

Manzana Answers (in brief)

1. To answer this question I will begin by assuming that a generic good exists and is comprised of the following mix: 13% RUN, 36% RAP, 9% RAIN, and 42% RERUN. The attached spreadsheets show these calculations. I will also ignore priorities given to certain types of requests.

If territories are no different from one another, every underwriting team will have the same arrival rate of the generic good. Using the queuing spreadsheet to determine the steady state process time (see attached), one can determine that the expected turn around time for Manzana is 402.28 minutes. This corresponds to approximately 6.7 hours.

If one allows the territories to have different arrivals of the generic good, one will notice that Underwriting Team 1 has a larger arrival rate than the other territories. Therefore, Underwriting Team 1 will have a larger queue time on average. Under this assumption, the average time in the system is 515.85 minutes. This corresponds to approximately 8.6 hours.

For any given process in the system, the chance that the processing time will be above the 95% Standard Completion time (SCT) is 5%. Based on the 95% SCT, the turn around time (TAT) given in exhibit 3 is 8.2 days. This is an extremely conservative estimate that bears little to no relevance to the actual wait time. The queuing model shows the expected turn around time to be closer to 1 day, rather than 8 days. The reason that the TAT given in exhibit 3 is so conservative is that the SCT is based on the 95th percentile of service times for every possible step in the operation process. This should make intuitive sense, because the probability that all four steps will be above the 95% SCT is $5\%*5\%*5\%*5\%$, or practically zero. Manzana Insurance is performing better than they think.

2. There are two bottlenecks in this operation. The first is Underwriting Team #1, which has a utilization of 95%. The second bottleneck occurs during the distribution process. The four distribution clerks have a combined utilization of 92%.

The basic change that should be realized is that pooling the underwriting teams will significantly improve operations. If the underwriters were pooled, the average system time would fall to approximately 303.5 minutes, or 5.1 hours. See the attached spreadsheets for the calculations. One should keep in mind that the tradeoff of this restructuring plan will probably be less localized knowledge of each underwriting team.

One may also want to consider hiring another distribution clerk (DC). Currently, the average time it takes a request to work through the DC step is 117.8 minutes. However, if 5 DC's were employed, the average time it would take to work through the DC step would be 52.0 minutes. Perhaps a policy writer could be transferred as a distribution clerk, causing the policy writing process to take approximately (51.1-38.8) 12.3 minutes longer, while reducing the distribution process by approximately (117.8-52.0) 65.8 minutes. This switch would result in a net savings of (65.8-12.3) 53.5 minutes. Of course, costs of labor should be taken into account before implementing this change.

3. Manzana management should pool their underwriting teams and potentially transfer a policy writer to the distribution process, as explained in step 2. They should also change the way RERUNS are treated. RERUNs are actually very profitable per unit of processing time. Treating RERUNS with lowest priority may not necessarily be a good strategy, since each policy generates an average annual premium of \$6,205 and takes only 172 minutes to complete. A RUN generates an average premium of \$6,724, but takes 259 minutes to complete. In other words, a RERUN generates more revenue than a RUN per minute spent on processing. If the Manzana management still wishes to treat RERUNS with low priority, releasing RERUNS into the system more than one day in advance will improve the ability to meet the deadline. Such a strategy would cause a negligible reduction in information on the policy holder.

Arrivals	1991 (6 mo) - Territory 1	1991 (6 mo) - Territory 2	1991 (6 mo) - Territory 3	1991 (6 mo)
Agents	23	26	27	76
Policies in Force	1151	1393	1402	3946
Requests Processed				
RUNs originating as RUNs	162	100	88	350
RAPs becoming RUNs	112	79	83	274
Total RUNs	274	179	171	624
RAPs (total)	761	513	524	1798
RAINs	196	125	130	451
RERUNs	636	840	605	2081
Renewals Lost	403	227	296	926
Gross Premium	\$5,915	\$6,497	\$4,988	17400
RAPs not becoming RUNs	649	434	441	1524
Total Requests	1755	1578	1347	4680

Percentages of Total Arrivals
 (note: RAPs that are turned into
 RUNs are counted as both a RAP
 and a RUN to determine
 percentage)

	1991 - Territory 1	1991 - Territory 2	1991 - Territory 3	1991 (6 mo)
RUN	15%	11%	12%	13%
RAP	41%	31%	37%	36%
RAIN	10%	8%	9%	9%
RERUN	34%	51%	42%	42%

Each Day has 7.5 hours
 Each Month has 20 days

Average Arrival Rates OF Generic (1991 - Territory 1	1991 - Territory 2	1991 - Territory 3	1991 (6 mo)
per 6. months	1755	1578	1347	4680
per 1. month	292.5	263	224.5	780
per day	14.625	13.15	11.225	39
per hour	1.95	1.753333333	1.496666667	5.2
per minute	0.0325	0.029222222	0.024944444	0.08666667

Average Interarrival Rates (min)	1991 - Territory 1	1991 - Territory 2	1991 - Territory 3	1991 (6 mo)
Generic good	30.76923077	34.22053232	40.08908686	11.5384615

Estimating Average Processing times for a generic good

	averages		std deviations		percent of mix relative probability	RUN	RAP		average	std dev	c.v.
	RUN	RAP	RUN	RAP		13%	36%		RUN/RAP	RUN/RAP	RUN/RAP
DC	68.5	50.0	30.7	24.9	0.27			DC	54.91	27.79	0.51
UW	43.6	38.0	32.0	24.5				UW	39.49	26.81	0.68
RA	75.5	64.7	20.5	13.6				RA	67.57	16.44	0.24
PW	71.0	0.0	10.3	0.0				PW	18.84	31.79	1.69

	averages		std deviations		percent of mix relative probability	RAIN	RERUN		average	std dev	c.v.
	RAIN	RERUN	RAIN	RERUN		9%	42%		RAIN/RE	RAIN/RE	RAIN/RE
DC	43.50	28.00	9.20	6.20	0.18			DC	30.74	9.03	0.29
UW	22.60	18.70	11.70	19.80				UW	19.39	18.69	0.96
RA	65.50	75.50	15.90	9.70				RA	73.74	11.69	0.16
PW	54.00	50.10	8.60	9.50				PW	50.79	9.46	0.19

	averages		std deviations		percent of mix relative probability	RU/RAP	RAI/RE		average	std dev	c.v.
	RUN/RAP	RAIN/RE	RUN/RAP	RAIN/RE		49%	51%		ALL	ALL	ALL
DC	54.91	30.74	27.79	9.03	0.49			DC	42.58	23.79	0.56
UW	39.49	19.39	26.81	18.69				UW	29.24	25.12	0.86
RA	67.57	73.74	16.44	11.69				RA	70.71	14.54	0.21
PW	18.84	50.79	31.79	9.46				PW	35.13	28.21	0.80

Estimated Average Processing Rate (in minutes)

DC	0.0234852
UW	0.0342044
RA	0.0141419
PW	0.0284641

System Times

Assumption 1) - No difference in arrivals between territories for underwriters

	Expected wait time in system (minutes)	Probability of reaching step	Expected wait time of generic good
DC	117.79	100.00%	117.79
UW (avg)	167.35	100.00%	167.35
RT	78.35	100.00%	78.35
PW	38.79	100.00%	38.79

System Time	Minutes	Hours	Days
	402.28	6.704733453	0.89396446

Assumption 2) - Arrival differences between territories for underwriters

	Expected wait time in system (minutes)	Probability of reaching step	Expected wait time of generic good
DC	117.79	100.00%	117.79
UW1	513.83	37.50%	192.69
UW2	178.30	33.72%	60.12
UW3	97.70	28.78%	28.12
RT	78.35	100.00%	78.35
PW	38.79	100.00%	38.79

Expected System	Minutes	Hours	Days
	515.85	8.5975324	1.14633765

Assumption 1) - Pooled underwriters. Territories now irrelevant to underwriting.

	Expected wait time in system (minutes)	Probability of reaching step	Expected wait time of generic good
DC	117.79	100.00%	117.79
UW (avg)	68.55	100.00%	68.55
RT	78.35	100.00%	78.35
PW	38.79	100.00%	38.79

Expected System Time	Minutes	Hours	Days
	303.48	5.057982834	0.67439771

Distribution Clerk

Inputs:

lambda 0.08667
 mu 0.02349
 Ca^2 1
 Cb^2 0.31218

Definitions of terms:

lambda = arrival rate
 mu = service rate
 s = number of servers
 Ca^2 = squared coeff. of variation of arrivals
 Cb^2 = squared coeff. of variation of service times
 Nq = average length of the queue
 Ns = average number in the system
 Wq = average wait in the queue
 Ws = average wait in the system
 P(0) = probability of zero customers in the system
 P(delay) = probability that an arriving customer has to wait

lambda/mu
 3.690267

Outputs:

s	Nq	Ns	Wq	Ws	P(delay)	Utilization	Intermediate Calculations:	
							(l/u)^s/s!	sum (l/u)^s/s!
0							1.00E+00	1.00E+00
1	infinity	infinity	infinity	infinity	1.000000	1.000000	3.69E+00	4.69E+00
2	infinity	infinity	infinity	infinity	1.000000	1.000000	6.81E+00	1.15E+01
3	infinity	infinity	infinity	infinity	1.000000	1.000000	8.38E+00	1.99E+01
4	6.518615	10.208882	75.214792	117.794792	0.833913	0.922567	7.73E+00	2.76E+01
5	0.815148	4.505414	9.405548	51.985548	0.440957	0.738053	5.70E+00	3.33E+01
6	0.225177	3.915444	2.598197	45.178197	0.214814	0.615044	3.51E+00	3.68E+01
7	0.070252	3.760519	0.810603	43.390603	0.096035	0.527181	1.85E+00	3.87E+01
8	0.022102	3.712369	0.255026	42.835026	0.039343	0.461283	8.53E-01	3.95E+01
9	0.006740	3.697006	0.077767	42.657767	0.014781	0.410030	3.50E-01	3.99E+01
10	0.001959	3.692226	0.022602	42.602602	0.005105	0.369027	1.29E-01	4.00E+01

Underwriting Team 1

Inputs:

lambda 0.03250
 mu 0.03420
 Ca^2 1
 Cb^2 0.73852

Definitions of terms:

lambda = arrival rate
 mu = service rate
 s = number of servers
 Ca^2 = squared coeff. of variation of arrivals
 Cb^2 = squared coeff. of variation of service times
 Nq = average length of the queue
 Ns = average number in the system
 Wq = average wait in the queue
 Ws = average wait in the system
 P(0) = probability of zero customers in the system
 P(delay) = probability that an arriving customer has to wait

lambda/mu
 0.95017

Outputs:

s	Nq	Ns	Wq	Ws	P(delay)	Utilization	Intermediate Calculations:	
							(l/u)^s/s!	sum (l/u)^s/s!
0							1.00E+00	1.00E+00
1	15.749316	16.699486	484.594338	513.830338	0.950170	0.950170	9.50E-01	1.95E+00
2	0.240762	1.190932	7.408060	36.644060	0.306024	0.475085	4.51E-01	2.40E+00
3	0.032293	0.982463	0.993638	30.229638	0.080145	0.316723	1.43E-01	2.54E+00
4	0.004659	0.954829	0.143358	29.379358	0.017204	0.237543	3.40E-02	2.58E+00
5	0.000628	0.950798	0.019332	29.255332	0.003081	0.190034	6.45E-03	2.58E+00
6	0.000077	0.950247	0.002363	29.238363	0.000470	0.158362	1.02E-03	2.59E+00
7	0.000008	0.950178	0.000261	29.236261	0.000062	0.135739	1.39E-04	2.59E+00
8	0.000001	0.950171	0.000026	29.236026	0.000007	0.118771	1.65E-05	2.59E+00
9	0.000000	0.950170	0.000002	29.236002	0.000001	0.105574	1.74E-06	2.59E+00
10	0.000000	0.950170	0.000000	29.236000	0.000000	0.095017	1.65E-07	2.59E+00

Underwriting Team 2

Inputs:

lambda 0.02922
 mu 0.03420
 Ca^2 1
 Cb^2 0.73852

Definitions of terms:

lambda = arrival rate
 mu = service rate
 s = number of servers
 Ca^2 = squared coeff. of variation of arrivals
 Cb^2 = squared coeff. of variation of service times
 Nq = average length of the queue
 Ns = average number in the system
 Wq = average wait in the queue
 Ws = average wait in the system
 P(0) = probability of zero customers in the system
 P(delay) = probability that an arriving customer has to wait

lambda/mu
 0.854341

Outputs:

s	Nq	Ns	Wq	Ws	P(delay)	Utilization	Intermediate Calculations:	
							(l/u)^s/s!	sum (l/u)^s/s!
0							1.00E+00	1.00E+00
1	4.355868	5.210209	149.060113	178.296113	0.854341	0.854341	8.54E-01	1.85E+00
2	0.165761	1.020102	5.672429	34.908429	0.255715	0.427170	3.65E-01	2.22E+00
3	0.021270	0.875611	0.727867	29.963867	0.061453	0.284780	1.04E-01	2.32E+00
4	0.002834	0.857175	0.096980	29.332980	0.012004	0.213585	2.22E-02	2.35E+00
5	0.000349	0.854690	0.011933	29.247933	0.001947	0.170868	3.79E-03	2.35E+00
6	0.000039	0.854380	0.001324	29.237324	0.000268	0.142390	5.40E-04	2.35E+00
7	0.000004	0.854345	0.000132	29.236132	0.000032	0.122049	6.59E-05	2.35E+00
8	0.000000	0.854341	0.000012	29.236012	0.000003	0.106793	7.04E-06	2.35E+00
9	0.000000	0.854341	0.000001	29.236001	0.000000	0.094927	6.68E-07	2.35E+00
10	0.000000	0.854341	0.000000	29.236000	0.000000	0.085434	5.71E-08	2.35E+00

Underwriting Team 3

Inputs:

lambda 0.02494
 mu 0.03420
 Ca^2 1
 Cb^2 0.73852

Definitions of terms:

lambda = arrival rate
 mu = service rate
 s = number of servers
 Ca^2 = squared coeff. of variation of arrivals
 Cb^2 = squared coeff. of variation of service times
 Nq = average length of the queue
 Ns = average number in the system
 Wq = average wait in the queue
 Ws = average wait in the system
 P(0) = probability of zero customers in the system
 P(delay) = probability that an arriving customer has to wait

lambda/mu
 0.729276

Outputs:

s	Nq	Ns	Wq	Ws	P(delay)	Utilization	Intermediate Calculations:	
							(l/u)^s/s!	sum (l/u)^s/s!
0							1.00E+00	1.00E+00
1	1.707680	2.436955	68.459320	97.695320	0.729276	0.729276	7.29E-01	1.73E+00
2	0.097214	0.826489	3.897201	33.133201	0.194866	0.364638	2.66E-01	2.00E+00
3	0.011460	0.740735	0.459405	29.695405	0.041048	0.243092	6.46E-02	2.06E+00
4	0.001347	0.730623	0.053993	29.289993	0.006949	0.182319	1.18E-02	2.07E+00
5	0.000144	0.729420	0.005775	29.241775	0.000971	0.145855	1.72E-03	2.07E+00
6	0.000014	0.729290	0.000553	29.236553	0.000115	0.121546	2.09E-04	2.07E+00
7	0.000001	0.729277	0.000047	29.236047	0.000012	0.104182	2.18E-05	2.07E+00
8	0.000000	0.729276	0.000004	29.236004	0.000001	0.091159	1.98E-06	2.07E+00
9	0.000000	0.729276	0.000000	29.236000	0.000000	0.081031	1.61E-07	2.07E+00
10	0.000000	0.729276	0.000000	29.236000	0.000000	0.072928	1.17E-08	2.07E+00

Underwriting Team (Average)

Inputs:

lambda 0.02889
 mu 0.03420
 Ca^2 1
 Cb^2 0.73852

Definitions of terms:

lambda = arrival rate
 mu = service rate
 s = number of servers
 Ca^2 = squared coeff. of variation of arrivals
 Cb^2 = squared coeff. of variation of service times
 Nq = average length of the queue
 Ns = average number in the system
 Wq = average wait in the queue
 Ws = average wait in the system
 P(0) = probability of zero customers in the system
 P(delay) = probability that an arriving customer has to wait

lambda/mu
 0.844596

Outputs:

s	Nq	Ns	Wq	Ws	P(delay)	Utilization	Intermediate Calculations:	
							(l/u)^s/s!	sum (l/u)^s/s!
0							1.00E+00	1.00E+00
1	3.990103	4.834699	138.118949	167.354949	0.844596	0.844596	8.45E-01	1.84E+00
2	0.159346	1.003942	5.515831	34.751831	0.250771	0.422298	3.57E-01	2.20E+00
3	0.020335	0.864931	0.703915	29.939915	0.059701	0.281532	1.00E-01	2.30E+00
4	0.002686	0.847281	0.092964	29.328964	0.011543	0.211149	2.12E-02	2.32E+00
5	0.000327	0.844923	0.011325	29.247325	0.001852	0.168919	3.58E-03	2.33E+00
6	0.000036	0.844631	0.001243	29.237243	0.000252	0.140766	5.04E-04	2.33E+00
7	0.000004	0.844599	0.000123	29.236123	0.000030	0.120657	6.08E-05	2.33E+00
8	0.000000	0.844596	0.000011	29.236011	0.000003	0.105574	6.42E-06	2.33E+00
9	0.000000	0.844596	0.000001	29.236001	0.000000	0.093844	6.03E-07	2.33E+00
10	0.000000	0.844596	0.000000	29.236000	0.000000	0.084460	5.09E-08	2.33E+00

Underwriting Team (Pooled)

Inputs:

lambda 0.08667
 mu 0.03420
 Ca^2 1
 Cb^2 0.73852

Definitions of terms:

lambda = arrival rate
 mu = service rate
 s = number of servers
 Ca^2 = squared coeff. of variation of arrivals
 Cb^2 = squared coeff. of variation of service times
 Nq = average length of the queue
 Ns = average number in the system
 Wq = average wait in the queue
 Ws = average wait in the system
 P(0) = probability of zero customers in the system
 P(delay) = probability that an arriving customer has to wait

lambda/mu
 2.533787

Outputs:

s	Nq	Ns	Wq	Ws	P(delay)	Utilization	Intermediate Calculations:	
							(l/u)^s/s!	sum (l/u)^s/s!
0							1.00E+00	1.00E+00
1	infinity	infinity	infinity	infinity	1.000000	1.000000	2.53E+00	3.53E+00
2	infinity	infinity	infinity	infinity	1.000000	1.000000	3.21E+00	6.74E+00
3	3.407206	5.940992	39.313912	68.549912	0.721212	0.844596	2.71E+00	9.46E+00
4	0.497734	3.031521	5.743089	34.979089	0.331341	0.633447	1.72E+00	1.12E+01
5	0.121806	2.655593	1.405456	30.641456	0.136389	0.506757	8.70E-01	1.20E+01
6	0.031884	2.565670	0.367888	29.603888	0.050177	0.422298	3.68E-01	1.24E+01
7	0.008149	2.541935	0.094022	29.330022	0.016524	0.361970	1.33E-01	1.25E+01
8	0.001971	2.535758	0.022745	29.258745	0.004892	0.316723	4.21E-02	1.26E+01
9	0.000446	2.534233	0.005149	29.241149	0.001310	0.281532	1.19E-02	1.26E+01
10	0.000094	2.533881	0.001087	29.237087	0.000319	0.253379	3.01E-03	1.26E+01

Raters

Inputs:

lambda 0.08667
 mu 0.01414
 Ca^2 1
 Cb^2 0.04231

Definitions of terms:

lambda = arrival rate
 mu = service rate
 s = number of servers
 Ca^2 = squared coeff. of variation of arrivals
 Cb^2 = squared coeff. of variation of service times
 Nq = average length of the queue
 Ns = average number in the system
 Wq = average wait in the queue
 Ws = average wait in the system
 P(0) = probability of zero customers in the system
 P(delay) = probability that an arriving customer has to wait

lambda/mu
 6.128373

Outputs:

s	Nq	Ns	Wq	Ws	P(delay)	Utilization	Intermediate Calculations:	
							(l/u)^s/s!	sum (l/u)^s/s!
0							1.00E+00	1.00E+00
1	infinity	infinity	infinity	infinity	1.000000	1.000000	6.13E+00	7.13E+00
2	infinity	infinity	infinity	infinity	1.000000	1.000000	1.88E+01	2.59E+01
3	infinity	infinity	infinity	infinity	1.000000	1.000000	3.84E+01	6.43E+01
4	infinity	infinity	infinity	infinity	1.000000	1.000000	5.88E+01	1.23E+02
5	infinity	infinity	infinity	infinity	1.000000	1.000000	7.20E+01	1.95E+02
6	infinity	infinity	infinity	infinity	1.000000	1.000000	7.36E+01	2.69E+02
7	2.411749	8.540122	27.827875	98.539875	0.658189	0.875482	6.44E+01	3.33E+02
8	0.661636	6.790010	7.634264	78.346264	0.387728	0.766047	4.93E+01	3.82E+02
9	0.240145	6.368518	2.770905	73.482905	0.215918	0.680930	3.36E+01	4.16E+02
10	0.093510	6.221884	1.078964	71.790964	0.113355	0.612837	2.06E+01	4.37E+02

Policy Writers

Inputs:

lambda 0.08667
 mu 0.02846
 Ca^2 1
 Cb^2 0.64498

Definitions of terms:

lambda = arrival rate
 mu = service rate
 s = number of servers
 Ca^2 = squared coeff. of variation of arrivals
 Cb^2 = squared coeff. of variation of service times
 Nq = average length of the queue
 Ns = average number in the system
 Wq = average wait in the queue
 Ws = average wait in the system
 P(0) = probability of zero customers in the system
 P(delay) = probability that an arriving customer has to wait

lambda/mu
 3.044773

Outputs:

s	Nq	Ns	Wq	Ws	P(delay)	Utilization	Intermediate Calculations:	
							(l/u)^s/s!	sum (l/u)^s/s!
0							1.00E+00	1.00E+00
1	infinity	infinity	infinity	infinity	1.000000	1.000000	3.04E+00	4.04E+00
2	infinity	infinity	infinity	infinity	1.000000	1.000000	4.64E+00	8.68E+00
3	infinity	infinity	infinity	infinity	1.000000	1.000000	4.70E+00	1.34E+01
4	1.385245	4.430018	15.983592	51.115592	0.528382	0.761193	3.58E+00	1.70E+01
5	0.316853	3.361627	3.656001	38.788001	0.247383	0.608955	2.18E+00	1.91E+01
6	0.088998	3.133771	1.026897	36.158897	0.105023	0.507462	1.11E+00	2.03E+01
7	0.025557	3.070331	0.294891	35.426891	0.040364	0.434968	4.81E-01	2.07E+01
8	0.007108	3.051881	0.082012	35.214012	0.014064	0.380597	1.83E-01	2.09E+01
9	0.001875	3.046648	0.021630	35.153630	0.004458	0.338308	6.20E-02	2.10E+01
10	0.000465	3.045238	0.005366	35.137366	0.001292	0.304477	1.89E-02	2.10E+01