50.25	505.0125	1.413252	0.193573	3.097166	1.1690607
	Sum		16	148.8	1392.12		1		2.9325141

$$\sigma = 0.742 \quad \text{Mean} = 9.3 \quad \chi^2 = 2.932$$

$$v = 5-3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H₀: Observations conform to Normal Distribution

C-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	4.9					-2.53238	0.005665		
	4.9	5.1	1	5.1	26.01	-1.70548	0.038388	0.704843	0.1235991
	5.3	5.5	2	11	60.5	-0.87858	0.145762	2.332192	0.0473166
	5.7	5.9	4	23.6	139.24	-0.05168	0.289577	4.633227	0.0865436
	6.1	6.3	5	31.5	198.45	0.775217	0.301503	4.824049	0.0064176
above	6.9	6.7	4	26.8	179.56	1.602115	0.164541	2.632649	0.7101775
	Sum		16	98	603.76		1		0.9740544

$$\sigma = 0.483 \quad \text{Mean} = 6.125 \quad \chi^2 = 0.974$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	4.41					-2.55	0.005386		
	4.41	4.59	1	4.59	21.0681	-1.75	0.034673	0.640946	0.2011401
	4.77	4.95	2	9.9	49.005	-0.95	0.130997	2.095952	0.0043926
	5.13	5.31	3	15.93	84.5883	-0.15	0.269326	4.309219	0.3977644
	5.49	5.67	5	28.35	160.7445	0.65	0.301772	4.828347	0.0061025
above	6.21	6.03	5	30.15	181.8045	1.45	0.184317	2.949068	1.4263227
	Sum		16	88.92	497.2104		1		2.0357224

$$\sigma = 0.45 \quad \text{Mean} = 5.557 \quad \chi^2 = 2.035$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	3.9					-2.53238	0.005665		
	3.9	4.3	1	4.1	16.81	-1.70548	0.038388	0.704843	0.1235991
	4.3	4.7	2	9	40.5	-0.87858	0.145762	2.332192	0.0473166
	4.7	5.1	4	19.6	96.04	-0.05168	0.289577	4.633227	0.0865436
	5.1	5.5	5	26.5	140.45	0.775217	0.301503	4.824049	0.0064176
above	5.9	5.7	4	22.8	129.96	1.602115	0.164541	2.632649	0.7101775
	Sum		16	82	423.76		1		0.9740544

$$\sigma = 0.483 \quad \text{Mean} = 5.125 \quad \chi^2 = 0.974$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	4.1					-3.0885	0.001006		
	4.1	4.5	1	4.3	18.49	-2.04816	0.019266	0.324352	1.407425
	4.5	4.9	1	4.7	22.09	-1.00783	0.136497	2.183953	0.6418382
	4.9	5.25	4	20.4	104.04	-0.09753	0.304383	4.870129	0.1554629
	5.25	5.55	6	32.4	174.96	0.682721	0.291456	4.663301	0.3831541
above	5.85	5.7	4	22.8	129.96	1.462973	0.175654	2.810467	0.5034714
	Sum		16	84.6	449.54		1		3.0913515

$$\sigma = 0.384 \quad \text{Mean} = 5.287 \quad \chi^2 = 3.091$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

Fitting the Distribution for the processing time of station 7

A-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	1.9					-2.42406	0.007674		
	1.9	2.3	1	2.3	5.29	-1.52208	0.05632	1.023906	0.0005582
	2.7	3.1	3	9.3	28.83	-0.62011	0.203599	3.257586	0.0203681
	3.5	3.9	6	23.4	91.26	0.281867	0.343384	5.494144	0.0465751
	4.3	4.7	4	18.8	88.36	1.183842	0.270785	4.332559	0.0255266
above	5.9	5.5	2	11	60.5	2.085818	0.09974	1.595844	0.1023545
	Sum		16	64.8	274.24		1		0.1953825

$$\sigma = 0.886 \quad \text{Mean} = 4.05 \quad \chi^2 = 0.195$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

A-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	1.375					-2.44344	0.007274		
	1.375	1.65	1	1.65	2.7225	-1.55492	0.052709	0.959729	0.0016898
	1.925	2.2	3	6.6	14.52	-0.66639	0.192597	3.081552	0.0021582
	2.475	2.75	5	13.75	37.8125	0.222131	0.335314	5.365022	0.0248352
	3.025	3.3	5	16.5	54.45	1.110654	0.278747	4.459958	0.0653919
above	4.125	3.85	2	7.7	29.645	1.999177	0.110564	1.769027	0.0301571
	Sum		16	46.2	139.15		1		0.1242322

$$\sigma = 0.619 \quad \text{Mean} = 2.887 \quad \chi^2 = 0.124$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

A-3

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2/E_i$
at or below	1.65					-2.38756	0.00848		
1.65	2.35	2	1	2	4	-1.5571	0.051243	0.955569	0.0020659
2.35	3.05	2.7	3	8.1	21.87	-0.72665	0.173998	2.783963	0.0167646
3.05	3.75	3.4	4	13.6	46.24	0.103807	0.307618	4.921888	0.172673
3.75	4.45	4.1	5	20.5	84.05	0.934262	0.283577	4.537229	0.0472
above	5.15	4.8	3	14.4	69.12	1.764716	0.136279	2.18046	0.308029
	Sum		16	58.6	225.28		1		0.5467324

$$\sigma = 0.842 \quad \text{Mean} = 3.66 \quad \chi^2 = 0.546$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$\chi^2 < \chi^2$ from Table

Accept H_0 : Observations conform to Normal Distribution

B-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2/E_i$
at or below	1.15					-2.55	0.005386		
1.15	1.65	1.4	1	1.4	1.96	-1.75	0.034673	0.640946	0.2011401
1.65	2.15	1.9	2	3.8	7.22	-0.95	0.130997	2.095952	0.0043926
2.15	2.65	2.4	3	7.2	17.28	-0.15	0.269326	4.309219	0.3977644
2.65	3.15	2.9	5	14.5	42.05	0.65	0.301772	4.828347	0.0061025
above	3.65	3.4	5	17	57.8	1.45	0.184317	2.949068	1.4263227
	Sum		16	43.9	126.31		1		2.0357224

$$\sigma = 0.625 \quad \text{Mean} = 2.74 \quad \chi^2 = 2.035$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$\chi^2 < \chi^2$ from Table

Accept H_0 : Observations conform to Normal Distribution

B-2

Lower Limit	Upper Limit	Xi	fi	fX	fX ²	Zi	Relative Frequency	Ei	(O _i -E _i) ² /E _i	
at or below	2					-2.65636	0.00395			
	2	2.8	2.4	1	2.4	5.76	-1.78897	0.03286	0.58895	0.2868868
	2.8	3.6	3.2	2	6.4	20.48	-0.92159	0.141561	2.264976	0.0309992
	3.6	4.4	4	3	12	48	-0.05421	0.300013	4.800207	0.6751259
	4.4	5.2	4.8	7	33.6	161.28	0.81317	0.313557	5.016905	0.7838829
above	6	5.6	3	16.8	94.08	1.680552	0.161635	2.586163	0.0662221	
	Sum		16	71.2	329.6		1		1.843117	

$$\sigma = 0.922 \quad \text{Mean} = 4.45 \quad \chi^2 = 1.843$$

$$v = 5-3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H₀: Observations conform to Normal Distribution

B-3

Lower Limit	Upper Limit	Xi	fi	fX	fX ²	Zi	Relative Frequency	Ei	(O _i -E _i) ² /E _i	
at or below	1.15					-2.53238	0.005665			
	1.15	1.55	1.35	1	1.35	1.8225	-1.70548	0.038388	0.704843	0.1235991
	1.55	1.95	1.75	2	3.5	6.125	-0.87858	0.145762	2.332192	0.0473166
	1.95	2.35	2.15	4	8.6	18.49	-0.05168	0.289577	4.633227	0.0865436
	2.35	2.75	2.55	5	12.75	32.5125	0.775217	0.301503	4.824049	0.0064176
above	3.15	2.95	4	11.8	34.81	1.602115	0.164541	2.632649	0.7101775	
	Sum		16	38	93.76		1		0.9740544	

$$\sigma = 0.483 \quad \text{Mean} = 2.375 \quad \chi^2 = 0.974$$

$$v = 5-3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H₀: Observations conform to Normal Distribution

C-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	11.95					-2.59517	0.004727		
	11.95	12.4	1	12.4	153.76	-1.76472	0.034078	0.620891	0.2314801
	12.85	13.3	2	26.6	353.78	-0.93426	0.136279	2.18046	0.0149354
	13.75	14.2	3	42.6	604.92	-0.10381	0.283577	4.537229	0.5208185
	14.65	15.1	6	90.6	1368.06	0.726648	0.307618	4.921888	0.2361545
above	16.45	16	4	64	1024	1.557103	0.173998	2.783963	0.5311657
	Sum		16	236.2	3504.52		1		1.5345542

$$\sigma = 1.083 \quad \text{Mean} = 14.76 \quad \chi^2 = 1.534$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-2

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$
at or below	7.1					-2.62461	0.004337		
	7.1	7.4	1	7.4	54.76	-1.81704	0.030268	0.553688	0.3597585
	7.7	8	2	16	128	-1.00947	0.12177	1.948321	0.0013708
	8.3	8.6	2	17.2	147.92	-0.20189	0.263625	4.217993	1.166311
	8.9	9.2	6	55.2	507.84	0.60568	0.307636	4.922179	0.2360131
above	10.1	9.8	5	49	480.2	1.413252	0.193573	3.097166	1.1690607
	Sum		16	144.8	1318.72		1		2.9325141

$$\sigma = 0.742 \quad \text{Mean} = 9.05 \quad \chi^2 = 2.932$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

C-3

Lower Limit	Upper Limit	\bar{x}_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$	
at or below	4.7					-2.53238	0.005665			
	4.7	5.1	4.9	1	4.9	24.01	-1.70548	0.038388	0.704843	0.1235991
	5.1	5.5	5.3	2	10.6	56.18	-0.87858	0.145762	2.332192	0.0473166
	5.5	5.9	5.7	4	22.8	129.96	-0.05168	0.289577	4.633227	0.0865436
	5.9	6.3	6.1	5	30.5	186.05	0.775217	0.301503	4.824049	0.0064176
above	6.7	6.5	4	26	169	1.602115	0.164541	2.632649	0.7101775	
	Sum		16	94.8	565.2		1		0.9740544	

$$\sigma = 0.483 \quad \text{Mean} = 5.925 \quad \chi^2 = 0.974$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-1

Lower Limit	Upper Limit	X_i	f_i	fX	fX^2	Z_i	Relative Frequency	E_i	$(O_i - E_i)^2 / E_i$	
at or below	4.35					-2.55	0.005386			
	4.35	4.65	4.5	1	4.5	20.25	-1.75	0.034673	0.640946	0.2011401
	4.65	4.95	4.8	2	9.6	46.08	-0.95	0.130997	2.095952	0.0043926
	4.95	5.25	5.1	3	15.3	78.03	-0.15	0.269326	4.309219	0.3977644
	5.25	5.55	5.4	5	27	145.8	0.65	0.301772	4.828347	0.0061025
above	5.85	5.7	5	28.5	162.45	1.45	0.184317	2.949068	1.4263227	
	Sum		16	84.9	452.61		1		2.0357224	

$$\sigma = 0.375 \quad \text{Mean} = 5.306 \quad \chi^2 = 2.035$$

$$v = 5 - 3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$$\chi^2 < \chi^2 \text{ from Table}$$

Accept H_0 : Observations conform to Normal Distribution

D-2

Lower Limit	Upper Limit	Xi	fi	fX	fX ²	Zi	Relative Frequency	Ei	(O _i -E _i) ² /E _i
at or below	3.825					-2.53238	0.005665		
3.825	4.175	4	1	4	16	-1.70548	0.038388	0.704843	0.1235991
4.175	4.525	4.35	2	8.7	37.845	-0.87858	0.145762	2.332192	0.0473166
4.525	4.875	4.7	4	18.8	88.36	-0.05168	0.289577	4.633227	0.0865436
4.875	5.225	5.05	5	25.25	127.5125	0.775217	0.301503	4.824049	0.0064176
above	5.575	5.4	4	21.6	116.64	1.602115	0.164541	2.632649	0.7101775
	Sum		16	78.35	386.3575		1		0.9740544

$$\sigma = 0.423 \quad \text{Mean} = 4.896 \quad \chi^2 = 0.974$$

$$v = 5-3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$\chi^2 < \chi^2$ from Table

Accept H₀: Observations conform to Normal Distribution

D-3

Lower Limit	Upper Limit	Xi	fi	fX	fX ²	Zi	Relative Frequency	Ei	(O _i -E _i) ² /E _i
at or below	4.075					-2.80011	0.002554		
4.075	4.425	4.25	1	4.25	18.0625	-1.92165	0.024771	0.437201	0.7244786
4.425	4.775	4.6	1	4.6	21.16	-1.04318	0.121108	1.937721	0.4537909
4.775	5.125	4.95	4	19.8	98.01	-0.16471	0.286153	4.57844	0.0730801
5.125	5.475	5.3	6	31.8	168.54	0.713754	0.327725	5.243607	0.1091101
above	5.825	5.65	4	22.6	127.69	1.592221	0.182022	2.912351	0.4061939
	Sum		16	83.05	433.4625		1		1.7666536

$$\sigma = 0.398 \quad \text{Mean} = 5.19 \quad \chi^2 = 1.766$$

$$v = 5-3 = 2 \quad \alpha = 0.05$$

From Table, $\chi^2 = 5.991$

$\chi^2 < \chi^2$ from Table

Accept H₀: Observations conform to Normal Distribution

Appendix A-3

Fitting the Distribution for the arrival of orders.

Orders/ 1/4 day	Frequency	P(x)	Number of Orders
0	176	0.49	
1	122	0.34	122
2	42	0.12	84
3	12	0.03	36
4	6	0.02	24
5	2	0.01	10
Sum	360	1.00	276

Expection of events = 0.767 order / 1/4 day

x	f(x)	E _i	O _i	(O _i - E _i) ² /E _i
0	0.464	167.19	176	0.465
1	0.356	128.23	122	0.303
2	0.137	49.18	42	1.047
3	0.035	12.57	12	1.406
4	0.007	2.41	6	
5	0.001	0.37	2	
	1			3.221

$$X^2 = 3.221$$

$$\text{Table: } X^2_{0.05,4-1-1} = 5.99 > X^2$$

Accept H₀: Observations conform to Normal Distribution

Appendix A-4

Verification of Simulation Model

Product A

F- Ratio test

Real	Simulation
21	20
17	18
16	19
18	18
15	15
	14
	15
	17
	15
	13
87	164

Mean 17.4 16.4
S.D. 2.302173 2.319003617

$F_{obs} =$ 1.014

$F_{0.05,4,9} =$ 3.63 $F_{obs} < F_{0.05,4,9}$

Accept H_0 : No difference between variances of data between real system and Simulation model

Use Student's t-Test

Pooled S.D. = 2.313837971
t = 0.789053461

v = 13

t .95,13 = 1.771 Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed t obs < 1.771

Conclusion: can't reject H_0

This model can be used to test the productivity of product A

Product B

F- Ratio test

	Real	Simulation
	17	14
	14	15
	13	15
	18	14
	19	22
		18
		13
		16
		18
		14
	81	159

Mean	16.2	15.9
S.D.	2.588436	2.726414006

$$F_{\text{obs}} = 1.1094$$

$$F_{0.05,4,9} = 3.63 \quad F_{\text{obs}} < F_{0.05,4,9}$$

Use Student's t-Test

Pooled S.D. =	2.684714567
t =	0.204015192

$$v = 13$$

$$t_{.95,13} = 1.771 \quad \text{Significant level} = .1$$

$$H_0: \text{means 1} = \text{means 2}$$

$$H_1: \text{means 1} \neq \text{means 2}$$

$$\text{two tailed} \quad t_{\text{obs}} < 1.771$$

Conclusion: can't reject H_0

This model can be used to test the productivity of product A

Product C

F- Ratio test

Real	Simulation
17	14
22	19
21	26
20	26
23	22
	21
	23
	18
	26
	24
103	219

Mean	20.6	21.9
S.D.	2.302173	3.984692934

$F_{obs} = 2.995807$

$F_{0.05,4,9} = 3.63$ $F_{obs} < F_{0.05,4,9}$

Accept H_0 : No difference between variances of data between real system and Simulation model

Use Student's t-Test

Pooled S.D. =	3.552896976
t =	-0.668036375

$v = 13$

$t_{.95,13} = 1.771$ Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed $t_{obs} > -1.771$

Conclusion: can't reject H_0

This model can be used to test the productivity of product A

Product D

F- Ratio test

Real	Simulation
21	19
20	17
19	16
17	17
15	17
	21
	20
	22
	15
	16
92	180

Mean	18.4	18		23.2	50	73.2
S.D.	2.408319	2.357022604		pooled S.D. = 2.3729		

 $F_{obs} = 0.957854$
 $F_{0.05,4,9} = 3.63$ $F_{obs} < F_{0.05,4,9}$

Accept H_0 : No difference between variances of data between real system and Simulation model

Use Student's t-Test

Pooled S.D. =	2.372924194
t =	0.307762357

 $v = 13$
 $t_{.95,13} = 1.771$ Significant level = .1

 H_0 : means 1 = means 2

 H_1 : means 1 \neq means 2

two tailed $t_{obs} < 1.771$
Conclusion: can't reject H_0

This model can be used to test the productivity of product A

Appendix A-5

Productivity Test for the suggested layout designs

Product A for the 2nd layout design

F- Ratio test

2nd	Current
16	20
18	18
12	19
19	18
21	15
29	14
23	15
13	17
12	15
19	13
182	164

Mean 18.2 16.4
 S.D. 3.420526 2.319003617

F_{obs} = 2.17562F_{0.05,9,9} = 3.18 F_{obs} < F_{0.05,9,9}Accept H₀: No difference between variances of data between current and 2nd design

Use Student's t-Test

Pooled S.D. = 2.299758441
 t = 1.750150054

v = 18

t .95,18 = 1.734 Significant level = .1

H₀: means 1 = means 2H₁: means 1 ≠ means 2

two tailed

t obs > 1.734

Conclude: Reject H₀

Productivity of 2nd design for Product A seems to be better than the current layout

Product B for the 2nd layout design

F- Ratio test

	2nd	Current
	18	14
	14	15
	20	15
	9	14
	15	22
	14	18
	14	13
	16	16
	10	18
	20	14
	150	159

Mean 15 15.9
 S.D. 4.207137 2.726414006

$F_{obs} =$ 2.381166

$F_{0.05,9,9} =$ 3.18 $F_{obs} < F_{0.05,9,9}$

Accept H_0 : No difference between variances of data between current and 2nd design

Use Student's t-Test

Pooled S.D. = 2.765863337
 t = -0.727606875

v = 18

$t_{.95,18} =$ 1.734 Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed

t obs > -1.734

Conclude: can't reject H_0

Productivity of 2nd design for Product B seems to equal to the current layout

Product C for the 2nd layout design

F- Ratio test

	2nd	Current
	22	14
	23	19
	20	26
	27	26
	20	22
	22	21
	27	23
	24	18
	24	26
	20	24
	229	219

Mean	22.9	21.9
S.D.	2.880972	3.984692934

$F_{obs} = 0.522743$

$F_{0.05,9,9} = 3.18$ $F_{obs} < F_{0.05,9,9}$

Accept H_0 : No difference between variances of data between current and 2nd design

Use Student's t-Test

Pooled S.D. =	3.12783205
t =	0.714893876

$v = 18$

$t_{.95,18} = 1.734$ Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed

$t_{obs} < 1.734$

Conclude: can't reject H_0

Productivity of 2nd design for Product C seems to equal to the current layout

Product D for the 2nd layout design

F- Ratio test

	2nd	Current
	20	19
	20	17
	18	16
	15	17
	21	17
	12	21
	14	20
	17	22
	20	15
	16	16
	173	180

Mean	17.3	18
S.D.	2.387467	2.357022604

$F_{obs} = 1.026$

$F_{0.05,9,9} = 3.18$ $F_{obs} < F_{0.05,9,9}$

Accept H_0 : No difference between variances of data between current and 2nd design

Use Student's t-Test

Pooled S.D. =	2.011080417
t =	-0.778311782

$v = 18$

$t_{.95,18} = 1.734$ Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed

$t_{obs} > -1.734$

Conclude: can't reject H_0

Productivity of 2nd design for Product C seems to equal to the current layout

Product A for the 4th layout design

F- Ratio test

4th	Current
21	20
23	18
14	19
15	18
15	15
20	14
21	15
20	17
18	15
20	13
187	164

Mean	18.7	16.4		67.2
S.D.	4.09878	2.319003617	pooled S.D. =	2.5342

$F_{obs} = 3.123967$

$F_{0.05,9,9} = 3.18$ $F_{obs} < F_{0.05,9,9}$

Accept H_0 : No difference between variances of data between current and 4th design

Use Student's t-Test

Pooled S.D. =	2.534210374
t =	2.029411765

$v = 18$

$t_{.95,18} = 1.734$ Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed

$t_{obs} > 1.734$

Conclude: Reject H_0

Productivity of 4th design for Product A seems to be better than the current layout

Product B for the 4th layout design

F- Ratio test

4th	Current
13	14
11	15
17	15
12	14
15	22
23	18
13	13
14	16
16	18
11	14
145	159

Mean	14.5	15.9		23.2
S.D.	2.408319	2.726414006	pooled S.D. =	2.2373

$F_{obs} = 1.281609$

$F_{0.05,9,9} = 3.18$ $F_{obs} < F_{0.05,9,9}$

Accept H_0 : No difference between variances of data between current and 4th design

Use Student's t-Test

Pooled S.D. =	2.237309893
t =	-1.39922287

v = 18

$t_{.95,18} = 1.734$ Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed

t obs > 1.734

Conclude: can't reject H_0

Productivity of 4th design for Product B seems to equal to the current layout

Product C for the 4th layout design

F- Ratio test

4th	Current
18	14
28	19
27	26
31	26
31	22
20	21
26	23
24	18
25	26
18	24
248	219

Mean	24.8	21.9		114
S.D.	5.338539	3.984692934	pooled S.D. =	3.7779

$F_{obs} = 1.794962$

$F_{0.05,9,9} = 3.18$ $F_{obs} < F_{0.05,9,9}$

Accept H_0 : No difference between variances of data between current and 4th design

Use Student's t-Test

Pooled S.D. =	3.777859476
t =	1.716473886

$v = 18$

$t_{.95,18} = 1.734$ Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed

$t_{obs} < 1.734$

Conclude: can't reject H_0

Productivity of 4th design for Product B seems to equal to the current layout

Product D for the 4th layout design

F- Ratio test

4th	Current
23	19
20	17
16	16
14	17
14	17
15	21
19	20
20	22
18	15
24	16
183	180

Mean	18.3	18		63.2
S.D.	3.974921	2.357022604	pooled S.D. =	2.5078

$F_{obs} = 2.844$

$F_{0.05,9,9} = 3.18$ $F_{obs} < F_{0.05,9,9}$

Accept H_0 : No difference between variances of data between current and 4th design

Use Student's t-Test

Pooled S.D. =	2.507765717
t =	0.267497234

$v = 18$

$t_{.95,18} = 1.734$ Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed

$t_{obs} > -1.734$

Conclude: can't reject H_0

Productivity of 4th design for Product C seems to equal to the current layout

Appendix A-6

Productivity Test between the suggested layout designs

Product A

F- Ratio test

	2nd	4th
	16	21
	18	23
	12	14
	19	15
	21	15
	29	20
	23	21
	13	20
	12	18
	19	20
	182	187

Mean	18.2	18.7
S.D.	3.420526	3.056868405

$F_{obs} = 1.252081$

$F_{0.05,9,9} = 3.18$ $F_{obs} < F_{0.05,9,9}$

Accept H_0 : No difference between variances of data between both models

Use Student's t-Test

Pooled S.D. =	2.696705809	
t =	-0.414592495	

v = 18

$t_{.95,18} = 1.734$ Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed

$t_{obs} > -1.734$

Conclude: Reject H_0

Productivity of 2nd design for Product B seems to equal to the 4th design

Product B

F- Ratio test

	2nd	4th
	18	13
	14	11
	20	17
	9	12
	15	15
	14	23
	14	13
	16	14
	10	16
	20	11
	150	145

Mean 15 14.5
S.D. 4.207137 3.597838857

$F_{obs} = 1.367382$

$F_{0.05,9,9} = 3.18$ $F_{obs} < F_{0.05,9,9}$

Accept H_0 : No difference between variances of data between both models

Use Student's t-Test

Pooled S.D. = 3.225764337
t = 0.346595062

v = 18

t .95,18 = 1.734 Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 means 2

two tailed

t obs < 1.734

Conclude: can't reject H_0

Productivity of 2nd design for Product B seems to equal to the 4th layout

Product C

F- Ratio test

	2nd	4th
	22	18
	23	28
	20	27
	27	31
	20	31
	22	20
	27	26
	24	24
	24	25
	20	18
	229	248

Mean	22.9	24.8
S.D.	2.880972	4.825856286

$F_{obs} = 0.356393$

$F_{0.05,9,9} = 3.18$ $F_{obs} < F_{0.05,9,9}$

Accept H_0 : No difference between variances of data between both models

Use Student's t-Test

Pooled S.D. =	3.672722272
t =	-1.156779316

$v = 18$

$t_{.95,18} = 1.734$ Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed

$t_{obs} > -1.734$

Conclude: can't reject H_0

Productivity of 2nd design for Product B seems to equal to the 4th layout

Product D

F- Ratio test

	2nd	4th
	20	23
	20	20
	18	16
	15	14
	21	14
	12	15
	14	19
	17	20
	20	18
	16	24
	173	183

Mean 17.3 18.3
S.D. 2.387467 3.560586718

$F_{obs} =$ 0.449606

$F_{0.05,9,9} =$ 3.18 $F_{obs} < F_{0.05,9,9}$

Accept H_0 : No difference between variances of data between both models

Use Student's t-Test

Pooled S.D. = 2.757817172
 $t =$ -0.810810811

$v =$ 18

$t_{.95,18} =$ 1.734 Significant level = .1

H_0 : means 1 = means 2

H_1 : means 1 \neq means 2

two tailed

$t_{obs} > -1.734$

Conclude: can't reject H_0

Productivity of 2nd design for Product B seems to equal to the 4th layout

Appendix B

Model for the current layout of Factory A

ProModel model: PRJ4.TXT
 * Factory A

ROUTING

Part	Location	Operation (min)	Output part	Next location	Condi- tion	Qty	Move time (min)
ORDER	DEPT	0	A	CO1	238	1	0
			B	CO2	191	0	0
			C	CO3	333	0	0
			X	CO4	238	0	0
A	CO1	0	A1	STORE	400	1	0
			A2	STORE	400	0	0
			A3	STORE	200	0	0
A1	STORE	0	A1	INE	0	1	N 18.65,4.3
A1	INE	0	A1	EXT	0	1	0
A1	EXT	N 610.5,132	A1E	INL	0	1	N 98.17,21.1
			A1E	STOREL	ALT	0	N 98.17,21.1
A1E	STOREL	0	A1E	INL	0	1	N 62.47,13.4
A1E	INL	0	A1E	LABEL	0	1	0
A1E	LABEL	N 296,64	A1EL	INP	0	1	N 62.47,13.4
			A1EL	STOREP	ALT	0	N 62.47,13.4
A1EL	STOREP	0	A1EL	INP	0	1	N 26.77,5.7
A1EL	INP	0	A1EL	PRINT	0	1	0
A1EL	PRINT	N 324,69	A1ELP	INI	0	1	N 26.77,5.7
			A1ELP	STOREI	ALT	0	N 26.77,5.7
A1ELP	STOREI	0	A1ELP	INI	0	1	N 62.47,13.2
A1ELP	INI	0	A1ELP	INSPEC	0	1	0
A1ELP	INSPEC	N 249,53	A1I	INPK	0	1	N 30.34,6.5
A1I	INPK	0	A1I	PACK	0	1	0
A1I	PACK	N 243,53	A1F	EXIT	0	1	N 21.42,4.6
A2	STORE	0	A2	INE	0	1	N 15.78,4.3
A2	INE	0	A2	EXT	0	1	0
A2	EXT	N 693,148	A2E	INL	0	1	N 144.37,30.8
			A2E	STOREL	ALT	0	N 144.37,30.8
A2E	STOREL	0	A2E	INL	0	1	N 91.87,19.6
A2E	INL	0	A2E	LABEL	0	1	0
A2E	LABEL	N 211,46	A2EL	INP	0	1	N 91.87,19.6
			A2EL	STOREP	ALT	0	N 91.87,19.6
A2EL	STOREP	0	A2EL	INP	0	1	N 39.37,8.4
A2EL	INP	0	A2EL	PRINT	0	1	0
A2EL	PRINT	N 226,46	A2ELP	INI	0	1	N 39.37,8.4
			A2ELP	STOREI	ALT	0	N 39.37,8.4
A2ELP	STOREI	0	A2ELP	INI	0	1	N 91.87,19.6
A2ELP	INI	0	A2ELP	INSPEC	0	1	0
A2ELP	INSPEC	N 177,40	A2I	INPK	0	1	N 44.62,9.5
A2I	INPK	0	A2I	PACK	0	1	0
A2I	PACK	N 172,37	A2F	EXIT	0	1	N 31.5,6.7
A3	STORE	0	A3	INE	0	1	N 18.65,4.3
A3	INE	0	A3	EXT	0	1	0
A3	EXT	N 1111,252	A3E	INL	0	1	N 250.25,57.7
			A3E	STOREL	ALT	0	N 250.25,57.7
A3E	STOREL	0	A3E	INL	0	1	N 159.25,36.7
A3E	INL	0	A3E	LABEL	0	1	0
A3E	LABEL	N 129,28	A3EL	INP	0	1	N 159.25,36.7
			A3EL	STOREP	ALT	0	N 159.25,36.7
A3EL	STOREP	0	A3EL	INP	0	1	N 68.25,15.7
A3EL	INP	0	A3EL	PRINT	0	1	0
A3EL	PRINT	N 135,28	A3ELP	INI	0	1	N 68.25,15.7
			A3ELP	STOREI	ALT	0	N 68.25,15.7
A3ELP	STOREI	0	A3ELP	INI	0	1	N 159.25,36.7
A3ELP	INI	0	A3ELP	INSPEC	0	1	0
A3ELP	INSPEC	N 231,50	A3I	INPK	0	1	N 77.35,17.8

A3I	INPK	0	A3I	PACK	0	1	0
A3I	PACK	N 219,50	A3F	EXIT	0	1	N 54.6,12.6
B	CO2	0	B1	STORE	500	1	0
			B2	STORE	250	0	0
			B3	STORE	250	0	0
B1	STORE	0	B1	INE	0	1	N 14.35,4.3
B1	INE	0	B1	EXT	0	1	0
B1	EXT	N 483,105	B1E	INP	0	1	N 78.92,17.3
			B1E	STOREP	ALT	0	N 78.92,17.3
B1E	STOREP	0	B1E	INP	0	1	N 21.52,4.7
B1E	INP	0	B1E	PRINT	0	1	0
B1E	PRINT	N 210,45	B1EP	INI	0	1	N 21.52,4.7
			B1EP	STOREI	ALT	0	N 21.52,4.7
B1EP	STOREI	0	B1EP	INI	0	1	N 50.22,11
B1EP	INI	0	B1EP	INSPEC	0	1	0
B1EP	INSPEC	N 170,37	B1I	INPK	0	1	N 24.39,5.3
B1I	INPK	0	B1I	PACK	0	1	0
B1I	PACK	N 164,37	B1F	EXIT	0	1	N 17.22,3.7
B2	STORE	0	B2	INE	0	1	N 24.39,5.7
B2	INE	0	B2	EXT	0	1	0
B2	EXT	N 1095,228	B2E	INP	0	1	N 227.15,48.1
			B2E	STOREP	ALT	0	N 227.15,48.1
B2E	STOREP	0	B2E	INP	0	1	N 61.95,13.1
B2E	INP	0	B2E	PRINT	0	1	0
B2E	PRINT	N 188,41	B2EP	INI	0	1	N 61.95,13.1
			B2EP	STOREI	ALT	0	N 61.95,13.1
B2EP	STOREI	0	B2EP	INI	0	1	N 144.55,30.6
B2EP	INI	0	B2EP	INSPEC	0	1	0
B2EP	INSPEC	N 288,61	B2I	INPK	0	1	N 70.21,14.8
B2I	INPK	0	B2I	PACK	0	1	0
B2I	PACK	N 267,55	B2F	EXIT	0	1	N 49.56,10.5
B3	STORE	0	B3	INE	0	1	N 12.91,2.8
B3	INE	0	B3	EXT	0	1	0
B3	EXT	N 761,166	B3E	INP	0	1	N 171.32,38.5
			B3E	STOREP	ALT	0	N 171.32,38.5
B3E	STOREP	0	B3E	INP	0	1	N 46.72,10.5
B3E	INP	0	B3E	PRINT	0	1	0
B3E	PRINT	N 99,21	B3EP	STOREI	0	1	N 46.72,10.5
B3EP	STOREI	0	B3EP	INI	0	1	N 109.02,24.5
B3EP	INI	0	B3EP	INSPEC	0	1	0
B3EP	INSPEC	N 154,36	B3I	INPK	0	1	N 52.95,11.9
B3I	INPK	0	B3I	PACK	0	1	0
B3I	PACK	N 142,29	B3F	EXIT	0	1	N 37.38,8.4
C	CO3	0	C1	STORE	428	1	0
			C2	STORE	286	0	0
			C3	STORE	286	0	0
C1	STORE	0	C1	INS	0	1	N 22.68,1.89
C1	INS	0	C1	STRETCH	0	1	0
C1	STRETCH	N 925,72	C1S	INL	0	1	N 304.5,24.3
			C1S	STOREL	ALT	0	N 304.5,24.3
C1S	STOREL	0	C1S	INL	0	1	N 183.75,14.7
C1S	INL	0	C1S	LABEL	0	1	0
C1S	LABEL	N 1036,161	C1SL	INP	0	1	N 183.75,14.7
			C1SL	STOREP	ALT	0	N 183.75,14.7
C1SL	STOREP	0	C1SL	INP	0	1	N 78.75,6.3
C1SL	INP	0	C1SL	PRINT	0	1	0
C1SL	PRINT	N 1130,175	C1SLP	INI	0	1	N 78.75,6.3
			C1SLP	STOREI	ALT	0	N 78.75,6.3
C1SLP	STOREI	0	C1SLP	INI	0	1	N 183.75,14.7
C1SLP	INI	0	C1SLP	INSPEC	0	1	0
C1SLP	INSPEC	N 922,72	C1I	INPK	0	1	N 89.25,7.1
C1I	INPK	0	C1I	PACK	0	1	0
C1I	PACK	N 885,64	C1F	EXIT	0	1	N 63,5
C2	STORE	0	C2	INS	0	1	N 20.79,1.8

C2	INS	0		C2	STRETCH	0	1	0	
C2	STRETCH	N	951,74	C2S	INL	0	1	N	470.96,38.5
C2S	STOREL	0		C2S	STOREL	ALT	0	N	470.96,38.5
C2S	INL	0		C2S	INL	0	1	N	284.2,23.2
C2S	LABEL	N	612,93	C2S	LABEL	0	1	0	
C2SL	STOREP	0		C2SL	INP	0	1	N	284.2,23.2
C2SL	INP	0		C2SL	STOREP	ALT	0	N	284.2,23.2
C2SL	PRINT	N	662,91	C2SL	INP	0	1	N	121.8,9.9
C2SLP	STOREI	0		C2SL	PRINT	0	1	0	
C2SLP	INI	0		C2SLP	INI	0	1	N	121.8,9.9
C2SLP	INSPEC	N	558,44	C2SLP	STOREI	ALT	0	N	121.8,9.9
C2I	INPK	0		C2SLP	INI	0	1	0	
C2I	PACK	N	543,44	C2SLP	INSPEC	0	1	N	284.2,23.2
C3	STORE	0		C2I	INPK	0	1	N	138.04,11.3
C3	INS	0		C2I	PACK	0	1	0	
C3	STRETCH	N	753,58	C2F	EXIT	0	1	N	97.44,7.9
C3S	STOREL	0		C3	INS	0	1	N	13.86,1.2
C3S	INL	0		C3	STRETCH	0	1	0	
C3S	LABEL	N	418,61	C3S	INL	0	1	N	434.42,34.5
C3SL	STOREP	0		C3S	STOREL	ALT	0	N	434.42,34.5
C3SL	INP	0		C3S	INL	0	1	N	262.15,20.8
C3SL	PRINT	N	462,74	C3S	LABEL	0	1	0	
C3SLP	STOREI	0		C3SL	INP	0	1	N	262.15,20.8
C3SLP	INI	0		C3SL	STOREP	ALT	0	N	262.15,20.8
C3SLP	INSPEC	N	367,28	C3SL	INP	0	1	N	112.35,8.9
C3I	INPK	0		C3SL	PRINT	0	1	0	
C3I	PACK	N	355,28	C3SLP	INI	0	1	N	112.35,8.9
X	CO4	0		C3SLP	STOREI	ALT	0	N	112.35,8.9
X1	STORE	0		C3SLP	INI	0	1	N	262.15,20.8
X1	INS	0		C3SLP	INSPEC	0	1	0	
X1	STRETCH	N	500,37	C3I	INPK	0	1	N	127.33,10.1
X1S	STOREP	0		C3I	PACK	0	1	0	
X1S	INP	0		C3F	EXIT	0	1	N	89.88,7.1
X1S	PRINT	N	381,49	X1	STORE	400	1	0	
X1SP	STOREI	0		X2	STORE	400	0	0	
X1SP	INI	0		X3	STORE	200	0	0	
X1SP	INSPEC	N	333,27	X1	INS	0	1	N	12.6,1.2
X1I	INPK	0		X1	STRETCH	0	1	0	
X1I	PACK	N	318,22	X1S	INP	0	1	N	164.43,14.2
X2	STORE	0		X1S	STOREP	ALT	0	N	164.43,14.2
X2	INS	0		X1S	INP	0	1	N	42.52,3.6
X2	STRETCH	N	512,42	X1S	PRINT	0	1	0	
X2S	STOREP	0		X1SP	INI	0	1	N	42.52,3.6
X2S	INP	0		X1SP	STOREI	ALT	0	N	42.52,3.6
X2S	PRINT	N	379,49	X1SP	INI	0	1	N	99.22,8.5
X2SP	STOREI	0		X1SP	INSPEC	0	1	0	
X2SP	INI	0		X1I	INPK	0	1	N	48.19,4.1
X2SP	INSPEC	N	307,28	X1I	PACK	0	1	0	
X2I	INPK	0		X1F	EXIT	0	1	N	34.02,2.9
X2I	PACK	N	293,25	X2	INS	0	1	N	11.34,1.2
X3	STORE	0		X2	STRETCH	0	1	0	
X3	INS	0		X2S	INP	0	1	N	253.75,22.3
X3	STRETCH	N	652,47	X2S	STOREP	ALT	0	N	253.75,22.3
				X2S	INP	0	1	N	65.62,5.7
				X2S	PRINT	0	1	0	
				X2SP	INI	0	1	N	65.62,5.7
				X2SP	STOREI	ALT	0	N	65.62,5.7
				X2SP	INI	0	1	N	153.12,13.4
				X2SP	INSPEC	0	1	0	
				X2I	INPK	0	1	N	74.37,6.5
				X2I	PACK	0	1	0	
				X2F	EXIT	0	1	N	52.5,4.6
				X3	INS	0	1	N	11.97,1.2
				X3	STRETCH	0	1	0	
				X3S	INP	0	1	N	375.55,28.4

X3S	STOREP	0	X3S	STOREP	ALT	0	N	375.55,28.4
X3S	INP	0	X3S	INP	0	1	N	97.12,7.3
X3S	PRINT	N 368,25	X3S	PRINT	0	1	0	
X3SP	STOREI	0	X3SP	INI	0	1	N	97.12,7.3
X3SP	INI	0	X3SP	STOREI	ALT	0	N	97.12,7.3
X3SP	INSPEC	N 317,23	X3SP	INI	0	1	N	226.62,17.1
X3I	INPK	0	X3SP	INSPEC	0	1	0	
X3I	PACK	N 311,23	X3I	INPK	0	1	N	110.07,8.3
			X3I	PACK	0	1	0	
			X3F	EXIT	0	1	N	77.7,5.8

PART SCHEDULING

Part	Location	Qty per arrival	No. of arrivals	Start (min)	Arrival frequency (min)
ORDER	DEPT	1	300	0	E 469

CAPACITIES

Resource	Qty	Resource	Qty	Resource	Qty	Resource	Qty	Resource	Qty
CO1	50	CO2	50	CO3	50	CO4	50	DEPT	50
EXT	2	INE	1	INL	1	INP	1	INI	1
INL	1	INP	1	INPK	1	INSPEC	1	INSPEC	1
LABEL	1	OUTS	1	PACK	1	PRINT	1	STORE	50
STOREI	20	PRINT	1	STORE	50	STOREI	1	STOREL	20
STOREP	20	STRETCH	1						

SIMULATION PARAMETERS

Run (hrs)	Startup (hrs)	Rept code	Resource to track	Seed
660	0	4	0	9

GRAPHIC OPTIONS

Graph mode	Max row	Max col	Scr clr	Fig clr	Icon file
0	100	160	0	0	0

END

BIOGRAPHY

Mr. Akaret Tangsuwan was born on January 4, 1977 in Nakhonrassima, Thailand. He obtained the Bachelor's Degree in Electronic Engineering from King Mongkut Institute Technology of Ladkrabang in 1996 academic year. He started working at Telecom Asia (TA). In 1998, he continued his graduate study in Engineering Management at the Regional Centre for Manufacturing Systems Engineering at Chulalongkorn University. In 2000, he moved to Siemens Ltd. in Mobile Business department.

