Jurnal Sistem Teknik Industri
Journal homepage: https://talenta.usu.ac.id/jsti

Analysis of the Queuing System in XYZ Food Industry in Batam City (Case Study of Queuing Time Observation)

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ARTICLE INFO
Article history:
Received 6 June 2024
Revised 17 July 2024
Accepted 20 July 2024
Available online 29 July 2024

E-ISSN: 2527-9408
P-ISSN: 1411-5247

How to cite:
Putera, D. A., Dermawan, A. A., Lawi, A., Saputra, P. T., Pane, A. N. K., & Maulidina, S. N. (2024). Analysis of the Queuing System in XYZ Food Industry in Batam City (Case Study of Queuing Time Observation). *Jurnal Sistem Teknik Industri*, 26(2), 242-257.

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https://doi.org/10.32734/jsti.v26i2.16688

ABSTRACT
This study analyzes the queuing system at XYZ fast food restaurant in Batam City to improve service efficiency and customer satisfaction. Observations were conducted over eight hours on Saturday, April 6th, 2024, from 2:00 PM to 10:00 PM. Data collected included arrival patterns, service time, and customer wait time. Using the queuing model [M/G/2/FIFO/4/∞], it was found that two servers are optimal. The average customer wait time in the system is 4.938 minutes, which is lower than the customer's aspirational wait time of 10 minutes. The system's utility reached 84.33%, indicating sufficient efficiency. Practical recommendations for XYZ fast food restaurant management are to maintain two servers to reduce wait time and increase customer satisfaction.
Keyword: Batam, Fast-food Restaurant, Queuing Analysis, Queuing Theory

ABSTRAK
Penelitian ini menganalisis sistem antrian di restoran cepat saji XYZ di Kota Batam untuk meningkatkan efisiensi layanan dan kepuasan pelanggan. Observasi dilakukan selama delapan jam pada hari Sabtu, 6 April 2024, dari pukul 14.00 hingga 22.00 WIB. Data yang dikumpulkan mencakup pola kedatangan, waktu pelayanan, dan waktu tunggu pelanggan. Dengan menggunakan model antrian [M/G/2/FIFO/4/∞], ditemukan bahwa dua server adalah yang optimal. Waktu tunggu rata-rata pelanggan dalam sistem adalah 4,938 menit, yang lebih rendah dari waktu aspirasi pelanggan sebesar 10 menit. Utilitas sistem mencapai 84,33%, yang menunjukkan efisiensi yang cukup baik. Rekomendasi praktis untuk manajemen restoran cepat saji XYZ adalah mempertahankan dua server untuk mengurangi waktu tunggu dan meningkatkan kepuasan pelanggan.
Kata Kunci: Analisis Antrian, Batam, Restoran Cepat Saji, Teori Antrian

1. Introduction

In the dynamic [1] and competitive landscape of the fast food industry, efficient management of operations is critical for ensuring customer satisfaction and maintaining profitability [2]. One of the core challenges in this sector is managing customer wait times, which directly impacts the customer experience [3]. Effective management theory suggests that operational efficiency and customer service quality are pivotal for business success [4]. This involves not only strategic planning and resource allocation but also the application of specific theories, such as queuing theory, to optimize service delivery processes [5].

Queues are an integral part of daily life [4], manifesting in various scenarios such as purchasing movie tickets, banking transactions, cashier payments, and parcel deliveries. Waiting is an inevitable component of many operational activities, which are inherently random in nature [6]. Queuing theory is the study of these waiting processes in various forms. This theory is employed to identify the optimal number of servers required to service customers within a system, while queuing models represent the different types of queuing systems encountered in practice [7]. The formulas within these models reflect the performance of the system, including average waiting time estimates under varying constraints. By utilizing queuing theory, bottlenecks within these systems can be identified [8].

In practical application, queuing modelling typically follows either an analytical or simulation path, depending on the background of the modeler [9]. Each path may be inadequate if used alone: the analytical approach requires assumptions that may not always be realistic, while the simulation approach risks overfitting or developing overly complex solutions for simple problems [10]. The combined use of numerical methods and "formula-like" simulations is highly appealing in practical situations. The importance of integrating analytical and simulation approaches in research and application presents a strong argument for a new discipline in queuing modelling [11]. This discipline can harness the combined strengths of both approaches to address queuing issues in research and practice [12].

The fast food industry is particularly sensitive to queuing issues due to the high volume of customer traffic and the need for quick service. Inefficient queuing systems can lead to increased wait times, decreased customer satisfaction, and ultimately, a loss in revenue. In this context, optimizing the queuing system is crucial for maintaining operational efficiency and ensuring customer satisfaction [13]. At XYZ fast food restaurant in Batam City, long queues have been observed during peak hours, causing significant delays and frustration among customers. This not only impacts customer satisfaction but also affects the overall turnover and profitability of the restaurant.

Technological advancements [14] offer promising solutions to these challenges [15]. For instance, the implementation of automated queuing systems, digital menu boards, and mobile ordering apps can significantly reduce wait times and improve service efficiency [16]. This study aims to harness both traditional queuing theory and contemporary digital solutions such as automated queuing systems, digital menu displays, and mobile ordering applications to enhance the queuing system at XYZ fast food restaurant.

Based on these considerations, an analysis of the queuing system at XYZ fast food restaurant in Batam City was conducted. The queue observation aimed to determine the optimal number of servers for the ordering system at XYZ. The observation was carried out over an eight-hour period, collecting data on customer arrival times, service times, and departure times. The data collected was then processed and analyzed to determine the optimal number of servers required, the existing queuing system model, and other relevant analyses of the queuing system.

This study employs quantitative methods to achieve a comprehensive understanding of the queuing dynamics [15], [17] at restaurant XYZ. Observational data is combined with statistical analysis to model the queuing system accurately. The findings from this research are expected to provide practical recommendations for the management of XYZ fast food restaurant, helping them to streamline their operations, integrate appropriate technologies, and enhance the overall customer experience.

In previous research studies, several studies were used as references for the implementation of this research, as shown in Table 1.

Table 1. State of the Art

No	Title	Author	Method	Places	Country
1	Impact of application of queuing theory on operational efficiency of patient registration [18]	Meeta Tyagi et. al	Queuing Theory	Hospital	India
2	Queuing Theory: Contributions and Applications in the Field of Health Service Management – A Bibliometric Approach [5]	A.B. Santos, R.D. Calado, A.C.S. Ze ferino,S.C. Bourgu ignon	Queuing Theory	Health Service	Brazil
3	Pricing for urban areas using queuing theory [19]	John Rios et al.	Queuing Theory	Parking Lot	Canada
4	Modeling taxi drivers' decisions at airport based on queueing theory [20]	Wen Jia	Queuing Theory	Airport	China
5	Analytical modelling of a vehicular ad hoc network using queueing theory models and the notion of channel availability [21]	I. Keramidi, D. Uz unidis, I. Moschol ios, M. Logothetis, P. Sarigiannidis	Queuing Theory	Network	USA

Queuing system analysis in fast food restaurants is rarely conducted in Batam City, according to the literature reviewed as a reference for this research. This study is necessary to improve the service strategies for fast food restaurants in Batam in managing customer service.

2. Methodology

2.1. Research Flowchart

In our study, the queuing system observed is situated at the XYZ fast food restaurant, focusing specifically on the order and service counters during peak hours from 2:00 PM to 10:00 PM. The boundaries of the study are confined to the customer interaction points, including order placement and pickup areas, ensuring a focused analysis of queuing dynamics within these zones. We made several assumptions for the sake of analysis: firstly, that all customers decide to stay in the queue until served, ignoring potential drop-outs due to long wait times; secondly, we assumed a steady arrival rate of customers without significant fluctuations typical of non-peak hours. Our activity sequence commenced with a systematic collection of data on customer arrivals, service times, and queue lengths, followed by an application of the [M/G/2/FIFO/4/∞] queuing model to determine optimal service efficiencies. This was supplemented by simulation techniques to validate our analytical models and ensure robustness of the recommendations provided for operational improvements.

The research flow can be seen in Figure 1, which begins with a literature review and field study and ends with drawing conclusions from the research results.

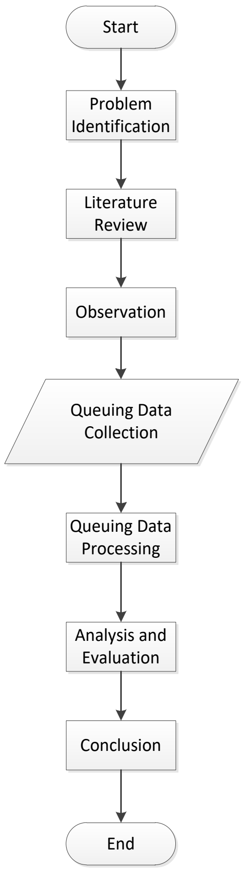

Figure 1. Flowchart

2.2. Data Collection

The queuing system observed is located on Gajah Mada Street, Tiban Lama, Sekupang. The queue observed involves the servers responsible for serving customers. There are two servers being observed. The service discipline applied in this queuing system is First In First Out (FIFO) can be seen in Figure 2.

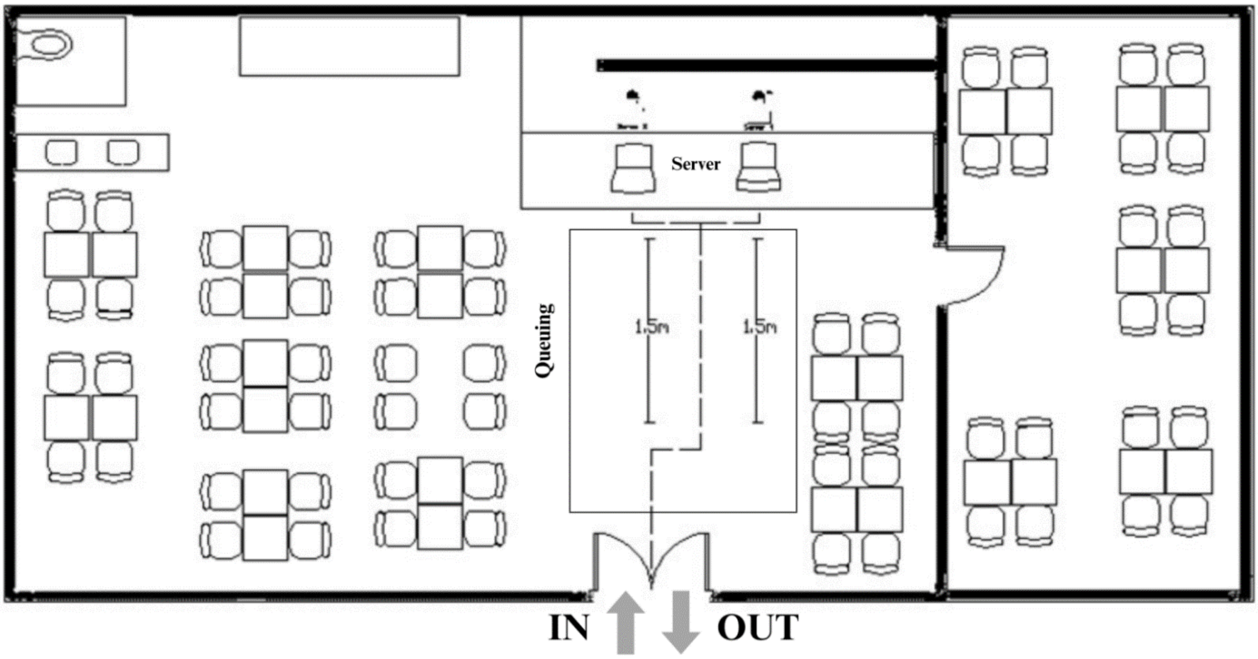

Figure 2. Layout Fastfood Restaurant

The results of observations on the arrival frequency within a 6-minute interval are as follows:

Table 2. Arrival Frequency Data

No	Interval			Amount of Customer		Total of Customer
				Server 1	Server 2	
1	14:00:00	-	14:05:59	0	0	0
2	14:06:00	-	14:11:59	1	1	2
3	14:12:00	-	14:17:59	2	1	3
4	14:18:00	-	14:23:59	1	1	2
5	14:24:00	-	14:29:59	2	2	4
6	14:30:00	-	14:35:59	1	1	2
7	14:36:00	-	14:41:59	1	2	3
8	14:42:00	-	14:47:59	1	2	3
9	14:48:00	-	14:53:59	3	2	5
10	14:54:00	-	14:59:59	1	1	2
11	15:00:00	-	15:05:59	3	2	5
12	15:06:00	-	15:11:59	1	1	2
13	15:12:00	-	15:17:59	1	1	2
14	15:18:00	-	15:23:59	1	1	2
15	15:24:00	-	15:29:59	1	1	2
16	15:30:00	-	15:35:59	0	3	3
17	15:36:00	-	15:41:59	1	2	3
18	15:42:00	-	15:47:59	1	2	3
19	15:48:00	-	15:53:59	1	0	1
20	15:54:00	-	15:59:59	1	3	4
21	16:00:00	-	16:05:59	1	1	2
22	16:06:00	-	16:11:59	1	2	3
23	16:12:00	-	16:17:59	0	1	1
24	16:18:00	-	16:23:59	2	1	3
25	16:24:00	-	16:29:59	1	2	3
26	16:30:00	-	16:35:59	3	2	5
27	16:36:00	-	16:41:59	1	2	3
28	16:42:00	-	16:47:59	3	3	6
29	16:48:00	-	16:53:59	1	2	3
30	16:54:00	-	16:59:59	1	1	2
31	17:00:00	-	17:05:59	1	1	2
32	17:06:00	-	17:11:59	0	0	0
33	17:12:00	-	17:17:59	2	0	2
34	17:18:00	-	17:23:59	2	2	4
35	17:24:00	-	17:29:59	1	2	3
36	17:30:00	-	17:35:59	2	1	3
37	17:36:00	-	17:41:59	0	2	2

No	Interval			Amount of Customer		Total of Customer
				Server 1	Server 2	
38	17:42:00	-	17:47:59	1	1	2
39	17:48:00	-	17:53:59	0	2	2
40	17:54:00	-	17:59:59	1	1	2
41	18:00:00	-	18:05:59	3	1	4
42	18:06:00	-	18:11:59	2	1	3
43	18:12:00	-	18:17:59	2	2	4
44	18:18:00	-	18:23:59	2	2	4
45	18:24:00	-	18:29:59	1	1	2
46	18:30:00	-	18:35:59	2	2	4
47	18:36:00	-	18:41:59	1	2	3
48	18:42:00	-	18:47:59	1	1	2
49	18:48:00	-	18:53:59	2	2	4
50	18:54:00	-	18:59:59	2	2	4
51	19:00:00	-	19:05:59	3	2	5
52	19:06:00	-	19:11:59	2	2	4
53	19:12:00	-	19:17:59	2	2	4
54	19:18:00	-	19:23:59	1	2	3
55	19:24:00	-	19:29:59	4	3	7
56	19:30:00	-	19:35:59	1	3	4
57	19:36:00	-	19:41:59	2	1	3
58	19:42:00	-	19:47:59	1	2	3
59	19:48:00	-	19:53:59	2	1	3
60	19:54:00	-	19:59:59	2	1	3
61	20:00:00	-	20:05:59	2	1	3
62	20:06:00	-	20:11:59	0	2	2
63	20:12:00	-	20:17:59	3	1	4
64	20:18:00	-	20:23:59	1	1	2
65	20:24:00	-	20:29:59	1	2	3
66	20:30:00	-	20:35:59	2	0	2
67	20:36:00	-	20:41:59	1	2	3
68	20:42:00	-	20:47:59	1	2	3
69	20:48:00	-	20:53:59	1	1	2
70	20:54:00	-	20:59:59	2	1	3
71	21:00:00	-	21:05:59	1	1	2
72	21:06:00	-	21:11:59	2	2	4
73	21:12:00	-	21:17:59	1	0	1
74	21:18:00	-	21:23:59	2	2	4
75	21:24:00	-	21:29:59	1	2	3
76	21:30:00	-	21:35:59	2	1	3
77	21:36:00	-	21:41:59	1	2	3
78	21:42:00	-	21:47:59	2	2	4
79	21:48:00	-	21:53:59	2	1	3
80	21:54:00	-	21:59:59	0	1	1

Inter-arrival time data is obtained from the time difference between the arrival of the first customer and the second customer, the second customer and the third customer, and so on. The observed inter-arrival time data can be seen in Table 3.

Table 3. Inter-arrival Time

No	Arrival Time	Time Difference	Inter-Arrival Time (Minutes)	No	Arrival Time	Time Difference	Inter-Arrival Time (Minutes)
1	14:09:05	-	-	16	14:35:26	00:06:11	6.1833
2	14:11:33	00:02:28	2.4667	17	14:41:58	00:06:32	6.5333
3	14:16:55	00:05:22	5.3667	18	14:44:10	00:02:12	2.2
4	14:17:02	00:00:07	0.1167	19	14:45:26	00:01:16	1.2667
5	14:17:40	00:00:38	0.6333	20	14:46:12	00:00:46	0.7667
6	14:18:57	00:01:17	1.2833	21	14:47:58	00:01:46	1.7667
7	14:21:28	00:02:31	2.5167	22	14:48:17	00:00:19	0.3167
8	14:22:25	00:00:57	0.95	23	14:50:07	00:01:50	1.8333
9	14:22:36	00:00:11	0.1833	24	14:50:44	00:00:37	0.6167
10	14:23:00	00:00:24	0.4	25	14:51:02	00:00:18	0.3
11	14:25:13	00:02:13	2.2167	26	14:52:58	00:01:56	1.9333
12	14:27:08	00:01:55	1.9167	27	14:52:59	00:00:01	0.0167
13	14:28:42	00:01:34	1.5667	28	14:53:10	00:00:12	0.2
14	14:28:44	00:00:02	0.0033	29	14:53:15	00:00:05	0.0833
15	14:29:15	00:00:33	0.55	30	14:55:10	00:01:55	1.9167

No	Arrival Time	Time Difference	Inter-Arrival Time (Minutes)	No	Arrival Time	Time Difference	Inter-Arrival Time (Minutes)
31	15:00:05	00:04:55	4.9167	98	17:31:40	00:01:37	1.6167
32	15:02:40	00:02:35	2.5833	99	17:35:29	00:03:49	3.8167
33	15:11:05	00:08:25	8.4167	100	17:36:38	00:01:09	1.15
34	15:11:09	00:00:04	0.0667	101	17:42:40	00:06:02	6.0333
35	15:11:17	00:00:08	0.1333	102	17:43:20	00:00:40	0.6667
36	15:15:08	00:03:51	3.85	103	17:49:30	00:06:10	6.1667
37	15:20:20	00:05:12	5.2	104	17:52:31	00:03:01	3.0167
38	15:22:15	00:01:55	1.9167	105	17:56:15	00:03:44	3.7333
39	15:26:15	00:04:00	4	106	17:57:18	00:01:03	1.05
40	15:29:37	00:03:22	3.3667	107	18:01:19	00:04:01	4.0167
41	15:31:25	00:01:48	1.8	108	18:02:16	00:00:57	0.95
42	15:33:15	00:01:50	1.8333	109	18:02:30	00:00:14	0.2333
43	15:36:12	00:02:57	2.95	110	18:02:56	00:00:26	0.4333
44	15:39:28	00:03:16	3.2667	111	18:03:40	00:00:44	0.7333
45	15:41:48	00:02:20	2.3333	112	18:09:50	00:06:10	6.1667
46	15:41:52	00:00:04	0.0667	113	18:11:44	00:01:54	1.9
47	15:46:35	00:04:43	4.7167	114	18:13:59	00:02:15	2.25
48	15:47:02	00:00:27	0.45	115	18:14:43	00:00:44	0.7333
49	15:49:50	00:02:48	2.8	116	18:14:47	00:00:04	0.0667
50	15:54:20	00:04:30	4.5	117	18:15:09	00:00:22	0.3667
51	15:56:01	00:01:41	1.6833	118	18:17:08	00:01:59	1.9833
52	15:57:40	00:01:39	1.65	119	18:18:32	00:01:24	1.4
53	15:58:10	00:00:30	0.5	120	18:18:42	00:00:10	0.1667
54	16:03:40	00:05:30	5.5	121	18:21:48	00:03:06	3.1
55	16:04:32	00:00:52	0.8667	122	18:25:02	00:03:14	3.2333
56	16:05:42	00:01:10	1.1667	123	18:26:38	00:01:36	1.6
57	16:05:47	00:00:05	0.0833	124	18:29:41	00:03:03	3.05
58	16:09:42	00:03:55	3.9167	125	18:30:32	00:00:51	0.85
59	16:10:29	00:00:47	0.7833	126	18:33:39	00:03:07	3.1167
60	16:11:20	00:00:51	0.85	127	18:34:01	00:00:22	0.3667
61	16:13:24	00:02:04	2.0667	128	18:35:12	00:01:11	1.1833
62	16:14:00	00:00:36	0.6	129	18:37:19	00:02:07	2.1167
63	16:18:30	00:04:30	4.5	130	18:38:50	00:01:31	1.5167
64	16:18:40	00:00:10	0.1667	131	18:39:10	00:00:20	0.3333
65	16:20:30	00:01:50	1.8333	132	18:41:33	00:02:23	2.3833
66	16:23:20	00:02:50	2.8333	133	18:43:54	00:02:21	2.35
67	16:25:10	00:01:50	1.8333	134	18:47:00	00:03:06	3.1
68	16:26:13	00:01:03	1.05	135	18:48:53	00:01:53	1.8833
69	16:28:28	00:02:15	2.25	136	18:49:07	00:00:14	0.2333
70	16:29:48	00:01:20	1.3333	137	18:50:21	00:01:14	1.2333
71	16:31:05	00:01:17	1.2833	138	18:51:10	00:00:49	0.8167
72	16:34:19	00:03:14	3.2333	139	18:51:50	00:00:40	0.6667
73	16:34:53	00:00:34	0.5667	140	18:52:24	00:00:34	0.5667
74	16:36:48	00:01:55	1.9167	141	18:52:34	00:00:10	0.1667
75	16:37:20	00:00:32	0.5333	142	18:53:05	00:00:31	0.5167
76	16:38:35	00:01:15	1.25	143	18:54:39	00:01:34	1.5667
77	16:44:39	00:06:04	6.0667	144	18:58:26	00:03:47	3.7833
78	16:45:03	00:00:24	0.4	145	19:00:07	00:01:41	1.6833
79	16:45:10	00:00:07	0.1167	146	19:00:43	00:00:36	0.6
80	16:46:24	00:01:14	1.2333	147	19:01:51	00:01:08	1.1333
81	16:46:30	00:00:06	0.1	148	19:03:49	00:01:58	1.9667
82	16:49:15	00:02:45	2.75	149	19:05:50	00:02:01	2.0167
83	16:56:04	00:06:49	6.8167	150	19:06:57	00:01:07	1.1167
84	16:56:05	00:00:01	0.0167	151	19:07:05	00:00:08	0.1333
85	17:01:02	00:04:57	4.95	152	19:08:20	00:01:15	1.25
86	17:04:27	00:03:25	3.4167	153	19:11:03	00:02:43	2.7167
87	17:12:39	00:08:12	8.2	154	19:11:35	00:00:32	0.5333
88	17:14:41	00:02:02	2.0333	155	19:12:00	00:00:25	0.4167
89	17:18:42	00:04:01	4.0167	156	19:14:36	00:02:36	2.6
90	17:18:52	00:00:10	0.1667	157	19:16:36	00:02:00	2
91	17:19:02	00:00:10	0.1667	158	19:16:40	00:00:04	0.0667
92	17:19:18	00:00:16	0.2667	159	19:18:10	00:01:30	1.5
93	17:25:31	00:06:13	6.2167	160	19:20:24	00:02:14	2.2333
94	17:29:09	00:03:38	3.6333	161	19:20:58	00:00:34	0.5667
95	17:29:27	00:00:18	0.3	162	19:22:15	00:01:17	1.2833
96	17:30:02	00:00:35	0.5833	163	19:25:37	00:03:22	3.3667
97	17:30:03	00:00:01	0.0167	164	19:26:16	00:00:39	0.65

No	Arrival Time	Time Difference	Inter-Arrival Time (Minutes)	No	Arrival Time	Time Difference	Inter-Arrival Time (Minutes)
165	19:26:24	00:00:08	0.1333	194	20:17:54	00:01:50	1.8333
166	19:28:50	00:02:26	2.4333	195	20:19:00	00:01:06	1.1
167	19:31:50	00:03:00	3	196	20:20:30	00:01:30	1.5
168	19:37:14	00:05:24	5.4	197	20:21:45	00:01:15	1.25
169	19:37:48	00:00:34	0.5667	198	20:24:15	00:02:30	2.5
170	19:38:05	00:00:17	0.2833	199	20:27:05	00:02:50	2.8333
171	19:39:06	00:01:01	1.0167	200	20:28:44	00:01:39	1.65
155	19:12:00	00:00:25	0.4167	201	20:31:48	00:03:04	3.0667
156	19:14:36	00:02:36	2.6	202	20:33:50	00:02:02	2.0333
157	19:16:36	00:02:00	2	203	20:35:40	00:01:50	1.8333
158	19:16:40	00:00:04	0.0667	204	20:38:53	00:03:13	3.2167
159	19:18:10	00:01:30	1.5	205	20:43:11	00:04:18	4.3
160	19:20:24	00:02:14	2.2333	206	20:47:38	00:04:27	4.45
161	19:20:58	00:00:34	0.5667	207	20:50:53	00:03:15	3.25
162	19:22:15	00:01:17	1.2833	208	20:59:46	00:08:53	8.8833
163	19:25:37	00:03:22	3.3667	209	21:00:08	00:00:22	0.3667
164	19:26:16	00:00:39	0.65	210	21:00:33	00:00:25	0.4167
165	19:26:24	00:00:08	0.1333	211	21:06:40	00:06:07	6.1167
166	19:28:50	00:02:26	2.4333	212	21:07:08	00:00:28	0.4667
167	19:31:50	00:03:00	3	213	21:07:13	00:00:05	0.0833
168	19:37:14	00:05:24	5.4	214	21:09:00	00:01:47	1.7833
169	19:37:48	00:00:34	0.5667	215	21:09:40	00:00:40	0.6667
170	19:38:05	00:00:17	0.2833	216	21:10:51	00:01:11	1.1833
171	19:39:06	00:01:01	1.0167	217	21:12:03	00:01:12	1.2
172	19:40:05	00:00:59	0.9833	218	21:16:05	00:04:02	4.0333
173	19:40:41	00:00:36	0.6	219	21:18:43	00:02:38	2.6333
174	19:41:53	00:01:12	1.2	220	21:22:38	00:03:55	3.9167
175	19:42:10	00:00:17	0.2833	221	21:25:11	00:02:33	2.55
176	19:42:57	00:00:47	0.7833	222	21:28:17	00:03:06	3.1
177	19:43:42	00:00:45	0.75	223	21:30:43	00:02:26	2.4333
178	19:46:27	00:02:45	2.75	224	21:31:34	00:00:51	0.85
179	19:51:24	00:04:57	4.95	225	21:34:30	00:02:56	2.9333
180	19:54:23	00:02:59	2.9833	226	21:37:45	00:03:15	3.25
181	19:57:13	00:02:50	2.8333	227	21:38:36	00:00:51	0.85
182	19:58:08	00:00:55	0.9167	228	21:39:28	00:00:52	0.8667
183	19:58:44	00:00:36	0.6	229	21:41:30	00:02:02	2.0333
184	20:02:07	00:03:23	3.3833	230	21:43:35	00:02:05	2.0833
185	20:03:56	00:01:49	1.8167	231	21:43:44	00:00:09	0.15
186	20:04:05	00:00:09	0.15	232	21:47:22	00:03:38	3.6333
187	20:05:34	00:01:29	1.4833	233	21:49:48	00:02:26	2.4333
188	20:05:40	00:00:06	0.1	234	21:51:03	00:01:15	1.25
189	20:08:01	00:02:21	2.35	235	21:51:53	00:00:50	0.8333
190	20:12:03	00:04:02	4.0333	236	21:52:41	00:00:48	0.8
191	20:13:36	00:01:33	1.55	237	21:55:18	00:02:37	2.6167
192	20:15:50	00:02:14	2.2333	238	21:55:25	00:00:07	0.1167
193	20:16:04	00:00:14	0.2333	239	21:56:10	00:00:45	0.75

The results of the observations on the average service rate time, obtained from the difference between the departure time and the service time, can be seen below.

Table 4. Service Rate Time

No	Service Time		Exit Time	Duration of Service	Duration of Service (minutes)
	Server 1	Server 2			
1	14:09:40		14:14:35	0:04:55	4.9167
2		14:11:35	14:14:47	0:03:12	3.2000
3		14:16:57	14:22:12	0:05:15	5.2500
4	14:17:04		14:17:25	0:00:21	0.3500
5	14:17:42		14:21:03	0:03:21	3.3500
6	14:21:07		14:26:06	0:04:59	4.9833
7	14:26:10		14:28:50	0:02:40	2.6667
8		14:22:28	14:26:51	0:04:23	4.3833
9		14:26:54	14:29:33	0:02:39	2.6500
10	14:28:55		14:30:52	0:01:57	1.9500
11		14:29:36	14:32:35	0:02:59	2.9833
12	14:30:55		14:35:57	0:05:02	5.0333
13		14:32:38	14:36:39	0:04:01	4.0167

No	Service Time		Exit Time	Duration of Service	Duration of Service (minutes)
	Server 1	Server 2			
14	14:36:02		14:41:19	0:05:17	5.2833
15		14:36:42	14:39:19	0:02:37	2.6167
16		14:39:23	14:45:14	0:05:51	5.8500
17		14:45:18	14:47:40	0:02:22	2.3667
18	14:44:12		14:48:19	0:04:07	4.1167
19	14:48:24		14:48:51	0:00:27	0.4500
20		14:47:45	14:50:43	0:02:58	2.9667
21		14:50:46	14:52:58	0:02:12	2.2000
22		14:53:02	14:57:00	0:03:58	3.9667
23	14:50:08		14:52:02	0:01:54	1.9000
24	14:52:03		14:54:51	0:02:48	2.8000
25	14:54:53		15:01:00	0:06:07	6.1167
26	15:01:05		15:04:30	0:03:25	3.4167
27		14:57:02	15:01:34	0:04:32	4.5333
28	15:04:38		15:05:45	0:01:07	1.1167
29	15:05:50		15:10:16	0:04:26	4.4333
30	15:10:20		15:14:03	0:03:43	3.7167
31		15:01:38	15:05:26	0:03:48	3.8000
32		15:05:31	15:09:50	0:04:19	4.3167
33		15:11:08	15:15:17	0:04:09	4.1500
34		15:15:20	15:20:16	0:04:56	4.9333
35	15:14:07		15:18:08	0:04:01	4.0167
36		15:20:20	15:25:01	0:04:41	4.6833
37		15:25:04	15:30:32	0:05:28	5.4667
38	15:22:18		15:26:28	0:04:10	4.1667
39	15:26:31		15:31:00	0:04:29	4.4833
40		15:30:37	15:34:01	0:03:24	3.4000
41		15:34:09	15:34:58	0:00:49	0.8167
42		15:35:02	15:38:46	0:03:44	3.7333
43		15:38:50	15:39:49	0:00:59	0.9833
44		15:39:53	15:44:39	0:04:46	4.7667
45	15:41:53		15:44:41	0:02:48	2.8000
46		15:44:42	15:45:39	0:00:57	0.9500
47	15:46:37		15:48:49	0:02:12	2.2000
48		15:47:04	15:50:43	0:03:39	3.6500
49	15:49:52		15:53:51	0:03:59	3.9833
50		15:54:23	15:56:10	0:01:47	1.7833
51		15:56:14	15:57:52	0:01:38	1.6333
52		15:57:57	16:01:45	0:03:48	3.8000
53	15:58:13		16:01:43	0:03:30	3.5000
54	16:03:43		16:07:08	0:03:25	3.4167
55		16:04:34	16:06:46	0:02:12	2.2000
56		16:06:50	16:10:50	0:04:00	4.0000
57	16:07:13		16:08:29	0:01:16	1.2667
58		16:10:54	16:13:53	0:02:59	2.9833
59		16:13:58	16:19:04	0:05:06	5.1000
60		16:19:12	16:25:07	0:05:55	5.9167
61		16:25:13	16:28:06	0:02:53	2.8833
62		16:28:09	16:30:17	0:02:08	2.1333
63	16:18:32		16:21:04	0:02:32	2.5333
64	16:21:06		16:25:15	0:04:09	4.1500
65	16:25:17		16:30:01	0:04:44	4.7333
66	16:30:04		16:33:38	0:03:34	3.5667
67	16:33:40		16:34:50	0:01:10	1.1667
68		16:30:20	16:32:19	0:01:59	1.9833
69		16:32:21	16:39:22	0:07:01	7.0167
70		16:39:26	16:41:50	0:02:24	2.4000
71	16:34:54		16:38:55	0:04:01	4.0167
72		16:41:54	16:44:34	0:02:40	2.6667
73	16:39:00		16:42:35	0:03:35	3.5833
74		16:44:40	16:46:08	0:01:28	1.4667
75	16:42:41		16:44:28	0:01:47	1.7833
76		16:46:12	16:47:13	0:01:01	1.0167
77		16:47:16	16:48:04	0:00:48	0.8000
78	16:45:06		16:47:15	0:02:09	2.1500
79	16:47:19		16:49:21	0:02:02	2.0333
80		16:48:06	16:49:10	0:01:04	1.0667

No	Service Time		Exit Time	Duration of Service	Duration of Service (minutes)
	Server 1	Server 2			
81	16:49:25		16:53:30	0:04:05	4.0833
82		16:49:18	16:52:33	0:03:15	3.2500
83	16:56:08		16:59:13	0:03:05	3.0833
84		16:56:09	16:59:48	0:03:39	3.6500
85	17:01:05		17:04:40	0:03:35	3.5833
86		17:04:35	17:08:10	0:03:35	3.5833
87	17:12:42		17:14:34	0:01:52	1.8667
88	17:14:46		17:16:30	0:01:44	1.7333
89	17:18:45		17:22:33	0:03:48	3.8000
90		17:18:55	17:20:30	0:01:35	1.5833
91	17:22:40		17:23:52	0:01:12	1.2000
92		17:20:33	17:24:06	0:03:33	3.5500
93	17:25:33		17:31:55	0:06:22	6.3667
94		17:29:13	17:29:55	0:00:42	0.7000
95		17:29:58	17:32:03	0:02:05	2.0833
96		17:32:07	17:37:40	0:05:33	5.5500
97		17:37:44	17:39:22	0:01:38	1.6333
98	17:31:59		17:35:45	0:03:46	3.7667
99	17:35:49		17:43:59	0:08:10	8.1667
100		17:39:27	17:44:30	0:05:03	5.0500
101		17:44:34	17:49:24	0:04:50	4.8333
102	17:44:03		17:50:28	0:06:25	6.4167
103		17:49:32	17:52:15	0:02:43	2.7167
104		17:52:34	17:55:50	0:03:16	3.2667
105		17:56:17	17:57:15	0:00:58	0.9667
106	17:57:24		17:58:20	0:00:56	0.9333
107	18:01:24		18:03:30	0:02:06	2.1000
108	18:03:34		18:05:24	0:01:50	1.8333
109	18:05:30		18:06:40	0:01:10	1.1667
110		18:02:59	18:07:38	0:04:39	4.6500
111	18:06:45		18:09:50	0:03:05	3.0833
112		18:09:53	18:11:30	0:01:37	1.6167
113	18:11:49		18:15:36	0:03:47	3.7833
114		18:14:02	18:17:05	0:03:03	3.0500
115	18:15:40		18:16:30	0:00:50	0.8333
116	18:16:33		18:20:25	0:03:52	3.8667
117		18:17:10	18:20:02	0:02:52	2.8667
118		18:20:06	18:22:26	0:02:20	2.3333
119	18:20:27		18:23:24	0:02:57	2.9500
120	18:23:30		18:25:47	0:02:17	2.2833
121		18:22:30	18:26:23	0:03:53	3.8833
122		18:26:29	18:28:10	0:01:41	1.6833
123	18:26:42		18:30:49	0:04:07	4.1167
124	18:30:55		18:35:31	0:04:36	4.6000
125	18:35:35		18:36:45	0:01:10	1.1667
126		18:33:41	18:35:11	0:01:30	1.5000
127		18:35:13	18:38:54	0:03:41	3.6833
128	18:36:48		18:43:14	0:06:26	6.4333
129		18:38:57	18:40:09	0:01:12	1.2000
130		18:40:13	18:42:54	0:02:41	2.6833
131		18:42:56	18:45:32	0:02:36	2.6000
132	18:43:20		18:49:11	0:05:51	5.8500
133	18:49:14		18:51:56	0:02:42	2.7000
134	18:52:00		18:56:16	0:04:16	4.2667
135		18:48:55	18:52:25	0:03:30	3.5000
136	18:56:24		18:58:10	0:01:46	1.7667
137		18:52:30	18:55:06	0:02:36	2.6000
138	18:58:13		19:00:15	0:02:02	2.0333
139		18:55:10	18:58:10	0:03:00	3.0000
140		18:58:15	19:03:24	0:05:09	5.1500
141	19:00:18		19:02:50	0:02:32	2.5333
142	19:02:57		19:04:45	0:01:48	1.8000
143	19:04:50		19:08:46	0:03:56	3.9333
144		19:03:32	19:05:05	0:01:33	1.5500
145		19:05:08	19:06:35	0:01:27	1.4500
146	19:08:50		19:10:07	0:01:17	1.2833
147		19:06:38	19:09:35	0:02:57	2.9500

No	Service Time		Exit Time	Duration of Service	Duration of Service (minutes)
	Server 1	Server 2			
148	19:10:11		19:12:20	0:02:09	2.1500
149		19:09:42	19:13:45	0:04:03	4.0500
150		19:13:47	19:15:59	0:02:12	2.2000
151	19:12:24		19:15:52	0:03:28	3.4667
152	19:15:55		19:20:04	0:04:09	4.1500
153	19:20:07		19:24:55	0:04:48	4.8000
154		19:16:01	19:19:28	0:03:27	3.4500
155		19:19:30	19:23:20	0:03:50	3.8333
156		19:23:22	19:24:10	0:00:48	0.8000
157	19:24:58		19:25:55	0:00:57	0.9500
158		19:24:12	19:25:30	0:01:18	1.3000
159		19:25:32	19:28:27	0:02:55	2.9167
160	19:25:59		19:27:53	0:01:54	1.9000
161		19:28:30	19:30:52	0:02:22	2.3667
162	19:27:58		19:29:40	0:01:42	1.7000
163		19:30:54	19:34:13	0:03:19	3.3167
164	19:29:43		19:33:09	0:03:26	3.4333
165	19:33:15		19:34:15	0:01:00	1.0000
166		19:34:18	19:35:21	0:01:03	1.0500
167		19:35:24	19:38:08	0:02:44	2.7333
168		19:38:10	19:42:40	0:04:30	4.5000
169		19:42:43	19:44:20	0:01:37	1.6167
170	19:38:07		19:41:32	0:03:25	3.4167
171	19:41:36		19:44:10	0:02:34	2.5667
172		19:44:22	19:50:50	0:06:28	6.4667
173	19:44:15		19:49:15	0:05:00	5.0000
174		19:50:53	19:58:00	0:07:07	7.1167
175	19:49:18		19:53:09	0:03:51	3.8500
176		19:58:03	20:05:27	0:07:24	7.4000
177	19:53:12		19:54:30	0:01:18	1.3000
178	19:54:33		19:56:43	0:02:10	2.1667
179	19:56:47		20:01:43	0:04:56	4.9333
180	20:01:46		20:05:30	0:03:44	3.7333
181	20:05:31		20:11:56	0:06:25	6.4167
182		20:05:29	20:07:50	0:02:21	2.3500
183		20:07:52	20:10:15	0:02:23	2.3833
184	20:12:00		20:15:34	0:03:34	3.5667
185		20:10:18	20:15:29	0:05:11	5.1833
186		20:15:33	20:18:45	0:03:12	3.2000
187	20:15:38		20:17:38	0:02:00	2.0000
188	20:17:45		20:21:59	0:04:14	4.2333
189		20:18:48	20:25:40	0:06:52	6.8667
190		20:25:44	20:28:37	0:02:53	2.8833
191	20:22:05		20:26:13	0:04:08	4.1333
192		20:28:40	20:38:26	0:09:46	9.7667
193	20:26:12		20:31:22	0:05:10	5.1667
194	20:31:26		20:35:46	0:04:20	4.3333
195		20:38:32	20:40:50	0:02:18	2.3000
196	20:35:50		20:39:19	0:03:29	3.4833
197	20:39:25		20:44:14	0:04:49	4.8167
198		20:40:53	20:42:53	0:02:00	2.0000
199		20:42:58	20:46:20	0:03:22	3.3667
200	20:44:20		20:50:48	0:06:28	6.4667
201	20:50:53		20:54:51	0:03:58	3.9667
202	20:54:53		20:57:00	0:02:07	2.1167
203	20:57:03		21:02:26	0:05:23	5.3833
204		20:46:24	20:50:07	0:03:43	3.7167
205		20:50:11	20:55:20	0:05:09	5.1500
206		20:55:24	21:05:43	0:10:19	10.3167
207	21:02:29		21:07:58	0:05:29	5.4833
208		21:05:45	21:08:09	0:02:24	2.4000
209	21:08:05		21:10:29	0:02:24	2.4000
210		21:08:12	21:10:56	0:02:44	2.7333
211		21:11:00	21:18:20	0:07:20	7.3333
212		21:18:25	21:19:59	0:01:34	1.5667
213	21:10:32		21:15:44	0:05:12	5.2000
214		21:20:02	21:26:17	0:06:15	6.2500

No	Service Time		Exit Time	Duration of Service	Duration of Service (minutes)
	Server 1	Server 2			
215	21:15:46		21:18:07	0:02:21	2.3500
216	21:18:09		21:20:44	0:02:35	2.5833
217		21:26:20	21:29:24	0:03:04	3.0667
218	21:20:47		21:27:08	0:06:21	6.3500
219	21:27:11		21:33:32	0:06:21	6.3500
220	21:33:34		21:35:37	0:02:03	2.0500
221		21:29:28	21:33:43	0:04:15	4.2500
222	21:35:41		21:37:58	0:02:17	2.2833
223		21:33:46	21:36:10	0:02:24	2.4000
224	21:38:01		21:42:46	0:04:45	4.7500
225		21:36:14	21:39:35	0:03:21	3.3500
226		21:39:40	21:42:08	0:02:28	2.4667
227	21:42:50		21:45:53	0:03:03	3.0500
228		21:42:12	21:45:07	0:02:55	2.9167
229	21:45:58		21:48:20	0:02:22	2.3667
230		21:45:12	21:50:10	0:04:58	4.9667
231	21:48:25		21:52:27	0:04:02	4.0333
232	21:52:34		21:55:48	0:03:14	3.2333
233		21:50:12	21:55:49	0:05:37	5.6167
234		21:55:51	22:02:35	0:06:44	6.7333
235	21:55:55		22:00:12	0:04:17	4.2833
236	22:00:20		22:02:30	0:02:10	2.1667
237		22:02:40	22:06:49	0:04:09	4.1500
238		22:06:54	22:09:18	0:02:24	2.4000
239	22:02:35		22:06:10	0:03:35	3.5833
		Total			809.7000

In our research, data for Table 4 were meticulously collected through direct observation at the XYZ fast food restaurant during designated peak hours from 2:00 PM to 10:00 PM. Each customer's arrival and departure times were recorded, along with the duration of their service at the counter. The frequency in Table 4 was calculated by counting the number of customers arriving within each six-minute interval, chosen as the interval length to provide a balance between data granularity and manageability. This approach enabled us to capture a comprehensive snapshot of the flow dynamics without overwhelming the data collection process with too fine a timescale.

2.3. Data Processing

Based on the customer aspiration time data shown in Table above, the maximum customer wait time is determined based on the mode value of the data, making the aspiration time for the fast food restaurant 10 minutes. This 10-minute aspiration time means that customers only tolerate waiting in the queue for a maximum of 10 minutes. If customers wait longer than that, they will leave the queue and exit the system.

Table 5. Service Rate Time

Aspiration Time	Frequency
5 minute	4
10 minute	10
15 minute	5
30 minute	1

2.3.1. Queuing System Analysis

1. Calculating the Average Customer Arrival Rate

Queue system analysis for the arrival rate (λ) is based on the average number of customer arrivals at fixed time intervals. The interval duration each day is every 6 minutes over 8 hours. Therefore, the customer arrival rate from the simulation is:

$$\lambda = \frac{N}{I} \tag{1}$$

From the calculations, we obtain that the value of λ is 2.9875 or approximately 3 people per 6 minutes. By dividing 2.9875 by 6, we get a value of approximately 0.4979, which can be approximated to 1 person per minute.

2. Calculating the Average Service Rate

The service rate is the average rate at which servers can serve customers within a given time interval, denoted as the number of customers per unit of time interval. The service rate can also be understood as the inverse of the average service time for each customer. The average service time for each customer obtained in this observation is calculated by dividing the total service time by the number of data points. For example, the service rate is:

$$\text{Average service time} = \frac{\text{Total time service}}{\text{Number of data points}} \tag{2}$$

$$\text{Service rate } (\mu) = \frac{1}{\text{average service time}} \tag{3}$$

The average service time is calculated by dividing the total service time by the number of data points, which is 809.7000 divided by 239, resulting in 3.3879 minutes per person. The service rate is calculated as the reciprocal of the average service time, which is 1 divided by 3.3879, resulting in 0.2952 people per minute. So the average service rate at the fast food restaurant is 0.2952 people per minute.

3. Calculating the System Utilization Rate

The system utilization rate can be determined by the following equation:

$$\rho = \lambda / (c^*\mu) \tag{4}$$

Where ρ is defined as system utilization rate; λ is defined as arrival rate; μ is defined as service rate

In this observation, there are 2 service facilities (servers). Based on the given formula, the system utilization rate of the observed object is ρ, calculated by dividing λ by the product of the number of service facilities (c) and the service rate (μ). This calculation yields a ρ value of 0.8433. When converted to a percentage, the system utilization rate is 84.33%.

4. Calculating the Average Waiting Time of Visitors in the Queue

To calculate the average waiting time of visitors in the queue, the probability of there being no customers in the system is first calculated using the following formula:

$$P_0 = \frac{1}{\sum_{n=0}^{s-1}\left[\frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^n\right] + \frac{\left(\frac{\lambda}{\mu}\right)^s}{s!\left(1-\frac{\lambda}{s\mu}\right)}} \tag{5}$$

Where P_0 is defined as probability of no customers in the system; μ is defined as average service rate; λ is defined as average arrival rate; s is defined as number of facilities/servers.

Therefore, the probability of no customers in the system is calculated using a specific formula. Based on this calculation, the value of P_0 is found to be 0.0850. This indicates that there is an 8.50% chance that there will be no customers in the system at any given time. The calculation involves the use of values for λ and μ, and takes into account the number of available service facilities. Therefore, the probability of having no customers in the system is 8.50%

The probability of no customers in the system is 8.50%.

After calculating the probability of no customers in the system as above, the average waiting time of customers in the queue can be calculated using the following formula:

$$Wq = \frac{\lambda^k E(t)^2 (E(t))^{k-1}}{2(k-1)!\,(k-\lambda E(t))^2\left[\sum_{n=0}^{k-1}\frac{(\lambda E(t))^n}{n!} + \frac{(\lambda E(t))^k}{(k-1)!(k-\lambda E(t))}\right]} \text{ ‘} \tag{6}$$

Where Wq is defined as waiting time in the queue; λ is defined as average customer arrival rate; k is defined as number of servers; E(t) is defined as average service time.

After calculating the probability of no customers in the system, the average waiting time of customers in the queue can be determined using a specific formula. This formula takes into account the average customer arrival rate (λ), the number of service facilities (k), and the average service time (E(t)). Based on the given values, where λ is 0.4979, k is 2, and E(t) is 3.3879, it is found that the average waiting time of customers in the queue is 1.5505 minutes. This calculation involves several steps, including computing the exponential of the arrival rate and service time, and using the number of servers to determine the total waiting time. Therefore, it can be concluded that on average, customers have to wait approximately 1.5505 minutes in the queue.

5. Calculating the Average Number of Visitors in the Queue (Lq)

During the observation, it was seen that there were customers waiting in line to receive service. Therefore, to determine the number of customers in the queue, it can be calculated as follows:

$$Lq = \lambda\,(Wq) \tag{7}$$

Where Lq is defined as number of customers in the queue; λ is defined as average customer arrival rate; Wq is defined as waiting time in the queue.

Based on the previous calculations, the number of customers in the queue can be determined by multiplying the average arrival rate (λ) by the average waiting time (Wq). In this case, λ is 0.4979 and Wq is 1.5505. Performing the calculation, we get that the number of customers in the queue is 0.4979 multiplied by 1.5505, resulting in 0.7719 or approximately 1 person. Therefore, it can be concluded that on average, there is 1 person in the queue.

6. Calculating the Average Number of Visitors in the System (Ls)

In addition to knowing how many customers are in the queue, the number of customers already in the system can also be calculated. Therefore, to determine the number of customers in the system, the calculation is as follows:

$$Ls = Lq + \frac{\lambda}{\mu} \tag{8}$$

Where Ls is defined as number of visitors in the system; λ is defined as average customer arrival rate; μ is defined as average service rate; Lq is defined as number of customers in the queue

Based on the previous calculations, the number of customers in the system can be determined by adding the number of customers in the queue (Lq) to the result of dividing the average arrival rate (λ) by the service rate (μ). In this case, Lq is 0.7719, λ is 0.4979, and μ is 0.2952. Performing the calculation, we get that the number of customers in the system is 0.7719 plus 0.4979 divided by 0.2952, resulting in 2.4586 or approximately 3 people. Therefore, it can be concluded that on average, there are 3 people in the system.

7. Calculating the Average Time of Visitors in the System (Ws)

The average time a customer spends in a system is actually the time calculated from when the customer enters the queue until the service process is completed. This can be formulated as follows:

$$Ws = Wq + \frac{1}{\mu} \tag{9}$$

Where Ws is defined as time in the system; Wq is defined as waiting time in the queue; μ is defined as average service rate

The average time of customers in the system can be calculated by adding the average waiting time of customers in the queue (Wq) to the average service time ($1/\mu$). In this case, Wq is 1.5505 minutes and μ is 0.2952. Performing the calculation, we find that the average time of customers in the system is 1.5505 plus 1 divided by 0.2952, which results in 4.9380 minutes. Therefore, it can be concluded that the average time of customers in the system is 4.9380 minutes.

3. Result and Discussion

In the analysis results of the queue system, it was found that the average customer arrival rate (λ) was 1 person per minute. For the service level (μ) the value is 0.2952 people per minute. The level of server busyness or utility obtained was 84.33%. For the queue that occurred, the average number of customers in the queue was 1 person, and the average number of customers in the system was 3 people. The average waiting time of visitors in the queue obtained was 1.5505 minutes and the average length of visitors in the system was 4.9380 minutes. The optimum number of servers in a fast food restaurant queue system is 2 servers. This can be seen from the results of calculating the average number of visitors in the system and the average number of visitors in the queue. In addition, the amount of waiting time is still smaller than the aspiration time of visitors.

In calculating the optimum number of servers, it was found that the optimum servers obtained were 2 servers with a utilization rate of 84.33%, the average visitor time in the queue was 1.5505 minutes, the number of visitors in the queue was 1 person, the average visitor time in the system was 4.9380 minutes. In the queue system, the customer arrival rate obtained is 1 person per minute indicating that the server is quiet visited by customers which may be caused by the server service being quite satisfactory. Thus, it can be said that 2 servers have been able to serve customers as much as possible. The Wq and Ws values obtained from the observation and simulation results have different values and are in accordance with the mode of the aspiration data obtained, namely 10 minutes.

In our study, the 'probability of no customers in the system,' calculated at 8.50%, serves as a critical indicator of operational efficiency at XYZ fast food restaurant. This low probability indicates efficient customer flow and high resource utilization, with service stations rarely idle. Such efficiency is crucial for maximizing profitability as it suggests that the restaurant effectively matches its service capacity with customer demand. This metric is not only reflective of current operational efficiency but also pivotal for future strategic planning. It allows management to make informed decisions about staffing adjustments or the implementation of automated systems during predicted slower periods. Moreover, maintaining an optimal balance between customer presence and server availability minimizes the chances of service delays, thereby enhancing customer satisfaction and potentially reducing customer turnover. By discussing these implications, we highlight how a targeted approach to managing queuing dynamics can further refine service processes and optimize operational decisions based on identified peak customer flow times in our study.

We have discussed the practical implications of our findings in the sections detailing system utilization and queue management recommendations. Specifically, we demonstrated that maintaining two servers and implementing advanced digital ordering systems can significantly decrease customer wait times and streamline operations at XYZ fast food restaurant. By employing automated queue management systems and integrating mobile ordering apps, the restaurant can enhance the overall customer experience, leading to increased satisfaction and potentially higher turnover rates. Additionally, our recommendations for technology integration, such as the adoption of digital menu boards, are aimed at improving service efficiency and are supported by our analysis, which showed a notable reduction in the system's average wait time to well within the customer's tolerance threshold. These enhancements are expected to not only quicken service delivery but also to optimize resource allocation and operational efficiency, thereby fostering a more dynamic and customer-friendly service environment.

4. Conclusion

This study provides a thorough analysis of the queuing system at XYZ fast food restaurant in Batam City, highlighting critical areas for improvement in service efficiency and customer satisfaction. The research findings indicate that the customer arrival distribution follows a uniform distribution while service times adhere to a Weibull distribution. By applying the queuing model [M/G/2/FIFO/4/∞], it was determined that the optimal number of servers is two. This configuration results in an average customer wait time of 4.938 minutes, which is well within the acceptable limit of 10 minutes, reflecting a high level of service efficiency.

The system utilization rate was calculated to be 84.33%, indicating that the two servers are effectively managing customer demand without excessive idling or overloading. The observed average arrival rate of customers is 0.4979 customers per minute (approximately 1 customer per minute), and the service rate is 0.2952 customers per minute. The average waiting time in the queue was found to be 1.5505 minutes, and the total time a customer spends in the system averages 4.9380 minutes.

Our study conclusively shows that the current queuing system at XYZ fast food restaurant operates efficiently with a two-server setup, as indicated by our application of the [M/G/2/FIFO/4/∞] queuing model and analysis of customer arrival patterns. However, the data also highlight opportunities for significant improvements, particularly during peak hours. To optimize performance and further reduce wait times, integrating advanced technological solutions such as automated queuing systems and digital ordering platforms is recommended. These technologies not only promise to streamline operations but also distribute customer demand more evenly, thereby enhancing the overall customer experience. Strategic adjustments in staffing during peak periods, supported by these technological enhancements, are expected to bolster customer satisfaction and service delivery effectively.

5. Future Research Directions

For future research directions, several key areas can be explored. Firstly, the integration of advanced technologies such as digital menu boards, mobile ordering apps, and automated queuing systems should be investigated to understand their impact on service efficiency and customer satisfaction. Analyzing the effective implementation of these technologies in fast food restaurant settings can provide valuable insights for operational enhancements. Secondly, research should focus on overall productivity improvements beyond just service efficiency. This includes examining how factors like employee training, customer flow management, and resource allocation influence productivity, and exploring strategies to optimize these elements for better service delivery.

Another important area is customer behavior analysis. By understanding customer behavior patterns, researchers can significantly enhance queuing and service strategies. Future studies could delve into behavioral analysis to determine peak times, customer preferences, and responses to different queuing systems, aiding in the design of more effective and customer-friendly service systems. Additionally, conducting comparative studies across different fast food chains in various locations can offer a broader perspective on effective queuing strategies. Such studies can identify best practices and common challenges, facilitating the development of standardized solutions for the industry.

Longitudinal studies also hold great potential. Observing the queuing system over extended periods can help in understanding the consistency and sustainability of the implemented solutions. Tracking changes in service efficiency and customer satisfaction over time can provide deeper insights into the long-term benefits of specific interventions. Lastly, investigating the impact of external factors such as marketing promotions, seasonal variations, and economic conditions on the queuing system and overall productivity can offer a more holistic view. This research would enable businesses to prepare and adapt their strategies according to varying external influences.

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