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# Model Analysis Queue Theory in Fast Food Restaurants in Padang City

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**Abstract-** Queuing systems represent service processes in which customers wait due to limited service resources. Analysing such systems is essential to ensure efficient service and minimise waiting time. This study aims to examine the queuing system applied at Hokben Sawahan Padang by analysing customer arrival and service rates to determine the appropriate model and system characteristics. A quantitative method was used, with primary data collected through direct observation of arrival and service times. The results indicate that the appropriate model is (M/M/1) with a FIFO discipline. The average number of customers waiting in line (Lq) is 0.52 customers per minute, while the average number in the system (L) is 1.03 customers per minute. The average time spent in the system (W) is 4.9 minutes, and the average waiting time before service (Wq) is 2.4 minutes. The server utilisation level is 50.62%, with an idle rate of 49.38%. These findings suggest that the queuing system is relatively efficient and can be categorised as quite ideal. However, further improvements are needed to increase server utilisation and service effectiveness. Enhancing service quality, cleanliness, comfort, and overall operational performance can improve customer satisfaction and business profitability. The study implies that queue performance indicators, such as waiting time and utilisation rate, can serve as important managerial tools for evaluating and optimising service operations.



## 1. Introduction

Waiting for service or queuing is a common situation in everyday life (Ary, 2018). Queues are a common phenomenon across various service sectors, such as banking, hospitals, public transportation, gas stations, post offices, and restaurants (Octavia, 2015).

Queuing is closely related to customer waiting time, which serves as a key indicator in evaluating the quality of service in a given sector (Nurhidayati et al., 2022). In the healthcare sector, particularly in hospitals, patient queues, waiting times, and service durations are critical factors for improving service quality (Bahadori et al., 2014). Excessively long and slow queues tend to create negative perceptions and disadvantage those in need of services (Faisal, 2005). However, such situations are often unavoidable due to customers' random arrival times (Hilmi et al., 2018). Therefore, the study and analysis of queuing theory are essential to supporting service providers in enhancing service quality.

Queuing theory is the mathematical study of waiting lines or queues, which explains how elements are served at the front of the queue, how elements wait within the queue, and how new elements enter the queue (Listiyani et al., 2019). Queues arise when demand for service exceeds the capacity of service facilities, causing customers who have not yet been served to wait before receiving service (Lestari & Sri, 2018). In addition, if a system's service facility is not operating optimally, service delays may occur, leading to queue formation (Darmaynis et al., 2022). Customers may even cancel their transactions if they perceive the service as unsatisfactory (Sari et al., 2016). These issues are analysed through queuing theory to determine whether the system is already optimal or requires further evaluation.

One sector whose image is often reflected by the quality of its service is the food industry. The development of the food industry, particularly restaurants in Indonesia, has experienced significant growth, in line with lifestyle changes that increasingly emphasise speed and efficiency in service. Fast food restaurants have become the primary choice for consumers seeking convenient meals with minimal preparation time. However, a major challenge for fast-food restaurants is managing long queues, especially during peak hours, which can reduce customer satisfaction with the service (Tyas et al., 2023). Therefore, applying queuing theory can help restaurant managers optimise the number of service facilities, such as cashiers and servers, to respond more efficiently to customer needs.

Hoka-Hoka Bento (HokBen) is a fast-food chain with numerous branches across Indonesia, including in Padang. Its presence has become a top choice for people seeking fast and practical food services. The high volume of customers arriving simultaneously at certain times, such as during lunch hours, highlights the importance of efficient service system management. In this context, applying queuing theory is a strategic approach to designing a service system that can accommodate surges in customer volume while maintaining smooth restaurant operations (Yusnita & Marsa, 2024).

The application of queuing theory to the fast-food industry has been widely explored in prior studies. Research conducted by Harahap (Harahap et al., 2018) at KFC Gajah Mada Street, Medan, demonstrated that using the M/M/S queuing model enabled the restaurant to determine the optimal number of cashiers to operate under busy, normal, or quiet conditions, thereby improving service efficiency. Meanwhile, a study by Purnomo et al. (2021) at KFC in Jember Regency applied simulations using ARENA software to evaluate the queuing system. It recommended increasing the number of cashiers to reduce customer waiting times.

Poor queue management not only results in long waiting times but also negatively affects perceptions of service quality and overall customer satisfaction (Darmaynis & Ayu, 2022). Therefore, it is essential for restaurant managers, such as those at HokBen Sawahan, to evaluate the queuing system in place regularly. Analysing parameters such as customer arrival rates, service times, and queue lengths can provide valuable insights for decision-making in improving service systems (Kadju et al., 2023).

This study aims to analyse the queuing system implemented at HokBen Sawahan and evaluate its efficiency and effectiveness using queuing theory. The novelty of this research lies in its integrated evaluation of arrival rates, service capacity, and queue performance within a specific fast-food branch context, linking quantitative queuing analysis directly to managerial decision-making and to improving customer satisfaction. Unlike previous studies that focus primarily on model application or simulation in general settings, this study provides an empirical, branch-level assessment that generates context-specific operational recommendations. Theoretically, this research is expected to contribute to the operations management literature, while in practice, the findings can serve as a basis for managerial decision-making to improve service quality.

## 2. Research Methods

### (a) Analysis Method

This study employs a quantitative approach to analyse and evaluate the queuing system at the Hoka-Hoka Bento (HokBen) fast-food restaurant at the Sawahan branch in Padang City. The data used in this study are primary data obtained through direct observation of customer queueing activities over a specific period. Primary data is data collected directly by researchers through observation or monitoring of research objects to obtain information relevant to the research objectives (Yusnita & Marsa, 2024). Observations were carried out over four consecutive days, specifically during lunch hours from 11:00 to 14:00 WIB, when customer volume is highest. The selection of this time is intended to obtain a representative picture of peak queue conditions. The research is focused on the HokBen restaurant in the Sawahan area of Padang City. The population in this study is unlimited, including all customers present and queuing at the restaurant during the specified lunchtime observation period. This approach is in line with research on applying queueing theory to service systems, using primary data from direct observation to determine the appropriate queueing model and evaluate service system performance to improve efficiency (Sari et al., 2016).

### (b) Data Collection

The sample collected during the observation period consisted of 150 people, randomly selected upon arrival and while in the queue. After the data was collected, the next step was to process it by calculating the average customer arrival rate and average customer service time, then using the (M/M/1) model to estimate queue performance. The (M/M/1) model is a widely used queueing model with a Poisson arrival process and an exponential service time distribution for analysing single-phase, single-line service systems (Harahap et al., 2018). Queueing performance calculations include the arrival rate (λ), service rate (μ), system utilization rate (ρ), average number of customers in the system (Ls), the average number of customers in the queue (Lq), as well as the average waiting time in the system (Ws) and in the queue (Wq) as applied in previous studies in the fast food restaurant sector (Yusnita & Marsa, 2024).

### (c) Research Steps

This research was conducted through several stages of queueing system analysis as follows:(1) Determine the research location (Harahap et al., 2018). (2) Collecting primary data through direct observation of customer arrivals and service (Yusnita & Marsa, 2024). (3) Pay attention to the research data obtained. (4). Conduct a distribution suitability test on arrival data (Poisson distribution) and service (exponential distribution) using the Kolmogorov-Smirnov test with the help of the SPSS application (Sari et al., 2016). (5). Determine the appropriate queue model. (6). Calculate the results of the notation of queue theory terminology. (7). Make conclusions and suggestions for the analysis

### (d) Data Analysis Techniques

The data analysis method to determine the average number of customer arrivals and average customer service can use the following formula (Yusnita & Marsa, 2024).
Average customer arrivals per unit of time:

$$\lambda = \frac{total\ customers}{total\ observation\ time} \quad (2.1)$$

Average service time (Ws) :

$$Ws = \frac{total\ service\ time}{number\ of\ cuetomers\ served} \quad (2.2)$$

Average customer service per unit time:

$$\mu = \frac{observation\ time\ unit}{average\ service\ time} \quad (2.3)$$

The following formulas are used to calculate queue performance for the (M/M/1) model (Yusnita & Marsa, 2024).

System busyness $(\rho)$ :

$$\rho = \frac{\lambda}{\mu} \tag{2.4}$$

Average number of customers in the system $(L)$ :

$$L = \frac{\lambda}{\mu - \lambda} \tag{2.5}$$

Average number of customers in the queue $(Lq)$ :

$$Lq = \frac{\lambda^2}{\mu(\mu - \lambda)} \tag{2.6}$$

Average time in system $(W)$ :

$$W = \frac{1}{\mu - \lambda} \tag{2.7}$$

Average time in queue $(Wq)$ :

$$Wq = \frac{\lambda}{\mu(\mu - \lambda)} \tag{2.8}$$

Probability of no customers on the arrival of an empty system/server $(p_0)$ :

$$p_0 = 1 - \rho \tag{2.9}$$

## 3. Results and Discussion

Customer arrival data and customer service time were collected through direct observation during the observation period. Observations were conducted over 4 days, from May 1, 2025, to May 4, 2025, from 11.00-14.00 am. The results of the observation are shown in Table 1.

**Table 1.** Customer arrival data

| Day/Date | Number of arrivals in a time interval (person) | | | |
|---|---|---|---|---|
| | 11.00-12.00 | 12.00-13.00 | 13.00-14.00 | Number of customers per hour per day |
| Thursday/1 May 2025 | 9 | 12 | 10 | 31 |
| Friday/2 May 2025 | 13 | 16 | 11 | 40 |
| Saturday/3 May 2025 | 14 | 16 | 12 | 42 |
| Sunday/4 May 2025 | 11 | 15 | 11 | 37 |
| Number of customers per hour per 4 days | 47 | 59 | 44 | 75 |

From Table 1, it can be seen that during the 4-day observation period from 11:00 a.m. to 14:00 a.m., there were 150 visitors. In addition, we can see the number of customer arrivals every hour: 47 between 11:00 a.m. and 12:00 a.m., 59 between 12:00 a.m. and 13:00 a.m., and 44 between 13:00 a.m. and 14:00 a.m., as shown in Table 2.

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**Table 2.** Customer services time data

| Day/Date | Number of services in a time interval (minutes) | | | |
|---|---|---|---|---|
| | 11.00-12.00 | 12.00-13.00 | 13.00-14.00 | Number of services per hour per day |
| Thursday/1 May 2025 | 17 | 27 | 22 | 66 |
| Friday/2 May 2025 | 34 | 36 | 27 | 97 |
| Saturday/3 May 2025 | 37 | 31 | 29 | 97 |
| Sunday/4 May 2025 | 34 | 35 | 36 | 105 |
| Number of services per hour per 4 days | 122 | 129 | 114 | 365 |

In Table 2, we can see that over 4 days of observation from 11.00 to 14.00, the service time for 150 people who came was 365 minutes. It can be seen that the number of minutes of customer service per hour, namely customer service time at 11.00-12.00 is 122 minutes, at 12.00-13.00 is 129 minutes, and at 13.00-14.00 is 114 minutes.

Next, we need to perform data processing to assess the distribution's suitability for determining the queue model. This test also ensures that the inter-arrival time and customer service time data are distributed according to the Poisson and Exponential distributions, respectively, using the Kolmogorov-Smirnov test in SPSS. The test is carried out at the 95% confidence level ($\alpha$ = 0.05) for the Poisson and Exponential distributions. If asymp. Sig is greater 0,05 then. $H_0$ fails to be rejected so that $H_0$ is accepted. Conversely, if asymp. Sig is less than 0.05 then. $H_0$ is rejected or $H_1$ is accepted.

## (a) Arrival Distribution Test

The hypothesis of customer arrival data is

$H_0$: arrival data is Poisson distributed

$H_1$: arrival data is not Poisson distributed

If asymp.Sig is greater 0,05 then. $H_0$ fails to be rejected so that $H_0$ is accepted. Conversely, if asymp. Sig is less than 0.05 then. $H_0$ is rejected or $H_1$ is accepted. The results of the Kolmogorov-Smirnov test are presented in Table 3.

**Table 3.** One-sample kolmogorov-smirnov 1

| | | Arrival |
|---|---|---|
| N | | 4 |
| Poisson Parameter[a,b] | Mean | 37.5000 |
| Most Extreme Differences | Absolute | .204 |
| | Positive | .204 |
| | Negative | -.196 |
| Kolmogorov-Smirnov Z | | .409 |
| Asymp. Sig. (2-tailed) | | .996 |

We can see the results of the Kolmogorov-Smirnov test in Table 3. The distribution of customer arrivals, based on data from May 1, 2025, to May 4, 2025, tested in SPSS, was Poisson-distributed, resulting in Asymp. Sig is 0.996 > 0.05 so that $H_0$ is accepted.

## (b) Service Distribution Test

The service data hypothesis is

$H_0$: service data is exponentially distributed

$H_1$: service data is not exponentially distributed

If asymp. Sig is greater than 0,05, so H0 is not rejected and is accepted. Conversely, if asymp. Sig is less than 0.05, then cap H sub 0 is rejected, or $H_1$ is accepted. The results of the Kolmogorov-Smirnov test are presented in Table 4.

**Table 4.** One-sample kolmogorov-smirnov 2

| | | Service |
|---|---|---|
| N | | 4 |
| Exponential parameter. [a,b] | Mean | 91.2500 |
| Most Extreme Differences | Absolute | .515 |
| | Positive | .316 |
| | Negative | -.515 |
| Kolmogorov-Smirnov Z | | 1.030 |
| Asymp. Sig. (2-tailed) | | .240 |

We can see the results of the Kolmogorov-Smirnov test in Table 4. The distribution of customer service, based on data from May 1, 2025, to May 4, 2025, tested in SPSS, was found to be an Exponential distribution, resulting in Asymp. Sig is 0.240>0.05 so that $H_0$ is accepted.

Next, we will analyse the queuing system and its characteristics to determine whether the system is performance-optimal. In this study, the following are the results of the analysis:

1. Calculation of queue parameters

To calculate the average arrival rate using the total customers from all time intervals for 4 days, if the total customers are 150 people with a total observation time of 720 minutes, then by using equation (2.1), the value of $\lambda = 0.2083$ customers/minute is obtained. To calculate the service rate using the total average service time per customer, if the total service time is 365 minutes and the total number of customers served is 150 people, using equation (2.2), we get the value of $Ws = 2.43$ minutes/customer. Next, we calculate the service rate using equation (2.3) and obtain the value. $\mu$ is 0.4115 customers/minute

2. Queuing system performance parameters

Based on the calculation results, the system occupancy rate (ϱ) is 50.62%. This value indicates that the system is in a steady state because ϱ < 1, which means that the arrival rate (λ) is smaller than the service rate (μ). This condition is the main requirement for the M/M/1 queueing model to be stable and mathematically analyzable (Harahap et al., 2018). The utilisation value of 50.62% indicates that the service facility is not yet overloaded. A utilisation rate below 60% is generally still considered stable and does not cause significant customer backlogs (Yusnita & Marsa, 2024). This is also consistent with other studies, which state that the smaller the ϱ value, the lower the probability of long queues (Nurhidayati et al., 2022). The average number of customers in the system (L) of 1.03 customers indicates that, on average, there is only about one customer in the system. The parameters L and Lq are important indicators in measuring the density of a service system (Sari et al., 2016). Other studies in the service sector also show that an L value close to one indicates that the system is relatively smooth and not congested (Rozandy et al., 2021).

The average number of customers in the queue (Lq) of 0.52 customers indicates a very short queue length. A small Lq value indicates that the system is operating efficiently and customer waiting times are relatively short (Heizer et al., 2017). This condition is also consistent with other studies, which state that a low Lq value reflects the effectiveness of the service system and good queue management (Taha, 2017). The average time customers spend in the system (W) is 4.9 minutes, indicating that the total time from arrival to service is relatively short. Time in the system is an important indicator in assessing service quality and operational efficiency (Shortle et al., 2018). The smaller the W value, the better the level of service performance provided. In addition, the average queue waiting time (Wq) of 2.4 minutes indicates that customers do not wait long before being served. Low waiting times have been shown to affect customer satisfaction and perceived service quality positively (Bahadori et al., 2014). Several studies on fast food restaurants also state that waiting times of less than five minutes are still considered good and responsive service (Ary, 2018). Overall, based on the parameters ϱ, L, Lq, W, and Wq, the M/M/1 queueing system in this study is stable and efficient. The evaluation of these performance parameters forms the basis for managerial decision-making to determine whether additional service facilities are needed or not (Harahap et al., 2018).

## 4. Conclusion

The result of data processing and analysis indicates that the appropriate queue model for this study is (M/M/1):(FIFO/I/I). This model indicates that customer arrivals follow a Poisson distribution, while service times follow an exponential distribution. This system has one waiter, uses a First In, First Out (FIFO) queue discipline, and has an unlimited number of customers in the queue and in the system. Based on the calculation results, the average number of customers waiting in line is 0.52 customers/minute, and the average number of customers in the system is 1.03 customers/minute. The average time customers spend in the system is 4.9 minutes, while the average time they wait before being served is 2.4 minutes. The level of waiter busyness while serving customers was 50.62%, while the level of idle time (not serving) was 49.38%. Based on these results, the queue system at the Hokben Sawahan Padang fast-food restaurant can be considered quite ideal. However, further improvements are still needed in service to bring the servers' utilisation rate closer to 100%. This is important for increasing the service's effectiveness while boosting the restaurant's popularity. If the restaurant has the potential to become more widely known, it is thanks to good service, delicious food, cleanliness and comfort of the business premises. If all of these aspects are developed consistently, it will positively impact customer satisfaction and ultimately increase overall business profits.

Further research could focus on developing a more realistic queueing model that accounts for variations in customer arrivals during peak hours, the use of multiple servers, and possible customer behaviours, such as queue cancellation. In addition, it is necessary to evaluate service improvement strategies, such as adding servers or implementing a digital ordering system, to optimise utilisation. Integrating queue performance analysis with customer satisfaction is also important to ensure that efficiency improvements are in line with service quality and increased business profits.

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