Jurnal Akuntansi, Ekonomi dan Manajemen Bisnis
Vol. 10 No. 1, Juli 2022, 54-60
E-ISSN: 2548-9836

Article History
Received May, 2022
Accepted July, 2022

Analysis on Queue System at Vitka Point Gas Station Number 14.294.722 on Motorcycle Line with Pertalite-Based Fuel

Bima Wahyu Pratama[*], Fandy Bestario Harlan[*], Adhitomo Wirawan[*] and Asadian Puja Enggita[#]

[*]Politeknik Negeri Batam
Business Management
Jl. Ahmad Yani, Batam Centre, Batam 29461, Indonesia
E-mail: fandybestario@polibatam.ac.id

[#]Politeknik ATI Makassar
Industrial Engineering
Sunu Street No.220, Suangga, Tallo, Makassar City, South Sulawesi 90211, Indonesia

Abstrak

Penelitian ini disusun guna mengetahui bagaimana kinerja sistem antrian pada SPBU 14.294.722 Vitka Poin Kota Batam jalur motor berbahan bakar pertalite. Metode analisis data menggunakan jenis analisis sistem antrian jalur tunggal (single channel, single phase). Adapun jenis data yang digunakan adalah data kuantitatif, yang proses perhitungannya dibantu dengan perangkat lunak “POM-QM Queuing Analysis”. Menurut hasil penelitian dengan menggunakan analisis teori antrian model tunggal, kinerja dari sistem antrian yang diterapkan oleh SPBU 14.294.722 Vitka Poin Kota Batam sudah dikatakan optimal, dilihat dari tingkat utilisasi server atau tingkat kesibukan operator secara rata-rata selama 7 hari sebesar 72,11%, sisanya 27,89%. Sedangkan efektivitas kinerja pada SPBU 14.294.722 Vitka Poin Kota Batam, dilihat dari rata-rata waktu yang dibutuhkan pelanggan dalam antrian sebesar 0.0139 jam atau 0,8322 menit, dan waktu yang dibutuhkan pelanggan dalam sistem sebesar 0,0192 jam atau 1,1541 menit.
Kata kunci: Kinerja, Antrian, Model Antrian Jalur Tunggal, Optimal

Abstract

This study aims to find out the performance of the queuing system at SPBU 14.294.722 Vitka Poin, Batam City on Pertalite fuel for motorcycles. The data analysis method uses a single line queuing system (single-channel, single-phase). The study used quantitative data in which the calculation was assisted by the "POM-QM Queuing Analysis" software. Based on the result of the single-channel single-phase analysis, the performance of the queuing system applied by the 14.294.722 Vitka Poin, Batam City gas station is optimal. It is because the server utilization level or the average operator's busyness level for 7 days is 72.11 %, the remaining 27.89%. Meanwhile, the effectiveness of performance at the 14.294.722 Vitka Poin, Batam City gas stations by referring to the average time required by customers in the queue which is 0.0139 hours or 0.8322 minutes, and the time required by customers in the system is 0.0192 hours or 1.1541 minutes.
Keywords: Performance, Queue, Single Line Queue Model, Optimal

1. Introduction

In the present modern era, everything is demanded to be fast-paced. This is inspired by the increasing number of population and the rapid development of technology, as well as development in all fields. Besides, every human being is clearly a social being in which his/her life cannot be separated from the involvement of others. At certain moments in fulfilling life needs, human definitely needs the services of others and although sometimes it requires them to wait for a moment. In fact, in everyday life, waiting has been a part of it. The thing that is extremely desirable is when services can be obtained without having to wait for so long. In view of this, a company in the service and manufacturing sector is needed to be able to provide fast and best service in accordance with the expectation of customers to meet their needs. Service itself is a rapidly growing economic sector and it is the largest economic sector in developed societies.

The Province of Riau Islands is one of the provinces which has the highest population density in Indonesia, and is the most populous in Sumatra with 267 inhabitants/km2 (BPS, 2019). Meanwhile in this province, Batam is the city which has the highest population density. According to the Batam City Population and Civil Registry Office as of 2015, the population of Batam reached 1,037,187 people. The growing number of residents in Batam City as time goes by leads to an increase in the needs of the population which in this case must be met.

The increasing population density definitely affects the increase in motorized vehicle users; one of them is two-wheeled vehicles. According to data (Regional Tax and Levy Management Agency, 2019) the Province of Riau Islands, the growth of two-wheeled vehicles in Batam from 2015-June 2019 was recorded at 143,819 vehicles, not including the number of vehicles that already existed. As the number of motorized vehicle users increases, the customer's need for fuel will automatically increase. In common, gas station is the place of choice for refueling vehicles. Vitka Poin Batam City Gas Station 14-294-722 is one of the public gas stations located at Gajah Mada Street, Tiban Lama Village, Sekupang District, Batam City. Vitka Poin Batam City Gas Station 14-294-722 has quite long operating hours, which is between 06.00-22.00. The average density of visitors occurs in the range of hours after work, namely 17.00-18.00. Sometimes, the queues during peak hours can be so long that motorcyclists who were willing to fill up with fuel had to queue for a long time. This, absolutely, has bad effects, such as slow service, other drivers who want to refuel are disturbed because of the queue that takes up the road, the potential for operators who are tired when doing services leading to make them lose concentration, and many other effects. Vitka Poin Batam City Gas Station 14-294-722 generally provides several refueling facilities, including Premium, Pertamax Turbo, Solar, Dexlite, and Pertalite. There is one lane for refueling motorcyclists with the type of pertalite, while in certain conditions which are quite busy, the queue line is made into two lanes intended to reduce queue problems.

Queues and how to manage them are important things to understand in operations management, so that schedules, job designs, inventories, and so on can be managed properly (Chase, 2014). According to Bronson (quoted from Prabowo & Brdroastuti, 2012), the queuing process is a form of case or process related to the arrival of customers at a service system, where they then wait to be served in a line (queue). Actually, queuing events are things that can be avoided or reduced if the parties involved know to what extent the queuing event benchmarks will be beneficial or even detrimental, even though this queuing event is not desired by various interested parties

Queuing theory is a science about the form of queues that was discovered and developed by A.K. Erlang, an engineer from Denmark. Queuing theory is a mathematical approach to queuing, which is basically considered a branch of operations research that is often used in business decision considerations (Shastrakar, Pokley, & Patil, 2016). Generally, the queuing system adheres to the principle of first-come, first-served or in other words, those who come first will be served first. However, not every queuing system is implemented based on this principle. Market segmentation is sometimes used to design queuing strategies that give different priorities to different customers. The assumption of the queuing model is that customers who come are patient people, patient customers are customers who are willing to wait in the queue and do not go out or move from the queue line (Hapsari, 2013). Companies or organizations must strive to provide the best service in order to keep customers comfortable when queuing. Therefore, service in the queue will greatly affect customer convenience, so that companies or organizations need a fast and effective queuing system. In his research (Rahmat & Dewi, 2016) revealed that time is a very important and valuable aspect, so the need for a system that is able to reduce excessive use of time to achieve effectiveness and efficiency. With fast, easy and satisfying service, it will make customers feel satisfied because the service makes customers loyal so that they will come back again (Hapsari, 2013).

Previous research by Nurfitria, Nureni, and Utami (2016) regarding queuing analysis with a single channel single phase service model at the I Gusti Ngurahrai Public gas station (SPBU) Palu, stated that it was necessary to add one server unit to achieve this optimal service.

From the description aforementioned, it is deemed necessary to conduct research on the analysis of the queuing system at Vitka Poin Batam Gas Station 14.294.722.

2. Research Method

Population and Sample

The population in this study were all customers who came to the Vitka Poin Gas Station No. 14,294,722 to refill general fuel. In determining the sample, the technique used is the purposive sampling technique. The sample in this study were users of pertalite-fueled two-wheeled vehicles who came to queue to refuel at the Vitka Point gas station No. 14294.722 Batam City, with data collection carried out for 7 days between 16.00-18.00 WIB.

Analysis Method

The data was tested using the POM-QM for Windows application by performing service performance analysis, optimization analysis of the number of lines and waiting time using a single line queuing system model, and cost analysis.

a. Service Performance Analysis

The method chosen to analyze the performance of the service or server at the Vitka Point Gas Station No. 14,294,722 is to use arrival data and service units of time. The data is then reprocessed to determine the level of server utility from the service. The performance of the service or server will be seen from the level of utility. The formula used is:

λ= (total arrivals)/ (observation time)
(1)

μ= (observation hours)/ (number of visitors)
(2)

ρ= λ/μ
(3)

b. Number Optimization and Waiting Time

The method chosen to analyze the optimization of the queuing system at SPBU Vitka Poin No. 14,294,722 is to use a single line queuing model which is a queuing system with one line or service station with one process to complete the service. In the implementation of its services, the Vitka Point Gas Station No. 14,294,722 applies a first-come, first-served (FCFS) system, which is a service system that prioritizes customers who come first.

Model A: M/M/I or single line queuing system is the model used in this research. This queuing model is also known as the Single Channel Single Phase Service model. Single Channel means that there is only one path to enter the service system. While the meaning of single phase is that there is only one phase that needs to be passed to complete the service.

3. Results and Discussion

1. In order to know the characteristics of the queuing system at the time of arrival and the rate of service, the researchers used the Kolmogorov Smirnov test. The distribution pattern of the time between arrivals and the rate of service will be tested whether it is Poisson distribution or not by using the Kolmogorov-Smirnov test on SPSS 25.0 for Windows. Based on the test results, the Asymp.Sig (2-tailed) value is 0.749. Because the Asymp.Sig (2-tailed) value is greater than the significant value of 0.05, it can be concluded that H0 is accepted, which means that the distribution of the hourly arrival rate at the Vitka Point gas station customers on motorcyle line with pertalite-based fuel follows the Poisson distribution.

TABLE I.

ARRIVAL RATE DISTRIBUTION TEST RESULTS

One-Sample Kolmogorov-Smirnov Test		
		Arrival
N		14
Poisson Parameter[a,b]	Mean	134.43
Most Extreme Differences	Absolute	.181
	Positive	.103
	Negative	-.181
Kolmogorov-Smirnov Z		.677
Asymp. Sig. (2-tailed)		**.749**

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

Source: author's calculation

2. Meanwhile, the test results for the distribution pattern of the service rate obtained by Asymp.Sig (2-tailed) is 0.375. Because the value of Asymp.Sig (2-tailed) is greater than the significant value of 0.05, it can be concluded that H0 is accepted, which means that the distribution of the hourly service level at the Vitka Point gas station customers on motorcyle line with pertalite-based fuel follows the Poisson distribution.

TABLE II.

SERVICE RATE DISTRIBUTION TEST RESULTS

One-Sample Kolmogorov-Smirnov Test		
		Service
N		14
Poisson Parameter[a,b]	Mean	187.64
Most Extreme Differences	Absolute	.244
	Positive	.102
	Negative	-.244
Kolmogorov-Smirnov Z		.913
Asymp. Sig. (2-tailed)		**.375**

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

Source: author's calculation

3.1 The Implementation of the Queue System

The queuing model considered appropriate to the case of general refueling of the motorcycle with pertalite-based fuel at the Vitka Point gas station No. 14,294,722 is the Single Channel-Single Phase model, which is a queuing model that applies a queuing system with a single facility or one facility that serves customers and only has one stage.

The characteristics of the implementation of the queuing system at the Vitka Point gas station No. 14,294,722 are as follows. One service unit and one stage, average arrival time is smaller than average service time, unlimited population, arrival pattern (λ) and service patterns per unit of time (μ), implementing POSSION DISTRIBUTION, UNLIMITED QUEUE LENGTH.

3.2 The Performance of Queue System Performance

To make it easier to perform calculations from these indicators, the researcher used POM-QM Queuing Analysis Software, following the results of the calculations.

Days	M/M/1 Queue System Calculation Results					
	P	1-ρ	L_s	W_s	L_q	W_q
Monday	0.7238	0.2762	2.6199	0.0179	1.8962	0.0130
Tuesday	0.7375	0.2625	2.8095	0.0198	2.0720	0.0146
Wednesday	0.6486	0.3514	1.8458	0.0143	1.1972	0.0093
Thursday	0.6879	0.3121	2.2041	0.0166	1.5162	0.0114
Friday	0.6277	0.3723	1.6864	0.0152	1.0586	0.0095
Saturday	0.7917	0.2083	3.8019	0.0265	3.0102	0.0210
Sunday	0.8300	0.1700	4.8824	0.0356	4.0524	0.0296
Overall average	**0.7211**	**0.2789**	**2.5857**	**0.1920**	**1.8646**	**0.1390**

TABLE III.

CALCULATION RESULTS

Source: author's calculation

The results of the calculations in Table 1 show some of the values sought, namely ρ, 1- ρ, Ls, Ws, Lq, Wq. The values in the table are obtained from observations for 7 days and 2 working hours, namely at 16.00-18.00 Western Indonesian Time. The calculation of these results can be described as follows:

1. Average Number of Customers in the System (Ls)

   The average number of customers in the system is the average number of all customers waiting to receive service, including customers who are currently receiving service. The overall average Ls with value of 2.5885 means that the average number of customers in the system is 3 people. The highest value is located on Sundays, which is 4.8824 or approximately 5 motorcycles. Meanwhile, the smallest number is on Fridays, namely 1.6864 each or approximately 2 motorcycles in the system. This certainly shows that on Sundays, the number of customer arrivals is greater than at other hours. In other words, the state of the service system tends to be more crowded.

2. Average Customer Time in the System (Ws)

   The average amount of time in the system is the average time spent by customers from waiting for service/queuing to completing service. The overall Ws value is 0.0192 or if it is converted to minutes, it is 1.1541 minutes, meaning that the average customer time in the system is 1.1541 minutes or 69.24 seconds. The highest average total time in the system is on Sundays with a time of 2.1383 minutes. This reveals that the time it takes customers to get service on Sundays is longer than on other days. Meanwhile, the shortest time is on Wednesdays with 0.8585 minutes.

3. Average Number of Customers in the Queue (Lq)

   The average number of customers in the queue is the number of customers in the queue waiting to receive service. The Lq value of the whole day is 1.8671, which means the average number of customers in the queue is 2 people. The average number of customers in the queue per day is the highest average number of customers in the queue on Sundays, which is 4.0524 or approximately 4-5 motorcycles. Meanwhile, the smallest number is on Fridays, which is 1.0586 or approximately 1-2 motorcycles in the queue.

4. Average Customer Time in the Queue (Wq)

   The average time in the queue is the average time required by customers from arrival and queuing to receiving service. The overall Wq value is 0.0139 or if it is converted to minutes, it becomes 0.8322, which means that the average customer time in the queue is approximately 1 minute. The highest average waiting time in the queue occurred on Sundays with 1.7748 minutes. This reveals that the time it takes customers to receive service on Sundays is longer than on other days. Meanwhile, the shortest time average value occurs on Wednesdays with a time of 0.5568 minutes.

5. Level of Server Busy Time (ρ)

   The level of server busy time is the level of utilization or usability of a service. This analysis is essential to determine the level of effectiveness of a service server or steady state. Therefore, after going through the calculations, the value of the level of server busy time is 0.7211 < 1, or if it is a percentage, it is 72.11%. The daily results show that on Mondays, the level of server busy time for serving is 72.38%; meanwhile, on Tuesdays, the level of server busy time for serving is 73.75%, on Wednesdays, the level of server busy time for serving is 64.86%; on Thursdays, the level of server busy time is 68.79%; on Fridays, the level of server busy time is smaller than other days which is 62.77%; while on Saturdays, the level of server busy time is 79.17% and on Sundays, it is the highest level of server busy time compared to other days, which is 83.00%. From the whole days, it can be seen that the level of server busy time with the use of 1 service server unit is optimal and meets the steady state, namely the value requirement is less than 100% or $\rho < 1$

6. Level of Server Idle Time (1- ρ)

   The level of server idle time itself shows the time when the server does not serve customers or commonly referred to as idle time. On average, the whole daily level of server idle time is 27.89%. Meanwhile, the calculation of the daily level of server idle time shows that on Mondays, the level of server idle time is 27.62%; on Tuesdays, the level of server idle time is 26.25%, on Wednesdays, the level of server idle time is 35.14%; on Thursdays, the level of server idle time is 31.21%; on Fridays, the level of server idle time is higher than other days of 37.23%; while on Saturdays, the level of server idle time is 20.83%; and on Sundays, it is the lowest level of server idle time compared to other days, which is 17.00%. From the overall value of server idle time, it shows that the use of 1 service server unit is optimal, it can be seen from the server idle time that there is no greater than the server utilization value.

3.3 Analysis on One Server Cost

In order to conduct a cost analysis, the researcher refers to previous research from Nurfitria, Nureni, and Utami (2016) with the title "Queue Analysis with Single Channel Single Phase Service Model at I Gusti Ngurahrai Gas Station (SPBU) in Palu". Cost analysis will be calculated based on the value from the analysis of the single channel - single phase queuing model from 16.00-18.00 Western Indonesian Time. In order to conduct a cost analysis, the researcher refers to previous research from Nurfitria, Nureni, and Utami (2016) with the title "Queue Analysis with Single Channel Single Phase Service Model at I Gusti Ngurahrai Gas Station (SPBU) in Palu". Cost analysis will be calculated based on the value from the analysis of the single channel - single phase queuing model from 16.00-18.00 Western Indonesian Time.

- Total cost of waiting (E(Cw)) which are as follows:

E(Cw) = nt x Cw

(4)

nt : Average customer in queuing system

Cw : Waiting cost

Is known:

Server salary = Rp. 4.200.000

nt = Ls x 2 hours x 30 days = 180 people

Cw = Server Salary x (1- ρ)

= Rp. 4.200.000 x 27,89%

= Rp. 1.170.540

Result:

E(Cw) = nt x cw

= 180 x Rp 1.170.540

= Rp. 210.697.200

- Total service cost (E(Cs)):

E(Cs) = s x CS (5)

s : Number of service servers

Cs: Service Cost

Is known:

Server Cost (maintenance and operation) = Rp. 5.000.000

(The server costs in question are monthly operating costs including pump maintenance, electricity and repairs)

Cs = Server Cost + Sever Salary

= Rp. 9.200.000

s = 1 unit server

Result:

E(Cs) = s x CS

= 1 x Rp 9.200.000

= Rp. 9.200.000

- T The total cost (E(Ct)) is as follows:

E(Ct) = E(Cw) + E(Cs)

(6)

= Rp. 210.697.200 + Rp. 9.200.000

= Rp. 219.897.200

Thus, it can be seen that the total monthly operating costs of the Vitka Point gas station for one server unit is Rp. 219.897.200.

Apart from calculating costs, monthly gross income from the Vitka Point gas station is also calculated for the use of one server unit for pertalite refueling for two-wheeled vehicles. The description of the calculation is as follows.

- Known by assumption:
- Maximum Filling 2 liters/customer
- Selling Price of Pertalite Fuel/liter = Rp. 8000

- Average Arrivals/hour= 134 customers/hour
- Working hour SPBU: 14 hours
- Working Days: 30 Days

• Asked:

• Monthly gross profit for pertalite refueling for two-wheeled vehicles (assuming purchase of 2 liters/customer)

• Gross Income

Result:

• Average arrivals during working hours x selling price x liters x 30 days

= 134 customers/hour x 2 liters/customer x Rp. 8000/liter x 14hours/day x 30 days = Rp. 900,480,000

• Assumed Cost/month

1 shift: 1 server or 1 worker

Worker Salary: Rp.4.200.000

Operational Cost: Rp. 5,000,000

Total Cost/month = Work Salary x Operating Cost

= Rp. 4,200,000 x Rp. 5,000,000

= Rp. 9,200,000

• Pendapatan/bulan:

Gross Income/month – Cost/month

= Rp. 900.480.000 x Rp. 9.200.000

= Rp. 891.280.000.

So, it can be seen that the monthly income from selling pertalite fuel for two-wheeled vehicles at the Vitka Point gas station for one server unit is Rp. 891,280,000

3.4 Feasibility Analysis of Server Addition Cost

Cost feasibility analysis is carried out to provide consideration in terms of performance and cost if the Vitka Point gas station in the future will add servers to maximize the queuing system and minimize queues as much as possible.

TABLE IV
COMPARISON OF QUEUE SYSTEM CALCULATION RESULTS

Total Server	Queue System Calculation Results					
	P	P_0	L_s	W_s	L_q	W_q
1	72.11%	27.89%	2.58	0.0192 (1.1541 Menit)	1.86	0.0139 (0.8322 Menit)
2	36.06%	47.00%	0.82	0.0062 (0.3699 Menit)	0.10	0.0008 (0.0481 Menit)

Source: author's calculation

Based on the calculation results in Table 2, it can be seen that the average waiting time in the system (Ws) when adding one server unit is quite different from before the addition of one server unit, namely one server unit takes 1.1541 minutes, while when it is added, it becomes two server units which can be reduced to 0.3699 Minutes. For the average waiting time in the queue (Wq), one server unit originally takes 0.8322 Minutes; while, for two servers, it takes 0.0481 Minutes. Meanwhile, the average number in the system (Ls) also shows a decrease from what was previously served by one server unit namely from 3 customers to 1 customer when served by two server units, as well as the average number in the queue (Lq) from 2 customers to 1 customer. There is also a clear decrease in the percentage of server busy time (ρ), which is from 72.11% on one server unit to 36.06% on two server units, meaning that the addition of servers will reduce the utilization value which in this case it is quite significant. This also affects the server idle time, which in one server unit, it is 27.89%, while in two server units, it is 63.94%. The cost analysis for adding one server unit is as follows. The cost analysis for adding one server unit is as follows.

• Total cost of waiting (E(Cw)):

Is known:

Server Salary (2 people) = Rp. 8.400.000

nt = Ls x 2 Hours x 30 Days= 60 People

Cw = Server Salary x idle time

= Rp. 8.400.000 x 63,94%.

= Rp. 5.370.960

Result:

Total cost of waiting = nt x Cw

= Rp. 322.257.600

• Total cost of service (E(Cs)):

Is known:

Server Salary (maintenance and operation) = Rp. 5.000.000

Cs = Server Cost + Server Salary

= Rp. 9.200.000

s = 2 unit server

Result:

Total cost of service = s x (Cs) = Rp. 18.400.000

• Overall Cost (E(Ct)):

E(Ct) = E(Cw) + E(Cs)

= Rp. 322.257.600 + Rp. 18.400.000

= Rp. 340.657.600

Hence, the total operational costs if the motorcycle line with pertalite-based fuel at the Vitka Point gas station uses 2 server units is Rp. 340.657.600. From the results of the comparison between the use of 1 server unit and 2 server units, it can be seen that the first utilization value for the use of 1 server unit can be regarded to be quite good, namely 72.11%, but if it is added to 2 server units, it will have less utilization value namely only 36.06%, which means that the idle time on the use of 2 server units is extremely high. The average time value in the system (Ws) has decreased from 1.1541 minutes for the use of 1 server unit, while when it is added to 2 server units, it becomes 0.3699 minutes, which means the value on other indicators such as the average time in the queue (Wq), the average number in the system (Ls), and the average number in the queue (Lq) also decreased when 2 server units were applied, but it can be stated that the value of the decrease is not significant enough and became less efficient when viewed from the cost analysis on addition to 2 server units, namely of Rp. 340.657.600 57.600.

4. Conclusions

Based on the analysis results on the queuing system that has been carried out at the Vitka Point gas station No. 14.294.722, on motorcycle line with pertalite based fuel, the conclusions are as follows:

1. The implementation of queue system at the Vitka Point gas station No. 14.294.722 on motorcycle line with Pertalite based fuel is single-channel-single-phase model (M/M/1).
2. Based on the calculation results, the performance of the queuing system at the Vitka Point gas station No. 14.294.722 on motorcycle line with Pertalite based fuel using the single channel-single phase queuing model is considered good, viewed from the first, the level of server busy time or the overall utilization value has fulfilled the steady state, which is 72.11% or not more than 100%, in which it means that the server idle time is 27.89%.
3. In order to provide additional feasibility consideration, an analysis is carried out with the assumption that if there are additional servers, there will be 2 server units. The results show that the level of effectiveness and efficiency in the use of 1 server unit is better than the use of 2 server units. This can be seen from the level of utilization or the level of server busy time on the use of 1 server unit of 72.11%; while the use of 2 server units has a very low utilization value of only 36.06%, which means the server idle time on the use of 2 server unit is quite high, even higher than the level of utilization or usability.

References

Badan Pusat Statistik. (2019). *Kepadatan Penduduk Menurut Provinsi: BPS*. Retrieved October 26, 2020, from Badan Pusat Statistik: www.bps.go.id

Chase, N. J. (2014). *Operationsand Supply Chain Management. 14th Edition.* Singapore: McGraw-Hill Education.

Hapsari, N. (2013). *Penerapan Metode Waiting Line Untuk Meningkatkan Layanan Perusahaan (Studi Kasus Pada PT Pos Indonesia Persero Cabang Sisingamangaraja Semarang).* Semarang: Universitas Diponegoro.

Nurfitria D, Nureni, Utami I. T. (2016). Analisis Antrian Dengan Model Single Channel Single Phase Service Pada Stasiun Pengisian Bahan Bakar Umum (SPBU) I Gusti Ngurahrai Palu. *Jurnal Ilmiah Matematika dan Terapan*, 125-138.

Prabowo, F., & Brdroastuti, T. (2012). Penentuan Jumlah Teller yang Optimal berdasarkan Metode Antrian. *STIE Widya Manggala*, 1-52.

Rahmat, & Dewi. (2016). Analisis Sistem Antrian Untuk Meningkatkan Efisiensi dan Efektivitas Layanan Pada Loket Pelayanan Pospay di Kantor Pos Indonesia Jalan Jendral Sudirman Batam Centre. *Seminar Nasional Teknik Industri Universitas Gadjah Mada* , 2.

Shastrakar, Pokley, & Patil. (2016). Literature Review of Waiting Lines Theory and its Applications in Queuing Model. *International Journal of Enginering Research & Technology*.

Utami, A. S. (2013). Simulasi Antrian Satu Channel Dengan Tipe Kedatangan Berkelompok. *Jurnal Generic*, *4*(1).