Simulation Techniques and Applications

EGRM 6681

United States Postal Service: A Simulation Project to Enhance Business Performance

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TABLE OF CONTENTS

1. INTRODUCTION:

The United States Postal Service is a crucial government agency providing people a means to send and receive mail as well as a place to process official documents. We observed people from all walks of life entering the system and getting their tasks done. The United States Postal Service is an independent agency of the U.S federal government responsible for providing mail services in the entire USA. It is one of the few organizations authorized by the US constitution. This system presented us with the task of optimizing wait times of the customers.

1.1) Open Timings of USPS:

Day	**Timing**
Monday	8:30 AM- 4:30 PM
Tuesday	8:30 AM- 4:30 PM
Wednesday	8:30AM–4:30PM
Thursday	8:30AM–4:30PM
Friday	8:30AM–4:30PM
Saturday	8AM–12PM
Sunday	Closed

The peak times were observed to be 12PM to 2PM and 3: 30 PM- 4:30PM during the weekdays. On Saturdays the location received more customers than usual, as per the information given by the employees working there.

1.2) Types of services:

United States Postal Service branch in West Haven offers different types of postal services like:

- Shipping all over US
- International Shipping

- Pickup
- Delivery to every door
- Money Order
- Stamps Sale
- Shipping Supplies Sale
- Drop Off
- Renting a PO box.

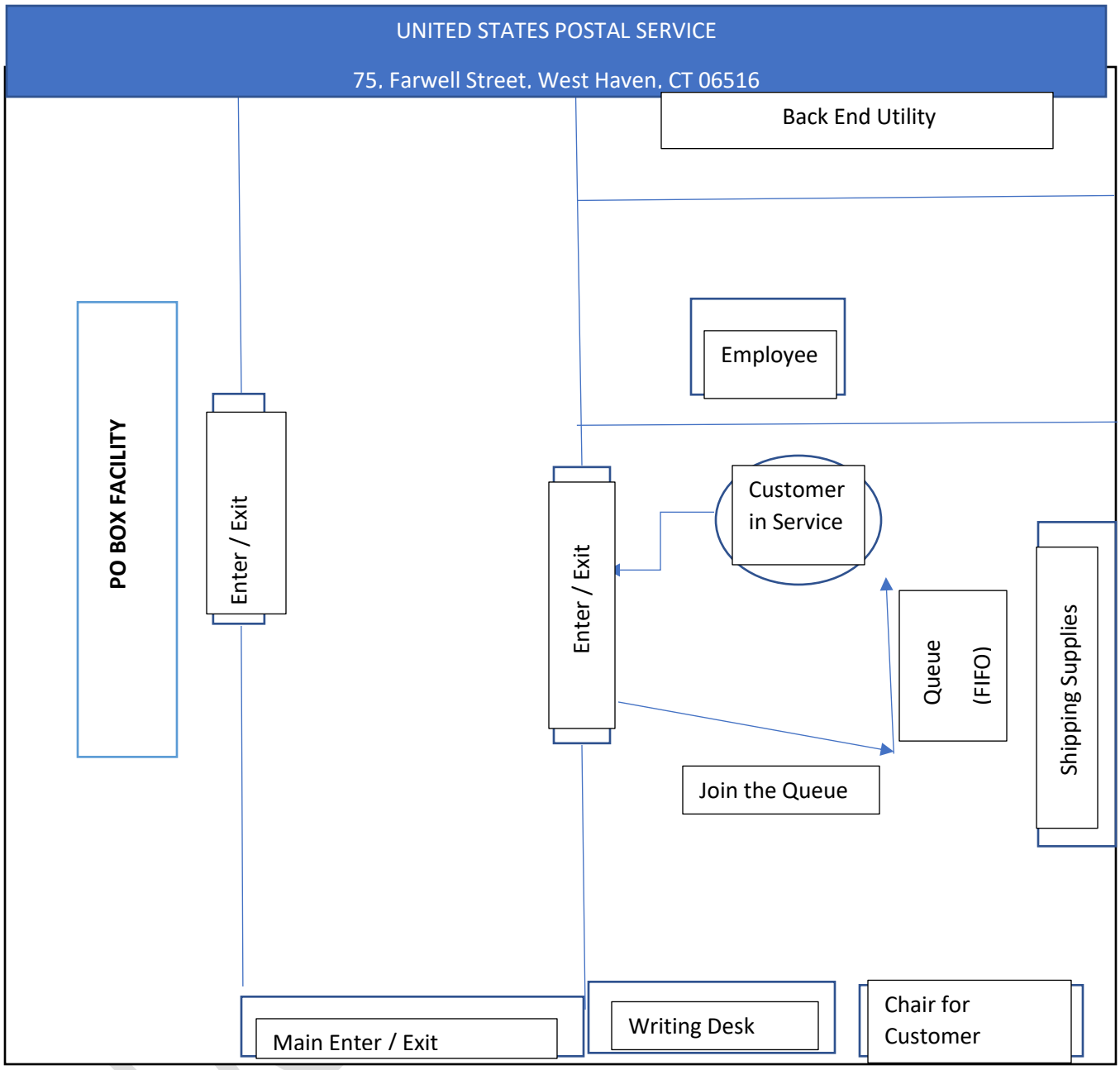
2. PROBLEM STATEMENT

This system presented us with the task of optimizing wait times of the customers. This problem was identified by observing the system performance.There is only one employee serving the customers all throughout the day and the queue length was always bigger even though the service times were smaller. There would be 2 issues in this scenario. One is increase in the customer dissatisfaction and the other is decrease in the performance levels of the employee.

3. SYSTEM ANALYSIS

3.1. Graphical Representation of the System:

The graphical representation of the system is shown below. It has a common entrance and exit. The facility is divided into two spaces, in which one space is for PO Box facility and the other space is the actual running system. In the running area, there is a common entrance and exit again for the customers. This system has only one employee working at the register to serve the customer and First In First Out Queue model is being followed. The area behind the employee register is the back end utility where all the packages are sorted and processed out for delivery.



3.2 Objective of the System:

Our main objective is to understand the system and to increase the productivity by decreasing the wait times. We have come up with this objective because, the system is always packed with 6 to 7 customers waiting in the queue, even though the service times are quick.

3.3 Elements of the System:

The USPS at West Haven had the following major components in the system:

- 1 Counter.
- 1 Employee behind the counter.
- POS Terminal. (Computer, cash drawer, receipt printer, weighing machine and a barcode scanner) ✞ Desk for Customers.
- 1 Bench.
- Self-Serve Shipping Supplies and Brochures. ✞ Trash Can.

3.4 Variables of the System:

The variables in our study are noted below:

- Arrival Time
- Service Time
- Queue Time

3.5 Parameters of the System:

We have observed both controlled and uncontrolled parameters in our system.

3.5.1 Controlled: Number of counters, Number of lanes.

3.5.2 Uncontrolled: Arrival Rates, Payment type (cash / card), Labelling Time Price checking time.

3.6 Feedback or Causal Relations:

We observed a causal relation between the cycle time and the number of tellers in the system. If the number of tellers is less, the cycle time of customer is big. Thus it has an inverse relation as "the more the number of tellers, the less the cycle time of customer".

3.7 Sub-System:

Our system has no sub system.

3.8 System Performance Metrics

- Maximum, Minimum, average, length of queue:

  This gives the average, minimum and maximum number of customers waiting in the queue.

- Maximum, minimum, average waiting time for customers:

  This gives the average, minimum and maximum waiting time for a customer in the queue.

- Maximum, Minimum, Average Service time:

  This gives the average, minimum and maximum time taken by the employee to serve customers.

- Utilization of Resources:

  This gives the percentage of the employee service utilization levels.

3.9 Constants of the System:

- Size of system.
- Location of system.

3.10 Constraints of the System:

- Number of counters.
- Number of employees.

The change in the constraints also generates different and improved system's performance metrics.

3.11 Description of the environment around the system

The United States Postal Service at West Haven is located in a residential area right next to a cemetery. The location has a spacious parking lot for the customers to use when they arrive. The location is very near to University of New Haven, Orange Commericial Center. It is a 10 minute drive from downtown New haven. Such a position allows it to have regular flow of customers coming into and leaving the system.

4. INPUT ANALYSIS:

First we have collected data, cleaned it by taking out the outliers from the data. The collected and cleaned data is as follows:

4.1) DATA-SET

Super Simulation Team has collected data on Monday, Wednesday and Friday in three different time slots on each day. The time slots we opted are 9:00 am to 11:00 am, 12:00 pm to 2:00 pm and 2:00 pm to 4:30 pm. The staff in the USPS were very encouraging and permitted us to record the data for three days.

So we initially collected the raw data, identified the outliers and removed them from the data to make it clean for further analysis. The data represented below is the initial raw data:

Data on Friday:

8/2018	Friday	9 am to 11:30 am							8/3/2018	Friday	12 pm to 02 pm							8/3/2018	Friday	2 pm to 4:30 pm						
ribe	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time		Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time		Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Second	Start Service Time
1	9:05:12	0:00:00	0	0:00:00	0:00:45	45	9:05:12		1	12:02:45	0:00:00	0	0:00:18	0:01:05	0:00:00	12:03:03		1	2:01:05	0:00:00	0:00:00	0:00:00	0:01:56	116	2:01:05
2	9:05:30	0:00:18	18	0:00:27	0:01:02	62	9:05:57		2	12:02:48	0:00:03	3	0:01:20	0:12:05	725	12:04:08		2	2:10:10	0:09:05	545	0:00:00	0:02:41	161	2:10:10
3	9:07:10	0:01:40	100	0:00:10	0:00:55	55	9:07:20		3	12:02:56	0:00:08	8	0:13:17	0:00:49	49	12:16:13		3	2:11:14	0:01:04	64	0:01:37	0:00:42	42	2:12:51
4	9:15:06	0:07:56	476	0:00:39	0:02:10	130	9:15:45		4	12:05:02	0:02:06	126	0:12:00	0:00:42	42	12:17:02		4	2:11:50	0:00:36	36	0:01:43	0:00:53	53	2:13:33
5	9:15:07	0:00:01	1	0:02:48	0:01:45	105	9:17:55		5	12:10:30	0:05:28	328	0:07:14	0:02:01	121	12:17:44		5	2:14:15	0:02:25	145	0:00:11	0:05:02	302	2:14:26
6	9:17:02	0:01:55	115	0:02:43	0:05:20	320	9:19:45		6	12:12:36	0:02:06	126	0:07:09	0:02:16	136	12:19:45		6	2:25:15	0:11:00	660	0:00:00	0:04:00	240	2:25:15
7	9:18:56	0:01:54	114	0:06:09	0:00:10	10	9:25:05		7	12:15:52	0:03:16	196	0:06:09	0:07:02	422	12:22:01		7	2:26:19	0:01:04	64	0:02:56	0:02:16	136	2:29:15
8	9:20:00	0:01:04	64	0:05:15	0:02:52	172	9:25:15		8	12:16:47	0:00:55	55	0:12:16	0:01:54	114	12:29:03		8	2:28:20	0:02:01	121	0:03:11	0:02:04	124	2:31:31
9	9:22:54	0:02:54	174	0:05:13	0:12:01	721	9:28:07		9	12:20:00	0:03:13	193	0:10:57	0:01:51	111	12:30:57		9	2:50:21	0:22:01	1321	0:00:00	0:01:54	114	2:50:21
10	9:30:14	0:07:20	440	0:10:06	0:00:48	48	9:40:20		10	12:31:15	0:11:15	675	0:01:33	0:01:12	72	12:32:48		10	3:02:08	0:11:47	707	0:00:00	0:01:19	79	3:02:08
11	9:31:07	0:00:53	53	0:10:01	0:00:51	51	9:41:08		11	12:32:18	0:01:03	63	0:01:42	0:05:12	312	12:34:00		11	3:03:05	0:00:57	57	0:00:22	0:03:04	184	3:03:27
12	9:45:25	0:14:18	858	0:00:00	0:02:04	124	9:45:25		12	12:35:20	0:03:02	182	0:03:52	0:12:06	726	12:39:12		12	3:04:19	0:01:14	74	0:02:12	0:03:00	180	3:06:31
13	9:48:13	0:02:48	168	0:00:00	0:05:02	302	9:48:13		13	12:37:05	0:01:45	105	0:14:13	0:08:23	503	12:51:18		13	3:10:59	0:06:40	400	0:00:00	0:01:43	103	3:10:59
14	9:49:18	0:01:05	65	0:03:57	0:01:04	64	9:53:15		14	12:40:25	0:03:20	200	0:19:16	0:00:49	49	12:59:41		14	3:11:28	0:00:29	29	0:01:14	0:02:15	135	3:12:42
15	9:50:20	0:01:02	62	0:03:59	0:00:57	57	9:54:19		15	12:41:01	0:00:36	36	0:19:29	0:02:05	125	13:00:30		15	3:11:30	0:00:02	2	0:03:27	0:01:00	60	3:14:57
16	9:50:30	0:00:10	10	0:04:46	0:04:56	296	9:55:16		16	12:43:52	0:02:51	171	0:18:43	0:01:41	101	13:02:35		16	3:11:45	0:00:15	15	0:04:12	0:01:26	86	3:15:57
17	9:50:45	0:00:15	15	0:09:27	0:03:50	230	10:00:12		17	12:49:05	0:05:13	313	0:15:11	0:01:19	79	13:04:16		17	3:18:17	0:06:32	392	0:00:00	0:02:09	129	3:18:17
18	10:02:06	0:11:21	681	0:01:56	0:02:02	122	10:04:02		18	13:05:12	0:16:07	967	0:01:23	0:01:37	97	13:06:35		18	3:18:45	0:00:28	28	0:01:41	0:01:40	100	3:20:26
19	10:05:19	0:03:13	193	0:00:45	0:01:05	65	10:06:04		19	13:08:02	0:02:50	170	0:00:10	0:02:09	129	13:08:12		19	3:20:34	0:01:49	109	0:01:32	0:00:35	35	3:22:06
20	10:05:35	0:00:16	16	0:01:34	0:03:21	201	10:07:09		20	13:09:52	0:01:50	110	0:00:29	0:05:02	302	13:10:21		20	3:22:38	0:02:04	124	0:00:03	0:01:42	102	3:22:41
21	10:09:27	0:03:52	232	0:01:03	0:00:50	50	10:10:30		21	13:13:05	0:03:13	193	0:02:18	0:00:50	50	13:15:23		21	3:30:59	0:08:21	501	0:00:00	0:04:49	289	3:30:59
22	10:20:32	0:11:05	665	0:00:00	0:00:20	20	10:20:32		22	13:15:22	0:02:17	137	0:00:51	0:04:36	276	13:16:13		22	3:32:47	0:01:48	108	0:03:01	0:07:26	446	3:35:48
23	10:25:26	0:04:54	294	0:00:00	0:09:02	542	10:25:26		23	13:19:05	0:03:43	223	0:01:44	0:02:05	125	13:20:49		23	3:32:50	0:00:03	3	0:10:24	0:01:56	116	3:43:14
24	10:26:07	0:00:41	41	0:08:21	0:06:23	383	10:34:28		24	13:20:25	0:01:20	80	0:02:29	0:02:09	129	13:22:54		24	3:40:27	0:07:37	457	0:04:43	0:08:30	510	3:45:10
25	10:26:18	0:00:11	11	0:14:33	0:10:02	602	10:40:51		25	13:22:10	0:01:45	105	0:02:53	0:06:10	370	13:25:03		25	3:42:56	0:02:29	149	0:10:44	0:00:19	19	3:53:40
26	10:28:15	0:01:57	117	0:22:38	0:07:01	421	10:50:53		26	13:29:21	0:07:11	431	0:01:52	0:02:00	120	13:31:13		26	3:44:24	0:01:28	88	0:09:35	0:00:43	43	3:53:59
27	10:28:56	0:00:41	41	0:29:06	0:02:01	121	10:58:02		27	13:30:52	0:01:31	91	0:02:21	0:01:53	113	13:33:13		27	3:45:09	0:00:45	45	0:09:33	0:02:27	147	3:54:42
28	10:35:07	0:06:11	371	0:24:56	0:01:45	105	11:00:03		28	13:31:21	0:00:29	29	0:03:45	0:01:46	106	13:35:06		28	3:50:14	0:05:05	305	0:06:55	0:02:36	156	3:57:09
29	10:45:25	0:10:18	618	0:16:23	0:02:09	129	11:01:48		29	13:31:52	0:00:31	31	0:05:00	0:00:59	59	13:36:52		29	3:50:19	0:00:05	5	0:09:26	0:05:01	301	3:59:45
30	10:46:45	0:01:20	80	0:17:12	0:01:15	75	11:03:57		30	13:36:03	0:04:11	251	0:01:48	0:00:54	54	13:37:51		30	3:55:08	0:04:49	289	0:09:38	0:01:42	102	4:04:46
31	10:50:12	0:03:27	207	0:15:00	0:02:01	121	11:05:12		31	13:36:58	0:00:55	55	0:01:47	0:01:21	81	13:38:45		31	3:55:45	0:00:37	37	0:10:43	0:01:01	61	4:06:28
32	11:04:02	0:13:50	830	0:03:11	0:00:35	35	11:07:13		32	13:38:00	0:01:02	62	0:02:06	0:00:54	54	13:40:06		32	3:58:20	0:02:35	155	0:09:09	0:00:52	52	4:07:29
33	11:05:01	0:00:59	59	0:02:47	0:00:45	45	11:07:48		33	13:38:06	0:00:06	6	0:02:54	0:00:38	38	13:41:00		33	3:59:02	0:00:42	42	0:09:19	0:00:34	34	4:08:21
34	11:06:12	0:01:11	71	0:02:21	0:00:50	50	11:08:33		34	13:39:52	0:01:46	106	0:01:46	0:01:24	84	13:41:38		34	4:02:45	0:03:43	223	0:06:10	0:02:02	122	4:08:55
35	11:08:05	0:01:53	113	0:01:18	0:02:03	123	11:09:23		35	13:40:02	0:00:10	10	0:03:00	0:02:01	121	13:43:02		35	4:05:02	0:02:17	137	0:05:55	0:02:56	176	4:10:57
36	11:12:04	0:03:59	239	0:00:00	0:05:01	301	11:12:04		36	13:42:52	0:02:50	170	0:02:11	0:02:00	120	13:45:03		36	4:06:45	0:01:43	103	0:07:08	0:00:12	12	4:13:53
37	11:12:50	0:00:46	46	0:04:15	0:01:12	72	11:17:05		37	13:43:00	0:00:08	8	0:04:03	0:01:01	61	13:47:03		37	4:09:52	0:03:07	187	0:04:13	0:00:46	46	4:14:05
38	11:15:01	0:02:11	131	0:03:16	0:01:04	64	11:18:17		38	13:45:06	0:02:06	126	0:02:58	0:00:51	51	13:48:04		38	4:10:21	0:00:29	29	0:04:30	0:01:13	73	4:14:51
39	11:20:52	0:05:51	351	0:00:00	0:00:49	49	11:20:52		39	13:45:40	0:00:34	34	0:03:15	0:00:32	32	13:48:55		39	4:12:12	0:01:51	111	0:03:52	0:01:41	101	4:16:04
40	11:22:12	0:01:20	80	0:00:00	0:00:32	32	11:22:12		40	13:46:21	0:00:41	41	0:03:06	0:01:27	87	13:49:27		40	4:13:21	0:01:09	69	0:04:24	0:01:21	81	4:17:45
41	11:23:01	0:00:49	49	0:00:00	0:00:56	56	11:23:01		41	13:48:11	0:01:50	110	0:02:43	0:01:42	102	13:50:54		41	4:15:21	0:02:00	120	0:03:45	0:02:06	126	4:19:06
42	11:25:02	0:02:01	121	0:00:00	0:03:01	181	11:25:02		42	13:48:55	0:00:44	44	0:03:41	0:01:52	112	13:52:36		42	4:21:00	0:05:39	339	0:00:12	0:01:34	94	4:21:12
43	11:27:12	0:02:10	130	0:00:51	0:02:51	171	11:28:03		43	13:49:02	0:00:07	7	0:05:26	0:01:12	72	13:54:28		43	4:22:06	0:01:06	66	0:00:40	0:01:27	87	4:22:46
44	11:29:10	0:01:58	118	0:01:44	0:00:50	50	11:30:54		44	13:49:36	0:00:34	34	0:06:04	0:02:58	178	13:55:40		44	4:22:56	0:00:50	50	0:01:17	0:00:41	41	4:24:13
45	11:30:20	0:01:10	70	0:01:24	0:00:31	31	11:31:44		45	13:49:42	0:00:06	6	0:08:56	0:00:59	59	13:58:38		45	4:22:59	0:00:03	3	0:01:55	0:02:05	125	4:24:54

Data on Monday:

Time in Second	Start Service Time	Customer Number	Arrival Time	Inter Arrival Times	Arrival Times in Seconds	Waiting Time	Service Time	Time in Second	Start Service Time	Customer Number	Arrival Time	Inter Arrival Times	Arrival Times in Seconds	Waiting Time	Service Time	Time in Second	Start Service Time	Customer Number	Arrival Time	Inter Arrival Times	Arrival Times in	Waiting Time	Service Time	Time in Second	Start Service Time
		2/26/2018	Monday	9 am to 11:30 am						2/26/2018	Monday	12 pm to 2 pm						2/26/2018	Monday	2 pm to 4:30 pm					
116	2:01:05	1	9:10:15	0:00:00	0	0:00:00	0:01:19	79	9:10:15	1	12:10:36	0:00:00	0	0:01:28	0:01:25	85	12:12:04	1	2:06:08	0:00:00	0	0:01:41	0:02:12	132	2:07:49
161	2:10:10	2	9:12:18	0:02:03	123	0:00:00	0:01:50	110	9:12:18	2	12:12:58	0:02:22	142	0:00:31	0:02:02	122	12:13:29	2	2:10:05	0:03:57	237	0:00:00	0:02:11	131	2:10:05
42	2:12:51	3	9:14:25	0:02:07	127	0:00:00	0:00:19	19	9:14:25	3	12:15:45	0:02:47	167	0:00:00	0:09:02	542	12:15:45	3	2:11:15	0:01:10	70	0:01:01	0:01:12	72	2:12:16
53	2:13:33	4	9:14:54	0:00:29	29	0:00:00	0:02:01	121	9:14:54	4	12:16:47	0:01:02	62	0:08:00	0:01:22	82	12:24:47	4	2:12:05	0:00:50	50	0:01:23	0:00:46	46	2:13:28
302	2:14:26	5	9:16:07	0:01:13	73	0:00:48	0:01:17	77	9:16:55	5	12:17:45	0:00:58	58	0:08:24	0:00:22	22	12:26:09	5	2:18:47	0:06:42	402	0:00:00	0:00:57	57	2:18:47
240	2:25:15	6	9:18:17	0:02:10	130	0:00:00	0:02:00	120	9:18:17	6	12:19:42	0:01:57	117	0:06:49	0:03:15	195	12:26:31	6	2:19:20	0:00:33	33	0:00:24	0:01:24	84	2:19:44
136	2:29:15	7	9:22:57	0:04:40	280	0:00:00	0:02:21	141	9:22:57	7	12:28:25	0:08:43	523	0:01:21	0:01:08	68	12:29:46	7	2:19:56	0:00:36	36	0:01:12	0:05:01	301	2:21:08
124	2:31:31	8	9:23:26	0:00:29	29	0:01:52	0:08:39	519	9:25:18	8	12:29:40	0:01:15	75	0:01:14	0:01:17	77	12:30:54	8	2:20:08	0:00:12	12	0:06:01	0:01:21	81	2:26:09
114	2:50:21	9	9:25:48	0:02:22	142	0:08:09	0:00:48	48	9:33:57	9	12:30:21	0:00:41	41	0:01:50	0:09:20	560	12:32:11	9	2:22:46	0:02:38	158	0:04:44	0:00:59	59	2:27:30
79	3:02:08	10	9:26:14	0:00:26	26	0:08:31	0:01:33	93	9:34:45	10	12:36:41	0:06:20	380	0:04:50	0:00:45	45	12:41:31	10	2:23:10	0:00:24	24	0:05:19	0:00:42	42	2:28:29
184	3:03:27	11	9:29:36	0:03:22	202	0:06:42	0:02:13	133	9:36:18	11	12:40:01	0:03:20	200	0:02:15	0:05:23	323	12:42:16	11	2:25:16	0:02:06	126	0:03:55	0:05:12	312	2:29:11
180	3:06:31	12	9:32:57	0:03:21	201	0:05:34	0:00:40	40	9:38:31	12	12:45:21	0:05:20	320	0:02:18	0:06:41	401	12:47:39	12	2:26:42	0:01:26	86	0:07:41	0:01:59	119	2:34:23
103	3:10:59	13	9:45:17	0:12:20	740	0:00:00	0:06:08	368	9:45:17	13	12:53:00	0:07:39	459	0:01:20	0:03:12	192	12:54:20	13	2:29:04	0:02:22	142	0:07:18	0:01:45	105	2:36:22
135	3:12:42	14	9:55:20	0:10:03	603	0:00:00	0:03:18	198	9:55:20	14	12:54:21	0:01:21	81	0:03:11	0:06:21	381	12:57:32	14	2:35:04	0:06:00	360	0:03:03	0:01:26	86	2:38:07
60	3:14:57	15	9:58:14	0:02:54	174	0:00:24	0:04:00	240	9:58:38	15	12:58:21	0:04:00	240	0:05:32	0:02:12	132	13:03:53	15	2:35:57	0:00:53	53	0:03:36	0:02:06	126	2:39:33
86	3:15:57	16	9:59:27	0:01:13	73	0:03:11	0:02:45	165	10:02:38	16	13:01:25	0:03:04	184	0:04:40	0:01:57	117	13:06:05	16	2:37:15	0:01:18	78	0:04:24	0:03:04	184	2:41:39
129	3:18:17	17	10:04:26	0:04:59	299	0:00:57	0:01:15	75	10:05:23	17	13:06:25	0:05:00	300	0:01:37	0:01:46	106	13:08:02	17	2:39:56	0:02:41	161	0:04:47	0:07:18	438	2:44:43
100	3:20:26	18	10:18:18	0:13:52	832	0:00:00	0:00:48	48	10:18:18	18	13:07:25	0:01:00	60	0:02:23	0:01:52	112	13:09:48	18	2:45:12	0:05:16	316	0:08:49	0:01:10	70	2:54:01
35	3:22:06	19	10:20:25	0:02:07	127	0:00:00	0:01:08	68	10:20:25	19	13:09:28	0:02:03	123	0:02:12	0:02:09	129	13:11:40	19	2:46:18	0:01:06	66	0:08:53	0:04:06	246	2:55:11
102	3:22:41	20	10:35:58	0:15:33	933	0:00:00	0:01:48	108	10:35:58	20	13:10:29	0:01:01	61	0:03:20	0:06:12	372	13:13:49	20	2:50:15	0:03:57	237	0:09:02	0:01:06	66	2:59:17
289	3:30:59	21	10:36:47	0:00:49	49	0:00:59	0:01:23	83	10:37:46	21	13:16:25	0:05:56	356	0:03:36	0:05:02	302	13:20:01	21	2:51:07	0:00:52	52	0:09:16	0:02:15	135	3:00:23
446	3:35:48	22	10:39:16	0:02:29	149	0:00:00	0:03:15	195	10:39:16	22	13:25:03	0:08:38	518	0:00:00	0:02:10	130	13:25:03	22	2:59:12	0:08:05	485	0:03:26	0:03:39	219	3:02:38
116	3:43:14	23	10:40:49	0:01:33	93	0:01:42	0:00:40	40	10:42:31	23	13:26:08	0:01:05	65	0:01:05	0:01:02	62	13:27:13	23	3:02:46	0:03:34	214	0:03:31	0:01:19	79	3:06:17
510	3:45:10	24	10:43:25	0:02:36	156	0:00:40	0:01:20	80	10:44:05	24	13:28:15	0:02:07	127	0:00:00	0:01:51	111	13:28:15	24	3:06:08	0:03:22	202	0:01:28	0:00:42	42	3:07:36
19	3:53:40	25	10:48:27	0:05:02	302	0:00:00	0:01:24	84	10:48:27	25	13:28:49	0:00:34	34	0:01:17	0:00:56	56	13:30:06	25	3:17:45	0:11:37	697	0:00:00	0:09:41	581	3:17:45
43	3:53:59	26	10:50:25	0:01:58	118	0:00:00	0:03:17	197	10:50:25	26	13:30:21	0:01:32	92	0:00:41	0:07:10	430	13:31:02	26	3:18:09	0:00:24	24	0:09:17	0:02:51	171	3:27:26
147	3:54:42	27	10:54:08	0:03:43	223	0:00:00	0:01:33	93	10:54:08	27	13:32:36	0:02:15	135	0:05:36	0:02:30	150	13:38:12	27	3:19:20	0:01:11	71	0:10:57	0:04:12	252	3:30:17
156	3:57:09	28	10:55:12	0:01:04	64	0:00:29	0:01:20	80	10:55:41	28	13:35:20	0:02:44	164	0:05:22	0:01:24	84	13:40:42	28	3:25:04	0:05:44	344	0:09:25	0:00:53	53	3:34:29
301	3:59:45	29	10:58:12	0:03:00	180	0:00:00	0:01:42	102	10:58:12	29	13:40:52	0:05:32	332	0:01:14	0:02:35	155	13:42:06	29	3:26:05	0:01:01	61	0:09:17	0:02:45	165	3:35:22
102	4:04:46	30	10:58:17	0:00:05	5	0:01:37	0:00:56	56	10:59:54	30	13:42:05	0:01:13	73	0:02:36	0:02:41	161	13:44:41	30	3:29:07	0:03:02	182	0:09:00	0:01:55	115	3:38:07
61	4:06:28	31	11:02:12	0:03:55	235	0:00:00	0:00:32	32	11:02:12	31	13:43:12	0:01:07	67	0:04:10	0:01:52	112	13:47:22	31	3:39:12	0:10:05	605	0:00:50	0:00:58	58	3:40:02
52	4:07:29	32	11:02:45	0:00:33	33	0:00:00	0:01:48	108	11:02:45	32	13:44:52	0:01:40	100	0:04:22	0:02:01	121	13:49:14	32	3:39:56	0:00:44	44	0:01:04	0:01:02	62	3:41:00
34	4:08:21	33	11:03:52	0:01:07	67	0:00:41	0:01:04	64	11:04:33	33	13:45:01	0:00:09	9	0:06:14	0:01:05	65	13:51:15	33	3:40:01	0:00:05	5	0:02:01	0:01:45	105	3:42:02
122	4:08:55	34	11:10:25	0:06:33	393	0:00:00	0:05:21	321	11:10:25	34	13:45:56	0:00:55	55	0:06:24	0:00:37	37	13:52:20	34	3:42:01	0:02:00	120	0:01:46	0:02:04	124	3:43:47
176	4:10:57	35	11:12:25	0:02:00	120	0:03:21	0:01:23	83	11:15:46	35	13:46:08	0:00:12	12	0:06:49	0:00:39	39	13:52:57	35	3:42:52	0:00:51	51	0:02:59	0:01:05	65	3:45:51
12	4:13:53	36	11:15:01	0:02:36	156	0:02:08	0:04:05	245	11:17:09	36	13:46:54	0:00:46	46	0:06:42	0:05:10	310	13:53:36	36	3:43:21	0:00:29	29	0:03:35	0:01:00	60	3:46:56
46	4:14:05	37	11:17:49	0:02:48	168	0:03:25	0:00:29	29	11:21:14	37	13:48:05	0:01:11	71	0:10:41	0:02:01	121	13:58:46	37	3:45:08	0:01:47	107	0:02:48	0:00:51	51	3:47:56
73	4:14:51	38	11:18:02	0:00:13	13	0:03:41	0:00:57	57	11:21:43	38	13:48:44	0:00:39	39	0:12:03	0:07:01	421	14:00:47	38	3:46:52	0:01:44	104	0:01:55	0:03:05	185	3:48:47
101	4:16:04	39	11:24:06	0:06:04	364	0:00:00	0:01:22	82	11:24:06	39	13:49:05	0:00:21	21	0:18:43	0:00:50	50	14:07:48	39	3:50:05	0:03:13	193	0:01:47	0:01:41	101	3:51:52
81	4:17:45	40	11:24:54	0:00:48	48	0:00:34	0:01:36	96	11:25:28	40	13:51:22	0:02:17	137	0:17:16	0:01:18	78	14:08:38	40	3:53:02	0:02:57	177	0:00:31	0:01:08	68	3:53:33
126	4:19:06	41	11:25:02	0:00:08	8	0:02:02	0:00:43	43	11:27:04	41	13:52:00	0:00:38	38	0:17:56	0:00:12	12	14:09:56	41	3:53:45	0:00:43	43	0:00:56	0:00:32	32	3:54:41
94	4:21:12	42	11:25:46	0:00:44	44	0:02:01	0:02:06	126	11:27:47	42	13:53:04	0:01:04	64	0:17:04	0:00:41	41	14:10:08	42	3:54:21	0:00:36	36	0:00:52	0:00:52	52	3:55:13
87	4:22:46	43	11:25:58	0:00:12	12	0:03:55	0:02:01	121	11:29:53	43	13:53:42	0:00:38	38	0:17:07	0:00:51	51	14:10:49	43	3:55:02	0:00:41	41	0:01:03	0:01:25	85	3:56:05
41	4:24:13	44	11:26:12	0:00:14	14	0:05:42	0:01:42	102	11:31:54	44	13:58:02	0:04:20	260	0:13:38	0:01:02	62	14:11:40	44	3:55:48	0:00:46	46	0:01:42	0:01:11	71	3:57:30
125	4:24:54	45	11:27:04	0:00:52	52	0:06:32	0:03:21	201	11:33:36	45	14:00:00	0:01:58	118	0:12:42	0:01:43	103	14:12:42	45	3:57:02	0:01:14	74	0:01:39	0:01:47	107	3:58:41

Data on Wednesday:

2/29/2018	Wednesday	9 am to 11 am						2/29/2018	Wednesday	12 pm to 2 pm						2/29/2018	Wednesday	2 pm to 4 pm					
Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Second	Start Service Time	Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Second	Start Service Time	Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Second	Start Service Time
1	9:04:12	0:00:00	0	0:00:00	0:04:06	246	9:04:12	1	12:02:15	0:00:00	0	0:00:34	0:01:28	88	12:02:49	1	2:03:12	0:00:00	0	0:00:49	0:05:02	302	2:04:01
2	9:05:15	0:01:03	63	0:03:03	0:00:56	56	9:08:18	2	12:13:52	0:11:37	697	0:00:00	0:00:36	36	12:13:52	2	2:05:10	0:01:58	118	0:03:53	0:01:20	80	2:09:03
3	9:12:06	0:06:51	411	0:00:00	0:01:03	63	9:12:06	3	12:13:59	0:00:07	7	0:00:29	0:01:48	108	12:14:28	3	2:16:05	0:10:55	655	0:00:00	0:00:19	19	2:16:05
4	9:18:06	0:06:00	360	0:00:00	0:00:36	36	9:18:06	4	12:15:01	0:01:02	62	0:01:15	0:02:56	176	12:16:16	4	2:18:41	0:02:36	156	0:00:00	0:01:45	105	2:18:41
5	9:25:47	0:07:41	461	0:00:00	0:00:16	16	9:25:47	5	12:16:25	0:01:24	84	0:02:47	0:01:45	105	12:19:12	5	2:19:02	0:00:21	21	0:01:24	0:02:51	171	2:20:26
6	9:26:06	0:00:19	19	0:00:00	0:00:56	56	9:26:06	6	12:20:42	0:04:17	257	0:00:15	0:08:52	532	12:20:57	6	2:22:06	0:03:04	184	0:01:11	0:02:01	121	2:23:17
7	9:27:19	0:01:13	73	0:00:00	0:08:39	519	9:27:19	7	12:25:21	0:04:39	279	0:04:28	0:01:23	83	12:29:49	7	2:26:41	0:04:35	275	0:00:00	0:02:09	129	2:26:41
8	9:29:52	0:02:33	153	0:06:06	0:00:48	48	9:35:58	8	12:35:08	0:09:47	587	0:00:00	0:02:14	134	12:35:08	8	2:27:28	0:00:47	47	0:01:22	0:03:12	192	2:28:50
9	9:31:06	0:01:14	74	0:05:40	0:02:13	133	9:36:46	9	12:36:02	0:00:54	54	0:01:20	0:01:53	113	12:37:22	9	2:29:01	0:01:33	93	0:03:01	0:01:16	76	2:32:02
10	9:34:27	0:03:21	201	0:04:32	0:00:40	40	9:38:59	10	12:37:01	0:00:59	59	0:02:14	0:00:57	57	12:39:15	10	2:31:02	0:02:01	121	0:02:16	0:01:24	84	2:33:18
11	9:35:04	0:00:37	37	0:04:35	0:01:33	93	9:39:39	11	12:38:20	0:01:19	79	0:01:52	0:00:48	48	12:40:12	11	2:35:26	0:04:24	264	0:00:00	0:02:45	165	2:35:26
12	9:36:09	0:01:05	65	0:05:03	0:04:45	285	9:41:12	12	12:40:04	0:01:44	104	0:00:56	0:00:13	13	12:41:00	12	2:45:06	0:09:40	580	0:00:00	0:03:12	192	2:45:06
13	9:37:08	0:00:59	59	0:08:49	0:06:08	368	9:45:57	13	12:58:25	0:18:21	1101	0:00:00	0:04:19	259	12:58:25	13	2:49:52	0:04:46	286	0:00:00	0:00:12	12	2:49:52
14	9:54:09	0:17:01	1021	0:00:00	0:03:17	197	9:54:09	14	13:04:08	0:05:43	343	0:00:00	0:02:30	150	13:04:08	14	2:50:06	0:00:14	14	0:00:00	0:00:45	45	2:50:06
15	9:56:54	0:02:45	165	0:00:32	0:00:49	49	9:57:26	15	13:10:52	0:06:44	404	0:00:00	0:06:21	381	13:10:52	15	2:52:39	0:02:33	153	0:00:00	0:02:17	137	2:52:39
16	10:10:15	0:13:21	801	0:00:00	0:01:24	84	10:10:15	16	13:14:10	0:03:18	198	0:03:03	0:02:30	150	13:17:13	16	2:56:30	0:03:51	231	0:00:00	0:02:19	139	2:56:30
17	10:11:05	0:00:50	50	0:00:34	0:01:31	91	10:11:39	17	13:15:08	0:00:58	58	0:04:35	0:02:10	130	13:19:43	17	2:59:06	0:02:36	156	0:00:00	0:01:05	65	2:59:06
18	10:13:26	0:02:21	141	0:00:00	0:01:02	62	10:13:26	18	13:16:23	0:01:15	75	0:05:30	0:02:13	133	13:21:53	18	3:07:52	0:08:46	526	0:00:00	0:01:49	109	3:07:52
19	10:20:25	0:06:59	419	0:00:00	0:00:40	40	10:20:25	19	13:20:54	0:04:31	271	0:03:12	0:02:03	123	13:24:06	19	3:14:51	0:06:59	419	0:00:00	0:02:04	124	3:14:51
20	10:21:26	0:01:01	61	0:00:00	0:10:02	602	10:21:26	20	13:22:09	0:01:15	75	0:04:00	0:00:48	48	13:26:09	20	3:16:02	0:01:11	71	0:00:53	0:02:17	137	3:16:55
21	10:26:45	0:05:19	319	0:04:43	0:01:19	79	10:31:28	21	13:25:01	0:02:52	172	0:01:56	0:01:06	66	13:26:57	21	3:21:42	0:05:40	340	0:00:00	0:00:55	55	3:21:42
22	10:27:26	0:00:41	41	0:05:21	0:02:15	135	10:32:47	22	13:26:41	0:01:40	100	0:01:22	0:01:45	105	13:28:03	22	3:22:06	0:00:24	24	0:00:31	0:05:12	312	3:22:37
23	10:29:43	0:02:17	137	0:05:19	0:00:12	12	10:35:02	23	13:26:49	0:00:08	8	0:02:59	0:03:16	196	13:29:48	23	3:22:17	0:00:11	11	0:05:32	0:01:47	107	3:27:49
24	10:36:12	0:06:29	389	0:00:00	0:08:02	482	10:36:12	24	13:27:05	0:00:16	16	0:05:59	0:01:12	72	13:33:04	24	3:26:08	0:03:51	231	0:03:28	0:10:23	623	3:29:36
25	10:37:06	0:00:54	54	0:07:08	0:01:23	83	10:44:14	25	13:29:05	0:02:00	120	0:05:11	0:03:21	201	13:34:16	25	3:29:45	0:03:37	217	0:10:14	0:02:05	125	3:39:59
26	10:40:25	0:03:19	199	0:05:12	0:05:12	312	10:45:37	26	13:45:47	0:16:42	1002	0:00:00	0:00:46	46	13:45:47	26	3:39:05	0:09:20	560	0:02:59	0:01:09	69	3:42:04
27	10:46:25	0:06:00	360	0:04:24	0:00:23	23	10:50:49	27	13:46:02	0:00:15	15	0:00:31	0:02:17	137	13:46:33	27	3:40:12	0:01:07	67	0:03:01	0:01:39	99	3:43:13
28	10:49:21	0:02:56	176	0:01:51	0:01:26	86	10:51:12	28	13:46:45	0:00:43	43	0:02:05	0:01:11	71	13:48:50	28	3:41:22	0:01:10	70	0:03:30	0:04:05	245	3:44:52
29	10:50:02	0:00:41	41	0:02:36	0:03:06	186	10:52:38	29	13:48:24	0:01:39	99	0:01:37	0:03:35	215	13:50:01	29	3:41:46	0:00:24	24	0:07:11	0:02:12	132	3:48:57
30	10:51:23	0:01:21	81	0:04:21	0:01:24	84	10:55:44	30	13:48:51	0:00:27	27	0:04:45	0:00:55	55	13:53:36	30	3:46:12	0:04:26	266	0:04:57	0:01:22	82	3:51:09
31	10:55:01	0:03:38	218	0:02:07	0:01:10	70	10:57:08	31	13:50:05	0:01:14	74	0:04:26	0:01:52	112	13:54:31	31	3:50:22	0:04:10	250	0:02:09	0:01:00	60	3:52:31
32	10:56:21	0:01:20	80	0:01:57	0:00:41	41	10:58:18	32	13:52:22	0:02:17	137	0:04:01	0:02:01	121	13:56:23	32	3:51:02	0:00:40	40	0:02:29	0:00:55	55	3:53:31
33	10:57:02	0:00:41	41	0:01:57	0:00:38	38	10:58:59	33	13:56:01	0:03:39	219	0:02:23	0:01:11	71	13:58:24	33	3:52:44	0:01:42	102	0:01:42	0:03:06	186	3:54:26
34	10:57:42	0:00:40	40	0:01:55	0:04:01	241	10:59:37	34	13:57:11	0:01:10	70	0:02:24	0:03:22	202	13:59:35	34	3:52:58	0:00:14	14	0:04:34	0:03:19	199	3:57:32
35	10:58:21	0:00:39	39	0:05:17	0:01:21	81	11:03:38	35	13:59:02	0:01:51	111	0:03:55	0:00:46	46	14:02:57	35	3:56:01	0:03:03	183	0:04:50	0:01:11	71	4:00:51
36	11:01:06	0:02:45	165	0:03:53	0:01:08	68	11:04:59	36	14:00:15	0:01:13	73	0:03:28	0:01:42	102	14:03:43	36	3:59:11	0:03:10	190	0:02:51	0:00:19	19	4:02:02
37	11:05:21	0:04:15	255	0:00:46	0:01:06	66	11:06:07	37	14:05:25	0:05:10	310	0:00:00	0:02:22	142	14:05:25	37	4:01:11	0:02:00	120	0:01:10	0:00:44	44	4:02:21
38	11:06:01	0:00:40	40	0:01:12	0:04:02	242	11:07:13	38	14:06:02	0:00:37	37	0:01:45	0:01:01	61	14:07:47	38	4:02:52	0:01:41	101	0:00:13	0:02:46	166	4:03:05
39	11:08:02	0:02:01	121	0:03:13	0:02:01	121	11:11:15	39	14:06:55	0:00:53	53	0:01:53	0:00:44	44	14:08:48	39	4:03:55	0:01:03	63	0:01:56	0:01:15	75	4:05:51
40	11:10:02	0:02:00	120	0:03:14	0:01:00	60	11:13:16	40	14:07:05	0:00:10	10	0:02:27	0:00:26	26	14:09:32	40	4:04:04	0:00:09	9	0:03:02	0:01:08	68	4:07:06
41	11:14:01	0:03:59	239	0:00:15	0:00:52	52	11:14:16	41	14:07:19	0:00:14	14	0:02:39	0:01:44	104	14:09:58	41	4:04:46	0:00:42	42	0:03:28	0:02:44	164	4:08:14
42	11:14:25	0:00:24	24	0:00:43	0:00:31	31	11:15:08	42	14:09:46	0:02:27	147	0:01:56	0:01:26	86	14:11:42	42	4:07:42	0:02:56	176	0:03:16	0:00:54	54	4:10:58
43	11:14:56	0:00:31	31	0:00:43	0:00:54	54	11:15:39	43	14:12:05	0:02:19	139	0:01:03	0:02:22	142	14:13:08	43	4:10:09	0:02:27	147	0:01:43	0:00:39	39	4:11:52
44	11:15:11	0:00:15	15	0:01:22	0:01:45	105	11:16:33	44	14:15:06	0:03:01	181	0:00:24	0:01:45	105	14:15:30	44	4:10:54	0:00:45	45	0:01:37	0:01:19	79	4:12:31
45	11:15:44	0:00:33	33	0:02:34	0:01:01	61	11:18:18	45	14:15:55	0:00:49	49	0:01:20	0:00:58	58	14:17:15	45	4:10:59	0:00:05	5	0:02:51	0:02:01	121	4:13:50

We have identified the outliers by calculating the first and third quartiles, IQR, LCL,UCL in each data set and the data with identified outliers is presented below. The outliers are the ones white in color in the Inter Arrival Times in Seconds column:

Data on Friday with identified outliers

2232018	Friday	9 am to 11:30 am							2232018	Friday	12 pm to 02 pm							2232018	Friday	2 pm to 4:30 pm						
Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time		Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time		Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	9:05:12	0:00:00	0	0:00:00	0:00:45	45	9:05:12		1	12:02:45	0:00:00	0	0:00:18	0:01:05	0:00:00	12:03:03		1	2:01:05	0:00:00	0	0:00:00	0:01:56	116	2:01:05
2	9:05:30	0:00:18	18	0:00:27	0:01:02	62	9:05:57		2	12:02:48	0:00:03	3	0:01:20	0:12:05	725	12:04:08		2	2:10:10	0:09:05	545	0:00:00	0:02:41	161	2:10:10
3	9:07:10	0:01:40	100	0:00:10	0:00:55	55	9:07:20		3	12:02:56	0:00:08	8	0:13:17	0:00:49	49	12:16:13		3	2:11:14	0:01:04	64	0:01:37	0:00:42	42	2:12:51
4	9:15:06	0:07:56	476	0:00:39	0:02:10	130	9:15:45		4	12:05:02	0:02:06	126	0:12:00	0:00:42	42	12:17:02		4	2:11:50	0:00:36	36	0:01:43	0:00:53	53	2:13:33
5	9:15:07	0:00:01	1	0:02:48	0:01:45	105	9:17:55		5	12:10:30	0:05:28	328	0:07:14	0:02:01	121	12:17:44		5	2:14:15	0:02:25	145	0:00:11	0:05:02	302	2:14:26
6	9:17:02	0:01:55	115	0:02:43	0:05:20	320	9:19:45		6	12:12:36	0:02:06	126	0:07:09	0:02:16	136	12:19:45		6	2:25:15	0:11:00	660	0:00:00	0:04:00	240	2:25:15
7	9:18:56	0:01:54	114	0:06:09	0:00:10	10	9:25:05		7	12:15:52	0:03:16	196	0:06:09	0:07:02	422	12:22:01		7	2:26:19	0:01:04	64	0:02:56	0:02:16	136	2:29:15
8	9:20:00	0:01:04	64	0:05:15	0:02:52	172	9:25:15		8	12:16:47	0:00:55	55	0:12:16	0:01:54	114	12:29:03		8	2:28:20	0:02:01	121	0:03:11	0:02:04	124	2:31:31
9	9:22:54	0:02:54	174	0:05:13	0:12:01	721	9:28:07		9	12:20:00	0:03:13	193	0:10:57	0:01:51	111	12:30:57		9	2:50:21	0:22:01	1321	0:00:00	0:01:54	114	2:50:21
10	9:30:14	0:07:20	440	0:10:06	0:00:48	48	9:40:20		10	12:31:15	0:11:15	675	0:01:33	0:01:12	72	12:32:48		10	3:02:08	0:11:47	707	0:00:00	0:01:19	79	3:02:08
11	9:31:07	0:00:53	53	0:10:01	0:00:51	51	9:41:08		11	12:32:18	0:01:03	63	0:01:42	0:05:12	312	12:34:00		11	3:03:05	0:00:57	57	0:00:22	0:03:04	184	3:03:27
12	9:45:25	0:14:18	858	0:00:00	0:02:04	124	9:45:25		12	12:35:20	0:03:02	182	0:03:52	0:12:06	726	12:39:12		12	3:04:19	0:01:14	74	0:02:12	0:03:00	180	3:06:31
13	9:48:13	0:02:48	168	0:00:00	0:05:02	302	9:48:13		13	12:37:05	0:01:45	105	0:14:13	0:08:23	503	12:51:18		13	3:10:59	0:06:40	400	0:00:00	0:01:43	103	3:10:59
14	9:49:18	0:01:05	65	0:03:57	0:01:04	64	9:53:15		14	12:40:25	0:03:20	200	0:19:16	0:00:49	49	12:59:41		14	3:11:28	0:00:29	29	0:01:14	0:02:15	135	3:12:42
15	9:50:20	0:01:02	62	0:03:59	0:00:57	57	9:54:19		15	12:41:01	0:00:36	36	0:19:29	0:02:05	125	13:00:30		15	3:11:30	0:00:02	2	0:03:27	0:01:00	60	3:14:57
16	9:50:30	0:00:10	10	0:04:46	0:04:56	296	9:55:16		16	12:43:52	0:02:51	171	0:18:43	0:01:41	101	13:02:35		16	3:11:45	0:00:15	15	0:04:12	0:01:26	86	3:15:57
17	9:50:45	0:00:15	15	0:09:27	0:03:50	230	10:00:12		17	12:49:05	0:05:13	313	0:15:11	0:01:19	79	13:04:16		17	3:18:17	0:06:32	392	0:00:00	0:02:09	129	3:18:17
18	10:02:06	0:11:21	681	0:01:56	0:02:02	122	10:04:02		18	13:05:12	0:16:07	967	0:01:23	0:01:37	97	13:06:35		18	3:18:45	0:00:28	28	0:01:41	0:01:40	100	3:20:26
19	10:05:19	0:03:13	193	0:00:45	0:01:05	65	10:06:04		19	13:08:02	0:02:50	170	0:00:10	0:02:09	129	13:08:12		19	3:20:34	0:01:49	109	0:01:32	0:00:35	35	3:22:06
20	10:05:35	0:00:16	16	0:01:34	0:03:21	201	10:07:09		20	13:09:52	0:01:50	110	0:00:29	0:05:02	302	13:10:21		20	3:22:38	0:02:04	124	0:00:03	0:01:42	102	3:22:41
21	10:09:27	0:03:52	232	0:01:03	0:00:50	50	10:10:30		21	13:13:05	0:03:13	193	0:02:18	0:00:50	50	13:15:23		21	3:30:59	0:08:21	501	0:00:00	0:04:49	289	3:30:59
22	10:20:32	0:11:05	665	0:00:00	0:00:20	20	10:20:32		22	13:15:22	0:02:17	137	0:00:51	0:04:36	276	13:16:13		22	3:32:47	0:01:48	108	0:03:01	0:07:26	446	3:35:48
23	10:25:26	0:04:54	294	0:00:00	0:09:02	542	10:25:26		23	13:19:05	0:03:43	223	0:01:44	0:02:05	125	13:20:49		23	3:32:50	0:00:03	3	0:10:24	0:01:56	116	3:43:14
24	10:26:07	0:00:41	41	0:08:21	0:06:23	383	10:34:28		24	13:20:25	0:01:20	80	0:02:29	0:02:09	129	13:22:54		24	3:40:27	0:07:37	457	0:04:43	0:08:30	510	3:45:10
25	10:26:18	0:00:11	11	0:14:33	0:10:02	602	10:40:51		25	13:22:10	0:01:45	105	0:02:53	0:06:10	370	13:25:03		25	3:42:56	0:02:29	149	0:10:44	0:00:19	19	3:53:40
26	10:28:15	0:01:57	117	0:22:38	0:07:01	421	10:50:53		26	13:29:21	0:07:11	431	0:01:52	0:02:00	120	13:31:13		26	3:44:24	0:01:28	88	0:09:35	0:00:43	43	3:53:59
27	10:28:56	0:00:41	41	0:29:06	0:02:01	121	10:58:02		27	13:30:52	0:01:31	91	0:02:21	0:01:53	113	13:33:13		27	3:45:09	0:00:45	45	0:09:33	0:02:27	147	3:54:42
28	10:35:07	0:06:11	371	0:24:56	0:01:45	105	11:00:03		28	13:31:21	0:00:29	29	0:03:45	0:01:46	106	13:35:06		28	3:50:14	0:05:05	305	0:06:55	0:02:36	156	3:57:09
29	10:45:25	0:10:18	618	0:16:23	0:02:09	129	11:01:48		29	13:31:52	0:00:31	31	0:05:00	0:00:59	59	13:36:52		29	3:50:19	0:00:05	5	0:09:26	0:05:01	301	3:59:45
30	10:46:45	0:01:20	80	0:17:12	0:01:15	75	11:03:57		30	13:36:03	0:04:11	251	0:01:48	0:00:54	54	13:37:51		30	3:55:08	0:04:49	289	0:09:38	0:01:42	102	4:04:46
31	10:50:12	0:03:27	207	0:15:00	0:02:01	121	11:05:12		31	13:36:58	0:00:55	55	0:01:47	0:01:21	81	13:38:45		31	3:55:45	0:00:37	37	0:10:43	0:01:01	61	4:06:28
32	11:04:02	0:13:50	830	0:03:11	0:00:35	35	11:07:13		32	13:38:00	0:01:02	62	0:02:06	0:00:54	54	13:40:06		32	3:58:20	0:02:35	155	0:09:09	0:00:52	52	4:07:29
33	11:05:01	0:00:59	59	0:02:47	0:00:45	45	11:07:48		33	13:38:06	0:00:06	6	0:02:54	0:00:38	38	13:41:00		33	3:59:02	0:00:42	42	0:09:19	0:00:34	34	4:08:21
34	11:06:12	0:01:11	71	0:02:21	0:00:50	50	11:08:33		34	13:39:52	0:01:46	106	0:01:46	0:01:24	84	13:41:38		34	4:02:45	0:03:43	223	0:06:10	0:02:02	122	4:08:55
35	11:08:05	0:01:53	113	0:01:18	0:02:03	123	11:09:23		35	13:40:02	0:00:10	10	0:03:00	0:02:01	121	13:43:02		35	4:05:02	0:02:17	137	0:05:55	0:02:56	176	4:10:57
36	11:12:04	0:03:59	239	0:00:00	0:05:01	301	11:12:04		36	13:42:52	0:02:50	170	0:02:11	0:02:00	120	13:45:03		36	4:06:45	0:01:43	103	0:07:08	0:00:12	12	4:13:53
37	11:12:50	0:00:46	46	0:04:15	0:01:12	72	11:17:05		37	13:43:00	0:00:08	8	0:04:03	0:01:01	61	13:47:03		37	4:09:52	0:03:07	187	0:04:13	0:00:46	46	4:14:05
38	11:15:01	0:02:11	131	0:03:16	0:01:04	64	11:18:17		38	13:45:06	0:02:06	126	0:02:58	0:00:51	51	13:48:04		38	4:10:21	0:00:29	29	0:04:30	0:01:13	73	4:14:51
39	11:20:52	0:05:51	351	0:00:00	0:00:49	49	11:20:52		39	13:45:40	0:00:34	34	0:03:15	0:00:32	32	13:48:55		39	4:12:12	0:01:51	111	0:03:52	0:01:41	101	4:16:04
40	11:22:12	0:01:20	80	0:00:00	0:00:32	32	11:22:12		40	13:46:21	0:00:41	41	0:03:06	0:01:27	87	13:49:27		40	4:13:21	0:01:09	69	0:04:24	0:01:21	81	4:17:45
41	11:23:01	0:00:49	49	0:00:00	0:00:56	56	11:23:01		41	13:48:11	0:01:50	110	0:02:43	0:01:42	102	13:50:54		41	4:15:21	0:02:00	120	0:03:45	0:02:06	126	4:19:06
42	11:25:02	0:02:01	121	0:00:00	0:03:01	181	11:25:02		42	13:48:55	0:00:44	44	0:03:41	0:01:52	112	13:52:36		42	4:21:00	0:05:39	339	0:00:12	0:01:34	94	4:21:12
43	11:27:12	0:02:10	130	0:00:51	0:02:51	171	11:28:03		43	13:49:02	0:00:07	7	0:05:26	0:01:12	72	13:54:28		43	4:22:06	0:01:06	66	0:00:40	0:01:27	87	4:22:46
44	11:29:10	0:01:58	118	0:01:44	0:00:50	50	11:30:54		44	13:49:36	0:00:34	34	0:06:04	0:02:58	178	13:55:40		44	4:22:56	0:00:50	50	0:01:17	0:00:41	41	4:24:13
45	11:30:20	0:01:10	70	0:01:24	0:00:31	31	11:31:44		45	13:49:42	0:00:06	6	0:08:56	0:00:59	59	13:58:38		45	4:22:59	0:00:03	3	0:01:55	0:02:05	125	4:24:54

Data on Monday with identified outliers

2/26/2018	Monday	9 am to 11:30 am							2/26/2018	Monday	12 pm to 2 pm							2/26/2018	Monday	2 pm to 4:30 pm						
Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time		Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time		Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	9:10:15	0:00:00	0	0:00:00	0:01:19	79	9:10:15		1	12:10:36	0:00:00	0	0:01:28	0:01:25	85	12:12:04		1	2:06:08	0:00:00	0	0:01:41	0:02:12	132	2:07:49
2	9:12:18	0:02:03	123	0:00:00	0:01:50	110	9:12:18		2	12:12:58	0:02:22	142	0:00:31	0:02:02	122	12:13:29		2	2:10:05	0:03:57	237	0:00:00	0:02:11	131	2:10:05
3	9:14:25	0:02:07	127	0:00:00	0:00:19	19	9:14:25		3	12:15:45	0:02:47	167	0:00:00	0:09:02	542	12:15:45		3	2:11:15	0:01:10	70	0:01:01	0:01:12	72	2:12:16
4	9:14:54	0:00:29	29	0:00:00	0:02:01	121	9:14:54		4	12:16:47	0:01:02	62	0:08:00	0:01:22	82	12:24:47		4	2:12:05	0:00:50	50	0:01:23	0:00:46	46	2:13:28
5	9:16:07	0:01:13	73	0:00:48	0:01:17	77	9:16:55		5	12:17:45	0:00:58	58	0:08:24	0:00:22	22	12:26:09		5	2:18:47	0:06:42	402	0:00:00	0:00:57	57	2:18:47
6	9:18:17	0:02:10	130	0:00:00	0:02:00	120	9:18:17		6	12:19:42	0:01:57	117	0:06:49	0:03:15	195	12:26:31		6	2:19:20	0:00:33	33	0:00:24	0:01:24	84	2:19:44
7	9:22:57	0:04:40	280	0:00:00	0:02:21	141	9:22:57		7	12:28:25	0:08:43	523	0:01:21	0:01:08	68	12:29:46		7	2:19:56	0:00:36	36	0:01:12	0:05:01	301	2:21:08
8	9:23:26	0:00:29	29	0:01:52	0:08:39	519	9:25:18		8	12:29:40	0:01:15	75	0:01:14	0:01:17	77	12:30:54		8	2:20:08	0:00:12	12	0:06:01	0:01:21	81	2:26:09
9	9:25:48	0:02:22	142	0:08:09	0:00:48	48	9:33:57		9	12:30:21	0:00:41	41	0:01:50	0:09:20	560	12:32:11		9	2:22:46	0:02:38	158	0:04:44	0:00:59	59	2:27:30
10	9:26:14	0:00:26	26	0:08:31	0:01:33	93	9:34:45		10	12:36:41	0:06:20	380	0:04:50	0:00:45	45	12:41:31		10	2:23:10	0:00:24	24	0:05:19	0:00:42	42	2:28:29
11	9:29:36	0:03:22	202	0:06:42	0:02:13	133	9:36:18		11	12:40:01	0:03:20	200	0:02:15	0:05:23	323	12:42:16		11	2:25:16	0:02:06	126	0:03:55	0:05:12	312	2:29:11
12	9:32:57	0:03:21	201	0:05:34	0:00:40	40	9:38:31		12	12:45:21	0:05:20	320	0:02:18	0:06:41	401	12:47:39		12	2:26:42	0:01:26	86	0:07:41	0:01:59	119	2:34:23
13	9:45:17	0:12:20	740	0:00:00	0:06:08	368	9:45:17		13	12:53:00	0:07:39	459	0:01:20	0:03:12	192	12:54:20		13	2:29:04	0:02:22	142	0:07:18	0:01:45	105	2:36:22
14	9:55:20	0:10:03	603	0:00:00	0:03:18	198	9:55:20		14	12:54:21	0:01:21	81	0:03:11	0:06:21	381	12:57:32		14	2:35:04	0:06:00	360	0:03:03	0:01:26	86	2:38:07
15	9:58:14	0:02:54	174	0:00:24	0:04:00	240	9:58:38		15	12:58:21	0:04:00	240	0:05:32	0:02:12	132	13:03:53		15	2:35:57	0:00:53	53	0:03:36	0:02:06	126	2:39:33
16	9:59:27	0:01:13	73	0:03:11	0:02:45	165	10:02:38		16	13:01:25	0:03:04	184	0:04:40	0:01:57	117	13:06:05		16	2:37:15	0:01:18	78	0:04:24	0:03:04	184	2:41:39
17	10:04:26	0:04:59	299	0:00:57	0:01:15	75	10:05:23		17	13:06:25	0:05:00	300	0:01:37	0:01:46	106	13:08:02		17	2:39:56	0:02:41	161	0:04:47	0:07:18	438	2:44:43
18	10:18:18	0:13:52	832	0:00:00	0:00:48	48	10:18:18		18	13:07:25	0:01:00	60	0:02:23	0:01:52	112	13:09:48		18	2:45:12	0:05:16	316	0:08:49	0:01:10	70	2:54:01
19	10:20:25	0:02:07	127	0:00:00	0:01:08	68	10:20:25		19	13:09:28	0:02:03	123	0:02:12	0:02:09	129	13:11:40		19	2:46:18	0:01:06	66	0:08:53	0:04:06	246	2:55:11
20	10:35:58	0:15:33	933	0:00:00	0:01:48	108	10:35:58		20	13:10:29	0:01:01	61	0:03:20	0:06:12	372	13:13:49		20	2:50:15	0:03:57	237	0:09:02	0:01:06	66	2:59:17
21	10:36:47	0:00:49	49	0:00:59	0:01:23	83	10:37:46		21	13:16:25	0:05:56	356	0:03:36	0:05:02	302	13:20:01		21	2:51:07	0:00:52	52	0:09:16	0:02:15	135	3:00:23
22	10:39:16	0:02:29	149	0:00:00	0:03:15	195	10:39:16		22	13:25:03	0:08:38	518	0:00:00	0:02:10	130	13:25:03		22	2:59:12	0:08:05	485	0:03:26	0:03:39	219	3:02:38
23	10:40:49	0:01:33	93	0:01:42	0:00:40	40	10:42:31		23	13:26:08	0:01:05	65	0:01:05	0:01:02	62	13:27:13		23	3:02:46	0:03:34	214	0:03:31	0:01:19	79	3:06:17
24	10:43:25	0:02:36	156	0:00:40	0:01:20	80	10:44:05		24	13:28:15	0:02:07	127	0:00:00	0:01:51	111	13:28:15		24	3:06:08	0:03:22	202	0:01:28	0:00:42	42	3:07:36
25	10:48:27	0:05:02	302	0:00:00	0:01:24	84	10:48:27		25	13:28:49	0:00:34	34	0:01:17	0:00:56	56	13:30:06		25	3:17:45	0:11:37	697	0:00:00	0:09:41	581	3:17:45
26	10:50:25	0:01:58	118	0:00:00	0:03:17	197	10:50:25		26	13:30:21	0:01:32	92	0:00:41	0:07:10	430	13:31:02		26	3:18:09	0:00:24	24	0:09:17	0:02:51	171	3:27:26
27	10:54:08	0:03:43	223	0:00:00	0:01:33	93	10:54:08		27	13:32:36	0:02:15	135	0:05:36	0:02:30	150	13:38:12		27	3:19:20	0:01:11	71	0:10:57	0:04:12	252	3:30:17
28	10:55:12	0:01:04	64	0:00:29	0:01:20	80	10:55:41		28	13:35:20	0:02:44	164	0:05:22	0:01:24	84	13:40:42		28	3:25:04	0:05:44	344	0:09:25	0:00:53	53	3:34:29
29	10:58:12	0:03:00	180	0:00:00	0:01:42	102	10:58:12		29	13:40:52	0:05:32	332	0:01:14	0:02:35	155	13:42:06		29	3:26:05	0:01:01	61	0:09:17	0:02:45	165	3:35:22
30	10:58:17	0:00:05	5	0:01:37	0:00:56	56	10:59:54		30	13:42:05	0:01:13	73	0:02:36	0:02:41	161	13:44:41		30	3:29:07	0:03:02	182	0:09:00	0:01:55	115	3:38:07
31	11:02:12	0:03:55	235	0:00:00	0:00:32	32	11:02:12		31	13:43:12	0:01:07	67	0:04:10	0:01:52	112	13:47:22		31	3:39:12	0:10:05	605	0:00:50	0:00:58	58	3:40:02
32	11:02:45	0:00:33	33	0:00:00	0:01:48	108	11:02:45		32	13:44:52	0:01:40	100	0:04:22	0:02:01	121	13:49:14		32	3:39:56	0:00:44	44	0:01:04	0:01:02	62	3:41:00
33	11:03:52	0:01:07	67	0:00:41	0:01:04	64	11:04:33		33	13:45:01	0:00:09	9	0:06:14	0:01:05	65	13:51:15		33	3:40:01	0:00:05	5	0:02:01	0:01:45	105	3:42:02
34	11:10:25	0:06:33	393	0:00:00	0:05:21	321	11:10:25		34	13:45:56	0:00:55	55	0:06:24	0:00:37	37	13:52:20		34	3:42:01	0:02:00	120	0:01:46	0:02:04	124	3:43:47
35	11:12:25	0:02:00	120	0:03:21	0:01:23	83	11:15:46		35	13:46:08	0:00:12	12	0:06:49	0:00:39	39	13:52:57		35	3:42:52	0:00:51	51	0:02:59	0:01:05	65	3:45:51
36	11:15:01	0:02:36	156	0:02:08	0:04:05	245	11:17:09		36	13:46:54	0:00:46	46	0:06:42	0:05:10	310	13:53:36		36	3:43:21	0:00:29	29	0:03:35	0:01:00	60	3:46:56
37	11:17:49	0:02:48	168	0:03:25	0:00:29	29	11:21:14		37	13:48:05	0:01:11	71	0:10:41	0:02:01	121	13:58:46		37	3:45:08	0:01:47	107	0:02:48	0:00:51	51	3:47:56
38	11:18:02	0:00:13	13	0:03:41	0:00:57	57	11:21:43		38	13:48:44	0:00:39	39	0:12:03	0:07:01	421	14:00:47		38	3:46:52	0:01:44	104	0:01:55	0:03:05	185	3:48:47
39	11:24:06	0:06:04	364	0:00:00	0:01:22	82	11:24:06		39	13:49:05	0:00:21	21	0:18:43	0:00:50	50	14:07:48		39	3:50:05	0:03:13	193	0:01:47	0:01:41	101	3:51:52
40	11:24:54	0:00:48	48	0:00:34	0:01:36	96	11:25:28		40	13:51:22	0:02:17	137	0:17:16	0:01:18	78	14:08:38		40	3:53:02	0:02:57	177	0:00:31	0:01:08	68	3:53:33
41	11:25:02	0:00:08	8	0:02:02	0:00:43	43	11:27:04		41	13:52:00	0:00:38	38	0:17:56	0:00:12	12	14:09:56		41	3:53:45	0:00:43	43	0:00:56	0:00:32	32	3:54:41
42	11:25:46	0:00:44	44	0:02:01	0:02:06	126	11:27:47		42	13:53:04	0:01:04	64	0:17:04	0:00:41	41	14:10:08		42	3:54:21	0:00:36	36	0:00:52	0:00:52	52	3:55:13
43	11:25:58	0:00:12	12	0:03:55	0:02:01	121	11:29:53		43	13:53:42	0:00:38	38	0:17:07	0:00:51	51	14:10:49		43	3:55:02	0:00:41	41	0:01:03	0:01:25	85	3:56:05
44	11:26:12	0:00:14	14	0:05:42	0:01:42	102	11:31:54		44	13:58:02	0:04:20	260	0:13:38	0:01:02	62	14:11:40		44	3:55:48	0:00:46	46	0:01:42	0:01:11	71	3:57:30
45	11:27:04	0:00:52	52	0:06:32	0:03:21	201	11:33:36		45	14:00:00	0:01:58	118	0:12:42	0:01:43	103	14:12:42		45	3:57:02	0:01:14	74	0:01:39	0:01:47	107	3:58:41

Data on Wednesday with identified outliers

Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	9:04:12	0:00:00	0	0:00:00	0:04:06	246	9:04:12
2	9:05:15	0:01:03	63	0:03:03	0:00:56	56	9:08:18
3	9:12:06	0:06:51	411	0:00:00	0:01:03	63	9:12:06
4	9:18:06	0:06:00	360	0:00:00	0:00:36	36	9:18:06
5	9:25:47	0:07:41	461	0:00:00	0:00:16	16	9:25:47
6	9:26:06	0:00:19	19	0:00:00	0:00:56	56	9:26:06
7	9:27:19	0:01:13	73	0:00:00	0:08:39	519	9:27:19
8	9:29:52	0:02:33	153	0:06:06	0:00:48	48	9:35:58
9	9:31:06	0:01:14	74	0:05:40	0:02:13	133	9:36:46
10	9:34:27	0:03:21	201	0:04:32	0:00:40	40	9:38:59
11	9:35:04	0:00:37	37	0:04:35	0:01:33	93	9:39:39
12	9:36:09	0:01:05	65	0:05:03	0:04:45	285	9:41:12
13	9:37:08	0:00:59	59	0:08:49	0:06:08	368	9:45:57
14	9:54:09	0:17:01	1021	0:00:00	0:03:17	197	9:54:09
15	9:56:54	0:02:45	165	0:00:32	0:00:49	49	9:57:26
16	10:10:15	0:13:21	801	0:00:00	0:01:24	84	10:10:15
17	10:11:05	0:00:50	50	0:00:34	0:01:31	91	10:11:39
18	10:13:26	0:02:21	141	0:00:00	0:01:02	62	10:13:26
19	10:20:25	0:06:59	419	0:00:00	0:00:40	40	10:20:25
20	10:21:26	0:01:01	61	0:00:00	0:10:02	602	10:21:26
21	10:26:45	0:05:19	319	0:04:43	0:01:19	79	10:31:28
22	10:27:26	0:00:41	41	0:05:21	0:02:15	135	10:32:47
23	10:29:43	0:02:17	137	0:05:19	0:00:12	12	10:35:02
24	10:36:12	0:06:29	389	0:00:00	0:08:02	482	10:36:12
25	10:37:06	0:00:54	54	0:07:08	0:01:23	83	10:44:14
26	10:40:25	0:03:19	199	0:05:12	0:05:12	312	10:45:37
27	10:46:25	0:06:00	360	0:04:24	0:00:23	23	10:50:49
28	10:49:21	0:02:56	176	0:01:51	0:01:26	86	10:51:12
29	10:50:02	0:00:41	41	0:02:36	0:03:06	186	10:52:38
30	10:51:23	0:01:21	81	0:04:21	0:01:24	84	10:55:44
31	10:55:01	0:03:38	218	0:02:07	0:01:10	70	10:57:08
32	10:56:21	0:01:20	80	0:01:57	0:00:41	41	10:58:18
33	10:57:02	0:00:41	41	0:01:57	0:00:38	38	10:58:59
34	10:57:42	0:00:40	40	0:01:55	0:04:01	241	10:59:37
35	10:58:21	0:00:39	39	0:05:17	0:01:21	81	11:03:38
36	11:01:06	0:02:45	165	0:03:53	0:01:08	68	11:04:59
37	11:05:21	0:04:15	255	0:00:46	0:01:06	66	11:06:07
38	11:06:01	0:00:40	40	0:01:12	0:04:02	242	11:07:13
39	11:08:02	0:02:01	121	0:03:13	0:02:01	121	11:11:15
40	11:10:02	0:02:00	120	0:03:14	0:01:00	60	11:13:16
41	11:14:01	0:03:59	239	0:00:15	0:00:52	52	11:14:16
42	11:14:25	0:00:24	24	0:00:43	0:00:31	31	11:15:08
43	11:14:56	0:00:31	31	0:00:43	0:00:54	54	11:15:39
44	11:15:11	0:00:15	15	0:01:22	0:01:45	105	11:16:33
45	11:15:44	0:00:33	33	0:02:34	0:01:01	61	11:18:18

Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	12:02:15	0:00:00	0	0:00:34	0:01:28	88	12:02:49
2	12:13:52	0:11:37	697	0:00:00	0:00:36	36	12:13:52
3	12:13:59	0:00:07	7	0:00:29	0:01:48	108	12:14:28
4	12:15:01	0:01:02	62	0:01:15	0:02:56	176	12:16:16
5	12:16:25	0:01:24	84	0:02:47	0:01:45	105	12:19:12
6	12:20:42	0:04:17	257	0:00:15	0:08:52	532	12:20:57
7	12:25:21	0:04:39	279	0:04:28	0:01:23	83	12:29:49
8	12:35:08	0:09:47	587	0:00:00	0:02:14	134	12:35:08
9	12:36:02	0:00:54	54	0:01:20	0:01:53	113	12:37:22
10	12:37:01	0:00:59	59	0:02:14	0:00:57	57	12:39:15
11	12:38:20	0:01:19	79	0:01:52	0:00:48	48	12:40:12
12	12:40:04	0:01:44	104	0:00:56	0:00:13	13	12:41:00
13	12:58:25	0:18:21	1101	0:00:00	0:04:19	259	12:58:25
14	13:04:08	0:05:43	343	0:00:00	0:02:30	150	13:04:08
15	13:10:52	0:06:44	404	0:00:00	0:06:21	381	13:10:52
16	13:14:10	0:03:18	198	0:03:03	0:02:30	150	13:17:13
17	13:15:08	0:00:58	58	0:04:35	0:02:10	130	13:19:43
18	13:16:23	0:01:15	75	0:05:30	0:02:13	133	13:21:53
19	13:20:54	0:04:31	271	0:03:12	0:02:03	123	13:24:06
20	13:22:09	0:01:15	75	0:04:00	0:00:48	48	13:26:09
21	13:25:01	0:02:52	172	0:01:56	0:01:06	66	13:26:57
22	13:26:41	0:01:40	100	0:01:22	0:01:45	105	13:28:03
23	13:26:49	0:00:08	8	0:02:59	0:03:16	196	13:29:48
24	13:27:05	0:00:16	16	0:05:59	0:01:12	72	13:33:04
25	13:29:05	0:02:00	120	0:05:11	0:03:21	201	13:34:16
26	13:45:47	0:16:42	1002	0:00:00	0:00:46	46	13:45:47
27	13:46:02	0:00:15	15	0:00:31	0:02:17	137	13:46:33
28	13:46:45	0:00:43	43	0:02:05	0:01:11	71	13:48:50
29	13:48:24	0:01:39	99	0:01:37	0:03:35	215	13:50:01
30	13:48:51	0:00:27	27	0:04:45	0:00:55	55	13:53:36
31	13:50:05	0:01:14	74	0:04:26	0:01:52	112	13:54:31
32	13:52:22	0:02:17	137	0:04:01	0:02:01	121	13:56:23
33	13:56:01	0:03:39	219	0:02:23	0:01:11	71	13:58:24
34	13:57:11	0:01:10	70	0:02:24	0:03:22	202	13:59:35
35	13:59:02	0:01:51	111	0:03:55	0:00:46	46	14:02:57
36	14:00:15	0:01:13	73	0:03:28	0:01:42	102	14:03:43
37	14:05:25	0:05:10	310	0:00:00	0:02:22	142	14:05:25
38	14:06:02	0:00:37	37	0:01:45	0:01:01	61	14:07:47
39	14:06:55	0:00:53	53	0:01:53	0:00:44	44	14:08:48
40	14:07:05	0:00:10	10	0:02:27	0:00:26	26	14:09:32
41	14:07:19	0:00:14	14	0:02:39	0:01:44	104	14:09:58
42	14:09:46	0:02:27	147	0:01:56	0:01:26	86	14:11:42
43	14:12:05	0:02:19	139	0:01:03	0:02:22	142	14:13:08
44	14:15:06	0:03:01	181	0:00:24	0:01:45	105	14:15:30
45	14:15:55	0:00:49	49	0:01:20	0:00:58	58	14:17:15

Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	2:03:12	0:00:00	0	0:00:49	0:05:02	302	2:04:01
2	2:05:10	0:01:58	118	0:03:53	0:01:20	80	2:09:03
3	2:16:05	0:10:55	655	0:00:00	0:00:19	19	2:16:05
4	2:18:41	0:02:36	156	0:00:00	0:01:45	105	2:18:41
5	2:19:02	0:00:21	21	0:01:24	0:02:51	171	2:20:26
6	2:22:06	0:03:04	184	0:01:11	0:02:01	121	2:23:17
7	2:26:41	0:04:35	275	0:00:00	0:02:09	129	2:26:41
8	2:27:28	0:00:47	47	0:01:22	0:03:12	192	2:28:50
9	2:29:01	0:01:33	93	0:03:01	0:01:16	76	2:32:02
10	2:31:02	0:02:01	121	0:02:16	0:01:24	84	2:33:18
11	2:35:26	0:04:24	264	0:00:00	0:02:45	165	2:35:26
12	2:45:06	0:09:40	580	0:00:00	0:03:12	192	2:45:06
13	2:49:52	0:04:46	286	0:00:00	0:00:12	12	2:49:52
14	2:50:06	0:00:14	14	0:00:00	0:00:45	45	2:50:06
15	2:52:39	0:02:33	153	0:00:00	0:02:17	137	2:52:39
16	2:56:30	0:03:51	231	0:00:00	0:02:19	139	2:56:30
17	2:59:06	0:02:36	156	0:00:00	0:01:05	65	2:59:06
18	3:07:52	0:08:46	526	0:00:00	0:01:49	109	3:07:52
19	3:14:51	0:06:59	419	0:00:00	0:02:04	124	3:14:51
20	3:16:02	0:01:11	71	0:00:53	0:02:17	137	3:16:55
21	3:21:42	0:05:40	340	0:00:00	0:00:55	55	3:21:42
22	3:22:06	0:00:24	24	0:00:31	0:05:12	312	3:22:37
23	3:22:17	0:00:11	11	0:05:32	0:01:47	107	3:27:49
24	3:26:08	0:03:51	231	0:03:28	0:10:23	623	3:29:36
25	3:29:45	0:03:37	217	0:10:14	0:02:05	125	3:39:59
26	3:39:05	0:09:20	560	0:02:59	0:01:09	69	3:42:04
27	3:40:12	0:01:07	67	0:03:01	0:01:39	99	3:43:13
28	3:41:22	0:01:10	70	0:03:30	0:04:05	245	3:44:52
29	3:41:46	0:00:24	24	0:07:11	0:02:12	132	3:48:57
30	3:46:12	0:04:26	266	0:04:57	0:01:22	82	3:51:09
31	3:50:22	0:04:10	250	0:02:08	0:01:00	60	3:52:31
32	3:51:02	0:00:40	40	0:02:29	0:00:55	55	3:53:31
33	3:52:44	0:01:42	102	0:01:42	0:03:06	186	3:54:26
34	3:52:58	0:00:14	14	0:04:34	0:03:19	199	3:57:32
35	3:56:01	0:03:03	183	0:04:50	0:01:11	71	4:00:51
36	3:59:11	0:03:10	190	0:02:51	0:00:19	19	4:02:02
37	4:01:11	0:02:00	120	0:01:10	0:00:44	44	4:02:21
38	4:02:52	0:01:41	101	0:00:13	0:02:46	166	4:03:05
39	4:03:55	0:01:03	63	0:01:56	0:01:15	75	4:05:51
40	4:04:04	0:00:09	9	0:03:02	0:01:08	68	4:07:06
41	4:04:46	0:00:42	42	0:03:28	0:02:44	164	4:08:14
42	4:07:42	0:02:56	176	0:03:16	0:00:54	54	4:10:58
43	4:10:09	0:02:27	147	0:01:43	0:00:39	39	4:11:52
44	4:10:54	0:00:45	45	0:01:37	0:01:19	79	4:12:31
45	4:10:59	0:00:05	5	0:02:51	0:02:01	121	4:13:50

The cleaned data set which is without any outlier is represented below for our analysis:

Cleaned data set on Friday:

2/23/2018	Friday	9 am to 11:30 am							2/23/2018	Friday	12 pm to 02 pm								2/23/2018	Friday	2 pm to 4:30 pm							
Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time		Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time		Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	9:05:12	0:00:00	0	0:00:00	0:00:45	45	9:05:12		1	12:02:45	0:00:00	0	0:00:18	0:01:05	65	12:03:03		1	2:01:05	0:00:00	0	0:00:00	0:01:56	116	2:01:05
2	9:05:30	0:00:18	18	0:00:27	0:01:02	62	9:05:57		2	12:02:48	0:00:03	3	0:01:20	0:12:05	725	12:04:08		2	2:11:14	0:01:04	64	0:01:37	0:00:42	42	2:12:51
3	9:07:10	0:01:40	100	0:00:10	0:00:55	55	9:07:20		3	12:02:56	0:00:08	8	0:13:17	0:00:49	49	12:16:13		3	2:11:50	0:00:36	36	0:01:43	0:00:53	53	2:13:33
4	9:15:06	0:07:56	476	0:00:39	0:02:10	130	9:15:45		4	12:05:02	0:02:06	126	0:12:00	0:00:42	42	12:17:02		4	2:14:15	0:02:25	145	0:00:11	0:05:02	302	2:14:26
5	9:15:07	0:00:01	1	0:02:48	0:01:45	105	9:17:55		5	12:10:30	0:05:28	328	0:07:14	0:02:01	121	12:17:44		5	2:26:19	0:01:04	64	0:02:56	0:02:16	136	2:29:15
6	9:17:02	0:01:55	115	0:02:43	0:05:20	320	9:19:45		6	12:12:36	0:02:06	126	0:07:09	0:02:16	136	12:19:45		6	2:28:20	0:02:01	121	0:03:11	0:02:04	124	2:31:31
7	9:18:56	0:01:54	114	0:06:09	0:00:10	10	9:25:05		7	12:15:52	0:03:16	196	0:06:09	0:07:02	422	12:22:01		7	3:03:05	0:00:57	57	0:00:22	0:03:04	184	3:03:27
8	9:20:00	0:01:04	64	0:05:15	0:02:52	172	9:25:15		8	12:16:47	0:00:55	55	0:12:16	0:01:54	114	12:29:03		8	3:04:19	0:01:14	74	0:02:12	0:03:00	180	3:06:31
9	9:22:54	0:02:54	174	0:05:13	0:12:01	721	9:28:07		9	12:20:00	0:03:13	193	0:10:57	0:01:51	111	12:30:57		9	3:10:59	0:06:40	400	0:00:00	0:01:43	103	3:10:59
10	9:30:14	0:07:20	440	0:10:06	0:00:48	48	9:40:20		11	12:32:18	0:01:03	63	0:01:42	0:05:12	312	12:34:00		10	3:11:28	0:00:29	29	0:01:14	0:02:15	135	3:12:42
11	9:31:07	0:00:53	53	0:10:01	0:00:51	51	9:41:08		12	12:35:20	0:03:02	182	0:03:52	0:12:06	726	12:39:12		11	3:11:30	0:00:02	2	0:03:27	0:01:00	60	3:14:57
13	9:48:13	0:02:48	168	0:00:00	0:05:02	302	9:48:13		13	12:37:05	0:01:45	105	0:14:13	0:08:23	503	12:51:18		12	3:11:45	0:00:15	15	0:04:12	0:01:26	86	3:15:57
14	9:49:18	0:01:05	65	0:03:57	0:01:04	64	9:53:15		14	12:40:25	0:03:20	200	0:19:16	0:00:49	49	12:59:41		13	3:18:17	0:06:32	392	0:00:00	0:02:09	129	3:18:17
15	9:50:20	0:01:02	62	0:03:59	0:00:57	57	9:54:19		15	12:41:01	0:00:36	36	0:19:29	0:02:05	125	13:00:30		14	3:18:45	0:00:28	28	0:01:41	0:01:40	100	3:20:26
16	9:50:30	0:00:10	10	0:04:46	0:04:56	296	9:55:16		16	12:43:52	0:02:51	171	0:18:43	0:01:41	101	13:02:35		15	3:20:34	0:01:49	109	0:01:32	0:00:35	35	3:22:06
17	9:50:45	0:00:15	15	0:09:27	0:03:50	230	10:00:12		17	12:49:05	0:05:13	313	0:15:11	0:01:19	79	13:04:16		16	3:22:38	0:02:04	124	0:00:03	0:01:42	102	3:22:41
19	10:05:19	0:03:13	193	0:00:45	0:01:05	65	10:06:04		19	13:08:02	0:02:50	170	0:00:10	0:02:09	129	13:08:12		17	3:32:47	0:01:48	108	0:03:01	0:07:26	446	3:35:48
20	10:05:35	0:00:16	16	0:01:34	0:03:21	201	10:07:09		20	13:09:52	0:01:50	110	0:00:29	0:05:02	302	13:10:21		18	3:32:50	0:00:03	3	0:10:24	0:01:56	116	3:43:14
21	10:09:27	0:03:52	232	0:01:03	0:00:50	50	10:10:30		21	13:13:05	0:03:13	193	0:02:18	0:00:50	50	13:15:23		19	3:40:27	0:07:37	457	0:04:43	0:08:30	510	3:45:10
23	10:25:26	0:04:54	294	0:00:00	0:09:02	542	10:25:26		22	13:15:22	0:02:17	137	0:00:51	0:04:36	276	13:16:13		20	3:42:56	0:02:29	149	0:10:44	0:00:19	19	3:53:40
24	10:26:07	0:00:41	41	0:08:21	0:06:23	383	10:34:28		23	13:19:05	0:03:43	223	0:01:44	0:02:05	125	13:20:49		21	3:44:24	0:01:28	88	0:09:35	0:00:43	43	3:53:59
25	10:26:18	0:00:11	11	0:14:33	0:10:02	602	10:40:51		24	13:20:25	0:01:20	80	0:02:29	0:02:09	129	13:22:54		22	3:45:09	0:00:45	45	0:09:33	0:02:27	147	3:54:42
26	10:28:15	0:01:57	117	0:22:38	0:07:01	421	10:50:53		25	13:22:10	0:01:45	105	0:02:53	0:06:10	370	13:25:03		23	3:50:14	0:05:05	305	0:06:55	0:02:36	156	3:57:09
27	10:28:56	0:00:41	41	0:29:06	0:02:01	121	10:58:02		27	13:30:52	0:01:31	91	0:02:21	0:01:53	113	13:33:13		24	3:50:19	0:00:05	5	0:09:26	0:05:01	301	3:59:45
28	10:35:07	0:06:11	371	0:24:56	0:01:45	105	11:00:03		28	13:31:21	0:00:29	29	0:03:45	0:01:46	106	13:35:06		25	3:55:08	0:04:49	289	0:09:38	0:01:42	102	4:04:46
30	10:46:45	0:01:20	80	0:17:12	0:01:15	75	11:03:57		29	13:31:52	0:00:31	31	0:05:00	0:00:59	59	13:36:52		26	3:55:45	0:00:37	37	0:10:43	0:01:01	61	4:06:28
31	10:50:12	0:03:27	207	0:15:00	0:02:01	121	11:05:12		30	13:36:03	0:04:11	251	0:01:48	0:00:54	54	13:37:51		27	3:58:20	0:02:35	155	0:09:09	0:00:52	52	4:07:29
33	11:05:01	0:00:59	59	0:02:47	0:00:45	45	11:07:48		31	13:36:58	0:00:55	55	0:01:47	0:01:21	81	13:38:45		28	3:59:02	0:00:42	42	0:09:19	0:00:34	34	4:08:21
34	11:06:12	0:01:11	71	0:02:21	0:00:50	50	11:08:33		32	13:38:00	0:01:02	62	0:02:06	0:00:54	54	13:40:06		29	4:02:45	0:03:43	223	0:06:10	0:02:02	122	4:08:55
35	11:08:05	0:01:53	113	0:01:18	0:02:03	123	11:09:23		33	13:38:06	0:00:06	6	0:02:54	0:00:38	38	13:41:00		30	4:05:02	0:02:17	137	0:05:55	0:02:56	176	4:10:57
36	11:12:04	0:03:59	239	0:00:00	0:05:01	301	11:12:04		34	13:39:52	0:01:46	106	0:01:46	0:01:24	84	13:41:38		31	4:06:45	0:01:43	103	0:07:08	0:00:12	12	4:13:53
37	11:12:50	0:00:46	46	0:04:15	0:01:12	72	11:17:05		35	13:40:02	0:00:10	10	0:03:00	0:02:01	121	13:43:02		32	4:09:52	0:03:07	187	0:04:13	0:00:46	46	4:14:05
38	11:15:01	0:02:11	131	0:03:16	0:01:04	64	11:18:17		36	13:42:52	0:02:50	170	0:02:11	0:02:00	120	13:45:03		33	4:10:21	0:00:29	29	0:04:30	0:01:13	73	4:14:51
39	11:20:52	0:05:51	351	0:00:00	0:00:49	49	11:20:52		37	13:43:00	0:00:08	8	0:04:03	0:01:01	61	13:47:03		34	4:12:12	0:01:51	111	0:03:52	0:01:41	101	4:16:04
40	11:22:12	0:01:20	80	0:00:00	0:00:32	32	11:22:12		38	13:45:06	0:02:06	126	0:02:58	0:00:51	51	13:48:04		35	4:13:21	0:01:09	69	0:04:24	0:01:21	81	4:17:45
41	11:23:01	0:00:49	49	0:00:00	0:00:56	56	11:23:01		39	13:45:40	0:00:34	34	0:03:15	0:00:32	32	13:48:55		36	4:15:21	0:02:00	120	0:03:45	0:02:06	126	4:19:06
42	11:25:02	0:02:01	121	0:00:00	0:03:01	181	11:25:02		40	13:46:21	0:00:41	41	0:03:06	0:01:27	87	13:49:27		37	4:21:00	0:05:39	339	0:00:12	0:01:34	94	4:21:12
43	11:27:12	0:02:10	130	0:00:51	0:02:51	171	11:28:03		41	13:48:11	0:01:50	110	0:02:43	0:01:42	102	13:50:54		38	4:22:06	0:01:06	66	0:00:40	0:01:27	87	4:22:46
44	11:29:10	0:01:58	118	0:01:44	0:00:50	50	11:30:54		42	13:48:55	0:00:44	44	0:03:41	0:01:52	112	13:52:36		39	4:22:56	0:00:50	50	0:01:17	0:00:41	41	4:24:13
45	11:30:20	0:01:10	70	0:01:24	0:00:31	31	11:31:44		43	13:49:02	0:00:07	7	0:05:26	0:01:12	72	13:54:28		40	4:22:59	0:00:03	3	0:01:55	0:02:05	125	4:24:54
									44	13:49:36	0:00:34	34	0:06:04	0:02:58	178	13:55:40									
									45	13:49:42	0:00:06	6	0:08:56	0:00:59	59	13:58:38									

Cleaned data set on Monday:

Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	9:10:15	0:00:00	0	0:00:00	0:01:19	79	9:10:15
2	9:12:18	0:02:03	123	0:00:00	0:01:50	110	9:12:18
3	9:14:25	0:02:07	127	0:00:00	0:00:19	19	9:14:25
4	9:14:54	0:00:29	29	0:00:00	0:02:01	121	9:14:54
5	9:16:07	0:01:13	73	0:00:48	0:01:17	77	9:16:55
6	9:18:17	0:02:10	130	0:00:00	0:02:00	120	9:18:17
7	9:22:57	0:04:40	280	0:00:00	0:02:21	141	9:22:57
8	9:23:26	0:00:29	29	0:01:52	0:08:39	519	9:25:18
9	9:25:48	0:02:22	142	0:08:09	0:00:48	48	9:33:57
10	9:26:14	0:00:26	26	0:08:31	0:01:33	93	9:34:45
11	9:29:36	0:03:22	202	0:06:42	0:02:13	133	9:36:18
12	9:32:57	0:03:21	201	0:05:34	0:00:40	40	9:38:31
15	9:58:14	0:02:54	174	0:00:24	0:04:00	240	9:58:38
16	9:59:27	0:01:13	73	0:03:11	0:02:45	165	10:02:38
17	10:04:26	0:04:59	299	0:00:57	0:01:15	75	10:05:23
19	10:20:25	0:02:07	127	0:00:00	0:01:08	68	10:20:25
21	10:36:47	0:00:49	49	0:00:59	0:01:23	83	10:37:46
22	10:39:16	0:02:29	149	0:00:00	0:03:15	195	10:39:16
23	10:40:49	0:01:33	93	0:01:42	0:00:40	40	10:42:31
24	10:43:25	0:02:36	156	0:00:40	0:01:20	80	10:44:05
25	10:48:27	0:05:02	302	0:00:00	0:01:24	84	10:48:27
26	10:50:25	0:01:58	118	0:00:00	0:03:17	197	10:50:25
27	10:54:08	0:03:43	223	0:00:00	0:01:33	93	10:54:08
28	10:55:12	0:01:04	64	0:00:29	0:01:20	80	10:55:41
29	10:58:12	0:03:00	180	0:00:00	0:01:42	102	10:58:12
30	10:58:17	0:00:05	5	0:01:37	0:00:56	56	10:59:54
31	11:02:12	0:03:55	235	0:00:00	0:00:32	32	11:02:12
32	11:02:45	0:00:33	33	0:00:00	0:01:48	108	11:02:45
33	11:03:52	0:01:07	67	0:00:41	0:01:04	64	11:04:33
34	11:10:25	0:06:33	393	0:00:00	0:05:21	321	11:10:25
35	11:12:25	0:02:00	120	0:03:21	0:01:23	83	11:15:46
36	11:15:01	0:02:36	156	0:02:08	0:04:05	245	11:17:09
37	11:17:49	0:02:48	168	0:03:25	0:00:29	29	11:21:14
38	11:18:02	0:00:13	13	0:03:41	0:00:57	57	11:21:43
39	11:24:06	0:06:04	364	0:00:00	0:01:22	82	11:24:06
40	11:24:54	0:00:48	48	0:00:34	0:01:36	96	11:25:28
41	11:25:02	0:00:08	8	0:02:02	0:00:43	43	11:27:04
42	11:25:46	0:00:44	44	0:02:01	0:02:06	126	11:27:47
43	11:25:58	0:00:12	12	0:03:55	0:02:01	121	11:29:53
44	11:26:12	0:00:14	14	0:05:42	0:01:42	102	11:31:54
45	11:27:04	0:00:52	52	0:06:32	0:03:21	201	11:33:36

Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	12:10:36	0:00:00	0	0:01:28	0:01:25	85	12:12:04
2	12:12:58	0:02:22	142	0:00:31	0:02:02	122	12:13:29
3	12:15:45	0:02:47	167	0:00:00	0:09:02	542	12:15:45
4	12:16:47	0:01:02	62	0:08:00	0:01:22	82	12:24:47
5	12:17:45	0:00:58	58	0:06:24	0:00:22	22	12:26:09
6	12:19:42	0:01:57	117	0:06:49	0:03:15	195	12:26:31
8	12:29:40	0:01:15	75	0:01:14	0:01:17	77	12:30:54
9	12:30:21	0:00:41	41	0:01:50	0:09:20	560	12:32:11
11	12:40:01	0:03:20	200	0:02:15	0:05:23	323	12:42:16
12	12:45:21	0:05:20	320	0:02:18	0:06:41	401	12:47:39
14	12:54:21	0:01:21	81	0:03:11	0:06:21	381	12:57:32
15	12:58:21	0:04:00	240	0:05:32	0:02:12	132	13:03:53
16	13:01:25	0:03:04	184	0:04:40	0:01:57	117	13:06:05
17	13:06:25	0:05:00	300	0:01:37	0:01:46	106	13:08:02
18	13:07:25	0:01:00	60	0:02:23	0:01:52	112	13:09:48
19	13:09:28	0:02:03	123	0:02:12	0:02:09	129	13:11:40
20	13:10:29	0:01:01	61	0:03:20	0:06:12	372	13:13:49
21	13:16:25	0:05:56	356	0:03:36	0:05:02	302	13:20:01
23	13:26:08	0:01:05	65	0:01:05	0:01:02	62	13:27:13
24	13:28:15	0:02:07	127	0:00:00	0:01:51	111	13:28:15
25	13:28:49	0:00:34	34	0:01:17	0:00:56	56	13:30:06
26	13:30:21	0:01:32	92	0:00:41	0:07:10	430	13:31:02
27	13:32:36	0:02:15	135	0:05:36	0:02:30	150	13:38:12
28	13:35:20	0:02:44	164	0:05:22	0:01:24	84	13:40:42
29	13:40:52	0:05:32	332	0:01:14	0:02:35	155	13:42:06
30	13:42:05	0:01:13	73	0:02:36	0:02:41	161	13:44:41
31	13:43:12	0:01:07	67	0:04:10	0:01:52	112	13:47:22
32	13:44:52	0:01:40	100	0:04:22	0:02:01	121	13:49:14
33	13:45:01	0:00:09	9	0:06:14	0:01:05	65	13:51:15
34	13:45:56	0:00:55	55	0:06:24	0:00:37	37	13:52:20
35	13:46:08	0:00:12	12	0:06:49	0:00:39	39	13:52:57
36	13:46:54	0:00:46	46	0:06:42	0:05:10	310	13:53:36
37	13:48:05	0:01:11	71	0:10:41	0:02:01	121	13:58:46
38	13:48:44	0:00:39	39	0:12:03	0:07:01	421	14:00:47
39	13:49:05	0:00:21	21	0:18:43	0:00:50	50	14:07:48
40	13:51:22	0:02:17	137	0:17:16	0:01:18	78	14:08:38
41	13:52:00	0:00:38	38	0:17:56	0:00:12	12	14:09:56
42	13:53:04	0:01:04	64	0:17:04	0:00:41	41	14:10:08
43	13:53:42	0:00:38	38	0:17:07	0:00:51	51	14:10:49
44	13:58:02	0:04:20	260	0:13:38	0:01:02	62	14:11:40
45	14:00:00	0:01:58	118	0:12:42	0:01:43	103	14:12:42

Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	2:06:08	0:00:00	0	0:01:41	0:02:12	132	2:07:49
2	2:10:05	0:03:57	237	0:00:00	0:02:11	131	2:10:05
3	2:11:15	0:01:10	70	0:01:01	0:01:12	72	2:12:16
4	2:12:05	0:00:50	50	0:01:23	0:00:46	46	2:13:28
5	2:18:47	0:06:42	402	0:00:00	0:00:57	57	2:18:47
6	2:19:20	0:00:33	33	0:00:24	0:01:24	84	2:19:44
7	2:19:56	0:00:36	36	0:01:12	0:05:01	301	2:21:08
8	2:20:08	0:00:12	12	0:06:01	0:01:21	81	2:26:09
9	2:22:46	0:02:38	158	0:04:44	0:00:59	59	2:27:30
10	2:23:10	0:00:24	24	0:05:19	0:00:42	42	2:28:29
11	2:25:16	0:02:06	126	0:03:55	0:05:12	312	2:29:11
12	2:26:42	0:01:26	86	0:07:41	0:01:59	119	2:34:23
13	2:29:04	0:02:22	142	0:07:18	0:01:45	105	2:36:22
14	2:35:04	0:06:00	360	0:03:03	0:01:26	86	2:38:07
15	2:35:57	0:00:53	53	0:03:36	0:02:06	126	2:39:33
16	2:37:15	0:01:18	78	0:04:24	0:03:04	184	2:41:39
17	2:39:56	0:02:41	161	0:04:47	0:07:18	438	2:44:43
18	2:45:12	0:05:16	316	0:08:49	0:01:10	70	2:54:01
19	2:46:18	0:01:06	66	0:08:53	0:04:06	246	2:55:11
20	2:50:15	0:03:57	237	0:09:02	0:01:06	66	2:59:17
21	2:51:07	0:00:52	52	0:09:16	0:02:15	135	3:00:23
23	3:02:46	0:03:34	214	0:03:31	0:01:19	79	3:06:17
24	3:06:08	0:03:22	202	0:01:28	0:00:42	42	3:07:36
26	3:18:09	0:00:24	24	0:09:17	0:02:51	171	3:27:26
27	3:19:20	0:01:11	71	0:10:57	0:04:12	252	3:30:17
28	3:25:04	0:05:44	344	0:09:25	0:00:53	53	3:34:29
29	3:26:05	0:01:01	61	0:09:17	0:02:45	165	3:35:22
30	3:29:07	0:03:02	182	0:09:00	0:01:55	115	3:38:07
32	3:39:56	0:00:44	44	0:01:04	0:01:02	62	3:41:00
33	3:40:01	0:00:05	5	0:02:01	0:01:45	105	3:42:02
34	3:42:01	0:02:00	120	0:01:46	0:02:04	124	3:43:47
35	3:42:52	0:00:51	51	0:02:59	0:01:05	65	3:45:51
36	3:43:21	0:00:29	29	0:03:35	0:01:00	60	3:46:56
37	3:45:08	0:01:47	107	0:02:48	0:00:51	51	3:47:56
38	3:46:52	0:01:44	104	0:01:55	0:03:05	185	3:48:47
39	3:50:05	0:03:13	193	0:01:47	0:01:41	101	3:51:52
40	3:53:02	0:02:57	177	0:00:31	0:01:08	68	3:53:33
41	3:53:45	0:00:43	43	0:00:56	0:00:32	32	3:54:41
42	3:54:21	0:00:36	36	0:00:52	0:00:52	52	3:55:13
43	3:55:02	0:00:41	41	0:01:03	0:01:25	85	3:56:05
44	3:55:48	0:00:46	46	0:01:42	0:01:11	71	3:57:30
45	3:57:02	0:01:14	74	0:01:39	0:01:47	107	3:58:41

Cleaned data set on Wednesday:

2/28/2018	Wednesday	9 am to 11 am						
Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	9:04:12	0:00:00	0	0:00:00	0:04:06	246	9:04:12
2	9:05:15	0:01:03	63	0:03:03	0:00:56	56	9:08:18
3	9:12:06	0:06:51	411	0:00:00	0:01:03	63	9:12:06
4	9:18:06	0:06:00	360	0:00:00	0:00:36	36	9:18:06
5	9:25:47	0:07:41	461	0:00:00	0:00:16	16	9:25:47
6	9:26:06	0:00:19	19	0:00:00	0:00:56	56	9:26:06
7	9:27:19	0:01:13	73	0:00:00	0:08:39	519	9:27:19
8	9:29:52	0:02:33	153	0:06:06	0:00:48	48	9:35:58
9	9:31:06	0:01:14	74	0:05:40	0:02:13	133	9:36:46
10	9:34:27	0:03:21	201	0:04:32	0:00:40	40	9:38:59
11	9:35:04	0:00:37	37	0:04:35	0:01:33	93	9:39:39
12	9:36:09	0:01:05	65	0:05:03	0:04:45	285	9:41:12
13	9:37:08	0:00:59	59	0:08:49	0:06:08	368	9:45:57
15	9:56:54	0:02:45	165	0:00:32	0:00:49	49	9:57:26
17	10:11:05	0:00:50	50	0:00:34	0:01:31	91	10:11:39
18	10:13:26	0:02:21	141	0:00:00	0:01:02	62	10:13:26
19	10:20:25	0:06:59	419	0:00:00	0:00:40	40	10:20:25
20	10:21:26	0:01:01	61	0:00:00	0:10:02	602	10:21:26
21	10:26:45	0:05:19	319	0:04:43	0:01:19	79	10:31:28
22	10:27:26	0:00:41	41	0:05:21	0:02:15	135	10:32:47
23	10:29:43	0:02:17	137	0:05:19	0:00:12	12	10:35:02
24	10:36:12	0:06:29	389	0:00:00	0:08:02	482	10:36:12
25	10:37:06	0:00:54	54	0:07:08	0:01:23	83	10:44:14
26	10:40:25	0:03:19	199	0:05:12	0:05:12	312	10:45:37
27	10:46:25	0:06:00	360	0:04:24	0:00:23	23	10:50:49
28	10:49:21	0:02:56	176	0:01:51	0:01:26	86	10:51:12
29	10:50:02	0:00:41	41	0:02:36	0:03:06	186	10:52:38
30	10:51:23	0:01:21	81	0:04:21	0:01:24	84	10:55:44
31	10:55:01	0:03:38	218	0:02:07	0:01:10	70	10:57:08
32	10:56:21	0:01:20	80	0:01:57	0:00:41	41	10:58:18
33	10:57:02	0:00:41	41	0:01:57	0:00:38	38	10:58:59
34	10:57:42	0:00:40	40	0:01:55	0:04:01	241	10:59:37
35	10:58:21	0:00:39	39	0:05:17	0:01:21	81	11:03:38
36	11:01:06	0:02:45	165	0:03:53	0:01:08	68	11:04:59
37	11:05:21	0:04:15	255	0:00:46	0:01:06	66	11:06:07
38	11:06:01	0:00:40	40	0:01:12	0:04:02	242	11:07:13
39	11:08:02	0:02:01	121	0:03:13	0:02:01	121	11:11:15
40	11:10:02	0:02:00	120	0:03:14	0:01:00	60	11:13:16
41	11:14:01	0:03:59	239	0:00:15	0:00:52	52	11:14:16
42	11:14:25	0:00:24	24	0:00:43	0:00:31	31	11:15:08
43	11:14:56	0:00:31	31	0:00:43	0:00:54	54	11:15:39
44	11:15:11	0:00:15	15	0:01:22	0:01:45	105	11:16:33
45	11:15:44	0:00:33	33	0:02:34	0:01:01	61	11:18:18

2/28/2018	Wednesday	12 pm to 2 pm						
Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	12:02:15	0:00:00	0	0:00:34	0:01:28	88	12:02:49
3	12:13:59	0:00:07	7	0:00:29	0:01:48	108	12:14:28
4	12:15:01	0:01:02	62	0:01:15	0:02:56	176	12:16:16
5	12:16:25	0:01:24	84	0:02:47	0:01:45	105	12:19:12
6	12:20:42	0:04:17	257	0:00:15	0:08:52	532	12:20:57
7	12:25:21	0:04:39	279	0:04:28	0:01:23	83	12:29:49
9	12:36:02	0:00:54	54	0:01:20	0:01:53	113	12:37:22
10	12:37:01	0:00:59	59	0:02:14	0:00:57	57	12:39:15
11	12:38:20	0:01:19	79	0:01:52	0:00:48	48	12:40:12
12	12:40:04	0:01:44	104	0:00:56	0:00:13	13	12:41:00
14	13:04:08	0:05:43	343	0:00:00	0:02:30	150	13:04:08
15	13:10:52	0:06:44	404	0:00:00	0:06:21	381	13:10:52
16	13:14:10	0:03:18	198	0:03:03	0:02:30	150	13:17:13
17	13:15:08	0:00:58	58	0:04:35	0:02:10	130	13:19:43
18	13:16:23	0:01:15	75	0:05:30	0:02:13	133	13:21:53
19	13:20:54	0:04:31	271	0:03:12	0:02:03	123	13:24:06
20	13:22:09	0:01:15	75	0:04:00	0:00:48	48	13:26:09
21	13:25:01	0:02:52	172	0:01:56	0:01:06	66	13:26:57
22	13:26:41	0:01:40	100	0:01:22	0:01:45	105	13:28:03
23	13:26:49	0:00:08	8	0:02:59	0:03:16	196	13:29:48
24	13:27:05	0:00:16	16	0:05:59	0:01:12	72	13:33:04
25	13:29:05	0:02:00	120	0:05:11	0:03:21	201	13:34:16
27	13:46:02	0:00:15	15	0:00:31	0:02:17	137	13:46:33
28	13:46:45	0:00:43	43	0:02:05	0:01:11	71	13:48:50
29	13:48:24	0:01:39	99	0:01:37	0:03:35	215	13:50:01
30	13:49:51	0:00:27	27	0:04:45	0:00:55	55	13:53:36
31	13:50:05	0:01:14	74	0:04:26	0:01:52	112	13:54:31
32	13:52:22	0:02:17	137	0:04:01	0:02:01	121	13:56:23
33	13:56:01	0:03:39	219	0:02:23	0:01:11	71	13:58:24
34	13:57:11	0:01:10	70	0:02:24	0:03:22	202	13:59:35
35	13:59:02	0:01:51	111	0:03:55	0:00:46	46	14:02:57
36	14:00:15	0:01:13	73	0:03:28	0:01:42	102	14:03:43
37	14:05:25	0:05:10	310	0:00:00	0:02:22	142	14:05:25
38	14:06:02	0:00:37	37	0:01:45	0:01:01	61	14:07:47
39	14:06:55	0:00:53	53	0:01:53	0:00:44	44	14:08:48
40	14:07:05	0:00:10	10	0:02:27	0:00:26	26	14:09:32
41	14:07:19	0:00:14	14	0:02:39	0:01:44	104	14:09:58
42	14:09:46	0:02:27	147	0:01:56	0:01:26	86	14:11:42
43	14:12:05	0:02:19	139	0:01:03	0:02:22	142	14:13:08
44	14:15:06	0:03:01	181	0:00:24	0:01:45	105	14:15:30
45	14:15:55	0:00:49	49	0:01:20	0:00:58	58	14:17:15

2/28/2018	Wednesday	2 pm to 4 pm						
Customer Number	Arrival Time	Inter Arrival Times	Inter Arrival Times in Seconds	Waiting Time	Service Time	Service Time in Seconds	Start Service Time
1	2:03:12	0:00:00	0	0:00:49	0:05:02	302	2:04:01
2	2:05:10	0:01:58	118	0:03:53	0:01:20	80	2:09:03
4	2:18:41	0:02:36	156	0:00:00	0:01:45	105	2:18:41
5	2:19:02	0:00:21	21	0:01:24	0:02:51	171	2:20:26
6	2:22:06	0:03:04	184	0:01:11	0:02:01	121	2:23:17
7	2:26:41	0:04:35	275	0:00:00	0:02:09	129	2:26:41
8	2:27:28	0:00:47	47	0:01:22	0:03:12	192	2:28:50
9	2:29:01	0:01:33	93	0:03:01	0:01:16	76	2:32:02
10	2:31:02	0:02:01	121	0:02:16	0:01:24	84	2:33:18
11	2:35:26	0:04:24	264	0:00:00	0:02:45	165	2:35:26
13	2:49:52	0:04:46	286	0:00:00	0:00:12	12	2:49:52
14	2:50:06	0:00:14	14	0:00:00	0:00:45	45	2:50:06
15	2:52:39	0:02:33	153	0:00:00	0:02:17	137	2:52:39
16	2:56:30	0:03:51	231	0:00:00	0:02:19	139	2:56:30
17	2:59:06	0:02:36	156	0:00:00	0:01:05	65	2:59:06
19	3:14:51	0:06:59	419	0:00:00	0:02:04	124	3:14:51
20	3:16:02	0:01:11	71	0:00:53	0:02:17	137	3:16:55
21	3:21:42	0:05:40	340	0:00:00	0:00:55	55	3:21:42
22	3:22:06	0:00:24	24	0:00:31	0:05:12	312	3:22:37
23	3:22:17	0:00:11	11	0:05:32	0:01:47	107	3:27:49
24	3:26:08	0:03:51	231	0:03:28	0:10:23	623	3:29:36
25	3:29:45	0:03:37	217	0:10:14	0:02:05	125	3:39:59
27	3:40:12	0:01:07	67	0:03:01	0:01:39	99	3:43:13
28	3:41:22	0:01:10	70	0:03:30	0:04:05	245	3:44:52
29	3:41:46	0:00:24	24	0:07:11	0:02:12	132	3:48:57
30	3:46:12	0:04:26	266	0:04:57	0:01:22	82	3:51:09
31	3:50:22	0:04:10	250	0:02:09	0:01:00	60	3:52:31
32	3:51:02	0:00:40	40	0:02:29	0:00:55	55	3:53:31
33	3:52:44	0:01:42	102	0:01:42	0:03:06	186	3:54:26
34	3:52:58	0:00:14	14	0:04:34	0:03:19	199	3:57:32
35	3:56:01	0:03:03	183	0:04:50	0:01:11	71	4:00:51
36	3:59:11	0:03:10	190	0:02:51	0:00:19	19	4:02:02
37	4:01:11	0:02:00	120	0:01:10	0:00:44	44	4:02:21
38	4:02:52	0:01:41	101	0:00:13	0:02:46	166	4:03:05
39	4:03:55	0:01:03	63	0:01:56	0:01:15	75	4:05:51
40	4:04:04	0:00:09	9	0:03:02	0:01:08	68	4:07:06
41	4:04:46	0:00:42	42	0:03:28	0:02:44	164	4:08:14
42	4:07:42	0:02:56	176	0:03:16	0:00:54	54	4:10:58
43	4:10:09	0:02:27	147	0:01:43	0:00:39	39	4:11:52
44	4:10:54	0:00:45	45	0:01:37	0:01:19	79	4:12:31
45	4:10:59	0:00:05	5	0:02:51	0:02:01	121	4:13:50

4.2)*Data Analysis:*

Descriptive Statistics for Inter-arrival Times

	Friday	Monday	Wednesday
Mean	117.8333	120.325	132.6667
Standard Error	9.898938	9.066631	10.23758
Median	95.5	89	99.5
Mode	0	0	0
Standard Deviation	108.4374	99.31997	112.1471
Sample Variance	11758.68	9864.457	12576.96
Kurtosis	1.628113	0.386742	0.340548
Skewness	1.391244	1.055967	1.048192
Range	476	402	461
Minimum	0	0	0
Maximum	476	402	461
Sum	14140	14439	15920
Count	120	120	120

Analysis of Variance for Inter-arrival Times

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Friday	120	14140	117.8333	11758.68
Monday	120	14439	120.325	9864.457
Wednesday	120	15920	132.6667	12576.96

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	15142.12	2	7571.058	0.664126	0.515358	3.021012
Within Groups	4069812	357	11400.03			
Total	4084954	359				

Descriptive Statistics for Service Times

	Friday	Monday	Friday
Mean	149.5417	135.6833	128.3417
Standard Error	13.77332	10.42073	10.55361
Median	102.5	102	92
Mode	50	121	105
Standard Deviation	150.8792	114.1534	115.609
Sample Variance	22764.54	13030.99	13365.44
Kurtosis	4.755468	3.403866	6.332448
Skewness	2.195767	1.912884	2.377759
Range	716	548	611
Minimum	10	12	12
Maximum	726	560	623
Sum	17945	16282	15401
Count	120	120	120

Analysis of Variance for Service Times

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Friday	120	17945	149.5417	22764.54
Monday	120	16282	135.6833	13030.99
Wednesday	120	15401	128.3417	13365.44

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	27815.74	2	13907.87	0.848714	0.428826	3.021012
Within Groups	5850155	357	16386.99			
Total	5877970	359				

5. CONCEPTUAL SIMULATION MODEL

5.1) SYSTEM PROCESS FLOW:

The system has one server and customers enter and exit it from the same door. So, the process flow of the system is explained as below:

STEP 1: Customer first enters in to the system.

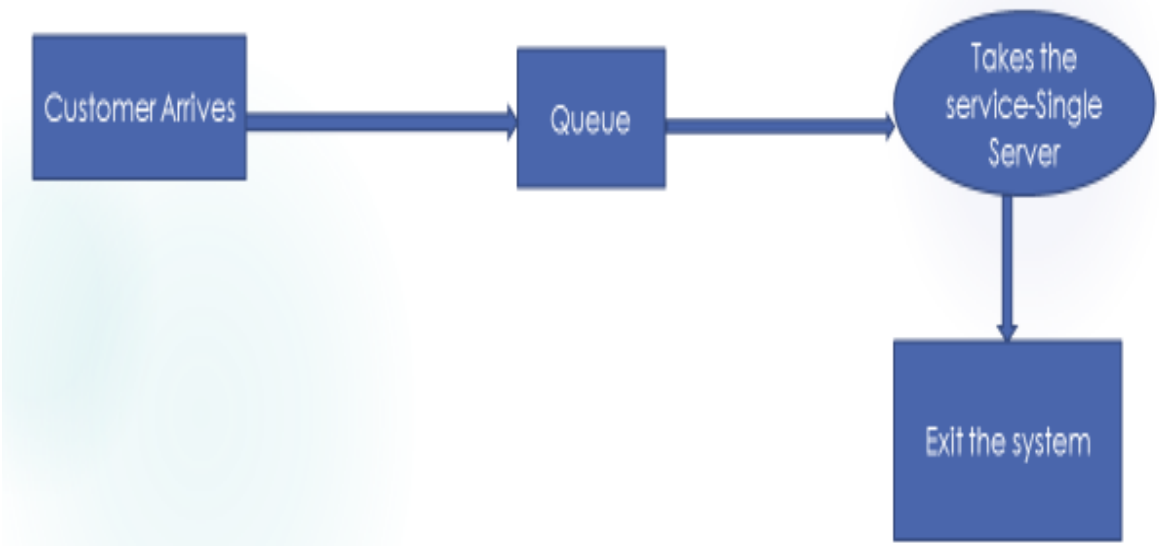
STEP 2: The customer joins the queue for the required service.

STEP 3: Customers in the queue are served in FIFO model at the single server in the system

STEP 5: Served customers exit the system.

The pictorial representation of the process flow is given below:

5.2) Flowchart:



6. ARENA MODEL:

Based on the process involved in the system, a simulation model is developed to run, compare and analyze the performance with the actual model of the system. This analysis helps in developing the present system and its performance metrics. In this regard, ARENA software is used to develop such a model and conduct simulation.

Before developing a model in ARENA and use it to analyze with the actual one, we need to first validate the actual collected data from the existing system to the simulated data generated in the ARENA software. If the collected data set is validated and proved to be in the same distributions with the simulated data, then a simulation model can be developed with the distribution expressions of the actual data in ARENA and analyzed.

The data to be analyzed is the interarrival times and the service times. As we have collected arrival times and service times for 3 days in the system viz., Monday, Wednesday and Friday, we thereby generate simulated arrival times data in ARENA for all the three days and service times data for 1 day.

Therefore, using ARENA, we have developed simulation models for all the day's timings separately and have generated the simulated arrival and service times by incorporating the expressions of the respective distributions. All the model thus developed are explained below:

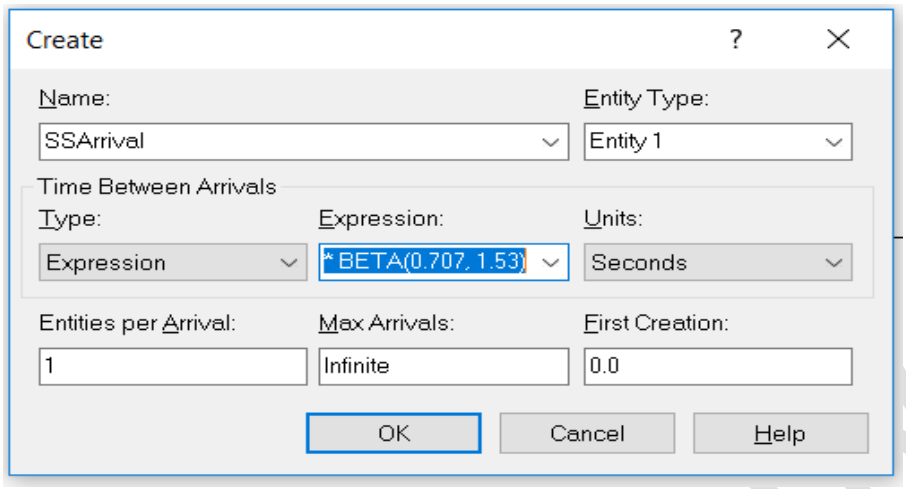
6.1) *COLLECTING ARRIVAL TIMES*:

6.1.1) MODEL FOR MONDAY MORNING 9 AM TO 11 AM:

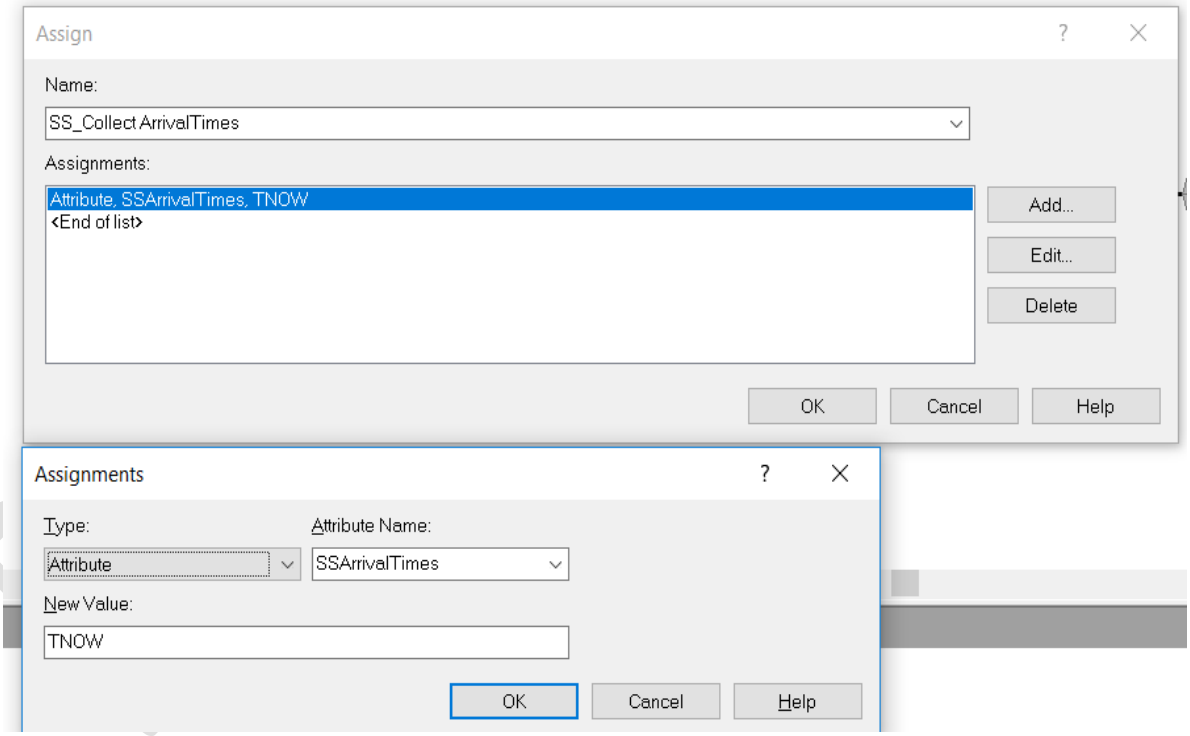
To develop a model for this, we have used 1 Create, 1 Assign, 1 Read/Write and 1 Dispose modules from basic and advanced processes. We have used Create module for describing the properties of an entity like entity name, type of expression to generate the entity arrival times and entity per arrivals. The developed model is as shown below:

MODEL FOR COLLECTING SIMULATED ARRIVAL TIMES FOR MON 9TO11

- In CREATE module, the entity is named as SSArrival and the type of expression used is - **0.001 + 393 * BETA(0.707, 1.53)** with seconds as units. Number of entities per arrival is 1 based on the system function and the maximum arrivals are infinite.

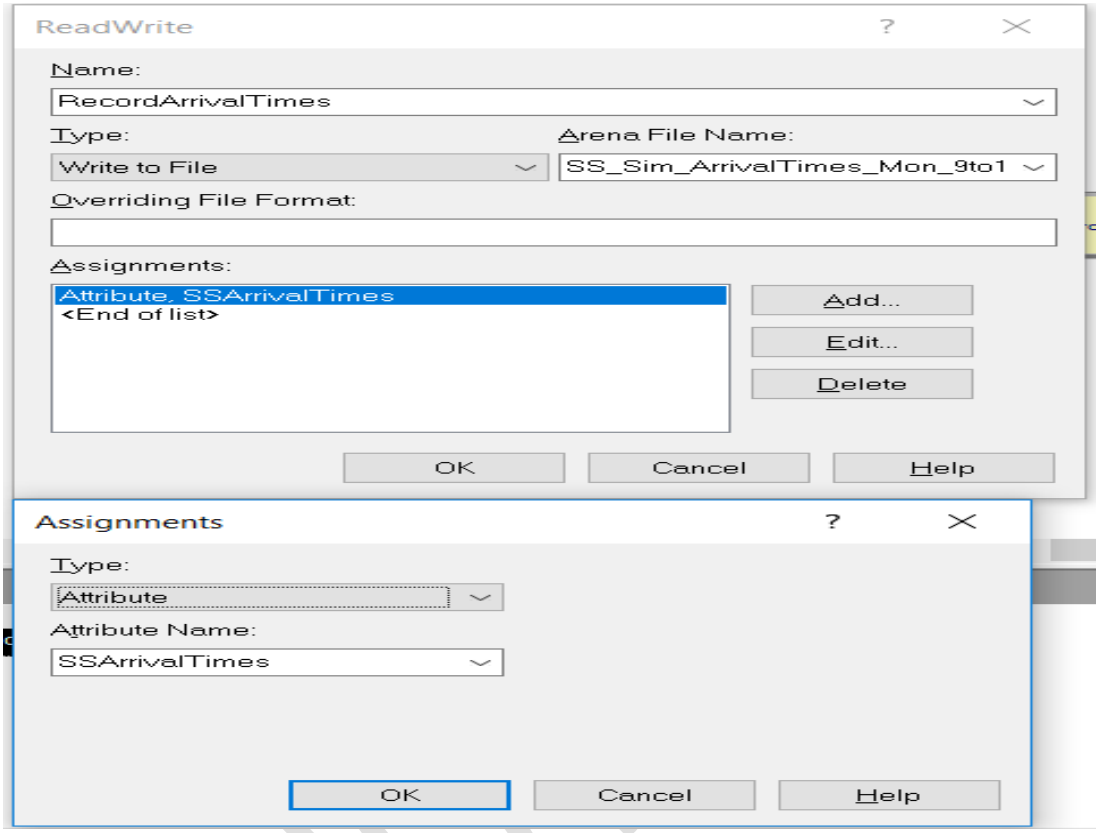


- The ASSIGN Module is named as SS_CollectArrivalTimes to collect the arrivals of the entity. The type of assignment used to collect these times is chosen to be an Attribute and named as SSArrivalTImes with a new value of TNOW.

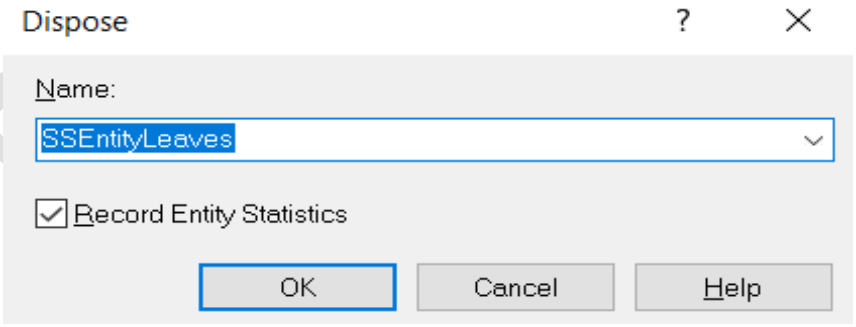


- Then a Read/Write Module from the Advanced Process is used to write the generated arrival times to an external file which is used for further validation process. So the module is named as RecordArrivalTimes and the data generated is saved with the file name

SS_Sim_ArrivalTimes_Mon_9to11. The assignment thus used is an Attribute with the name SSArrivalTimes.



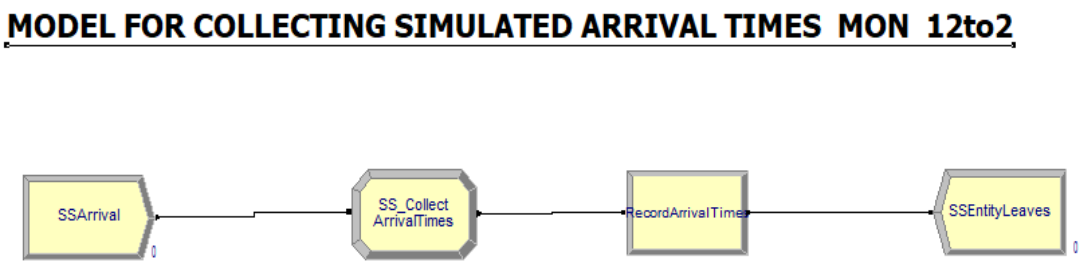
- The DISPOSE Module is named as SSEntityLeaves and all the statistics are recorded.



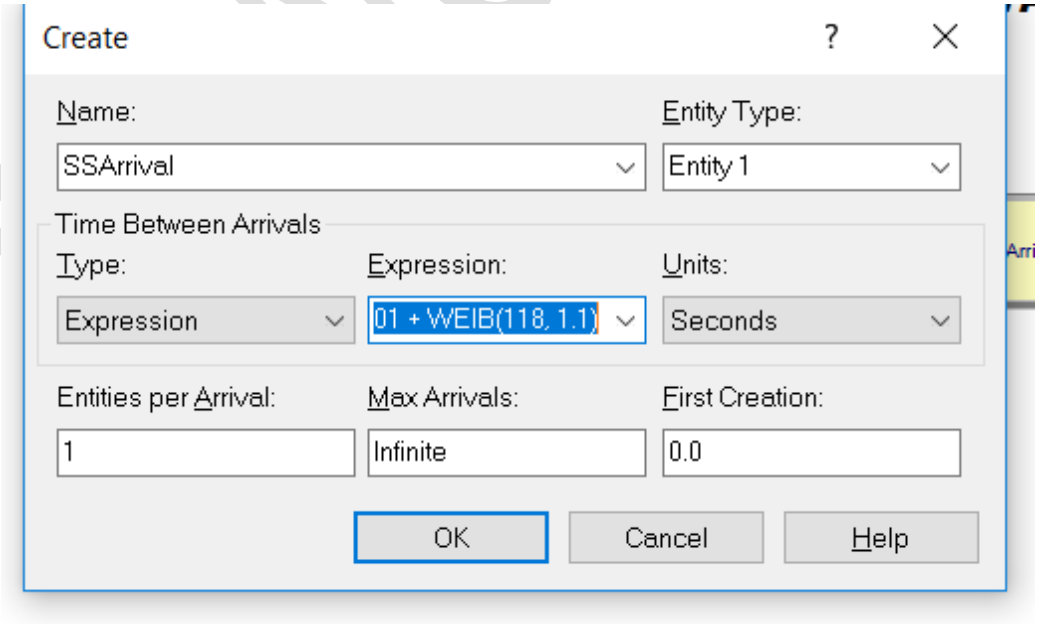
Finally, model is made to run for 10 number of replications by considering 40 as replication length (8 hours/5days), 8 hours per day and minutes as base time units. Thus, the simulated data is generated and saved in the given external file for analysis.

6.1.2. *MODEL FOR MONDAY AFTERNOON 12PM TO 2 PM:*

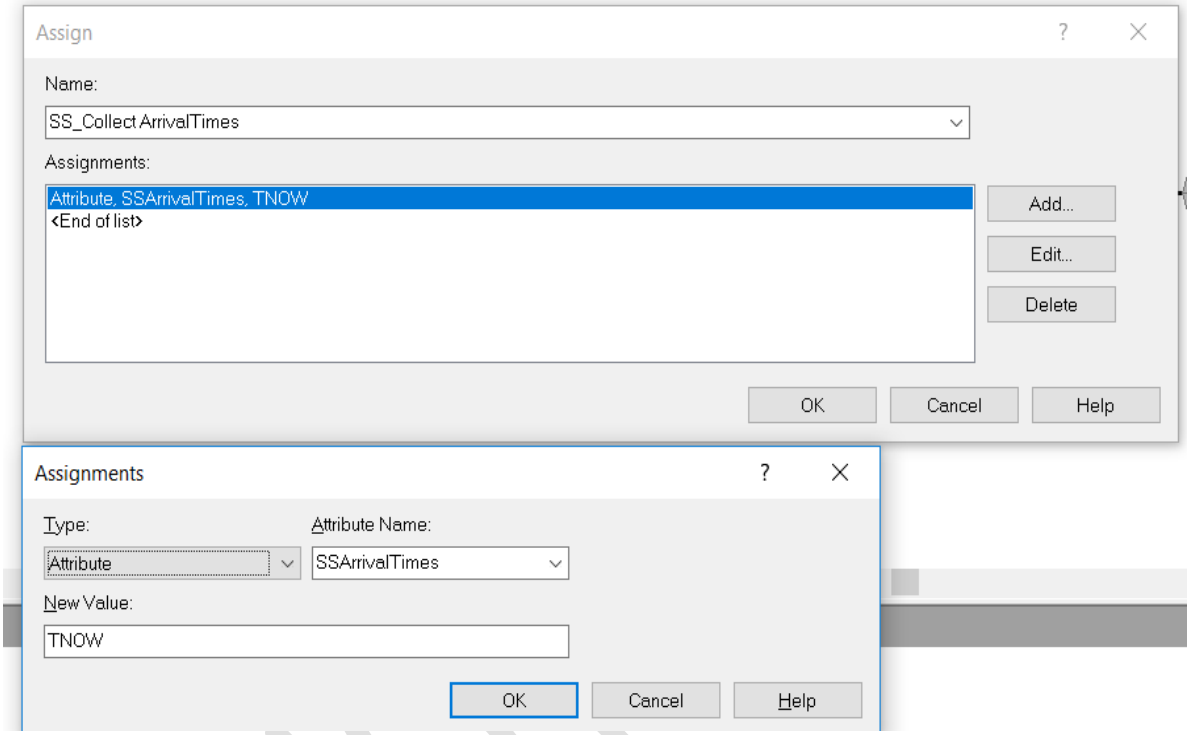
To develop a model for this, we have used 1 Create, 1 Assign, 1 Read/Write and 1 Dispose modules from basic and advanced processes. We have used Create module for describing the properties of an entity like entity name, type of expression to generate the entity arrival times and entity per arrivals. The developed model is as shown below:



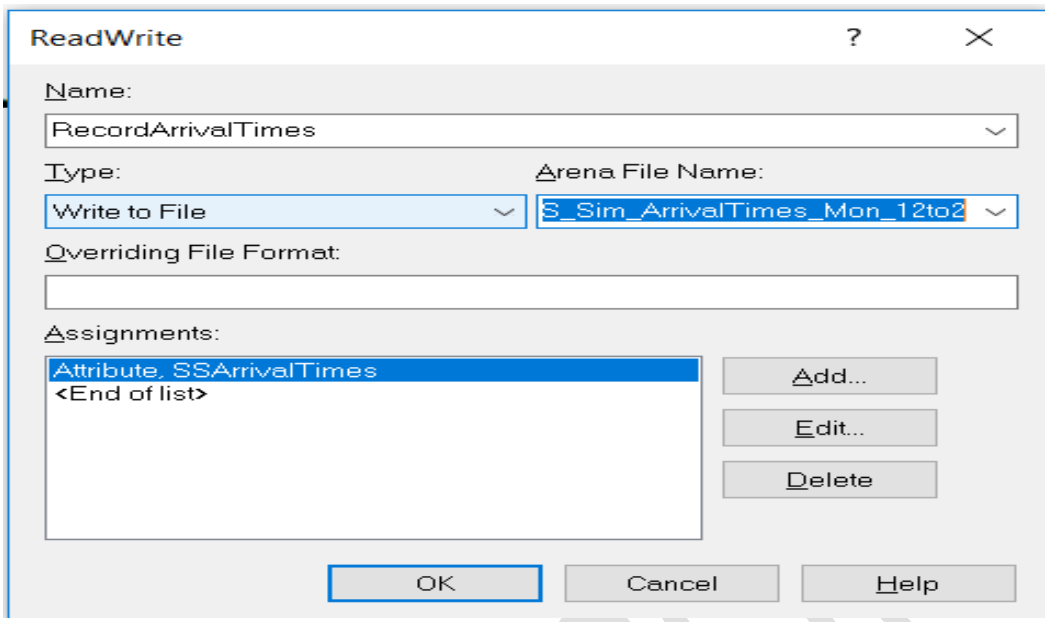
- In CREATE module, the entity is named as SSArrival and the type of expression used is - **0.001 + WEIB(118, 1.1)** with seconds as units. Number of entities per arrival is 1 based on the system function and the maximum arrivals are infinite.



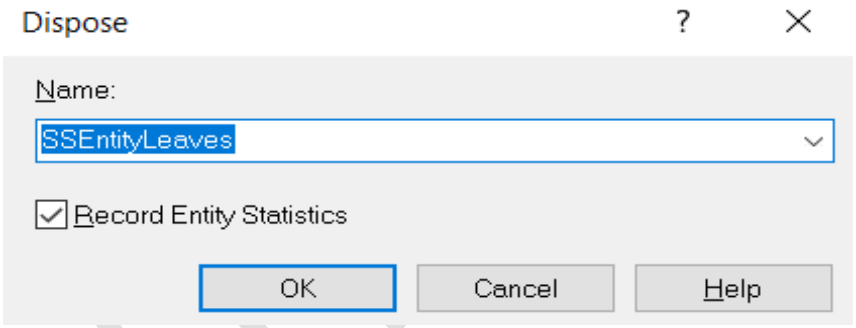
- The ASSIGN Module is named as SS_CollectArrivalTimes to collect the arrivals of the entity. The type of assignment used to collect these times is chosen to be an Attribute and named as SSArrivalTImes with a new value of TNOW.



- Then a Read/Write Module from the Advanced Process is used to write the generated arrival times to an external file which is used for further validation process. So the module is named as RecordArrivalTimes and the data generated is saved with the file name SS_Sim_ArrivalTimes_Mon_12to2. The assignment thus used is an Attribute with the name SSArrivalTimes.



- The DISPOSE Module is named as SSEntityLeaves and all the statistics are recorded.

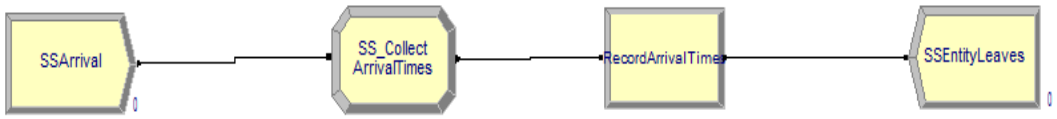


Finally, model is made to run for 10 number of replications by considering 40 as replication length (8 hours/5days), 8 hours per day and minutes as base time units. Thus, the simulated data is generated and saved in the given external file for analysis.

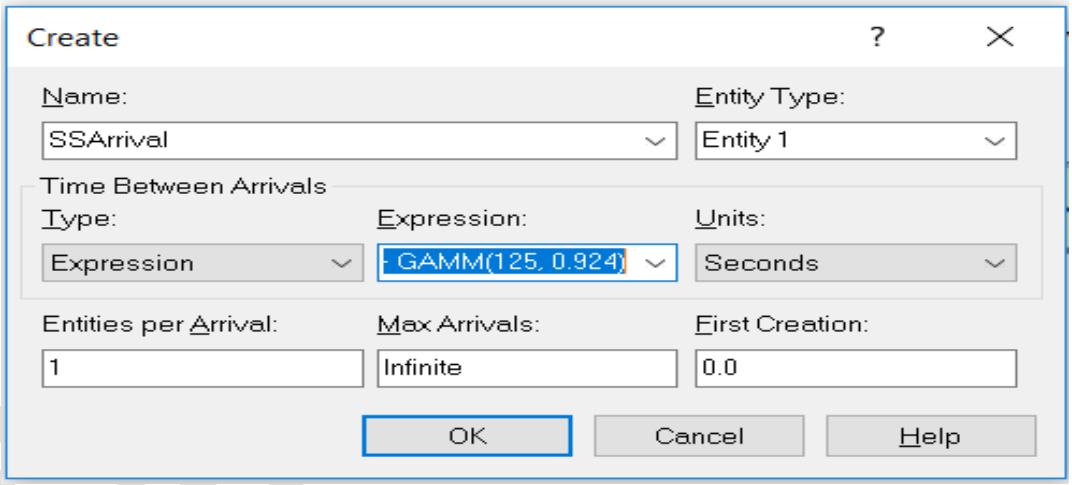
6.1.3. MODEL FOR MONDAY EVENING 2PM TO 4 PM:

To develop a model for this, we have used 1 Create, 1 Assign, 1 Read/Write and 1 Dispose modules from basic and advanced processes. We have used Create module for describing the properties of an entity like entity name, type of expression to generate the entity arrival times and entity per arrivals. The developed model is as shown below:

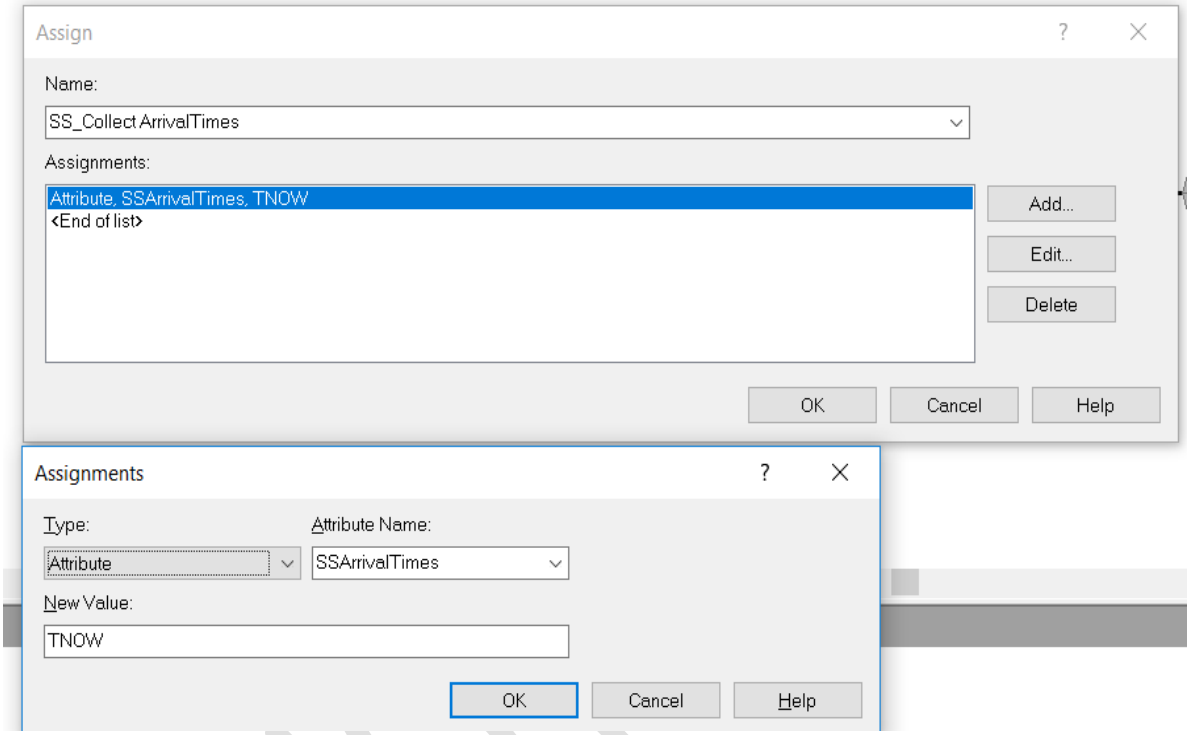
MODEL FOR COLLECTING SIMULATED ARRIVAL TIMES MON 2to4



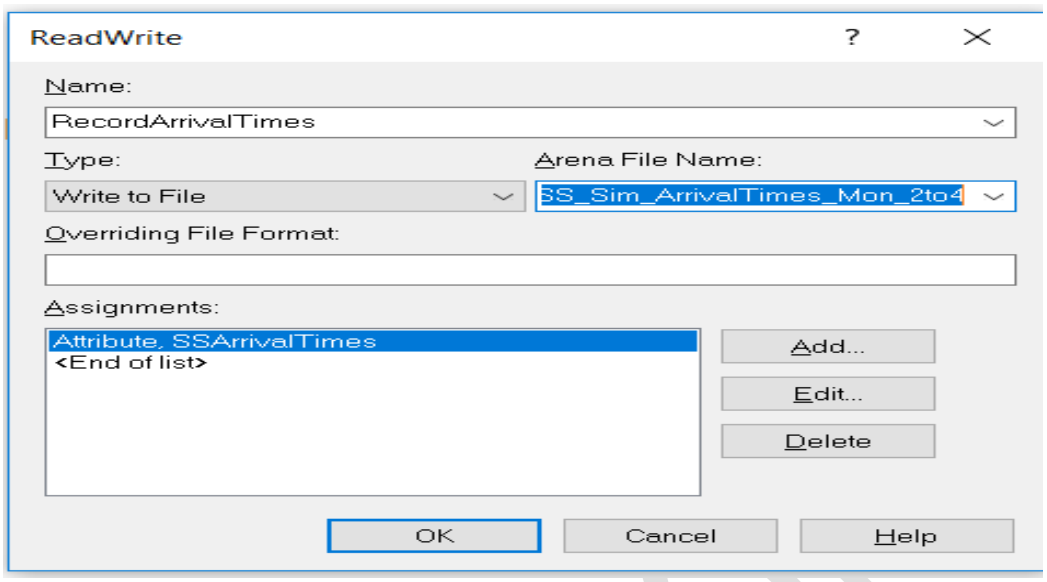
- In CREATE module, the entity is named as SSarrival and the type of expression used is - **0.001 + GAMM(125, 0.924)**with seconds as units. Number of entities per arrival is 1 based on the system function and the maximum arrivals are infinite.



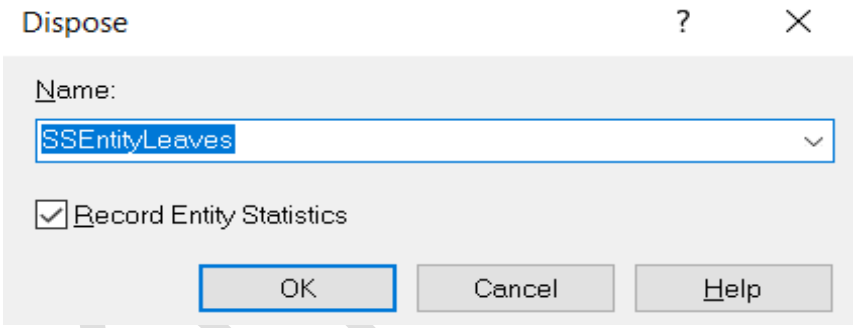
- The ASSIGN Module is named as SS_CollectArrivalTimes to collect the arrivals of the entity. The type of assignment used to collect these times is chosen to be an Attribute and named as SSArrivalTImes with a new value of TNOW.



- Then a Read/Write Module from the Advanced Process is used to write the generated arrival times to an external file which is used for further validation process. So the module is named as RecordArrivalTimes and the data generated is saved with the file name SS_Sim_ArrivalTimes_Mon_2to4. The assignment thus used is an Attribute with the name SSArrivalTimes.



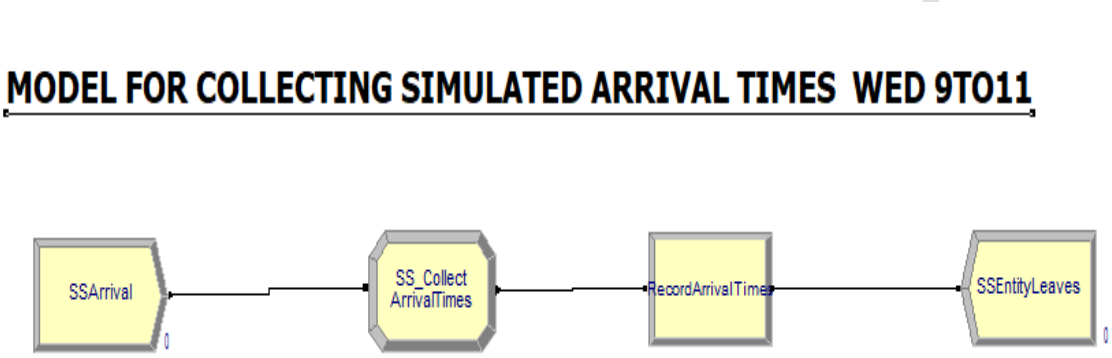
- The DISPOSE Module is named as SSEntityLeaves and all the statistics are recorded.



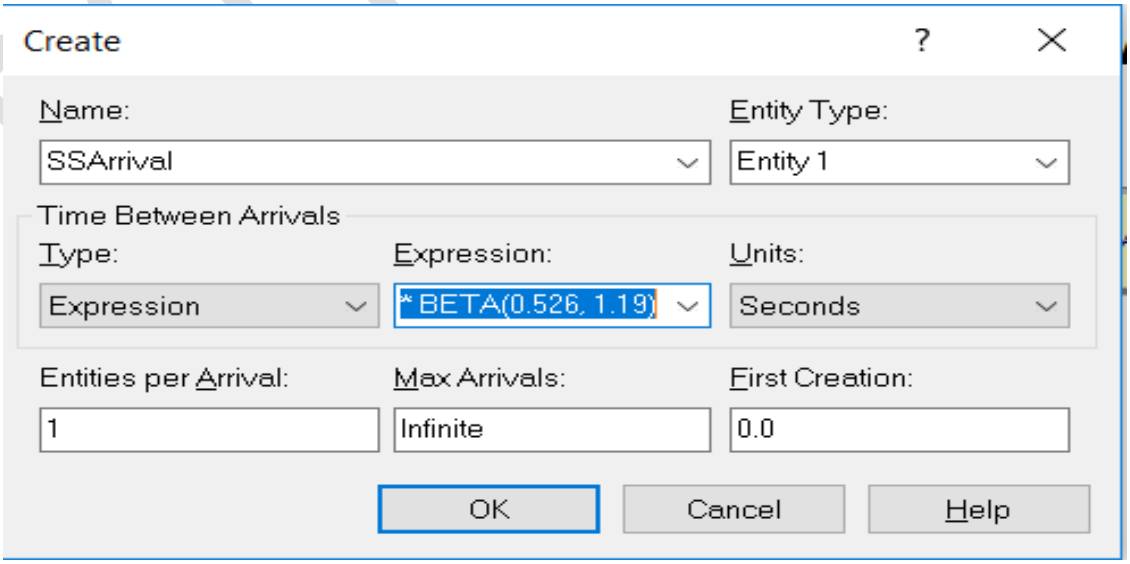
Finally, model is made to run for 10 number of replications by considering 40 as replication length (8 hours/5days), 8 hours per day and minutes as base time units. Thus, the simulated data is generated and saved in the given external file for analysis.

6.1.4. *MODEL FOR WEDNESDAY MORNING 9 AM TO 11 AM:*

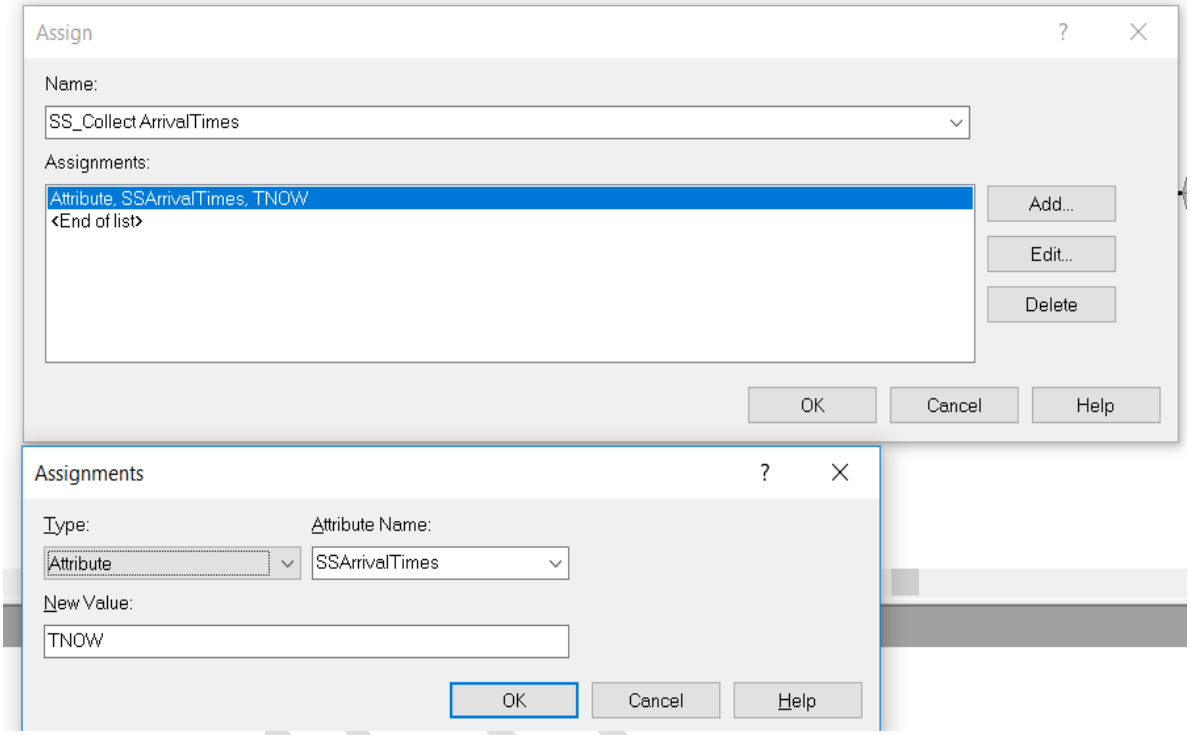
To develop a model for this, we have used 1 Create, 1 Assign, 1 Read/Write and 1 Dispose modules from basic and advanced processes. We have used Create module for describing the properties of an entity like entity name, type of expression to generate the entity arrival times and entity per arrivals. The developed model is as shown below:



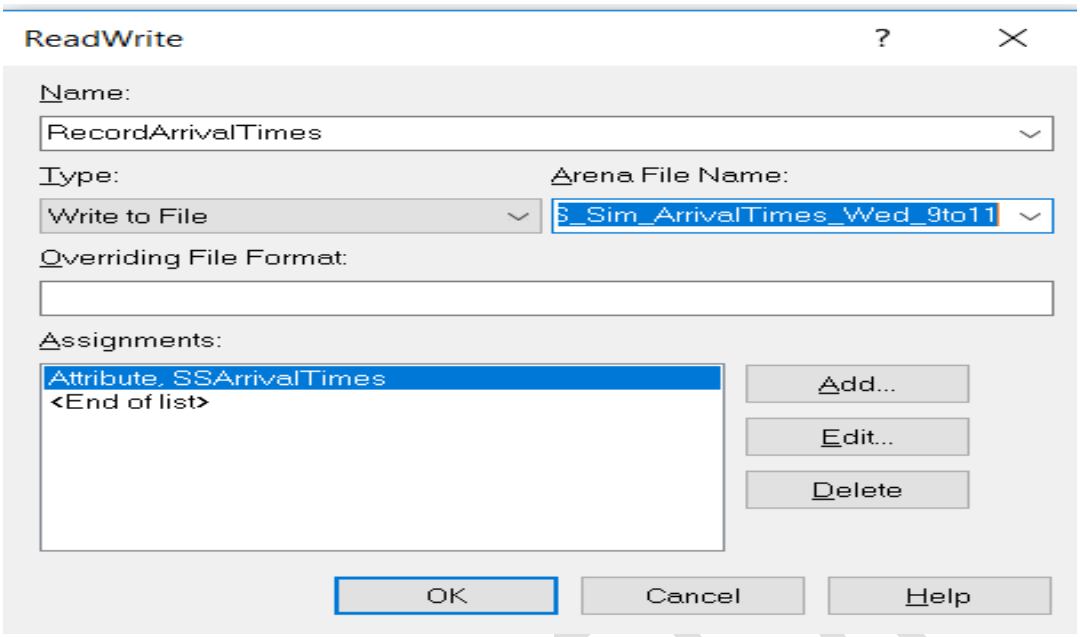
- In CREATE module, the entity is named as SSArrival and the type of expression used is - **0.001 + 461 * BETA(0.526, 1.19)** with seconds as units. Number of entities per arrival is 1 based on the system function and the maximum arrivals are infinite.



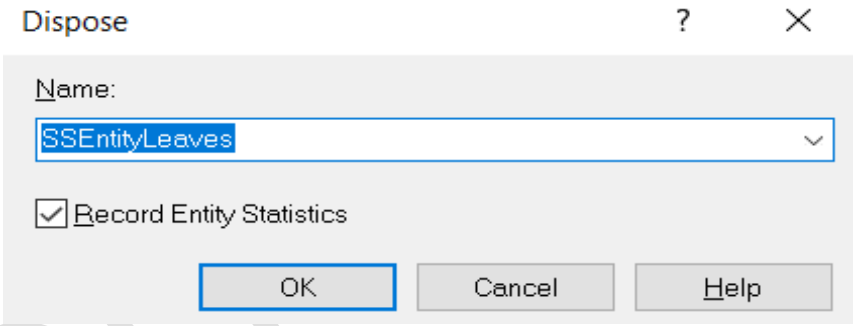
- The ASSIGN Module is named as SS_CollectArrivalTimes to collect the arrivals of the entity. The type of assignment used to collect these times is chosen to be an Attribute and named as SSArrivalTImes with a new value of TNOW.



- Then a Read/Write Module from the Advanced Process is used to write the generated arrival times to an external file which is used for further validation process. So the module is named as RecordArrivalTimes and the data generated is saved with the file name SS_Sim_ArrivalTimes_Wed_9to11. The assignment thus used is an Attribute with the name SSArrivalTimes.



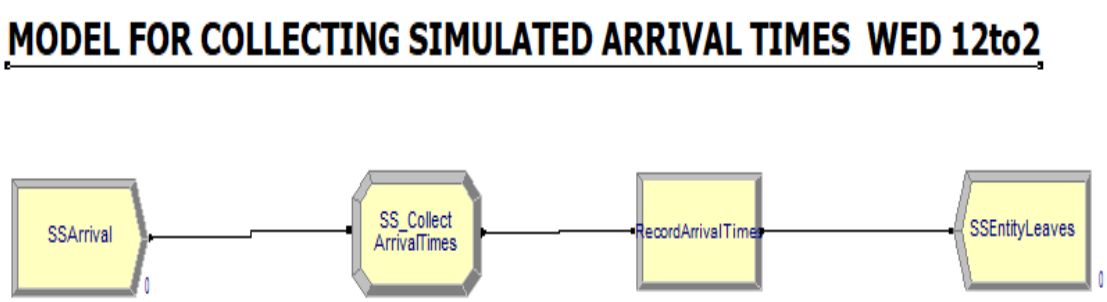
- The DISPOSE Module is named as SSEntityLeaves and all the statistics are recorded.



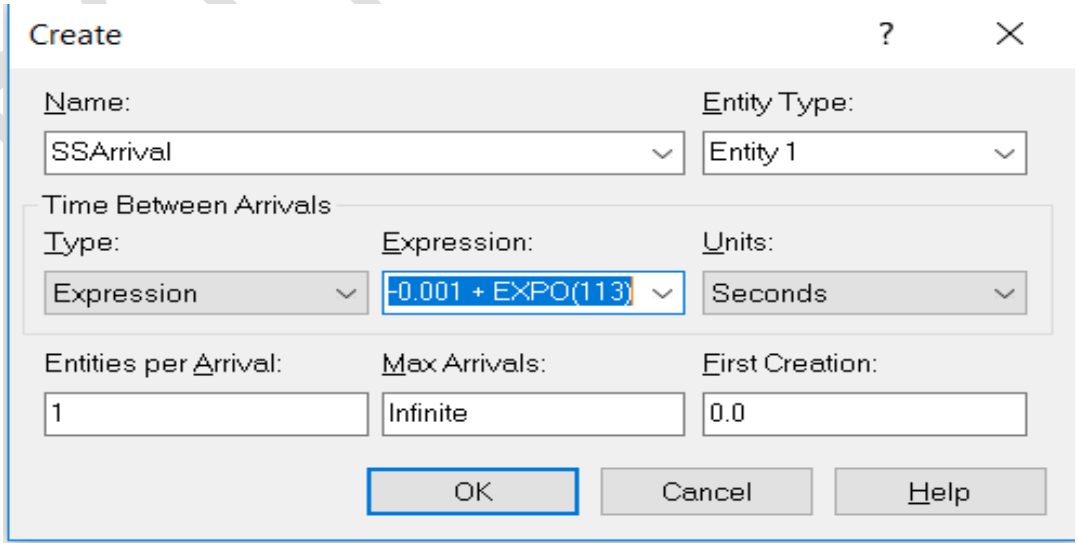
Finally, model is made to run for 10 number of replications by considering 40 as replication length (8 hours/5days), 8 hours per day and minutes as base time units. Thus, the simulated data is generated and saved in the given external file for analysis.

6.1.5. *MODEL FOR WEDNESDAY AFTERNOON 12 PM TO 2 PM:*

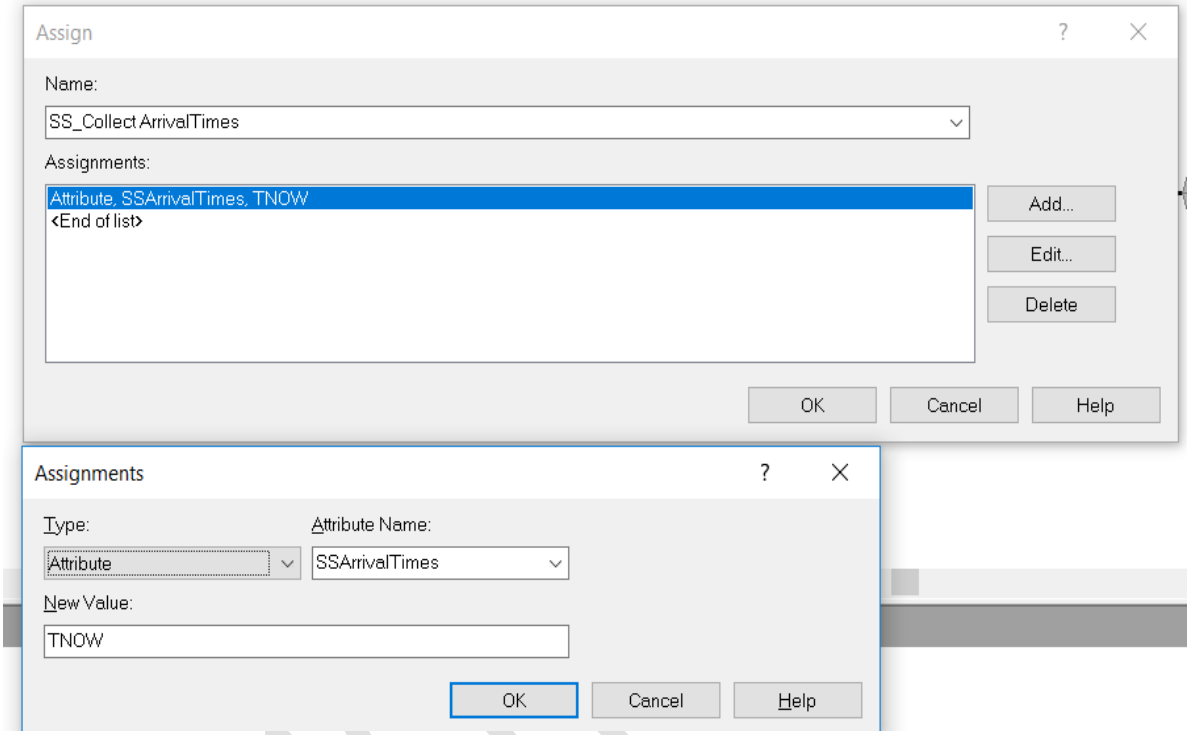
To develop a model for this, we have used 1 Create, 1 Assign, 1 Read/Write and 1 Dispose modules from basic and advanced processes. We have used Create module for describing the properties of an entity like entity name, type of expression to generate the entity arrival times and entity per arrivals. The developed model is as shown below:



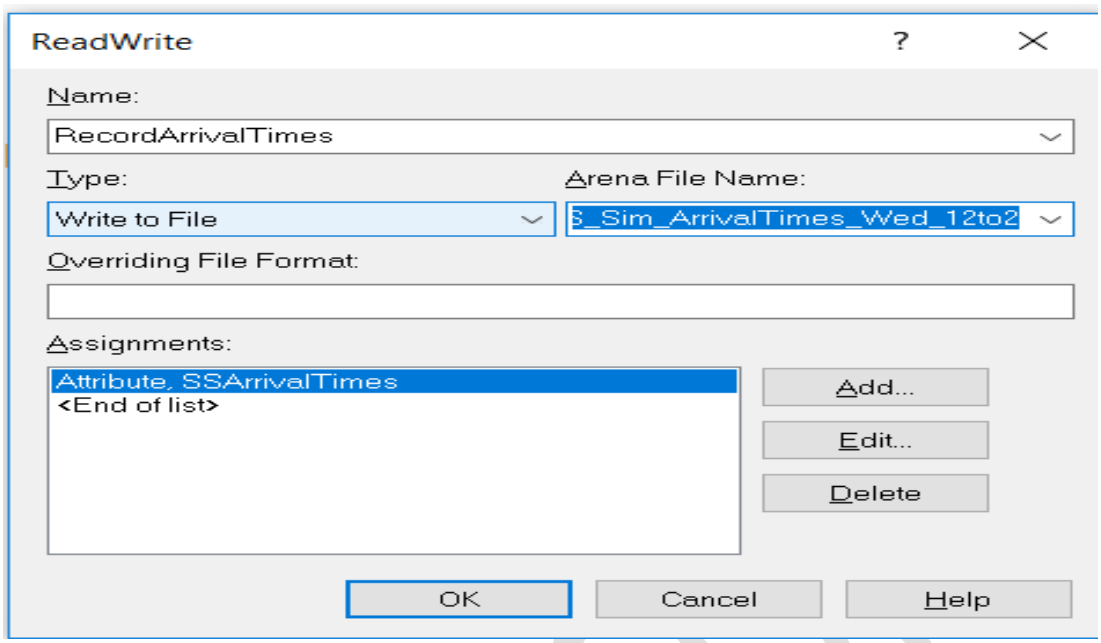
- In CREATE module, the entity is named as SSArrival and the type of expression used is - **0.001 + EXPO(113)** with seconds as units. Number of entities per arrival is 1 based on the system function and the maximum arrivals are infinite.



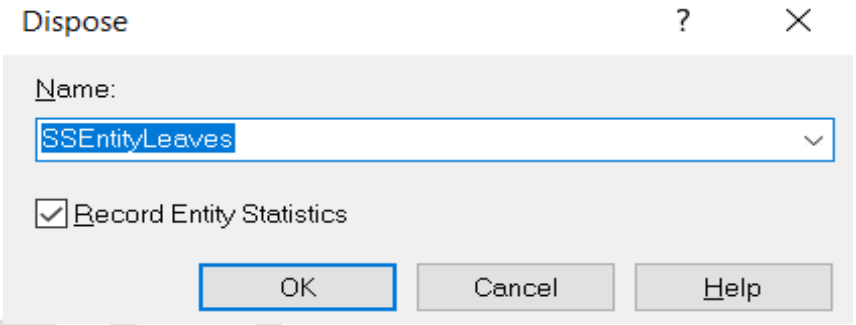
- The ASSIGN Module is named as SS_CollectArrivalTimes to collect the arrivals of the entity. The type of assignment used to collect these times is chosen to be an Attribute and named as SSArrivalTImes with a new value of TNOW.



- Then a Read/Write Module from the Advanced Process is used to write the generated arrival times to an external file which is used for further validation process. So the module is named as RecordArrivalTimes and the data generated is saved with the file name SS_Sim_ArrivalTimes_Wed_12to2. The assignment thus used is an Attribute with the name SSArrivalTimes.



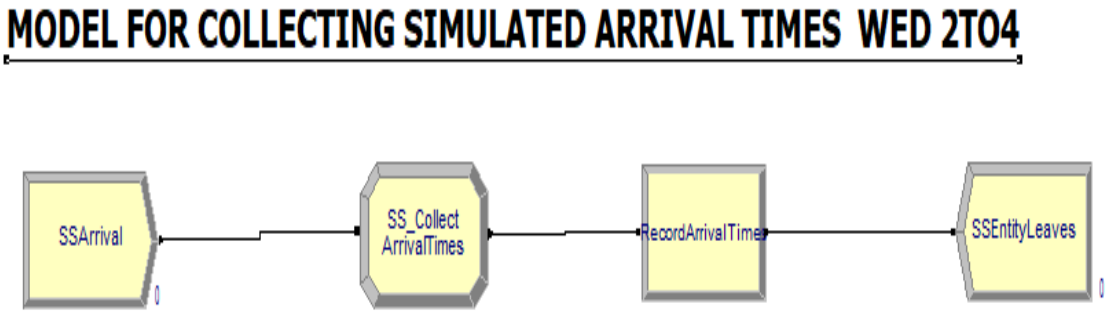
- The DISPOSE Module is named as SSEntityLeaves and all the statistics are recorded.



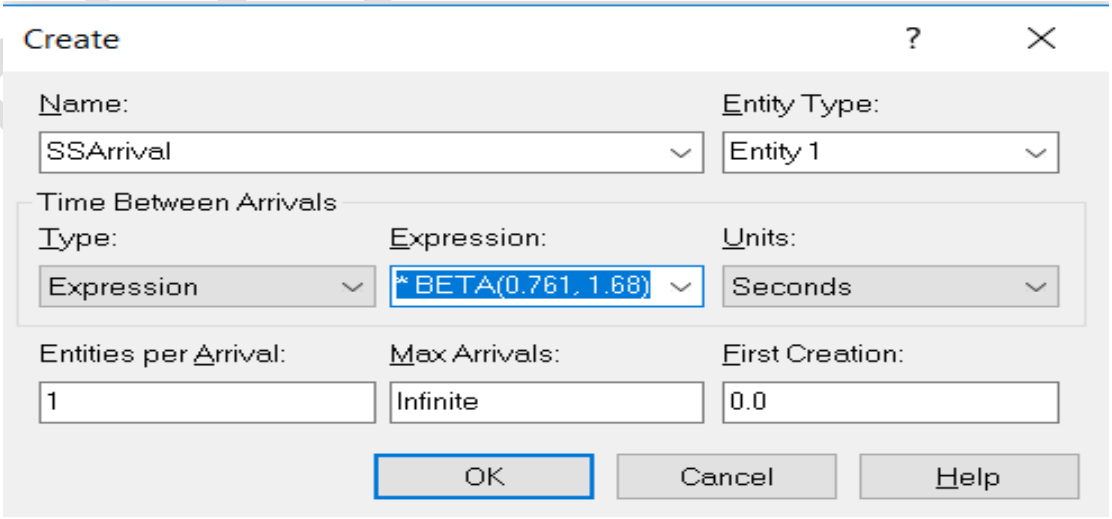
Finally, model is made to run for 10 number of replications by considering 40 as replication length (8 hours/5days), 8 hours per day and minutes as base time units. Thus, the simulated data is generated and saved in the given external file for analysis.

6.1.6. *MODEL FOR WEDNESDAY EVENING 2 PM TO 4 PM*:

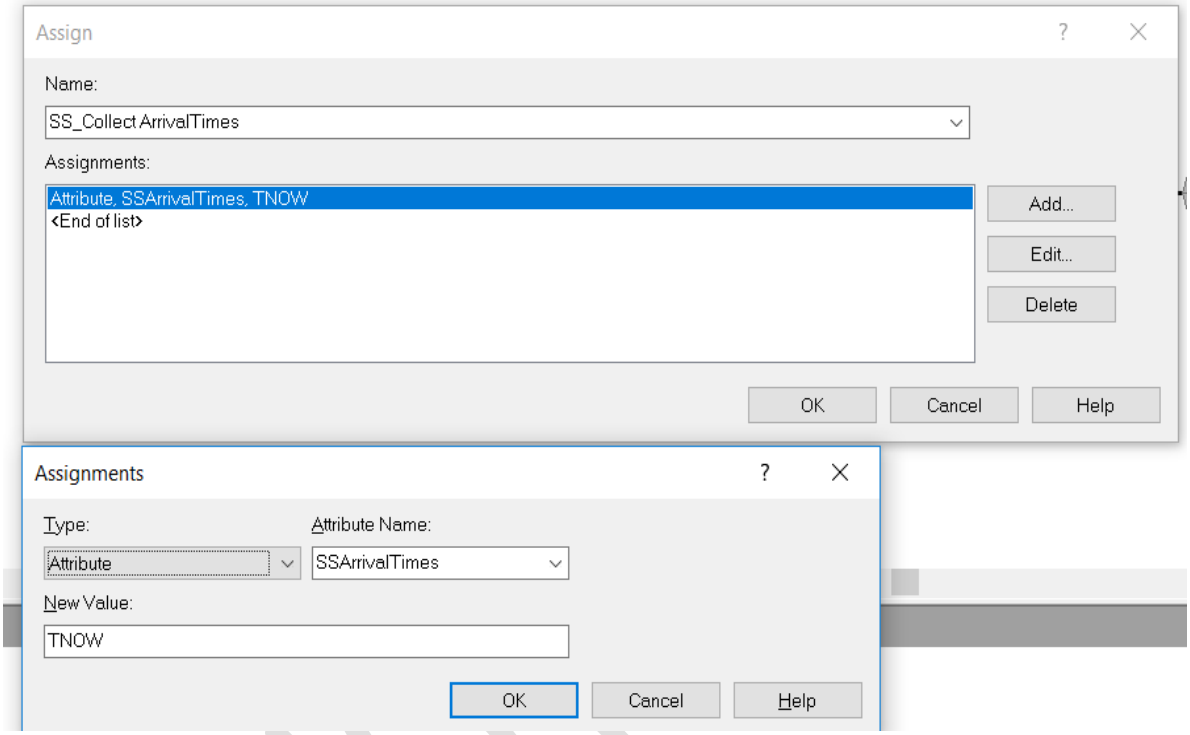
To develop a model for this, we have used 1 Create, 1 Assign, 1 Read/Write and 1 Dispose modules from basic and advanced processes. We have used Create module for describing the properties of an entity like entity name, type of expression to generate the entity arrival times and entity per arrivals. The developed model is as shown below:



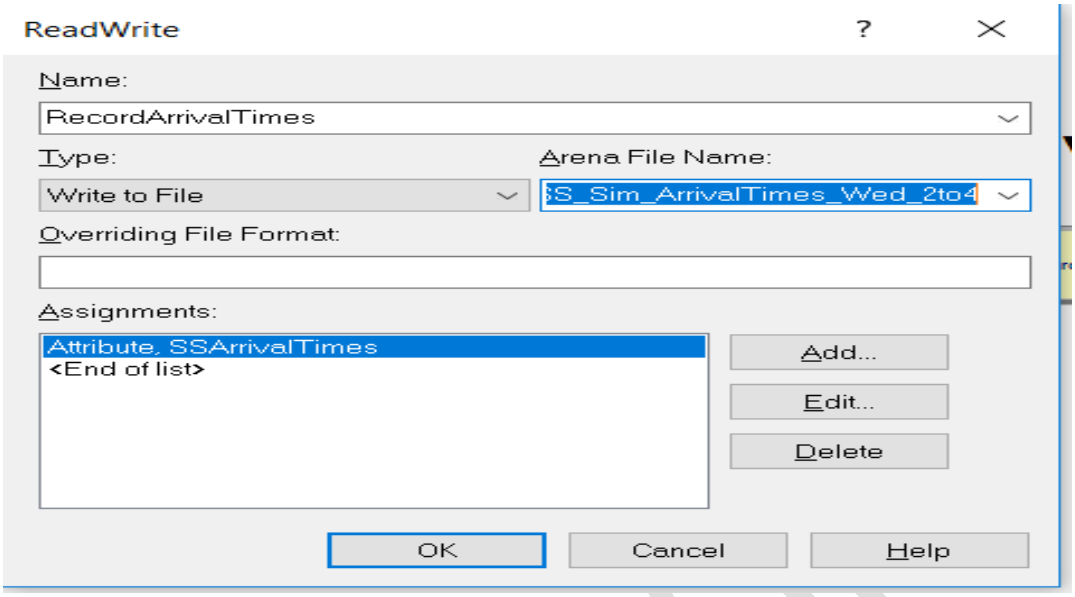
- In CREATE module, the entity is named as SSArrival and the type of expression used is - **0.001 + 419 * BETA(0.761, 1.68)** with seconds as units. Number of entities per arrival is 1 based on the system function and the maximum arrivals are infinite.



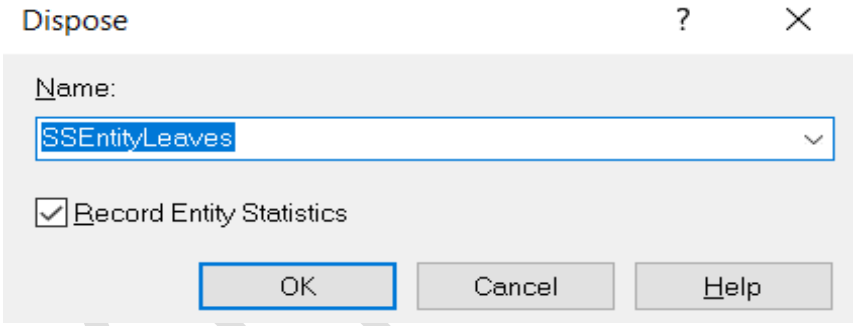
- The ASSIGN Module is named as SS_CollectArrivalTimes to collect the arrivals of the entity. The type of assignment used to collect these times is chosen to be an Attribute and named as SSArrivalTImes with a new value of TNOW.



- Then a Read/Write Module from the Advanced Process is used to write the generated arrival times to an external file which is used for further validation process. So the module is named as RecordArrivalTimes and the data generated is saved with the file name SS_Sim_ArrivalTimes_Wed_2to4. The assignment thus used is an Attribute with the name SSArrivalTimes.



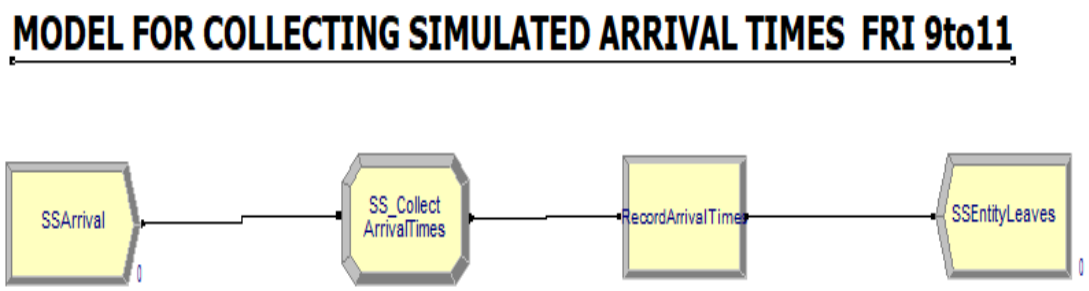
- The DISPOSE Module is named as SSEntityLeaves and all the statistics are recorded.



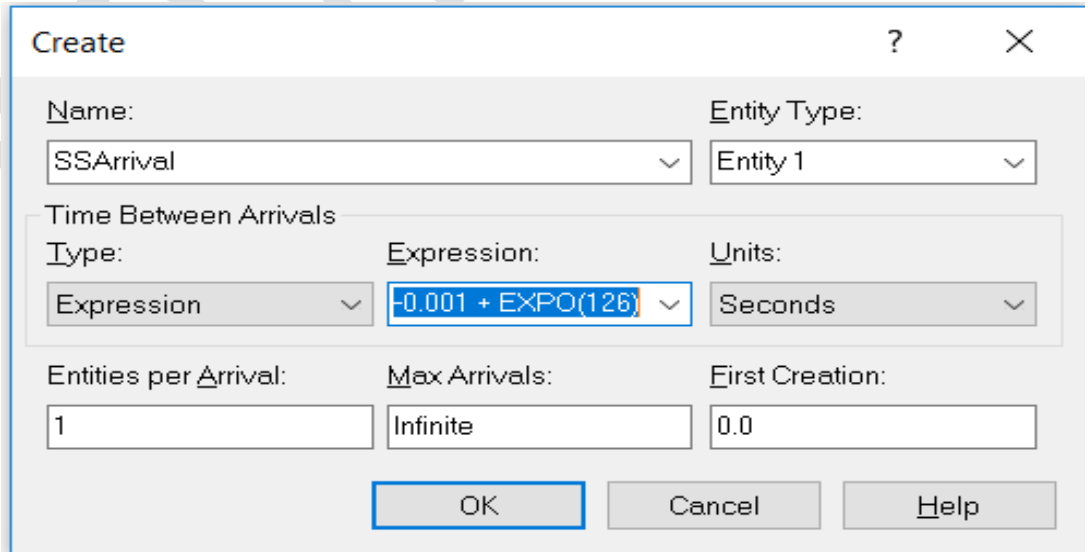
Finally, model is made to run for 10 number of replications by considering 40 as replication length (8 hours/5days), 8 hours per day and minutes as base time units. Thus, the simulated data is generated and saved in the given external file for analysis.

6.1.7. *MODEL FOR FRIDAY 9 AM TO 11 AM:*

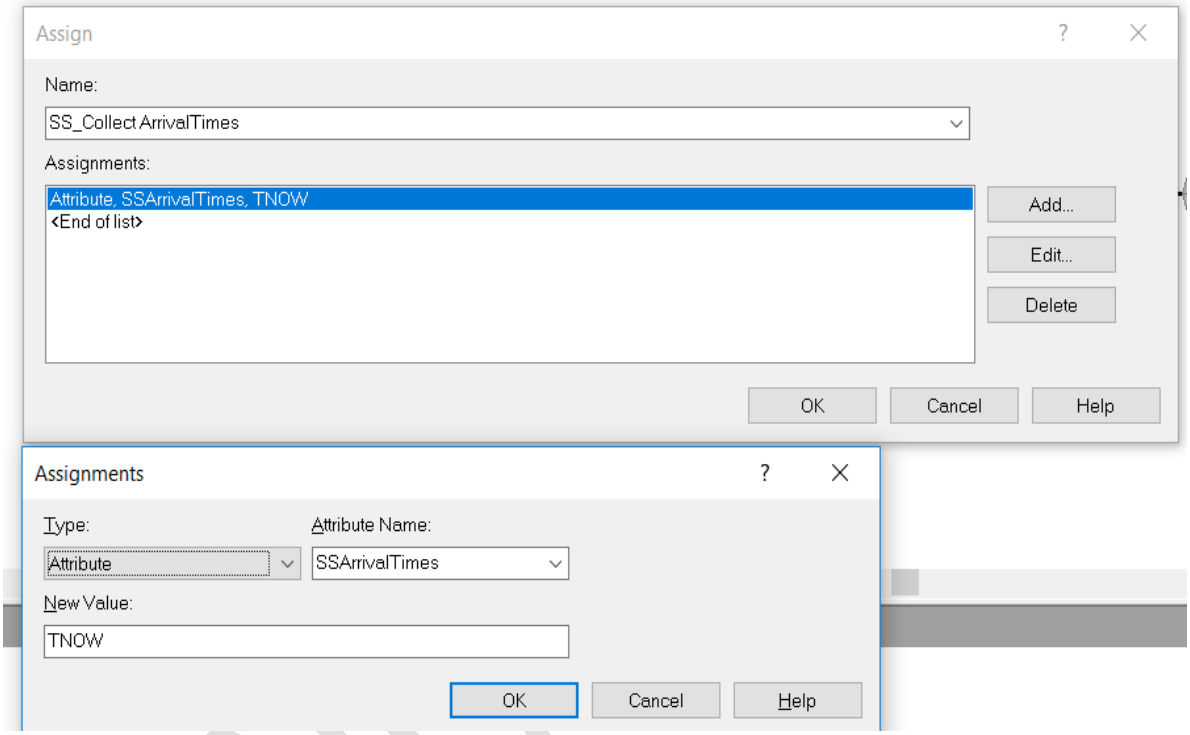
To develop a model for the system we have used 1 Create, 1 Assign, 1 Read/Write and 1 Dispose modules from basic and advanced processes. We have used Create module for describing the properties of an entity like entity name, type of expression to generate the entity arrival times and entity per arrivals. The developed model is as shown below:



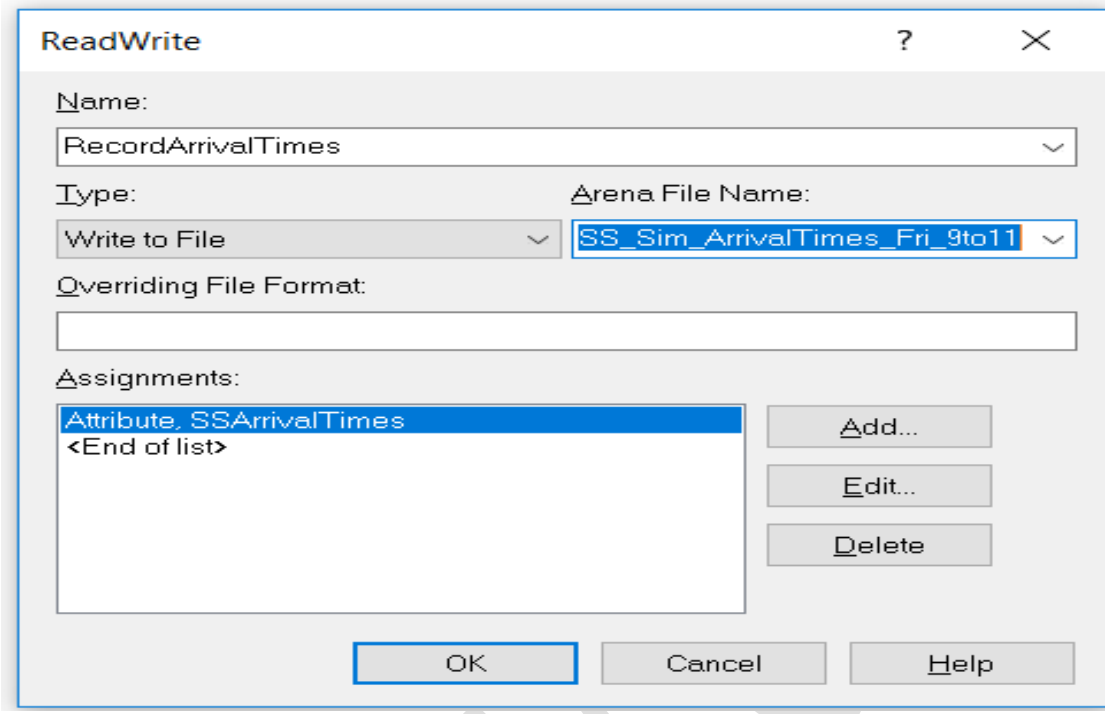
- In CREATE module, the entity is named as SSArrival and the type of expression used is - **0.001 + EXPO(126))** with seconds as units. Number of entities per arrival is 1 based on the system function and the maximum arrivals are infinite.



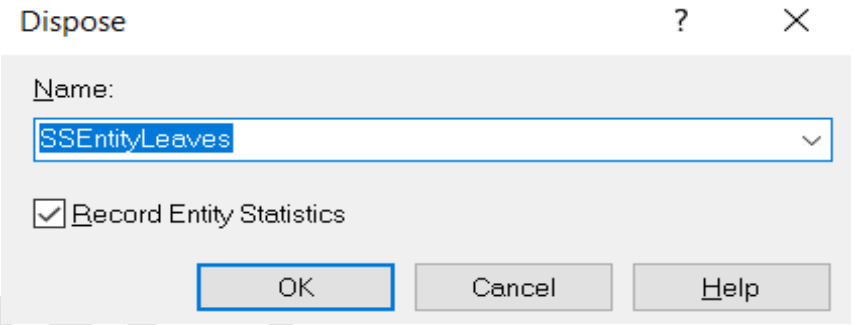
- The ASSIGN Module is named as SS_CollectArrivalTimes to collect the arrivals of the entity. The type of assignment used to collect these times is chosen to be an Attribute and named as SSArrivalTimes with a new value of TNOW.



- Then a Read/Write Module from the Advanced Process is used to write the generated arrival times to an external file which is used for further validation process. So the module is named as RecordArrivalTimes and the data generated is saved with the file name SS_Sim_ArrivalTimes_Fri_9to11. The assignment thus used is an Attribute with the name SSArrivalTimes.



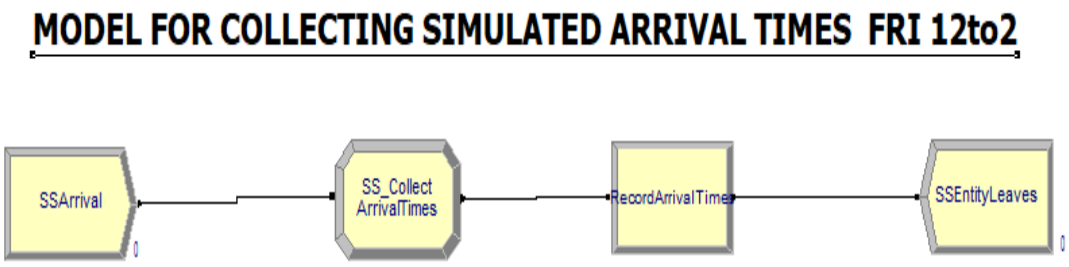
- The DISPOSE Module is named as SSEntityLeaves and all the statistics are recorded.



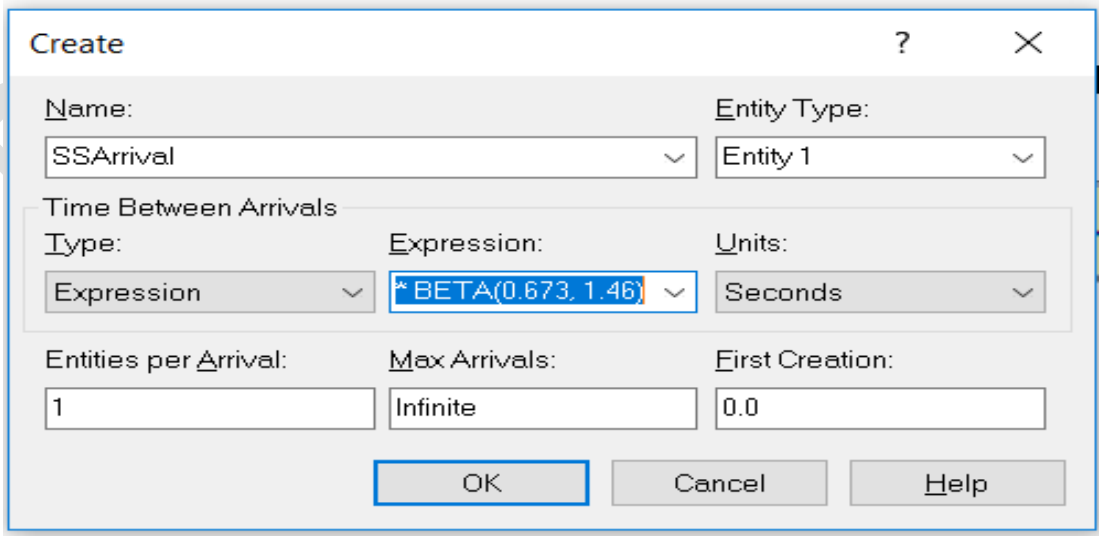
Finally, model is made to run for 10 number of replications by considering 40 as replication length (8 hours/5days), 8 hours per day and minutes as base time units. Thus, the simulated data is generated and saved in the given external file for analysis.

6.1.8. MODEL FOR FRIDAY AFTERNOON 12 PM TO 2 PM:

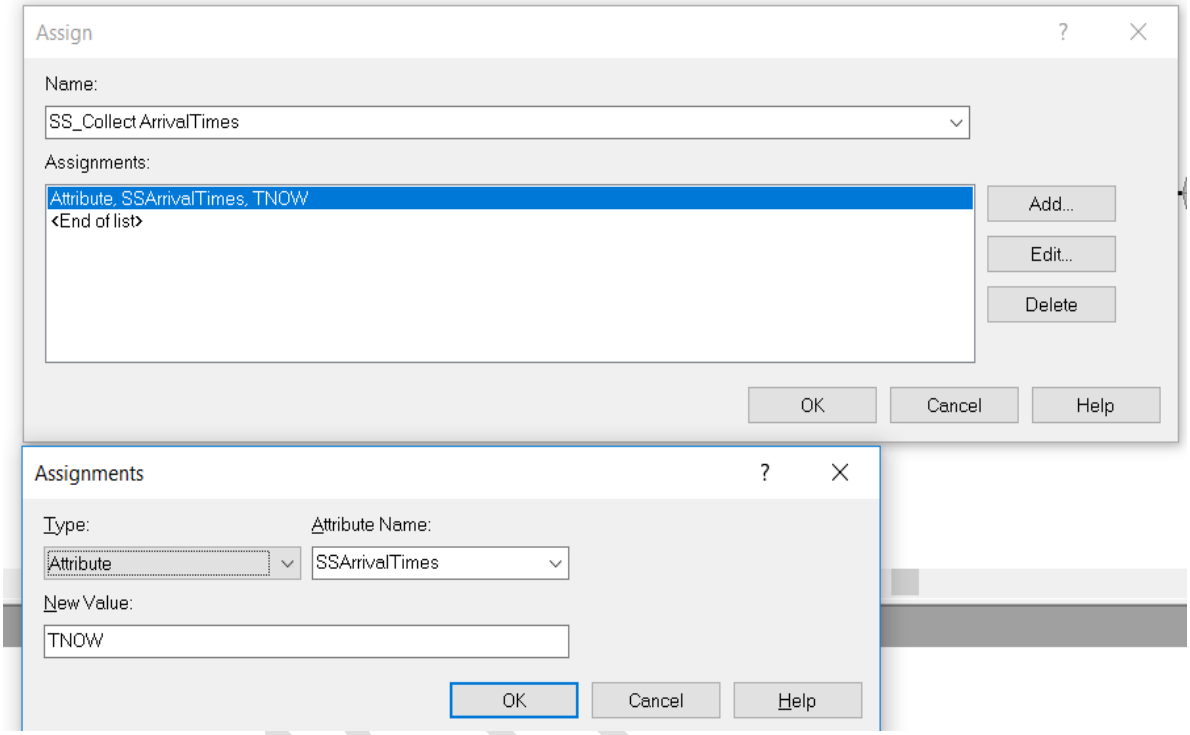
To develop a model for this, we have used 1 Create, 1 Assign, 1 Read/Write and 1 Dispose modules from basic and advanced processes. We have used Create module for describing the properties of an entity like entity name, type of expression to generate the entity arrival times and entity per arrivals. The developed model is as shown below:



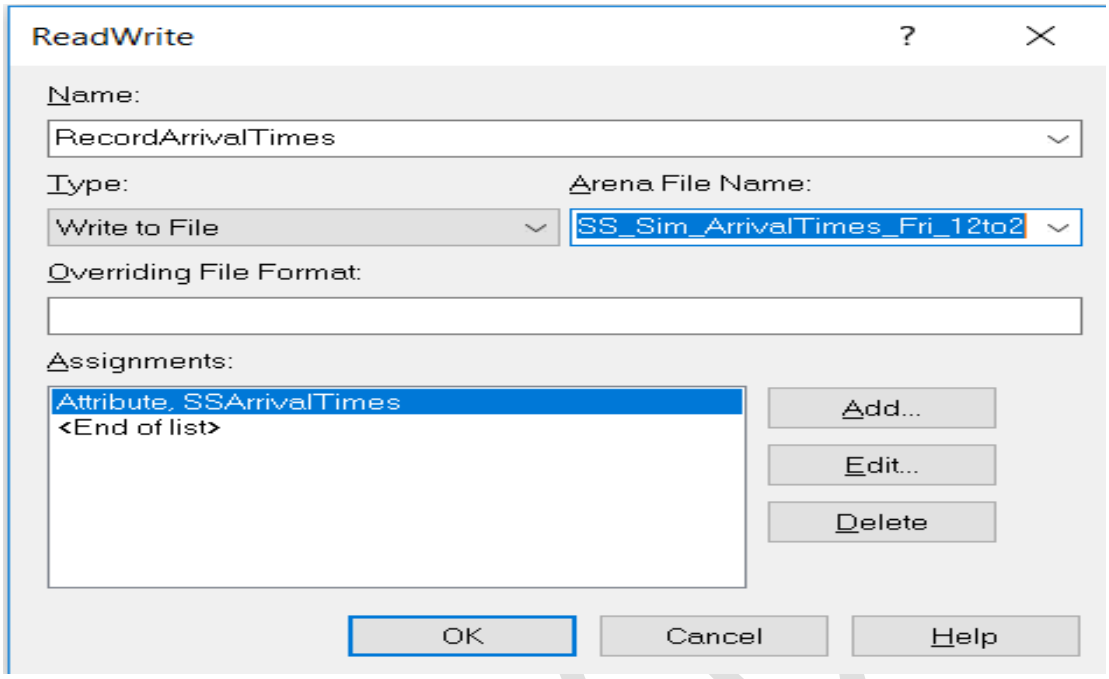
- In CREATE module, the entity is named as SSArrival and the type of expression used is - **0.001 + 328 * BETA(0.673, 1.46)** with seconds as units. Number of entities per arrival is 1 based on the system function and the maximum arrivals are infinite.



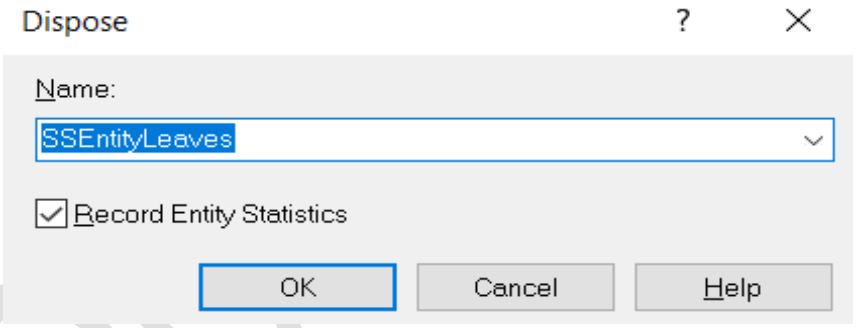
- The ASSIGN Module is named as SS_CollectArrivalTimes to collect the arrivals of the entity. The type of assignment used to collect these times is chosen to be an Attribute and named as SSArrivalTImes with a new value of TNOW.



- Then a Read/Write Module from the Advanced Process is used to write the generated arrival times to an external file which is used for further validation process. So the module is named as RecordArrivalTimes and the data generated is saved with the file name SS_Sim_ArrivalTimes_Fri_12to2. The assignment thus used is an Attribute with the name SSArrivalTimes.



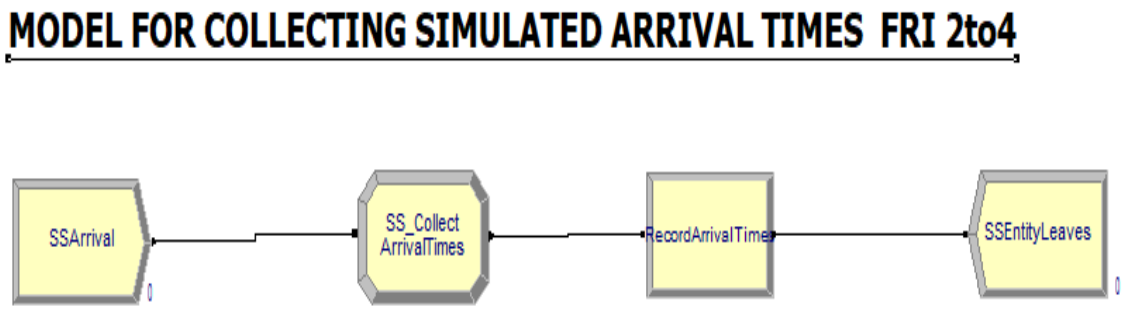
- The DISPOSE Module is named as SSEntityLeaves and all the statistics are recorded.



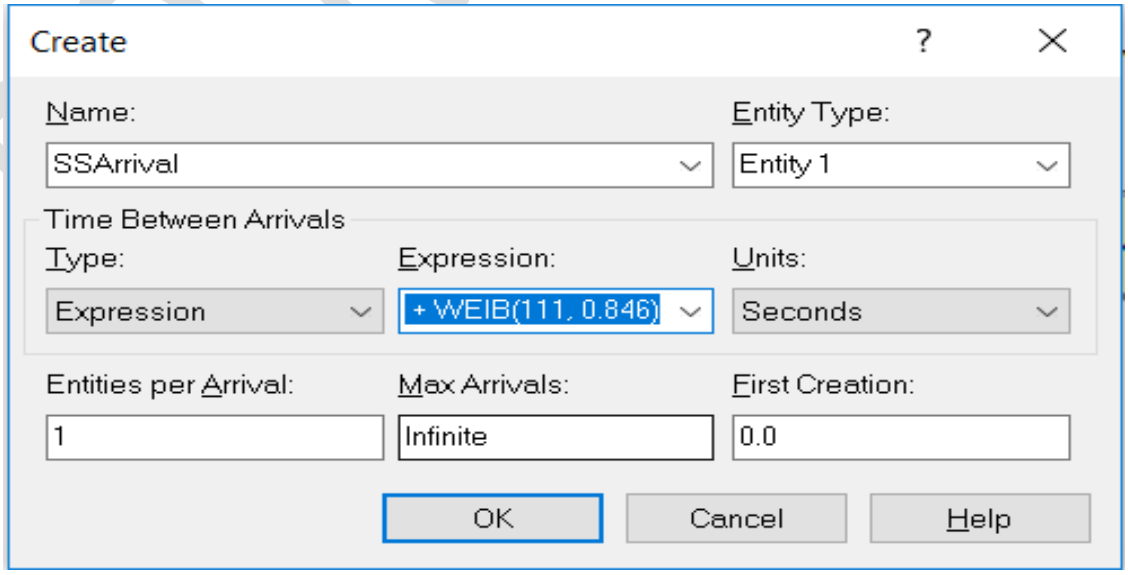
Finally, model is run for 10 replications by considering 40 as replication length (8 hours/5days), 8 hours per day and minutes as base time units. Thus, the simulated data is generated and saved in the given external file for analysis.

6.1.9. *MODEL FOR FRIDAY EVENING 2 PM TO 4 PM:*

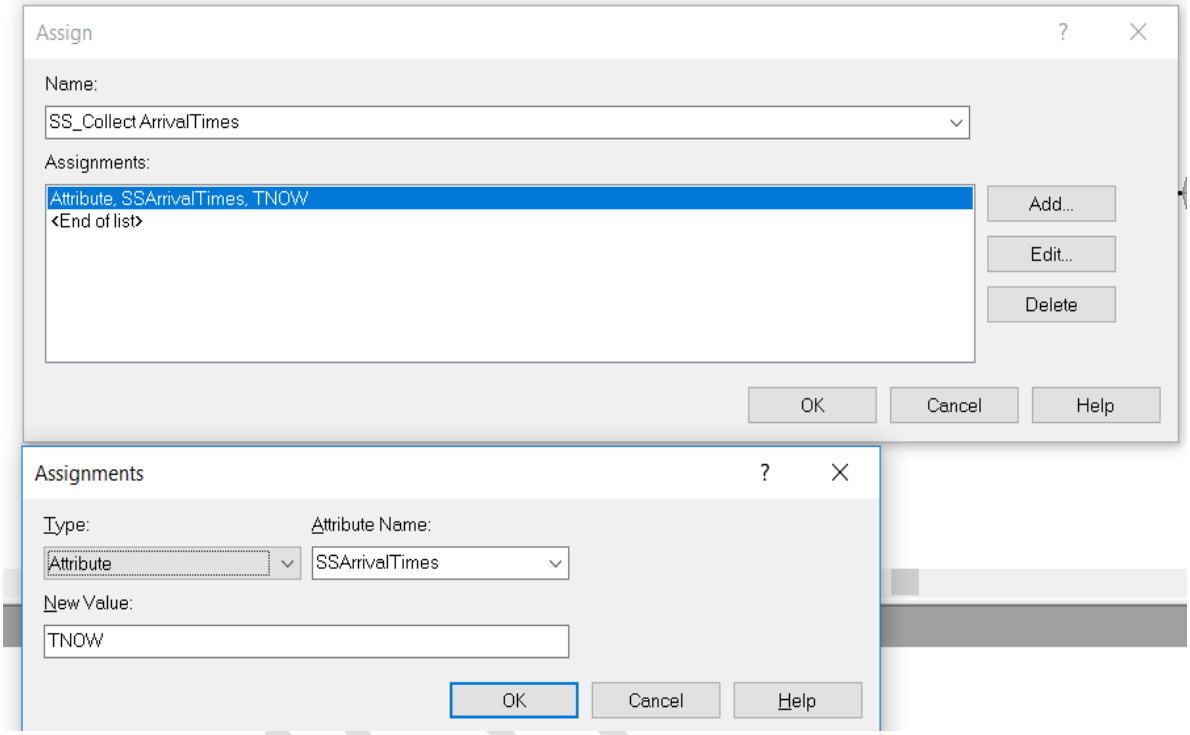
To develop a model for this, we have used 1 Create, 1 Assign, 1 Read/Write and 1 Dispose modules from basic and advanced processes. We have used Create module for describing the properties of an entity like entity name, type of expression to generate the entity arrival times and entity per arrivals. The developed model is as shown below:



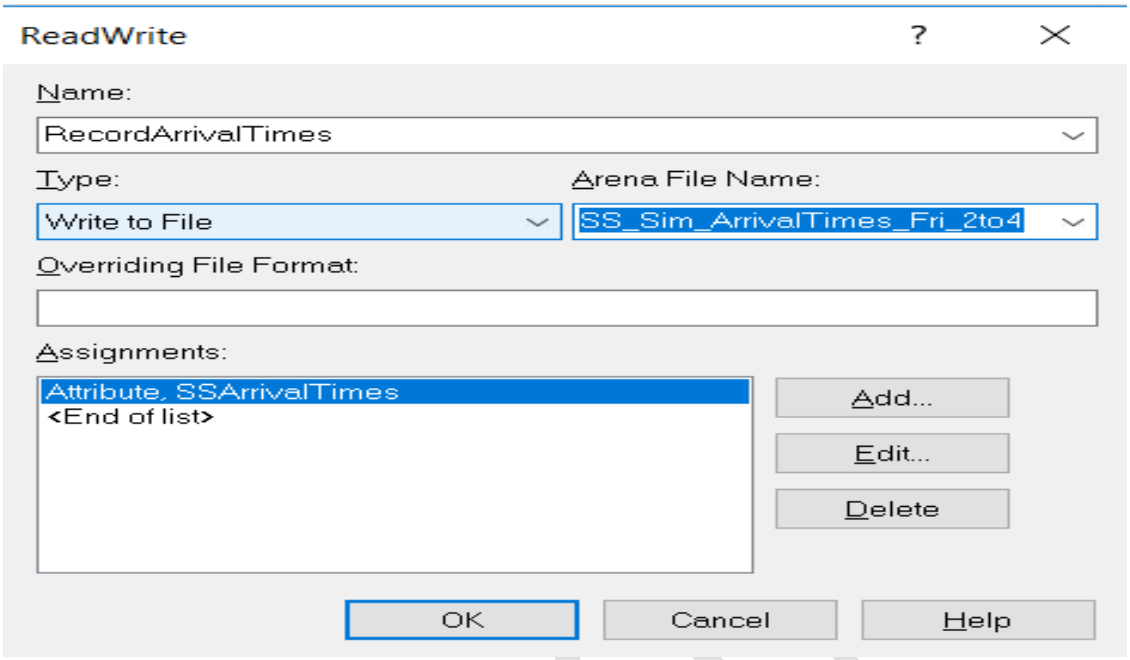
- In CREATE module, the entity is named as SSArrival and the type of expression used is - **0.001 + WEIB(111, 0.846)** with seconds as units. Number of entities per arrival is 1 based on the system function and the maximum arrivals are infinite.



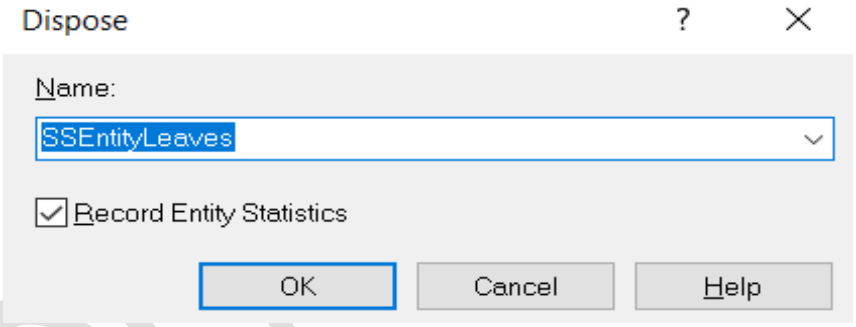
- The ASSIGN Module is named as SS_CollectArrivalTimes to collect the arrivals of the entity. The type of assignment used to collect these times is chosen to be an Attribute and named as SSArrivalTImes with a new value of TNOW.



- Then a Read/Write Module from the Advanced Process is used to write the generated arrival times to an external file which is used for further validation process. So the module is named as RecordArrivalTimes and the data generated is saved with the file name SS_Sim_ArrivalTimes_Fri_2to4. The assignment thus used is an Attribute with the name SSArrivalTimes.



- The DISPOSE Module is named as SSEntityLeaves and all the statistics are recorded.



Finally, model is made to run for 10 number of replications by considering 40 as replication length (8 hours/5days), 8 hours per day and minutes as base time units. Thus, the simulated data is generated and saved in the given external file for analysis.

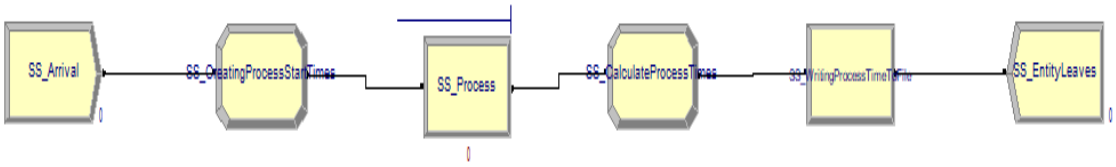
6.2) *COLLECTION OF SERVICE TIMES:*

Service time data is generated for 1 day which we have chosen as Monday. The following are the models related to the 3 timings on Monday:

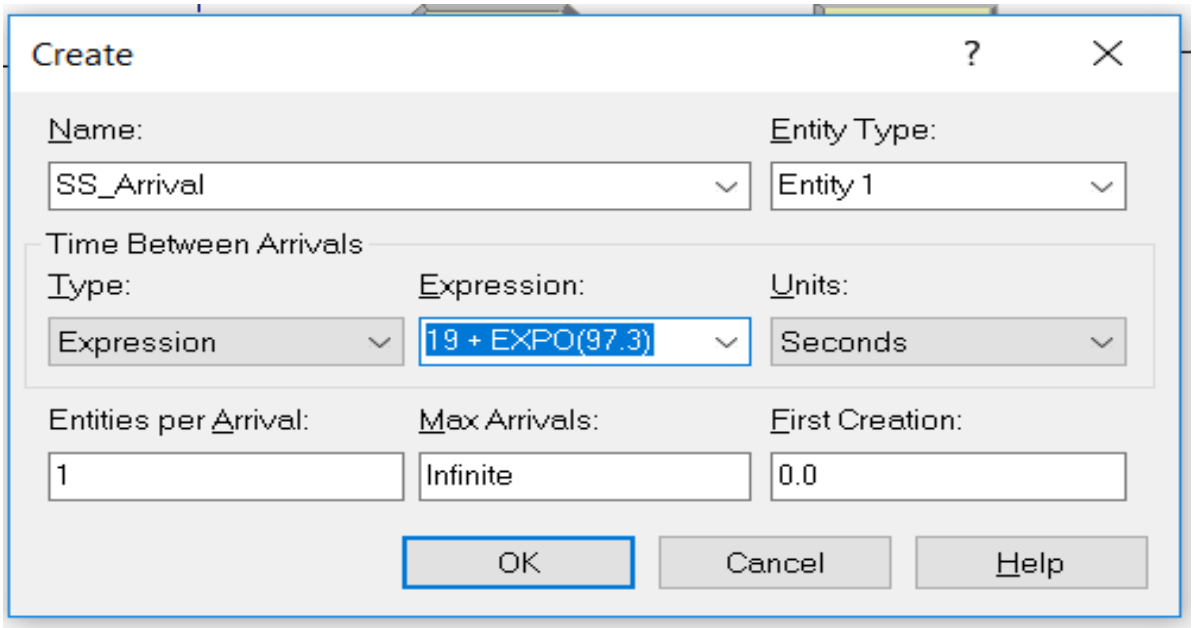
6.2.1MODEL FOR SERVICE TIMES ON MONDAY 9 AM TO 11 AM:

To develop a model which generated simulated service times data, we have used 1 Create, 2 Assign, 1 Process and 1 Dispose modules.

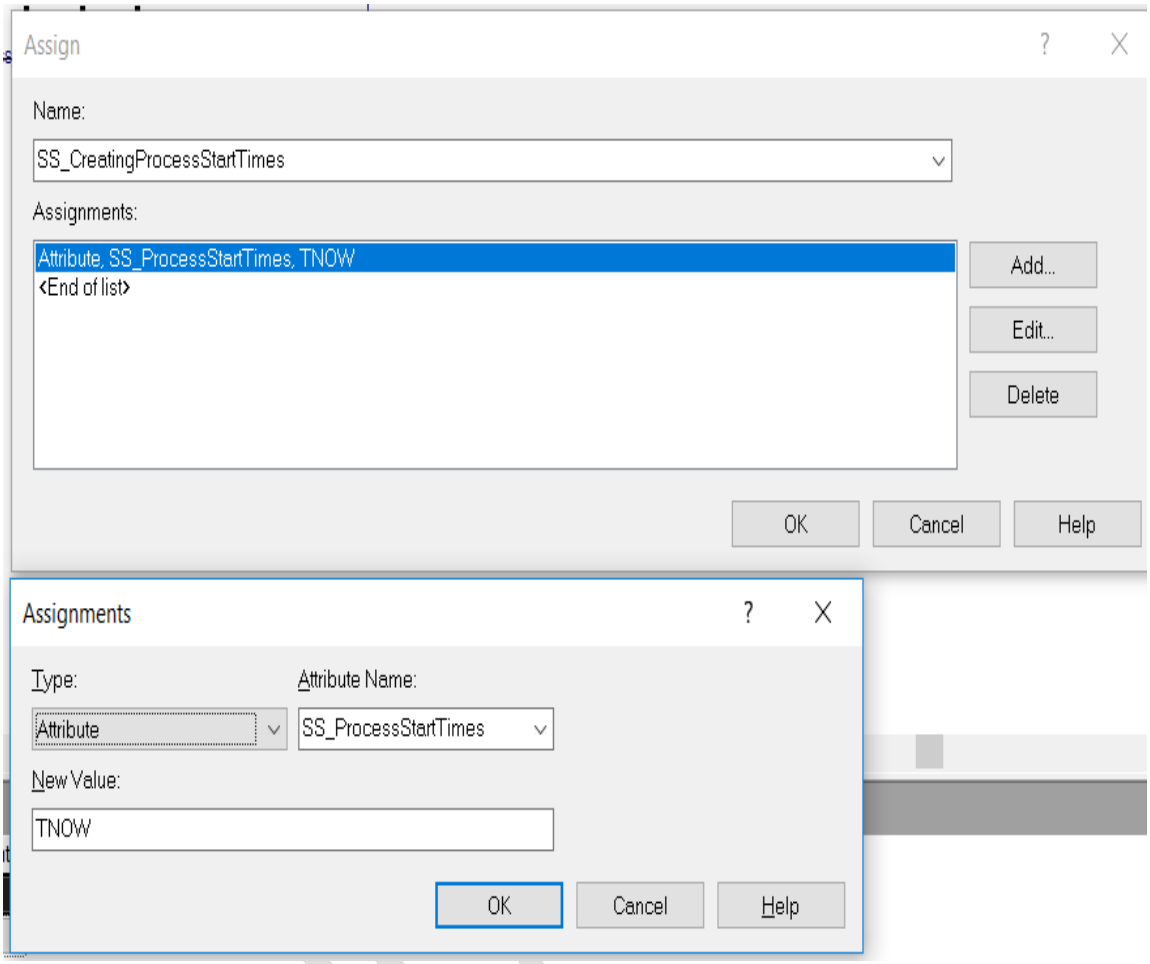
MODEL FOR SIMULATED DATA FOR SERVICE TIMES MONDAY 9TO11



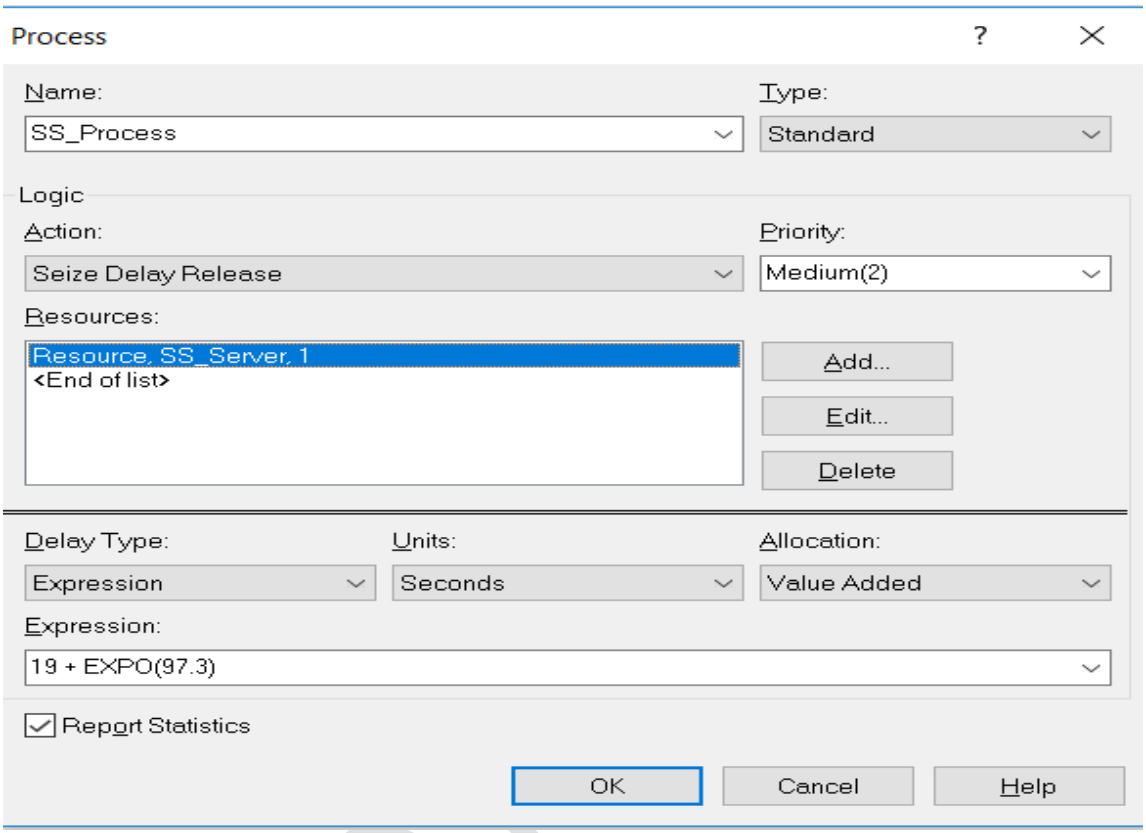
- CREATE Module is named as SS_Arrival and the entity properties are given. The expression is mentioned as 19 + EXPO(97.3) which is obtained from the fitted distribution from the input analyzer and units are mentioned as seconds. The number of entities per arrival are given as 1 based on the system function and the maximum of arrivals is noted as infinite.



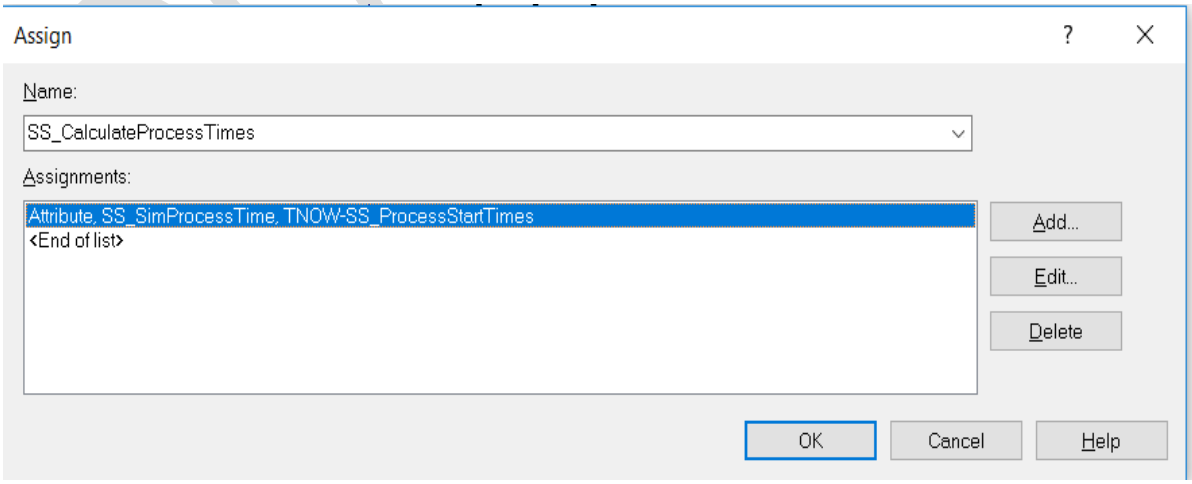
- The first Assign module is used for counting the starting times of the service and named as SS_CreatingProcessStartingTimes. The assigned attribute is named as SS_ProcessStartTimes with a new value as TNOW.



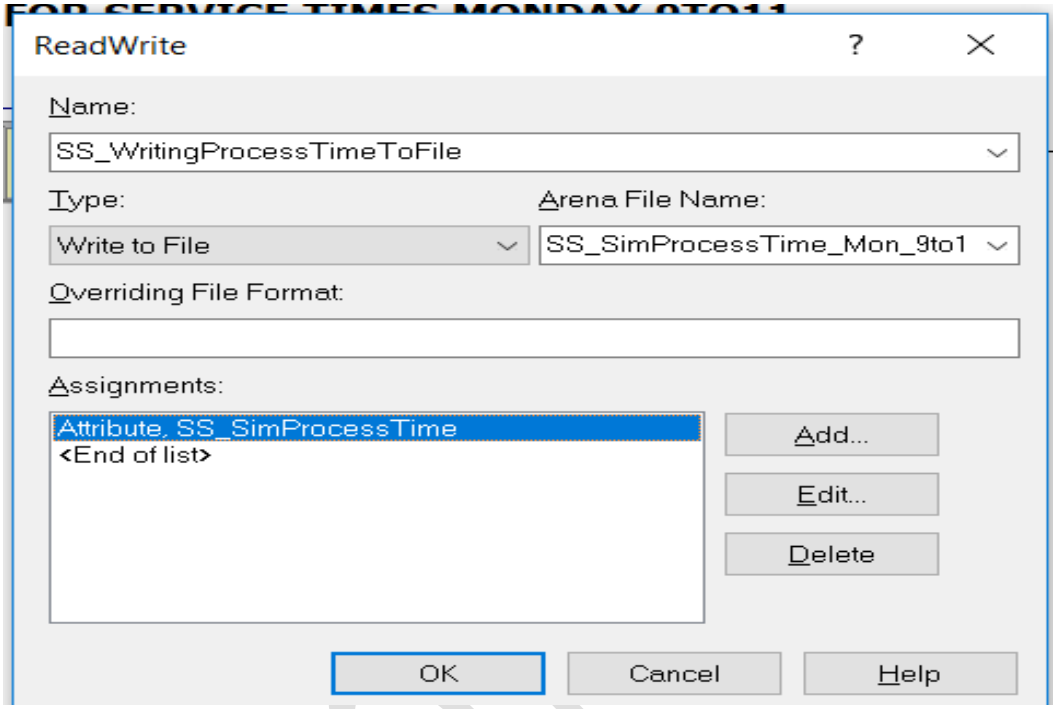
- The process module is named as SS_Process with a logic of SiezeDelayRelease type of action and the resource here is SS_Server and the number of units to be seized or released are taken as 1 as per the system functioning. The delay type is taken with an expression as in Create Module and units are mentioned in seconds.



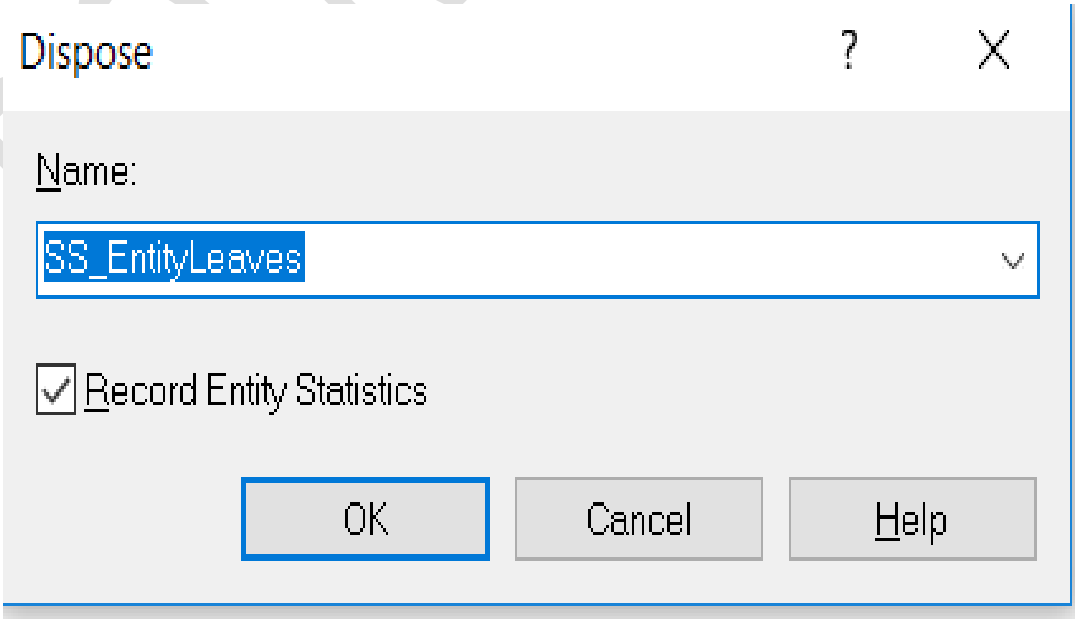
- The second Assign module is to calculate the total process time by subtracting the starting times from TNOW value. The module is named as SS_CalculateProcessTImes. The assigned attribute is named as SS_SimProcessTime with a new value of TNOW-SS_ProcessStartTimes.



- The READ/WRITE Module is used for writing the generated simulated service times to an external file and is saved. The assigned attribute here is named as SS_SimProcessTime.

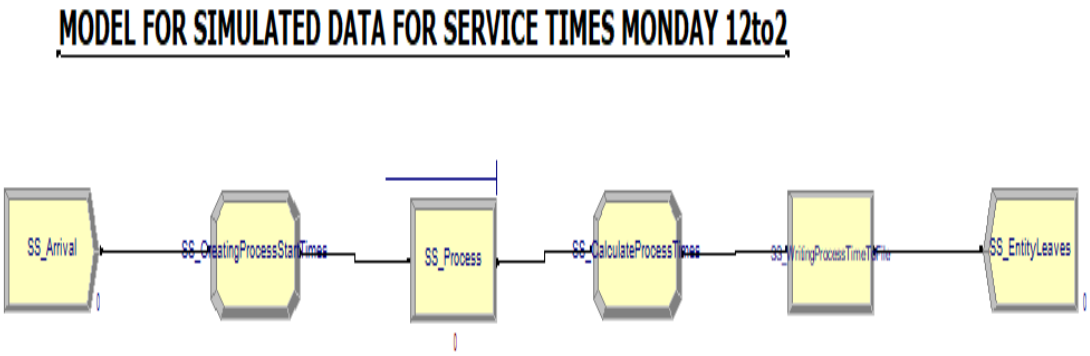


- The DISPOSE module is named as SS_EntityLeaves.

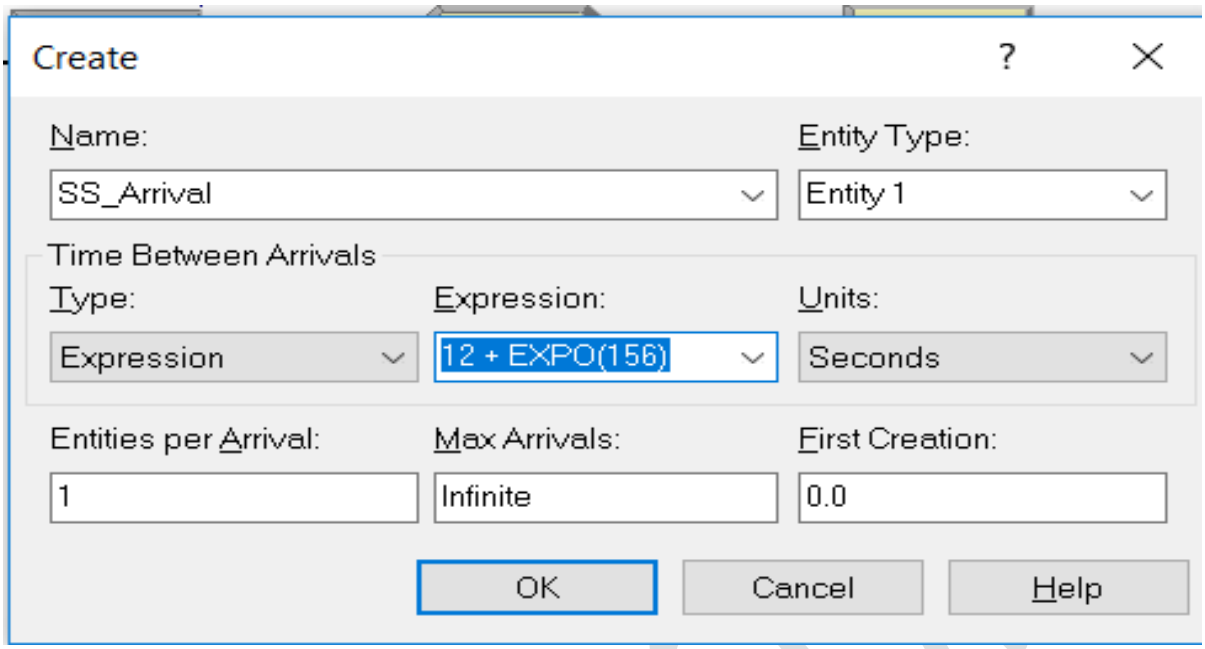


6.2.2 MODEL FOR SERVICE TIMES ON MONDAY 12 PM TO 2 PM:

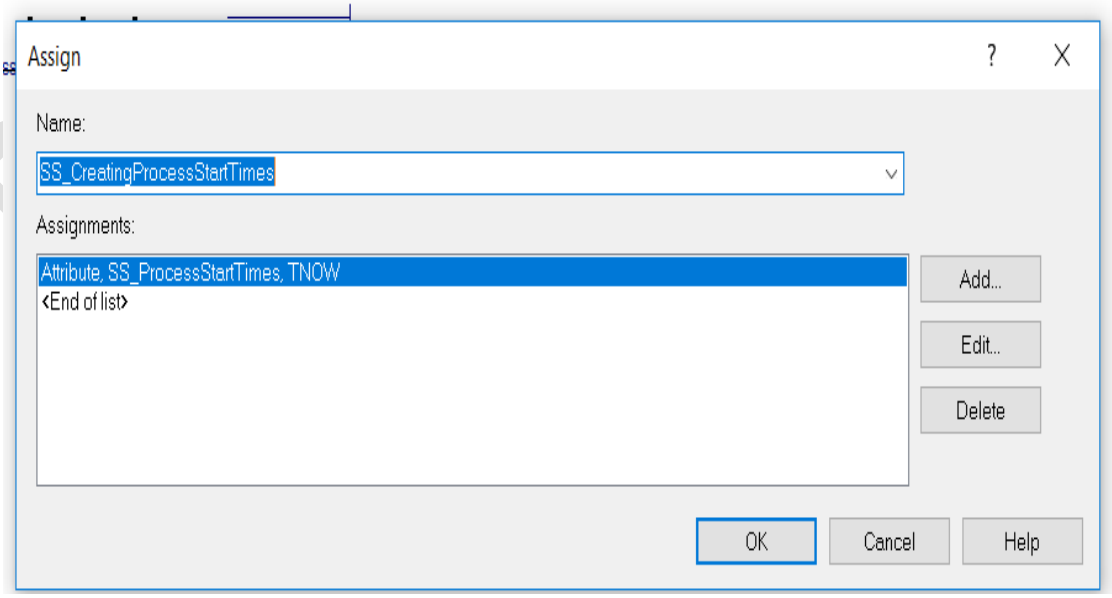
To develop a model which generated simulated service times data, we have used 1 Create, 2 Assign, 1 Process and 1 Dispose modules.



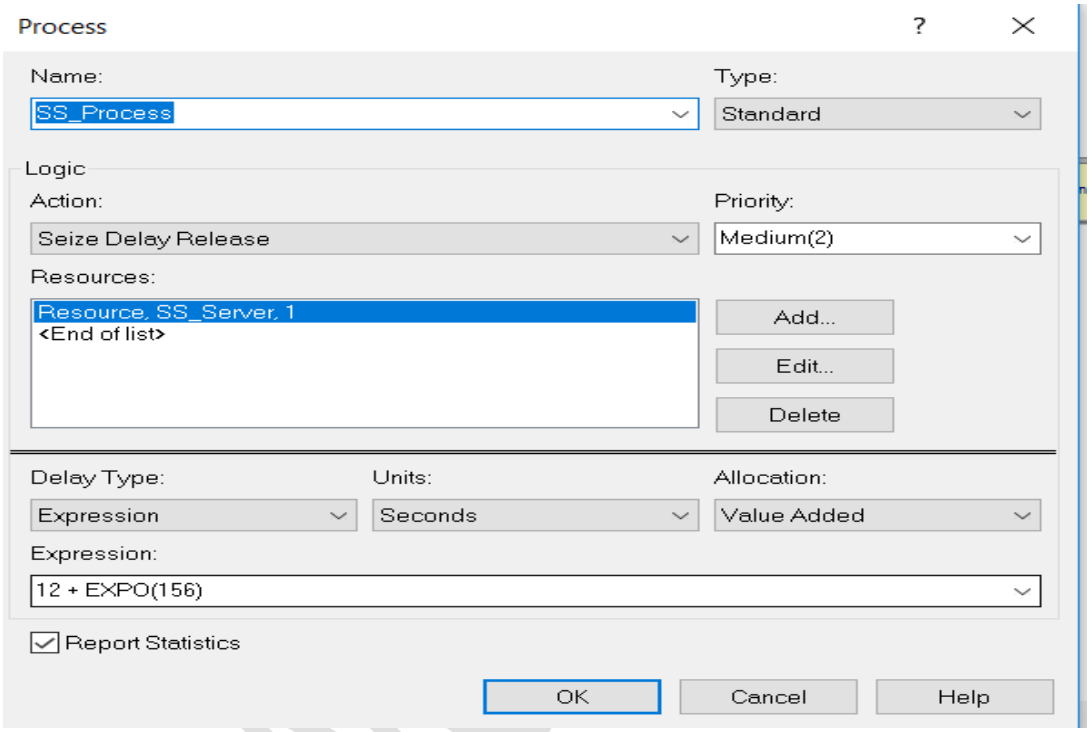
- CREATE Module is named as SS_Arrival and the entity properties are given. The expression is mentioned as 12 + EXPO(156)which is obtained from the fitted distribution from the input analyzer and units are mentioned as seconds. The number of entities per arrival are given as 1 based on the system function and the maximum of arrivals is noted as infinite.



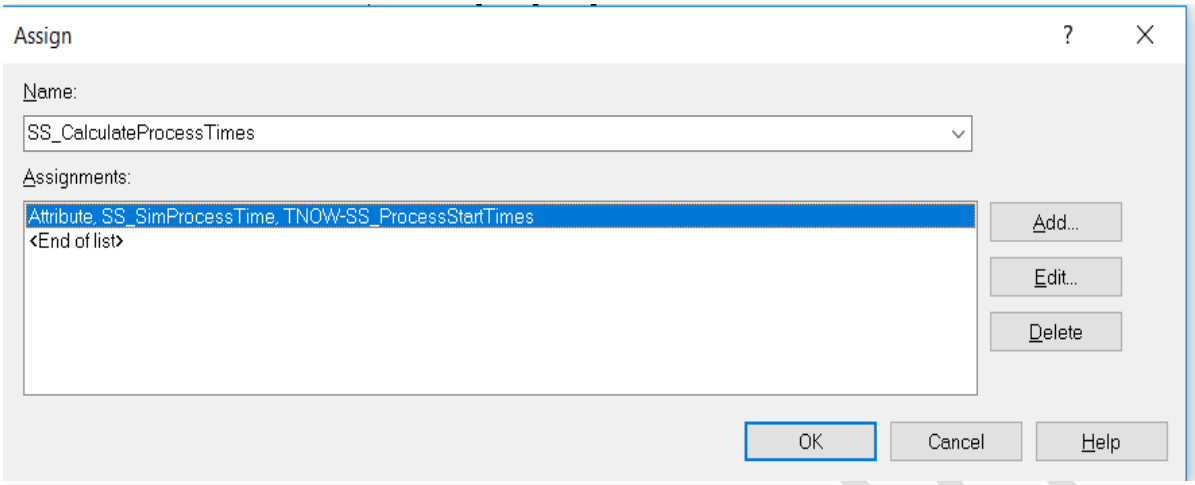
- The first Assign module is used for counting the starting times of the service and named as SS_CreatingProcessStartingTimes.The assigned attribute is named as SS_ProcessStartTimes with a new value as TNOW.



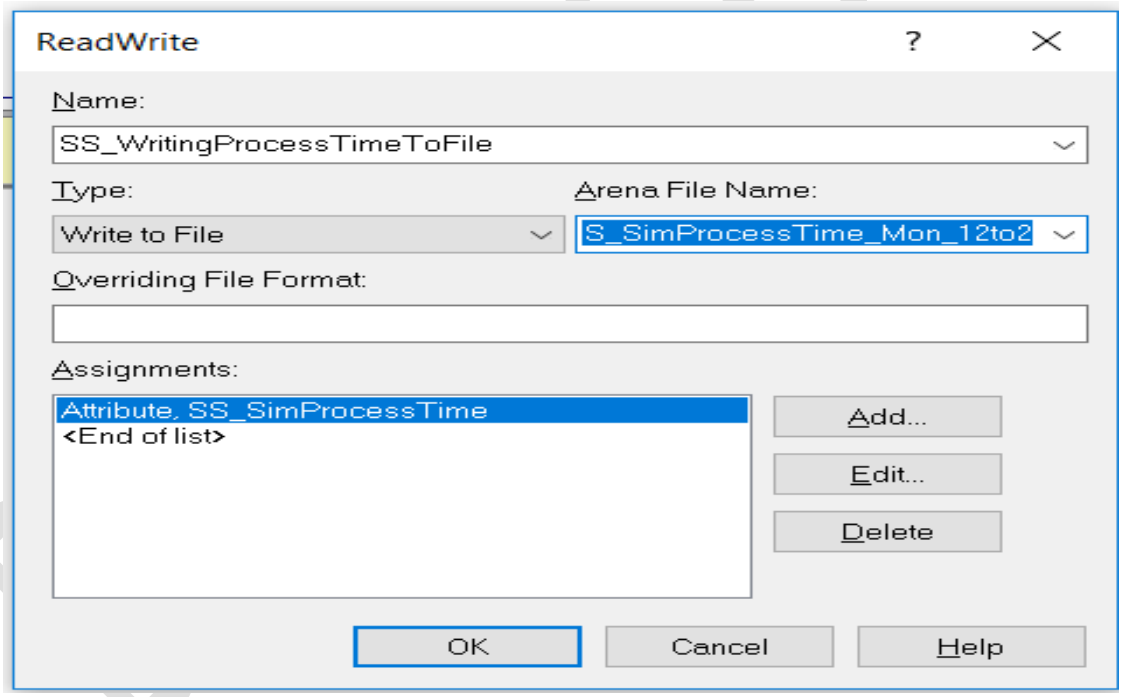
- The process module is named as SS_Process with a logic of SiezeDelayRelease type of action and the resource here is SS_Server and the number of units to be seized or released are taken as 1 as per the system functioning. The delay type is taken with an expression as in Create Module and units are mentioned in seconds.



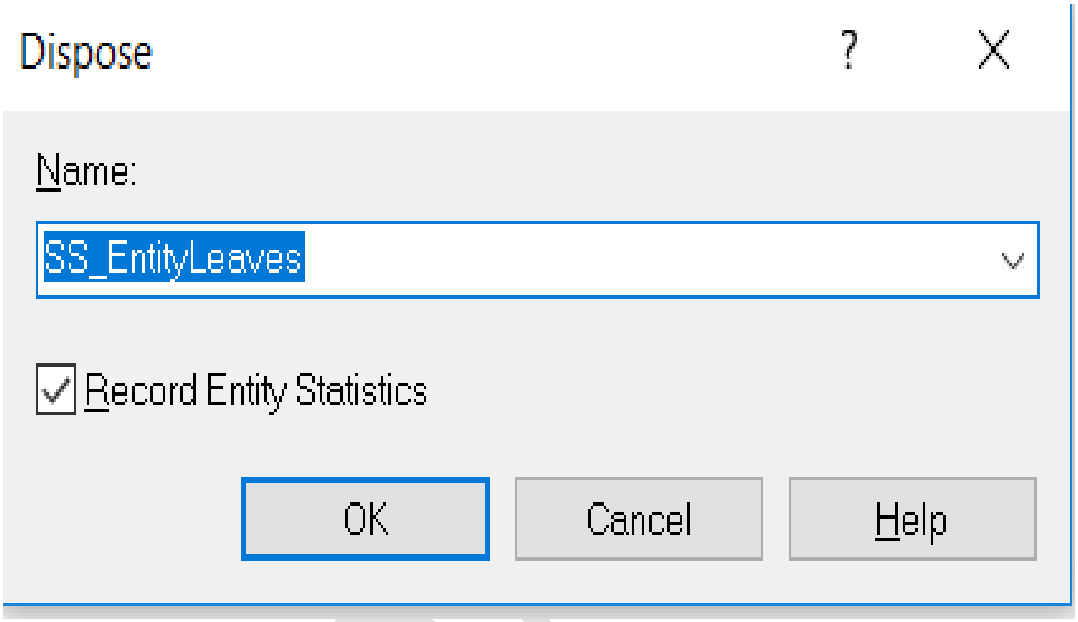
- The second Assign module is to calculate the total process time by subtracting the starting times from TNOW value. The module is named as SS_CalculateProcessTImes. The assigned attribute is named as SS_SimProcessTime with a new value of TNOW-SS_ProcessStartTimes.



- The READ/WRITE Module is used for writing the generated simulated service times to an external file and is saved. The assigned attribute here is named as SS_SimProcessTime.

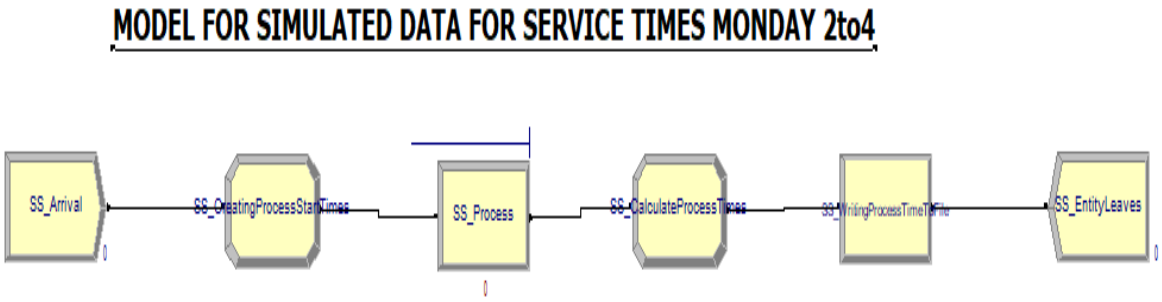


- The DISPOSE module is named as SS_EntityLeaves.

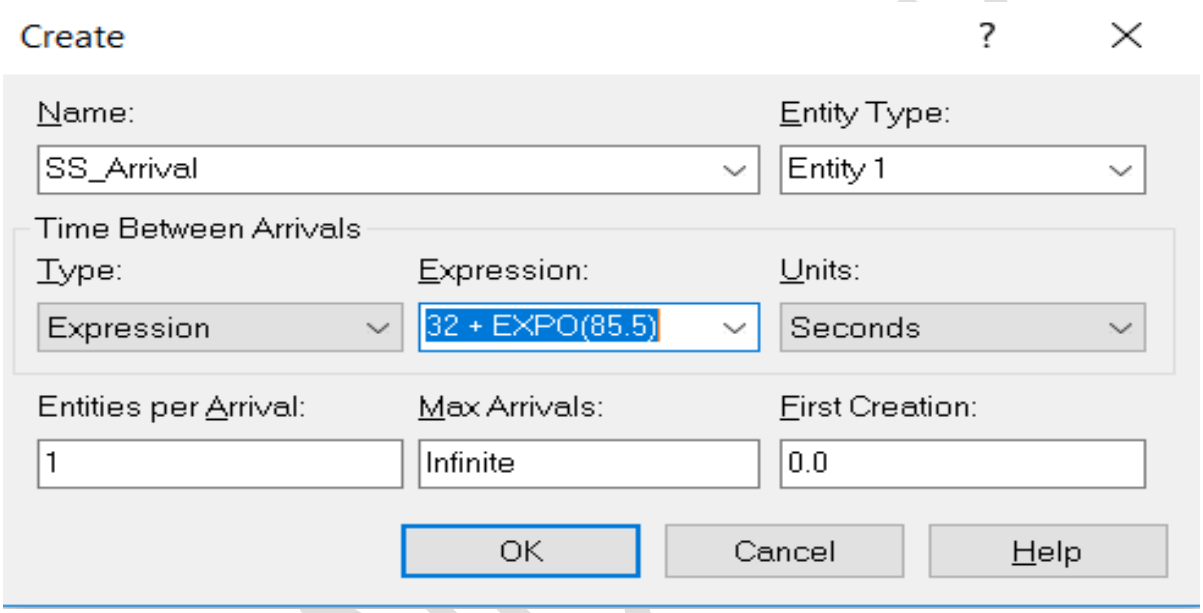


6.2.3 MODEL FOR SERVICE TIMES ON MONDAY 2 PM TO 4 PM:

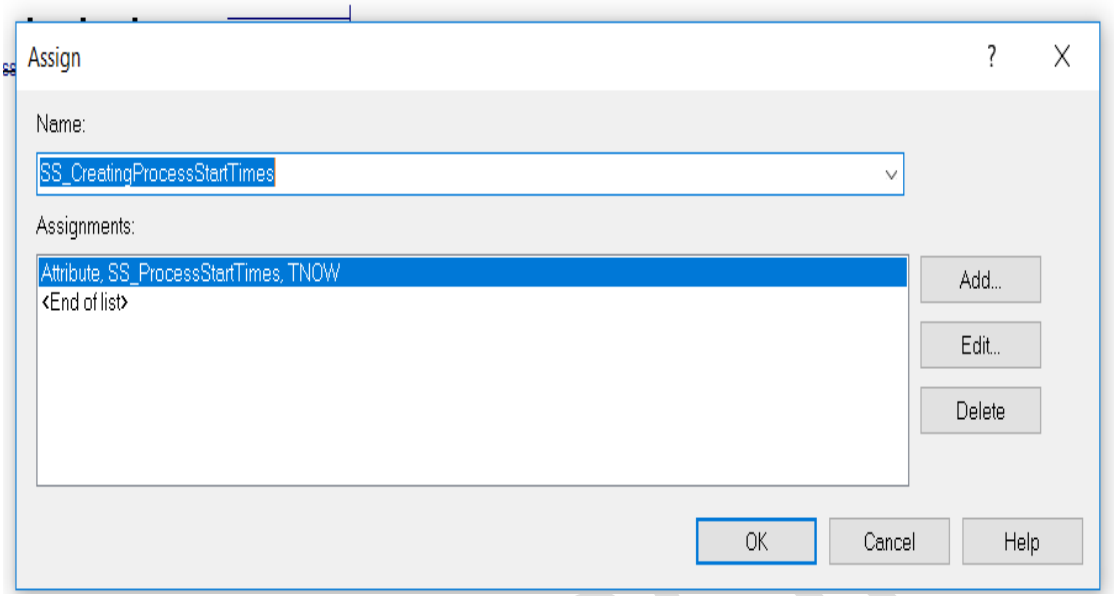
To develop a model which generated simulated service times data, we have used 1 Create, 2 Assign, 1 Process and 1 Dispose modules.



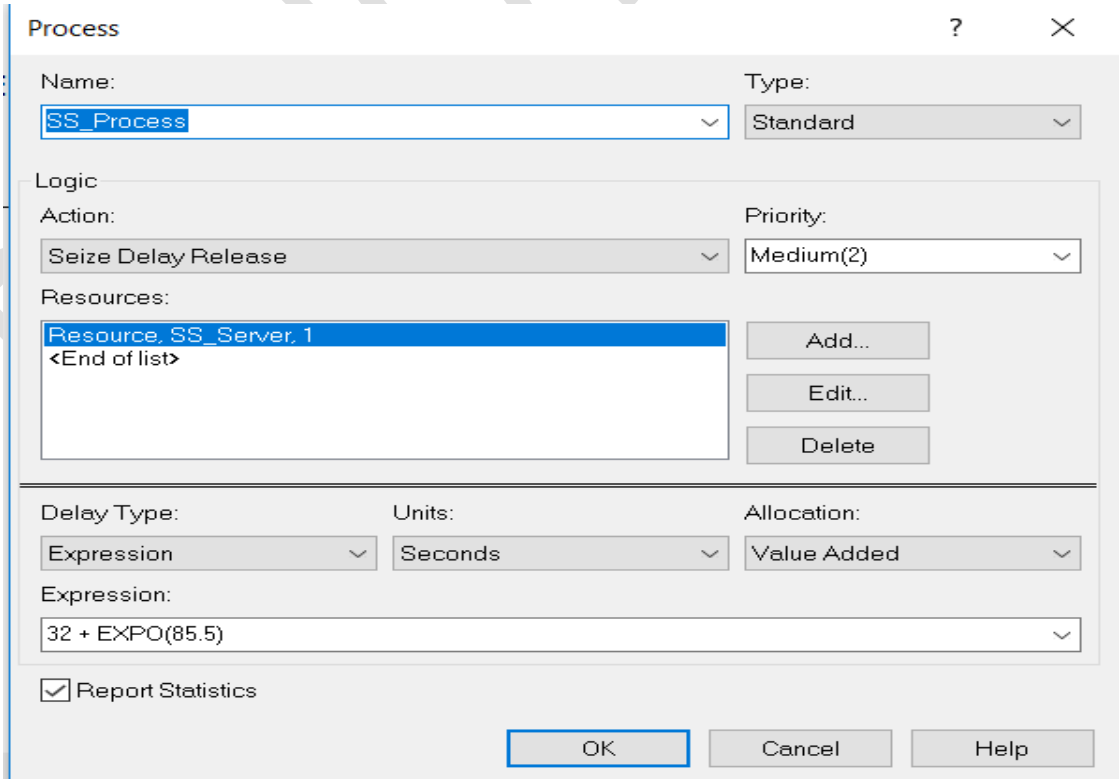
- CREATE Module is named as SS_Arrival and the entity properties are given. The expression is mentioned as 32 + EXPO(85.5)which is obtained from the fitted distribution from the input analyzer and units are mentioned as seconds. The number of entities per arrival are given as 1 based on the system function and the maximum of arrivals is noted as infinite.



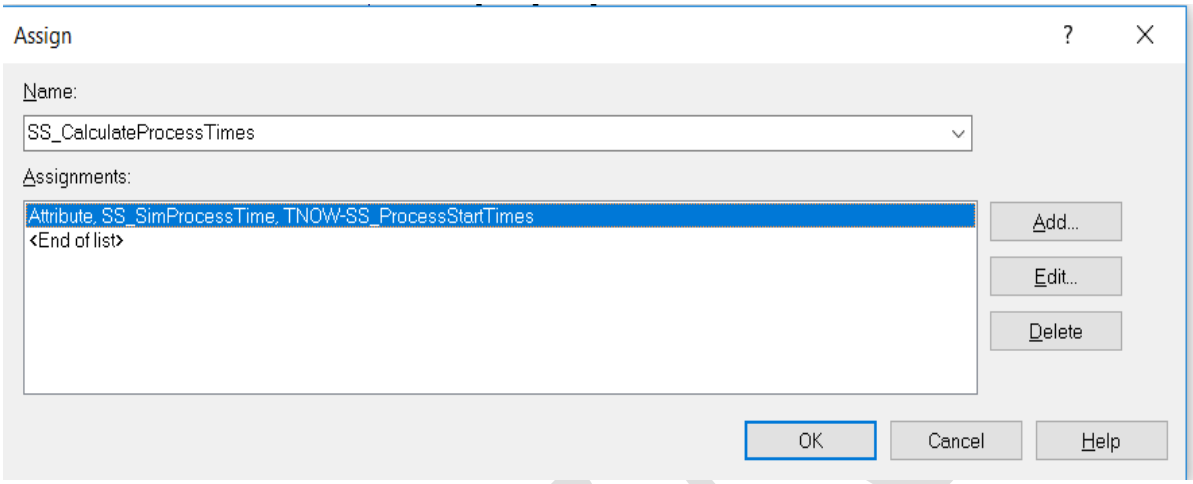
- The first Assign module is used for counting the starting times of the service and named as SS_CreatingProcessStartingTimes. The assigned attribute is named as SS_ProcessStartTimes with a new value as TNOW.



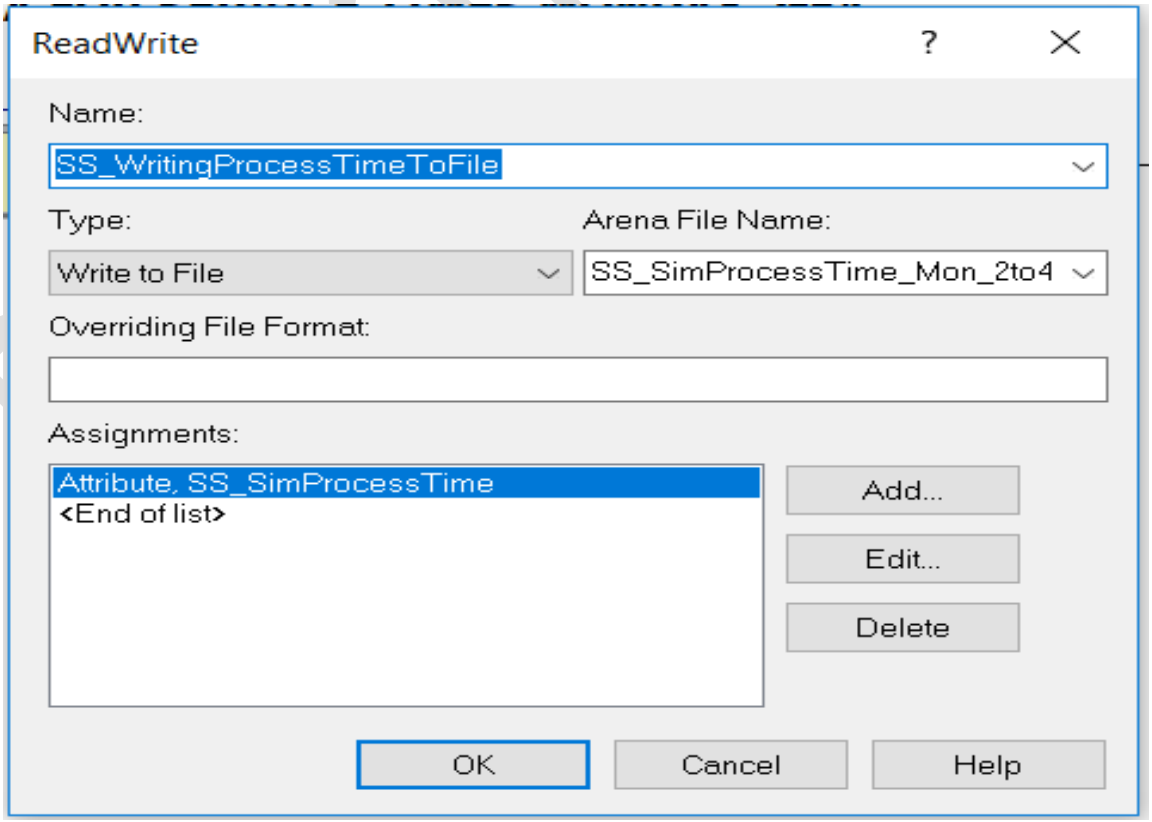
- The process module is named as SS_Process with a logic of SiezeDelayRelease type of action and the resource here is SS_Server and the number of units to be seized or released are taken as 1 as per the system functioning. The delay type is taken with an expression as in Create Module and units are mentioned in seconds.



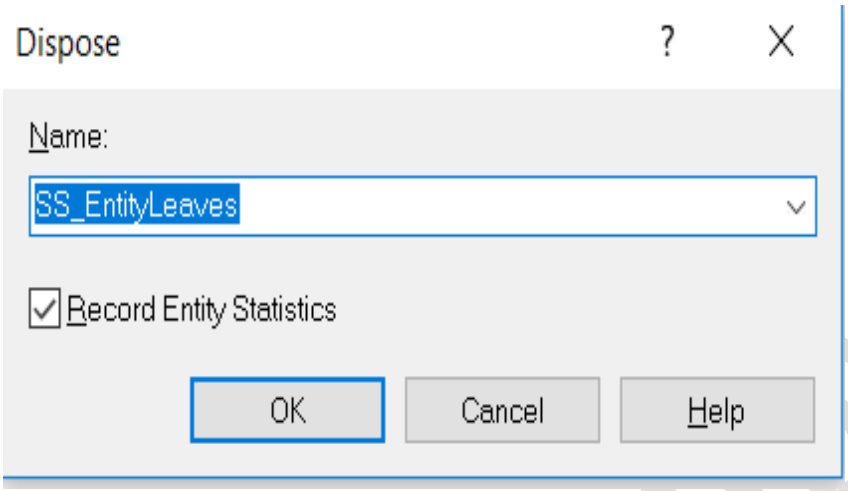
- The second Assign module is to calculate the total process time by subtracting the starting times from TNOW value. The module is named as SS_CalculateProcessTImes. The assigned attribute is named as SS_SimProcessTime with a new value of TNOW-SS_ProcessStartTimes.



- The READ/WRITE Module is used for writing the generated simulated service times to an external file and is saved. The assigned attribute here is named as SS_SimProcessTime.



- The DISPOSE module is named as SS_EntityLeaves.

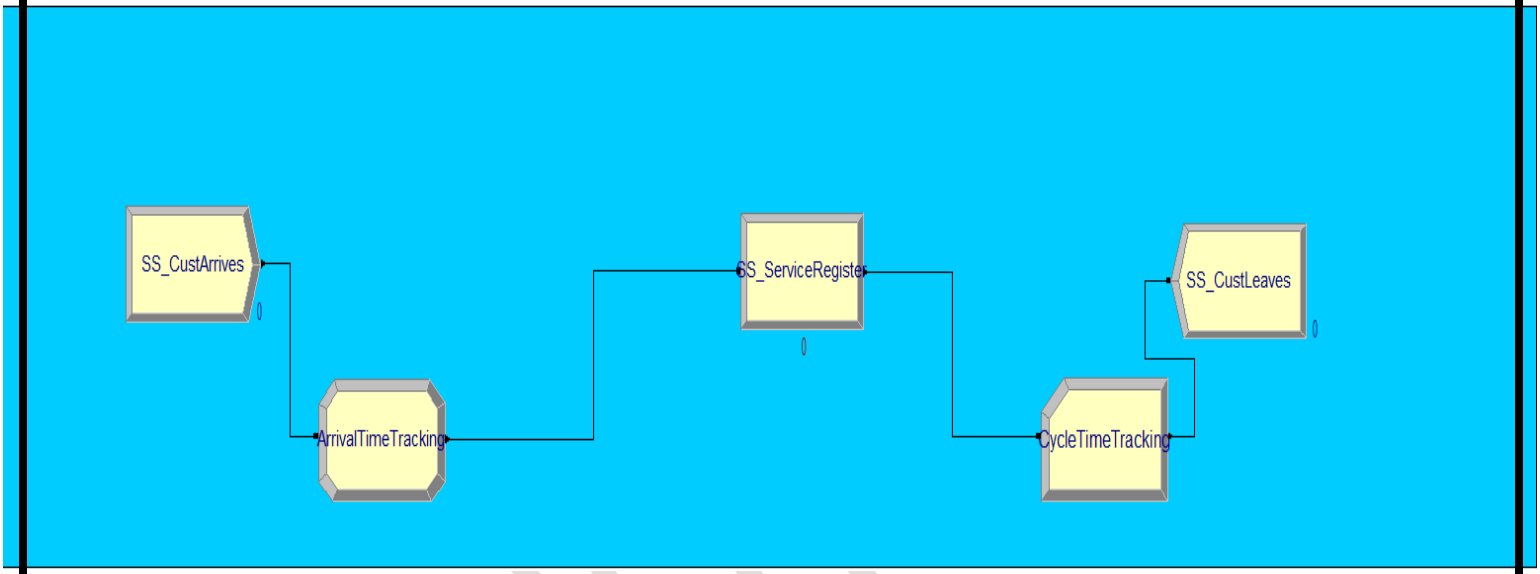


6.3) DEVELOPED ARENA MODEL FOR USPS SYSTEM:

In the United States, Postal Service System located in West Haven, Connecticut, the type of process used to serve its customers is “Single Queue Single Server”. According to the system we observed, following is the picture of model developed in the ARENA software:

SIMULATION MODEL ON UNITED STATES POSTAL SERVICE

By TEAM SUPER SIMULATION

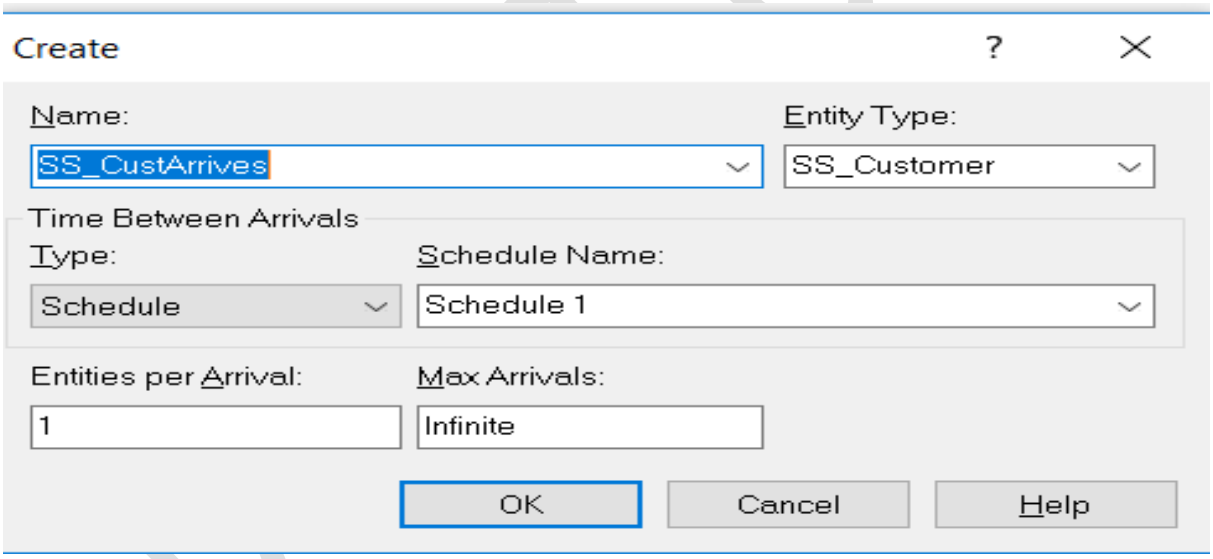


In our system, the entrance and the exit are the same. Here, the customer enters into the system as proceeds towards the queue to get the postal service. The customer waits in the queue and gets the service in First In First Out Queue model. After getting the service from the only server available, customer exits the system. As per this existing process in the system, we have developed a model of the system in the ARENA platform.

For this, we have used 1 CREATE Module, 1 ASSIGN Module, 1 PROCESS Module, 1 RECORD Module and 1 DISPOSE Module. Following is the detailed explanation of each module and the properties incorporated in it.

6.3.1 CREATE MODULE:

The Create Module is used to define the entity properties and is named as SS_CustArrives. The entity in this named as SS_Customer and the type of arrivals is chosen to the SCHEDULE type as we are going to conduct simulation for the entire 5 business days to a total of 40 hours. So the schedule is separately defined using the SCHEDULE Module. The number of entities per arrival is 1 and the maximum is infinite.



6.3.2 SCHEDULE MODULE:

Schedule - Basic Process

	Name	Type	Time Units	Scale Factor	File Name	Durations
1	Schedule 1	Arrival	Hours	1.0		15 rows

Double-click here to add a new row.

ess panel selected.

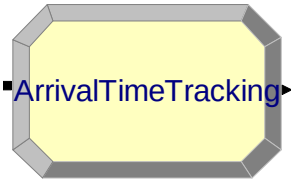
	Value	Duration
1	3600/(-0.001 + 393 * BETA(0.707,	2.66
2	3600/(-0.001 + WEIB(118, 1.1))	2.66
3	3600/(-0.001 + GAMM(125, 0.924))	2.66
4	3600/(-0.001 + 393 * BETA(0.707,	2.66
5	3600/(-0.001 + WEIB(118, 1.1))	2.66
6	3600/(-0.001 + GAMM(125, 0.924))	2.66
7	3600/(-0.001 + 461 * BETA(0.526,	2.66
8	3600/(-0.001 + EXPO(113))	2.66
9	3600/(-0.001 + 419 * BETA(0.761,	2.66
10	3600/(-0.001 + 461 * BETA(0.526,	2.66
11	3600/(-0.001 + EXPO(113))	2.66
12	3600/(-0.001 + 419 * BETA(0.761,	2.66
13	3600/(-0.001 + EXPO(126))	2.66
14	3600/(-0.001 + 328 * BETA(0.673,	2.66
15	3600/(-0.001 + WEIB(111, 0.846))	2.66

2.66

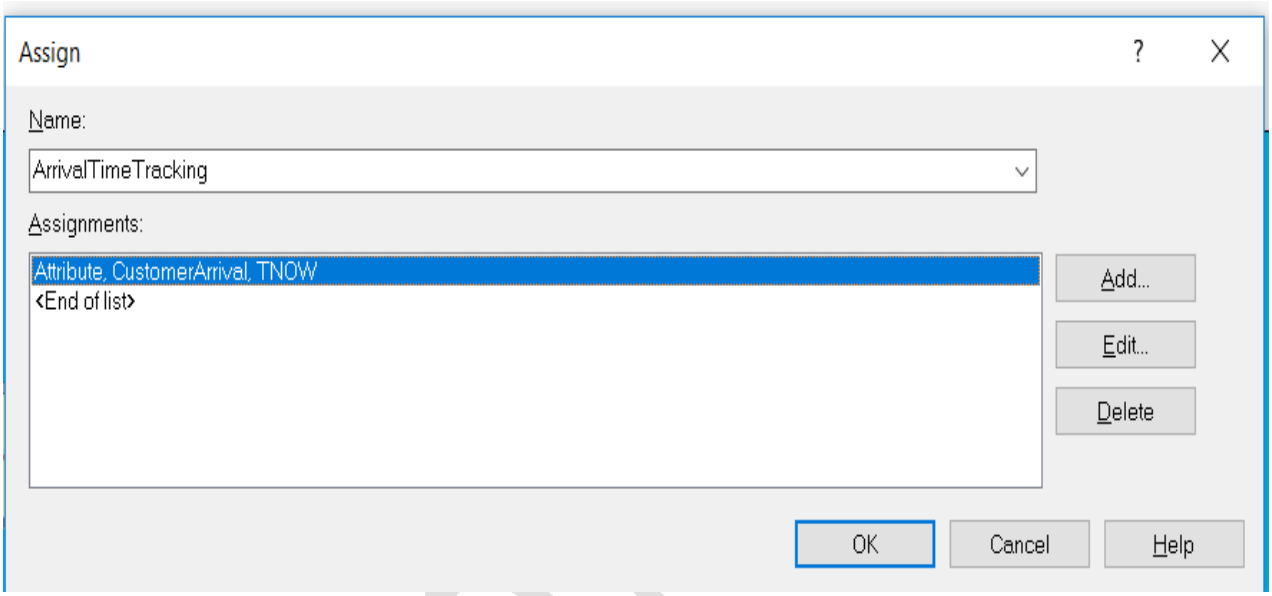
In the above-defined SCHEDULE characteristics, it is to be noted that, as our system works for 40 hours per week and as we have collected data at 3 different timings on each day, we need 15 rows to schedule the entire week. As the data is validated and found to be in the same distributions and similar to the generated simulated data, we have considered the data on Monday to be same for Tuesday and the data on Wednesday to be same for Thursday.

As we have collected our data in seconds and need to convert it into hours, we have noted the value to 3600/(expression of that distribution) for every data set. Since our system works for 8 hours a day and there are 3-time slots, each time slot is comprised of 2.66 hours. By using these characteristics, the performance metrics will be generated.

6.3.3. *ASSIGN MODULE:*



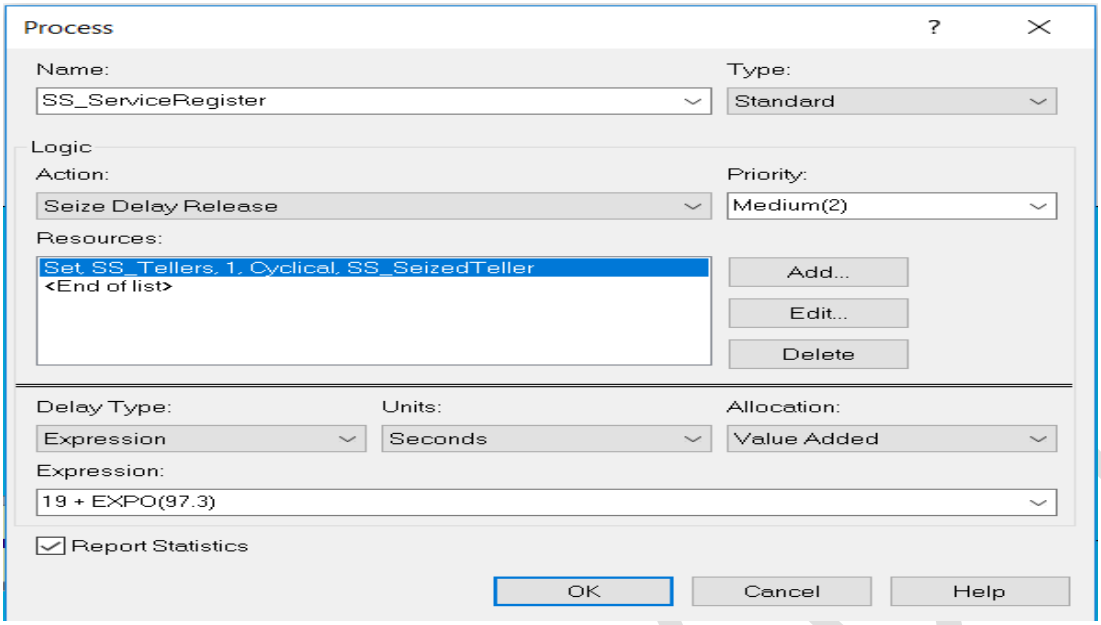
The Assign Module is used to note the arrival time of the customer into the queue. So the assign module is named as ArrivalTImeTracking in our system. The assigned Attribute is named as CustomerArrival with a new value as TNOW.



6.3.4 .PROCESS MODULE:

The process in our system is, as soon as the customer enters the system, he/she joins the single queue and waits for the server to be free where the employee is serving the previous customer. Once the customer turn comes, he/she avails the service and then finally leaves the

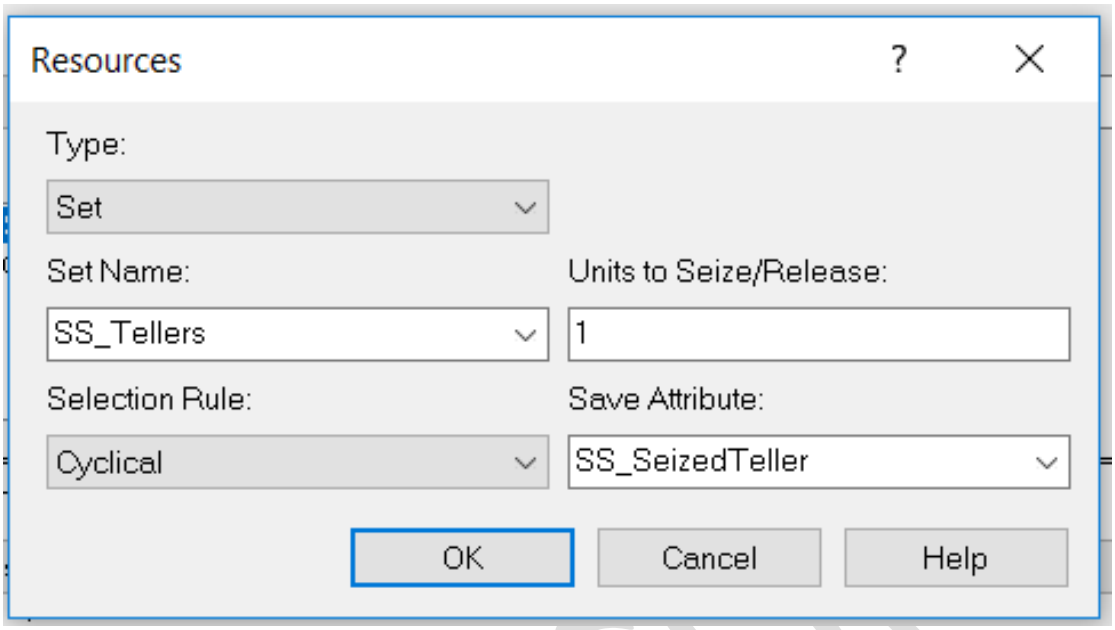
system. Hence, the process type adopted here in the system is Seize Delay Release type:



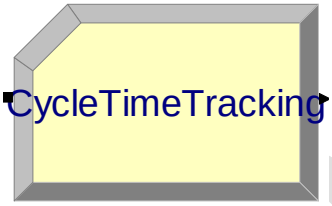
The above picture shows the properties of the PROCESS Module we incorporated in the model. The module is named as SS_ServerRegister with a Standard Type. As per the system's process, the action logic is defined as SeizeDelayRelease.

As the system has single employee working in the single register, the resource is named as SS_Tellers with a value 1. The Delay type is defined to be an expression which is the distributed expression we got for the service times in the server times analyzer.

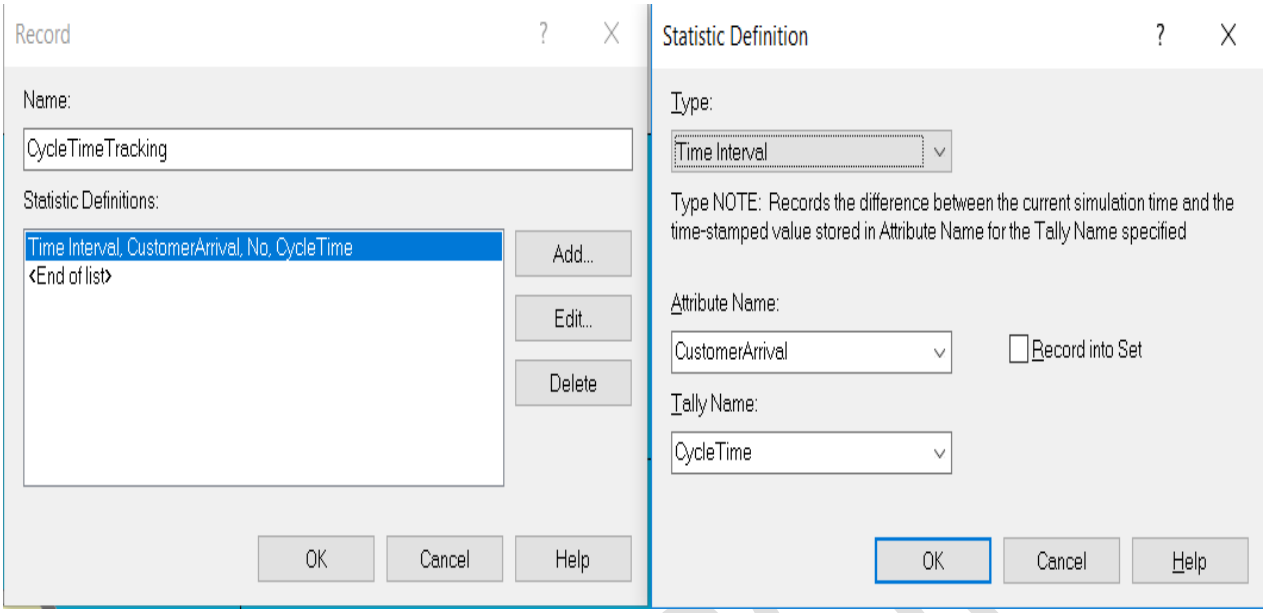
To calculate the number of customers arriving into the system and leaving the system we need to define the resource type as Set and named as SS_Tellers. Units to be Seized or Released is mentioned as 1 as per the system's functionality. As there is a single server and customer enters, get the service and leaves the system, the selection rule is chosen as Cyclical and the attribute is saved as SS_SeizedTeller.



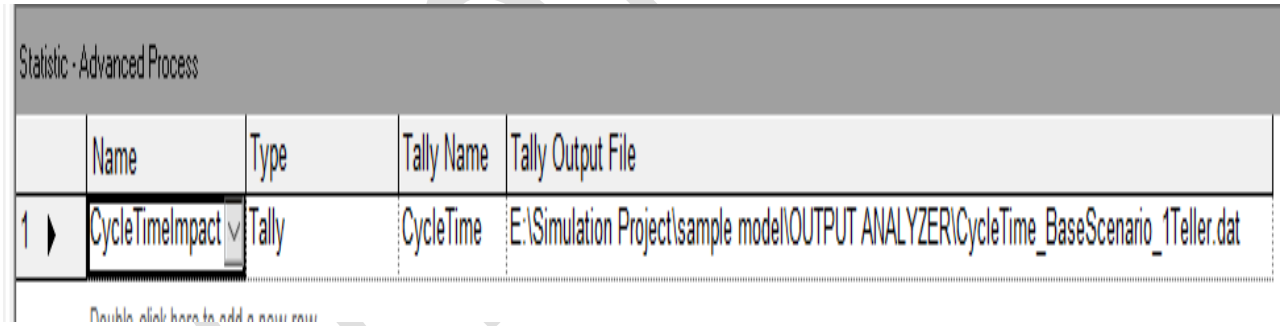
6.3.5 RECORD MODULE:



Record Module is used to record the statistics of the cycle time in the system and it is named as CycleTimeTracking.



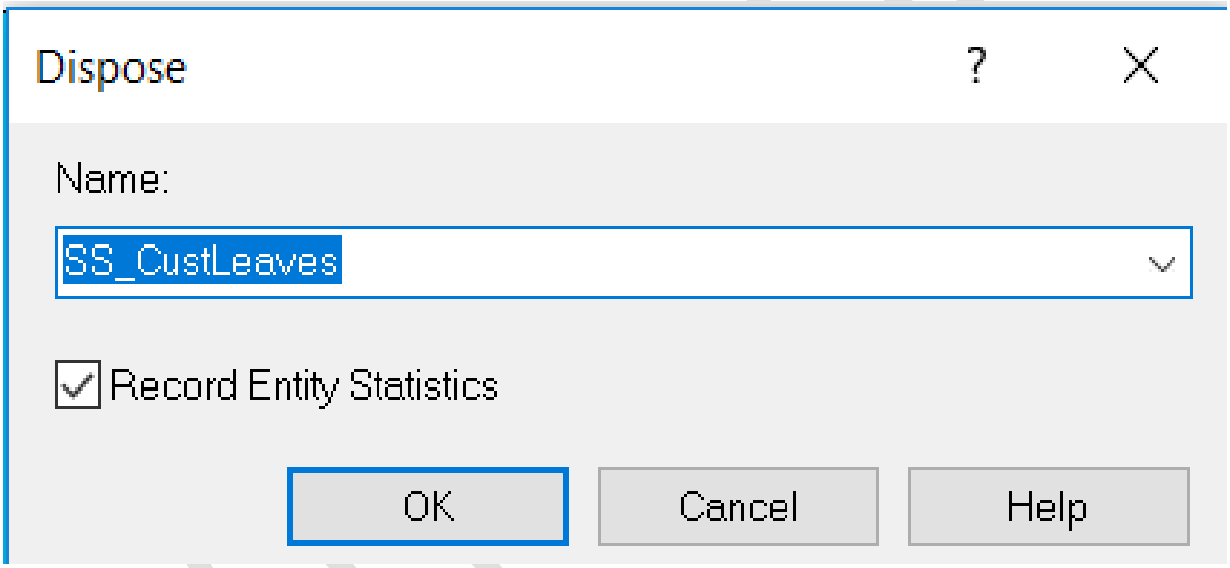
The statistical definition is Time Interval type. The attribute is CustomerArrival and the Tally Name is Cycle Time. These properties define the statistical data to be collected.



- When observed from the above picture, the Statistics thus collected need to be saved in an external file with .dat extension. These files are saved as per different scenarios we opt and each file is saved separately for each scenario.
- All these files are used to study the system with different proposed scenarios in OUTPUT Analyzer.

6.3.6 DISPOSE MODULE:

Dispose Module is named as SS_CustLeaves. All the customers who got the service leaves the system and those exits are recorded in this module which is as shown below:



7. MODEL VALIDATION:

To validate our model, we need to generate simulated arrival times and simulated service times using ARENA. From the simulated arrival times, we calculate the inter-arrival times. Using these interarrival times and service times generated in ARENA, we need to compare with the actual data collected from the system.

We have generated the simulated arrival and service times as it is described in detail in sections 6.1 and 6.2 of this report. Then we have validated our actual data with the simulated

data in SPSS tool. We checked for the normality and homogeneity of the data. For this the null hypothesis we consider is “All means are equal” and “All variances are equal”

7.1) *SPSS Analysis for Arrival Times:*

7.1.1) *SPSS Analysis for Monday for 9am to 11am.*

Test of Homogeneity of Variances

INTARRTIMES

Levene Statistic	df1	df2	Sig.
.057	1	11463	.812

Significance level =0.812 > 0.005, do not reject the null hypothesis. So, variances are equal, ANOVA can be used.

ANOVA

INTARRTIMES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	133.189	1	133.189	.029	.864
Within Groups	51860392.674	11463	4524.155		
Total	51860525.863	11464			

Sigma=0.864 > 0.05, the null hypothesis is not rejected. There is no significant difference between the two datasets. Model output is valid of interarrival times

7.1.2) SPSS Analysis for Monday for 12pm to 2pm.

Test of Homogeneity of Variances

INTARRTIMES

Levene Statistic	df1	df2	Sig.
.049	1	11463	.824

Sigma =0.824 > 0.005, do not reject the null hypothesis. So, variances are equal, ANOVA can be used.

ANOVA

INTARRTIMES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	114.097	1	114.097	.028	.866
Within Groups	46105386.618	11463	4022.105		
Total	46105500.716	11464			

Sigma=0.866 > 0.05, the null hypothesis is not rejected. There is no significant difference between the two datasets. Model output is valid of inter arrival times.

7.1.3) *SPSS Analysis for Monday for 2pm to 4pm.*

Test of Homogeneity of Variances

INTARRTIMES

Levene Statistic	df1	df2	Sig.
.047	1	12286	.828

Sigma =0.828 > 0.005, do not reject the null hypothesis. So, variances are equal, ANOVA can be used.

ANOVA

INTARRTIMES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	125.994	1	125.994	.030	.863
Within Groups	51872977.022	12286	4222.121		
Total	51873103.016	12287			

Sigma=0.863 > 0.05, the null hypothesis is not rejected. There is no significant difference between the two datasets. Model output is valid of inter-arrival times.

7.1.4. SPSS Analysis for Wednesday for 9am to 11am.

Test of Homogeneity of Variances

INTARRTIMES

Levene Statistic	df1	df2	Sig.
.058	1	9903	.810

Sigma =0.81 > 0.005, do not reject the null hypothesis. So, variances are equal, ANOVA can be used.

ANOVA

INTARRTIMES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	193.727	1	193.727	.037	.848
Within Groups	51877884.305	9903	5238.603		
Total	51878078.032	9904			

Sigma=0.848 > 0.05, the null hypothesis is not rejected. There is no significant difference between the two datasets. Model output is valid of inter-arrival times.

7.1.5 SPSS Analysis for Wednesday for 12pm to 2pm.

Test of Homogeneity of Variances

INTARRTIMES

Levene Statistic	df1	df2	Sig.
.050	1	12286	.824

Sigma =0.824 > 0.005, do not reject the null hypothesis. So, variances are equal, ANOVA can be used.

ANOVA

INTARRTIMES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	129.115	1	129.115	.031	.861
Within Groups	51779591.235	12286	4214.520		
Total	51779720.350	12287			

Sigma=0.861 > 0.05, the null hypothesis is not rejected. There is no significant difference between the two datasets. Model output is valid of inter-arrival times.

7.1.6 SPSS Analysis for Wednesday for 2pm to 4pm.

Test of Homogeneity of Variances

INTARRTIMES

Levene Statistic	df1	df2	Sig.
.057	1	10925	.812

Sigma =0.812 > 0.005, do not reject the null hypothesis. So, variances are equal, ANOVA can be used.

ANOVA

INTARRTIMES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	151.209	1	151.209	.032	.858
Within Groups	51839903.763	10925	4745.071		
Total	51840054.971	10926			

Sigma=0.858 > 0.05, the null hypothesis is not rejected. There is no significant difference between the two datasets. Model output is valid of inter-arrival times.

7.1.7 SPSS Analysis for Friday for 9am to 11am.

Test of Homogeneity of Variances

INTARRTIMES

Levene Statistic	df1	df2	Sig.
.046	1	11683	.830

Sigma =0.83 > 0.005, do not reject the null hypothesis. So, variances are equal, ANOVA can be used.

ANOVA

INTARRTIMES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	144.032	1	144.032	.032	.857
Within Groups	51849735.049	11683	4438.050		
Total	51849879.081	11684			

Sigma=0.857 > 0.05, the null hypothesis is not rejected. There is no significant difference between the two datasets. Model output is valid of inter-arrival times.

7.1.8 SPSS Analysis for Friday for 12pm to 2pm.

Test of Homogeneity of Variances

INTARRTIMES

Levene Statistic	df1	df2	Sig.
.046	1	13617	.831

Sigma =0.831 > 0.005, do not reject the null hypothesis. So, variances are equal, ANOVA can be used.

ANOVA

INTARRTIMES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	100.216	1	100.216	.026	.871
Within Groups	51839623.762	13617	3806.978		
Total	51839723.979	13618			

Sigma=0.871 > 0.05, the null hypothesis is not rejected. There is no significant difference between the two datasets. Model output is valid of inter-arrival times.

7.1.9 SPSS Analysis for Friday for 2pm to 4pm.

Test of Homogeneity of Variances

INTARRTIMES

Levene Statistic	df1	df2	Sig.
.043	1	12186	.837

Sigma =0.837 > 0.005, do not reject the null hypothesis. So, variances are equal, ANOVA can be used.

ANOVA

INTARRTIMES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	128.452	1	128.452	.030	.862
Within Groups	51878364.769	12186	4257.210		
Total	51878493.221	12187			

Sigma=0.862 > 0.05, the null hypothesis is not rejected. There is no significant difference between the two datasets. Model output is valid of inter-arrival times.

7.2) SPSS Analysis for Service Times

7.2.1) SPSS Service times on Monday:

We have considered Monday to analyze our service times. Since the distributions for all the three-time slots on Monday is Expo, we have combined the data of the 3 slots on Monday and analyzed it.

Test of Homogeneity of Variances

SERVICE TIMES

Levene Statistic	df1	df2	Sig.
.146	1	12368	.702

Sigma =0.702 > 0.005, do not reject the null hypothesis. So, variances are equal, ANOVA can be used.

ANOVA

SERVICE TIMES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	508.158	1	508.158	.121	.728
Within Groups	51873291.997	12368	4194.154		
Total	51873800.154	12369			

Sigma=0.728 > 0.05, the null hypothesis is not rejected. There is no significant difference between the two datasets. Model output is valid of service times.

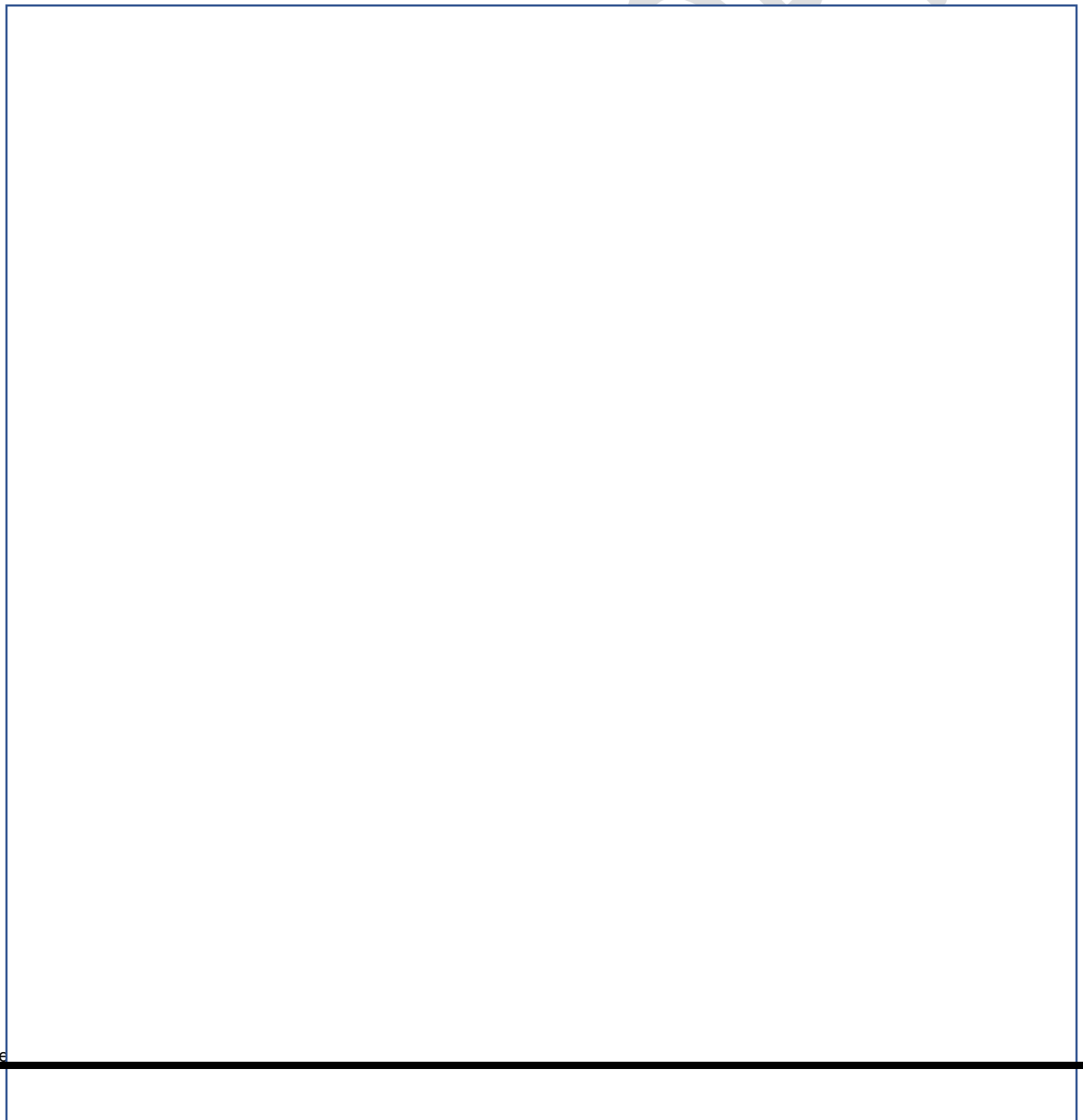
8. INITIAL PERFORMANCE ANALYSIS:

8.1) *BASE MODEL*: Once the model is designed and checked for no errors, it is made to run with 10 replications with 8 hours per day and 40 hours as replication length. Base time is given in minutes. Now for the base model which has 1 teller in the system, the following are the ARENA reports for 1 teller:

Key Performance Indicators

System

	Average
Number Out	1,203



Values Across All Replications

USPS ANALYSIS_SCENARIO_1TELLERS

Replications: 10 Time Units: Minutes

Entity

Time

VA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_Customer	1.9414	0.03	1.8811	1.9855	0.3167	15.3320

NVA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_Customer	0.00	0.00	0.00	0.00	0.00	0.00

Wait Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_Customer	696.97	197.35	347.65	1113.69	0.00	2257.17

Transfer Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_Customer	0.00	0.00	0.00	0.00	0.00	0.00

Other Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_Customer	0.00	0.00	0.00	0.00	0.00	0.00

Total Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_Customer	698.91	197.35	349.60	1115.60	0.3333	2258.12

Other

Number In	Average	Half Width	Minimum Average	Maximum Average
SS_Customer	29540.60	38,334.60	3671.00	172587.00

Number Out	Average	Half Width	Minimum Average	Maximum Average
SS_Customer	1203.00	23.83	1136.00	1253.00

WIP	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_Customer	15446.68	23,387.52	902.31	105188.49	0.00	171413.00

Values Across All Replications

USPS ANALYSIS_SCENARIO_1TELLERS

Replications: 10 Time Units: Minutes

Process

Time per Entity

VA Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_ServiceRegister	1.9414	0.03	1.8811	1.9855	0.3167	15.3320

Wait Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_ServiceRegister	696.97	197.35	347.65	1113.69	0.00	2257.17

Total Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_ServiceRegister	698.91	197.35	349.60	1115.60	0.3333	2258.12

Accumulated Time

Accum VA Time	Average	Half Width	Minimum Average	Maximum Average
SS_ServiceRegister	2334.97	42.31	2255.48	2399.72

Accum Wait Time	Average	Half Width	Minimum Average	Maximum Average
SS_ServiceRegister	839576.43	243,701.27	425868.01	1395452.65

Other

Number In	Average	Half Width	Minimum Average	Maximum Average
SS_ServiceRegister	29540.60	38,334.60	3671.00	172587.00

Number Out	Average	Half Width	Minimum Average	Maximum Average
SS_ServiceRegister	1203.00	23.83	1136.00	1253.00

Values Across All Replications

USPS ANALYSIS_SCENARIO_1TELLERS

Replications: 10 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_ServiceRegister.Queue	697.67	197.45	348.15	1114.60	0.00	2257.80

Other

Number Waiting	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
SS_ServiceRegister.Queue	15445.71	23,387.52	901.36	105187.52	0.00	171412.00

Resource

Usage

Instantaneous Utilization	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Employee	0.9735	0.02	0.9405	1.0000	0.00	1.0000

Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Employee	0.9735	0.02	0.9405	1.0000	0.00	1.0000

Number Scheduled	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Employee	1.0000	0.00	1.0000	1.0000	1.0000	1.0000

Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average
Employee	0.9735	0.02	0.9405	1.0000

Total Number Seized	Average	Half Width	Minimum Average	Maximum Average
Employee	1204.00	23.83	1137.00	1254.00

User Specified

Tally

Interval	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
CycleTime	698.91	197.35	349.60	1115.60	0.3333	2258.12

8.2) *PROBLEMS OBSERVED*:

- The total time customer is in the system is high as it has 696.97 minutes as average.
- The no of customer being served are 1203 on an average.
- The queue length is very high having an average of 15445.71

Hence the main problem is due to system with only one server and huge number of customers.

We have thus developed a model and proposed few scenarios to improve the performance metrics of the system. So, that with the best proposed scenario, the customer total time in the system, queue length and customer waiting time would be decreased and number of customers out can be increased.

9. PROPOSED PERFORMANCE IMPROVEMENT SCENARIOS:

As per the performance metrics studied and problems observed from the system performance reports generated by ARENA, we are hereby proposing 2 scenarios to improve the performance levels of the system. They are:

i. System with 2 Tellers
ii. System with 3 Tellers

We are limiting the proposal of increasing the number of tellers to 3 and not more because of the physical area available in the system

10. TEST OF THE SCENARIOS:

10.1). PROCESS ANALYZER (PAN):

PAN is an ARENA tool to analyze the performance metrics of the base model and different scenarios proposed by the model developer. This tool helps us to evaluate the results of different scenarios all at once, compare them with each other along with the base scenario and then choose the best adaptable scenario to improve the system performance.

By adding controls and different types of responses from all the scenarios, strong analysis can be done. In our model, we have 2 proposed scenarios along with the base scenario. They are:

Base Scenario : System with 1 teller

Scenario 1 : System with 2 tellers

Scenario 2 : System with 3 tellers

Running this tool requires to add all the scenarios into the analyzer along with the .p file of the base model created when the base model is executed. After adding all the scenarios into the tool, we need to add controls. The controls added are:

i. Number of employees
ii. Number of replications

Once the controls are added, we need to add the responses. The responses added are:

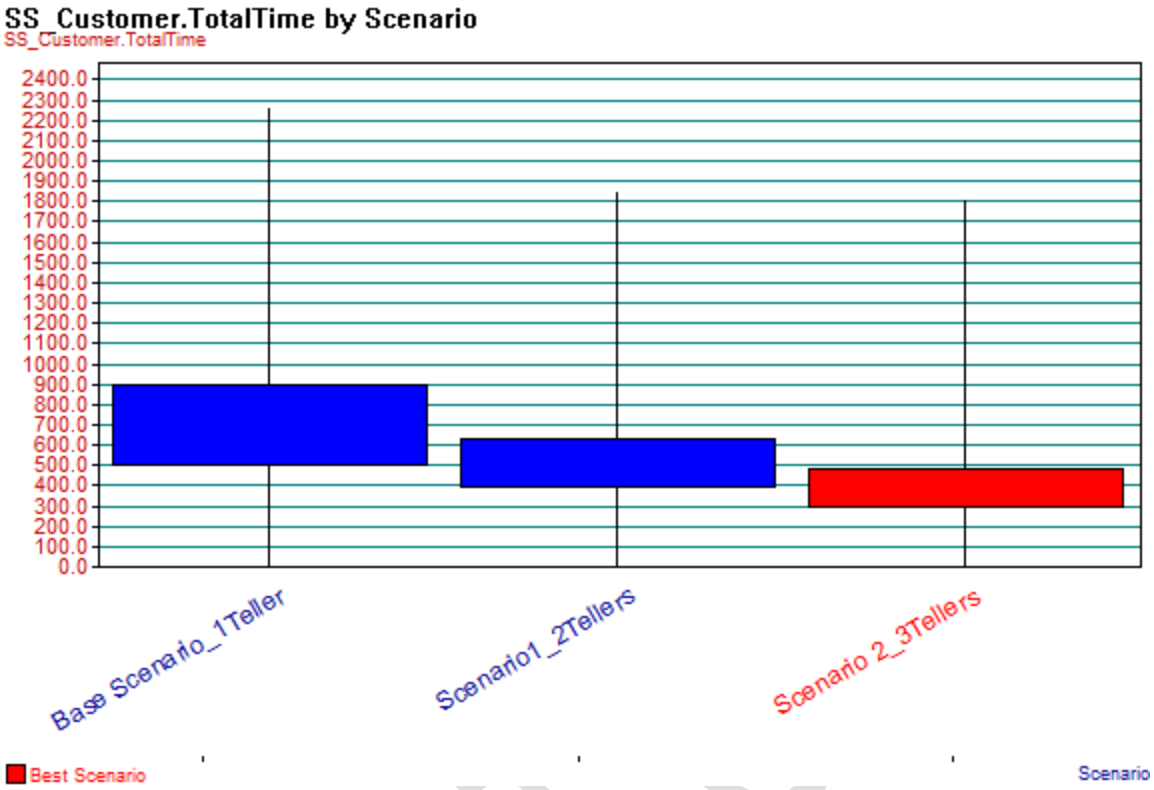
i. Customer total time
ii. Employee Utilization
iii. Total waiting time in the queue
iv. Number of customers out (who got the service and took an exit)
v. Cycle Time

Following is the screenshot of the PAN window after adding all the scenarios, controls and responses:

	Scenario Properties			Controls				Responses		
	S	Name	Program File	Reps	Employee	Num Reps	SS_Customer.TotalTime	Employee.Utilization	SS_ServiceRegister.Queue.WaitingTime	System.NumberOut	CycleTime
1		Base Scenari	1 : SIMULATI	10	1.0000	10	698.911	0.974	697.666	1203.000	698.911
2		Scenario1_2T	1 : SIMULATI	20	2.0000	20	516.106	0.904	514.760	2244.600	516.106
3		Scenario 2_3	1 : SIMULATI	30	3.0000	30	387.190	0.807	385.695	3017.233	387.190

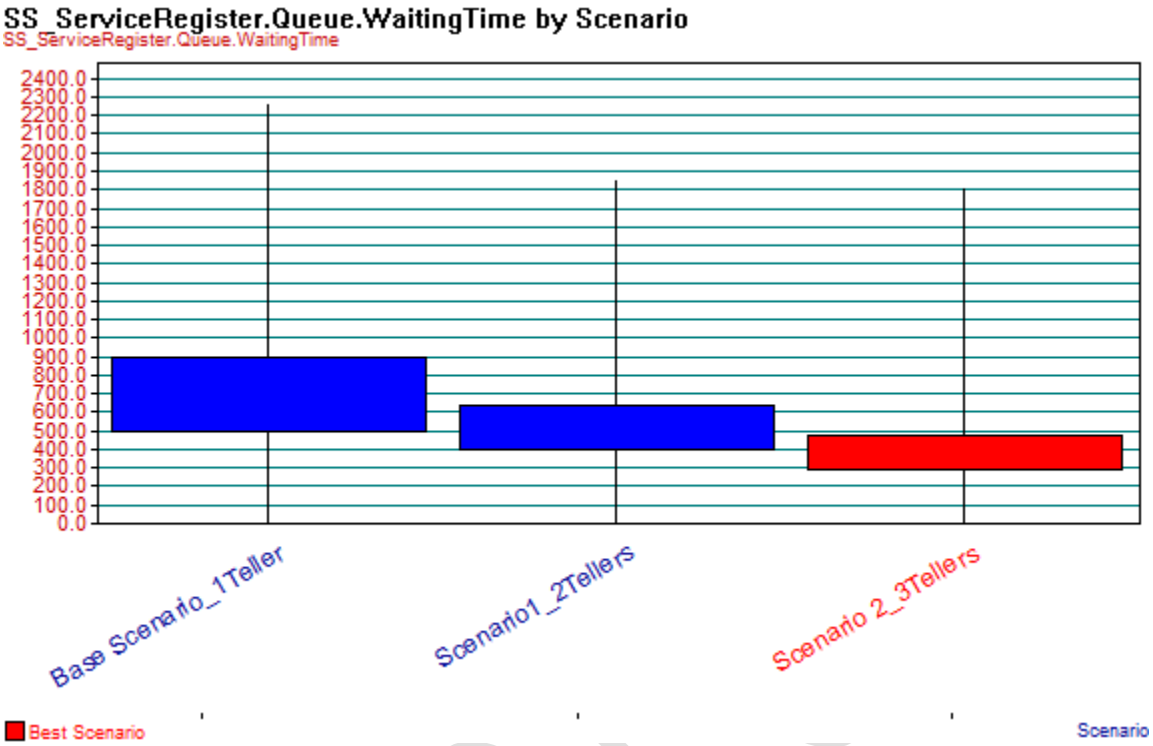
After adding all the requirements into the tool, the analyzer is set to run through all the scenarios. Now graphs related to all the responses are created to identify the best scenario. The graphs thus created are the following:

10.1.1)



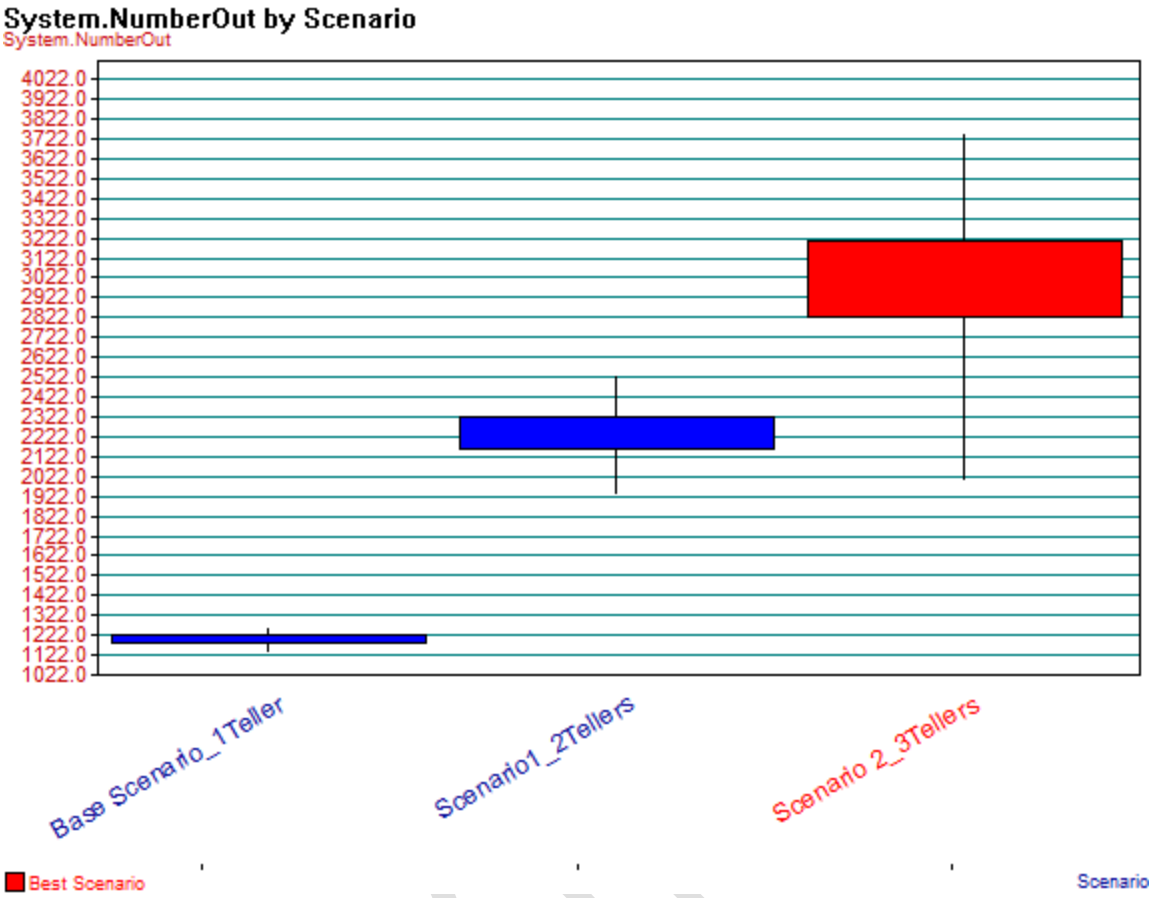
From the above graph, it is clearly evident that scenario 2 with 3 tellers is the best option to improve the performance metrics of the present system. The total time spent by the customer in the entire system is reduced with 3 tellers.

10.1.2)



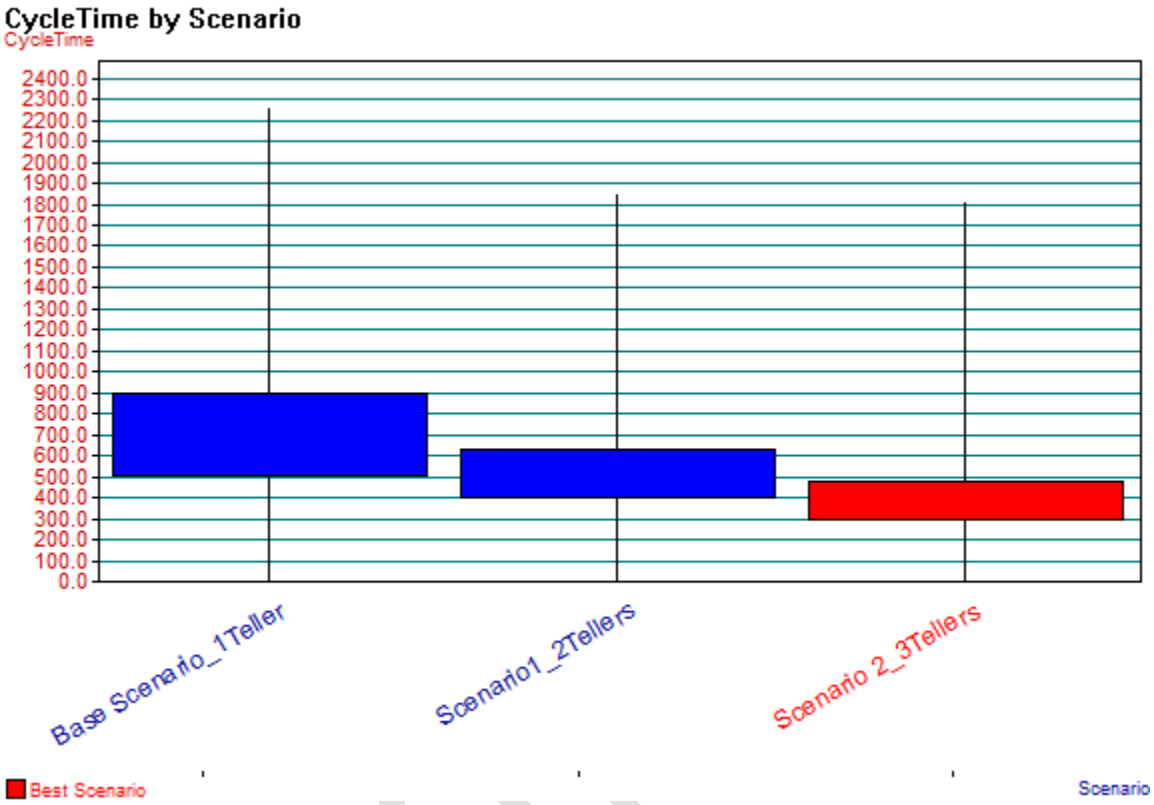
From the above graph, it is clearly evident that scenario 2 with 3 tellers is the best option to improve the performance metrics of the present system. The total time or the queue length is reduced from base scenario to the second scenario which is with 3 tellers. So the customer need not wait for long hours in the queue.

10.1.3)



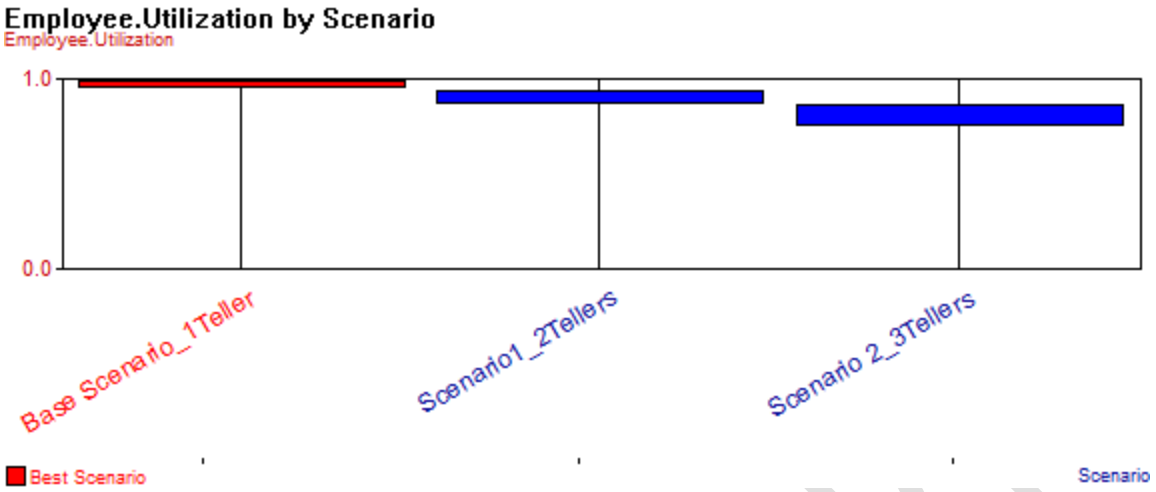
From the above graph, it is clearly evident that scenario 2 with 3 tellers is the best option to improve the performance metrics of the present system. More number of customers are being served with 3 tellers in the working hours when compared with the number of customers out with 1 teller.

10.1.4)



From the above graph, it is clearly evident that scenario 2 with 3 tellers is the best option to improve the performance metrics of the present system. The total cycle time of the customer in the system is reduced with 3 tellers.

10.1.5)



From the above graph, we can clearly understand that when the number of tellers is increased automatically, more number of customers can be served in less time and at the same time some percentage of employee utilization time will be ideal. That is the reason why the base scenario is shown as the best with 1 teller.

However, our objective is to decrease the waiting times for the customers and help the system serve more number of customers too. So, unless and until the cost is not a very stringent and unchangeable factor. The current system which is being supported by only 1 teller can be improved a lot with 3 tellers and earn more customer satisfaction and profits.

10.2) OUTPUT ANALYZER (OA):

Output analyzer is used to analyze different scenarios generated. In this model, we have proposed 2 different scenarios. They are:

Scenario 1 : System with 2 tellers

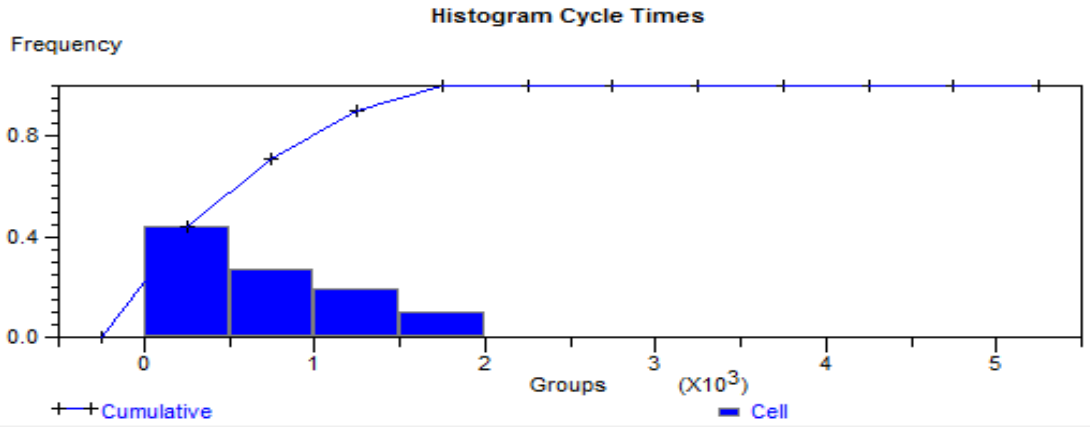
Scenario 2 : System with 3 tellers

The developed ARENA model is made to run in 3 different scenarios which is with 1 teller, 2 tellers, and 3 tellers by changing the number of resources in the Resource Module. Then in the Statistics Module, a separate file name is given to save each scenario's statistical data. The files

thus created are saved with .dat extensions. From the Output Analyzer, we create different graphs, with lumped replications, then, compare means, confidence intervals and study the cycle times.

The following are different types of graphs to analyze the cycle times:

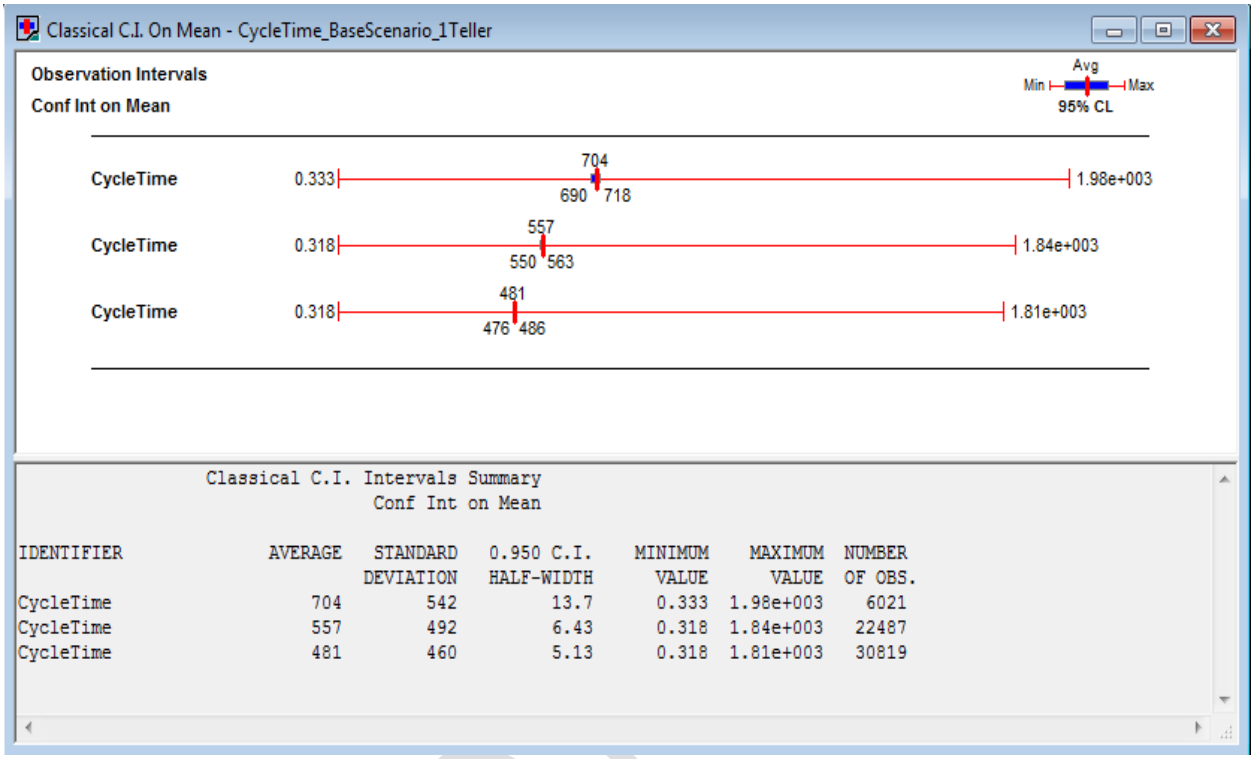
10.2.1) Histogram of Cycle Times:



Histogram Summary
Histogram Cycle Times

Cell	Cell Limits From	To	Abs. Freq. Cell	Cumul.	Rel. Freq. Cell	Cumul.
1	-Infinity	0	0	0	0	0
2	0	500	2637	2637	0.438	0.438
3	500	1000	1613	4250	0.2679	0.7059
4	1000	1500	1159	5409	0.1925	0.8984
5	1500	2000	612	6021	0.1016	1
6	2000	2500	0	6021	0	1
7	2500	3000	0	6021	0	1
8	3000	3500	0	6021	0	1
9	3500	4000	0	6021	0	1
10	4000	4500	0	6021	0	1
11	4500	5000	0	6021	0	1
12	5000	+Infinity	0	6021	0	1

10.2.2) Confidence Intervals on Mean Cycle Times:

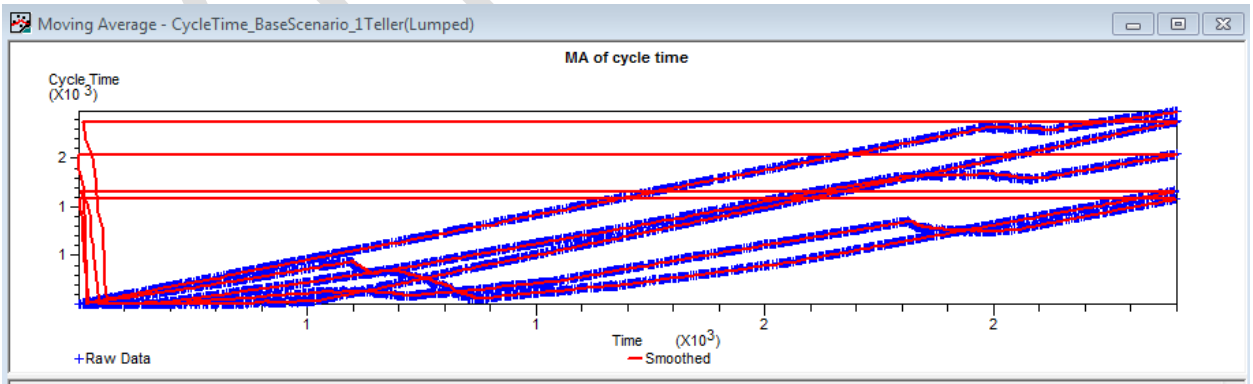


Classical C.I. Intervals Summary
Conf Int on Mean

IDENTIFIER	AVERAGE	STANDARD DEVIATION	0.950 C.I. HALF-WIDTH	MINIMUM VALUE	MAXIMUM VALUE	NUMBER OF OBS.
CycleTime	704	542	13.7	0.333	1.98e+003	6021
CycleTime	557	492	6.43	0.318	1.84e+003	22487
CycleTime	481	460	5.13	0.318	1.81e+003	30819

From the above graph, no confidence interval are overlapping. Therefore, no ANOVA test is required further to prove that means are different.

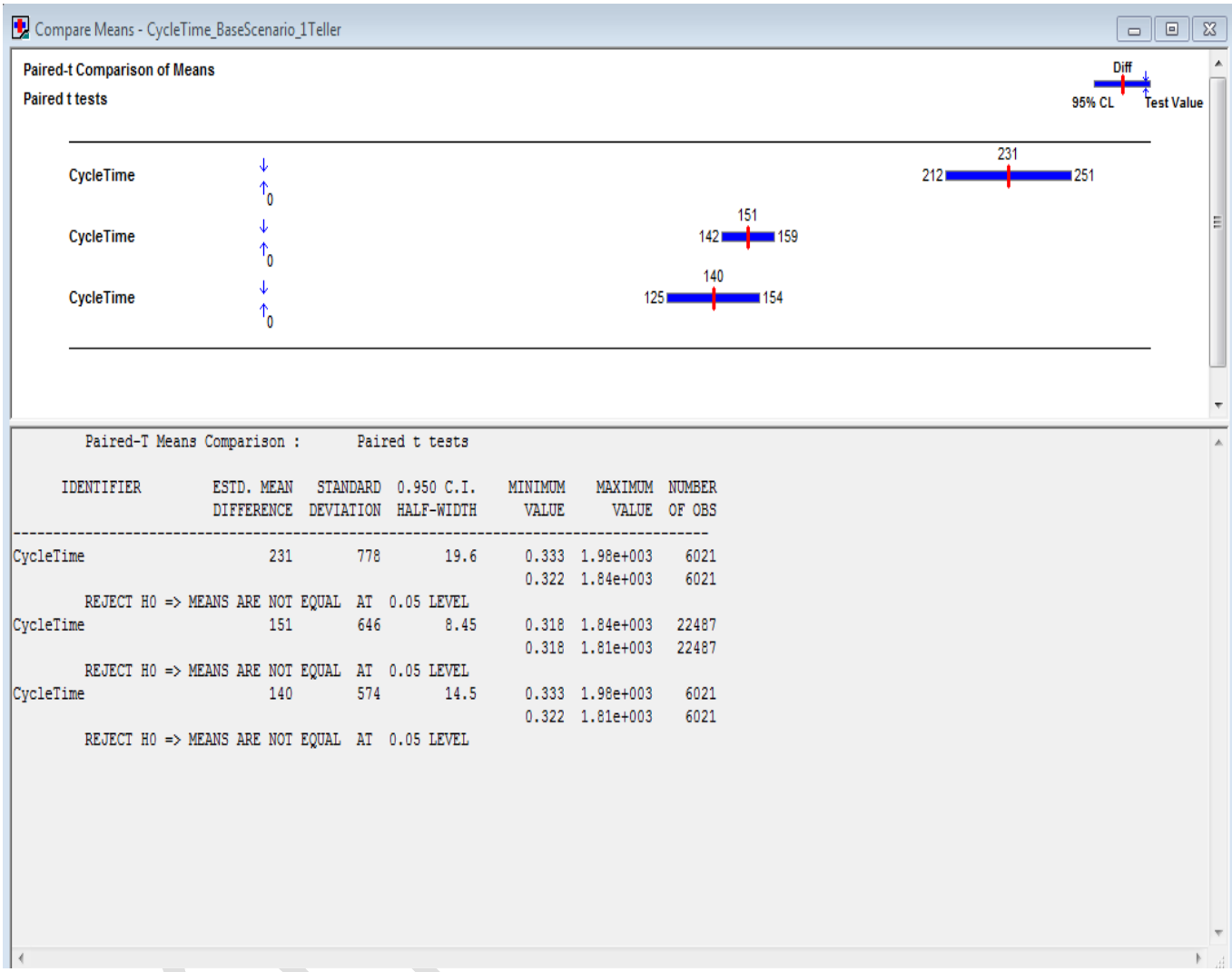
10.2.3 t-tests



Display Forecasted Values Not Selected

TOTAL ABS.DEVIATION	8.098e+004
MEAN ABS.DEVIATION	13.47
MEAN BIAS	-1.806

10.2.4) Paired t-tests:



Paired-T Means Comparison : Paired t tests

IDENTIFIER	ESTD. MEAN DIFFERENCE	STANDARD DEVIATION	0.950 C.I. HALF-WIDTH	MINIMUM VALUE	MAXIMUM VALUE	NUMBER OF OBS
CycleTime	231	778	19.6	0.333	1.98e+003	6021
				0.322	1.84e+003	6021
REJECT H0 => MEANS ARE NOT EQUAL AT 0.05 LEVEL						
CycleTime	151	646	8.45	0.318	1.84e+003	22487
				0.318	1.81e+003	22487
REJECT H0 => MEANS ARE NOT EQUAL AT 0.05 LEVEL						
CycleTime	140	574	14.5	0.333	1.98e+003	6021
				0.322	1.81e+003	6021
REJECT H0 => MEANS ARE NOT EQUAL AT 0.05 LEVEL						

From the above graph, none of the means are observed to be equal. It is also observed that the average scenario 1 has decreased the cycle time by 231 when compared to the base scenario cycle time based on the t-test.

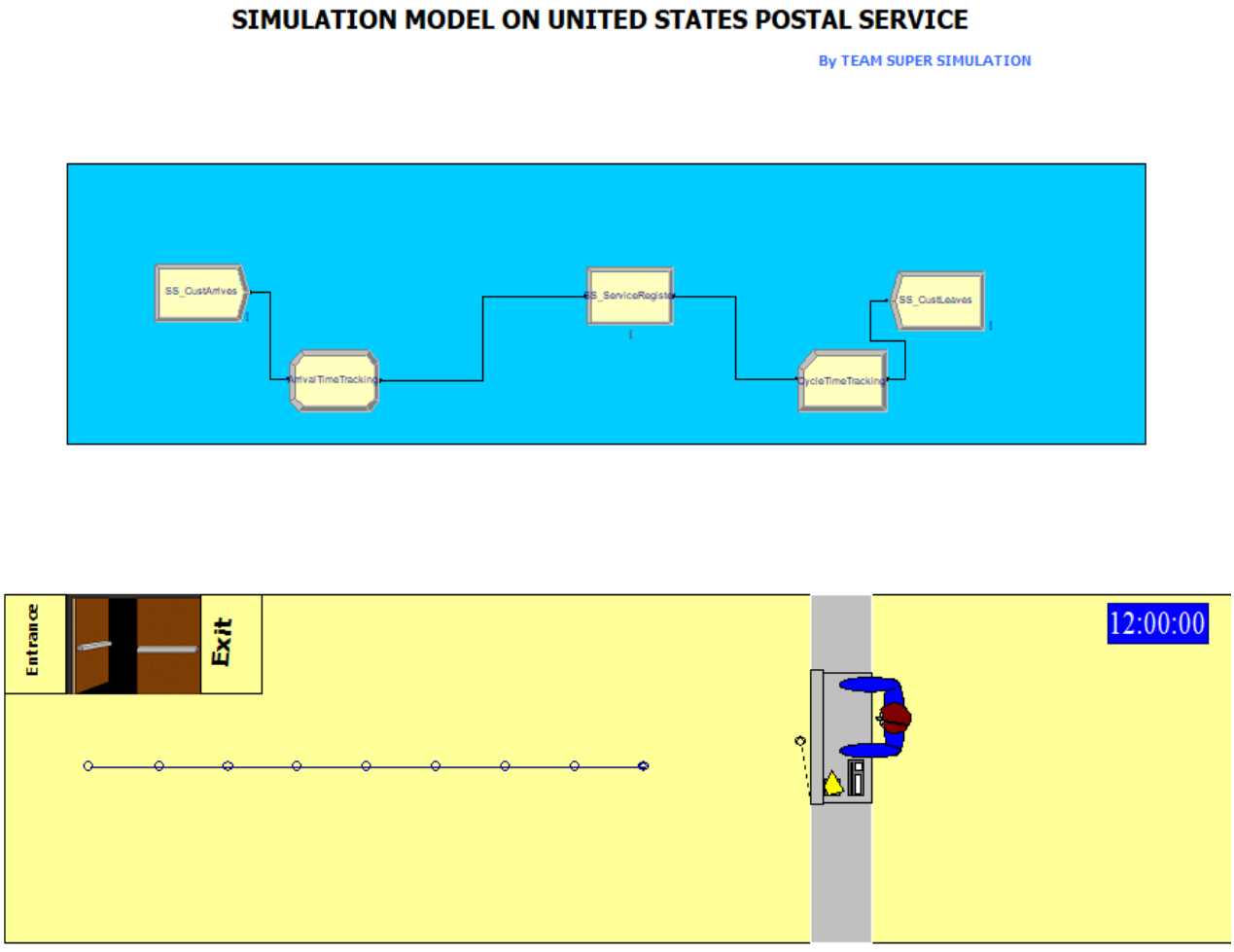
11. 2D ANIMATION:

Animation helps us to understand the system process much better as it is a graphical representation of the system. As we have single queue and single server, we have used the single queue with points where the entities are people. Then we have selected the workers module to

upload two types of workers performing task and sitting idle. The worker doing task is allotted to the system in busy state and the workers in idle state is allotted to the system in idle state.

We have also included the time at the top right which shows the arrival times of the customers. The entrance and exit are the same in the system.

The developed model along with 2D Animation is shown below:



12. COST BENEFIT ANALYSIS:

We have 1 and 2 additional tellers in our proposed scenarios. From the results discussed so far, it is very clear that there are improvements in the system performance with the increase in the number of tellers.

12.1 Cost with additional tellers.

	Tellers	Hourly Wage	Total Wage
Base Scenario	1	$30/hr	40*30=$1200
Scenario 1	2	$30/hr	2*40*30=$2400
Scenario 2	3	$30/hr	3*40*30=$3600

It can be noted from the above table that there is an increase of $1200 and $2400 in the scenario 1 and 2 respectively.

12.2 Comparison between cost and the benefit.

	Cost Increase	Number Out Increase	Queue Time Decrease (Seconds)	Increase in Income.
Scenario 1	$1200	1041.6	182.9	$2083.3
Scenario 2	$2400	1814.23	311.97	$3628.46

The above table shows the increase in cost compared to the improvement in performance metrics and the increase in income. We can safely say that the proposed scenarios are worth the investment.

13. CONCLUSIONS:

From the developed model and its Arena Reports, we have come up with 2 different scenarios to improve the performance of the system. From the extracted ARENA reports, PAN analysis results and Output Analysis results, it is observed that increasing the number of tellers will show impact on the system performance in such a way that, it increases the number of

customers out and decreases the cycle time, queue length and number of customer waiting in the queue.

Out of the 2 scenarios which are Scenario 1 to run the system with 2 tellers and Scenario 2 to run the system with 3 tellers, we have found that Scenario 3 is the better alternative. Hence if USPS, West Haven can employ 2 more tellers and have a system with 3 servers, they can improve their performance metrics and as well as improve their customer satisfaction levels.

13. EXECUTIVE SUMMARY:

We began our project with the careful selection of the project site at USPS, West Haven. This project was undertaken over a period of three months after collecting the data. We conducted our data collection process on three different days of a single week namely Monday, Wednesday, and Friday. On successfully compiling and cleaning the collected data, we proceeded with the statistical analysis of the data-sets. We found our data-sets suitable for creating the simulation model by comparing it with simulated data from ARENA. The data was found to be normal and homogeneous. Our team created a model for the system and we ran the simulation for two different scenarios aimed at improving the productivity of the system. The project proved to be an enriching learning experience for us and we hope that our findings can bring about a positive change for USPS, West Haven.

14. BIBLIOGRAPHY

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