

DataMOCCA

DATA MOdel for Call Center Analysis

Volume 4.4

Empirical Analysis of a Call Center

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DataMOCCA

DATA Model for Call Center Analysis

The DataMOCCA Project is an initiative of researchers from the Technion—Israel Institute of Technology and The Wharton School—University of Pennsylvania. The mission of the project is to collect, pre-process, organize and analyze data from Telephone Call/Contact Centers. The raw data obtained are call-by-call records of at least one year's duration from active Call Centers. Among the goals of the project are the development and distribution of Call Center databases, using a uniform schema. The data repository created, together with software tools, will be accessible through the world-wide-web and provide a resource for researchers and teachers of Service Engineering, Science and Management.

List of Documents

Volume	Title	Revision Date
1	Model Description and Introduction to User Interface	July 29, 2006
2	Summary Tables Variable Definitions	August, 2006
3.1	SEESat Guide I – Beginning User	to be completed
3.2	SEESat Guide II – Advanced User	July, 2008
3.3	SEESat Guide III – Data Extraction Facility	to be completed
4.1	The Call Center of a "US Bank"	November 2, 2006
4.2	The Call Center of "IL Telecom"	November 2, 2006
4.3	Empirical Analysis of a Call Center in an Israeli Commercial Company	July, 2009
4.4	Empirical Analysis of a Call Center	August, 2009
5.1	Skills-Based-Routing in a US Bank	February, 2008
6.1	Empirical Analysis of Little's law using Data from the Call Center of US Bank	May, 2010
6.2	Implementing the Offered-Load in SEESat	May, 2011

For more information concerning access to the database and materials please contact:
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Basic Counts

Table 2: Monthly call counters

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arrivals	31599	33344	38801	32036	39553	37935	39022	42078	31371	34625	41019	43065

Table 3: Call Counts by outcome

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Agent	27060	27162	27847	23583	29923	31193	29596	31402	27062	30861	33371	34083
Hang	4299	5904	10547	8148	9212	6420	9048	10366	4146	3617	7351	8648
Phantom	240	278	407	305	418	322	378	310	163	147	297	334
Total	31599	33344	38801	32036	39553	37935	39022	42078	31371	34625	41019	43065

Table 4: Call counts by waiting status

Date	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Q=0	14694	15038	10635	10691	13031	15942	11975	16116	17704	22578	16643	16176
Q>0	16905	18306	28166	21345	26522	21993	27047	25962	13667	12047	24376	26889
Total	31599	33344	38801	32036	39553	37935	39022	42078	31371	34625	41019	43065

Table 5: Calls Counts by being identified

Date	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
ID<>0	18175	19558	15436	13827	17837	20047	17175	23030	21071	26082	21109	21205
ID=0	13424	13786	23365	18209	21716	17888	21847	19048	10300	8543	19910	21860
Total	31599	33344	38801	32036	39553	37935	39022	42078	31371	34625	41019	43065

Table 6: Counts stratification by waiting status and identification

Date	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Q=0 ID=0	3955	5038	5830	3911	5511	4595	5725	7204	3487	3588	4814	5484
Q>0 ID=0	14220	14520	9606	9916	12326	15452	11450	15826	17584	22494	16295	15721
ID<>0 Q=0	12950	13268	22336	17434	21011	17398	21322	18758	10180	8459	19562	21405
Q>0 ID<>0	474	518	1029	775	705	490	525	290	120	84	348	455
Total	31599	33344	38801	32036	39553	37935	39022	42078	31371	34625	41019	43065

Table 7: Refined outcome counts (types PS, NE, NW, IN, PE)

Date	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
A Q=0	12873	12337	7271	7183	9998	13412	8951	12487	15905	20824	14171	13244
A Q>0	13335	13841	18795	15147	18779	16792	19644	18275	10861	9748	18394	19888
H Q=0	1206	1965	1959	2468	2136	1781	2258	3100	1590	1528	1855	2162
H Q>0	3018	3876	8454	5598	7009	4586	6719	7199	2521	2067	5389	6380
Phantom	195	237	319	260	335	284	319	299	161	143	296	326
Total	30627	32256	36798	30656	38257	36855	37891	41360	31038	34310	40105	42000

Table 8: Refined outcome counts for type TT

Date	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
A Q=0	602	729	1398	1019	894	745	763	523	208	226	616	757
A Q>0	250	255	383	234	252	244	238	117	88	63	190	194
H Q=0	13	7	7	21	3	4	3	6	1	0	1	13
H Q>0	62	56	127	61	64	49	68	61	34	22	106	93
Phantom	45	41	88	45	83	38	59	11	2	4	1	8
Total	972	1088	2003	1380	1296	1080	1131	718	333	315	914	1065

Table 9: combinations of VRU, queue and service times

Date	VRU<0		VRU=0				VRU>0				Total
	queue>0		queue=0		queue>0		queue=0		queue>0		
	service=0	service>0	service=0	service>0	service=0	service>0	service=0	service>0	service=0	service>0	
Jan-99	11	22	328	2	127	189	1064	13300	2978	13578	31599
Feb-99	2	23	355	2	55	255	1653	13028	3828	14143	33344
Mar-99	8	19	608	0	107	419	1380	8647	8420	19193	38801
Apr-99	6	31	600	2	44	224	1902	8187	5561	15479	32036
May-99	30	48	558	2	48	268	1601	10870	6913	19215	39553
Jun-99	4	23	433	1	47	264	1396	14112	4563	17092	37935
Jul-99	12	34	598	2	55	264	1692	9683	6738	19944	39022
Aug-99	4	15	547	1	61	124	2602	12966	7151	18607	42078
Sep-99	4	10	279	0	29	81	1370	16055	2529	11014	31371
Oct-99	2	2	186	2	19	63	1370	21020	2039	9922	34625
Nov-99	2	18	408	1	100	174	1463	14771	5338	18744	41019
Dec-99	3	17	490	0	93	181	1708	13978	6338	20257	43065

The arrival process

Figure 2: Strategical level. Number of calls per month

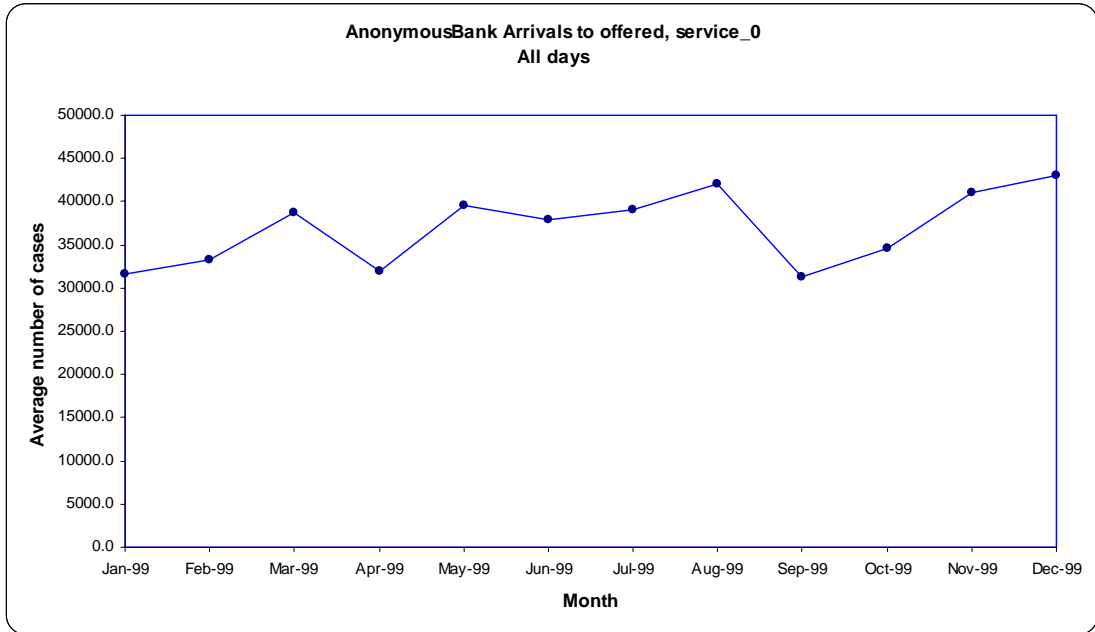


Figure 3: Tactical level. Number of calls per day (Nov)

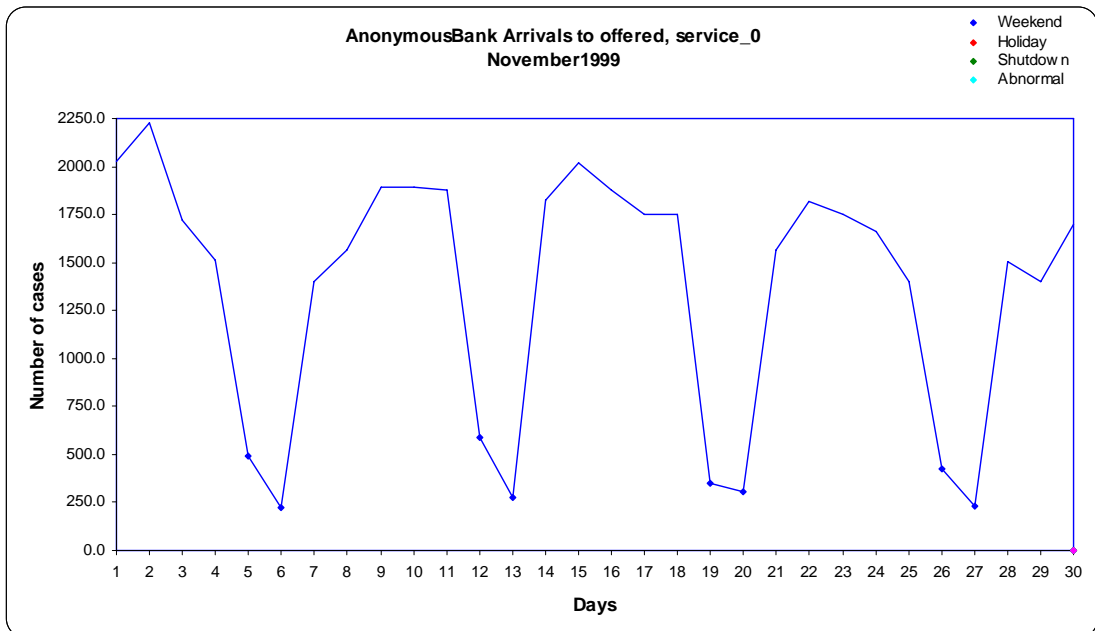


Figure 4: Operational level. Average number of calls per hour (Nov, weekdays)

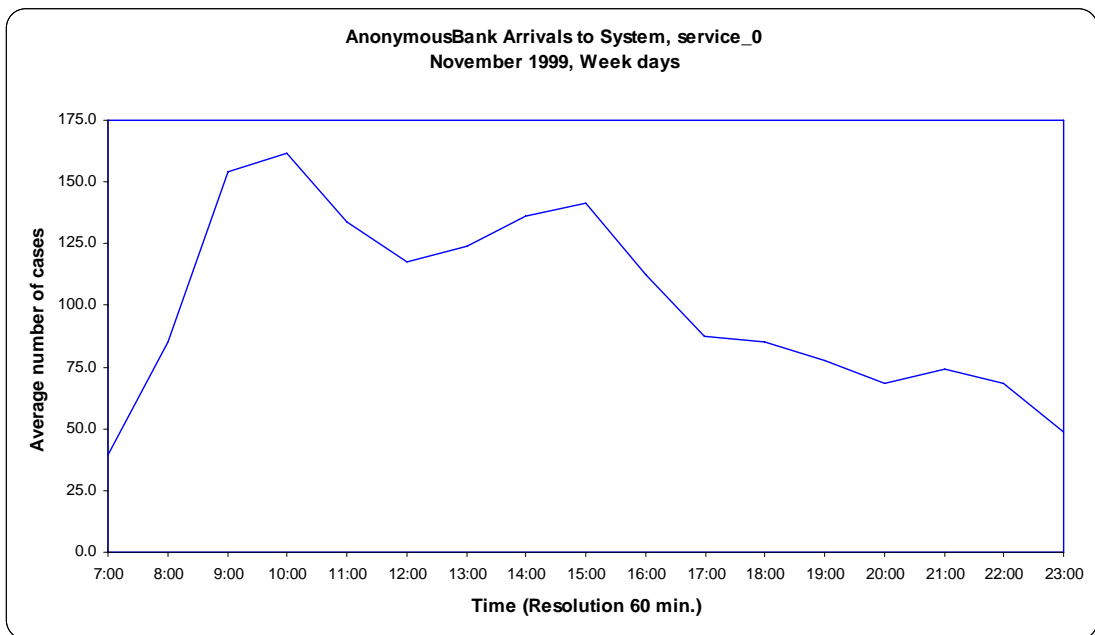


Figure 5: Stochastic level. Number of calls per minute (Nov 7th)

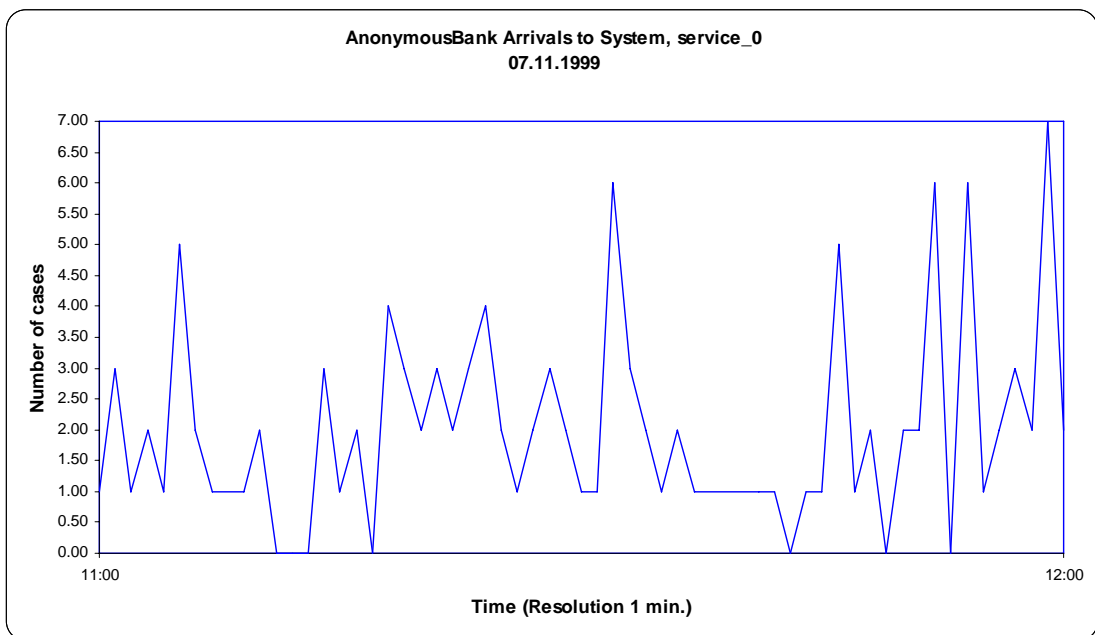


Figure 6: Number of calls per day

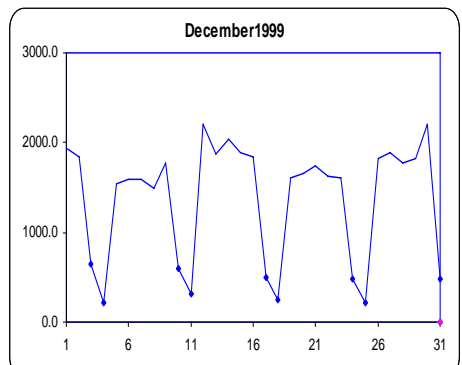
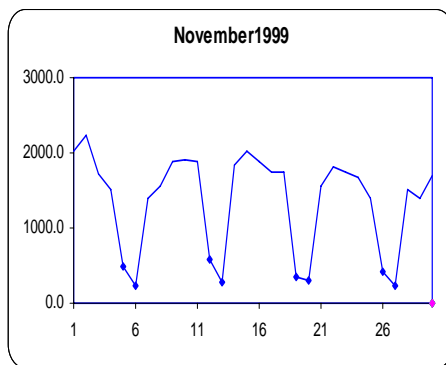
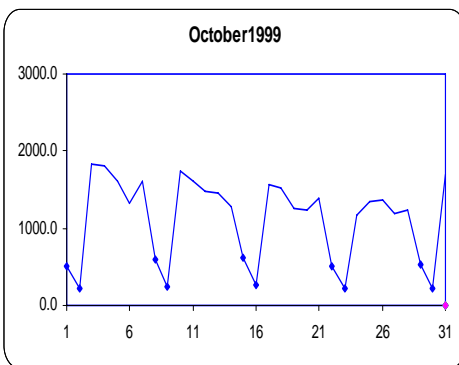
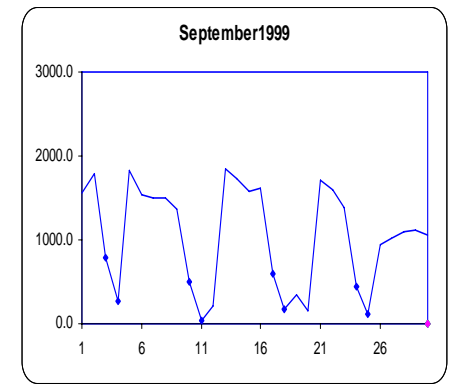
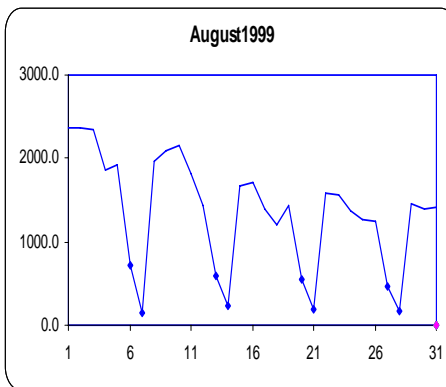
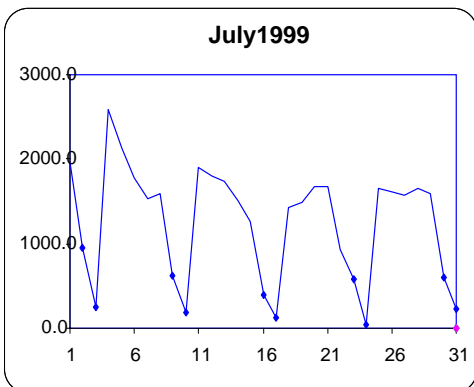
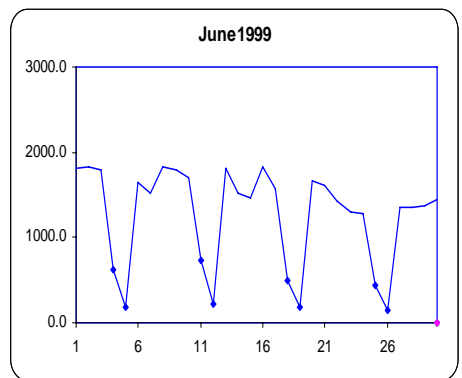
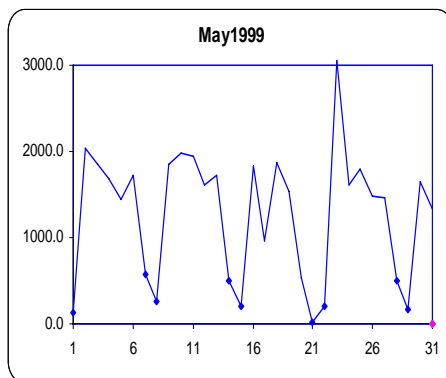
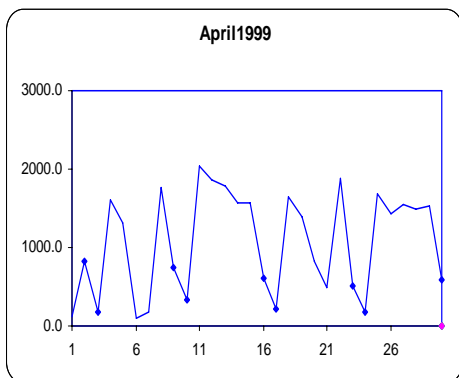
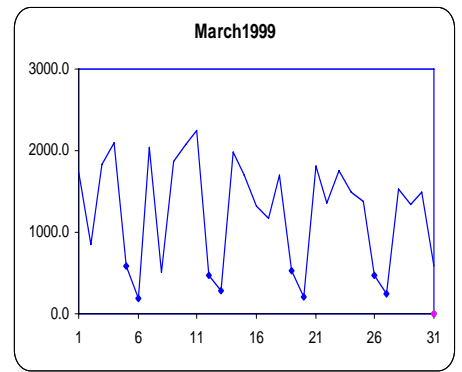
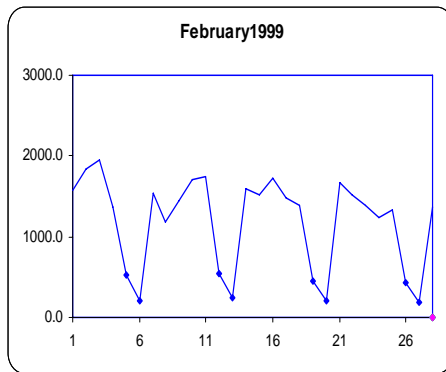
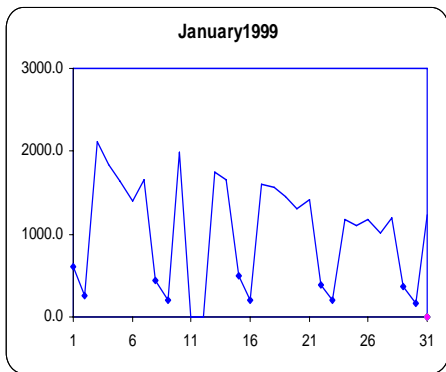


Table 10: Call counts by service

Date	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
PS	22998	21460	25910	22551	28482	26608	27269	27312	20810	23145	27156	28821
NW	5582	7604	6732	4760	5126	5832	5723	6923	4340	5222	5104	4780
PE	164	149	163	117	146	156	160	181	113	141	170	164
NE	1586	2750	3490	2776	4011	3776	3536	3381	2635	2815	4418	4168
TT	972	1088	2003	1380	1296	1080	1131	718	333	315	914	1065
IN	295	293	503	451	492	483	1202	3563	3139	2987	3257	4067
AA	2	0	0	1	0	0	1	0	1	0	0	0
Total	31599	33344	38801	32036	39553	37935	39022	42078	31371	34625	41019	43065

Figure 7: Number of calls per month according to services

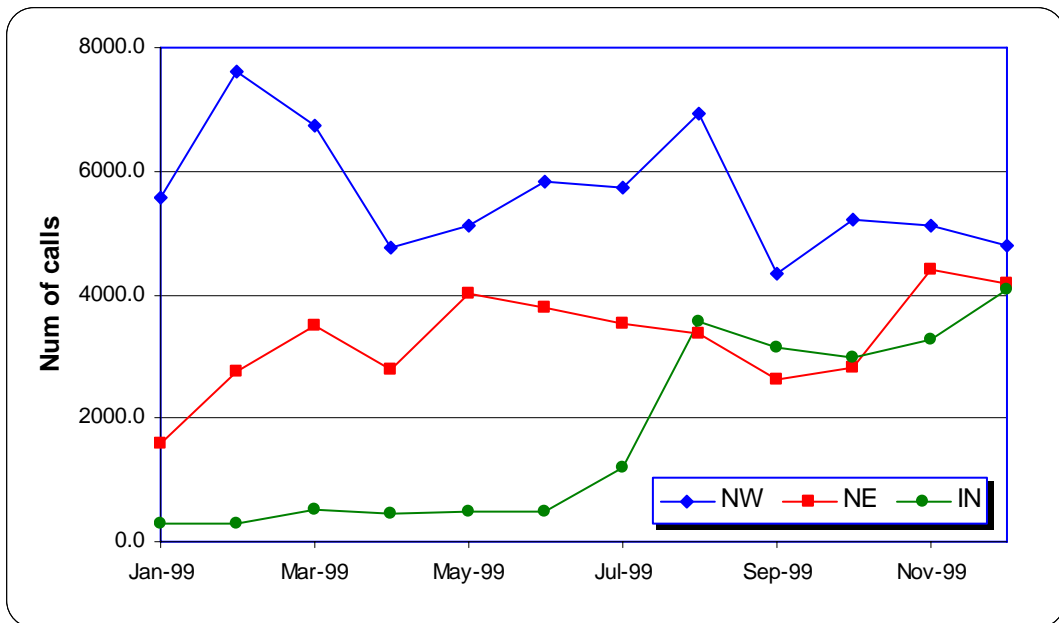


Table 11: Call counts by priorities

Date	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
priority_0	18224	19602	15490	13880	17917	20076	17221	23112	21086	26103	21146	21311
priority_1	4530	4623	7844	6274	7164	5666	7583	6573	3626	3203	6804	7937
priority_2	8845	9119	15467	11882	14472	12193	14218	12393	6659	5319	13069	13817

Table12: Call counts by type and priorities

Date	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
PS -	11268	10229	6900	7526	10852	11929	8802	10781	12015	15889	10949	10533
PS 0	32	30	24	31	65	20	30	70	13	15	28	97
PS 1	3956	3915	6591	5363	6172	4992	6678	5907	3181	2840	5876	6891
PS 2	7742	7286	12395	9631	11393	9667	11759	10554	5601	4401	10303	11300
NW 0	5562	7539	6701	4734	5098	5808	5699	6882	4323	5213	5090	4765
NE -	740	1107	731	714	1039	1374	1045	1381	1389	1729	1369	1338
NE 1	147	256	511	351	480	313	476	382	315	262	624	692
NE 2	699	1387	2248	1711	2492	2089	2015	1618	931	824	2425	2138
IN 0	295	293	502	451	492	483	1201	3562	3139	2987	3257	4067
PE 0	79	65	48	36	59	74	48	72	47	68	61	55
PE 1	38	32	50	42	47	48	69	77	27	35	47	43
PE 2	47	52	65	39	40	34	43	32	39	38	62	66
TT 0	246	339	584	387	312	388	395	364	159	202	392	456
TT 1	379	386	679	507	445	295	351	183	92	63	250	305
TT 2	347	363	740	486	539	397	385	171	82	50	272	304

VRU time

Table 13: Statistics for VRU time

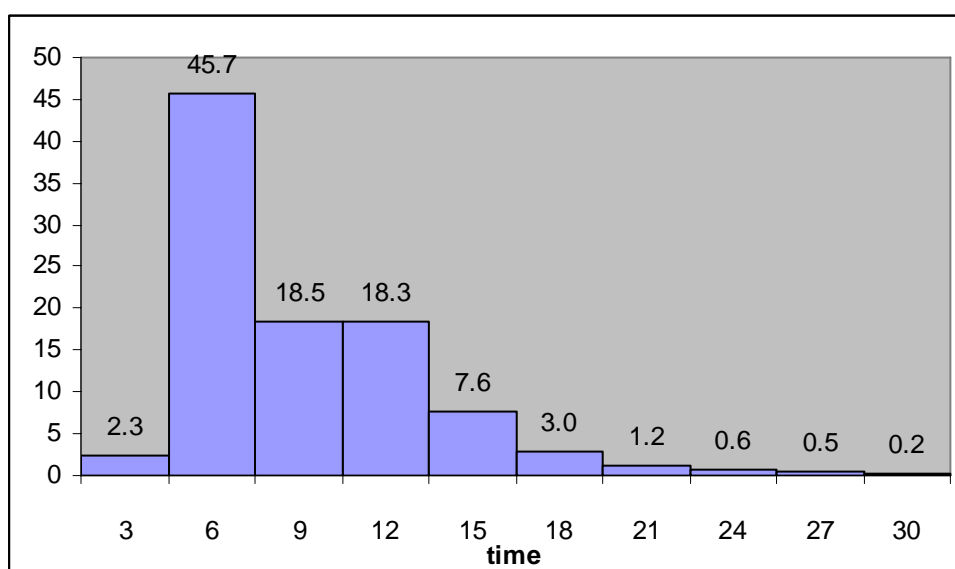
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	10.11	10.52	9.74	10.37	9.93	9.63	9.7	11.84	10.64	10.78	10.25	10.46
Median	9	9	6	6	6	8	6	9	9	9	6	6
SD	24.54	25.56	40.67	40.83	39.62	26.94	36.88	43.91	19.88	21.32	39.21	39.53
Minimum	0	0	0	0	0	0	0	0	0	0	0	0
Maximum	4832	4832	4832	4832	4832	4832	4832	4832	4832	4832	4832	4832
Total	31566	33319	38774	31203	39461	37908	38976	42059	30516	34391	40999	43045

The difference between total numbers of calls in table 13 is caused by minimal value of VRU time (0) that is taken in our table and negative values of VRU time in original one.

Table 14: Statistics for VRU time, truncated at 60 sec

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	8.99	9.24	7.76	8.35	8.27	8.6	8.08	8.94	10.03	10.2	8.62	8.46
Median	9	9	6	6	6	8	6	8	9	9	7	6
SD	4.65	5.35	4.65	5.71	5.06	4.69	4.79	5.34	5.32	4.94	4.7	4.85
Total	30665	32325	37349	30813	38336	36977	37817	40478	30815	34244	39964	41813

Figure 8: Distribution of VRU time (1999)



Queue time

Table 15: Call counts by waiting status

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Q=0	13475	13066	8669	8202	10892	14157	9714	13010	16113	21050	14787	14001
Q>0	16905	18306	28166	21345	26522	21993	27047	25962	13667	12047	24376	26889
Total	30380	31372	36835	29547	37414	36150	36761	38972	29780	33097	39163	40890

Table 16: Summary statistics for time in queue

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	38.04	44.42	91.83	79.3	68.57	53.43	77.69	77.38	38.78	27.8	63.32	74.01
Median	11	13	46	38	29	16	38	29	0	0	20	28
SD	65.2	70.46	124.9	107.54	97.63	216	104.98	119.26	75.98	153.59	102.51	114.39
Total	30380	31372	36835	29547	37414	36150	36761	38972	29780	33097	39163	40890

Table 17: Summary statistics for time in queue, truncated at 15 minutes

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	37.56	44.39	90.83	78.79	68.18	51.81	77.11	76.02	38.57	26.53	62.67	73.02
Median	11	13	46	38	29	16	38	28	0	0	20	28
SD	59.92	70.29	120.87	103.94	95.32	80.97	101.48	111.15	73.28	61.24	98.96	107.51
Total	30369	31371	36797	29535	37401	36143	36742	38930	29776	33082	39138	40859

Table 18: Summary statistics for waiting time (wait > 0)

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	68.37	76.12	120.09	109.77	96.74	85.38	105.59	116.16	84.49	74.27	101.74	112.55
Median	46	50	75	72	62	55	69	72	54	45	63	71
SD	74.61	78.07	130.41	112.53	103.55	90.09	109.7	129.8	93.36	92.27	113.9	124.74
Total	16905	18306	28166	21345	26522	21991	27047	25962	13667	12046	24376	26889

Table 19: Summary statistics for waiting time (wait > 0), truncated at 15 minutes

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	67.52	76.08	118.82	109.08	96.2	85.18	104.83	114.18	84.05	72.96	100.73	111.08
Median	46	50	75	72	62	55	69	72	54	45	63	71
SD	66.56	77.83	125.64	107.95	100.61	89.09	105.33	119.16	88.76	83.22	109.11	115.56
Total	16894	18305	28128	21333	26509	21986	27028	25920	13663	12032	24351	26858

Figure 9: Distribution of waiting time (1999)

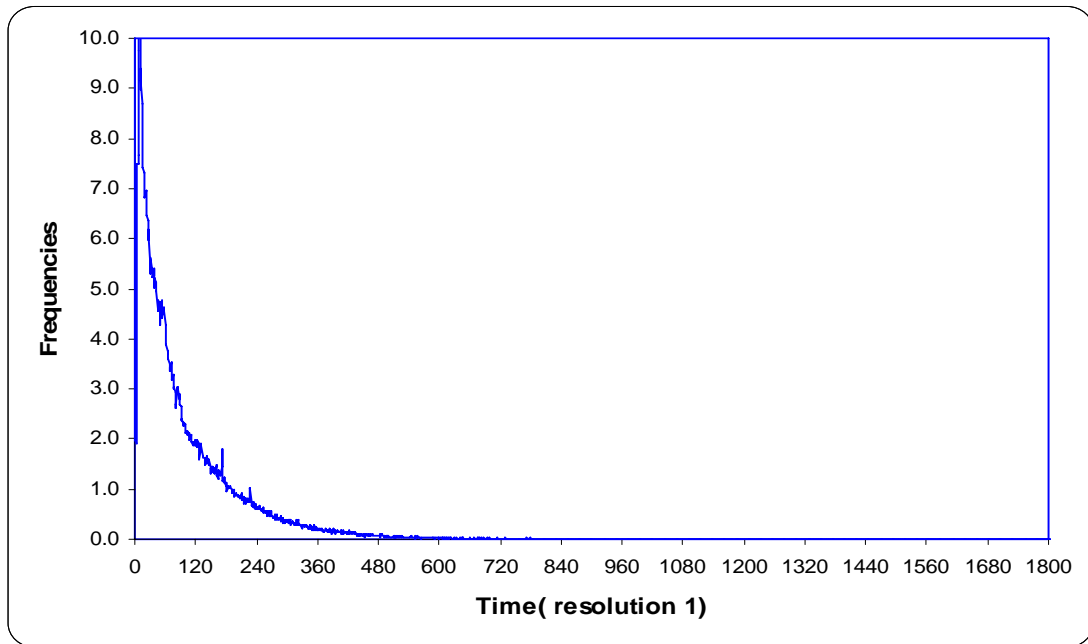


Table 20: Waiting time when abandon

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	61.14	66.05	84.9	84.82	71.56	70.74	81.73	89.54	75.82	79.47	80.09	86.42
Median	39	43	56	56	43	47	53	54	51	49	52	56
SD	95.17	72.56	100.72	104.45	91.15	79.97	102.54	128.95	101.49	112.23	99.96	119.91
Total	3080	3932	8581	5659	7073	4635	6787	7260	2555	2089	5495	6473

Table 21: Waiting time when abandon, truncated at 15 min

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	57.47	65.83	83.95	82.95	70.44	70.56	80.32	85.23	74.2	76.63	79.18	83.63
Median	39	43	55	56	43	47	53	54	51	49	52	55
SD	66.07	71.32	95.66	90	83.82	79.01	90.9	100.99	80.59	94.74	93.67	97.52
N	3071	3931	8573	5651	7066	4634	6780	7237	2553	2084	5491	6460

Table 22: Waiting time when reaching an agent

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	69.77	78.57	134.9	118.43	105.35	88.84	112.73	126.02	86.23	72.96	107.39	120.38
Median	48	52	91	83	71	58	78	83	55	44	68	80
SD	67.34	79.13	137.75	113.91	105.26	91.26	110.08	128.5	91.06	87.07	115.9	124.84
Total	13585	14096	19178	15381	19031	17036	19882	18392	10949	9811	18584	20082

Table 23: Waiting time when reaching an agent, truncated at 15 min

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	69.67	78.57	133.55	118.14	105.12	88.69	112.21	124.95	86.06	71.94	106.44	119.3
Median	48	52	91	83	71	58	77	83	55	44	68	80
SD	66.21	79.13	133.06	112.14	104.01	90.51	107.84	123.59	90.15	80.03	111.74	119.04
N	13584	14096	19150	15377	19027	17033	19871	18374	10947	9802	18565	20064

Figure 10: Distribution of waiting time given abandonment

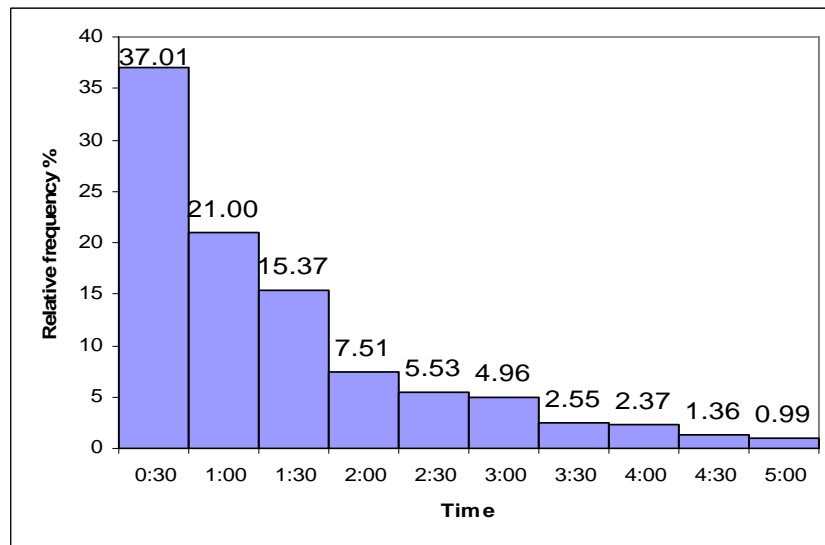
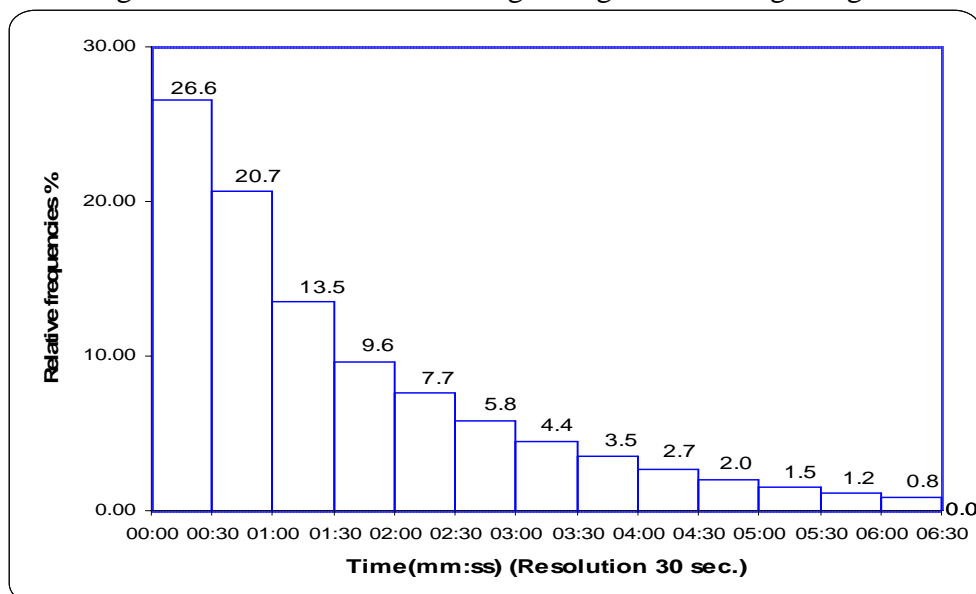


Figure 11: Distribution of waiting time given reaching an agent



The difference in frequencies in Figures 10, 11 is caused by different way of counting values in intervals (to include or not to include an upper border in interval).

Table 24: Waiting time when abandoning for type PS

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	51.1	53.37	69.09	68.6	55.41	54.85	62.48	66.55	56.67	54.05	61.37	64.2
Median	37	37	50	50	33	37	43	48	41	39	43	47
SD	61.07	56.85	75.56	72.12	67.85	61	67.14	73.97	57.19	59.68	66.53	69.03
N	1643	1666	4880	3340	4600	2439	3894	3585	1192	735	2935	3657

Table 25: Waiting time when abandoning for type NW

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	58.26	71.41	95.47	96.87	95.8	86.44	101.22	90.16	86.9	70.44	87.08	97.13
Median	40	47	61	64	62	60	63	56	58	46	56	63
SD	60.65	74.48	99.81	92.86	96.21	85.34	107.82	101.51	93.51	78.9	94.98	100.69
N	1203	1950	2810	1778	1801	1713	1979	2363	946	906	1505	1620

Table 26: Waiting time when abandoning for type IN

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	134.64	143.06	171.96	178.09	131.9	150.82	132.85	142.44	101.1	137.58	143	140.23
Median	98.5	100.5	91.5	119	76	83.5	93	84	71	85	82	86
SD	112.24	123.06	191.06	169.85	124.25	160.28	124.87	152.7	99.37	147.13	153.18	152.8
Total	58	62	208	159	170	124	411	942	286	345	531	713

Table 27: Waiting time when abandoning for type NE

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	108	91.46	121.4	115.91	99.66	73.01	87.34	87.11	79.31	70.09	97.54	106.67
Median	58	53	74.5	69	53	40	50	50	47.5	44	56	72
SD	113.09	93.98	133.09	135.65	115.68	84.43	99.02	101.38	70.55	76.17	110.7	117.46
N	83	181	496	283	398	285	382	243	80	57	386	346

Table 28: Waiting time when abandoning for priority 1 customers

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	56.92	61.56	73.81	72	65.22	59.49	70.16	71.2	63.21	64.21	67.17	70.94
Median	43	44	54	52	43	40	50	53	46	48	49	52
SD	63.2	65.88	77.31	80.34	74.97	66.27	73.13	76.3	61.8	70.55	73.15	76.12
Total	798	911	2451	1752	1971	1197	1902	1789	657	440	1579	1990

Table 29: Waiting time when abandoning for priority 2 customers

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	54.04	55.71	74.45	71.97	67.27	59.68	66.39	67.34	54.88	49.38	65.17	66.64
Median	35	38	49	48	43	40	44	46	38	33	41	45
SD	70.58	61.93	88.94	79.3	79.73	64.72	75.58	77.88	59.56	58.4	76.74	79.7
Total	920	902	3034	1911	2160	1401	2175	2022	643	365	1822	2066

Table 30: Waiting time when reaching an agent for type PS

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	65.5	68.7	125.54	109.99	98.01	80.35	103.86	111.8	77.61	59.5	97.78	107.28
Median	45	47	84	77	67	53	72	76	50	39	63	72
SD	61.08	67	127.77	103.71	97.38	80.02	98.94	109.43	79.64	59.71	101.04	104.73
Total	10038	9594	13887	11486	14219	12305	14787	12885	7494	6426	13062	14383

Table 31: Waiting time when reaching an agent for type NW

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	81.21	107.29	168.63	152.01	146.88	121.67	164.54	167.84	118.89	97.02	131.57	170.86
Median	55	73	125	117	109	79	125	123	74	60	84	127
SD	76.95	101.36	151.73	133.19	130.72	118.85	143.09	146.98	119.98	101.43	126.92	151.36
Total	2337	2577	2402	1679	1770	2115	2231	2254	1386	1477	1688	1671

Table 32: Waiting time when reaching an agent for type IN

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	124.33	144.81	255.95	219.31	189.2	176.24	159.35	193.02	114.65	135.33	147.44	155.85
Median	87.5	112	221.5	181	147	147	113	139.5	78	87	85	92
SD	109.23	133.81	195.99	166.31	145.99	151.13	141.77	172.74	117.4	138.1	164.97	166.53
Total	128	139	150	139	167	201	423	1292	763	753	898	1265

Table 33: Waiting time when reaching an agent for type NE

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	82.26	87.93	147.01	137.5	114.63	97.48	109.71	117.17	83.41	65.7	121.78	137.08
Median	56	61	109	100	82	69	80	76	57	44	84	100
SD	78.06	85.07	131.52	127.72	107.75	95.22	100.74	115.38	78.8	65.89	122.94	127.97
Total	762	1456	2251	1781	2557	2107	2118	1752	1165	1026	2645	2471

Table 34: Waiting time when reaching an agent for priority 1 customers

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	69.5	81.4	144.91	128.99	116.73	97.01	117	129.8	93.62	73.99	118.33	130.76
Median	48	58	108	100	86	66	90	98	65	49	85	96
SD	62.75	74.78	136.17	114.93	106.04	91.31	104.22	117.58	90.33	70.12	112.7	119.36
Total	3395	3327	4765	3997	4709	4143	5292	4527	2842	2655	4938	5583

Table 35: Waiting time when reaching an agent for priority 2 customers

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	65.27	67.21	120.63	105.96	95.33	77.51	98.59	105.36	71.22	53.61	94.01	102.25
Median	45	45	80	72	65	51	68	69	47	37	60	69
SD	62.27	67.41	124.3	102.91	95.92	78.54	95.93	106.13	73.08	54.33	100.97	102.14
Total	7586	7864	11682	9455	11771	10383	11631	10100	5905	4867	10944	11376

Hazard rates and survival functions for patience and virtual wait

Figure 12: Hazard rate for time willing to wait (Nov + Dec)

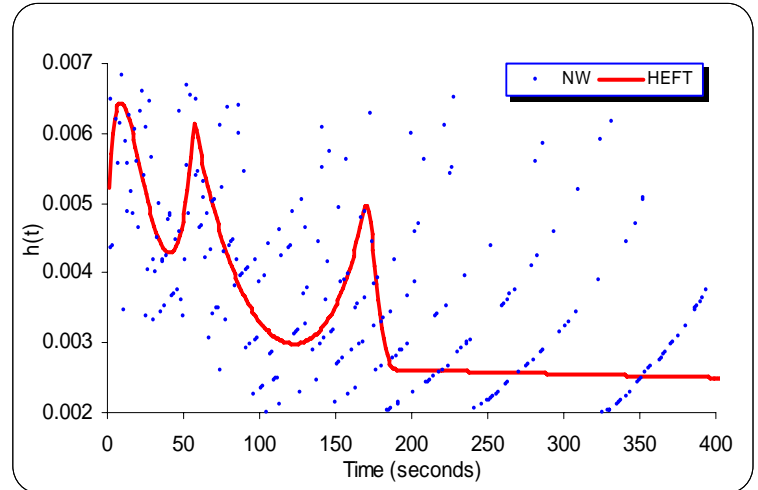
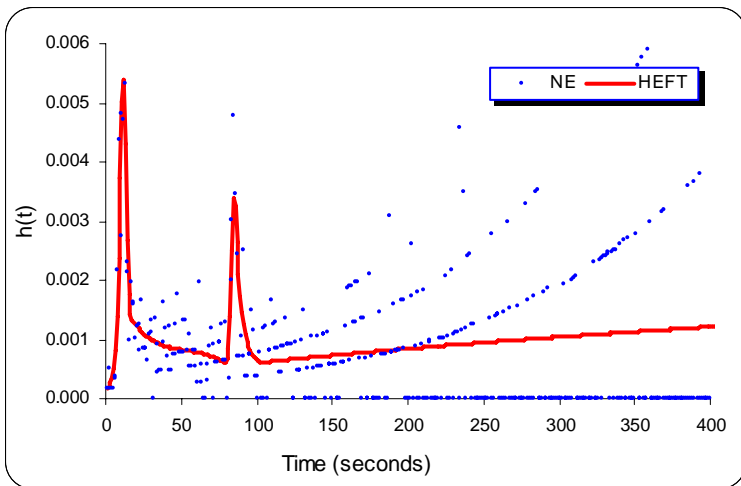
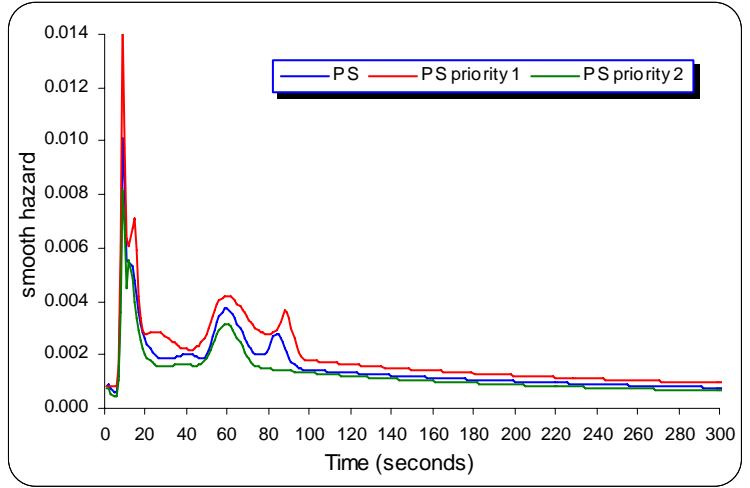
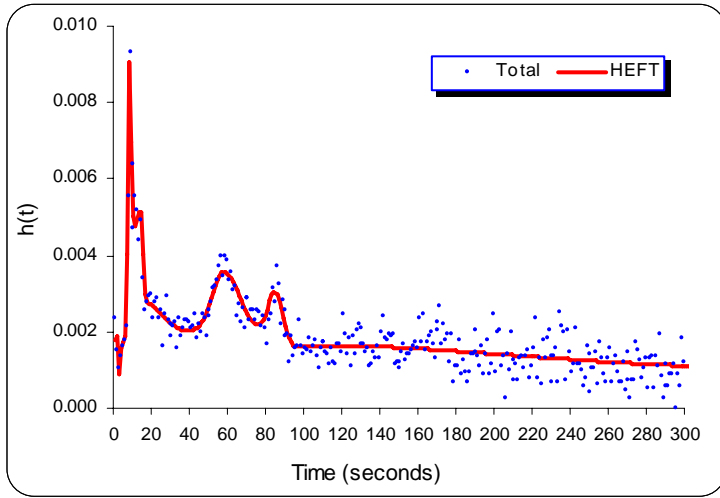


Figure 13: Survival function (Nov + Dec)

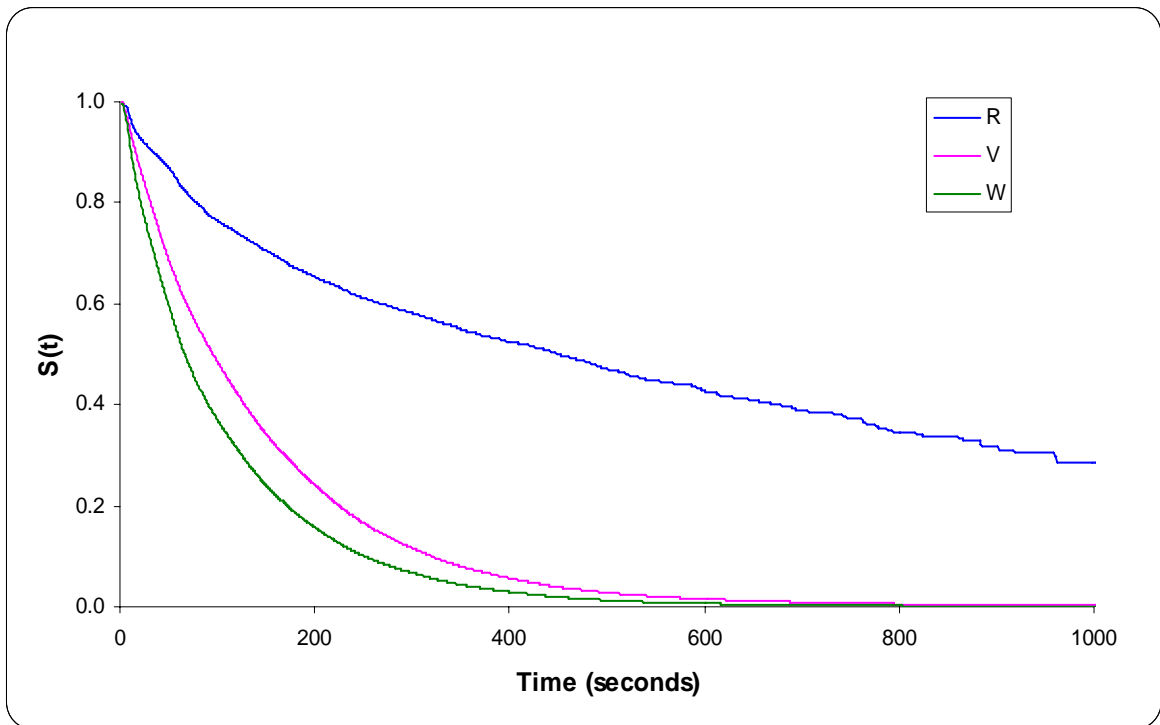


Figure 14: Hazard rates for virtual waiting time (Nov + Dec)

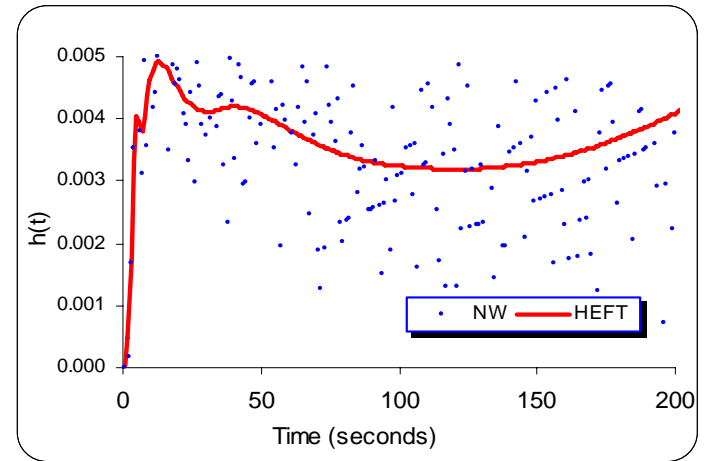
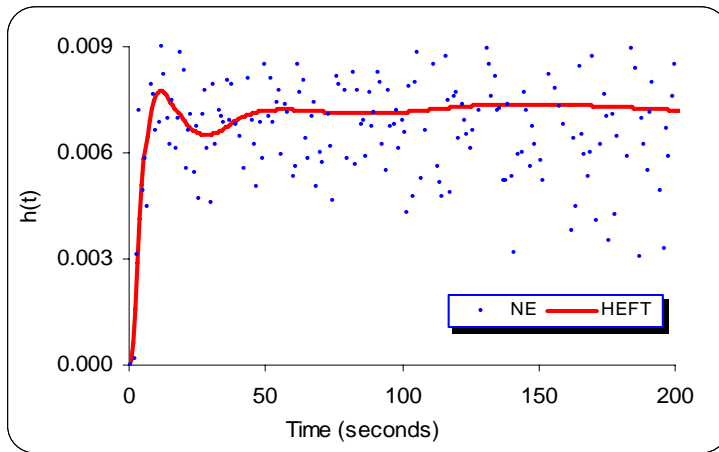
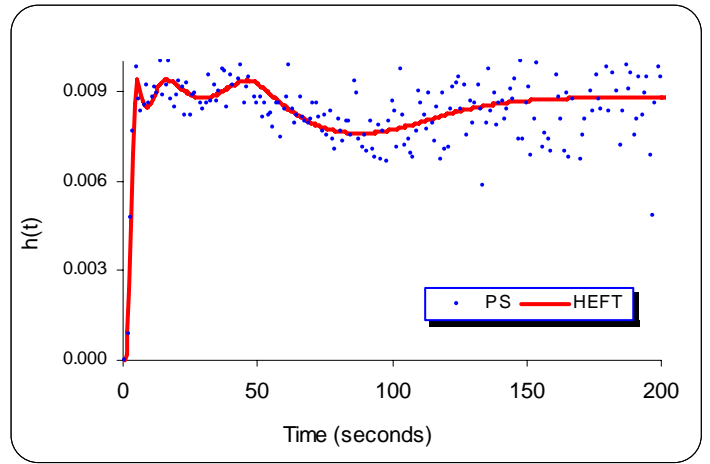
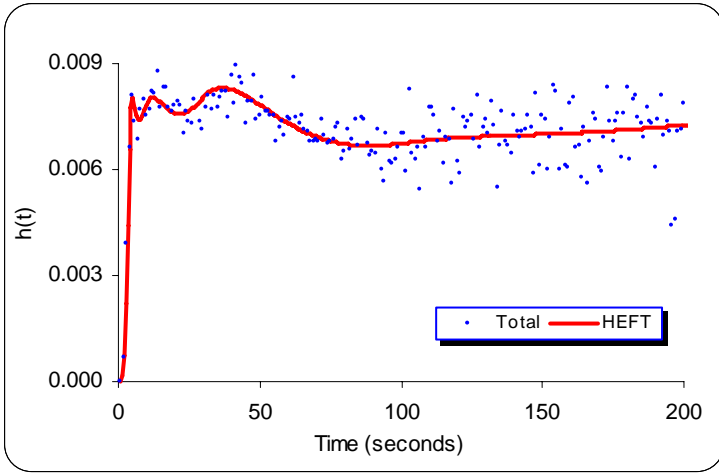
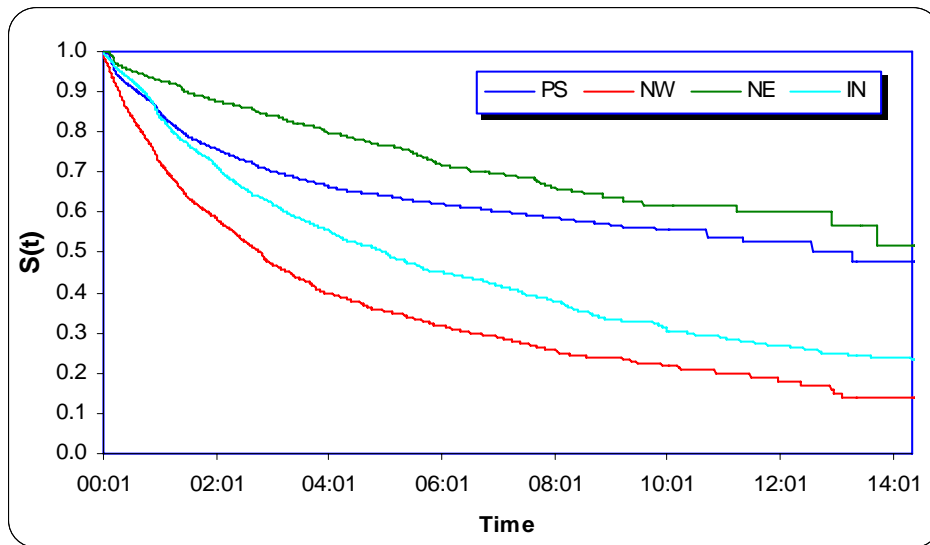
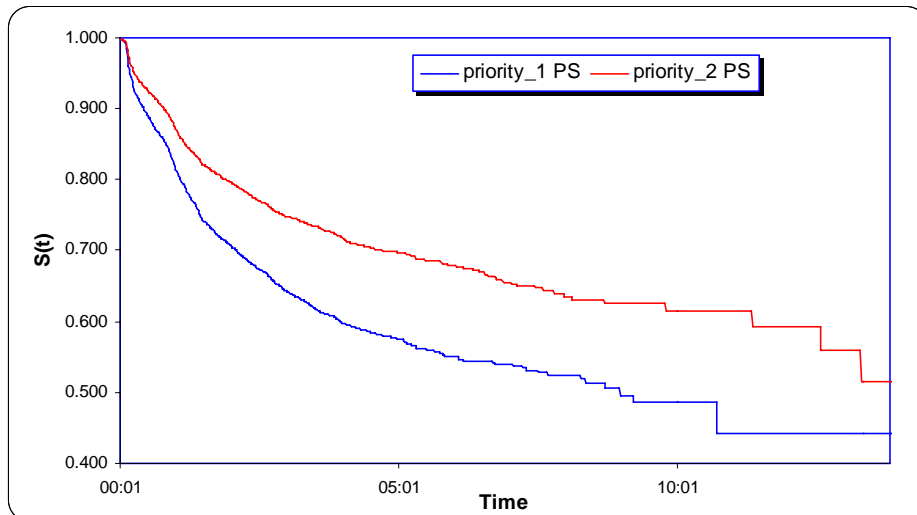


Figure 15: Survival curves for time willing to wait (Nov + Dec)



PS customers



NE customers

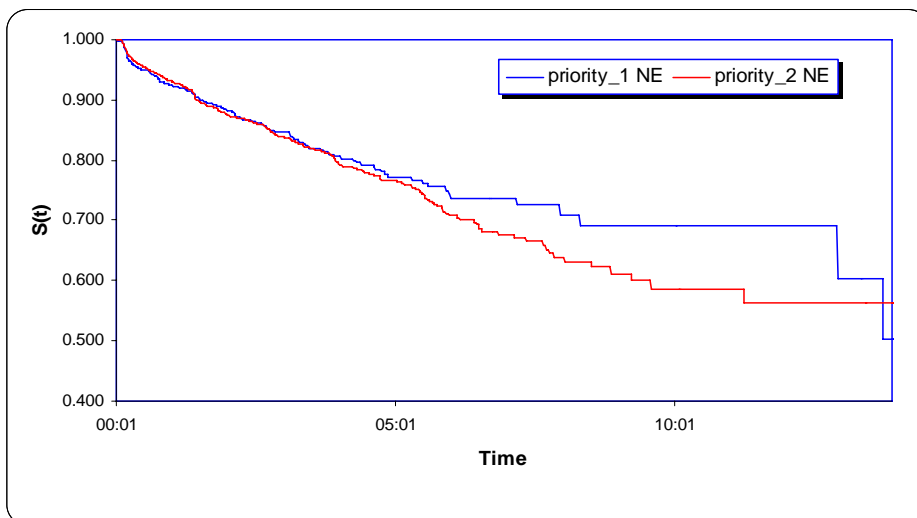
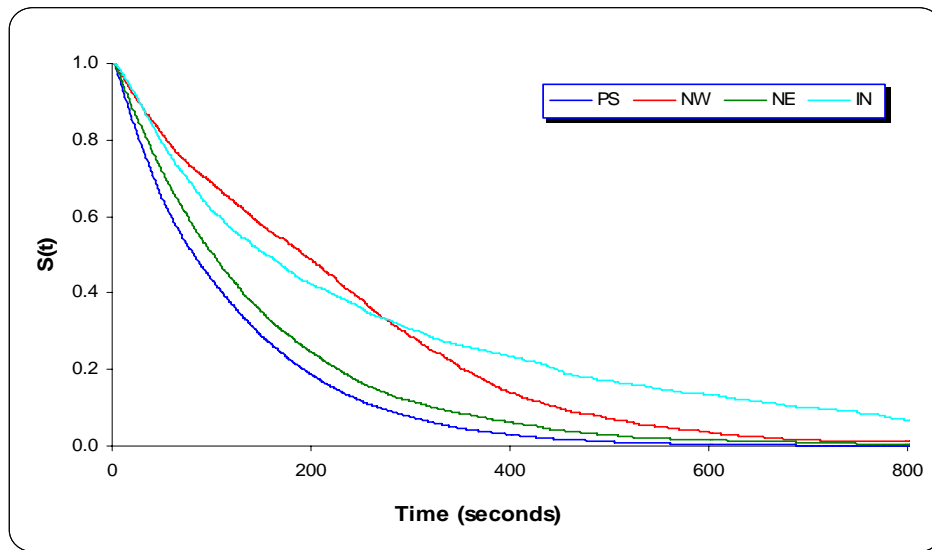
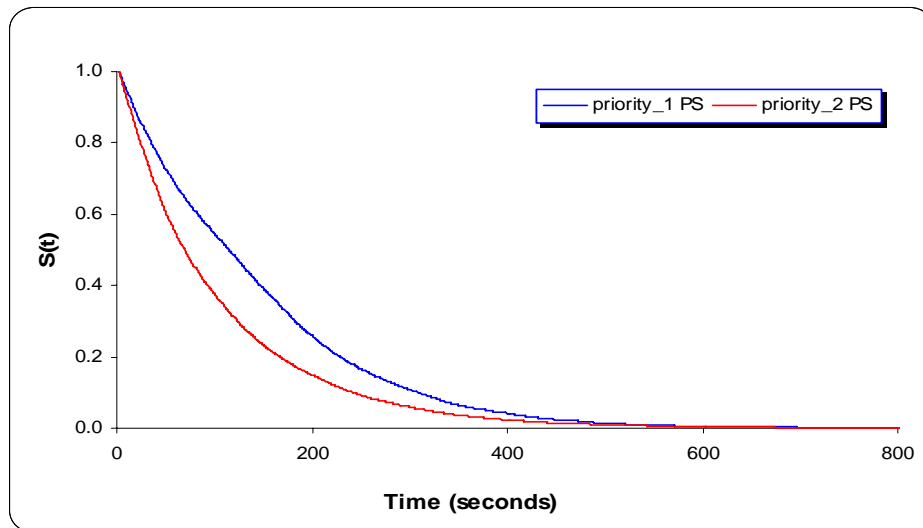


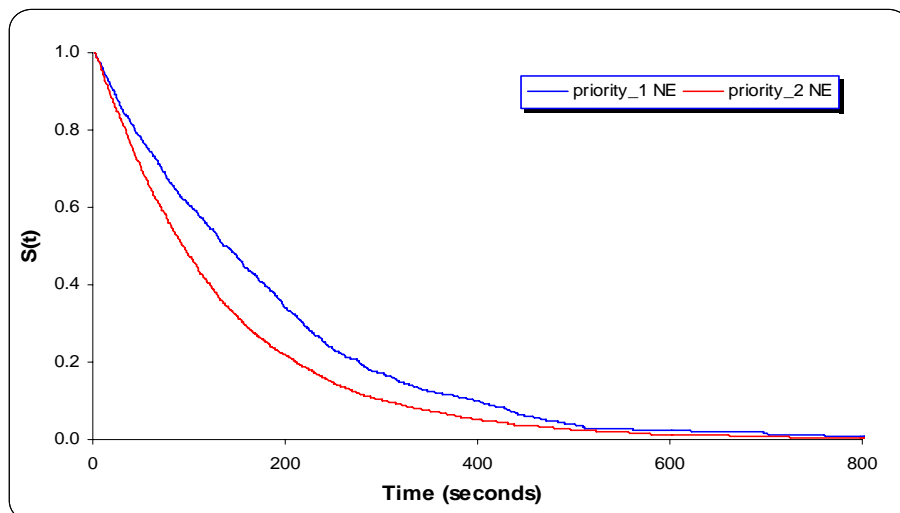
Figure 16: Survival curves for virtual waiting time (Nov + Dec)



PS customers



NE customers



Service time

Table 38: Service time

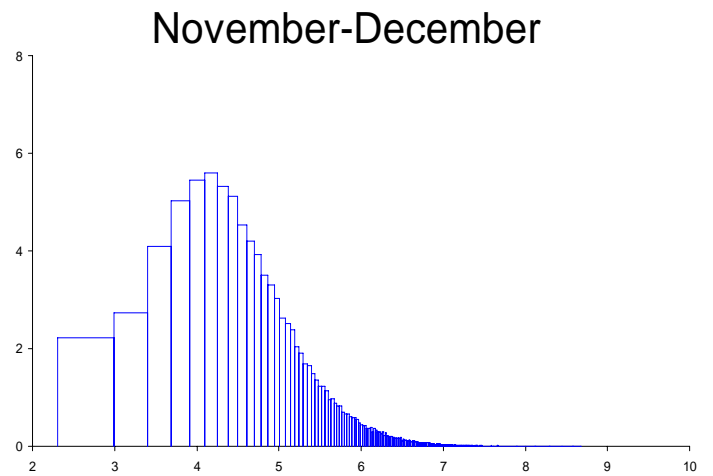
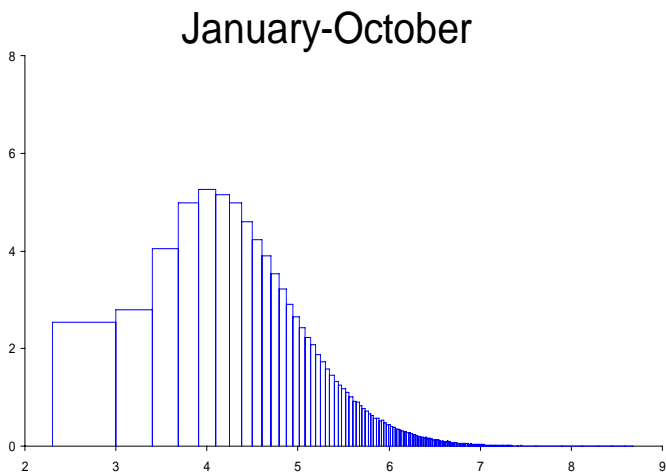
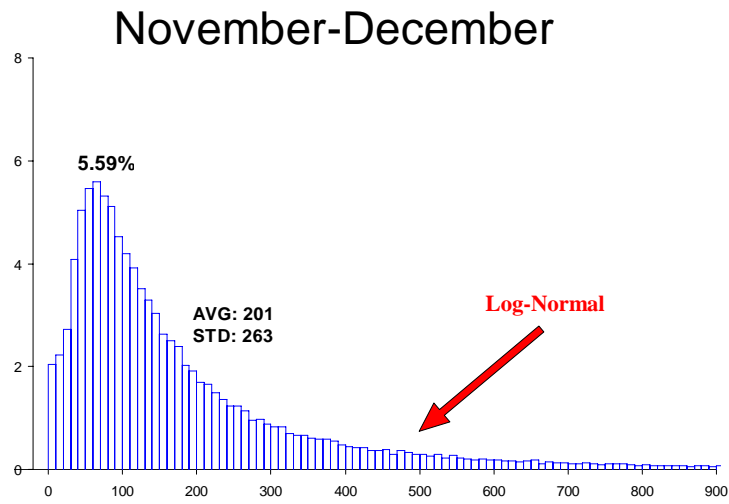
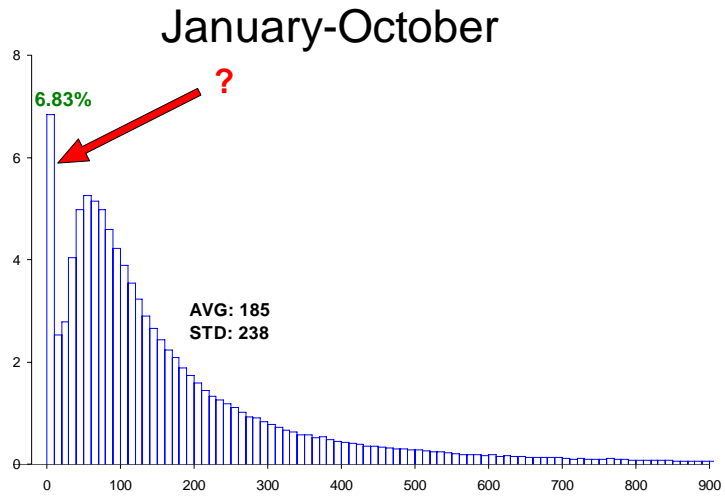
	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	183.88	175.33	183.89	207.99	196.84	186.86	179.72	179.41	190.69	178.95	195.9	206.24
Median	113	106	110	123	117	114	112	110	111	105	117	128
SD	230.14	216.96	239.26	265.11	253.06	244.5	231.46	253.35	279.73	258.34	266.73	258.53
Total	27091	27451	28278	23920	30401	31489	29921	31701	27158	31006	33707	34430

The difference between total numbers in table 38 is caused by ... (?)

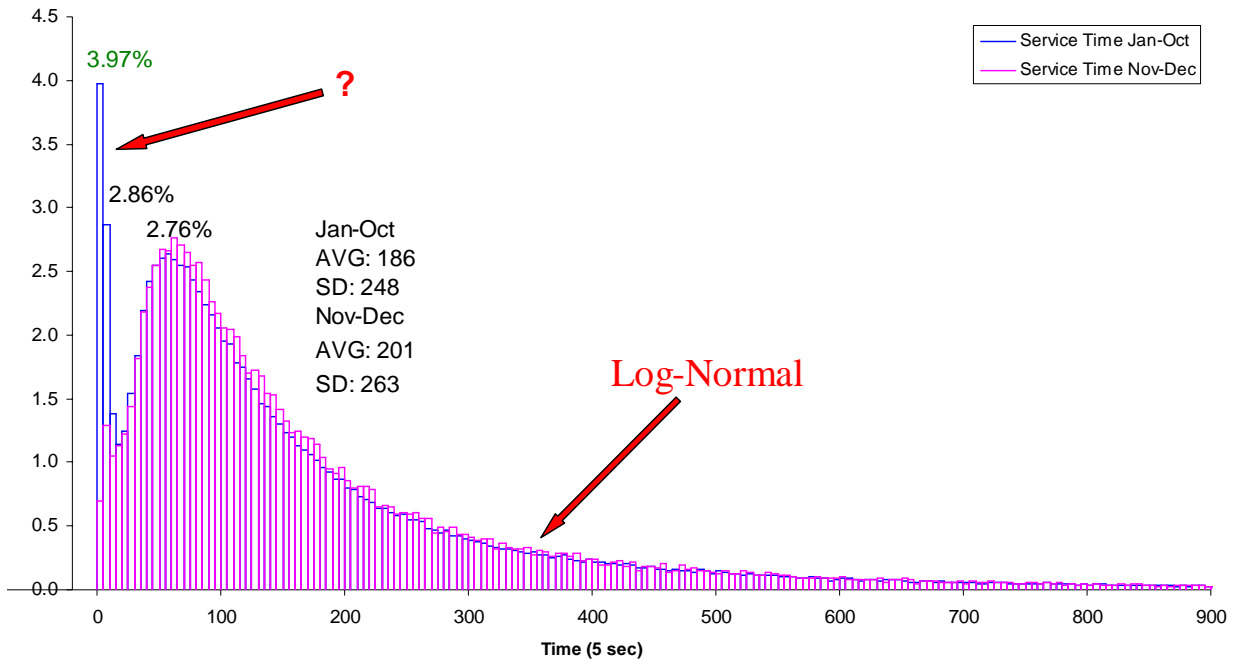
Table 39: Service time, truncated at 1 hour of service (3600 sec)

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	183.24	174.93	183.06	207.32	196.36	185.49	179.17	176.62	188.69	177.35	193.98	204.98
Median	113	106	110	123	117	114	112	109	111	105	117	128
SD	224.02	213.49	232.39	259.86	249.64	232	226.47	228.63	264.04	244.96	249.24	248.74
Total	27087	27448	28272	23916	30397	31479	29917	31680	27145	30994	33693	34419

Figure 17: Distribution of service time



January - December



January - December

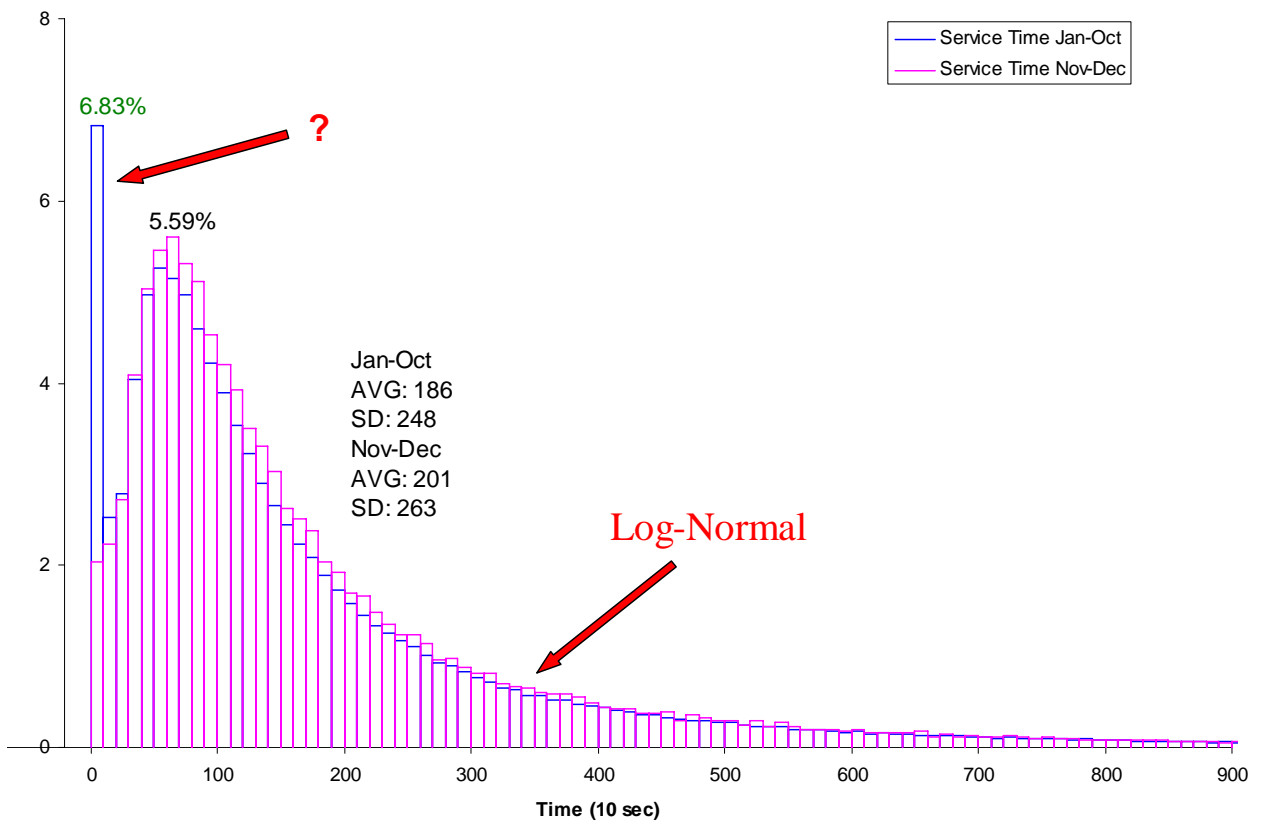


Table 40: Cumulative percentages for short Service time

Time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.4	0.7	0.7	0.7	0.6	1.0	1.0	0.7	0.9	0.6	0.0	0.0
2	0.8	1.5	1.8	1.5	1.8	2.3	2.2	1.6	2.3	1.5	0.0	0.0
3	1.7	2.8	3.2	2.7	3.4	3.4	3.6	2.7	3.5	2.2	0.2	0.3
4	2.6	4.0	4.4	3.9	4.8	4.4	4.7	3.6	4.2	3.0	0.7	0.7
5	3.3	4.8	5.4	4.8	5.8	5.3	5.6	4.2	4.8	3.5	1.0	1.1
10	5.7	7.5	8.4	7.6	8.8	7.6	8.1	6.3	6.6	5.1	2.2	2.2
15	6.8	9.1	10.0	8.9	10.5	8.9	9.2	7.4	7.6	6.2	3.3	3.2
20	7.8	10.4	11.2	9.9	12.0	9.9	10.3	8.5	8.6	7.3	4.5	4.3
30	10.7	13.8	14.3	12.3	15.2	12.8	12.8	11.2	11.3	10.4	7.5	6.9

Table 41: Service time, PS customers

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	190.33	182.94	189.21	207.95	194.22	186.41	179.49	169.52	160.03	156.64	173.28	181.1
Median	122	116	119	132	122	120	116	113	108	105	115	123
SD	215.52	206.8	221.46	238.49	232.08	214.26	211.02	193.6	179.08	178.64	190.79	188.55
Total	20551	18533	19704	17395	22365	22948	21854	21817	18677	21529	22945	23807

Table 42: Service time, NW customers

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	106.71	106.26	112.61	106.79	110.65	125.02	127.8	116.04	105.8	91.27	104.49	125.64
Median	61	60	65	58	60	66	74	68	62	59	67	78
SD	149.99	145.06	150.3	146.73	151.66	186.33	178.06	162.67	149.88	115.87	140.02	153.9
Total	4054	5056	3462	2508	2908	3686	3199	3936	2946	3852	3280	2722

Table 43: Service time, IN customers

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	263.51	267.39	304.03	330.82	333.38	298.17	248.38	287.69	450.33	426.47	410	391.2
Median	165.5	159	160	202.5	191.5	162.5	120.5	119	243	243	219	220
SD	292	349.31	420.8	347.96	433.88	419.22	424.49	452.18	541.17	521.21	492.63	452.13
Total	208	196	193	200	248	310	658	2179	2630	2485	2588	3111

Table 44: Service time, NE customers

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	320.6	274.65	272.91	340.52	300.93	257.2	242.24	237.22	230.78	241.89	259.98	280.02
Median	199	177	165	200	187.5	159	158	163	147	153	168	181
SD	376.49	300.58	329.13	405.99	356.84	331.79	290.32	254.72	290.01	288.69	293.84	318.27
N	1476	2516	2938	2432	3544	3404	3050	2988	2503	2719	3958	3722

Table 45: Service time, PS customers, priority 1

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	176.4	180.03	172.87	191.25	184.43	173.77	169.22	159.21	148.17	140.88	164.76	167.39
Median	111	114	114	124	116	113	107	104	99	94	109	114
SD	209.66	208.33	195.48	223.47	224.81	198.78	213.95	187.37	170.18	170.67	182.39	175.67
Total	3245	3134	4389	3737	4374	3889	4903	4225	2558	2435	4447	5051

Table 46: Service time, PS customers, priority 2

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	199.84	192.61	201.32	222.82	212.72	199.69	193.51	186.48	170.1	179.55	193.34	198.79
Median	127	121	124	141	135	128	124	125	115	118	127	134
SD	227.99	215.91	241.56	256.13	246.29	231.76	223.02	210.86	188.6	206.7	211.4	202.84
Total	6910	6524	9750	7947	9557	8493	9886	8743	5018	4084	8818	9518

Table 47: Service time, NE customers, priority 1

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	228.84	206.27	202.77	221.46	212.6	168.66	239.85	207.32	186.05	159.37	181.3	213.05
Median	137	126	124	120.5	128.5	97	149	137.5	103	111	125.5	141.5
SD	275.95	295.12	251.77	288.82	239.95	240.53	276.02	215.93	246.49	162.58	176.13	229.45
Total	113	181	342	272	370	253	397	336	290	237	534	600

Table 48: Service time, NE customers, priority 2

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
Mean	299.18	268.35	281.21	350.23	304.55	264.67	227.87	234	232.23	254.56	268.93	281.25
Median	194	175	171	207.5	191	170	159	172	158	169	177	182
SD	325.79	296	333.71	410.39	356.36	317.05	254.46	243.86	278.05	298.95	294.26	327.02
Total	648	1275	1924	1514	2200	1859	1713	1420	869	791	2129	1881

Figure 18: Hazard rate for service time, Jan-Oct and Nov-Dec

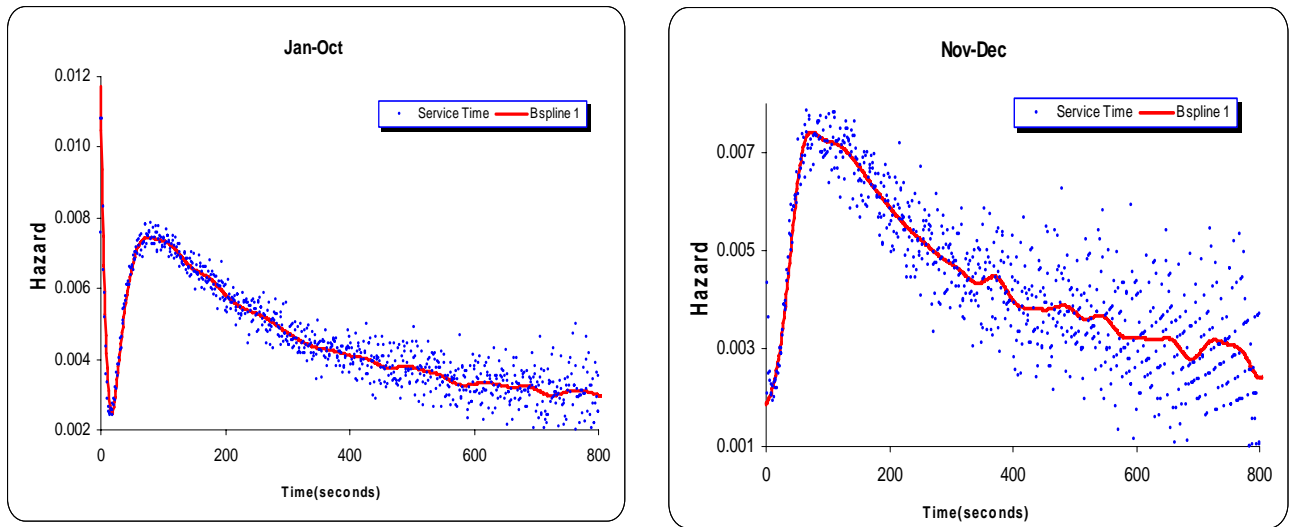
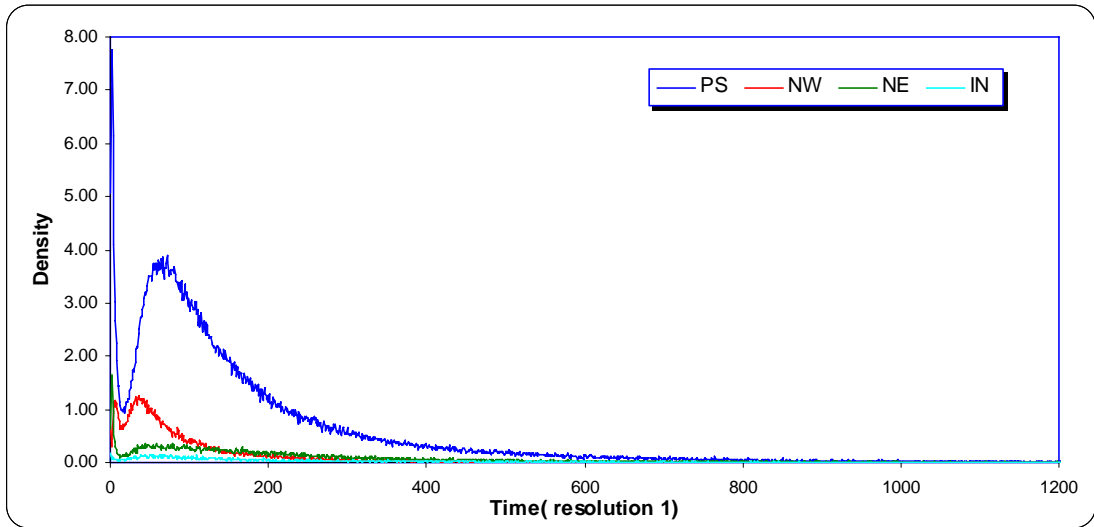
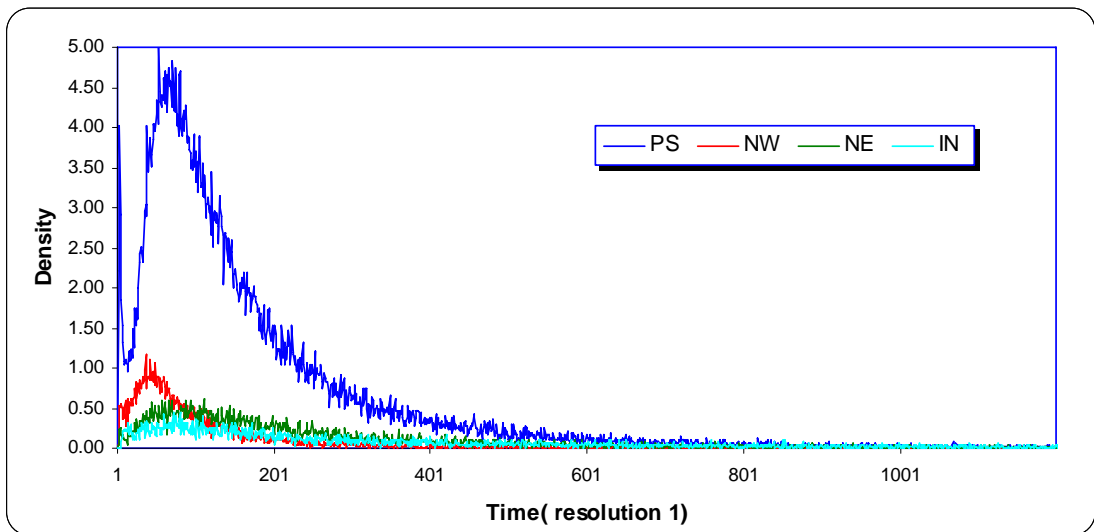


Figure 19: Densities of service times, by types and priorities

Jan-Oct



Nov-Dec



Individual behavior of customers and agents

Analysis of individual agents

Table 53: Number of calls handled by an agent

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
AVI	0	0	0	1117	2208	2019	2789	2710	1417	2026	2523	2395
AVNI	1493	1736	642	539	1786	2219	2092	2392	1156	1888	1988	2136
BASCH	999	1164	1708	1155	982	906	858	2185	1973	1055	1326	1242
BENSION	1283	1135	0	1053	1108	1016	1682	1298	1076	1303	1546	1176
DARMON	309	515	633	519	577	436	309	370	297	194	425	128
DORIT	696	1047	0	811	546	862	750	2228	1319	1384	1640	1605
ELI	387	508	777	447	560	436	395	458	416	363	502	352
GELBER	333	143	510	427	859	281	386	332	67	179	165	269
GILI	668	614	1155	803	1108	974	418	0	355	456	412	298
KAZAV	1995	1693	1240	1451	1731	2251	1737	1168	729	1570	1047	2038
MEIR	0	0	0	0	0	0	127	344	318	280	406	454
MORIAH	1360	1223	1591	1351	1866	1980	2416	2152	1526	1940	1793	515
PINHAS	79	40	359	244	31	311	422	241	143	105	51	63
ROTH	0	0	397	1292	1928	1967	1831	1749	1625	1914	1458	1038
SHARON	1985	1674	2780	1938	2563	2657	2537	2875	1803	1935	2532	2140
STEREN	0	1043	2294	1516	2163	2231	1423	2455	1672	709	2375	2568
TOVA	1923	1679	1562	1059	1464	1389	1890	1811	1361	1971	941	0
VICKY	895	0	0	0	1006	1378	1415	1674	1472	1582	1641	1990
YIFAT	1312	1901	1745	1305	1464	1076	780	90	1137	1315	0	0
YITZ	1771	1791	1402	1203	1355	1367	1009	69	705	1743	2420	2353
ZOHARI	891	1144	1398	1148	1479	1450	980	1494	1423	1359	1504	1094
Z2ARIE	0	0	0	0	0	0	0	56	225	315	432	534
Z2ELINOR	0	0	0	0	0	0	0	45	352	288	222	310
Z2EYAL	0	0	0	0	0	0	0	95	331	428	579	618
Z2IFAT	0	0	0	0	0	0	0	94	260	314	215	0
Z2LIOR	0	0	0	0	0	0	0	84	250	136	126	138
Z2OFERZ	0	0	0	0	0	0	0	0	311	260	242	334
Z2SPIEGEL	0	0	0	0	0	0	0	0	0	0	153	322

The difference between number of calls for agents Z2OFERZ and Z2SPIEGEL is caused by possible mistake when filling original table.

Table 54: Number of calls with short service time

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MORIAH	233	230	356	290	614	695	865	597	490	455	4	1
AVI	0	0	0	47	111	144	295	221	121	76	35	26
AVNI	11	13	4	5	6	25	16	18	4	8	8	11
DARMON	2	11	8	9	10	7	1	0	1	1	0	0
ELI	9	7	10	12	22	18	15	4	8	3	6	5
KAZAV	57	40	48	44	48	63	40	27	15	18	4	6
MEIR	0	0	0	0	0	0	1	8	3	1	2	1
PINHAS	3	0	58	25	4	14	11	6	8	1	0	0
ROTH			10	10	36	21	43	25	32	31	3	6
SHARON	58	49	86	52	67	78	66	63	38	23	43	49
TOVA	52	163	269	132	231	193	100	109	207	190	6	0
ZOHARI	4	8	12	22	17	20	9	14	5	7	10	7

Table 55: Characteristics of AVNI

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
PS	74	68	70	81	82	76	76	72	74	80	80	77
NE	5	5	2	1	1	3	2	9	11	7	3	4
NW	18	23	21	12	12	18	19	19	15	12	13	16
TT	2	4	5	5	4	2	2	0	0	1	4	4
PE	0	0	1	0	1	1	1	1	0	0	0	0
Mean	281.92	256.93	299.05	267.95	263.88	199.53	228.43	208.74	214.53	209.46	245.22	221.29
SD	291.16	250.54	312.38	269.47	257.98	191.31	226.35	196.93	227.09	251.79	291.65	214.19
Median	188	176.5	197.5	179	183	138	151.5	147	153.5	145	160	151.5

Table 56: Characteristics of DARMON

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
PS	83	75	73	77	72	77	75	84	85	85	82	73
NE	9	17	17	15	18	15	20	9	13	13	16	23
NW	1	3	3	1	1	1	1	2	0	1	0	1
IN	0	0	0	1	0	0	2	1	2	1	0	0
TT	6	5	7	6	9	7	2	4	0	1	1	3
Mean	285.54	249.94	243.14	256.82	281.52	273.99	273.44	284.76	273.27	294.72	269.84	300.38
SD	361.71	283.55	272.93	265.94	355.54	323.8	279.45	304.92	319	366.74	520.17	338.69
Median	173	153	155	179	172	160	180	180.5	165	154.5	176	196.5

Table 57: Characteristics of ELI

Date	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
PS	24	10	23	13	9	2	4	3	17	10	5	9
NE	71	89	74	82	91	98	94	96	83	90	95	91
NW	1	1	0	1	0	0	2	0	0	0	0	0
TT	4	0	2	4	0	1	0	0	0	0	0	0
Mean	444.8	394.02	381.99	481.89	486.79	554.42	430.68	384.84	437.69	446.7	440.17	496.74
SD	479.2	424.26	417.03	557.44	578.15	1084.9	491.51	371.28	595.04	459.38	538.7	841.91
Median	254	253	248	280	292.5	327.5	266	275.5	249.5	289	291.5	279.5

Table 58: Characteristics of MORIAH

	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99	Dec-99
PS	71.76	58.71	68.32	68.54	68.22	61.87	70.45	67.33	65.33	62.01	50.53	51.26
NW	19.49	24.45	16.09	16.21	15.01	19.60	15.81	20.21	18.15	23.45	33.46	37.28
PE	1.618	0.491	0.566	0.666	0.536	0.909	1.159	1.348	1.442	1.495	1.283	0.000
NE	6.76	16.35	15.02	14.43	16.08	17.63	12.38	10.87	15.07	13.04	12.77	11.46
Mean	202.9	192.83	189.29	214.6	191.19	163.09	140.02	151.05	141.86	127.13	154.29	189.72
SD	247.41	241.91	239.07	314.39	291.22	254.04	220.51	223.04	224.49	180.76	163.33	209.14
Median	125	110	111	109	74.5	71	65	83	75	77	102	111

Table 59: Characteristics of ZOHARI

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PS	66.55	45.45	70.03	55.49	64.84	74.48	60.92	63.45	70.91	74.76	67.89	61.33
NW	1.91	5.42	3.51	3.40	1.62	0.28	0.41	7.76	3.79	1.69	1.20	0.73
NE	31.09	46.42	24.25	36.85	33.20	25.03	37.65	28.31	25.09	23.55	30.39	37.57
TT	0.45	2.71	2.15	4.27	0.34	0.21	1.02	0.47	0.21	0.00	0.53	0.37
Mean	258	252.39	266.51	292.27	284.82	274.23	274.34	235.5	216.6	233.39	269.03	337.45
SD	327.39	267.67	295.03	304.67	303.33	312.48	280.6	256.12	203.11	224.76	289.74	424.9
Median	155	161.5	175	199	188	186	189	160	154	173	179.5	210.5

Table 60: Characteristics of MEIR

	Jul	Aug	Sep	Oct	Nov	Dec
PS	59.06	69.77	74.53	70.00	67.98	68.94
NW	18.90	18.90	10.69	16.07	11.82	15.42
NE	14.17	11.34	13.84	13.93	20.20	15.64
TT	0.000	0.000	0.943	0.000	0.000	0.000
IN	7.87	0.00	0.00	0.00	0.00	0.00
Mean	207.31	185.74	179.47	183.1	201.55	212.23
SD	225.45	172.63	188.36	228.81	236.44	248.27
Median	130	135	122.5	115.5	130.5	127.5

Table 61: Characteristics of Internet agents

		Aug	Sep	Oct	Nov	Dec
	Mean	589.82	635.08	530.84	482.29	438.03
Z2ARIE	SD	785.01	787.13	542.45	590.06	495.86
	Median	278.5	354	361	276.5	263.5
	Mean	859.8	525.14	425.08	372.24	404.19
Z2ELINOR	SD	891.5	608.64	480.32	426	529.37
	Median	428	287	249	213	214.5
	Mean	405.93	454.89	417.15	366.92	342.45
Z2EYAL	SD	480.93	530.51	629.51	493.75	411.01
	Median	243	253	199.5	183.5	189.5
	Mean	380.72	418.26	435.3	376.24	385.04
Z2NIRIT	SD	568.45	560.22	549.67	453.39	442.13
	Median	125.5	218	250	207.5	214.5

Table 61: Some more characteristics of ZOHARI

	TOTAL	Mean	SD	Median
Overall	15364	264.61	293.37	176
PS	10030	233.56	256.56	161
NE	4761	346.65	354.11	235
NW	418	122.72	137.82	77
TT	154	136.86	174.78	71

Call dynamics during an individual day

The November data

Figure 24: Average arrival rate per hour (Nov, weekdays)

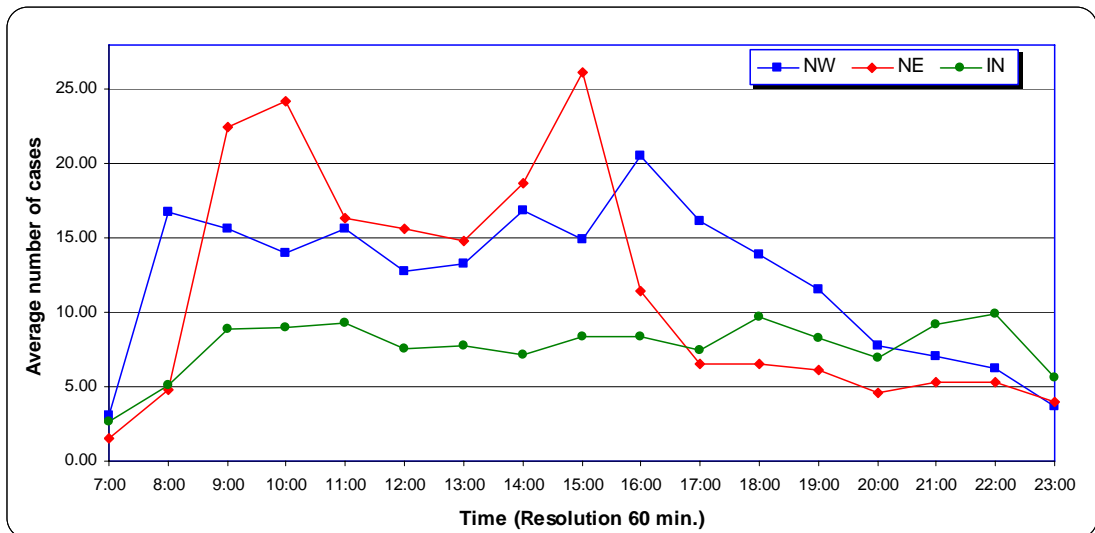
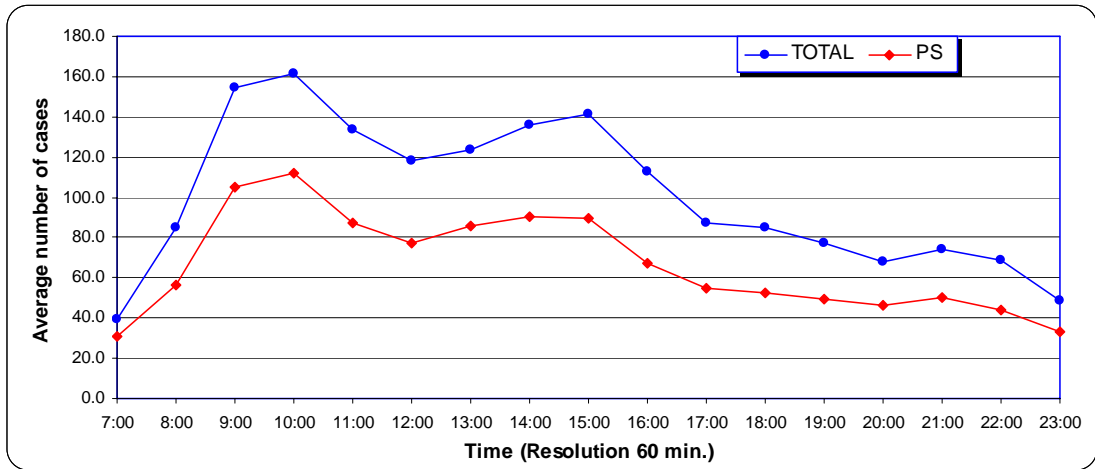


Figure 25: Average service time per hour (Nov, weekdays)

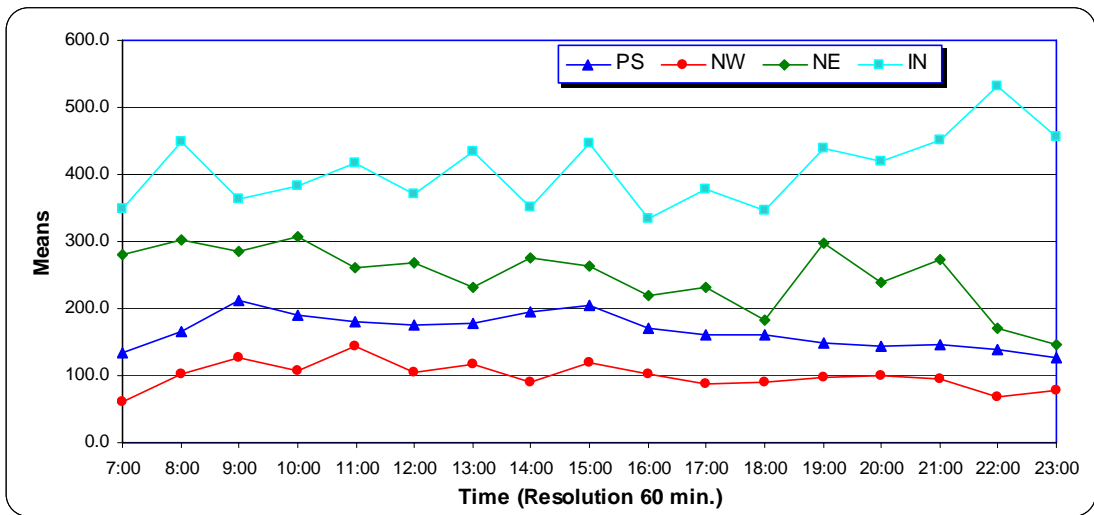
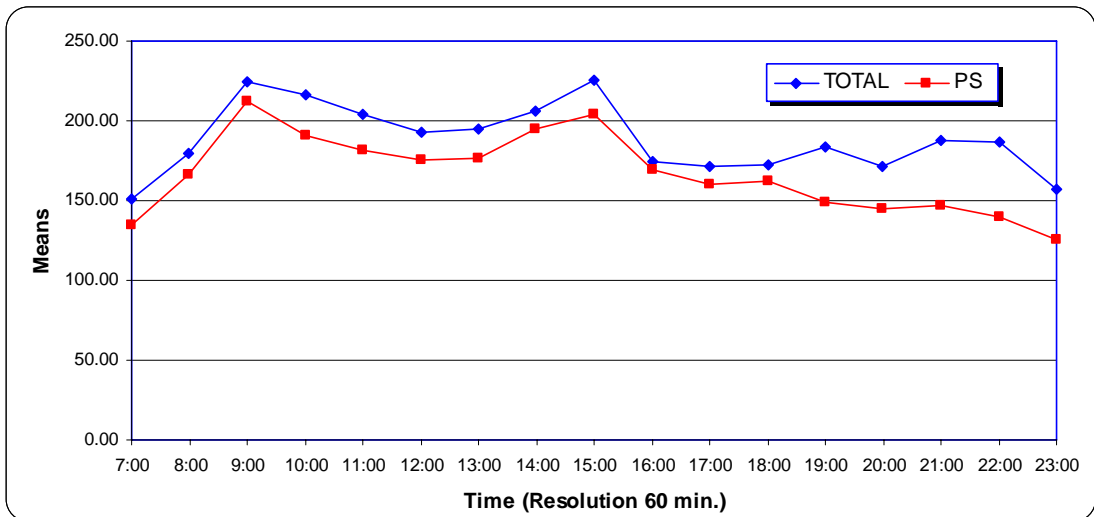


Figure 27: Probability of waiting per hour (Nov, weekdays)

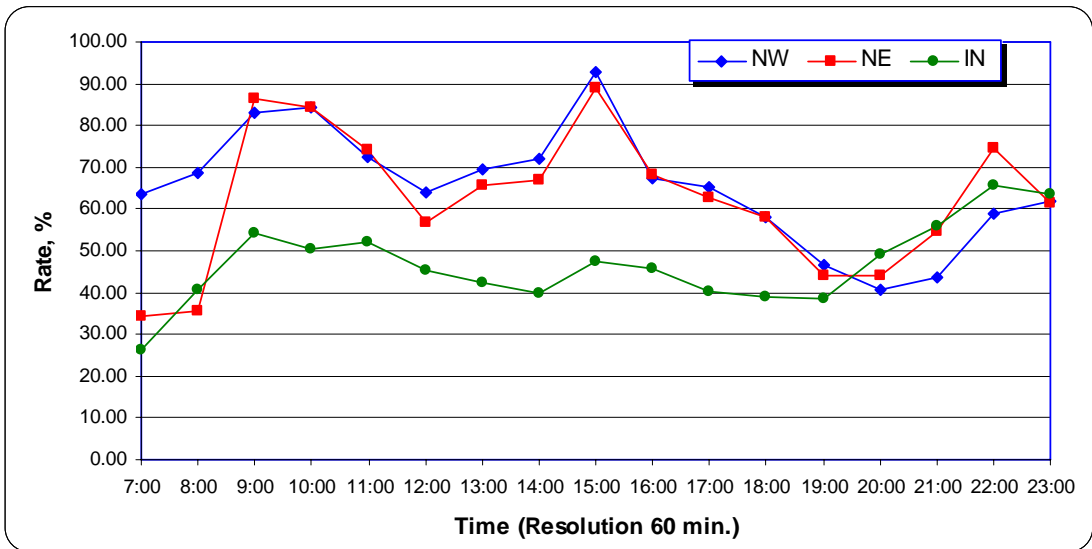
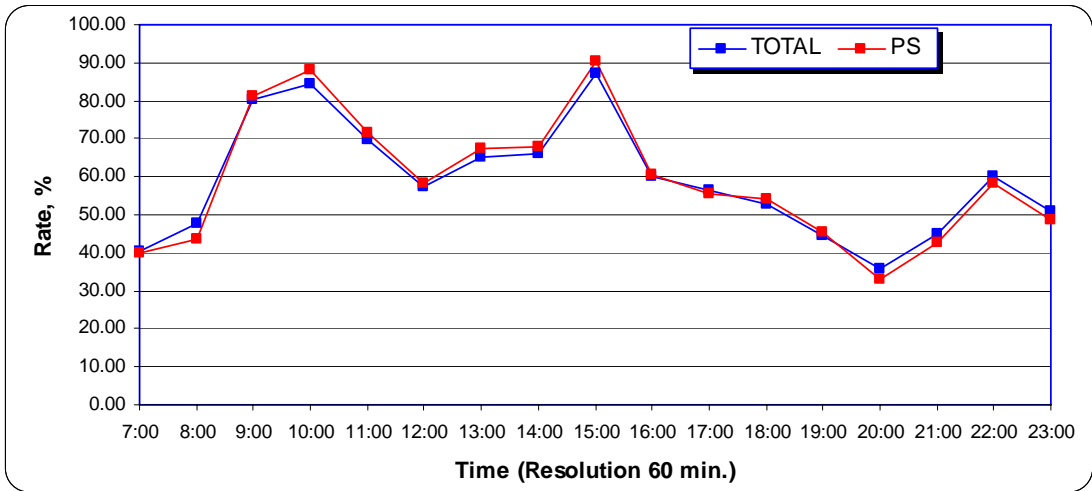


Figure 28: Average queuing time per hour (Nov, weekdays)

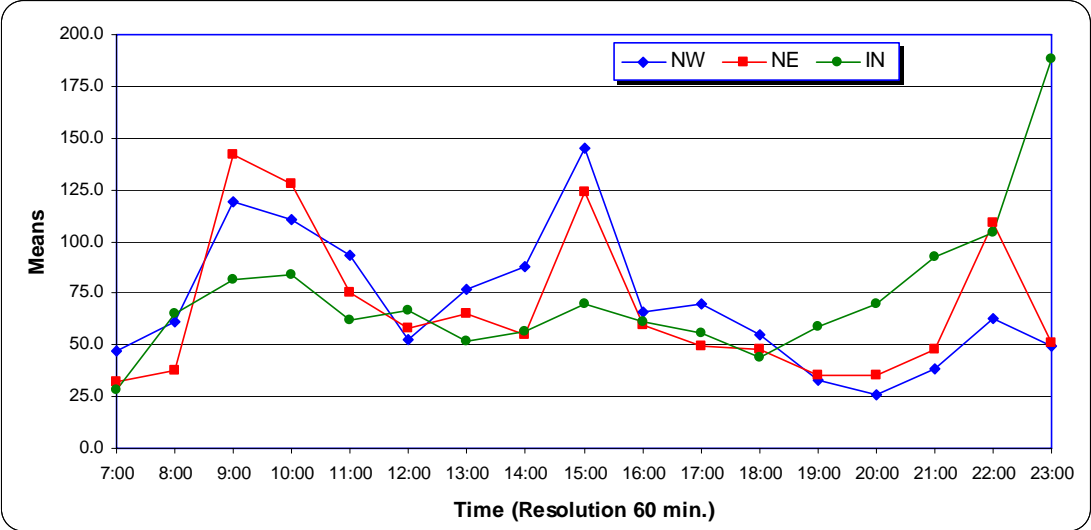
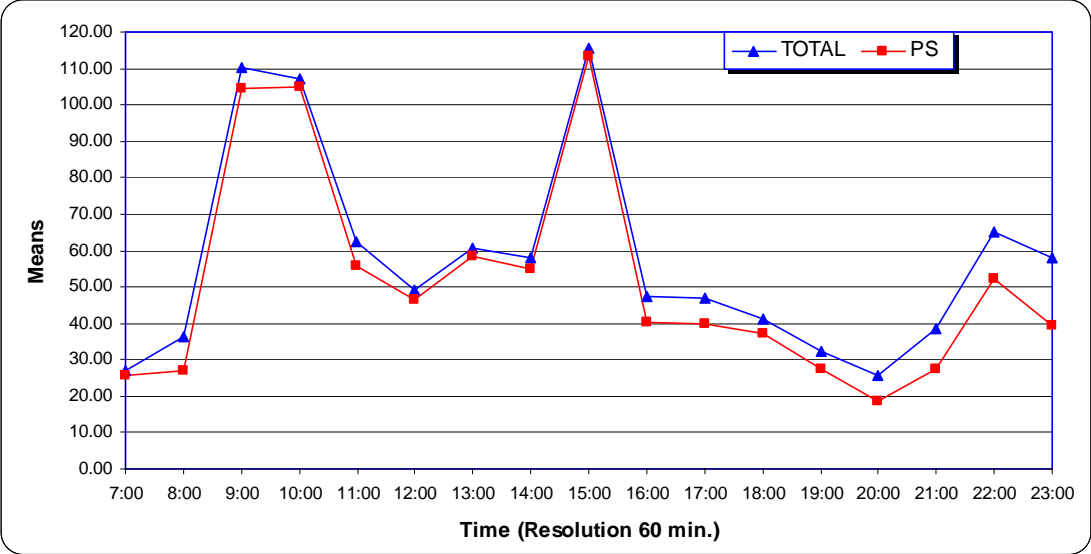


Figure 29: Average queuing time per hour among customers who waited (Nov, weekdays)

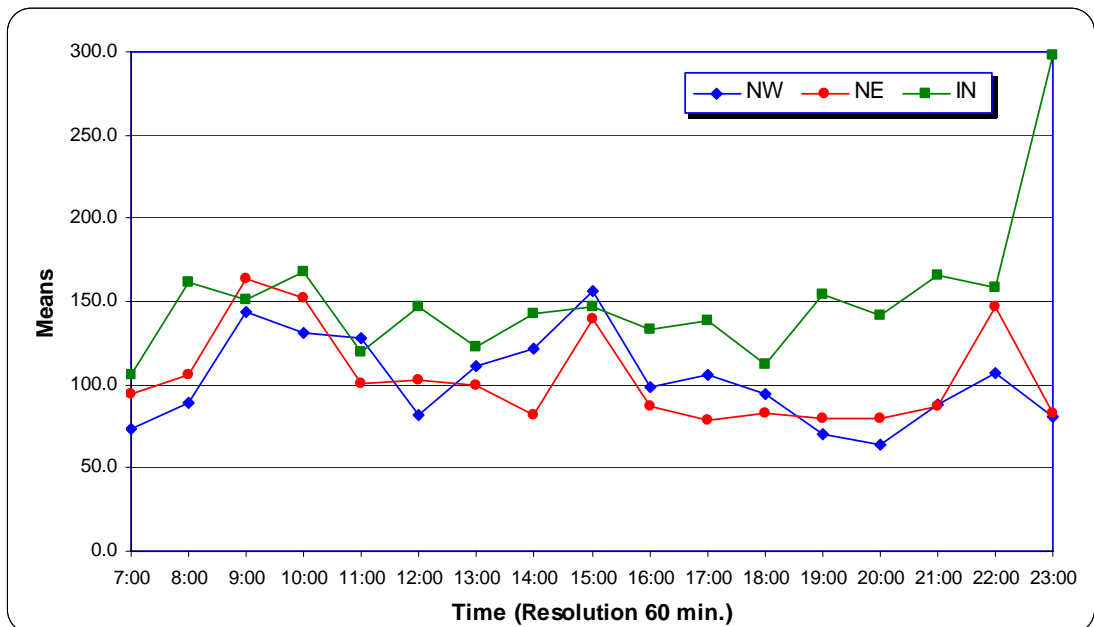
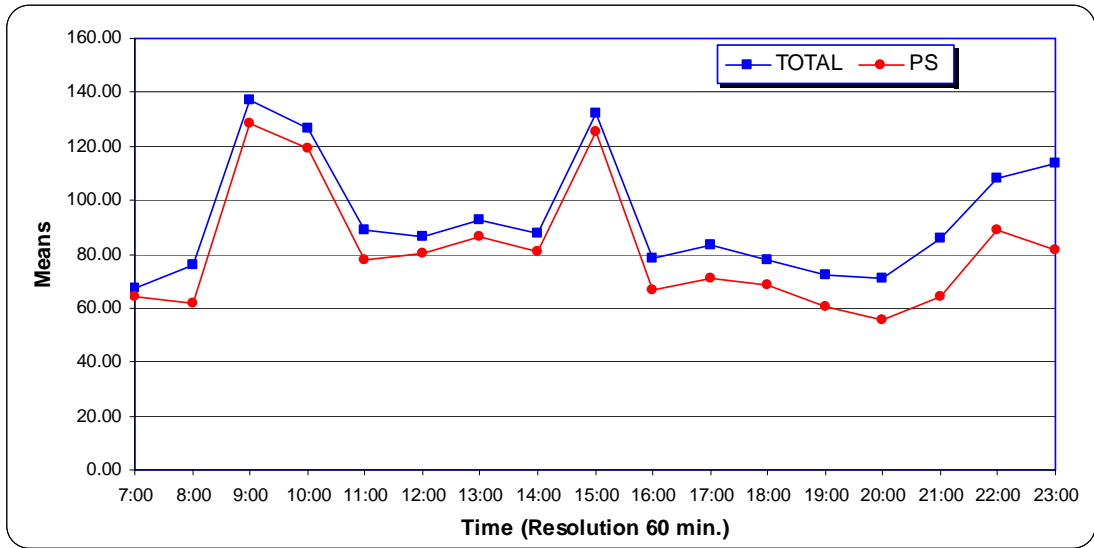


Figure 30: Probability to abandon (Nov, weekdays)

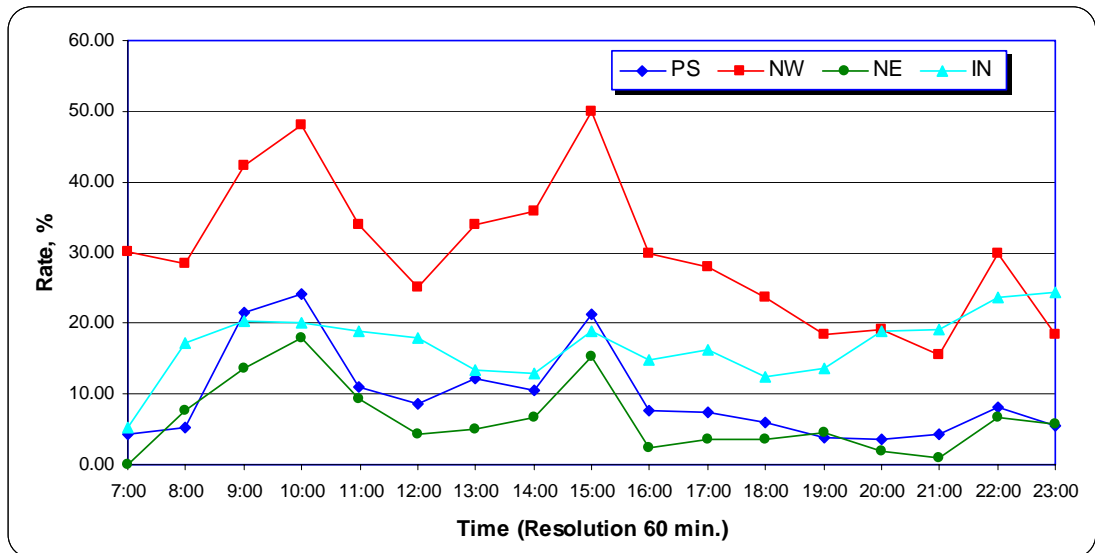
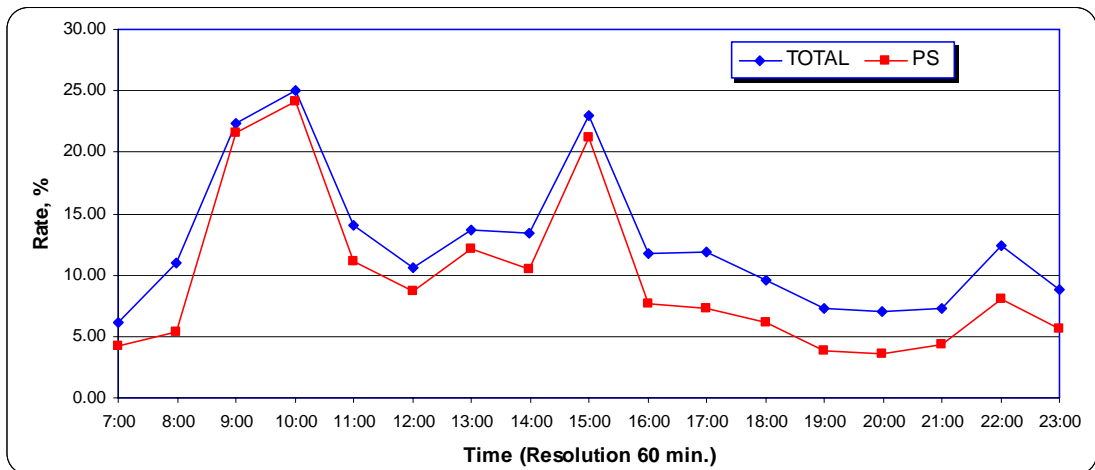


Figure 31: Probability to abandon conditional on waiting (Nov, weekdays)

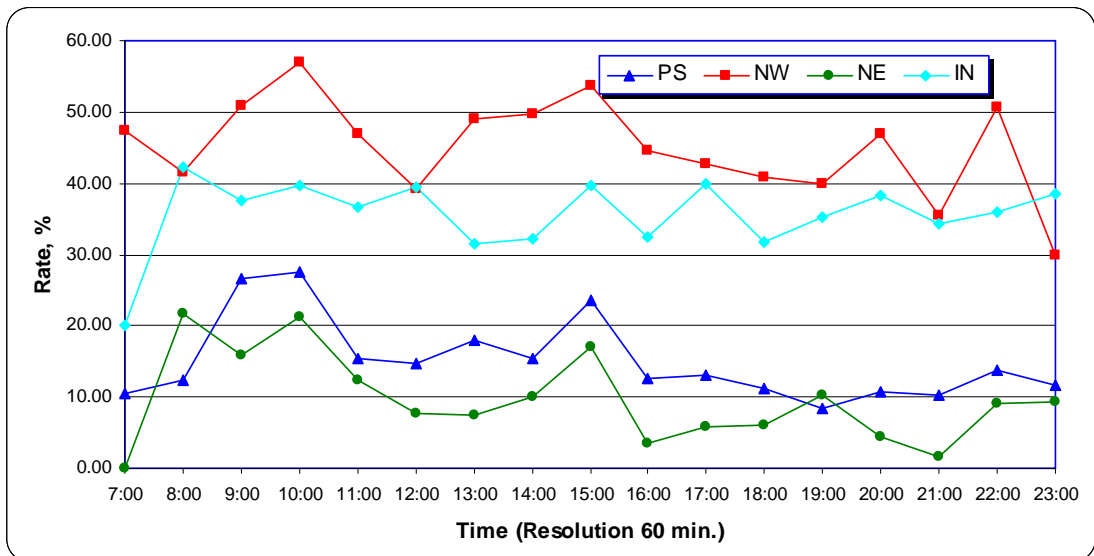
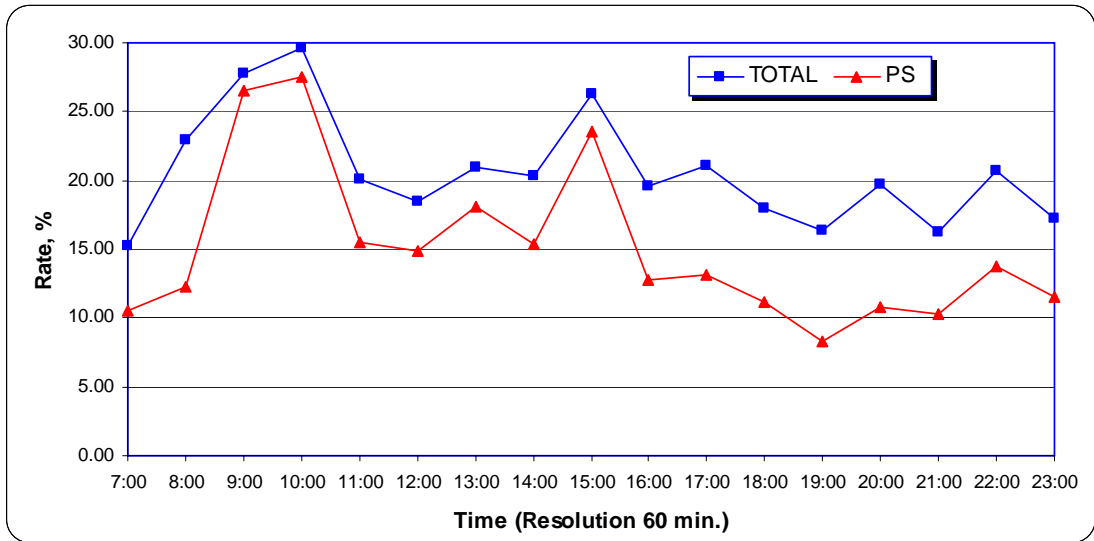


Figure 32: Average number of calls in system (Nov, weekdays)

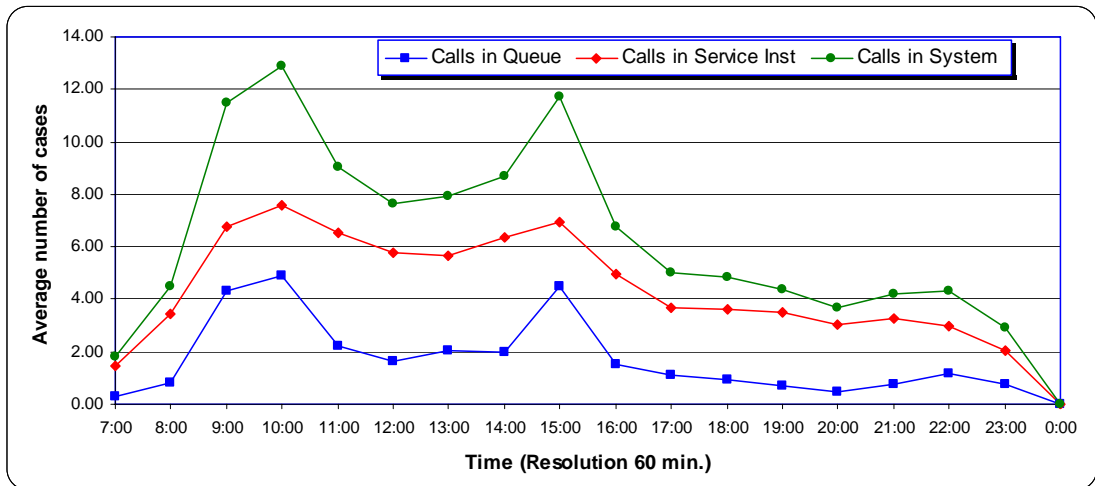


Figure 33: Average number of calls in queue (Nov, weekdays)

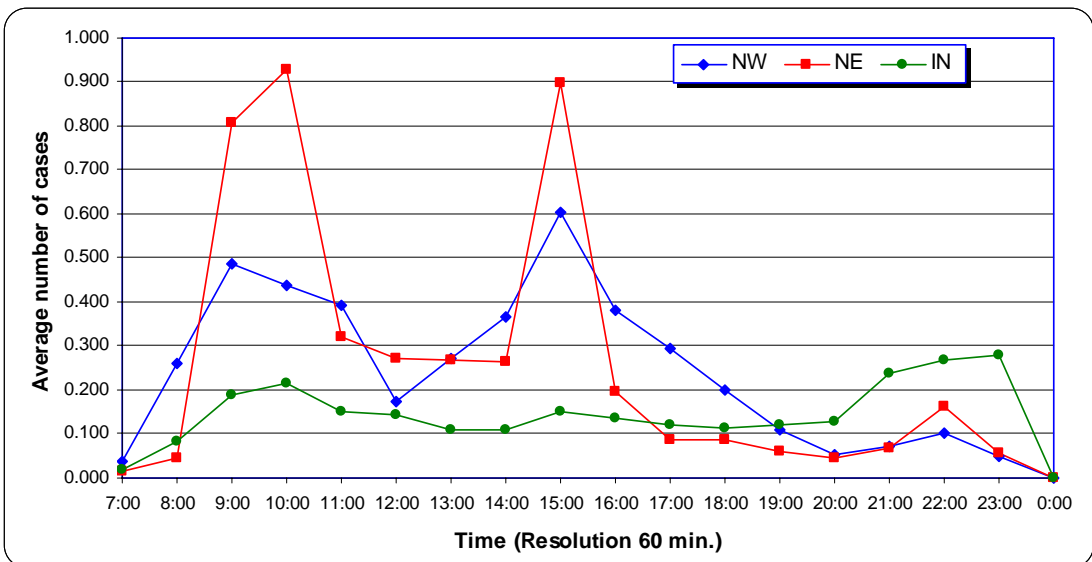
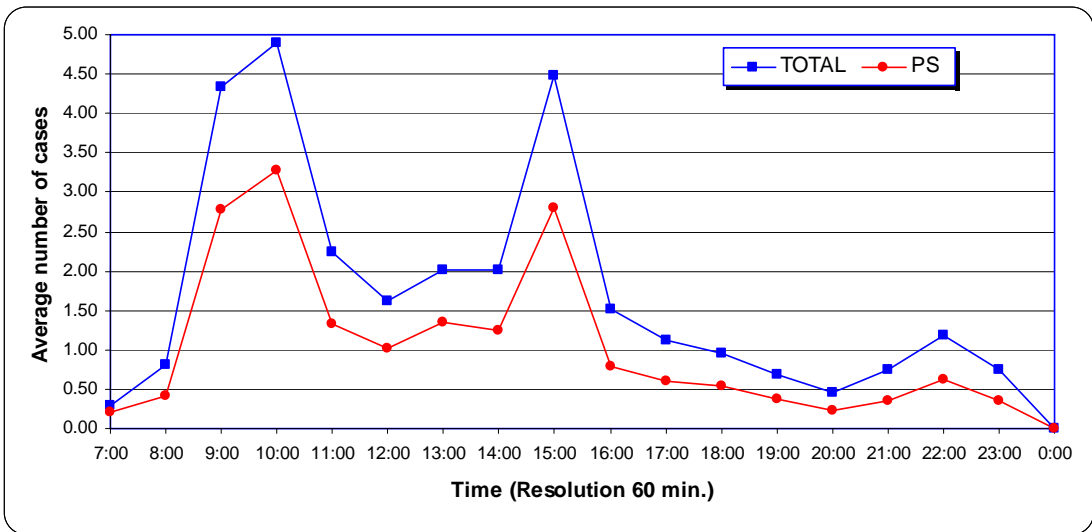
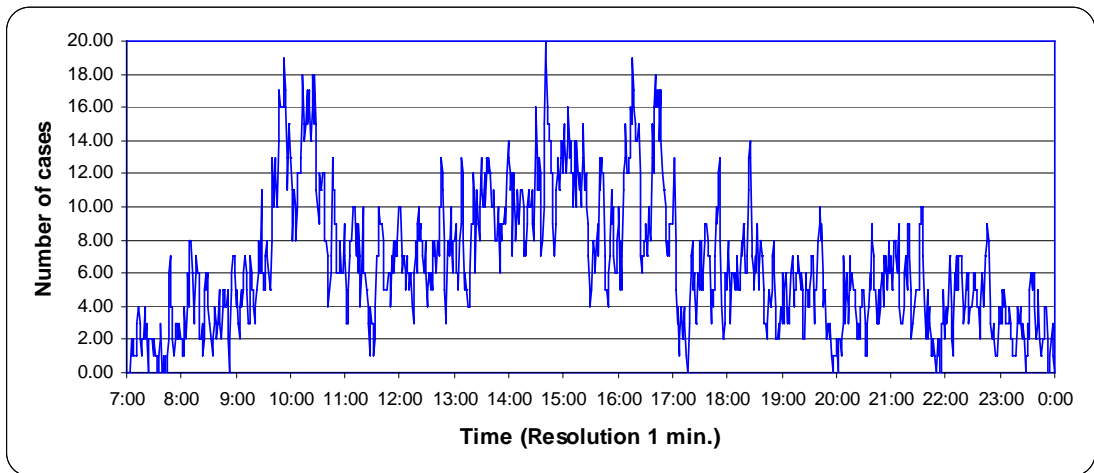


Figure 34: Number of calls in system (Nov 9th)



Two unpredictable days

Sunday, May 23rd

Figure 36: Arrival rate per hour (May 23rd)

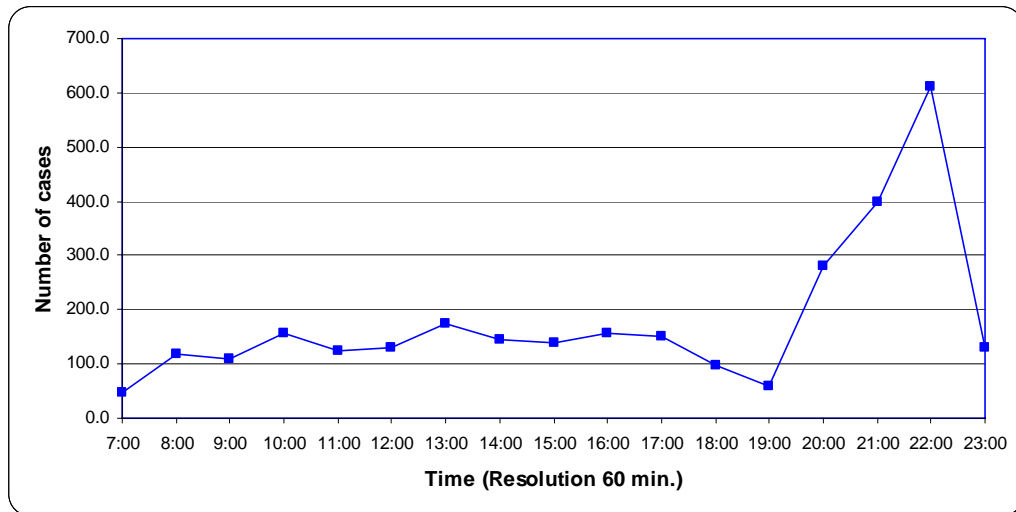


Figure 37: Arrival queuing time per hour (May 23rd)

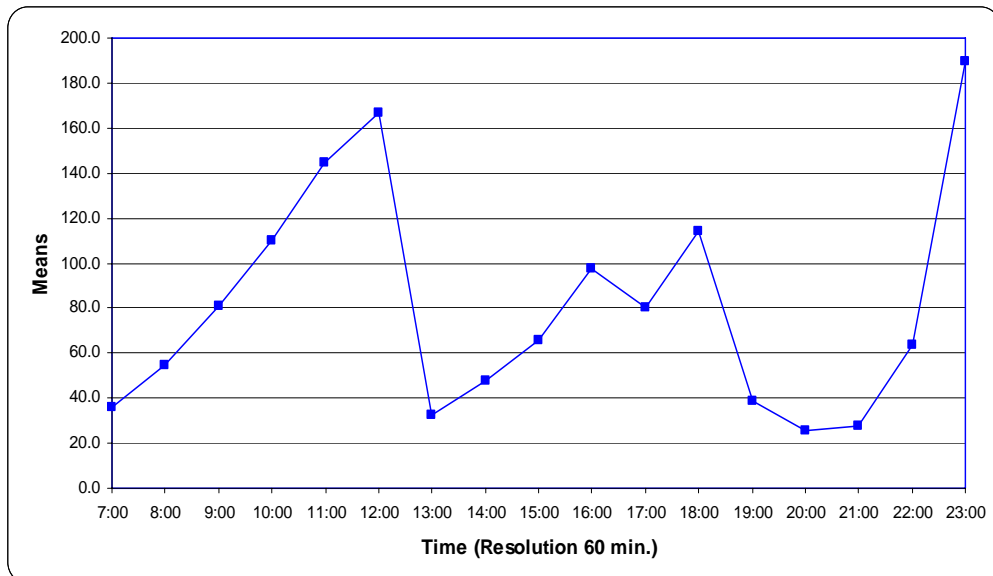


Figure 38: Probability to abandon per hour (May 23rd)

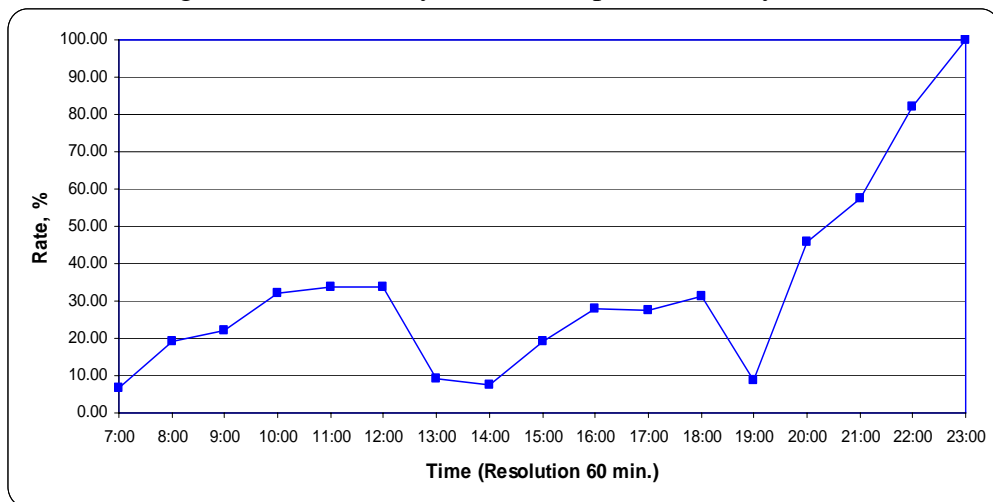


Figure 39: Number of calls in queue during evening (May 23rd)

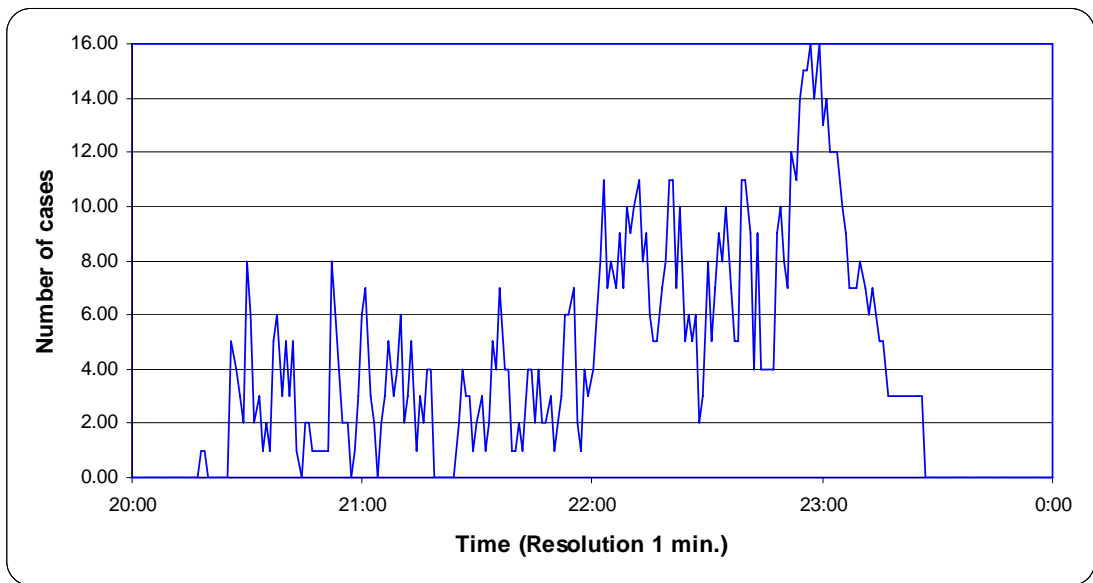
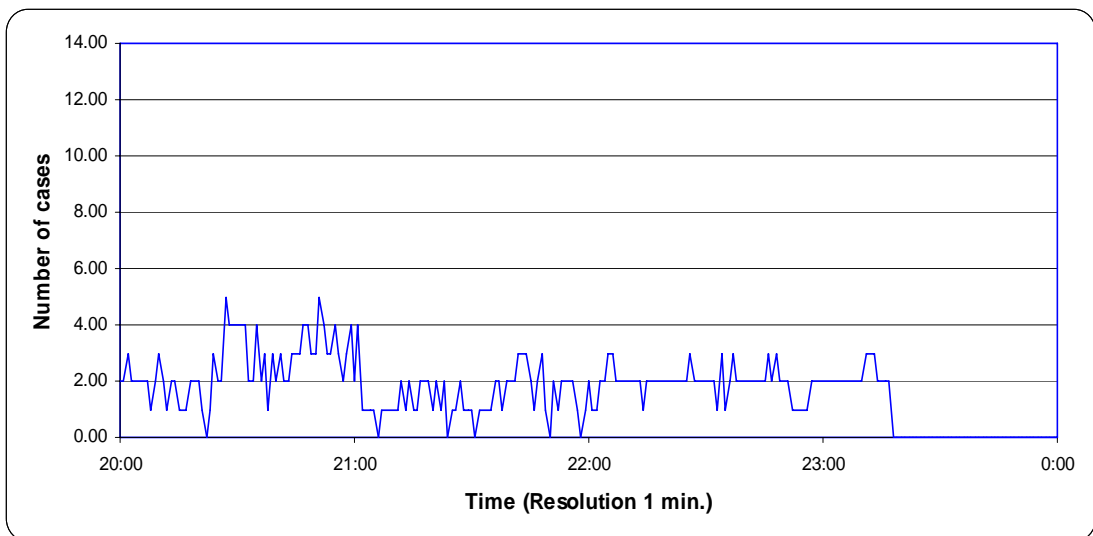


Figure 40: Number of calls in service during evening (May 23rd)



Sunday, July 4th

Figure 41: Arrival rate per hour (Jul 4th)

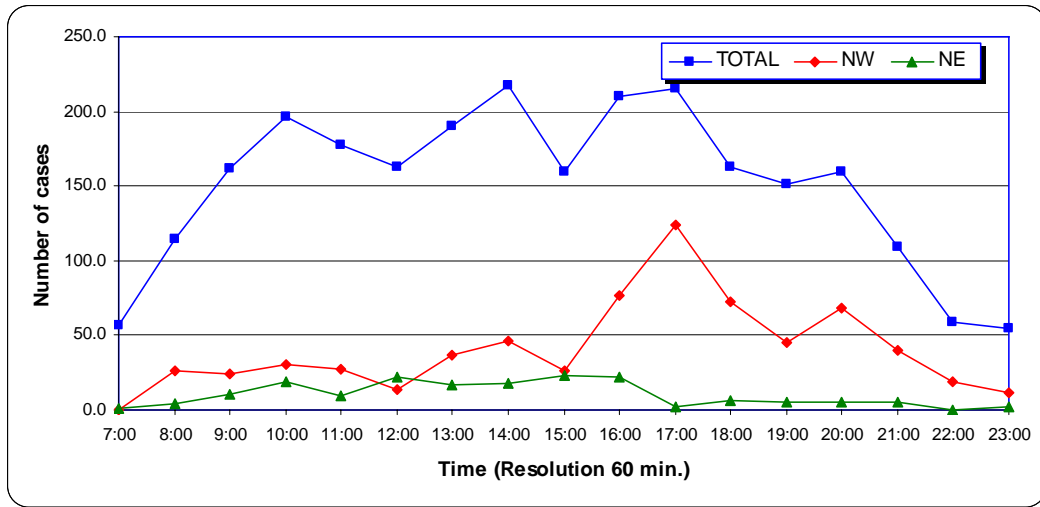


Figure 42: Average queuing time per hour (Jul 4th)

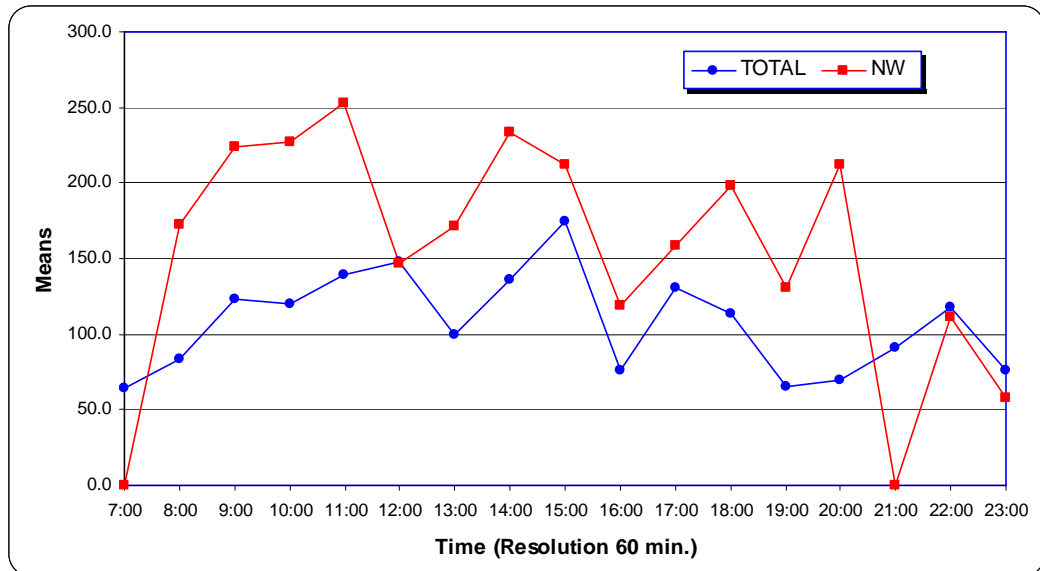


Figure 43: Probability to abandon per hour (Jul 4th)

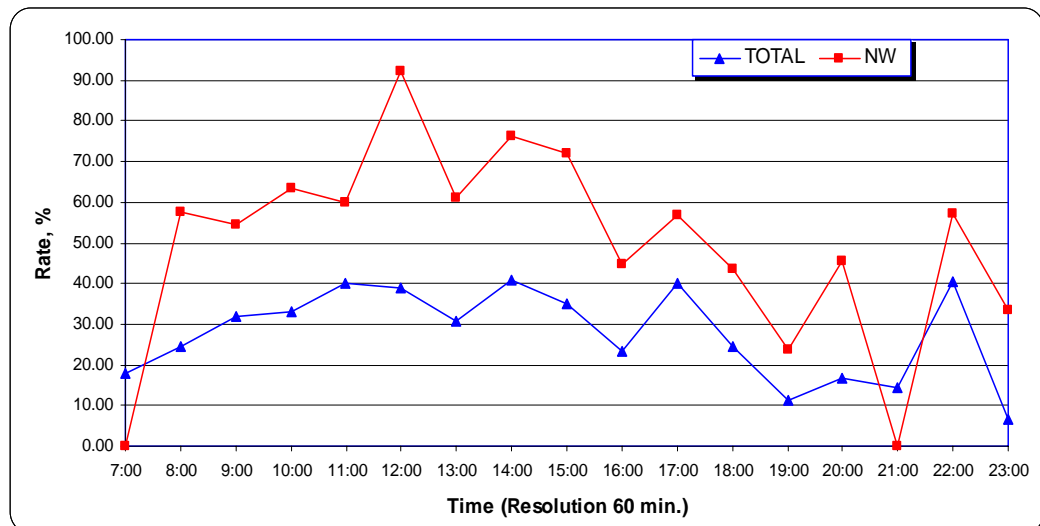


Figure 44: Number of calls in queue during evening (Jul 4th)

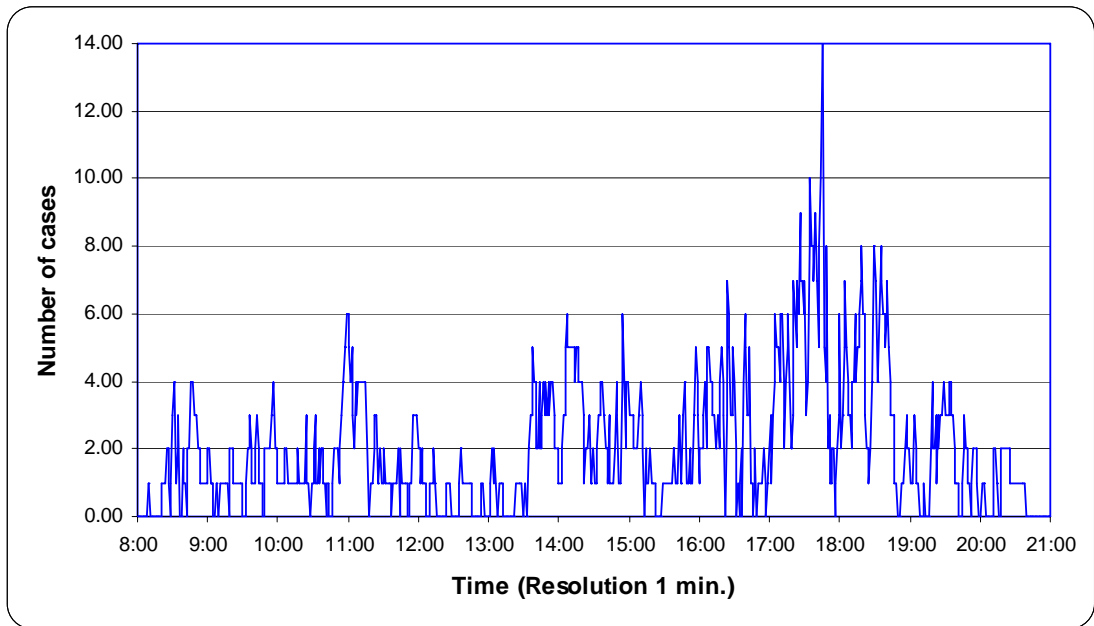


Figure 45: Number of calls in service during evening (Jul 4th)

