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Analysis of Photocopy Service Queue System in "Sustainable Photocopy" Using The FIFO Queue Method

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***Abstract*—Photocopying services are services that are always sought by students, students, teachers, lecturers, and even office people for the need to duplicate school assignments, theses, document files, etc. "Sustainable" Photocopy Services are rarely empty of customers. And for a certain time, there are a lot of customers from "Sustainable" Photocopies. With this research, we can find out whether the queuing system at Sustainable Photocopy Services is optimal, and with the analysis of this queuing system by calculating the queuing formula it can be seen the call arrival rate, employee utility level, the average number of customers to be served, the number of customers in the system, the number of customers in the queue, the average time in the queue, the average time in the system, and the probability of waiting.**

***Keywords*: Queue Formula; Queuing System Analysis; Queuing System for Copy Services.**

I. INTRODUCTION

Photocopying services are services that are always sought by students, students, teachers, lecturers, and even office people for the need to duplicate school assignments, theses, document files, etc. This photocopy service business opportunity is quite promising considering its needs as a support for the smooth running of schools and offices. This service will be very easy to find in schools, campuses, and offices, especially if it's thesis season, surely any place for photocopies will be filled with students. Photocopy services are an alternative source of income for communities around school areas and residential areas. This business is very tempting with a wide market coverage and many people who need it. In addition to photocopying, this service also provides binding, scanning, typing, printing, photo printing, and laminating, so the benefits of services have enormous opportunities.Of course, this photocopying service is becoming a business that is increasingly mushrooming in society.

Customer satisfaction is the main thing to achieve big profits in this business. Customer satisfaction is defined as how much the level of one's feelings is generated based on the cognitive and emotional aspects of comparing one or more types of products or services. Based on this definition, it can be seen that the comparison of services is a consideration for customers to use a service. Differences in services offered based on service quality often make perceptions and judgments on customers to reconsider using these services[1], [2], [3]. Customer satisfaction will create interest in making repeat transactions on the products or services offered. Customer engagement is a behavior from customers who contribute voluntary resources that focus on a product, occurs in interactions between consumers and product or service providers, the result of consumer motivation towards interest in an existing product or service. Customer engagement is closely related to service contexts characterized by high customer/brand interactivity[4]. Customer engagement behavior

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results from aspects of an individual's motivational drive such as word-of-mouth activity, customer-to-customer (C2C) interaction, and/or blogging activity[5].Customers tend to seek pleasurable experiences in the customer engagement process, and positive consistency towards pleasurable experiences will lead customers to engage further[6].

This "Sustainable" Photocopy Service has a strategic location. Photocopy "Lestari" provides several services, including photocopying, laminating, binding,
"Lestari" Photocopy Services are open from 07:00 to 22:00. The "Lestari" Photocopy Service employs 2 employees. The average time needed to serve customers is 15 minutes. And for the average number of customers, the average number of customers who come is 20 people (Saturday, Sunday) and 25 people (Monday to Friday).

Stationery, etc. "Lestari" photocopy services are generally quite busy, causing queues for customers.The queue appears because the existing requests temporarily exceed the capacity of a server or facility so that customers who come cannot be served right away[7].Queuing is not a strange event, almost every day we are often involved in queuing events, such as when we want to pay at a supermarket cashier, pay tolls while driving, during visits to hospitals, and when we want to wash our vehicles at a washing machine, even in a wider industrial scope, queuing is applied to production management, inventory management, business management, transportation, banking, medical services, computer design, etc[8], [9]. Generally, events to be served immediately have very little chance[9]. Queuing is the process of waiting on a system to be served to ensure a reduction of waiting time with extra planning and investment by the company concerned [10], [11]. This queuing process is closely related to the arrival of a customer in a system, queuing if the queue cannot be served, being served, and finally leaving the facility after being served[12].

A queue, of course, has a close relationship with time, giving rise to the question of whether a system is running efficiently in terms of the time the customer queues in the system.The queue process is a stochastic event, both for system time and service time by the system[13]. To retain consumers, large or small companies certainly must provide the best service for their customers, one of which is by providing fast service and reducing consumer waiting time[14].

To be able to find out whether or not the existing queuing system is optimal, queuing theory is needed to study and analyze the existing queuing system.The application of queuing theory to processes involving queues, in general, has been widely used in industry to optimize the supply of fixed resources under variable demand conditions[16].This theory supports managers to calculate the resources needed to be able to meet customer demands[17]. Queuing Theory is a mathematical method for analyzing various types of systems and observing their behavior related to system performance and service quality. This includesanalysis of the service chain to complex queues. Usually used to analyze probability distributions in a continuous state space[18]. Because it requires only a small amount of data and provides more general results than simulations, this queuing model is considered simpler[19].

In the queuing system known various methods that can be applied in an industry. Of course, the chosen method is adjusted to the product or service offered. One of the queuing methods is the First In First Out method.

In the field of warehousing, the First In First Out method or abbreviated as FIFO is defined as a method of inventory management, in which the first purchased goods are the first goods used or sold. In simple terms, First In First Out is a method for products or services that are the first to enter and the first to leave[20], [21].
Within a service, server services or facilities can be single or multiple in batch size. The service process depends on the number of customers waiting to be served. If the queue is long, the server is required to work faster so that queue buildup does not occur which causes the system to become inefficient [15]. In photocopying services, of course, you will experience all conditions from the number of customers. Sometimes a few customers arrive and for a certain time, there are many customers from "Continuous" Photocopying. With this as a basis, I made a queuing system analysis that will find out whether this copy service is optimal or not.

II. RESEARCH METHOD

The method used is the quantitative method. This quantitative method is a method used to examine a particular population or sample. For

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this study, the form of the sample is proportional sampling. Data were obtained from interviews with owners and employees of Lestari Photocopy Services. The research variables used were the number of employees, length of service, length of time the store was opened, and the average number of customer visits per day.

III. RESULT AND DISCUSSION

In this photocopy service, for the arrival of customers, namely the arrival pattern is random or customers come randomly. And for queue discipline, this photocopy service includes a First Come First Served / First in First Out queue where customers are served first, namely customers who come first. Meanwhile, the queue structure model includes Single Channel - Single Phase because there is only oneservice station. And this photocopy service does not limit customers who come.

QUEUE ANALYSIS (QUEUE FORMULA):

A. Saturday - Sunday

Hiring 2 Employee(s) Working time 15 hours
There are 20 customers per day Service time is about 15 minutes

- Call arrival rate
  μ = 60 / 15 minutes
  = 4 customers/hour
  λ = 20 / 15
  = 1.34 customers/hour

- Employee utility rate
  P = λ / s μ
  = 1.34 / 2(4)
  = 1.34 / 8
  = 0.1675

- The aTheverage number of customers waiting to be served

$$P0 = \frac{1}{1 + \frac{(1{,}34/4)}{1!} + \frac{(1{,}34/4)^2}{2!}\left(1(1{,}34/8)\right)}$$

$$= \frac{1}{1 + 0{,}335 + 0{,}675}$$

  = 1/2,01
  = 0,4975

- The number of customers in the queue

$$Lq = \lambda\mu \left(\frac{\lambda}{\mu}\right)^s Po$$

$$= \frac{(1{,}34 \times 4)\,(1{,}34/4)^2\,(0{,}4975)}{(2-1)!\,(8-1{,}34)^2}$$

$$= \frac{(5{,}36)\,(0{,}1122)\,(0{,}4975)}{1!\,(87{,}2356)}$$

  = 0,0034 customers

- The number of customers in the system
  $L = Lq + \frac{\lambda}{\mu}$
  = 0.0034 + 1.34/4
  = 0.0034 + 0.335
  = 0.3384 customers

- Average time in queue

$$Wq = \frac{P}{\mu\, s\,(s!)\,(1-\lambda/s\,\mu)^2}\,(\lambda/\mu)^s$$

$$= \frac{0.4975}{4\,(2)\,(2)\,(1-1.34/8)^2}\,(1.34/4)^2$$

$$= \frac{0.4975}{16\,(0.6930)}\,(0.1122)$$

$$= \frac{0.4975}{11{,}088}\,(0.1122)$$

  = (0.0879) (0.1122)
  = 0.0099 hours or0.594 minutes or35.64 seconds

- The average time in the system
  W = Wq + (1 / μ)
  = 0.0099 + (1/4)
  = 0.0099 + 0.25
  = 0.2401 hours or14.406 minutes or864.36 seconds

- Probability to wait

$$Pw = (\lambda/\mu)^s \frac{Po}{S!\,[1-(\lambda/S\,\mu)]}$$

$$= (1.34/4)^2 \frac{0.4975}{2!\,[1-(1.34/8)]}$$

$$= (0.1122)\frac{0.4975}{2\,[0.8325]}$$

  = (0.1122) (0.2988)
  = 0.03352

B. Monday - Friday

Hiring 2 Employee(s) Working time 15 hours
There are 20 customers per day Service time is about 15 minutes

- Call arrival rate
  μ = 60 / 15 minutes

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= 4 customers/hour
λ = 25 / 15
= 1.67customers/hour

- Employee utility rate
P= λ / s μ
= 1.67 / 2(4)
= 1.67 / 8
= 0.20875

- The average number of customers waiting to be served
$P0 = \frac{1}{1 + \frac{(1.67/4)}{1!} + \frac{(1.67/4)^2}{2!\,(1-(1.67/8)}}$
$= \frac{1}{1 + 0.4175 + 0.1101}$
= 1 / 1.5276
= 0.6546

- **The number of customers in the queue**
$Lq = \frac{\lambda\mu \left(\frac{\lambda}{\mu}\right)^s Po}{(S-1)\ (S\,\mu - \lambda)^2}$
$=\frac{(1.67 \times 4)\,(1.67/4)^2\,(0.6546)}{(2-1)!\,(8 - 1.67)^2}$
$=\frac{(6.68)\,(0.174)\,(0.6546)}{1!\,(40.0689)}$
=0.0190 customers

- The number of customers in the system
$L = Lq + \frac{\lambda}{\mu}$
= 0,0190 + 1,67/4
= 0,0190 + 0,4175
= 0,4365 customers

- Average time in queue
$Wq = \frac{P}{\mu\, s\, (s!)\,(1 - \lambda/s\,\mu)^2}\ (\lambda/\mu)^s$
$= \frac{0{,}6546}{4\,(2)\,(2)\,(1 - 1{,}67/8)2}\ (1.67/4)^2$
$= \frac{0{,}6546}{16\,(0{,}0436)}\ (0{,}1743)$
$= \frac{0{,}6546}{0{,}6976}\ (0{,}1743)$
= (0.0879) (0.1122)
= 0,1636 hours or9,816 minutes or588,96 seconds

- The average time in the system
W = Wq + (1 / μ)
= 0,1636 + (1/4)
= 0,1636 + 0.25
= 0,4136 hours or24,816 minutes or1.488,96 seconds

- Probability to wait
$Pw = (\lambda/\mu)^s \frac{Po}{S!\,[1 - (\lambda/S\,\mu)]}$
$= (1,67/4)^2 \frac{0{,}6546}{2!\ [1 - (1,67/8)]}$
$= (0{,}1743)\frac{0.4975}{2\ [0{,}79125]}$
= (0,1743) (0,4136)
= 0,0721

IV. CONCLUSION

From the overall results of queue analysis. Lestari Photocopy Services employs 2 employees, with a working time of 15 hours, and a service time of 15 minutes for each customer. It can be concluded, on weekends such as Saturdays and Sundays, the calculation for the employee utility level is 0.1675, the average number of customers waiting to be served is 0.4975, the number of customers in the queue is 0.0034 customers, and the number of customers in the queue is the result is 0.3384 customers, and the average time in the queue is 0.0099 hours, while the average time in the system is 0.2401 hours. And the last calculation, the probability of waiting for the results obtained is 0.03352. And on weekdays such as Monday to Friday the calculation for the utility rate of employees obtained results of 0.20875, the average number of customers waiting to be served obtained results of 0.6546, the number of customers in the queue obtained the results of 0.0190 customers and the number of customers in the queue obtained the results 0.4365 customers, and the average time in the queue is 0.1636 hours, while the average time in the system is 0.4136 hours. And the last calculation, the probability of waiting for the results obtained is 0.0721

Based on these calculations, it can be concluded that the performance of the service system at Sustainable Photocopying Services

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with the FIFO method is quite good.

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