THE APPLICATION QUEUEING THEORY IN SINGKIL SERVICE CAR WASH

PENERAPAN TEORI ANTRIAN DI SINGKIL *SERVICE CAR WASH*

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Abstract: *In the service industry, long queuing will for waiting to be served is a taboo. Since, customers will switch to other competitors and reduce revenues. This research is conducted to find out the effectiveness and efficiency in queuing system in order to achieve customer satisfaction in the Singkil Service Car Wash. This research used model B M/M/S formula to get the average incoming customer. In normal condition, there were 2 customers and 3 line services, in the quiet condition, 1 customer and 2 line services, in the crowded condition there were 3 customers and 4 line services. The Singkil Service Car Wash performance is under optimal condition since the number of customers who came is still low. It is advisable to the owner of the Singkil Service Car Wash to reduce the service line and to reassign the unproductive employees to other area so the worker productivity can be retained. This will result in a more efficient and effective employee's management and better profit for the company.*

Keywords: *queueing system, singkil service car wash*

Abstrak: Pelayanan pada sektor jasa, bagi sebagian orang khususnya menyangkut antrian memiliki masalah seperti sering menimbulkan kebosanan, hal ini akan merugikan bagi perusahaan. Penelitian ini dilakukan untuk mengetahui efektivitas dan efisiensi dalam sistem antrian untuk mencapai kepuasan pelanggan di Singkil *Service Car Wash*. Penelitian ini menggunakan rumus Model B M/M/S untuk mendapatkan jumlah pelanggan rata-rata. Hasil perhitungan dalam situasi normal dimana 2 pelanggan dengan penggunaan layanan 3 jalur layanan, dalam kondisi sunyi dimana 1 pelanggan dengan penggunaan 2 jalur layanan dan dalam situasi ramai ada 3 pelanggan dengan penggunaan 4 jalur layanan. Kinerja sistem pelayanan Singkil *Service Car Wash* kurang optimal karena tingkat kesibukan dalam jalur layanan masih rendah. Saran bagi pemilik yaitu untuk mengurangi jumlah jalur dan bagi pekerja yang menganggur diperbantukan pada bagian lainnya sehingga tidak ada pekerja yang menganggur dan dalam setiap kondisi dapat memaksimalkan efektivitas pekerja, sehingga tidak perlu memecat mereka untuk mencapai keuntungan dan pekerjaan akan lebih efektif.

Kata kunci: *sistem antrian, singkil service car wash*

INTRODUCTION

Research Background

Different needs of every human being and also based on the area they live in. The development of a regional and personal income will also increase the need for that in the big cities, people will try to meet their needs better to fulfill primer needs, secondary or tertiary. In the cities of developing, business people are in race to provide the best for the customer so that it can be seen many kinds of existing business. Therefore business people are always changing their strategy to increase its income.

Long queues often we look at the current bank customers queuing at the teller to make transactions, airport when the passengers to check-in, in the super market as buyers lining up to make the payment, at a car wash: cars queued to be washed and compassionate many other examples. In hospital, queuing theory can be applied to assess a multitude of factors such as registration fill-time, patient waiting time, patient counseling time, and receptionists and technician staffing levels as said by Prasanra Kumar Braha.

Queuing theory is the mathematical study of queues or waiting line. Waiting line is a natural phenomenon that occurs when demand for a certain time exceed the capacity of the service. In general, the busy period can be described by the process of the queuing system starts when the customer arrives, then wait, and will end when the customer leaves the system.

Data from Gaikindo in 2009, units of car sold in Indonesia was 486.000 and it increased in 2010 with 765.000, 894.000 in 2011 and 1.116.000 in 2012. From this data we can see that car production and car sales is growing year by year and it means people who own a car are increased also. The more people have cars, the more they need service to maintenance them and it is a good news for car wash business. Automatically, the increasing number of people who buy cars also affects the car production growth in Manado. While the number of cars are increasing, the people who own cars are forced to maintain their cars from the outter parts until the very complicated parts inside a car. Car cleaning (washing car) is a basic need of any other needs to maintain a car.

Because of that needs, there are several car wash businesses in Manado just like Singkil Service Car Wash. From the table below, we can see that Singkil Service's customers are unpredictable.

Table 1. Data of The Numbers of Consumer Arrival

March	April	May	June	July	Total
394	451	454	444	579	2.322

Source:Singkil Service Car Wash bookkeeping

There are ups and downs in consumer arrival from the data above. Sometimes it is crowded and it can be quiet in no time. In crowded situation there will be long queues but in quiet time, few workers will be idle.

Research Objective

The objective of this research is to determine the queue models in Singkil Service Car wash.

THEORITICAL FRAMEWORK

Service

Kotler and Keller (2009:789) define service as service is any act and performance that one party can offer to another that is essentially intangible and does not result in the ownership of anything. Fitzsimmons (2008:4) states that a service is a time perishable, intangible experience performed for a customer acting in the role of co-producer. A service is an intangible commodity. That is, services are an example of intangible economic goods. Service is often to be assumed as a complicated phenomenon because it has a lot of meanings. So far there are many researchers of marketing trying to describe the meaning of service.

Queue

Heizer and Render (2006:418) defines queues are people or goods in a row waiting to be served. Tjutju Tarliah Dimyati and Ahmad Dimyati (2010:349) state that queuing theory is a theory concerning the mathematical study of queues or waiting lines. Queuing theory is the mathematical study of queues or high line and it is an event in everyday's life, waiting for the next booth to get the service exceeds the ability (capacity) services and service facilities.

Queue Discipline

1. FCFS (*First come first service*) : a queuing discipline that is often used in several places where the customer comes first will be served first.
2. LCFS (*Last come first service*) : a queuing discipline in which customers come first served it last.
3. SOT (*Short operation times*) : the shortest service system gets first service.
4. SIRO (*Service in random*) : a customer service system which may be served randomly no matter who first arrived to be served is the shortest service system gets first service.

System Design Service

a. Single Channel Single Phase

Single channel single phase is one of service, the queue line. Systematically is as follows:

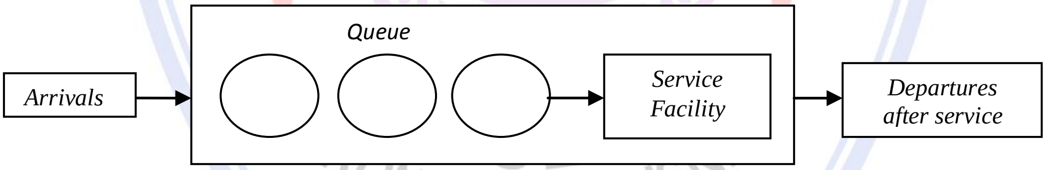

Figure 1. Single Channel Single Phase
Source: Processed Data, 2015

Single Channel which means there is only one path that enters the system there is only one service or service facilities. Single Phase means there is only one service facilities.

b. Single Channel Multi Phase

Service process is sequenced / work order. Such services such process is the hospital. Systematically will look as follows:

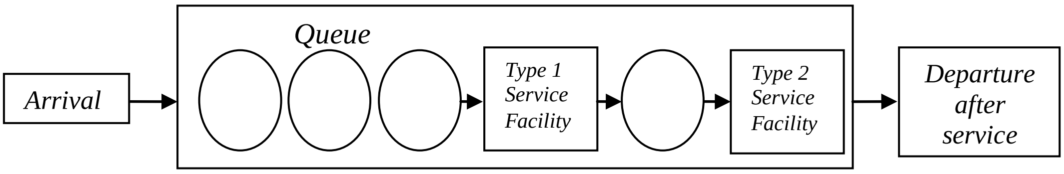

Figure 2. Single Channel Multi Phase
Source: Processed Data, 2015

Single lane queuing system with multiple stages of this show there are two or more services are executed sequentially.

c. Multi Channel Single Phase

Multi Channel Single Phase is some units of service, the queue line. This system occurs where there are two or more service facilities which are flowed by a single queue.
Sistematically is shown below:

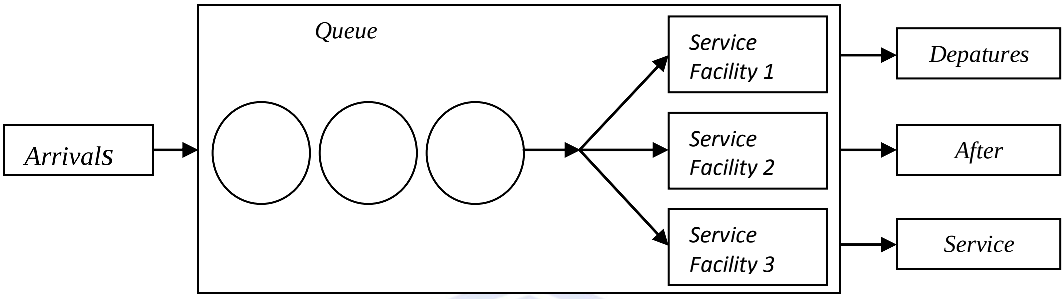

Figure 3. Multi Channel Single Phase
Source: Processed Data, 2015

d. Multi Channel Multi Phase

Multi Channel multi phase is a model that consists of several units of service, several lines of queues. This system shows that every system has some service facilities at each stage so that there is more than one customer can be served at the same.

Sistematically is shown as follow :

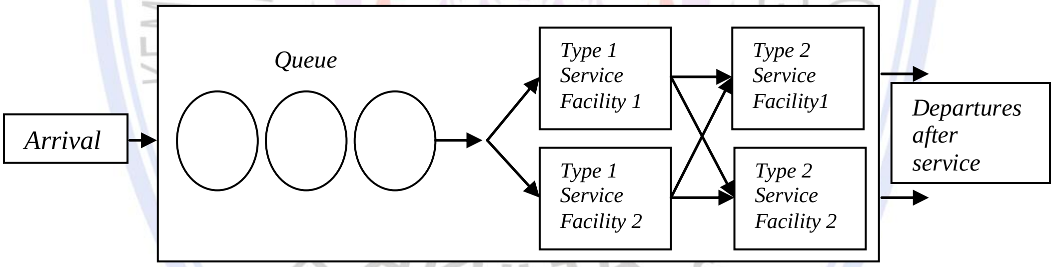

Figure 4. Multi Channel Multi Phase
Source: Processed Data, 2015

Previous Researchers

Brahma (2013), Queuing Theory an Customer Satisfaction: A Review Of Terminology, Trends, And Applications To Hospital Practice. The result of Brahma's research is there are several tools such as computer simulation, modeling, and automated queuing technology that can assist in this process improvement endeavor. Fomundam (2007), A Survey of Queuing Theory Applications in Healthcare. As he said in his research that larger organizations with more patients are able to attain the same quality of service at higher utilizations than smaller organizations. Although appointment systems are often designed to avoid doctor idle time (without considering patient waiting time), it is possible to reduce patient wait time without significantly increasing doctor idle time. Sahoo (2008), The Monitoring of The Network Traffic based on Queuing Theory. The research program cites the analysis of the network traffic model through Queuing Theory. In the present analysis, the description is how to make queuing model on the basis of queuing theory and subsequently derive the estimation after analyzing the network traffic through queuing model. Using the queuing theory models, it is convenient and simple way for calculating and monitoring the network traffic properly in the network communication system.

RESEARCH METHOD

Type of Research

This research will use the comparison type of research because this research will compare the identifiable groups of customer in order to find the effectiveness of the application the queueing theory in Singkil Service Car Wash.

Place and Time of Research

The study was conducted in Singkil Service Car wash Manado City and it takes 3 months to do the research.

Population and Sample

Population refers to the entire group of people, events, or things of interest that the researcher wishes to investigate (Sekaran and Bougie 2009:265). The population of this research is the customers in Singkil *Service Car Wash* (individual or a group of people) from March until July 2015. The population from 5 months consumer arrival is 2.322 consumers. Sample is a subset of the population (Sekaran, 2009). The sample size (n) given the population size (N) and a margin of error (e) is computed as: $n = N / 1 + N(r^2)$ (Ghozali, 2006). From the formula calculation, the sample that should be taken is 96 costumers. To get more valid result, the research sample was taken from 185 customers (individual or a group of persons) which is above the minimum numbers of suggested sample taken got from the calculation in Singkil Service Car Wash.

Data Collection Method

There are two types of data that are used to make an appropriate result, which are: (1) Primary data which is a type of information that is obtained directly from first-hand sources by means of surveys, observation or experimentation. And (2) Secondary data is the data collected by a party not related to the research study but collected these data for some other purpose and at different time in the past. These may be available in written, typed or in electronic forms.

Queue Performance Measurement

1. The average time spent by the customer in the queue.
2. The average time spent by the customer in the system (waiting time plus service time).
3. The number of customers in the system average.
4. Probability of service facilities will be empty.
5. The system utilization factor.
6. Probability of a number of customers who are in the system.

Data Analysis Method

Model B : M/M/S (Multiple Channel Query System)

1. Probabilities are 0 people in the system (lack of customers in the system)

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

2. The number of customers in the average system.

$$L_s = P0 + \frac{\lambda\mu(\lambda/\mu)^M}{(M-1)(M\mu - \lambda)} \frac{\lambda}{\mu}$$

3. Average time spent in a queue or a customer is being served (in the system)

$$Ws = \frac{L_s}{\lambda}$$

4. The number of people or the average unit waiting in the queue

$$Lq = Ls - \frac{\lambda}{\mu}$$

5. The average time spent by a customer or unit to wait in the queue

$$Wq = \frac{Lq}{\lambda}$$

RESULT AND DISCUSSION

Table 1. Arrival Rate

Hours	Numbers of arrival	Arrival rate of Customer
08.00-09.00	22	2
09.00-10.00	13	1
10.00-11.00	16	2
11.00-12.00	8	1
12.00-13.00	15	2
13.00-14.00	16	2
14.00-15.00	28	3
15.00-16.00	29	3
16.00-17.00	38	4
Total	185	20

Source: Processed data, 2015

In Table 2 below indicates that the average consumer arrival at normal conditions (08:00 to 11:00 hours) of 2 people per hour, the average consumer arrival in quiet conditions (11:00 to 14:00 hours) for 1 people per hour, and the average arrival consumers in crowded conditions (14:00 to 18:00 hours) of 3 people per hour.

Table 2. Arrival Rate in Separate Condition

Situation	Time	Numbers of customer per hour	Total of consumer to every situation	λ
Normal	08.00-09.00 09.00-10.00 10.00-11.00	22 13 16	51	**1,7 or 2**
Quiet	11.00-12.00 12.00-13.00 13.00-14.00	8 15 16	39	**1,3 or 1**
Crowd	14.00-15.00 15.00-16.00 16.00-17.00	28 29 38	95	**3,1 or 3**

Source: Processed data, 2015

Table 3. Data Calculation Result

Situation	Time	λ	μ	M	Po	Ls	Ws	Lq	Wq
Normal	08.00-09.00 09.00-10.00 10.00-11.00	2	2	4	0,3676	1,0068	0,5034	0,0068	0,0034
Quiet	11.00-12.00 12.00-13.00 13.00-14.00	1	2	4	0,6065	0,5002	0,5002	0,0002	0,0002
Crowd	14.00-15.00 15.00-16.00 16.00-17.00	3	2	4	0,2213	1,544	0,5149	0,044	0,0146

M = the number of lanes opened
λ = average number of arrivals per time unit
μ = number of people served per unit time in each lane.
Source: Processed data, 2015

Explanation of the calculation results of the analysis of queues using M/M/S on Singkil Service Station at the beginning of the month based on Table 3 are:

1. Probabilities are 0 people in the system (Po)
   In normal conditions (08:00 - 11:00 hours) probabilities are 0 people in the system of 0.3676 or 36.76%. In quiet conditions (11:00 - 14:00 hours) probabilities are 0 people in the system of 0.6065 or 60.65%. In the crowded conditions (14:00 - 17:00 hours) probabilities are 0 people in the system by 0.2213 or 22.13%.
2. The average number of customers in the system (Ls)
   The average number of customers waiting in the system under normal conditions (8:00 - 11:00 hours) of 1.0068 people, in quiet conditions (11:00 - 14:00 hours) of 0.5002 people, and the crowded conditions (14.00 - 17:00 hours) as 1.544 people.
3. The average time spent by a customer in the system (Ws)
   The average time spent on a consumer in the system under normal conditions (hours 08:00 - 11:00) is 0.5034 minutes or 30.2 seconds, while the quiet condition (11:00 - 14:00 hours) the average time spent on the consumer to wait in the system is 0.5002 minutes or 30.01 seconds, and the crowded conditions (14:00 - 17:00 hours) average time spent on the consumer to wait is 0.5149 minutes or 30.89 seconds.
4. Average number of queues in the queue (Lq)
   The average number of customers waiting in line at normal conditions (08:00 - 11:00 hours) of 0.0068, while the average number of customers in the queue in quiet conditions (11:00 - 14:00 hours) of 0.0002, and the average number of customers in the queue at crowded conditions (14.00 - 17:00 hours) as much as 0.044.
5. The average time spent by a consumer to wait in the queue (Wq)
   The average time spent on the consumer to wait in the queue at normal conditions (08:00 - 11:00 hours) is 0.0034 minutes, while in quiet conditions (11.00 - 14.00 hours) the average time spent on the consumer to wait in the queue is 0.0002 minutes, and the crowded conditions (14:00 - 17:00 hours) average time spent on the consumer to wait in the queue is 0.0146 minutes.

Table 4. Optimal Service Levels in Normal Conditions With 3 Lanes

Condition	Time	*Po*	*Ls*	*Ws*	*Lq*	*Wq*
Normal	08.00-09.00 09.00-10.00 10.00-11.00	*0.3636*	*1.045*	*0.5227*	*0.045*	*0.0225*

Source: Processed data, 2015

The average probability of 0 people in the system (Po) was 36.36%. The average number of customers in the system (Ls) is 1.045 people. The average time spent on a consumer in the system (Ws) is 0.5227 minutes or 31.36 seconds. The average number of customers waiting in the queue (Lq) is 0.045 people and the time spent in a consumer queue (Wq) is 0.0225 minutes or 1.35 seconds.

Table 5. Optimal Service Levels in Quiet Conditions With 2 Lines

Condition	Time	*Po*	*Ls*	*Ws*	*Lq*	*Wq*
Quiet	11.00-12.00 12.00-13.00 13.00-14.00	*0.606*	*0.503*	*0.503*	*0.003*	*0.003*

Source: Processed data, 2015

The optimal level of service occurs after reduction of 4 lanes to 2 service lanes in quiet conditions in Singkil Service Car Wash so as to have an average probability of 0 people in the system (Po) was 0.606 or 60.0%. The average number of customers in the system (Ls) is 0.503 people. The average time spent on a consumer in the system (Ws) is 0.503 minutes. The average number of customers waiting in the queue (Lq) is 0.03 persons and the time spent in a consumer queue (Wq) was 0.003 minutes, where it showed a low number of arrivals consumers because there is no or 0 people waiting in queue.

Table 6. Optimal Service Levels in Crowded Conditions With 4 Lines

Condition	Time	*Po*	*Ls*	*Ws*	*Lq*	*Wq*
Crowded	14.00-15.00 15.00-16.00 16.00-17.00	*0.2213*	*1.544*	*0.5149*	*0.044*	*0.0146*

Source: Processed data, 2015

The optimal level of service occurs when all the lanes are opened for service which has an average probability of 0 people in the system (Po) 0.2213. The average number of customers in the system (Ls) is 1.544 people which mean the number of consumers who are in the system as much as 2 people. The average time spent on a consumer in the system (Ws) is 0.5149 minutes or 30.89 seconds. The average number of customers waiting in the queue (Lq) is 0.044 people and time spent in a consumer in the queue (Wq) is 0.0146 minutes or 0.876 seconds.

Discussion

As Brahma (2013) said in his research titled Queuing Theory An Customer Satisfaction : A Review Of Terminology, Trends, And Applications To Hospital Practice, queuing theory is a powerful management tool that often gets overlooked, especially in hospital operations management. Proper application of this effective management tool can yield impressive results. There are volumes of additional material on queuing theory and in fact this paper has only touched the surface. The goal of this paper was to give the reader a general understanding of concepts, current technology, and applications of queuing theory as it relates to patient satisfaction and waiting time. Undoubtedly, there are numerous factors—physical, psychological, and emotional, to name a few—that affect a patient's perception of the waiting experience. By better understanding queuing theory and the various measures associated with patient waiting time, service managers can make decisions that have a beneficial impact on the satisfaction of all relevant participants: patients, employees and management. There are several tools such as computer simulation, modeling, and automated queuing technology that can assist in this process improvement endeavor. Waiting in line will always be prevalent in our society and in our hospitals. As the health care industry continues to evolve, staffs are under continued and growing pressure to do more and more.

Queue occurs because the number of arrivals of consumers who require services in the payment system and the number of lanes available services less balanced. This could harm consumers who must spend time to wait in a queue system. However, sometimes the number of consumers who come into the system only slightly, causing their idle time on the track in the open service that can cause harm to the company. This problem is also experienced by at Singkil Service Car Wash which uses multiple lines queuing model where the number of lines or line payment no more than one to serve consumers with a service stages traversed by the consumer in the transaction. One of the problems faced is determining the number of paths that must be employed in a state of quiet, normal, and crowded in which every hour has a different length of the queue. Quiet conditions in Singkil Service Car Wash occurred at 08:00-11:00 hours, the normal conditions in Singkil Service Car Wash occurred at 11:00-14:00 hours, and most crowded conditions occurred at 14:00-17:00 hours. So the total time of the work done at the time was 9 hours. At a certain moment the consumer has to queue to remember sometimes it takes a consumer service can take a long time or even going on their path of unemployed due to the small number of consumers who make a payment transaction.

The calculation under normal conditions of use 3 lines of service on payment systems in Singkil Service Car Wash, to serve consumers who make payment transactions is more optimal than with 4 lanes. Based on calculation, the use of 2 lines in Singkil Service Car Wash is to serve consumers who make a payment transaction in quiet conditions more optimal than with 4 lanes. The use of 4 lines and 3 lines can be said to be less than optimal because the more optimal level of service if using 2 lines. Based on the calculation, it shows in crowded conditions, with all of the 4 lines open, it leads to more optimal service levels. Queuing system performance problems that occur in Singkil Service Car Wash with the average number of lines operated by 4 lines is a lane on customer service transactions and their time idle path. In fact, the Singkil Service Car Wash number of workers employed by 4 people. Based on the analysis that has been carried out above shows that the level of utility lines are still low, which means level of activity is still low path then the path is not in operation can be transferred to other parts so that no idle time on the track and the company can deliver optimum performance in serving consumers.

CONCLUSION AND RECOMMENDATION

Conclusion

The conclusion that can be obtained from the application of queuing theory in Singkil Service Car Wash as follows:

1. Singkil Service Car Wash has 4 cashiers. The model used by the queue structure Singkil Service Car Wash is a Single Channel Multi Phase and serve consumers with queuing disciplines First Come First Serve (FCFS) where consumers who come first will be served first. The results of data processing showed that the optimal number of cashier in quiet conditions is two cashiers, under normal conditions is three cashiers, and in crowded conditions as much as four cashier.
2. The performance of the service systems of Singkil Service Car Wash less than optimal because the busyness in their service lines is low. Cashier reduction in quiet conditions into 2 cashiers, the cashier normally is 3, and the line in a crowded conditions lead to 4 lines which makes Singkil Service Car Wash is optimal in serving consumers.

Recommendation

1. In normal time, 3 lines are more effective than 4 lines, in quiet time 2 lines are optimal to be used and in crowded time 4 lines is the most optimal. The using of every circumstance to maximize the effectivity of the staffs is not to fire them to reduce the “waste time” by those people who work and hire them when needed to the situation such as crowd but more to an activity which can help the company to achieve profit and an effective work.
2. Choosing a research object that has a very high customer arrival and the company has a number of cashiers who are not disproportionate to the arrival of customers that really need improvement in the queue system.

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