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QUEUE SYSTEM ANALYSIS IN SERVICE OPTIMIZATION IN PT. BANK SULSELBAR MAIN BRANCH MAKASSAR CITY

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ABSTRACT

PT. Bank Sulselbar is a regionally owned business entity engaged in banking services. Companies in the service sector must be able to provide the best service to meet the wishes of customers who require fast service. As the number of customers increases, there are queuing problems in serving customers, this problem results in many customers waiting for quite a long time. For this reason, this study aims to reduce the length of time waiting for customers to avoid queues that are too long . This research uses queuing theory analysis method with queuing model (M/M/S). The results of this study using queuing theory analysis, namely the model calculation (M/M/S) shows that the busy period occurs in the period 08.00-09.00, and 13.00-14.00 by adding 1 service facility from 6 to 7 customer service, there will be a decrease customer waiting time. The waiting time in the system in the time period of 08.00-09.00 from 25.15 minutes to 10.07 minutes, and the time period of 13.00-14.00 from 19.39 to 9.13 minutes.

Keywords: Queue, Queuing System, Optimization, Customer Service, Poisson Distribution, Exponential Distribution

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1. Introduction

PT. Bank Sulselbar is a regionally owned business entity engaged in banking services. Bank Sulselbar Main Branch is one of the banks that can survive in the midst of competition in the banking world so that it has quite a lot of customers, who make transactions every day and customers need to be served properly. This is done so that banks can retain existing customers and increase the number of new customers. As the number of customers to be served increases, there is a new problem, namely queues.

A queue can be defined as a long line of customers who require service from one or more service facilities. The imbalance between being served and the service results in queues. This queue occurs because the demand for a service exceeds the number of services or facilities available (Anjum *et al.*, no date). According to Lusiani and Irawan (2016), queues are commonplace in everyday life. We often see long queues at the bank when customers are waiting to make transactions (Indra and Sarjono, 2010). According to Hidayat & Agustina (2016) Queues have become part of the service process. In terms of time, it is a very important and valuable aspect that the system can reduce excessive use of time so as to achieve efficiency and effectiveness in the use of that time (Munzir, Zannah and Mahmudi, 2018).

Waiting in line is boring for some people, so long queues result in customers leaving. Customers often judge the quality of a bank's operating system based on the waiting time in providing services to its customers. In general, every customer expects to be served immediately without having to wait long or queue (Ghaleb, Suryahatmaja and Alharkan, 2015). The occurrence of queues is an example of poor service. Because this makes customers wait to be served (Dahlan *et al.*, 2021)

A system is a group of elements with certain characteristics or attributes that interact with each other to achieve a goal. The queuing system is a collection of customers, services (counters) and rules that regulate customer arrivals and handling queue service problems, characterized by 5 components, namely arrival patterns, customers, service patterns, number of services, facility capacity to accommodate customers and rules where customers served (Dahlan *et al.*, 2022). The queuing system consists of a set of customers, services, and a rule that regulates customer arrivals and problem processors. The queuing process is a process that involves a customer arriving at a service facility, then waiting in a temporary queue for all services, and finally leaving the facility (Siregar and S, 2021).

Based on initial observations, it shows that there are still many customers who wait long enough at the customer service department, especially at certain times such as 08.00-14.00. There are 6 available customer services which are considered insufficient to serve customers who want to carry out transactions such as account closing, complaint handling and other service transactions. The role of customer service is to serve customers in opening a savings account at a bank, by serving customers in a friendly, smiling and patient manner (Mursak *et al.*, 2021).

At the company there are two criteria that are desired by the company, namely the average number of customers waiting in the queue is no more than 5 people and the average time customers wait in the system is no more than 15 minutes. These two criteria have represented the views of customers and customer service in providing services. Waiting too long in the queue can cause customers to be reluctant to visit again in the future. On the other hand, if there is no queue until many workers in the service facility are unemployed, it will cause implicit losses for the company (Aulele, 2014).

Optimization can be interpreted as making the company's production efficient and effective, always trying to maximize

profits and reduce the company's survival costs as much as possible (Farida *et al.*, 2021). According to (Huda, 2018) states that optimization is an optimal effort to achieve the best results to achieve what meets planned expectations and goals (Qamari and Trizula, 2022). Meanwhile, according to (Nurrohman, 2017) optimization is an effort to improve the performance of a job or personal related to the public interest, in order to achieve satisfaction and success from the implementation of these activities (Zeng and Wan, 2018).

To optimize the service, we can use the queuing model to determine the service time, the number of queuing channels, and the right number of servers (Putri and Ismanto, 2019). The four models most widely used by companies are adapted to their respective situations and conditions. The four queuing models are (1) M/M/I (Single Channel Query System or single line queuing model), (2) M/M/S (Multiple Channel Query System), (3) M/D/1 (Constant service or constant service time), and (limited population) (Hooper, Coughlan and R. Mullen, 2013).

With the queuing problem at PT. Bank Sulselbar Main Branch Makassar City, then conducted a systematic research to overcome the queue. The use of the queuing model allows the bank to design an operational system for the service staff.

2.1 *Place and Time of Research.*

This research was conducted at PT. Bank Sulselbar Makassar City Main Branch which is located on Jl. Dr. Sam Ratulangi No. 16, Makassar, South Sulawesi. This research was carried out for approximately one month.

2.2 Data Collection.

2.2.1 Primary Data

Primary data obtained directly from the object of research either through observation, interviews or other methods. This primary data is a description of service activities in the company.

2.2.2 Secondary Data

Secondary data comes from data and *records* owned by the research location company. This secondary data is in the form of the number of customer arrivals, the number of open lines, and the time of service.

2.3 Data Processing

The data processing in this study is as follows : testing the suitability of the distribution of the number of customer arrivals and service times using the Kolmogorov-Smirnov test. Determine the appropriate queuing model. Calculation of the speed of arrival and average service. Calculation of queuing system performance.

3. Results and Discussion

The data used in this study are data on the number of customer arrivals taken every 1 hour interval and service level data. The following is the number of customer arrivals every working day that makes transactions for 1 month or 22 working days from 08.00 – 15.00. For the level of aspiration, it is obtained that the company wants the average number of customers in the queue to be no more than 5 people, and the average time customers wait in the system is no more than 15 minutes.

3.1 Customer Arrival Data

Table 1. Customer Arrival Data

Date	Time Period (Hourly)					
	08.00 - 09.00	09.00 - 10.00	10.00 - 11.00	11.00 - 12.00	13.00 - 14.00	14.00 - 15.00
01/03/2022	58	69	75	67	36	54
02/03/2022	45	70	72	72	51	52
04/03/2022	45	73	74	73	53	62
07/03/2022	45	71	76	70	42	45
08/03/2022	34	74	69	65	42	47
09/03/2022	44	65	68	72	42	45
10/03/2022	39	69	65	68	39	37
11/03/2022	43	68	66	69	36	34
14/03/2022	31	65	66	64	33	41
15/03/2022	48	69	67	65	28	29
16/03/2022	47	64	68	66	47	40
17/03/2022	49	62	69	67	33	43
18/03/2022	46	65	65	65	37	29
21/03/2022	58	67	67	65	53	42
22/03/2022	39	65	69	59	46	32
23/03/2022	27	63	65	64	44	34
24/03/2022	43	65	66	67	45	44
25/03/2022	47	63	57	52	52	36
28/03/2022	45	68	59	56	50	41
29/03/2022	42	54	56	55	36	40
30/03/2022	34	49	58	54	34	29
31/03/2022	42	52	55	53	40	38

3.2 Service Time Data

Table 2. Service Time Data

Date	Time Period (Hourly)					
	08.00 - 09.00	09.00 - 10.00	10.00 - 11.00	11.00 - 12.00	13.00 - 14.00	14.00 - 15.00
01/03/2022	6,12	5,17	4,75	5,34	8,06	6,44
02/03/2022	7,64	5,06	4,97	4,83	7,06	6,83
04/03/2022	7,80	4,88	4,84	4,92	6,72	7,40
07/03/2022	8,40	6,27	5,39	5,41	7,21	7,33
08/03/2022	7,93	5,06	4,74	5,07	7,21	7,33
09/03/2022	8,14	5,32	5,07	5,00	8,02	6,32
10/03/2022	9,26	5,20	5,51	5,29	9,23	9,70
11/03/2022	8,37	5,24	5,44	5,09	9,94	19,61
14/03/2022	11,29	5,52	5,42	5,63	10,58	8,83
15/03/2022	7,40	5,22	5,34	5,45	12,82	11,39
16/03/2022	7,66	5,59	5,28	5,45	7,55	8,90
17/03/2022	7,31	5,77	5,20	5,25	9,79	7,73
18/03/2022	7,80	5,42	5,46	5,48	9,46	12,24
21/03/2022	6,09	5,36	5,24	5,37	6,72	8,43
22/03/2022	8,49	5,38	5,19	6,03	7,41	9,34
23/03/2022	10,48	5,56	5,48	5,44	7,34	8,29
24/03/2022	8,19	5,54	5,30	5,36	7,42	8,30
25/03/2022	7,34	5,38	6,02	6,46	6,71	9,83
28/03/2022	7,44	5,43	6,05	6,59	7,08	8,37
29/03/2022	8,55	6,57	6,29	6,33	8,67	8,58
30/03/2022	9,53	7,29	6,41	6,26	9,44	11,34
31/03/2022	8,29	6,85	6,38	6,02	7,88	9,61

3.3 Test Distribution of Customer Arrivals and Service Time

a. Customer Arrival Distribution Test

Table 3. Test Results of Customer Arrival Distribution

One-Sample Kolmogorov-Smirnov Test

		Customer Arrival
N		22
Poisson Parameter[a,b]	Mean	360.00
Most Extreme Differences	Absolute	.187
	Positive	.166
	Negative	-.187
Kolmogorov-Smirnov Z		.877
Asymp. Sig. (2-tailed)		.425

Based on the results of the Kolmogorov-Smirnov test, it can be concluded that customer arrivals have a Poisson distribution. The Poisson distribution is a distribution of events with low probability where the occurrence depends on a certain time interval or interval with observations on discrete variables and between independent variables. The time interval can be any time such as minutes, days, weeks, months or even years [15]. With a significant level of 0.425. Conclusions are drawn to prove whether the data is Poisson distributed or not, using the Kolmogorov-Smirnov SPSS, which is to compare the significance value (Asymp.Sig) with the value (real level) that has been determined, namely, 0.05. If the significance value is greater than the real level that has been applied, then the distribution hypothesis of the test is accepted, otherwise if the significance value is smaller than the real level, the distribution hypothesis is rejected. The result of the decision is that H0 is accepted because the significance value = 0.425 > 0.05.

b. Service Time Distribution Test

Table 4. Test Results of Service Time Distribution

One-Sample Kolmogorov-Smirnov Test

		Service Time
N		22
Normal Parameters[a,b]	Mean	7.29
	Std. Deviation	1.680
Most Extreme Differences	Absolute	.272
	Positive	.272
	Negative	-.270
Test Statistic		.272
Asymp. Sig. (2-tailed)		.126

Based on the results of the Kolmogorov-Smirnov test, it can be concluded that the customer service time is exponentially distributed. The exponential distribution is used to describe the distribution of time at service facilities, where service time is assumed to be random, the time spent serving customers does not depend on the time spent serving previous customers, nor does it depend on the number of customers waiting to be served. [16]. With a significant level of 0.126. Drawing conclusions to prove whether the data is exponentially distributed or not, using the Kolmogorov - S mirnov SPSS, which is to compare the significance value (Asymp.Sig) with the value of (real level) that has been set, namely, 0.05. If the significance value is greater than the real level that has been applied, then the distribution hypothesis of the test is accepted, otherwise if the significance value is smaller than the real level, the distribution hypothesis is rejected. The result of the decision is that H0 is accepted because the significance value = 0.126 > 0.05.

3.4 Queue System Model

In the transaction section at PT. Bank Sulselbar Main Branch Makassar City there are 6 *customer services that operate using* a queuing system, which is opened to serve customers with service rules that are first to come, to be served first (*First Come First Server*). The number of queues in the system and queues as well as sources of visitor arrivals are unlimited. So the queuing system at PT. Bank Sulselbar Makassar City Main Branch follows the (M/M/S) model.

3.5 Calculation of Customer Arrival Speed and Average Service Time

The results of the calculation of the speed of customer arrival and the average service time can be seen in the following table:

Table 5. Results of calculation of customer arrival speed and average customer service speed

Time Period (Hourly)	λ Customer/hour	μ Customer/hour
08.00 - 09.00	43	8,16
09.00 - 10.00	65	5,59
10.00 - 11.00	66	5,44
11.00 – 12.00	64	5,55
13.00 – 14.00	42	8,29
14.00 – 15.00	41	9,19

3.6 Queue System Performance

By using the arrival speed and average service time, the queue system is calculated using the existing formulas .

1. 08.00 – 09.00 is known: M = 6 , =43, = 8.16
   a. The probability that there are 0 people in the system (there are no customers in the system)

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

$$P_0 = \frac{1}{\left[\frac{1}{0!}\left(\frac{43}{8.16}\right)^0 + \frac{1}{1!}\left(\frac{43}{8.16}\right)^1 + \frac{1}{2!}\left(\frac{43}{8.16}\right)^2 + \frac{1}{3!}\left(\frac{43}{8.16}\right)^3 + \frac{1}{4!}\left(\frac{43}{8.16}\right)^4 + \frac{1}{5!}\left(\frac{43}{8.16}\right)^5\right] + \frac{1}{6!}\left(\frac{43}{8.16}\right)^6 \frac{6(8.16)}{6(8.16)-43}}$$

$$= 0{,}009$$

   So, the probability that there are 0 people in the system (there are no customers in the system is 0.009.

   b. Level of utility or busyness

$$\rho = \frac{\lambda}{M\mu} \quad (2)$$

$$= \frac{43}{6(8.16)}$$

$$0{,}8782$$

   So, the utility or busyness level is 0.8782.

   c. Average number of customers in the system

$$L_s = \frac{\lambda\mu\left(\frac{\lambda}{\mu}\right)^M}{(M-1)!\,(M\mu-\lambda)^2}\rho_0 + \frac{\lambda}{\mu} \quad (3)$$

$$= \frac{43(8{,}16)\left(\frac{43}{8.16}\right)^6}{(6-1)!\,(6(8{,}16)-43)^2}\,0{,}009 + \frac{43}{8{,}16}$$

$$= 21{,}13 \text{ Orang}$$

   So, the average number of customers in the queue is 21.13 people.

   d. Average time a customer spends in queue or being served (in the system)

$$W_s = \frac{L_s}{\lambda} \quad (4)$$

$$= \frac{21{,}13}{43}$$

$$= 0{,}4913 \text{ jam atau } 25{,}15 \text{ menit}$$

   So, the average queue time or customer service in the system is 0.4913 hours or 25.15 minutes.

e. Average number of customers or units waiting in

$$L_q = L_s - \frac{\lambda}{\mu} \quad (5)$$

$$= 21{,}13 - \frac{43}{8{,}16}$$

$$= 15{,}86 \text{ orang}$$

queue

So, the average number of customers or units waiting in the queue is 15.86 people.

f. Average time spent by a customer or unit waiting in

$$W_q = \frac{L_q}{\lambda} \quad (6)$$

$$= \frac{15{,}86}{43}$$

$$= 0{,}3688 \text{ Jam atau } 22{,}12 \text{ menit}$$

a queue

So, the average time a customer or unit waits in a queue is 0.3688 hours or 22.12 minutes.

Table 6. Queue System Performance

Time Period (Hourly)	Queue System Performance					
	P_0	ρ	L_s	W_s	L_q	W_q
08.00 - 09.00	0,009	0,8782	21,13	25,15	15,86	22,12
09.00 - 10.00	0,0003	1,937	13,89	12,81	2,26	2,082
10.00 - 11.00	0,0002	2,022	13,84	12,576	1,7	1,542
11.00 - 12.00	0,0003	1,9219	13,74	12,876	2,2	2,058
13.00 - 14.00	0,0104	0,8443	13,58	19,39	8,51	12,156
14.00 - 15.00	0,0162	0,7435	6,46	9,45	1,99	2,91

Based on table 4 above, it can be seen that the time periods of 08.00 - 9.00 and 13.00 - 14.00 do not match the desired criteria. Therefore, the optimal number of *customer service is determined again* for that period of time. After calculating using the 7 *customer service* above, there was a decrease in the number of customers queuing and waiting time for customers in the system. The calculation results can be seen in table 7

Table 7. Calculation Results with 7 *Customer service*

	L_q count	Standard	W_s count	Standard
08.00-09.00	1,95	5 orang	10,07	15 menit
13.00-14.00	1,33	5 orang	9,13	15 menit

Based on the table above where the values obtained have met the criteria in accordance with the number of customers queuing no more than 5 people, and waiting time not more than 15 minutes.

4. Conclusions and Suggestions

4.1 Conclusion

Based on the results of the research that has been done, it can be concluded that according to the model (M/M/S) the busy period occurs in the time period of 08.00-09.00 and 13.00-14.00 by adding 1 service facility from 6 to 7 *customer service,* there will be a decrease customer waiting time. The waiting time in the system in the time period of 08.00-09.00 from 25.15 minutes to 10.07 minutes, and the time period of 13.00-14.00 from 19.39 to 9.13 minutes.

4.2 Suggestions

Suggestions that can be given to the company to improve the performance of the queuing system and reduce the number of customer accumulations or long waiting times for customers, the company needs to consider adding 1 service facility so that operational performance is not disrupted and the transaction process can run optimally so that customers do not queue too long.

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