QUEUE SYSTEM ANALYSIS TO IMPROVE THE EFFECTIVENESS OF PATIENT SERVICES AT PUSKESMAS PANJANG BANDAR LAMPUNG

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Abstract

This study aims to analyze queue design and improve the effectiveness of services to patients at Puskesmas Panjang Bandar Lampung. The research model used is a descriptive quantitative method using an observation model. The analysis tool applied is M/M/S, and this research was carried out at the Long Health Center Bandar Lampung. The study sample was taken through observation time at the location, while the population that was the focus was patient service at the registration counter of Puskesmas Panjang Bandar Lampung. The type of data needed includes primary and secondary data, obtained through observation, interviews with officers of the Bandar Lampung Long Health Center, and secondary data based on the biography of the Puskesmas. The results showed that the queuing design applied at the Bandar Lampung Long Health Center Registration Counter was a Multi-Channel-Single Phase queue system. The performance of the queuing system at the Bandar Lampung Long Health Center counter has reached an optimal level based on the evaluation results of the analyzed indicators

Keywords: Keywords: Service Effectiveness, Queue Theory, Operational Management, Health Agencies.

1. Introduction

Population growth is increasingly crowded, especially in Indonesia today, requiring someone to do a culture of queuing anywhere, especially in crowded population gathering areas. This queue is the most important unit of operations and a valuable tool for operational managers. This queue arises because the need for service is more than the potential of service, so that users do not immediately get service because of busy services (Siagian, 2018).

In various cases, the addition of service facilities can be used in minimizing queues and overcoming large queues. However, there are costs caused by providing additional services, resulting in a decrease in profits to the level that it can accept. Conversely, the existence of long queues can cause customer loss because this requires a long time to get a service shift.

Although queuing is a common problem, under certain circumstances, queuing will make a sense of boredom and boredom, thus making his time wasted in queuing. This makes consumers who queue for a long time decide to leave and move elsewhere that can provide service quickly and satisfactorily (Nature & Anggraini, 2021).

Service can be defined as a series of actions or activities carried out by individuals or groups in meeting the needs, expectations, and requests of others. Services can occur in a variety of contexts, including in the fields of public services, business, health, education, and so on. Quality service can increase customer satisfaction, build loyalty, and create a good reputation for service providers (Wulan & Joharis, 2012).

One of the service agencies that often queue is the Puskesmas, Puskesmas is a service business in the medical service sector, a number of things that can determine its success at the operational stage are service quality, service design, technology, and order when serving from the Puskesmasnya (Permenkes, 2019). Basically, Puskesmas has the same goal, which is to provide health services and treatment for each patient.

An institution that focuses on the medical field certainly makes the puskesmas have a vision or mission in providing services that will help the community get the best health services. In carrying out the vision or mission, puskesmas always need to improve the services provided to its patients. Health services are very influential for the safety of patients.

In adding services to the people, Puskesmas needs to be able to decide and determine an effective queue design pattern, to minimize the long queue system so that it runs well in order to show the smooth running of Puskesmas services. Effectiveness is the use of resources, infrastructure at an amount previously applied in forming some performance based on its time. This is interpreted into a standard that explains to what extent the target will be achieved.

Puskesmas was formed to increase the professionalism of employees, and increase health infrastructure in satisfying customers related to their services. The tighter competition in consumers, making Puskesmas in providing medical services in order to always improve the quality of its services. In maximizing service quality, it is necessary to find the stage of service that is given what is appropriate or not. From the background above, the research aims to analyze the queuing system to increase service efficiency to patients at the Long Bandar Lampung health center.

This research refers to research conducted by (Safdar et al., 2020) entitled "An optimized queue management system to improve patient flow in the absence of appointment system". The study developed a queue evaluation model for crowded outpatient departments in public hospitals, where "all" patients come without appointments and don't use an appointment system. The model provides critical information in the form of the required "number" of personnel, allowing administrators to preemptively control queues to minimize wait times, with optimal yet dynamic staff allocation. In addition, this dynamic framework is specifically aimed at practical implementation in empowered public hospitals lacking in developing countries for continuous queue monitoring.

Research conducted by (Bhattacharjee & Ray, 2014) entitled Patient flow modelling and performance analysis of healthcare delivery processes in hospitals: A review and reflections. Patient flow modeling, analysis, and management, in this context, play a key role in performance analysis and improvement of hospital processes, as proper modeling of patient flow can help healthcare managers make decisions regarding capacity planning, resource allocation and scheduling, appointment scheduling, and to make necessary changes in the care process.

2. Theoretical Background
2.1 Queue

Queue theory is interpreted as a set of insights about waiting lines, as a unit for operational activities and auxiliary facilities for operational managers. Waiting lines often appear in their daily lives, this makes queues arise. Queue is access to someone who is waiting for his job, or is waiting for work. Design the queue to be a stage when consumers queue to get a service (Jacobs & Richard, 2016).

By (Heizer & Render, 2016) Queue theory is the most important part of operational activities and valuable auxiliary facilities for operational managers. The waiting line is a general condition when waiting for products and services. This is the most important unit of operations and equipment that is valuable to its operations manager. From the above understanding, it can be concluded that the queue is a stage related to a consumer's arrival in the service facility, then waiting for an antiquity to leave the facility (Iskandar, 2021).

2.2 Queuing System

The queuing system is a method used in organizing and managing queues in a service system. According to (Smith et al., 2017) An effective queuing system can help reduce patient wait times, increase productivity, and improve patient satisfaction. Some common methods used in queuing systems are number-based queuing methods and time-based queuing methods.

According to (Heizer & Render, 2016) Queue theory is in the basic components of the queue, namely arrivals, services, and queues. The components are:

Source	→	Queue	→	Queue Mechanism	→	Exit Queue
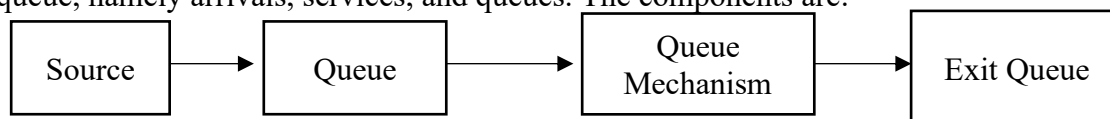
a. Source of Arrival

That is, a person or unit in being given service. This is often called the input stage, in general it is random arrival.

b. Queue

The length of the queue depends on the arrival umber based on the level of service. The most important determination of the queue is queue discipline. This is a step in providing services to queue, for example at the beginning of arrival, or exit at the beginning, and the end of coming, or exit at the beginning, of priority, etc. If there is no queue, it means that there are idle services or excess facilities of service infrastructure.

c. Service

Composed of a service or more stages. Such as the existence of puskesmas that have two or more service facilities that have a stage.

d. Service Completed

Usually, a person or unit who leaves the queue gives a marker when the service is over. By (Heizer & Render, 2016) Explain if there are 4 methods of antran, namely:

a. M/M/1 Queue Model

It's the simplest queue. Based on the Kendal notation, the M/M/1 design describes that the queue design has an interarival time and service times distribution with an exponential distribution of 1 server.

b. M/M/S queue model

That is the queue design in double access where there are 2 or more existing service access in providing customer service in the future. Assumption if consumers who wait for services will design an access and service in the design that existed at the beginning. This assumption is that the arrival will be according to the distribution of poison, the service period is based on the distribution of negative suspension, the service is carried out first-come, first-served, and all service stations are considered to be of the same service level.

c. Model M/D/1

Some service systems have appropriate service periods, when consumers are processed based on a cycle in automatic car washes or rides in their amusement parks, the service period that arises will generally be constant.

d. Limited population model

When there is a potentially limited consumer population for a service infrastructure, the queuing method will be different so it needs to be reviewed. The method is not the same based on the previous three queue methods, because now there is a relationship that depends between the length of the queue and the level of arrival. Extreme conditions can be illustrated such as: a factory has 5 machines that are entirely damaged, are being repaired, so that the arrival level will fall to 0. So that the queue access will extend to the small population method, so that the level of consumer arrivals will decrease.

The queue model that is in line with this research is the M/M/S queue method, this is a double-track queue design where there are 2 or exceed existing access and service design in providing services to consumers in the future. The idea that consumers who wait for services will design an access so that they are given services in the design that existed at the beginning at that time.

3. Methods

The study used a quantitative approach. Based on opinion (Sugiyono, 2018) Quantitative data is a research model based on concrete data, the data is in numerical form which is measured based on statistics which is a means of calculation, related to research problems in concluding. The quantitative method has a purpose in collecting and analyzing data in the form of numbers (Sugiyono, 2019). This approach will also allow researchers to measure and analyze the effectiveness of patient care based on the data collected (Sugiyono, 2017).
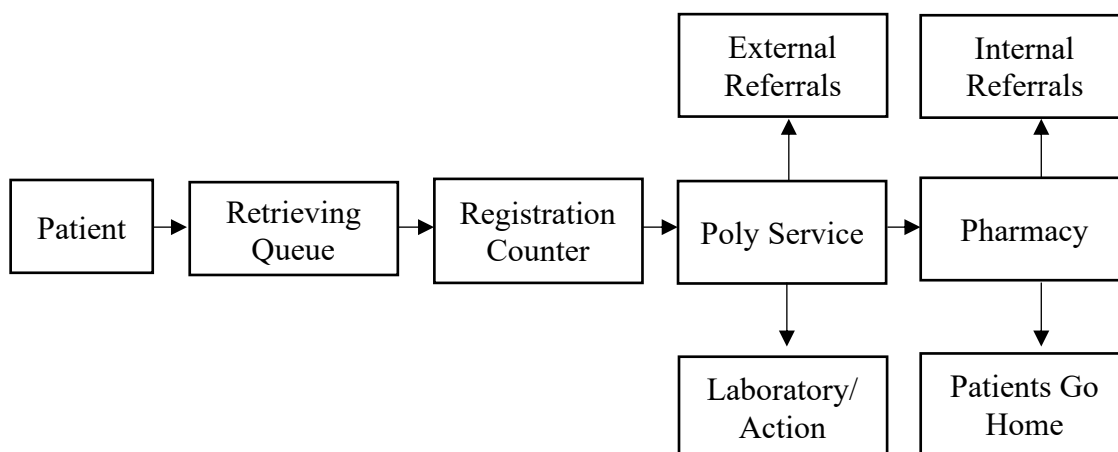
The model in collecting data in the research uses observation models and literature studies, based on (Sujarweni, 2015) Observation is a systematic review and recording of the marks seen in the object of research. In this study, observations on the object of research, namely the Long Health Center in Lampung to obtain data based on this research topic. Literature studies are carried out in obtaining secondary data in research, theoretical studies will be related to research ideas sourced from library data (Sugiyono, 2015).

The population at this risen is all patients of Puskesmas Panjang Bandar lampung. The sampling technique in the study is a non-probability sample which is a technique that does not provide the same opportunity for each age or member of the population to be putucsed as a sample. This will be half or the population with their characteristics that will be studied and felt to be able to answer the entire population. The samples in the study were all patients at the Long Bandar Lampung Health Center who checked on the specified date. There are 2 officers on duty at the registration counter.

4. Results and Discussion
4.1 Data Description

The queue system used at the Bandar Lampung Long Health Center is a Multichannel-Single Phase queue system, where there are two accesses in the service design available, there are two service facilities. There are 2 counters that provide patient services but there is only one service that patients go through. There are 2 officers at the registration counter. After getting the service, someone will log out based on the system. The queue components used at Puskesmas Panjang Bandar Lampung are as follows:

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                                    ┌──────────┐      ┌──────────┐
                                    │ External │      │ Internal │
                                    │ Referrals│      │ Referrals│
                                    └────▲─────┘      └────▲─────┘
                                         │                 │
┌─────────┐  ┌──────────┐  ┌──────────┐  ┌──────────┐  ┌──────────┐
│ Patient │→ │Retrieving│→ │Registration│→│   Poly   │→ │ Pharmacy │
│         │  │  Queue   │  │  Counter │  │  Service │  │          │
└─────────┘  └──────────┘  └──────────┘  └────┬─────┘  └────┬─────┘
                                              │             │
                                    ┌─────────▼┐      ┌──────▼───┐
                                    │Laboratory/│     │Patients Go│
                                    │  Action  │      │   Home   │
                                    └──────────┘      └──────────┘
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The data processed was obtained by observation at the registration counter starting from August 13, 2023 to August 18, 2023 at the Bandar Lampung Long Health Center which is presented in the table below:

Table 1. Number of Patient Services at Puskesmas Panjang Bandar Lampung

Date	Operating Hours	Number of Counters	Service
November 13, 2023	7 Hours	2	55
November 14, 2023	7 Hours	2	40
November 15, 2023	7 Hours	2	34
November 16, 2023	7 Hours	2	39
November 17, 2023	7 Hours	2	35
November 18, 2023	7 Hours	2	30

Source: Total Services of Puskesmas Panjang Bandar Lampung 2023

Based on the table of the number of patient services above, it can be seen that on November 13, there were 55 patients who came, on the 14th there were 40 patients, on the 15th there were 34 patients, on the 16th there were 39 patients, on the 17th there were 35 patients, while on November 18 there were only 30 patients who came to the Long Pusekesmas Bandar Lampung.

Table 2. Number of Patient Arrivals at Puskesmas Panjang Bandar Lampung

Date	Operating Hours	Number of Counters	Number (Patients)
November 13, 2023	7 Hours	2	57
November 14, 2023	7 Hours	2	44
November 15, 2023	7 Hours	2	37
November 16, 2023	7 Hours	2	41
November 17, 2023	7 Hours	2	35
November 18, 2023	7 Hours	2	30

Source: Number of Arrivals of Puskesmas Panjang Bandar Lampung 2023

Based on the table of the number of patient arrivals above, it can be seen that on November 13, there were 57 patients who came, on the 14th there were 44 patients, on the 15th there were 37 patients, on the 16th there were 41 patients, on the 17th there were 35 patients, while on November 18 there were only 30 patients who came to the Long Lampung City Health Center.

4.2 Data Analysis

From the data that has been collected, it can be done with the results of the queue work at the registration counter of the Bandar Lampung Long Health Center, the results of the queue design work at the counter every day within 6 days of observation and response time for 2 minutes. In being able to measure the results of queue work, the M, λ, and µ scores must be found first after which the scores of P, Pn, L, Lq, W, Wq. M explains the total server and counter will be active, λ explains the average arrival level in time units, and µ explains the average service level in time units. The formula and calculation of this queuing system is a theory of haizer and render.

Performance of the Queuing System at the Bandar Lampung Puskesmas Registration Counter November 13, 2023. Below is the result of the queue design work obtained from observations at the Bandar Lampung Long Health Center Registration counter.

M = 2 servers

$\lambda = \frac{57}{7} = 8.14$ patients / hour or 7-8 patients per hour.

$\mu = \frac{55}{7} = 7.85$ patients / hour and 8-9 patients per hour have covered the requirements and stability.

$\left(\rho = \frac{\lambda}{m.\mu} = \frac{8,14}{2.7,85} < 1 \right) = 0.518$

This means that ρ includes steady states, which can be explained if the average level of arrival is no more than the capacity of the service.

1) Probability of 0 patients on the plan (idle servers/no service)

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

$$P_0 = \frac{1}{\left[1 + \frac{1}{1!} \left(\frac{8,14}{7,85} \right)^1 + \frac{1}{2!} \left(\frac{8,14}{7,85} \right)^2 + \frac{2.(7,85)}{2.(7,85) - 8,14} \right]} = 0.122$$

This means that the probability of no patients being provided with services in the queuing system is 0.122 or 12.2%.

2) Average total patients in the system

$$L_s = \frac{\lambda.\mu \left(\frac{\lambda}{\mu} \right)^m}{(m-1)!(m.\lambda - \mu)^2} P_0 + \frac{\lambda}{\mu}$$

$$L_s = \frac{8,14 x 7,85 \left(\frac{8,14}{7,85} \right)^2}{(2-1)!(2.8,14 - 7,85)^2} 0,122 + \frac{8,14}{7,85} = 1.986$$

This means that the total average patient in the system is 1,986 patients and 1-2 patients in the system.

3) Average patient waiting time in the system

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

$$W_s = \frac{1,986}{8,14} = 0.243$$

This means that the average time spent by patients waiting for the system is around 0.243 or 14.58 minutes

4) Average total patients in line

$$L_q = L_s \frac{\lambda}{\mu}$$

$$L_q = 1,986 - \frac{8,14}{7,85} = 0.95$$

This means that the total average number of patients waiting in line is 0.95 patients and 1-2 patients waiting in line.

5) Average wait time for patients in line

$$W_q = \frac{L_q}{\lambda}$$

$$W_q = \frac{0,95}{8,14} = 0.116$$

This means that the average time spent by patients in queuing is 0.116 or about 6.96 minutes.

Based on the analysis that has been carried out, the results of the work of the queue system can be found at the registration counter at the Long Bandar Lampung health center.

Table 3. Performance Measures of the Queuing System at the Registration Counter of the Long Puskesmas Bandar Lampung.

Date	Queue Performance Measures					Steady
	P0	Ls	Ws	Lq	Wq	State ρ< 1
13/11/2023	0,122	1,986	14,58	0,95	6,96	0,518
14/11/2023	0,114	1,416	13,5	0,326	3,06	0,549
15/11/2023	0,115	1,638	18,6	0,558	6,3	0,544
16/11/2023	0,119	1,714	18,6	0,664	6,3	0,525
17/11/2023	0,166	1,83	21,96	0,83	9,96	0,5
18/11/2023	0,2	1	13,98	0	0	0,5
Average	0,1393	1,5973	16,87	0,5547	5,43	0,5227

Source: Data Processed 2023

Based on the data above, information can be obtained that the probability of no patients in the system (P0) is 13.93%, the average number of patients in the queue (Lq) is 0.5547 patients, the average time spent by patients in the system (Ws) is 16.87 minutes, and the average time spent by patients in line (Wq) is 5.43 minutes. Evaluation of the performance of a queuing system requires the fulfillment of certain indicators. According to (Fakhan et al., 2014), a queuing system is considered optimal if it meets steady state requirements, where the value of ρ in this study, is 0.5227, indicating that the average patient arrival rate does not exceed service capacity. The second indicator, which is the probability of the server being idle (P0), should be below 50% (Adiyani et al., 2013). thus, in this study, P0 is 13.93%, which indicates that the probability of the server being idle corresponds to the second indicator. The less idle time the service facility or server has, the better the officer's performance, according to the view (Septiani et al., 2017). The last indicator can be seen from the average patient waiting time in the system (Ws) which should be in accordance with the time standard set by the Bandar Lampung Long Health Center, which is less than 2 minutes. In this study, the average time patients spent in the system met the third indicator, Ws of 0.2782 seconds. As for each hour, each patient must wait about 14.58 minutes to be served. Therefore, the performance of the queuing system at the Long Bandarlampung Health Center has run optimally.

The research is in line with research from (Dian, 2021) entitled Analysis of the Queuing System to Improve the Effectiveness of Outpatient Services with BPJS at UPT Puskesmas Ngawen I Gunungkidul. The result of the research is that there is a decrease in service period to patients. In stage I, the busy score in the system ( ) = 0.87, the probability score of no consumers (P0) = 0.13 (13%), the average total patients in the

queue (Lq) = 5.75 people, the average total patients in the system (Ls) = 6.62 people, the average service period of each patient in the queue (Wq) = 61.8 minutes and the average service period of each patient in the system (Ws) is 71.4. After optimization, the score on the work outcome standard has decreased except in the P0 score, namely with a score = 0.44, a P0 score = 0.39 (39%), an Lq score = 0.21 patients, an Ls score = 1.08 patients, a Wq score = 2.22 minutes and a Ws score = 12 minutes. Keywords: queue system, service effectiveness, outpatient BPJS.

5. Conclusion

From the data above, the conclusion that can be drawn is that the work of the queuing system at the Bandar Lampung Long Health Center Counter is now maximized. This can be reviewed based on a number of evaluation factors that have been considered. The probability of no patients in the system (P0) is 13.93%, the total number of patients in the queue (Lq) is 0.5547 patients, the average time needed for patients in the system (Ws) reaches 16.87 minutes, and the average time needed for patients in the queue (Wq) is 5.43 minutes.

Evaluation of queue system performance refers to certain indicators, including steady state measured by the value of ρ. In the study, a ρ score of 0.5227 explained that the level of patient arrival was no more than service capacity, meeting steady state requirements. The second indicator, namely the probability of the server being idle (P0), according to the established standard is below 50%, with a P0 value of 13.93%. This explains if the probability of the server being idle is based on the 2nd indicator.

Thus, it can be concluded that the work of the queuing system at the Bandar Lampung Long Health Center Counter has reached an optimal level based on the evaluation results of the indicators that have been analyzed.

Suggestions and implications in my opinion, the Long Health Center has worked very well and just needs to improve the facilities and infrastructure for the queue.
Through this research, there is an implication for the Long Health Center that several additional officers are needed at the counter to assist the 2 counter officers available

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