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Optimization of Service at Public Fuel Filling Stations (SPBU) Using Multiple Channel Single Phase Queue Model

Rianita Simamora[1*], Rector Sianturi[2] , Junarti[3], Gayus Simarmata[4]

[1,2,4]HKBP Nommensen University, Pematangsiantar, Indonesia
[3]Mathematics Education Study Program, FPMIPA, IKIP PGRI Bojonegoro, Indonesia

Email: rianitacharlito@gmail.com

ABSTRACT

Queues are a phenomenon that often occurs in people's lives, especially in the service industry such as what happens at the 14.211.207 Pematangsiantar gas station where the queue starts in the morning. One indicator is that customers have to queue for a long time to get fuel filling services at the gas station if left alone, it can cause customers to exit the system. So the queue problem must immediately be a priority to find a way out. This study aims to determine the level of optimal fuel filling system service and to determine the optimal or ideal fuel filling service system at the 14.211.07 Pematangsiantar gas station. The research method used in this study is applied research, namely research conducted to obtain information used to solve problems using quantitative methods to determine the level of optimal fuel filling system service at the gas station. Data collection was carried out by observing and recording the queues that occurred in the morning. The queue model used is Multiple Channel Single Phase with the First In First Out (FIFO) queue discipline. From the results of the calculation of the performance of the queue system at the 14,211,207 Pematangsiantar gas station, it was found that the service level with two or more gas stations was optimal, namely below 50%.

Keywords: First In First Out, Multiple Channel Single Phase, Queue Model, Service Optimization, Server Petrol

INTRODUCTION

Human development from year to year continues to increase, along with the progress of the times in various sectors. As social beings, humans cannot avoid the involvement of others in everyday life. In certain situations, humans definitely need the help of others to meet their life needs, and to get it, patience is often needed in waiting [1].

This phenomenon is very likely to occur because many individuals need the same goods or services at the same time [2]. This situation often occurs in everyday life, such as when waiting to get a train ticket, queuing at the supermarket cashier, waiting for an order at a restaurant, and queuing in a long queue at a Public Fuel Station (SPBU) [3].

According to Sinulangga [4] in his book, he explains that queuing theory is a probabilistic study of waiting lines, which is a waiting line of customers who need service from an existing system [5]. A queue is a waiting line of units that require service from one or more service facilities P. Siagian [6]. A queue is a situation where customers have

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to wait their turn to be served because of an imbalance between the number of customer arrivals and the service time available. When the number of customers increases but is not accompanied by an increase in the number of service facilities, there will be long queues that can be detrimental to both customers and the company itself. If the company is unable to cope with long queues, customers will most likely switch to another company that has a more efficient queuing system [7].

Queues occur due to limited service resources, which are generally related to limited servers (operational staff) for economic reasons [8]. If the number of servers available is limited, it can cause long queues, which can eventually cause some people to choose to leave the queue. This is a loss for the company, because it causes loss of customers. To prevent this loss, the company needs to ensure an adequate number of servers, but this also means greater costs for the procurement and maintenance of the servers [9].

Currently, the production of motor vehicles continues to increase due to high customer demand every year. Along with the increasing number of motor vehicle users, the need for fuel automatically increases. This is because motorcycles are a productive, effective, and efficient means of transportation for almost all levels of society in daily activities, especially for going to work [10].

Optimization is a process that aims to increase the effectiveness and efficiency of a system, both existing and newly designed [11]. According to Sugioko [12], optimization is a discipline of mathematics that focuses on finding the best value, such as the minimum or maximum value systematically of a function, opportunities or other value searches in various contexts or cases. Optimization is very useful in order to achieve the desired target effectively and efficiently [13]. Optimization aims to satisfy or ensure the success of the activity organizer by trying to improve performance or individuals who are relevant to the public interest [14].

In the context of service at Public Fuel Filling Stations (SPBU), one form of optimization that can be done is to reduce or prevent long queues by increasing the number of service facilities. However, it should be noted that too many service facilities can also cause the performance of the queue system to become too loose. Therefore, an analysis method is needed to determine the optimal and ideal number of servants, so that customers can feel comfortable using the service at the SPBU without causing losses to the SPBU.

According to Wospakrik [15] explains that the queue system is a collection of customers, servers and rules that regulate the arrival of customers and their services. The growth in the number of motorcycle users in Pematangsiantar also continues to increase, but the limited availability of Public Fuel Filling Stations (SPBU) can result in less than optimal service [16]. One of the consequences is that customers have to queue for a long time to get fuel filling services at gas stations. If this queue problem is not resolved immediately, it can cause customers to switch to gas stations with fewer queues. Therefore, handling queue problems is a priority to ensure smooth service at gas stations [17].

Gas Station 14.211.207 is one of the public fuel filling stations located on Jl. Sangnawaluh Pematangsiantar. This gas station has a strategic location and is visited by many vehicles because it is close to the Parluasan market which is a meeting place for buyers and sellers to make transactions for buying and selling goods and services. In addition, this gas station is also located in the middle of the city. It is only right that this gas station is visited by many people because of the needs of the community in meeting their needs, such as a housewife who wants to shop at the market or a trader who will sell his merchandise, the needs of the community to work, take children to school, or as a livelihood such as online motorcycle taxis or other public transportation [18]. This gas station has 4 fuel filling facility lines and has 2 types of oil, namely pertalite and pertamax. Two facilities with pertalite and pertamax oil types are specifically for four-wheeled vehicles or more, each has two oil filling pump machines and each is guarded by one server [19]. The other two facilities with the same type of oil are specifically for two-wheeled vehicles which have two oil filling pump machines and each is guarded by two servers [20]. The crowds at every facility that occurs at this gas station occur in the morning starting at 07.00, where many vehicle users come but the number of facilities and servers is less than optimal, causing very long queues, especially in the queues of two-wheeled vehicle stations with the type of Pertalite oil where the queue can reach the highway [21]. Based on the background of the problem, it can be concluded that the identification of the problem is: The occurrence of long queues and a lot of time is cut because they have to queue to fill up vehicle fuel at the 14.211.207 Jl. Sangnawaluh gas station which causes a slowdown in traffic flow in the morning.

By looking at the fuel filling lane for the type of Pertalite oil specifically for motorbikes which only has two oil filling pumps and two servers, it causes a slow service process, resulting in discomfort for those who are queuing for too long. When they find out that the queue they are following is too long and certainly takes a long time, they will most likely leave the queue at the 14.211.207 Pematangsiantar gas station and look for a gas station that has a small queue [22]. The solution that can be done to overcome the queues that occur at this gas station is to use the queue method by optimizing service to the queue at the Pertalite type of oil filling station, especially for two-wheeled vehicles, which can minimize the queues that occur [23]. The results of this study are expected to contribute to determining future policies so that they can optimize the company's performance at 14,211,207 Jl. Sangnawaluh Pematangsiantar in preventing and reducing the occurrence of queues.

METHODS

The type of research used in this study is applied research, namely research conducted to obtain information used to solve problems using quantitative methods to determine the optimal level of service system for refueling at gas station 14.211.207 Jl. Sangnawaluh Pematangsiantar [24].

The research design is as follows:

1. Problem Identification , Problem identification is defined as an effort to explain the problem and create an explanation that can be measured [25].
2. Formulating the Problem , The purpose of formulating the problem is to clarify the problem in conducting research so that it can be easy to find a solution to solve the problem.
3. Collecting Data , At this stage, the researcher collects the data needed for the research, namely data on the number of arrivals and data on the number of services.
4. Data Analysis, Analyzing the data collected using the Multiple Queue Line Model formula, namely the stage to find out the average number of customers in the system (L_s) , the average amount of time spent in the system (waiting time plus service time) (W_s), average number of units waiting in the queue (L_q) , average time waiting in the system *(Wq),* system utilization factor (population of busy service facilities) ($\boldsymbol{p}$), Next, analyze the optimal service level to determine the optimal number of facility lines and analyze the service time performance at the optimal level.

5. Drawing Conclusions After completing these stages, a conclusion is drawn regarding the optimal level of customer service system using a queuing system.

Population is a collection of all subjects, variables, concepts, or phenomena that are the focus of the study. We can examine each member of the population to find out the nature of the population in question [26]. In this study, the population is all consumers who come to refuel their vehicles during the study, and the study uses samples for 5 working days.

According to Sugiyono [2], in quantitative research, a sample is a part or subset of the number and characteristics of the population being studied. What is learned from the sample, the conclusion will be applied to the population. The sample of this study was motorcycle customers who queued to fill up with Pertalite fuel starting from 08.00 - 12.00 for 5 days.

The queue model at gas station 14.211.207 on the Pertalite type of fuel filling line specifically for motorbikes is multiple channel-single phase with the notation M/M/S, where there are two fuel pumps and two servers serving or one queue line with two service stations.

RESULTS AND DISCUSSION

Queue System Performance

Gas Station 14.211.207 Pematangsiantar has four fuel filling facility lines with two types of fuel, namely pertalite and pertamax. However, queues often occur only at the pertalite type of fuel filling station specifically for motorbikes, which only has one service server. The type of queue system at Gas Station 14.211.207 Pematangsiantar is the Single Channel Single Phase or M/M/1 queue model, where there is one queue line or one service station. The time required for each server to serve customers is random, and the duration of service time determines the service time standard for each server. The service discipline applied at Gas Station 14.211.207 Pematangsiantar is First In First Out (FIFO), where customers who come first will be served first. In data processing, researchers use the POM-QM application to assist in calculations.

Server Arrival Rate and Service Rate

Customer arrival rate is the number of customers who come to get service at the server, expressed in the number of customers (people) in a certain time period. The customer arrival rate is assumed to follow a Poisson distribution, where the arrival of other customers is independent of time (infinite), and the arrival rate is different every day because each customer has different needs. The service level of the service server is the duration of time provided by the server to serve customers. Customer arrival data is obtained by observing the number of customers entering the queue system at the 14.211.207 Pematangsiantar gas station. Observations were carried out for 5 days during working hours and were carried out at 08.00-12.00 WIB, the number of customers entering the queue system at the 14.211.207 Pematangsiantar gas station was recorded every one hour interval [25]. The following is data on customer arrivals who filled up at the 14.211.207 Pematangsiantar gas station for 5 days.

Table 1. Customer Arrival Data

No.	Day	Arrival of customers/people	Total working hours
1	Monday	416	
2	Tuesday	410	
3	Wednesday	429	4 hours
4	Thursday	422	
5	Friday	416	
Amount		2093	4 hours

Source: Primary research data at SPBU 14,211,207 Pematangsiantar

Table 2. Hourly Customer Arrival Data

No.	Day/Date	Time Period (Per hour)	Arrival (Motorcycle)
1		08.00-09.00	102
	Monday	09.00-10.00	105
		10.00-11.00	100
		11.00-12.00	109
2		08.00-09.00	106
	Tuesday	09.00-10.00	103
		10.00-11.00	102
		11.00-12.00	99
3		08.00-09.00	104
	Rabu	09.00-10.00	112
		10.00-11.00	107
		11.00-12.00	106
4		08.00-09.00	101
	Kamis	09.00-10.00	107
		10.00-11.00	105
		11.00-12.00	109
5		08.00-09.00	110
	Jumat	09.00-10.00	105
		10.00-11.00	102
		11.00-12.00	99

Source: Primary research data at SPBU 14,211,207 Pematangsiantar

Table 4.3.2 data shows that the number of customers coming every day and every hour varies, because each customer's fuel needs are different. The customer arrival rate per hour can be calculated by adding up the customer arrivals at the same hour for 5 working days, then dividing it by 5 [26]. The average number of customer arrivals per hour (λ) can be calculated by:

$$\lambda = \frac{\text{number of customers at a certain hour for 5 day}}{\text{Many Days}}$$

The following is the average customer arrival rate data:

Table 3. Average Arrival Rate

Time period (hours)	Average number of arrivals (motorcycles)
08.00-09.00	105
09.00-10.00	107
10.00-11.00	103
11.00-12.00	104
Total	419

It can be seen from Table 4.3.3 that the highest customer arrival rate is at 09.00-10.00 WIB with an average of 107 motorbikes, while the lowest customer arrival rate with an average of 103 motorbikes is at 10.00-11.00 WIB.

The level of ability (average) to serve customer needs at each arrival is called service capability. This level of ability (average) of service must be able to meet customer needs, but the ability to serve each customer arrival is not always the same, even though the type of service desired by the customer is the same. This difference is caused by the condition of service activities that are always changing, although the time difference is not significant. The hourly service level at SPBU 14.211.207 Pematangsiantar can be calculated as follows:

$$\mu = \frac{number\ of\ customer\ arrivals}{total\ working\ hours} = \frac{419}{4} = 104.75$$

So, the hourly service level is 104.75 people per hour, which is rounded up to 105 customers per hour.

Table 4. Average Level of Facility Service (pump machine/service server)

Time period (hours)	Average customer arrival (motorcycle)	Total working hours	Level of service (motorcycle)
08.00-09.00	105		
09.00-10.00	107	4 hours	105
10.00-11.00	103		
11.00-12.00	104		
Total	419	4 hours	105 per hour

Customer Arrival Distribution Test

Conducting distribution suitability testing using the *Kolmogorov-Smirnov test* for arrival distribution and service distribution. The data obtained is processed using IBM SPSS statistics 25 *software. If the distribution follows the Poisson distribution, then the hypothesis for the number of arrival distributions and the number* of service distributions is accepted and if *H0* is rejected, then the arrival and service distributions are generally distributed.

If the probability value < significance level, then H_0 is rejected.

If the probability value ≥ significance level, then H_0 is accepted.

The significance level used is α = 5%.

Tabel 5. Customer Arrival Distribution Test

One-Sample Kolmogorov-Smirnov Test		
		VAR00003
N		20
Poisson Parameter[a,b]	Mean	104.6500
Most Extreme Differences	Absolute	.277
	Positive	.230
	Negative	-.277
Kolmogorov-Smirnov Z		1.240
Asymp. Sig. (2-tailed)		.092

a. Test distribution is Poisson.
b. Calculated from data.

Based on the calculation results above, the Asymptotic significance value (2-tailed) or p-value is 0.092, which means it is greater than α = 0.05. Because p > α, Ho is accepted, in other words, customer arrivals are distributed Poisson.

Queue Analysis Queue Using Multi Channel Single Phase Model

The average number of customer arrivals per hour (λ) can be calculated as follows:

$$\lambda = \frac{\text{number of customers at a certain hour for 5 day}}{\text{many days}}$$

$$\lambda\text{Monday} = \frac{416}{5} = 83$$

$$\lambda\text{Tuesday} = \frac{410}{5} = 82$$

$$\lambda\text{Wednesday} = \frac{429}{5} = 86$$

$$\lambda\text{Thursday} = \frac{422}{5} = 84$$

$$\lambda\text{Friday} = \frac{416}{5} = 83$$

The optimization that can be used at the 14.211.207 Pematangsiantar gas station is by using a multiple lane queue system with the M/M/S model. In this system, researchers must determine the number of gas station operators operating *(c),* the average customer arrival rate ($\boldsymbol{\lambda}$)**,** and the average service level ($\boldsymbol{\mu}$)**.** The next calculation is to find *Ls, Ws, Lq,* and *Wq* .

1. Monday's data with known c = 2, λ= 83 , μ= 1 05 using POM-QM

Table 6. Performance Results on Monday

			Pengoptimalan solution		
Parameter	**Value**	**Parameter**	**Value**	**Minutes**	**Seconds**
MM/s		Avarage Server Ultization	,4		
Arrival rate (λ)	83	Avarage number in the queue (Lq)	,15		
Service rate (μ)	105	Avarage number in the system (Ls)	,94		
Number of servers	2	Avarage time in the queue (Wq)	,0	,11	6,35
		Avarage time in the system (Ws)	,01	,68	40,63

Information : Average customer arrival rate($\boldsymbol{\lambda}$) on Monday it was 83 customers per hour. Average service level ($\boldsymbol{\mu}$) as much as 1.05 customers per hour. The number of operators operating (c) is 2 people. Service probability level P by 0.40 or 40 %. The average number of customers waiting in the queue (Lq) is 0.15 or 0 customers. The average number of customers waiting in the system (Ls) is 0.94 or 1 customer. The average waiting time spent by customers in the queue (Wq) was 0.11 minutes. The average waiting time spent by customers in the system (Ws) is 0.68 minutes .

2. Tuesday's data with known c = 2, λ= 82 , μ= 1 05 using POM-QM

Table 7. Performance Results on Tuesday

			Pengoptimalan solution		
Parameter	**Value**	**Parameter**	**Value**	**Minutes**	**Seconds**
MM/s		Avarage Server Ultization	,39		
Arrival rate (λ)	82	Avarage number in the queue (Lq)	,14		
Service rate (μ)	105	Avarage number in the system (Ls)	,92		
Number of servers	2	Avarage time in the queue (Wq)	,0	,1	6,17
		Avarage time in the system (Ws)	,01	,67	40,45

Information : Average customer arrival rate($\boldsymbol{\lambda}$) on Monday it was 82 customers per hour. Average service level ($\boldsymbol{\mu}$) as much as 1.05 customers per hour The number of operators operating (c) is 2 people**.** Service probability level P by 0.3 9 or 3 9 %**.** The average number of customers waiting in the queue (Lq) is 0.14 or 0 customers. The average number of customers waiting in the system (Ls) is 0.92 or 1 customer. The average waiting time spent by customers in the queue (Wq) is 0.10 minutes. The average waiting time spent by customers in the system (Ws) is 0.67 minutes .

3. Wednesday's data is known as c = 2, λ= 86 , μ= 1 05 using POM-QM

Table 8. . Performance Results on Wednesday

			Pengoptimalan solution		
Parameter	**Value**	**Parameter**	**Value**	**Minutes**	**Seconds**
MM/s		Avarage Server Ultization	,41		
Arrival rate (λ)	86	Avarage number in the queue (Lq)	,17		
Service rate (μ)	105	Avarage number in the system (Ls)	,98		
Number of servers	2	Avarage time in the queue (Wq)	,0	,12	6,17
		Avarage time in the system (Ws)	,01	,69	41,19

Information : Average customer arrival rate(λ) on Monday it was 86 customers per hour. Average service level (μ) as much as 1.05 customers per hour, the number of operators operating (c) is 2 people Service probability level P by 0.41 or 41. The average number of customers waiting in the queue (Lq) is 0.17 or 0 customers. The average number of customers waiting in the system (Ls) is 0.98 or 1 customer . The average waiting time spent by customers in the queue (Wq) is 0.12 minutes. The average waiting time spent by customers in the system (Ws) is 0.69 minutes.

4. Thursday's data with known c = 2, λ= 84 , μ= 1 05 using POM-QM

Table 9. Performance Results on Thursday

			Pengoptimalan solution		
Parameter	Value	**Parameter**	**Value**	**Minutes**	**Seconds**
MM/s		Avarage Server Ultization	,4		
Arrival rate (λ)	84	Avarage number in the queue (Lq)	,15		
Service rate ((μ))	105	Avarage number in the system (Ls)	,95		
Number of servers	2	Avarage time in the queue (Wq)	,0	,11	6,53
		Avarage time in the system (Ws)	,01	,68	40,82

Information : Average customer arrival rate(λ) on Monday it was 84 customers per hour. Average service level (μ) as much as 1.05 customers per hour, the number of operators operating (c) is 2 people. Service probability level P by 0.40 or 40 %. The average number of customers waiting in the queue (Lq) is 0.15 or 0 customers. The average number of customers waiting in the system (Ls) is 0.95 or 1 customer. The average waiting time spent by customers in the queue (Wq) is 0.11 minutes. The average waiting time spent by customers in the system (Ws) is 0.68 minutes .

5. Friday's data with known c = 2, λ= 83 , μ= 1 05 using POM-QM

Table 10. Performance Results on Friday

			Pengoptimalan solution		
Parameter	**Value**	**Parameter**	**Value**	**Minutes**	**Seconds**
MM/s		Avarage Server Ultization	,4		
Arrival rate (λ)	83	Avarage number in the queue (Lq)	,15		
Service rate ((μ))	105	Avarage number in the system (Ls)	,94		
Number of servers	2	Avarage time in the queue (Wq)	,0	,11	6,55
		Avarage time in the system (Ws)	,01	,68	40,63

Information: Average customer arrival rate(λ) on Monday it was 83 customers per hour. Average service level (μ) as much as 1.05 customers per hour. The number of operators operating (c) is 2 people. Service probability level P by 0.40 or 40 %. The average number of customers waiting in the queue (Lq) is 0.15 or 0 customers. The average number of customers waiting in the system (Ls) is 0.94 or 1 customer. The average waiting time spent by customers in the queue (Wq) was 0.11 minutes. The average waiting time spent by customers in the system (Ws) is 0.68 minutes .

DISCUSSION

Service optimization refers to the process of improving the efficiency of a pre-existing service system or designing a new system so as to provide the best conditions for service facilities and service users. One form of service optimization that can be implemented at gas stations is to reduce or prevent long queues in the queuing system, thus providing more comfort to all customers. According to Kotler in Hendro and Syamswana (2017: 117) the definition of service refers to any action or activity that can be offered by a party to another party, which is basically intangible and does not result in any ownership.

According to Kotler and Armstrong (2012: 681) service quality is the whole of the features that have characteristics of a product or service that support its ability to satisfy needs directly or indirectly. From the several definitions of service that have been explained above, it can be concluded that service is an activity or series of activities that occur in direct interaction between individuals and other individuals or machines physically, with the aim of providing satisfaction to customers and is considered important and valuable. The average waiting time is highly dependent on the average rate of service [27]. The theory of queuing was developed by A.K. Erlang, a Danish engineer who worked at a telephone company in Copenhagen in 1910. Erlang conducted an experiment related to fluctuations in demand for telephone facilities connected to automatic typing equipment, namely automatic telephone connection equipment. During busy times, operators are overwhelmed to serve callers quickly, so callers have to queue to wait for their turn and it may take quite a long time [28]. Erlang's original problem only treated the calculation of delay from one operator, then in 1917 Erlang continued the research to calculate the busyness of several operators. Second Research Results Erlang in 1917 published two important research papers on queuing theory entitled "The Application of Probability Theory to Telephone Traffic" which aimed to develop a mathematical model to analyze queuing systems in telephone networks [29].

The method used in his research is probability theory to calculate various parameters of the queuing system, such as average waiting time, number of servers needed, and the probability that all servers are busy. Some of the results obtained are to calculate the average waiting time in a queuing system with a Poisson arrival distribution and an exponential service time distribution, to calculate the probability that all servers are busy in a queuing system and to determine the number of servers needed to achieve the desired service level. Queuing theory is now used in various fields to analyze and improve queuing systems. In this period Erlang published his famous book entitled Solution of some problems in the theory of probabilities of significance in Automatic Telephone Exchange. After the Second World War, Erlang's research results became more widely used. The first research was conducted by Maman Hilman, Nugraha Kusuma, and Priyo Nur Utomo (2019) with the title Service Optimization at PD Gas Stations. Aladdin 4 Banjarmasin with Multiple Channel Single Phase Queue Method" the model used in this study is a queue model with a Multiple Channel Single Phase model where the number of arrivals and service time with First Come First Served service discipline. The results of this study are optimal service facilities with 5 service facilities, looking at the results of the calculation of the expected queue length including those being served which were previously 15 vehicles in the system, after the service facilities were added to 5 facilities, it became 11 vehicles in the system. While the expected queue length excluding those being served which were previously 7 vehicles in the queue became 4 vehicles in the queue. The expected waiting time in the system (including service time) which was previously 33.733 seconds became 31.468 seconds. While the expectation of waiting in the queue (excluding queue time) which was previously 16.190 seconds became 12.272 seconds. And looking at the total cost of efficiency that the use of 3 service facilities incurred a total efficiency cost of Rp.42,625.70 while for 5 service facilities incurred a total efficiency cost of Rp.42,632.72.

The second study was conducted by Erwin H. Pellondou, Ronald P.C Fanggidae, and Antonio (2021) with the title "Queue Theory Analysis on the Motorcycle Lane of the Oebobo Public Fuel Filling Station (SPBU). The purpose of this study was to determine the performance of the motorcycle service lane and the optimal number of fuel filling facilities at the Oebobo Fuel Filling Station (SPBU). This study is a quantitative study and the analysis method used is queue theory analysis applied to the Oebobo gas station. The results of the study showed that the highest average motorcycle arrivals were at 08.00-09.00 with 271 motorcycles and the lowest at 16.00-17.00 with the arrival of 154 motorcycles and an average service level of 199 motorcycles/hour. Meanwhile, the service performance at the Oebobo gas station specifically for motorcycle lanes is not optimal because there are still unemployed operators. So that the queue system analysis shows the optimal number of facility lanes at the Oebobo gas station, namely at 08.00-10.00 the lanes opened are 3 facility lanes and at 16.00-20.00 the lanes opened are 2 facility lanes [30].

The third study was conducted by Dirarini Sudarwadi [31] with the title "Analysis of the Queue System at a General Fuel Filling Station Case Study on Solar Filling at (SPBU) 84-983-02 Jl. Esau Manokwari Regency "which aims to analyze the optimal number of facility lanes and service performance at an optimal level. The type of data used is quantitative data and the data sources used are primary data, namely observation and interviews. The analysis method used is the queuing theory analysis in accordance with the queuing model applied to the Esau Sesa Manokwari gas station, namely the Multiple Lane Queue Model [32]. This means that there is more than one facility lane and there is only one service stage that must be passed by customers to complete the service. The results of the study at the Esau Sesa Manokwari gas station using queue theory analysis, namely by calculating the multiple-path Queue Model, obtained the longest queue in the System (Wq) 0.60 and the shortest (Wq) 0.28. In calculating the performance of the queue system in the study, it is still optimal in accordance with the established service standards.

The real purpose of queuing theory is to investigate the activity of service facilities in a series of random conditions of a queuing system that occurs. To achieve this goal, logical measurements are made in two aspects. First, how long customers have to wait, which is measured by the average time it takes for customers to wait before getting service. Second, how long the server is idle, which describes the period of time when no customers are being served.

CONCLUSIONS

Based on the results of the analysis of the service performance system at the 14.211.207 Pematangsiantar gas station, it can be concluded that the service system implemented at the 14.211.207 gas station using the multiple channel single phase model (multiple lane queue system with two or more lanes or service stations) at the gas station is optimal. Based on the calculation results obtained, the level of service facility activity is below 50%. Based on the results of data processing that has been carried out in the previous chapter, the author can provide suggestions for further research on all queue lines at the gas station. The implications of this study will later be to maintain the performance of the queue system implemented at the 14.211.207 Pematangsiantar gas station, it is necessary to consider the level of customer arrivals and the level of queues that occur every day. The limitations of this study are how the optimal service system can be implemented at the 14.211.207 Jl. Sangnawaluh Pematangsiantar gas station using the multiple channel - single phase queue model.

REFERENCES

[1] O. I. Boniface, N. O. Donatus, E. E. Mong, Z. Chinyeaka, En I. C. Amaechi, "Application Of Multi-Channel, Single Stage Queue Model To Optimize Service Delivery In Banking Industry (A Case Study Of Diamond Bank Plc, Eziukwu Branch, Aba)", *Int. J. Sci. Eng. Sci.*, Vol 2, No 2, Bll 36–41, 2018.

[2] S. A. Ginanjar En B. Halimi, "Solar Pv-Wind Turbine Integration In Hydrogen Production And Electricity Generation For Electric Charging Station And Hydrogen Fueling Station In Indonesia", In *Ieom Society International*, 2024, Bl 110001, Doi: 10.1063/5.0235547.

[3] U. M. Center, "Xxii International Conference Mathematical Optimization Theory And Operations Research (Motor 2023) Ekaterinburg, Russia", 2023.

[4] F. Firdalius, "Simulation Model Scheduling Queue In Teller Bank With Multi Channel–Multi Phase", *J. Ipteks Terap.*, Vol 15, No 2, Bll 204–214, 2021, Doi: Https://Doi.Org/10.22216/Jit.V15i2.260.

[5] U. Arfan En N. Paraga, "Perbandingan Algoritma K-Means, Naïve Bayes Dan Decision Tree Dalam Memprediksi Penjualan Bahan Bakar Minyak: The Comparison Of K-Means, Naïve Bayes And Decision Tree Algorithm In Predicting Fuel Oil Sales", *Malcom Indones. J. Mach. Learn. Comput. Sci.*, Vol 4, No 4, Bll 1379–1389, 2024.

[6] S. A. Ginanjar En B. Halimi, "Solar Pv-Wind Turbine Integration In Hydrogen Production And Electricity Generation For Electric Charging Station And Hydrogen Fueling Station In Indonesia", In *Aip Conference Proceedings*, 2024, Vol 3215, No 1.

[7] A. U. Khasanah, M. S. Muqaffi, En Nurcahyati, "Simulation Of Two Channels, Single-Phase Queuing System Using Monte Carlo Model In A Government Office", In *Aip Conference Proceedings*, 2023, Vol 2485, No 1, Bl 090003, Doi: 10.1063/5.0105465.

[8] A. V Aganov En A. L. Larionov, "On The 75-Th Anniversary Of Magnetic Resonance (Epr) Discovery. Pages In History. The Development Of Radiospectroscopy At Kazan University", *Magn. Reson. Solids. Electron. J.*, Vol 22, No 2, Bl 20202, 2020.

[9] A. Hardianto, Marimin, L. Adrianto, En I. Fahmi, "A Multi-Objective Optimization Business Model For Non-Commercial Port Sustainability", *Int. J. Sustain. Dev. Plan.*, Vol 19, No 10, Bll 3901–3910, Okt 2024, Doi: 10.18280/Ijsdp.191018.

[10] I. Nurhayati, D. Yudhawati, M. J. Avessina, En L. Muniroh, "The Analysis Of Multiple Channels Single Phase Queuing Model After The Merger: The Case Of Bank Sharia Indonesia", In *20th International Symposium On Management (Insyma 2023)*, Atlantis Press, 2024, Bll 447–455.

[11] P. S. Annatasya, "Medication Inventory Planning Control At Pharmaceutical Installation Of Naili Dbs Hospital Padang". Universitas Andalas, 2022.

[12] A. Ahuja, A. Jain, En M. Jain, "Transient Analysis And Anfis Computing Of Unreliable Single Server Queueing Model With Multiple Stage Service And Functioning Vacation", *Math. Comput. Simul.*, Vol 192, Bll 464–490, Feb 2022, Doi: 10.1016/J.Matcom.2021.09.011.

[13] A. Alfiansyah En A. Hasin, "Integrasi Abc System Dan Eoq Dalam Pengendalian Persediaan Bahan Baku (Studi Kasus Pada Perusahaan Tisu Di Yogyakarta)", *Innov. J. Soc. Sci. Res.*, Vol 3, No 4, Bll 10202–10213, 2023, Doi: Https://Doi.Org/10.31004/Innovative.V3i4.4863.

[14] P. Sarla, M. Reddy Doodipala, En P. Endla, "Performance Of Vehicle Arrival Traffic Data At Fuel Station Using Queuing System", *Iop Conf. Ser. Mater. Sci. Eng.*, Vol 981, No 2, Bl 022080, Des 2020, Doi: 10.1088/1757-899x/981/2/022080.

[15] G. L. Kumawat En D. Roy, "A New Solution Approach For Multi-Stage Semi-Open Queuing Networks: An Application In Shuttle-Based Compact Storage Systems", *Comput. Oper. Res.*, Vol 125, Bl 105086, Jan 2021, Doi: 10.1016/J.Cor.2020.105086.

[16] A. Furtyfatimah En A. A. Istiningrum, "Inventory Cost Reduction With Economic Order Quantity For Filter Spare Part In Aircraft Filling Depot", *J. Manaj. Dan Organ.*, Vol 14, No 3, Bll 310–321, 2023.

[17] A. Sumantika, G. Sirait, E. Susanti, En E. P. L. Tarigan, "Determination Of Economic Value Using The Eoq And Rop Approaches In The Raw Material Control System", *Formosa J. Appl. Sci.*, Vol 2, No 6, Bll 1051–1064, 2023, Doi: Https://Doi.Org/10.55927/Fjas.V2i6.4323.

[18] C. Soraya, A. Surwanti, En F. Pribadi, "Drug Inventory Management Using Abc-Ven And Eoq Analysis For Improving Hospital Efficiency", *J. Aisyah J. Ilmu Kesehat.*, Vol 7, No 1, Bll 373–382, 2022.

[19] G. Wu, Z. Xu, H. Zhang, S. Shen, En S. Yu, "Multi-Agent Drl For Joint Completion Delay And Energy Consumption With Queuing Theory In Mec-Based Iiot", *J. Parallel Distrib. Comput.*, Vol 176, Bll 80–94, Jun 2023, Doi: 10.1016/J.Jpdc.2023.02.008.

[20] A. Sahnan En T. Wibowo, "Arah Baru Kebijakan Kurikulum Merdeka Belajar Di Sekolah Dasar", *Sittah J. Prim. Educ.*, Vol 4, No 1, Bll 29–43, Mei 2023, Doi: 10.30762/Sittah.V4i1.783.

[21] R. Qi, X. Chi, L. Zhao, En W. Yang, "Martingales-Based Aloha-Type Grant-Free Access Algorithms For Multi-Channel Networks With Mmtc/Urllc Terminals Co-Existence", *Ieee Access*, Vol 8, Bll 37608–37620, 2020, Doi: 10.1109/Access.2020.2975545.

[22] P. Setianah, H. A. Prabowo, En F. Farida, "Optimisasi Sistem Antrian Di Era Pandemi Untuk Meningkatkan Kinerja Pelayanan Stasiun Pengisian Bahan Bakar Umum (Spbu)", *Innov. J. Soc. Sci. Res.*, Vol 4, No 1, Bll 8994–9008, 2024, Doi: Https://Doi.Org/10.31004/Innovative.V4i1.8861.

[23] N. Kumar, T. Kumar, S. Nema, En T. Thakur, "A Comprehensive Planning Framework For Electric Vehicles Fast Charging Station Assisted By Solar And Battery Based On Queueing Theory And Non-Dominated Sorting Genetic Algorithm-Ii In A Co-Ordinated Transportation And Power Network", *J. Energy Storage*, Vol 49, Bl

104180, Mei 2022, Doi: 10.1016/J.Est.2022.104180.

[24] A. A. Rahmi, "Queue Analysis Of Vehicle Pertalite Motorcycle At Spbu: 64.771. 02 Mountain Lingkas, Tarakan East, Tarakan City North Kalimantan", In *Proceeding Of The Borneo International Conference Of Management, Accounting And Economy*, 2023, Vol 1, No 1, Bll 438–449.

[25] B. W. Pratama, F. B. Harlan, A. Wirawan, En A. P. Enggita, "Analysis On Queue System At Vitka Point Gas Station Number 14.294. 722 On Motorcycle Line With Pertalite-Based Fuel", *J. Akuntansi, Ekon. Dan Manaj. Bisnis*, Vol 10, No 1, Bll 54–60, 2022.

[26] A. Nurjannah, M. Amin, En I. Prakoso, "Optimization Of Gas Station Service Performance In Yogyakarta City To Increase Company Work Productivity", *J. Ind. Eng. Manag.*, Vol 9, No 2, Bll 77–87, 2024, Doi: Https://Doi.Org/10.33536/Jiem.V9i2.1880.

[27] F. A. Gifari, M. A. Maulana, En S. Maulana, "Analisis Rantai Markov Untuk Mengetahui Peluang Perpindahan Konsumen Merek Laptop Pada Mahasiswa Teknik Industri Universitas Indraprasta Pgri", *Bull. Appl. Ind. Eng. Theory*, Vol 3, No 1, 2022.

[28] D. A. T. Wahyudi En M. D. Sinaga, "Penerapan Metode Order Quantity (Eoq) Dalam Sistem Informasi Pengendalian Persediaan Barang Desain Interior Dan Eksterior Berbasis Web", *J. Rekayasa Sist.*, Vol 1, No 2, Bll 751–761, 2023.

[29] A. Al-Hroub En D. Whitebread, "Dynamic Assessment For Identification Of Twice-Exceptional Learners Exhibiting Mathematical Giftedness And Specific Learning Disabilities", *Roeper Rev.*, Vol 41, No 2, Bll 129–142, Apr 2019, Doi: 10.1080/02783193.2019.1585396.

[30] A. Ardiningrum, A. D. Mabruroh, D. P. Sari, R. Yuliandhari, En U. Suherman, "Penerapan Metode Eoq (Economic Order Quantity) Dalam Pengendalian Persediaan Bahan Baku Pada Jasa Griya Laundry", *Neraca J. Ekon. Manaj. Dan Akunt.*, Vol 2, No 1, Bll 129–137, 2024.

[31] M. Andiana En G. Pawitan, "Aplikasi Metode Eoq Dalam Pengendalian Persediaan Bahan Baku Pt X", *J. Akunt.*, Vol 10, No 1, 2018.

[32] H. Kartika En C. S. Bakti, "Analysis Of 6004-2rsl Skf Bearing Inventory By Economic Order Quantity (Eoq) Method In Spart Part Division", *J. Ind. Eng. Manag. Res.*, Vol 1, No 1b, Bll 17–27, 2020, Doi: Https://Doi.Org/10.7777/Jiemar.V1i1.19.