1.

Customer Number	Customer Type	Interarrival Time (min)	Arrival Time	Service Time (min)	Time Service Begins	Waiting Time in Queue (min)	Time Service Ends	Time Customer Spends in System (min)
1	H	20	20	5	20	0	25	5
2	H	20	40	5	40	0	45	5
3	T	10	50	10	50	0	60	10
4	H	20	70	5	70	0	75	5
5	T	10	80	10	80	0	90	10
6	H	20	100	5	100	0	105	5
7	T	10	110	10	110	0	120	10
8	H	20	130	5	130	0	135	5
9	H	20	150	5	150	0	155	5
10	T	10	160	10	160	0	170	10
11	H	20	180	5	180	0	185	5
12	H	20	200	5	200	0	205	5
13	H	20	220	5	220	0	225	5
14	T	10	230	10	230	0	240	10
15	H	20	250	5	250	0	255	5
Event Type	Customer Number	Customer Type	Clock Time					
Arrival	1	H	20					
Departure	1	H	25					
Arrival	2	H	40					
Departure	2	H	45					
Arrival	3	T	50					
Departure	3	T	60					
Arrival	4	H	70					
Departure	4	H	75					
Arrival	5	T	80					
Departure	5	T	90					
Arrival	6	H	100					

Departure	6	H	105					
Arrival	7	T	110					
Departure	7	T	120					
Arrival	8	H	130					
Departure	8	H	135					
Arrival	9	H	150					
Departure	9	H	155					
Arrival	10	T	160					
Departure	10	T	170					
Arrival	11	H	180					
Departure	11	H	185					
Arrival	12	H	200					
Departure	12	H	205					
Arrival	13	H	220					
Departure	13	H	225					
Arrival	14	T	230					
Departure	14	T	240					
Arrival	15	H	250					
Departure	15	H	255					

2. a) average service time: $1/\mu = 100/15 \approx 6.67$ min

b) average interarrival time: $1/\lambda = 250/15 \approx 16.67$ min

c) server utilization = $\lambda/\mu = 1/(250/25) / 1/(100/15) = (25/250) / (15/100) = 0.40$

d) theoretical average service time = $(8*5+7*10) / 15 = 110/15 \approx 7.33$ min

theoretical average interarrival time = $(8*20 + 7*10) / 15 = 230/15 \approx 15.33$ min

theoretical server utilization = $\lambda/\mu = 1/(230/15) / 1/(110/15) = 110/230 \approx 0.48$

There is a discrepancy between theoretical and simulated results. In theory, the probability of getting head and tail is 50% and 50%. In a simulated result, there is a random probability of getting heads and tails, which could result in a different unequal number of heads and tails.

e) average time customer spends in the system = 100/15 ≈ 6.67 min

f) 1) average service time = 5*p + 10*(1-p) = 10-5p

2) average interarrival time = 20*p+ 10*(1-p) = 10p+10
λ/μ < 1, (1/(10+10p)) / (1/(10-5p)) < 1

(10-5p) / (10+10P) < 1

p > 0

1 > p > 0

3. a) Mean of interarrival time: 4.5
Type of distribution: exponential

b) Mean of service time: 3.2
Type of distribution: normal

c) p = λ/μ = (1/4.5) / (1/3.2) = 3.2/4.5 = 0.71

d) Seed 123

SINGLE SERVER QUEUE SIMULATION - GROCERY STORE CHECKOUT COUNTER

MEAN INTERARRIVAL TIME	4.484937414241473
MEAN SERVICE TIME	3.2038784013913877
STANDARD DEVIATION OF SERVICE TIMES	0.6
NUMBER OF CUSTOMERS SERVED	10000
SERVER UTILIZATION	0.7049222216971142
MAXIMUM LINE LENGTH	12.0
AVERAGE RESPONSE TIME	7.115576370796644 MINUTES
PROPORTION WHO SPEND FOUR MINUTES OR MORE IN SYSTEM	0.6719
SIMULATION RUNLENGTH	45446.83664344078 MINUTES
NUMBER OF DEPARTURES	10000

Seed 1234

SINGLE SERVER QUEUE SIMULATION - GROCERY STORE CHECKOUT COUNTER

MEAN INTERARRIVAL TIME	4.5045104664108795
MEAN SERVICE TIME	3.203995395418198
STANDARD DEVIATION OF SERVICE TIMES	0.6
NUMBER OF CUSTOMERS SERVED	10000
SERVER UTILIZATION	0.7066296138298112
MAXIMUM LINE LENGTH	11.0
AVERAGE RESPONSE TIME	7.174039890912215 MINUTES
PROPORTION WHO SPEND FOUR	

MINUTES OR MORE IN SYSTEM 0.6715
SIMULATION RUNLENGTH 45336.54043668547 MINUTES
NUMBER OF DEPARTURES 10000

e) seed 123

SINGLE SERVER QUEUE SIMULATION - GROCERY STORE CHECKOUT COUNTER

MEAN INTERARRIVAL TIME 4.510485949306854
MEAN SERVICE TIME 3.2017824924828995
STANDARD DEVIATION OF SERVICE TIMES 0.6
NUMBER OF CUSTOMERS SERVED 50000
SERVER UTILIZATION 0.713978871038784
MAXIMUM LINE LENGTH 13.0
AVERAGE RESPONSE TIME 7.403404868300479 MINUTES
PROPORTION WHO SPEND FOUR
MINUTES OR MORE IN SYSTEM 0.68154
SIMULATION RUNLENGTH 224217.80229046897 MINUTES
NUMBER OF DEPARTURES 50000

Seed 1234

SINGLE SERVER QUEUE SIMULATION - GROCERY STORE CHECKOUT COUNTER

MEAN INTERARRIVAL TIME 4.504641323891673
MEAN SERVICE TIME 3.20457039662842
STANDARD DEVIATION OF SERVICE TIMES 0.6
NUMBER OF CUSTOMERS SERVED 50000
SERVER UTILIZATION 0.7084635924931595
MAXIMUM LINE LENGTH 15.0
AVERAGE RESPONSE TIME 7.253838061225486 MINUTES
PROPORTION WHO SPEND FOUR
MINUTES OR MORE IN SYSTEM 0.67552
SIMULATION RUNLENGTH 226163.37879489307 MINUTES
NUMBER OF DEPARTURES 50000

f) Although e part has more customers than the d part, there's not a significant difference on the mean interarrival time, mean service time or the server utilization. One insignificant difference we can notice is the longer maximum line length for 50000 customers simulation, which is reasonable due more customers in the simulation.

g)

Seed 123

SINGLE SERVER QUEUE SIMULATION - GROCERY STORE CHECKOUT COUNTER

MEAN INTERARRIVAL TIME 4.511166369575721
MEAN SERVICE TIME 3.2360090364298326

STANDARD DEVIATION OF SERVICE TIMES 0.6
NUMBER OF CUSTOMERS SERVED 10000
SERVER UTILIZATION 0.7100634020074623
MAXIMUM LINE LENGTH 25.0
AVERAGE RESPONSE TIME 11.446153839480445 MINUTES
PROPORTION WHO SPEND FOUR
MINUTES OR MORE IN SYSTEM 0.6928
SIMULATION RUNLENGTH 45568.403773886836 MINUTES
NUMBER OF DEPARTURES 10000

Seed 1234
SINGLE SERVER QUEUE SIMULATION - GROCERY STORE CHECKOUT COUNTER
MEAN INTERARRIVAL TIME 4.489140628133454
MEAN SERVICE TIME 3.2164653487482955
STANDARD DEVIATION OF SERVICE TIMES 0.6
NUMBER OF CUSTOMERS SERVED 10000
SERVER UTILIZATION 0.7133888775462107
MAXIMUM LINE LENGTH 22.0
AVERAGE RESPONSE TIME 10.92358311078041 MINUTES
PROPORTION WHO SPEND FOUR
MINUTES OR MORE IN SYSTEM 0.7086
SIMULATION RUNLENGTH 45082.352392194174 MINUTES
NUMBER OF DEPARTURES 10000

h)
Seed 123
SINGLE SERVER QUEUE SIMULATION - GROCERY STORE CHECKOUT COUNTER
MEAN INTERARRIVAL TIME 4.516499641526125
MEAN SERVICE TIME 3.1893044221619977
STANDARD DEVIATION OF SERVICE TIMES 0.6
NUMBER OF CUSTOMERS SERVED 50000
SERVER UTILIZATION 0.7087349765144222
MAXIMUM LINE LENGTH 32.0
AVERAGE RESPONSE TIME 11.012533551721186 MINUTES
PROPORTION WHO SPEND FOUR
MINUTES OR MORE IN SYSTEM 0.69354
SIMULATION RUNLENGTH 224995.01801963578 MINUTES
NUMBER OF DEPARTURES 50000

Seed 1234
SINGLE SERVER QUEUE SIMULATION - GROCERY STORE CHECKOUT COUNTER
MEAN INTERARRIVAL TIME 4.498940378902244
MEAN SERVICE TIME 3.2044688119616906
STANDARD DEVIATION OF SERVICE TIMES 0.6

NUMBER OF CUSTOMERS SERVED 50000
SERVER UTILIZATION 0.7093996850768385
MAXIMUM LINE LENGTH 25.0
AVERAGE RESPONSE TIME 11.155914150236947 MINUTES
PROPORTION WHO SPEND FOUR
MINUTES OR MORE IN SYSTEM 0.69628
SIMULATION RUNLENGTH 225852.44047861075 MINUTES
NUMBER OF DEPARTURES 50000

Seed 234
SINGLE SERVER QUEUE SIMULATION - GROCERY STORE CHECKOUT COUNTER
MEAN INTERARRIVAL TIME 4.516410114374245
MEAN SERVICE TIME 3.1804260185630278
STANDARD DEVIATION OF SERVICE TIMES 0.6
NUMBER OF CUSTOMERS SERVED 50000
SERVER UTILIZATION 0.7033172095038384
MAXIMUM LINE LENGTH 24.0
AVERAGE RESPONSE TIME 10.491173563237954 MINUTES
PROPORTION WHO SPEND FOUR
MINUTES OR MORE IN SYSTEM 0.68812
SIMULATION RUNLENGTH 226101.28041674607 MINUTES
NUMBER OF DEPARTURES 50000

Seed 2345
SINGLE SERVER QUEUE SIMULATION - GROCERY STORE CHECKOUT COUNTER
MEAN INTERARRIVAL TIME 4.490652551142984
MEAN SERVICE TIME 3.191028872338437
STANDARD DEVIATION OF SERVICE TIMES 0.6
NUMBER OF CUSTOMERS SERVED 50000
SERVER UTILIZATION 0.7060200693999877
MAXIMUM LINE LENGTH 29.0
AVERAGE RESPONSE TIME 10.471727092716197 MINUTES
PROPORTION WHO SPEND FOUR
MINUTES OR MORE IN SYSTEM 0.69314
SIMULATION RUNLENGTH 225981.36199304878 MINUTES
NUMBER OF DEPARTURES 50000

Seed 345
SINGLE SERVER QUEUE SIMULATION - GROCERY STORE CHECKOUT COUNTER
MEAN INTERARRIVAL TIME 4.513367178971067
MEAN SERVICE TIME 3.1794816971021644
STANDARD DEVIATION OF SERVICE TIMES 0.6
NUMBER OF CUSTOMERS SERVED 50000

SERVER UTILIZATION	0.704817851116021
MAXIMUM LINE LENGTH	21.0
AVERAGE RESPONSE TIME	10.59076296407124 MINUTES
PROPORTION WHO SPEND FOUR MINUTES OR MORE IN SYSTEM	0.6883
SIMULATION RUNLENGTH	225550.77244381697 MINUTES
NUMBER OF DEPARTURES	50000

Mean of mean interarrival time
(4.516499641526125 + 4.498940378902244 + 4.516410114374245 + 4.490652551142984 + 4.513367178971067)/5 = 4.50717397298
Variance of mean interarrival time
((4.516499641526125 - 4.50717397298)^2 + (4.498940378902244 - 4.50717397298)^2 + (4.516410114374245 - 4.50717397298)^2 + (4.490652551142984 - 4.50717397298)^2 + (4.513367178971067 - 4.50717397298)^2) / 5 = 0.000110275

Mean of mean service time
(3.1893044221619977 + 3.2044688119616906 + 3.1804260185630278 + 3.191028872338437 + 3.1794816971021644) / 5 ≈ 3.1889419644254637
Variance of mean service time
((3.1893044221619977 - 3.1889419644254637)^2 + (3.2044688119616906 - 3.1889419644254637)^2 + (3.1804260185630278 - 3.1889419644254637)^2 + (3.191028872338437 - 3.1889419644254637)^2 + (3.1794816971021644 - 3.1889419644254637)^2) / 5 ≈ 0.0000630361603585

Mean of server utilization
(0.7087349765144222 + 0.7093996850768385 + 0.7033172095038384 + 0.7060200693999877 + 0.704817851116021) / 5 ≈ 0.7064579583202218
Variance of server utilization
((0.7087349765144222 - 0.7064579583202218)^2 + (0.7093996850768385 - 0.7064579583202218)^2 + (0.7033172095038384 - 0.7064579583202218)^2 + (0.7060200693999877 - 0.7064579583202218)^2 + (0.704817851116021 - 0.7064579583202218)^2) / 5 ≈ 0.000000416889016

Mean of average response time
(11.012533551721186 + 11.155914150236947 + 10.491173563237954 + 10.471727092716197 + 10.59076296407124) / 5 ≈ 10.744222264396706
Variance of average response time
((11.012533551721186 - 10.744222264396706)^2 + (11.155914150236947 - 10.744222264396706)^2 + (10.491173563237954 - 10.744222264396706)^2 + (10.471727092716197 - 10.744222264396706)^2 + (10.59076296407124 - 10.744222264396706)^2) / 5 ≈ 0.08066791251717687

The mean of interarrival time, service time and especially server utilization is very close to previous 50000 customers simulation and the variance for each is very low. Even though the variance for average response time is higher than the rest, it is reasonable considering the number of customers.

4.

With uniformed service distribution

TOTALS	424		343		234		577	85
AVERAGES	4.28		3.43		2.34		5.77	
Number of Customers =			100					
Simulation Table								
Step	**Activity**	**Clock**	**Activity**	**Clock**	**Output**	**Clock**	**Output**	**Output**
Customer	**Interarrival Time (Minutes)**	**Arrival Time**	**Service Time (Minutes)**	**Time Service Begins**	**Waiting Time in Queue (Minutes)**	**Time Service Ends**	**Time Customer Spends in System (Minutes)**	**Idle Time of Server (Minutes)**
1		0	1	0	0	1	1	
2	5	5	6	5	0	11	6	4
3	3	8	1	11	3	12	4	0
4	2	10	2	12	2	14	4	0
5	8	18	1	18	0	19	1	4
6	4	22	1	22	0	23	1	3
7	5	27	4	27	0	31	4	4
8	3	30	3	31	1	34	4	0
9	5	35	4	35	0	39	4	1
10	7	42	3	42	0	45	3	3
11	1	43	4	45	2	49	6	0
12	4	47	2	49	2	51	4	0
13	5	52	1	52	0	53	1	1
14	1	53	4	53	0	57	4	0
15	5	58	6	58	0	64	6	1
16	6	64	3	64	0	67	3	0
17	7	71	1	71	0	72	1	4
18	1	72	2	72	0	74	2	0

19	1	73	5	74	1	79	6	0
20	8	81	6	81	0	87	6	2
21	8	89	2	89	0	91	2	2
22	1	90	1	91	1	92	2	0
23	6	96	6	96	0	102	6	4
24	8	104	6	104	0	110	6	2
25	2	106	2	110	4	112	6	0
26	3	109	4	112	3	116	7	0
27	1	110	3	116	6	119	9	0
28	7	117	6	119	2	125	8	0
29	6	123	1	125	2	126	3	0
30	2	125	3	126	1	129	4	0
31	4	129	5	129	0	134	5	0
32	3	132	4	134	2	138	6	0
33	4	136	1	138	2	139	3	0
34	5	141	4	141	0	145	4	2
35	5	146	5	146	0	151	5	1
36	8	154	5	154	0	159	5	3
37	8	162	4	162	0	166	4	3
38	3	165	5	166	1	171	6	0
39	1	166	1	171	5	172	6	0
40	5	171	3	172	1	175	4	0
41	8	179	4	179	0	183	4	4
42	1	180	2	183	3	185	5	0
43	2	182	1	185	3	186	4	0
44	4	186	5	186	0	191	5	0
45	7	193	3	193	0	196	3	2
46	4	197	1	197	0	198	1	1
47	6	203	5	203	0	208	5	5
48	7	210	6	210	0	216	6	2
49	6	216	5	216	0	221	5	0
50	8	224	2	224	0	226	2	3
51	6	230	1	230	0	231	1	4

52	4	234	4	234	0	238	4	3
53	5	239	2	239	0	241	2	1
54	1	240	4	241	1	245	5	0
55	1	241	5	245	4	250	9	0
56	1	242	1	250	8	251	9	0
57	4	246	5	251	5	256	10	0
58	5	251	5	256	5	261	10	0
59	1	252	3	261	9	264	12	0
60	3	255	2	264	9	266	11	0
61	1	256	6	266	10	272	16	0
62	5	261	6	272	11	278	17	0
63	6	267	6	278	11	284	17	0
64	8	275	1	284	9	285	10	0
65	8	283	3	285	2	288	5	0
66	7	290	3	290	0	293	3	2
67	3	293	5	293	0	298	5	0
68	4	297	4	298	1	302	5	0
69	8	305	5	305	0	310	5	3
70	3	308	3	310	2	313	5	0
71	1	309	5	313	4	318	9	0
72	3	312	6	318	6	324	12	0
73	4	316	2	324	8	326	10	0
74	1	317	1	326	9	327	10	0
75	4	321	6	327	6	333	12	0
76	6	327	5	333	6	338	11	0
77	7	334	1	338	4	339	5	0
78	5	339	5	339	0	344	5	0
79	2	341	1	344	3	345	4	0
80	2	343	4	345	2	349	6	0
81	6	349	4	349	0	353	4	0
82	5	354	5	354	0	359	5	1
83	1	355	2	359	4	361	6	0
84	7	362	6	362	0	368	6	1

85	3	365	1	368	3	369	4	0
86	2	367	2	369	2	371	4	0
87	1	368	2	371	3	373	5	0
88	5	373	6	373	0	379	6	0
89	1	374	1	379	5	380	6	0
90	1	375	6	380	5	386	11	0
91	7	382	1	386	4	387	5	0
92	1	383	4	387	4	391	8	0
93	6	389	6	391	2	397	8	0
94	2	391	6	397	6	403	12	0
95	3	394	1	403	9	404	10	0
96	5	399	2	404	5	406	7	0
97	7	406	4	406	0	410	4	0
98	4	410	1	410	0	411	1	0
99	6	416	4	416	0	420	4	5
100	8	424	4	424	0	428	4	4

With non-uniform distribution service distribution

TOTALS	424		315		154		469	112
AVERAGES	4.28		3.15		1.54		4.69	
Number of Customers =			100					

Simulation Table								
Step	**Activity**	**Clock**	**Activity**	**Clock**	**Output**	**Clock**	**Output**	**Output**
Customer	**Interarrival Time (Minutes)**	**Arrival Time**	**Service Time (Minutes)**	**Time Service Begins**	**Waiting Time in Queue (Minutes)**	**Time Service Ends**	**Time Customer Spends in System (Minutes)**	**Idle Time of Server (Minutes)**
1		0	1	0	0	1	1	
2	5	5	5	5	0	10	5	4
3	3	8	2	10	2	12	4	0
4	2	10	2	12	2	14	4	0
5	8	18	2	18	0	20	2	4
6	4	22	2	22	0	24	2	2
7	5	27	4	27	0	31	4	3

8	3	30	3	31	1	34	4	0
9	5	35	3	35	0	38	3	1
10	7	42	3	42	0	45	3	4
11	1	43	4	45	2	49	6	0
12	4	47	2	49	2	51	4	0
13	5	52	1	52	0	53	1	1
14	1	53	3	53	0	56	3	0
15	5	58	5	58	0	63	5	2
16	6	64	3	64	0	67	3	1
17	7	71	1	71	0	72	1	4
18	1	72	2	72	0	74	2	0
19	1	73	4	74	1	78	5	0
20	8	81	5	81	0	86	5	3
21	8	89	2	89	0	91	2	3
22	1	90	2	91	1	93	3	0
23	6	96	5	96	0	101	5	3
24	8	104	5	104	0	109	5	3
25	2	106	3	109	3	112	6	0
26	3	109	3	112	3	115	6	0
27	1	110	3	115	5	118	8	0
28	7	117	5	118	1	123	6	0
29	6	123	1	123	0	124	1	0
30	2	125	3	125	0	128	3	1
31	4	129	4	129	0	133	4	1
32	3	132	4	133	1	137	5	0
33	4	136	2	137	1	139	3	0
34	5	141	3	141	0	144	3	2
35	5	146	4	146	0	150	4	2
36	8	154	4	154	0	158	4	4
37	8	162	3	162	0	165	3	4
38	3	165	4	165	0	169	4	0
39	1	166	2	169	3	171	5	0
40	5	171	3	171	0	174	3	0

41	8	179	4	179	0	183	4	5
42	1	180	2	183	3	185	5	0
43	2	182	2	185	3	187	5	0
44	4	186	4	187	1	191	5	0
45	7	193	3	193	0	196	3	2
46	4	197	2	197	0	199	2	1
47	6	203	4	203	0	207	4	4
48	7	210	6	210	0	216	6	3
49	6	216	4	216	0	220	4	0
50	8	224	2	224	0	226	2	4
51	6	230	1	230	0	231	1	4
52	4	234	3	234	0	237	3	3
53	5	239	2	239	0	241	2	2
54	1	240	4	241	1	245	5	0
55	1	241	4	245	4	249	8	0
56	1	242	1	249	7	250	8	0
57	4	246	4	250	4	254	8	0
58	5	251	4	254	3	258	7	0
59	1	252	3	258	6	261	9	0
60	3	255	2	261	6	263	8	0
61	1	256	6	263	7	269	13	0
62	5	261	5	269	8	274	13	0
63	6	267	5	274	7	279	12	0
64	8	275	2	279	4	281	6	0
65	8	283	3	283	0	286	3	2
66	7	290	3	290	0	293	3	4
67	3	293	4	293	0	297	4	0
68	4	297	4	297	0	301	4	0
69	8	305	4	305	0	309	4	4
70	3	308	3	309	1	312	4	0
71	1	309	4	312	3	316	7	0
72	3	312	5	316	4	321	9	0
73	4	316	2	321	5	323	7	0

74	1	317	1	323	6	324	7	0
75	4	321	5	324	3	329	8	0
76	6	327	4	329	2	333	6	0
77	7	334	1	334	0	335	1	1
78	5	339	4	339	0	343	4	4
79	2	341	1	343	2	344	3	0
80	2	343	3	344	1	347	4	0
81	6	349	4	349	0	353	4	2
82	5	354	4	354	0	358	4	1
83	1	355	2	358	3	360	5	0
84	7	362	5	362	0	367	5	2
85	3	365	2	367	2	369	4	0
86	2	367	2	369	2	371	4	0
87	1	368	2	371	3	373	5	0
88	5	373	5	373	0	378	5	0
89	1	374	1	378	4	379	5	0
90	1	375	5	379	4	384	9	0
91	7	382	1	384	2	385	3	0
92	1	383	3	385	2	388	5	0
93	6	389	6	389	0	395	6	1
94	2	391	5	395	4	400	9	0
95	3	394	2	400	6	402	8	0
96	5	399	2	402	3	404	5	0
97	7	406	4	406	0	410	4	2
98	4	410	1	410	0	411	1	0
99	6	416	4	416	0	420	4	5
100	8	424	3	424	0	427	3	4

Average theoretical service time: 0.17*1 + 0.17*2 + 0.17*3 + 0.17*4 + 0.17*5 +0.17*6 = 3.57 min

Average service time = 343/100 = 3.43 min

Server utilization = (1/ 4.28) / (1/ 3.43) = 0.80

The simulation with a uniformed service time distribution has a larger average service time, which results in a higher server utilization. However, it also has a longer waiting time in queue for customers.

5.a) Modified function for Column F, Server chosen:
=IF(OR(F20<=D20,F20<=E20),"Baker","Able")
I modified the F20 cell and applied it to the whole column

b)

										TOTALS	
TOTALS										**111**	**303**
Number of Callers =		50		**Seed for Random Numbers**		12345					

Simulation Table

Step	Activity	Clock	Clock	Clock	State	Activity	Clock	Clock	Clock	Output	Output
Caller Number	Interarrival Time (Minutes)	Arrival Time	When Able Available	When Baker Available	Server Chosen	Service Time (Minutes)	Time Service Begins	Service Completion Time		Caller Delay (Minutes)	Time in System (Minutes)
								Able	Baker		
1		0	0	0	Baker	3	0	0	3	0	3
2	3	3	0	3	Baker	4	3		7	0	4
3	2	5	0	7	Able	2	5	7		0	2
4	2	7	7	7	Baker	6	7		13	0	6
5	3	10	7	13	Able	5	10	15		0	5
6	2	12	15	13	Baker	6	13		19	1	7
7	3	15	15	19	Able	5	15	20		0	5
8	2	17	20	19	Baker	4	19		23	2	6
9	3	20	20	23	Able	4	20	24		0	4
10	1	21	24	23	Baker	6	23		29	2	8
11	2	23	24	29	Able	2	24	26		1	3

12	3	26	26	29	Able	2	26	28		0	2
13	4	30	28	29	Baker	5	30		35	0	5
14	1	31	28	35	Able	2	31	33		0	2
15	1	32	33	35	Able	3	33	36		1	4
16	2	34	36	35	Baker	5	35		40	1	6
17	3	37	36	40	Able	2	37	39		0	2
18	1	38	39	40	Able	2	39	41		1	3
19	2	40	41	40	Baker	3	40		43	0	3
20	3	43	41	43	Baker	4	43		47	0	4
21	4	47	41	47	Baker	4	47		51	0	4
22	3	50	41	51	Able	3	50	53		0	3
23	2	52	53	51	Baker	3	52		55	0	3
24	3	55	53	55	Baker	6	55		61	0	6
25	2	57	53	61	Able	3	57	60		0	3
26	2	59	60	61	Able	3	60	63		1	4
27	1	60	63	61	Baker	4	61		65	1	5
28	2	62	63	65	Able	5	63	68		1	6
29	2	64	68	65	Baker	4	65		69	1	5
30	1	65	68	69	Able	4	68	72		3	7
31	2	67	72	69	Baker	5	69		74	2	7
32	2	69	72	74	Able	3	72	75		3	6
33	2	71	75	74	Baker	6	74		80	3	9
34	2	73	75	80	Able	4	75	79		2	6
35	1	74	79	80	Able	3	79	82		5	8
36	2	76	82	80	Baker	3	80		83	4	7
37	1	77	82	83	Able	4	82	86		5	9
38	1	78	86	83	Baker	5	83		88	5	10
39	4	82	86	88	Able	3	86	89		4	7
40	2	84	89	88	Baker	6	88		94	4	10
41	1	85	89	94	Able	2	89	91		4	6
42	2	87	91	94	Able	4	91	95		4	8
43	2	89	95	94	Baker	6	94		100	5	11
44	1	90	95	100	Able	2	95	97		5	7

45	1	91	97	100	Able	3	97	100		6	9
46	2	93	100	100	Baker	3	100		103	7	10
47	1	94	100	103	Able	2	100	102		6	8
48	1	95	102	103	Able	5	102	107		7	12
49	1	96	107	103	Baker	5	103		108	7	12
50	4	100	107	108	Able	4	107	111		7	11

Caller Delay (Column L)	
Bins	**Frequency**
0	27
1	4
2	3
3	5
4	5
5	2
6	4
7	0
8	0
Total =	50

Around half of the customers won't have any call delay. However, the wait time for the rest can vary from 1 minute to 6 minutes. It is also noticeable that caller delay is getting longer and longer while more customers are getting served, which contributes to longer time in the system.

c) Original Policy

Average Caller Delay		**1.56**	
Response Table		**Multi-Trial Summary**	
Trial	**Average Caller Delay**	**Bins**	**Frequency**
1	0.17	0	0
2	0.52	0.5	65
3	0.82	1	99
4	0.33	1.5	23

5	0.64	2	9
6	0.93	2.5	4
7	0.54	3	0
8	0.26	3.5	0
9	0.32	4	0
10	1	4.5	0
11	0.58	5	0
12	0.6	>5	0
13	1.04		
14	0.35	**Total =**	200
15	1.07		
16	0.64		
17	0.83	**Average**	0.73
18	0.52	**Median**	0.6
19	1.07		
20	0.83	**Minimum**	0.17
21	0.71	**Maximum**	2.4
22	1.17		
23	0.78		
24	0.41		
25	0.81		
26	0.46		
27	1.32		
28	0.43		
29	0.88		
30	1.7		
31	0.81		
32	0.52		
33	0.4		
34	0.7		
35	0.49		
36	0.46		
37	0.21		

38	0.46		
39	1.11		
40	0.65		
41	0.66		
42	0.57		
43	0.47		
44	0.68		
45	0.74		
46	0.92		
47	0.87		
48	0.51		
49	0.43		
50	0.57		
51	0.58		
52	0.88		
53	0.5		
54	0.56		
55	0.77		
56	0.85		
57	1.52		
58	0.97		
59	0.45		
60	0.41		
61	1.19		
62	0.45		
63	0.56		
64	0.43		
65	0.65		
66	0.34		
67	0.77		
68	1.28		
69	0.32		
70	0.4		

71	0.65		
72	0.6		
73	0.45		
74	0.52		
75	0.56		
76	1.23		
77	0.42		
78	1.47		
79	0.62		
80	0.97		
81	0.68		
82	0.43		
83	0.46		
84	0.45		
85	0.42		
86	1.09		
87	0.6		
88	1.09		
89	2.05		
90	1.89		
91	0.24		
92	0.92		
93	0.41		
94	0.7		
95	0.53		
96	0.37		
97	0.33		
98	0.5		
99	0.24		
100	0.82		
101	1.15		
102	0.44		
103	0.51		

104	0.46		
105	0.29		
106	0.75		
107	0.37		
108	0.5		
109	2.03		
110	0.41		
111	0.57		
112	0.52		
113	0.3		
114	0.53		
115	1.1		
116	0.49		
117	0.46		
118	0.59		
119	0.93		
120	0.42		
121	0.73		
122	0.92		
123	0.47		
124	0.59		
125	1.48		
126	0.37		
127	0.45		
128	0.43		
129	0.52		
130	0.79		
131	0.66		
132	0.34		
133	0.38		
134	1.05		
135	2.4		
136	0.76		

137	1.5		
138	0.48		
139	1.79		
140	1.81		
141	0.25		
142	1.57		
143	1.63		
144	0.55		
145	0.72		
146	0.52		
147	0.9		
148	0.64		
149	0.77		
150	0.49		
151	0.53		
152	0.94		
153	1.02		
154	0.57		
155	0.67		
156	1.28		
157	0.42		
158	0.7		
159	0.72		
160	0.9		
161	0.38		
162	0.33		
163	0.9		
164	0.37		
165	0.72		
166	0.56		
167	2		
168	0.68		
169	0.73		

170	1.29		
171	0.53		
172	0.56		
173	0.7		
174	1		
175	0.58		
176	0.6		
177	0.34		
178	0.92		
179	0.89		
180	1.23		
181	0.48		
182	0.57		
183	0.37		
184	0.86		
185	0.43		
186	0.57		
187	0.54		
188	0.3		
189	2.08		
190	0.19		
191	1.05		
192	0.75		
193	0.59		
194	0.96		
195	0.74		
196	0.79		
197	1.28		
198	0.62		
199	0.45		
200	1.56		

Modified Policy

Average Caller Delay	0.8		
Response Table		Multi-Trial Summary	
Trial	Average Caller Delay	Bins	Frequency
1	1.69	0	0
2	0.75	0.5	41
3	1.1	1	106
4	0.37	1.5	35
5	1.6	2	12
6	0.75	2.5	4
7	0.54	3	0
8	0.73	3.5	1
9	0.49	4	0
10	0.4	4.5	0
11	0.67	5	0
12	0.68	>5	1
13	0.56		
14	0.75	**Total =**	200
15	0.71		
16	0.66		
17	0.69	**Average**	0.85
18	0.4	**Median**	0.72
19	0.69		
20	0.77	**Minimum**	0.17
21	0.48	**Maximum**	5.31
22	0.7		
23	0.91		
24	0.45		
25	1.13		
26	0.62		
27	0.78		
28	0.47		

29	1			
30	1.18			
31	0.7			
32	1.23			
33	1.08			
34	0.74			
35	0.71			
36	0.71			
37	0.37			
38	0.23			
39	0.51			
40	0.77			
41	1.68			
42	1.15			
43	0.65			
44	0.18			
45	0.65			
46	0.78			
47	0.92			
48	0.91			
49	1.26			
50	0.67			
51	0.51			
52	0.97			
53	1.67			
54	0.69			
55	0.84			
56	1.21			
57	0.8			
58	0.27			
59	0.33			
60	1.83			
61	1.41			

62	1.09			
63	0.62			
64	0.51			
65	1.28			
66	2.44			
67	0.96			
68	0.9			
69	1.19			
70	0.42			
71	0.33			
72	1.45			
73	0.63			
74	0.72			
75	0.49			
76	0.75			
77	0.7			
78	1.21			
79	0.88			
80	0.53			
81	0.42			
82	0.65			
83	0.87			
84	0.99			
85	2.25			
86	0.92			
87	0.82			
88	0.93			
89	2.23			
90	0.6			
91	0.45			
92	0.44			
93	0.47			
94	0.85			

95	2			
96	0.56			
97	5.31			
98	0.61			
99	1.06			
100	0.53			
101	0.28			
102	1.31			
103	1.24			
104	0.76			
105	0.53			
106	0.58			
107	0.56			
108	0.54			
109	1.69			
110	0.75			
111	0.84			
112	0.56			
113	0.61			
114	1.13			
115	0.73			
116	0.53			
117	1.05			
118	0.29			
119	0.46			
120	1.08			
121	3.08			
122	0.94			
123	0.69			
124	1.64			
125	1.16			
126	1.26			
127	0.96			

128	0.81			
129	0.8			
130	0.24			
131	1.09			
132	0.72			
133	0.63			
134	1.55			
135	0.17			
136	1.26			
137	0.64			
138	0.58			
139	0.32			
140	1.32			
141	0.61			
142	0.56			
143	0.78			
144	0.89			
145	0.34			
146	0.75			
147	0.76			
148	0.31			
149	0.32			
150	0.54			
151	1.16			
152	0.55			
153	0.56			
154	1.39			
155	0.41			
156	1.62			
157	0.44			
158	0.81			
159	0.71			
160	1.61			

161	0.59			
162	0.62			
163	1.16			
164	0.5			
165	0.51			
166	0.77			
167	2.41			
168	1.03			
169	1.19			
170	0.38			
171	0.63			
172	0.48			
173	1.07			
174	1.34			
175	0.72			
176	0.67			
177	0.79			
178	0.44			
179	1.3			
180	0.87			
181	0.45			
182	1.02			
183	0.47			
184	0.43			
185	0.52			
186	0.35			
187	0.47			
188	1.09			
189	0.45			
190	0.63			
191	0.54			
192	0.78			
193	0.79			

194	0.67			
195	0.69			
196	0.28			
197	1.73			
198	0.6			
199	0.75			
200	0.8			

The original policy is better even though it has a longer average caller delay than the modified policy. From the results of 200 trails, we can see that the original policy has a lower average, median, and maximum value. Able server's service time varies from 2-5 minutes while Baker's service time varies from 3-6 minutes. This also means there's a higher probability callers have shorter delay due to shorter service time.

6. a)

Number of Trials:	**200**		
Link to Measure of Performance:			
Name of Measure		**Link**	
Number of Hits		**6**	
Response Table		**Multi-Trial Summary**	
Trial	**Number of Hits**	**Bins**	**Frequency**
1	3	0	0
2	5	1	8
3	3	2	18
4	3	3	47
5	5	4	59
6	1	5	39
7	4	6	19
8	3	7	7
9	4	8	2
10	5	9	1
11	4	10	0
12	5		
13	3	**Average**	4.02
14	3	**Median**	4

15	5	**Mode**	4
16	2	**Minimum**	1
17	6	**Maximum**	9
18	3		
19	5		
20	4		
21	6		
22	4		
23	4		
24	4		
25	4		
26	5		
27	2		
28	7		
29	5		
30	6		
31	9		
32	5		
33	4		
34	4		
35	6		
36	2		
37	5		
38	3		
39	3		
40	2		
41	6		
42	3		
43	4		
44	3		
45	7		
46	6		
47	3		

48	4		
49	7		
50	2		
51	3		
52	4		
53	4		
54	3		
55	3		
56	3		
57	4		
58	4		
59	3		
60	4		
61	3		
62	3		
63	4		
64	7		
65	5		
66	3		
67	5		
68	3		
69	4		
70	5		
71	5		
72	4		
73	4		
74	3		
75	3		
76	4		
77	4		
78	4		
79	6		
80	3		

81	3		
82	3		
83	4		
84	5		
85	3		
86	5		
87	4		
88	1		
89	3		
90	2		
91	4		
92	4		
93	2		
94	6		
95	3		
96	4		
97	4		
98	4		
99	6		
100	4		
101	6		
102	4		
103	4		
104	4		
105	3		
106	5		
107	5		
108	6		
109	3		
110	5		
111	3		
112	3		
113	4		

114	2		
115	7		
116	5		
117	4		
118	5		
119	5		
120	4		
121	4		
122	5		
123	3		
124	5		
125	4		
126	2		
127	2		
128	4		
129	2		
130	3		
131	4		
132	5		
133	4		
134	3		
135	3		
136	4		
137	6		
138	6		
139	4		
140	4		
141	4		
142	4		
143	6		
144	3		
145	6		
146	2		

147	1		
148	3		
149	5		
150	4		
151	5		
152	3		
153	1		
154	7		
155	4		
156	5		
157	5		
158	5		
159	1		
160	4		
161	5		
162	2		
163	4		
164	5		
165	5		
166	2		
167	5		
168	3		
169	6		
170	3		
171	4		
172	6		
173	8		
174	4		
175	1		
176	2		
177	1		
178	4		
179	8		

180	5		
181	6		
182	4		
183	2		
184	1		
185	2		
186	3		
187	5		
188	3		
189	2		
190	5		
191	4		
192	5		
193	7		
194	3		
195	3		
196	4		
197	3		
198	5		
199	4		
200	6		

b)

Number of Trials:	**400**	
Link to Measure of Performance:		
Name of Measure		**Link**
Number of Hits		**4**

Response Table		**Multi-Trial Summary**	
Trial	**Number of Hits**	**Bins**	**Frequency**
1	5	0	3
2	3	1	14
3	3	2	36

4	5	3	79
5	5	4	112
6	4	5	75
7	5	6	56
8	7	7	16
9	6	8	8
10	4	9	1
11	3	10	0
12	4		
13	3	**Average**	4.17
14	5	**Median**	4
15	3	**Mode**	4
16	5	**Minimum**	0
17	4	**Maximum**	9
18	6		
19	7		
20	2		
21	4		
22	4		
23	3		
24	6		
25	4		
26	4		
27	4		
28	4		
29	5		
30	5		
31	1		
32	5		
33	3		
34	4		
35	4		
36	3		

37	6		
38	6		
39	5		
40	6		
41	4		
42	4		
43	4		
44	4		
45	5		
46	4		
47	6		
48	4		
49	6		
50	5		
51	2		
52	7		
53	6		
54	4		
55	5		
56	0		
57	2		
58	3		
59	5		
60	4		
61	5		
62	8		
63	3		
64	3		
65	4		
66	6		
67	8		
68	6		
69	8		

70	3		
71	2		
72	4		
73	3		
74	2		
75	4		
76	5		
77	5		
78	5		
79	2		
80	3		
81	6		
82	3		
83	3		
84	6		
85	4		
86	5		
87	5		
88	4		
89	4		
90	4		
91	6		
92	5		
93	6		
94	4		
95	3		
96	8		
97	3		
98	3		
99	4		
100	3		
101	3		
102	3		

103	6		
104	7		
105	3		
106	4		
107	8		
108	5		
109	3		
110	5		
111	6		
112	5		
113	6		
114	5		
115	3		
116	3		
117	2		
118	3		
119	6		
120	5		
121	5		
122	5		
123	4		
124	3		
125	2		
126	5		
127	1		
128	3		
129	4		
130	8		
131	4		
132	4		
133	1		
134	3		
135	2		

136	5		
137	5		
138	4		
139	1		
140	5		
141	2		
142	4		
143	2		
144	2		
145	6		
146	2		
147	4		
148	2		
149	4		
150	3		
151	4		
152	3		
153	3		
154	4		
155	3		
156	7		
157	3		
158	4		
159	4		
160	6		
161	5		
162	1		
163	6		
164	4		
165	2		
166	4		
167	6		
168	2		

169	3		
170	4		
171	6		
172	4		
173	4		
174	3		
175	3		
176	5		
177	0		
178	3		
179	5		
180	0		
181	4		
182	6		
183	2		
184	1		
185	3		
186	3		
187	3		
188	4		
189	6		
190	6		
191	5		
192	3		
193	3		
194	5		
195	5		
196	4		
197	4		
198	3		
199	1		
200	5		
201	2		

202	4		
203	4		
204	1		
205	6		
206	3		
207	5		
208	7		
209	3		
210	3		
211	6		
212	5		
213	3		
214	3		
215	3		
216	2		
217	4		
218	4		
219	3		
220	3		
221	4		
222	4		
223	2		
224	4		
225	9		
226	4		
227	4		
228	7		
229	3		
230	2		
231	5		
232	4		
233	5		
234	5		

235	7		
236	5		
237	5		
238	6		
239	6		
240	5		
241	5		
242	5		
243	4		
244	3		
245	5		
246	4		
247	4		
248	2		
249	3		
250	5		
251	3		
252	4		
253	8		
254	6		
255	4		
256	5		
257	6		
258	4		
259	5		
260	3		
261	5		
262	7		
263	5		
264	2		
265	6		
266	4		
267	5		

268	4		
269	2		
270	5		
271	5		
272	5		
273	6		
274	5		
275	3		
276	6		
277	6		
278	4		
279	4		
280	4		
281	4		
282	2		
283	4		
284	1		
285	6		
286	3		
287	4		
288	4		
289	1		
290	2		
291	2		
292	3		
293	6		
294	5		
295	3		
296	6		
297	5		
298	3		
299	6		
300	2		

301	5		
302	4		
303	4		
304	7		
305	6		
306	3		
307	2		
308	7		
309	4		
310	4		
311	4		
312	4		
313	5		
314	4		
315	3		
316	3		
317	5		
318	6		
319	6		
320	7		
321	3		
322	3		
323	2		
324	4		
325	3		
326	4		
327	2		
328	4		
329	6		
330	4		
331	6		
332	3		
333	2		

334	5		
335	7		
336	6		
337	5		
338	3		
339	4		
340	4		
341	5		
342	3		
343	6		
344	4		
345	6		
346	4		
347	3		
348	4		
349	5		
350	5		
351	3		
352	1		
353	3		
354	4		
355	3		
356	3		
357	8		
358	4		
359	4		
360	4		
361	6		
362	2		
363	6		
364	1		
365	3		
366	7		

367	4		
368	6		
369	5		
370	4		
371	2		
372	4		
373	5		
374	4		
375	5		
376	4		
377	2		
378	4		
379	6		
380	6		
381	5		
382	7		
383	6		
384	2		
385	4		
386	6		
387	4		
388	4		
389	4		
390	5		
391	4		
392	1		
393	4		
394	4		
395	3		
396	1		
397	4		
398	7		
399	4		

400	4		

c)

Number of Trials:	200	
Link to Measure of Performance:		
Name of Measure		Link
Number of Hits		10

Response Table		Multi-Trial Summary	
Trial	Number of Hits	Bins	Frequency
1	10	0	0
2	9	1	0
3	9	2	0
4	9	3	0
5	10	4	0
6	9	5	0
7	8	6	1
8	10	7	8
9	9	8	33
10	10	9	59
11	9	10	99
12	8		
13	10	Average	9.24
14	8	Median	9
15	10	Mode	10
16	10	Minimum	6
17	9	Maximum	10
18	9		
19	9		
20	10		
21	9		
22	8		
23	10		
24	10		
25	8		

26	8		
27	10		
28	10		
29	9		
30	10		
31	10		
32	10		
33	8		
34	8		
35	10		
36	10		
37	9		
38	10		
39	9		
40	10		
41	9		
42	10		
43	10		
44	10		
45	10		
46	10		
47	8		
48	10		
49	10		
50	10		
51	10		
52	10		
53	9		
54	8		
55	10		
56	9		
57	10		
58	10		

59	9		
60	10		
61	10		
62	10		
63	10		
64	10		
65	9		
66	10		
67	10		
68	10		
69	9		
70	9		
71	10		
72	8		
73	10		
74	9		
75	10		
76	9		
77	8		
78	9		
79	10		
80	9		
81	9		
82	10		
83	10		
84	10		
85	7		
86	10		
87	9		
88	9		
89	9		
90	10		
91	9		

92	10		
93	10		
94	10		
95	8		
96	10		
97	9		
98	6		
99	9		
100	8		
101	9		
102	10		
103	9		
104	8		
105	9		
106	9		
107	8		
108	10		
109	8		
110	10		
111	10		
112	8		
113	10		
114	9		
115	10		
116	9		
117	7		
118	10		
119	9		
120	9		
121	8		
122	10		
123	10		
124	10		

125	9		
126	8		
127	10		
128	9		
129	8		
130	8		
131	10		
132	10		
133	8		
134	9		
135	8		
136	10		
137	9		
138	10		
139	10		
140	10		
141	10		
142	10		
143	10		
144	9		
145	9		
146	10		
147	7		
148	10		
149	9		
150	9		
151	7		
152	10		
153	8		
154	10		
155	9		
156	9		
157	9		

158	9		
159	10		
160	10		
161	9		
162	10		
163	9		
164	10		
165	8		
166	7		
167	10		
168	10		
169	8		
170	10		
171	10		
172	10		
173	10		
174	9		
175	8		
176	8		
177	7		
178	10		
179	10		
180	10		
181	9		
182	8		
183	8		
184	10		
185	10		
186	8		
187	10		
188	8		
189	10		
190	10		

191	9		
192	10		
193	10		
194	9		
195	7		
196	9		
197	10		
198	9		
199	7		
200	10		

d)

Number of Trials:	**200**		
Link to Measure of Performance:			
Name of Measure		**Link**	
Number of Hits		**8**	
Response Table		**Multi-Trial Summary**	
Trial	**Number of Hits**	**Bins**	**Frequency**
1	4	0	0
2	7	1	0
3	6	2	0
4	5	3	4
5	9	4	17
6	4	5	30
7	6	6	52
8	6	7	45
9	9	8	34
10	5	9	15
11	8	10	3
12	7		
13	7	**Average**	6.47
14	5	**Median**	6
15	8	**Mode**	6

16	8	**Minimum**	3
17	7	**Maximum**	10
18	7		
19	6		
20	8		
21	3		
22	5		
23	7		
24	8		
25	7		
26	4		
27	8		
28	7		
29	5		
30	6		
31	8		
32	6		
33	4		
34	6		
35	5		
36	3		
37	6		
38	7		
39	9		
40	6		
41	9		
42	6		
43	5		
44	6		
45	8		
46	6		
47	8		
48	7		

49	7		
50	7		
51	9		
52	7		
53	5		
54	7		
55	6		
56	9		
57	5		
58	8		
59	7		
60	9		
61	8		
62	6		
63	9		
64	6		
65	6		
66	6		
67	8		
68	5		
69	5		
70	4		
71	5		
72	5		
73	5		
74	8		
75	6		
76	6		
77	6		
78	8		
79	8		
80	7		
81	5		

82	8		
83	6		
84	7		
85	5		
86	6		
87	7		
88	7		
89	7		
90	7		
91	4		
92	10		
93	7		
94	5		
95	6		
96	8		
97	8		
98	9		
99	4		
100	7		
101	6		
102	7		
103	4		
104	7		
105	5		
106	9		
107	8		
108	5		
109	5		
110	8		
111	9		
112	8		
113	5		
114	6		

115	8		
116	4		
117	7		
118	6		
119	8		
120	9		
121	4		
122	6		
123	6		
124	4		
125	4		
126	5		
127	9		
128	8		
129	6		
130	7		
131	4		
132	8		
133	5		
134	6		
135	6		
136	7		
137	5		
138	6		
139	6		
140	7		
141	7		
142	8		
143	3		
144	8		
145	7		
146	9		
147	6		

148	8		
149	6		
150	7		
151	6		
152	7		
153	7		
154	5		
155	6		
156	6		
157	7		
158	6		
159	6		
160	7		
161	5		
162	5		
163	6		
164	8		
165	7		
166	5		
167	7		
168	4		
169	7		
170	6		
171	4		
172	4		
173	6		
174	8		
175	9		
176	8		
177	5		
178	6		
179	7		
180	7		

181	6		
182	7		
183	8		
184	3		
185	6		
186	10		
187	8		
188	6		
189	6		
190	5		
191	4		
192	7		
193	6		
194	7		
195	7		
196	10		
197	6		
198	6		
199	6		
200	8		

e)

Standard Deviation in X Direction =	450
Standard Deviation in Y Direction =	225

Number of Trials:	**400**		
Link to Measure of Performance:			
Name of Measure		**Link**	
Number of Hits		**7**	
Response Table		**Multi-Trial Summary**	
Trial	**Number of Hits**	**Bins**	**Frequency**
1	5	0	0
2	6	1	0

3	5	2	3
4	5	3	19
5	8	4	41
6	3	5	77
7	8	6	108
8	5	7	83
9	4	8	49
10	8	9	16
11	5	10	4
12	5		
13	7	**Average**	6.04
14	6	**Median**	6
15	7	**Mode**	6
16	7	**Minimum**	2
17	6	**Maximum**	10
18	5		
19	6		
20	6		
21	6		
22	7		
23	4		
24	5		
25	6		
26	7		
27	6		
28	9		
29	6		
30	8		
31	9		
32	6		
33	6		
34	6		
35	8		

36	6		
37	6		
38	4		
39	6		
40	6		
41	8		
42	5		
43	6		
44	5		
45	10		
46	7		
47	7		
48	5		
49	9		
50	4		
51	4		
52	6		
53	6		
54	7		
55	6		
56	3		
57	7		
58	5		
59	5		
60	8		
61	7		
62	5		
63	7		
64	8		
65	6		
66	4		
67	7		
68	4		

69	6		
70	6		
71	6		
72	8		
73	7		
74	6		
75	5		
76	7		
77	7		
78	6		
79	7		
80	5		
81	5		
82	4		
83	5		
84	7		
85	3		
86	9		
87	6		
88	6		
89	5		
90	3		
91	7		
92	4		
93	3		
94	8		
95	6		
96	6		
97	6		
98	5		
99	7		
100	5		
101	6		

102	6		
103	6		
104	6		
105	6		
106	6		
107	6		
108	6		
109	6		
110	7		
111	6		
112	3		
113	7		
114	6		
115	7		
116	8		
117	6		
118	5		
119	8		
120	8		
121	6		
122	7		
123	6		
124	8		
125	5		
126	3		
127	4		
128	8		
129	4		
130	4		
131	7		
132	8		
133	4		
134	6		

135	4		
136	8		
137	7		
138	8		
139	6		
140	6		
141	5		
142	7		
143	7		
144	5		
145	7		
146	7		
147	3		
148	5		
149	7		
150	7		
151	6		
152	6		
153	7		
154	8		
155	5		
156	5		
157	6		
158	6		
159	5		
160	4		
161	6		
162	6		
163	7		
164	6		
165	6		
166	4		
167	7		

168	5		
169	6		
170	6		
171	6		
172	7		
173	9		
174	7		
175	3		
176	5		
177	2		
178	8		
179	8		
180	7		
181	9		
182	7		
183	5		
184	4		
185	6		
186	5		
187	7		
188	5		
189	7		
190	7		
191	8		
192	7		
193	9		
194	6		
195	6		
196	5		
197	4		
198	5		
199	6		
200	6		

201	7		
202	6		
203	5		
204	7		
205	6		
206	7		
207	10		
208	6		
209	5		
210	6		
211	7		
212	7		
213	6		
214	7		
215	7		
216	6		
217	9		
218	8		
219	6		
220	9		
221	7		
222	7		
223	7		
224	5		
225	5		
226	7		
227	5		
228	5		
229	5		
230	8		
231	7		
232	8		
233	7		

234	7		
235	4		
236	8		
237	5		
238	7		
239	6		
240	4		
241	8		
242	5		
243	6		
244	5		
245	5		
246	6		
247	6		
248	6		
249	3		
250	5		
251	7		
252	8		
253	3		
254	6		
255	3		
256	7		
257	6		
258	6		
259	3		
260	6		
261	5		
262	5		
263	6		
264	8		
265	7		
266	4		

267	4		
268	9		
269	8		
270	6		
271	4		
272	5		
273	6		
274	6		
275	9		
276	3		
277	6		
278	4		
279	5		
280	6		
281	4		
282	4		
283	8		
284	7		
285	3		
286	6		
287	5		
288	6		
289	8		
290	7		
291	10		
292	8		
293	7		
294	5		
295	7		
296	2		
297	4		
298	8		
299	4		

300	8		
301	4		
302	7		
303	6		
304	6		
305	7		
306	6		
307	9		
308	9		
309	6		
310	9		
311	5		
312	5		
313	6		
314	8		
315	6		
316	6		
317	7		
318	5		
319	5		
320	7		
321	4		
322	5		
323	5		
324	8		
325	8		
326	4		
327	6		
328	8		
329	4		
330	7		
331	5		
332	8		

333	7		
334	4		
335	7		
336	5		
337	7		
338	4		
339	5		
340	5		
341	4		
342	7		
343	6		
344	7		
345	5		
346	7		
347	8		
348	4		
349	8		
350	6		
351	4		
352	8		
353	7		
354	6		
355	9		
356	6		
357	6		
358	5		
359	6		
360	4		
361	4		
362	5		
363	6		
364	6		
365	7		

366	9		
367	7		
368	4		
369	8		
370	8		
371	3		
372	7		
373	7		
374	7		
375	6		
376	5		
377	6		
378	5		
379	6		
380	5		
381	5		
382	5		
383	3		
384	8		
385	3		
386	2		
387	5		
388	5		
389	6		
390	8		
391	3		
392	5		
393	8		
394	10		
395	5		
396	4		
397	8		
398	7		

399	5		
400	7		

f) If large trails are running, it doesn't affect the average number of hits much. Although small changes are made to standard deviation x and y, it can lead to huge changes to the number of hits, which also affects the minimum values for experiments with 200 or 400 trials.

7. a) Enter the probability for Head: 0.3
Estimated Value of P: 0.2916
Normalized Estimation Error: 0.02799999999999988

b) Enter the probability for Head: 0.1
Estimated Value of P: 0.1015
Normalized Estimation Error: 0.015000000000000013

c)Enter the probability for Head: 0.001
Estimated Value of P: 0.0011
Normalized Estimation Error: 0.10000000000000005

d) Enter the probability for Head: 0.0001
Estimated Value of P: 0.0002
Normalized Estimation Error: 1.0

e) When the probability of getting head from a coin is getting smaller and smaller or the difference between getting head and tail probability greater and greater, the normalized estimation error is increasing dramatically even though small changes are made to the head probability. For extreme values like 0.001, 0.0001, increasing the trails or the number of tosses could reduce the normalized estimation error.

When p=0.001, we will run 20000 and 50000 tosses to see the differences
20000 tosses
Enter the probability for Head: 0.001
Estimated Value of P: 0.00105
Normalized Estimation Error: 0.04999999999999991

50000 tosses
Enter the probability for Head: 0.001
Estimated Value of P: 0.00106
Normalized Estimation Error: 0.05999999999999994

20000 tosses
Enter the probability for Head: 0.0001
Estimated Value of P: 0.00015

Normalized Estimation Error: 0.4999999999999998

50000 tosses
Enter the probability for Head: 0.0001
Estimated Value of P: 0.0001
Normalized Estimation Error: 0.0

We can see the normalized estimation error is getting smaller but the sample sizes would need to be modified based on the head probability.