The Analysis of Multiple Channels Single Phase Queuing Model After the Merger: The Case of Bank Sharia Indonesia

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Abstract. Queues often happen in everyday life. Queues occur when the demand for services exceeds the capacity provided. Long queues with long waiting times indicate poor service, which can lead to customer dissatisfaction. One of the determining factors for the success of a company, especially companies engaged in the service sector, is customer service. In the era of the industrial revolution 4.0, information and communication technology has provided fast and precise services. This study aims to analyze banking service queues at Bank Sharia Indonesia after the merger using multiple channels single-phase model. Multiple channels single-phase means there is more than one counter to serve the same service to a different customer, while a single phase means one set of operations performed. After receiving the service, the individual exits the system. This research is quantitative. The data used in this study is primary data consisting of the number of arrivals, services, and servers. Based on observations for 21 days, the average number of customer arrivals (λ) is twelve people per hour, the average customer service (μ) is six people per hour with four service facilities, and the average number of individuals in the system is two persons. The average waiting in the system is 11 min per person. The results showed that the queuing system applied at Bank Sharia Indonesia was optimal, as indicated by the usability of service facilities and the absence of customers queuing in queues (ρ) 50%.

Keywords: Queuing Model · Multiple Channels Single-Phase · Number of Arrival

1 Introduction

The COVID-19 pandemic has been going on for almost three years, causing a decline in global economic growth [1, 2]. In the first year that COVID-19 occurred, economic growth experienced a sharp decline, and the second quarter of 2020 experienced a slump. Various sectors affected by COVID-19 include the financial market sector [2, 3], logistics and retail [4], food safety management [5], social and politics [6]. Indonesia has also experienced economic contraction in the financial and non-financial sectors [7]. The Indonesian government has formulated various policies to deal with the impact of the

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COVID-19 pandemic. One of the government policies in the banking sector is the merger of Islamic banks on February 1, 2021, by issuing a permit for the merger of Islamic banks Number: SR-3/PB.1/2021. The three sharia banks that carried out the merger, namely Bank BRI Syariah Tbk (BRIS), Bank Syariah Mandiri Tbk (BSM), and Bank Negara Indonesia Syariah Tbk (BNIS) to become Bank Sharia Indonesia (BSI) [8]. The main objective of merging three Islamic banks is to improve post-pandemic Islamic banking performance by increasing competitiveness, developing business, strengthening capital, and increasing financial inclusion [9].

In carrying out their activities, Islamic banks refer to provisions in the Qur'an and al-Hadith [10], one of which is freeing from the problem of usury [11]. Islamic banks are free from interest. Islam prohibits riba or interest payment in whatever sharia transaction [12]. Riba is an amount of money over the principal amount of the loan for a certain period. An Islamic bank is a place to carry out financial transactions and save, which apply Islamic principles [10]. After the merger, Bank Syariah Indonesia should have experienced better performance by improving aspects of customer services. Excellent service to customers is something that needs attention as an indicator of customer satisfaction [13, 14]. The queue is a situation where a group of people or goods are waiting to get service [15] Queuing can occur because the number of servers is smaller than the number of people who will get the service [13], and the number of customers who come exceeds the number of service facilities provided, so the customers who come cannot be served immediately because of the busyness of the servers.

This study aims to analyze the multiple channels single phase queuing system implemented by Bank Sharia Indonesia after the merger. The queuing problem at Bank Sharia Indonesia is interesting to be analyzed. Merging three Islamic banks will increase the number of bank customers and lead to high service intensity. A decrease in service levels can lead to long queues. This condition will reduce the quality of bank services and can lead to customer dissatisfaction. Previous research about the analysis of multiple channel single phase queuing systems at the Maluku development bank concluded that the system implemented can serve queue numbers without waiting for another teller [16]. The single-phase multiple-channel queuing system at the Ibnu Sina Hospital in Padang has a positive impact on reducing queues and customer satisfaction [17].

2 Literature Review

The queuing theory was discovered and developed by A. K. Erlang, an engineer from Denmark who worked for a telephone company in Copenhagen in 1909, the experiments on fluctuations in demand for telephone facilities related to automatic equipment, namely automatic telephone connection equipment [18]. Erlang calculates the delay and the busyness of operators. The study result expanded on queuing theory [19]. A queuing process is related to the arrival of a customer at a service facility, then waiting in a line (queue) if everything is busy, and finally leaving a facility.

There are four basic queuing structure models in all queuing systems, single channel single phase, single channel multiple phases, multiple channel single phase, and multiple channels multiple phases. Single-channel means only one path enters the service system,

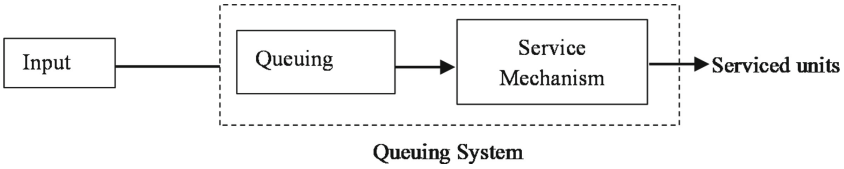

Fig. 1. The Basic Component Queuing System

or there is one service facility, and a single phase means only one service. The multiple-phase indicates there are two or more services carried out sequentially. These systems have several service facilities at each stage [20].

Three main components in the queuing systems are arrival, waitress, and queue. Arrival is every queuing problem involving arrivals. This element is often called the input process. The input process includes the source of arrival and how arrivals occur, which are generally random variables. Service mechanisms may consist of one or more servers. The emergence of queues mainly depends on the nature of the arrival and service process (Fig. 1).

On multiple-channel single-phase, more than one server can serve customers but only go through one process stage. Customers can use some of these servers to get services and leave the queuing system if it has completed the service process. The purpose of the queuing system analysis is to determine the performance of the queuing system in providing services, such as how many customers come to get service per unit of time, how long it takes to serve each customer, and how long to wait to get processed. Queuing theory is implemented in daily business activities such as traffic service improvement [21], fast food restaurants [22] goods delivery, banking service improvement [23], and call centers.

3 Research Methodology

The data used in this study are primary data obtained directly from the research object, namely the Bogor branch of the BSI. This research was carried out during the COVID-19 pandemic, to be precise sixth months after the merger of three Islamic banks in Indonesia for one month from 1 to 30 September 2021. This research is interesting to conduct due to changes in service mechanisms during the post-merger transition period. Maximizing customer service is a priority when the number of post-merger customers is higher with a more integrated service system. The model used to calculate service effectiveness at Bank Syariah Indonesia is a multiple-channel single phase with the pattern of service currently taking place at Bank Syariah Indonesia. Multiple channels have several paths or service facilities to enter the service systems. Single-phase means only one service or a set of operations is processed. After receiving the service, the individual exits the system. Multiple line queue model (M/M/s) is a queue for models that have multiple servers. In a single phase multiple channel model queuing system with two or more service lines provided to serve incoming customers.

4 Result and Discussion

BSI has operating hours as banks in general. Working days start Monday - Friday at 08.00 WIB - 15.00 WIB. Rest Hours at 12.00 WIB – 13.00 WIB and Friday at 11.30 WIB – 13.00 WIB. Customers who come will get a queue number and enter the queue system. Customers who arrive earlier will get a queue number and get service first. If the queue is long, customers wait until they get their turn. Even though there are digital services, people prefer to transact in person and are used to coming to the bank to make transactions. The queue structure model at Indonesian Islamic banks is Multi-Channel Single Phase, as shown in Fig. 2

Table 1 shows customer arrival and service for 21 working days with an average of 7 working hours per day, including rest hours. Based on the data in Table 1, the arrival rate of BSI's customers (λ) is 83 people/day. The highest number, 182 people on September 3, 2021, and the least on September 17, 2021, is 52. The average customer arrival (λ) is 12 people/hour. The average service per day (μ) is 10 min and 30 s per person or six people per hour. The waiting time in the queue (minute) is 13 min and 23 s.

To get the value of the average number of individuals in the queue (n-q), the average number of individuals in the system (n-t), the average waiting time in the queue (t-q), the average waiting time in the system (t-t), service facility utilization rate (Po) and facility usage rate (ρ), displayed in the following calculations.

The facility usage rate (ρ)

$$(\rho) = \lambda / S\mu$$

$$(\rho) = 12/4(6) = 0.5$$

The average probability of no customer in the system (P_o)

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

$$P_0 = \frac{1}{\frac{\left(\frac{12}{6}\right)^{0}}{0!} + \frac{\left(\frac{12}{6}\right)^{1}}{1!} + \frac{\left(\frac{12}{6}\right)^{2}}{2!} + \frac{\left(\frac{12}{6}\right)^{3}}{3!} + \frac{\left(\frac{12}{6}\right)^{4}}{4!\left(1-\frac{12}{4(6)}\right)}}$$

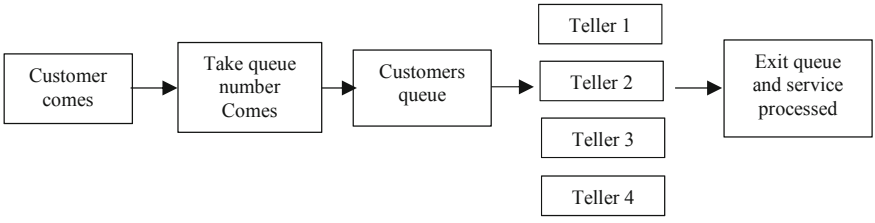

Fig. 2. Queuing System Bank Sharia Indonesia

Table 1. Customers Arrival and Service of BSI on September 2021

Date Period	Number of Arrival per day (customers)	Number of Arrival (customers per hour)	Number of Server	The average of service time		The waiting time in queue	
				Minute	Second	Minute	Second
1	73	10.42857	4	13.73	31.97	15.3013	25.3698
2	147	21	5	6.73	30.36	4.43	18.7
3	182	26	5	8.4	26.9	11.44505	19.5055
6	124	17.71428	4	8.15	29.7	14.17742	24.4355
7	83	11.85714	4	6.9	29.8	7.21687	29.3373
8	84	12	4	8.39	28.89	8.02381	25.2262
9	107	15.28571	5	7.38	27.67	3.80374	22.1773
10	93	13.28571	4	10.96	30.92	22.2903	26.5376
13	93	13.28571	4	10.7	30.31	15.9355	25.9785
14	87	12.42857	4	14.59	29.86	16.8161	23.4023
15	62	8.857143	4	14.66	30.16	13.7097	24.2742
16	57	8.142857	3	12.05	33.17	17.5789	22.895
17	52	7.428571	3	10.17	27.95	11.2885	19.6346
20	61	8.714286	3	12.06	29.31	10.6065	19.8666
21	49	7	3	1.53	28.28	12.1020	22.1428
22	69	9.857143	4	9.84	29.43	13.3188	20.7536
23	58	8.285714	3	10.34	29.41	14.2241	25.2069
24	75	10.71428	3	8.08	30.85	17.44	24.16
27	68	9.714286	3	11.45	28.26	14.4559	20.5147
28	61	8.714285	4	14.01	29.65	19.9180	19.4262
29	60	8.571428	4	9.98	30.68	12.1167	22.8667
Average	83.0952	11.8707	4	10.3753	29.6920	13.1523	22.966

$$P_0 = \frac{1}{6.333 + \frac{16}{12}} = 0.136$$

Average number of customers in queue/waiting before getting service ($\overline{n}_q$)

$$\overline{n}_q = \frac{\lambda\mu\left(\frac{\lambda}{\mu}\right)^S}{(S-1)!(S\mu-\lambda)^2}P_0$$

$$\overline{n}_q = \frac{12(6)\left(\frac{12}{6}\right)^4}{(4-1)!(4(6)-12)^2}0.136$$

$$\bar{n}_q = \frac{1152}{864} 0.136 = 0.1733$$

Average number of customers in the system ($\bar{t}_q$)

$$\bar{n}_t = 0.1733 + \left(\frac{\lambda}{\mu}\right)$$

$$\bar{n}_t = 0.1733 + \frac{12}{6} = 2.17\text{people}$$

Average waiting time in queue ($\bar{t}_q$)

$$\bar{t}_q = \frac{\bar{n}_q}{\lambda}$$

$$\bar{t}_q = \frac{0.1733}{12} = 0.0144\text{hours} = 0.86\text{minutes}$$

Average waiting time in the system ($\bar{t}_t$)

$$\bar{t}_t = \bar{t}_q + \frac{1}{\mu} = \bar{t}_t = 0.0144 + \frac{1}{6} = 0.18\text{hours} = 10.86\text{minutes}$$

The result of average number of individuals in the queue ($\bar{n}$ q), the average number of individuals in the system ($\bar{n}$ t), average waiting time in queue ($\bar{t}$ q), average waiting in the system ($\bar{t}$ t), level of usability of service facilities (Po) and facility usage rate (ρ) as shown in Table 2.

Based on the results of calculating the activity level of the bank, it shows an optimal level of activity indicated by $\rho < 50\%$. The average number of customers in the queue indicates there are no customers in the queuing. The average number of customers in the system is two people per hour. The average number of customers in the system must be greater than in the queue. These results indicate that the system can accommodate customers. The average waiting time in queuing is 0.86 min. The average waiting time in the system is 11 min. The results of this study are consistent with previous research conducted by Aulele (2014), showing that services at the AMbon branch of BJB bank are not optimal when using three tellers and optimal when using four tellers to serve customers [24]. The results of the research on the Multiple Channel-Single Phase (M/M/S) queuing model by applying service discipline, namely First Come-First Serve (FCFS) at BJB, shows teller service is less than optimal, indicated by the level of facility utilization is still low [23].

5 Conclusion

Based on the analysis, the type of queue that existed during data collection in September 2021 after the merger in the pandemic period at BSI was a multiple-channel single-phase model queue with four servers with seven hours of work a day, including rest hours. After being analyzed, the results show an optimal level of activity indicated

Table 2. The Result of Queue Formulas Model B (M/M/S) on September 2021

Variable Name	Description	Unit	Formula Model (M/M/S)	Value
λ	The average arrival rate	people/hour	λ	12
μ	The average of service rate	people/hour	μ	6
S	Number of server	unit	S	4
$\bar{n}$ q	The average number of individuals in the queue	people	$\bar{n}_q = \frac{\lambda\mu\left(\frac{\lambda}{\mu}\right)^S}{(S-1)!(S\mu-\lambda)^2}P_0$	0.1733
$\bar{n}$ t	The average number of individuals in the system	people	$\bar{n}_t = \bar{n}_q + \frac{\lambda}{\mu}$	2
$\bar{t}$ q	The average waiting time in queue	hour	$\bar{t}_q = \frac{\bar{n}_q}{\lambda}$	0.86
$\bar{t}$ t	The average waiting in the system	hour	$\bar{t}_t = \bar{t}_q + \frac{1}{\mu}$	10.86
ρ	Level of usability of service facilities	ratio	$\rho = \frac{\lambda}{S\mu}$	0.5
Po	The average probability of no customers in the system	ratio	$P_0 = \frac{1}{\sum_{\mu=0}^{S-1}\left[\frac{\left(\frac{\lambda}{\mu}\right)^\mu}{\mu!}\right] + \frac{\left(\frac{\lambda}{\mu}\right)^S}{S!\left(1-\frac{\lambda}{S\mu}\right)}}$	0.136

by $\rho < 50\%$. The average number of customers in the system is two customers. This condition provides customer satisfaction for BSI services. Excellent service is a crucial aspect of success in commercial business, especially in organizations engaged in the service sector. Customers will be reluctant to reuse services if the services provided are unsatisfactory. It will cause a loss in the success of the organization. Excellent service will give satisfaction. Excellent service after the merger for BSI as a step to increase BSI's performance growth after being hit by the Covid-19 pandemic. BSI is determined to maintain the momentum of this economic recovery with excellent service for customers.

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