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Evaluation of Queue System Management Implementation at XYZ Supermarket in Lampung

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Abstract
Queuing system management (QSM) can help improve operational efficiency, reduce customer waiting time, node from human resource management (HRM) based on the effectiveness of HR performance and optimize employees as HR in improving customer service. This research was conducted with the aim of knowing the mplementing queuing results of system management in one of the Supermarkets in Lampung Province and knowing the optimal number of cashier lines in the QSM. Research conducted on the research object, namely XYZ Supermarket, is recorded every one hour interval. This research was conducted for 14 days, working hours from 09.00-21.00 Western Indonesian Time zone. The population in this study are all consumers whose population is unlimited. The sample used is consumers who enter the XYZ Supermarket QSM. The study purpose was to optimize the QSM with Ws less than 3 minutes and Ls less than 4 people in accordance with the SOP. This research method uses the multi channel single phase model with system time and systems number. The analysis results in this study can be concluded that the performance of the queuing system implemented with the number of cashiers (M) of 2 cashiers at 09.00-09.59, 12.00-12.59, and 19.00-19.59. It's makes optimal QSM with Ws less than 3 minutes, Ls less than 4 people.

Keyword *: Queuing model, Multi-channel single phase model, Weighting score (Ws), Lengths score (Ls), Lengths queue (Lq).*

1. *INTRODUCTION*

Queuing system management (QSM) is a process that ensures that customers are served in the correct order, a process that manages the customer's waiting experience throughout the journey, from pre-work to post-work according to Maghfirah et al (2019:31). Changes in people's lifestyles today affect all lines of life. In the past, people preferred to shop in traditional markets with a bargaining system that showed intimacy between sellers and buyers. Nowadays, people prefer to shop in modern markets by reason of various factors including better services. Services provided by supermarkets such as cleanliness of the place, ease of information and the system of using electronic cash registers to shorten waiting times. According to the Global Business Guide Indonesia, the number of traditional markets in 2007-2015 has decreased by 8% from 13,550 to 12,000. In 2007-2011 the number of modern retail outlets in Indonesia experienced

significant growth of 17.57% per year, while the number of modern retail outlets increased from 10,365 outlets to 18,152 outlets.

In general, there is a big difference between the quality of work or efficiency of modern marketing and traditional marketing. Customer satisfaction and customer service quality in modern markets are considered good. as the results of this journal research based on the exposure of Jannah et al (2023:29) that increasing the consumer satisfaction index can be done by increasing the level of performance provided. One of the most important services or services in self-service is queuing. Queuing according to Levin et al, in the journal Jannah et al (2023:29) is a process that creates a waiting line. This waiting line can be people or certain items. Queues are caused by arrival rates that are greater than the system capacity. Queues for consumers will cause the cost of waiting, the longer the queue, the greater the cost of waiting. To maintain consumer comfort, a good and integrated queuing system is needed so that it will make consumers in the supermarket have a good relationship and maintain the company's image.

XYZ Supermarket is one of the modern retailers in Lampung Province, established by an entrepreneur in 2002. XYZ Supermarket is a service company that provides daily consumer needs and also provides a fashion store. The queuing model used by XYZ Supermarket is Multi Channel - Single Phase (M/M/S), meaning that there is more than one payment counter and there is only one service stage that must be passed by customers to complete the payment. This supermarket has 3 payment cashier lines to serve consumers to pay for the goods purchased. On weekdays only 2 cashier lines are used in serving payments by consumers. The use of 3 payment cashier lines is only done for religious holidays such as Eid al- Adha and Eid al-Fitr. The time required by customers is random, considering that the number of needs of each customer is different. XYZ Supermarket applies First-Come, First-Served (FCFS) service where customers who come first will be served first. The liquidity of a company's balance sheet is the company's ability to cover its liabilities to creditors with its assets.

XYZ Supermarket operates every day from 09.00 - 21.00 WIB. This supermarket continues to operate on national holidays and religious holidays. The peak crowd of XYZ Supermarket visitors occurs at 15.00 - 17.00 WIB, namely when buses arrive from Java and office hours for employees. Crowds occur often through bus passengers or other motorized vehicles from Java stopping around XYZ Supermarket to change buses or just rest. XYZ Supermarket is also a gathering place for city transportation heading to areas around Bandar Lampung such as Natar, Tegineneng and Metro. The XYZ Supermarket queue data in December can be seen in Table 1.1 as follows:

***Table 1.1** Queue Data of XYZ Supermarket in December*

No	*Day/ Date*	*Queue (people)*	*Po (%)*	*LS (Person)*	*Ws (Minutes)*
1	Thursday, December 01	207	51	1	2m 29s
2	Friday, Dec 02	205	52	1	2m 29s
3	Saturday, Dec 03	412	22	2	3m 47s
4	Sunday, Dec 04	320	34	1	2m 58s
5	Monday, Dec 05	250	44	1	2m 38s
6	Tuesday, Dec 6th	417	21	2	4m 8s
7	Wednesday, Dec 07	320	34	1	2m 58s
8	Thursday , Dec 08	460	17	3	4m 34s
9	Friday, Dec 09	387	25	2	3m 30s
10	Saturday, Dec 10th	410	21	2	4m 2s
11	Sunday, Dec 11	340	31	1	3m 6s
12	Monday, Dec 12	233	47	1	2m 34s
13	Tuesday, Dec 13	202	52	1	2m 29s
14	Wednesday, Dec 14th	318	33	1	3m 6s
15	Thursday , Dec 15th	258	43	1	2m 40s
16	Friday, Dec 16	230	47	1	2m 34s
17	Saturday, Dec 17th	244	45	1	2m 37s
18	Sunday, Dec 18th	411	22	2	3m 46s
19	Monday, Dec 19th	239	46	1	2m 35s
20	Tuesday, Dec 20th	220	49	1	2m 32s
21	Wednesday, Dec 21st	305	36	1	2m 53s
22	Thursday , Dec 22nd	267	41	1	2m 42s
23	Friday, Dec 23rd	382	26	2	3m 27s
24	Saturday, Dec 24th	223	49	1	2m 32s
25	Sunday, Dec 25th	587	5	11	13m 23s
26	Monday, Dec 26th	257	43	1	2m 40s

27	Tuesday, Dec 27th	213	51	1	2m 30s
28	Wednesday, Dec 28th	200	53	1	2m 29s
29	Thursday, Dec 29th	470	16	3	4m 48s
30	Friday, Dec 30th	390	25	2	3m 32s
31	Saturday, December 31	592	4	12	14m 26s
Total		**9.969**	**1.085**	**63**	**116m 56s**
Average		**321,58**	**48**	**2**	**3m 46s**

Source: XYZ Supermarket December with QM-POM Software for Windows V4

Description:

Po : Probability that there are 0 people in the system

Ls : Average number of customers in the system / lengths score

Ws : Average time a customer spends in the system/weighting score

The highest probability of there being 0 people in the system (Po) occurred on Saturday, December 31, which was 4% and the lowest occurred on Thursday, December 15, which was 53%. The average Po value of XYZ Supermarket in December is 48%. The average number of customers in the system / lenghts score (Ls) of XYZ Supermarket in December is 2 People. In general, there is no problem with Ls due to the Standard Operating Procedure (SOP) is set at 4 people, however on December 25 and December 31 there was a build up until the Ls was more than 4 people. The average time a customer spends in the system / Weightung score (Ws) of XYZ Supermarket in December was 3m 46s. There is a problem with the Ws meanwhile it is greater than the SOP set at 3 Minutes. Queuing conditions with Ws greater than 3 minutes according to the SOP also occurred on December 03, December 06, December 08, December 09, December 10, December 11, December 14, December 18, December 23, December 25, December 29, December 30, and December 31.

2. *LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT*

2.1. Management

According to V.P. Galenko, A.I. Rakhmenov and O.A. Strakhova (2003), management science is the theory of management in science is very deep and diverse, the category of "management" is much broader than the categories that make up the structure of management theory, including providing three aspects of management science, including: Epistemological aspects (division and specialization of work, assignment of management functions to management subjects); Subject of the management process (information); Work results of the management process (managerial decisions). The definition of Management according to the Authors of this journal after this research is completed, that Management is the art or science of organizing various management disciplines to achieve certain goals by deliberating on the discipline of financial management which applies cost effectiveness, applying elaboration on the science of queue management by means of time efficiency, and implementing collaboration of human resource (HR)

2.2. Management Operations

According to Natalia Novoselova and Svetlana Vladislavovna Sysoeva (2019) operations management is a way of developing or optimizing the organizational structure of a retail store, distributing tasks and responsibilities between positions and departments, how to organize business processes for product distribution and customer service, setting work standards, implementing employee work patterns and monitoring their implementation, evaluating and monitoring the work patterns of employees in retail stores. Based on this opinion and according to the results of this study, it can be concluded by the Author that Operations Management is an activity related to the creation of goods or services through the process of transforming inputs into outputs in order to control the quality of goods or services.

However, it does not result in a transfer of ownership. According to the Author of the results of this study, it can be stated that there are two types of services: Luxury Services, services that are packaged with an exclusive look without requiring heavy effort from the customer, the first opportunity to order services has been equipped with a periodic ordering menu

with comprehensive details regarding the services needed and has the opportunity to terminate the service if the service provided is not exclusive. Example: Scientific invention patent services, Technology subscription services, etc. The second type is Ordinary Services, Services that are provided only once a booking without exclusive presentation and no comprehensive facilities. Example: Food ordering services via application, Traditional massage services, etc.

2.3. Retail

Retail is retail trade: trade in goods and provision of services to customers for personal, family, household use not related to entrepreneurial activity. (State Standard of the Russian Federation GOST R 51303-99 "Retail trade. Terms and definitions"). Based on the results of this study, the Authors define *that Retailing is* the art of organizing many modern digital technologies used at retail scale product sales trade for customers direct users of product benefits. digital technologies, as well as changes in consumer attitudes, identifying modern trends in retail trade, their significance and prospects.

2.4. Services

According to Adian Payne in Dwi Dewianawati, et.al., (2018) services are economic activities that have a number of elements of value and benefits associated with them which involve a number of interactions with consumers or with goods management with marketing management so that employee performance is always maximized and sales of products or services can reach sales targets in each quarter, semester, and annual sales period.

2.5. Queuing Theory

As this research materializes, the Researchers of this journal defines that the Queue Theory Model is an art made to predict queue length and waiting time, the Queue Simulation Method is the art of stimulating and estimating queue length in order to create time effectiveness, both methods aim to analyze, predict, and develop performance on queue systems and queue models to present suggestions for improvements to queues in a company.

This is the basis for the author's analysis of the queuing system. According to Listiyani, R., et.al., (2019) Queuing Theory is a mathematical study related to circumstances related to all aspects of people / goods waiting to be served. Queuing theory was first introduced by Agner Krarup Erlang, a mathematician from Denmark in 1917.

2*.6. Queuing Characteristics Services*

According to the Researchers and authors of this journal, Queuing System is the art of providing services with a sincere heart for a group of customers, regulations that are applied to organize customer arrivals, and provide fast, fixed, and accurate service for each customer. There are three characteristic components in a queuing system revealed by Heizer and Render in Andrea R., (2022:11) namely: Arrival or input characteristics of the system, queue discipline, and service facilities.

2.7. Structure Queuing

According to Heizer and Render in Andrea R., (2022: 11) there are four basic queuing structure models that are common in all queuing systems: Single Chanel - Single Phase, Single Channel - Multi Phase, Multi Channel - Single Phase, Multi Channel - Multi Phase. The four phases have advantages and disadvantages depending on the scheme of each supermarket, the number of employees with the number of customers, the layout of the supermarket, etc. which cannot be forced for a supermarket, therefore this research was conducted in order to examine and find out what phase of the queuing structure is appropriate to apply.

2.8. Queuing Model

According to Heizer and Render in Andrea R., (2022: 11) there are four queuing models that are often applied by companies, namely: Model A (M / M / 1, Model B (M / M / S), Model C (M / D / 1 = constant service or constant service time), Model D (limited population or

limited population). Outro caption The discussion of the Queuing Model is the same as the four phases of the Queuing Structure, where the four phases of the Queuing Model have advantages and disadvantages that adjust to customer arrivals and service times supported by the scheme of each supermarket, the number of employees with the number of customers, the layout of the supermarket, etc. which cannot be applied to one supermarket against another supermarket, therefore this research is presented in order to be able to research and find out what queuing models are accurate to implement.

There are several hypotheses that will be researched, including the following:

Hypothesis 1: The implementation of a queuing system management (QSM) at XYZ Supermarket in Lampung Province can reduce customer waiting time.
Hypothesis 2: The implementation of the QSM at XYZ Supermarket in Lampung can increase customer satisfaction.
Hypothesis 3: The application of the QSM at XYZ Supermarket in Lampung can increase the efficiency of supermarket operations

3. *RESEARCH METHODOLOGY*

The type of research used in this research is descriptive research depending on the information to be sought in the research, this is inasmuch as it relates to a particular object, namely the XYZ Supermarket with a certain period of time by collecting the data and information needed and adjusted to the research objectives. Then the population used in this study were consumers who bought and made payments at XYZ Supermarket and the sample in this study used Purposive Sampling technique, in its application was consumers who made transactions at the XYZ Supermarket cashier in South Lampung.

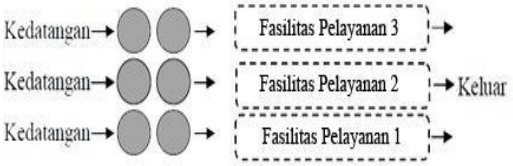
Data validity techniques are used to obtain a level of trust related to how far the truth of the research results is, revealing and clarifying data with actual facts in the field. This is done by using data analysis with a multiple line queuing model (multi channel- single phase). The formula for the M / M / S queuing model is as follows:

Tabel 3 Queuing Model Formula B (M/M/S)

No	Model B (M/M/S)	The Formula
1	*Average arrival rate (λ)*	$= \frac{\text{Total consumers per the same periode}}{\text{Total time period}}$
2	*Average service level (μ)*	$= \frac{\text{Total arrivals}}{\text{Total working hours}}$
3	*The probability that there are 0 people in the system (Po)*	$= \frac{1}{[\sum_{n=0}^{M-1} \frac{1}{n!}(\frac{\lambda}{\mu})^n] + \frac{1}{M!}(\frac{\lambda}{\mu})^2 \frac{M\mu}{M\mu - \lambda}}$
4	*Cashier utility rate (ρ)*	$= \frac{\lambda}{M}$
5	*The average number of consumers in the system (Ls)*	$= \frac{\lambda\mu(\lambda/\mu)^M}{(M-1)!(M\mu-\lambda)^2} Po + \frac{\lambda}{\mu}$
6	*The average time a customer spends in the system (Ws)*	$= \frac{Ls}{\lambda}$
7	*The average number of people or units waiting in a queue (Lq)*	$= Ls - \frac{\lambda}{\mu}$
8	*The average time spent by a customer in the queue (Wq)*	$= \frac{Lq}{\lambda}$

Source: Heizer and Render (2011:778)

Multi Channel Single Phase systems occur when two or more service facilities are served by a single queue. Examples of this queuing structure are services at a bank that are served by several tellers or shopping centers or supermarkets that have many cashiers for payments.

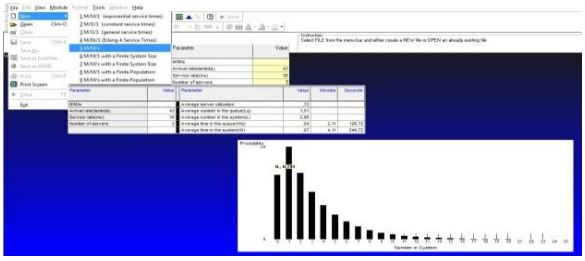


zer and Render (2011: 775) in Maghfirah et al (2019: 31)

The multiple line queuing model (M/M/S) has two or more service station lines available to handle incoming customers. The assumption in this system is that arrivals follow a Poisson distribution, service time follows an exponential distribution. An example of Model B (M / M / S) is teller service at bank service facilities are served by a single queue. Examples of this queuing structure are services at a bank that are served by several tellers or shopping centers or supermarkets that have many cashiers for payments.

Uni research to obtain valid results is done through calculations with QM- POM Software for Windows V4. Calculations with QM- POM Software for Windows V4 to get faster and more accurate results.

Figure 3.1 QM-POM for Windows V4 software



Source: QM-POM Software for Windows V4

Description:

λ = *Average arrival rate*
μ = *Average service level*
M = *Number of Cashiers*
M = *Number of Cashiers*
Po = *Probability that there are 0 people in the system*
P = *Cashier utility rate*
Ls = *Lengths score / Average number of consumers in the system*
Ws = *Weighting score / Average time a customer spends in the system*
Lq = *Lengths Queue / Average number of people or units waiting in queue*
Wq = *Weighting queue / Average time a customer spends in queue*

4. RESULTS AND DISCUSSION

At XYZ Supermarket there are three cashier lines provided to be able to serve consumers who will make payments for purchased goods. On weekdays XYZ Supermarket only operates two cashier lines. The use of three cashiers is only done on Eid al-Adha and Eid al-Fitr holidays.

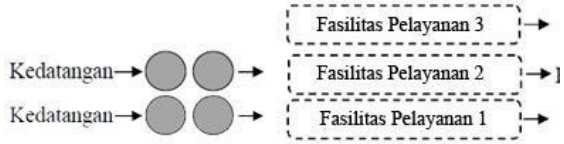


Figure 4.1 Queuing Model of XYZ Supermarket South Lampung Source: Primary research data

The type of queuing system applied by XYZ Supermarket is the Multi Channel - Single Phase (M / M / S) model queuing system. One of the efforts to provide the best service in the transaction process, XYZ Supermarket determines the standard service time for each consumer is a maximum of 3 (three) minutes. The maximum queue length in each cashier line is 4 (four) people. The service discipline applied is the FCFS service discipline where consumers who come first will be served first.

4.1. Arrival Rate and Service Level

The arrival rate is the number of consumers who come to get service from the cashier. The arrival rate of cashiers is assumed to follow the Poisson distribution. The cashier service level is the length of service time provided by the cashier to serve consumers.

The following is data on the average customer arrival rate at XYZ Supermarket in South Lampung. The average hourly customer arrival rate (λ) is obtained using the formula of the number of consumers in each condition divided by the total hours in the same condition multiplied by 14 research days.

Consumer arrival data is obtained by observing the number of consumers entering the queuing system at XYZ Supermarket for 14 days, from February 20 to March 05. Observations were made at 09.00 – 21.00 a.m. to find out the number of consumers entering the XYZ Supermarket queuing system which was recorded at every one hour interval. The research time carried out for 14 days is considered to have represented the required queue data, namely peak hours on weekdays and weekends. The research time also represents queuing data at the end of February and early March. The following is the arrival data of consumers who transact at XYZ Supermarket in South Lampung:

Table 4.1 Consumer Arrival Data

No	Day	Date	Customer Arrival
1	Monday	February 20	289 people
2	Tuesday	February 21	341 people
3	Wednesday	February 22	266 people
4	Thursday	February 23	421 people
5	Friday	February 24	292 people
6	Saturday	February 25	409 people
7	Sunday	February 26	475 people
8	Monday	February 27	309 people
9	Tuesday	February 28	348 people
10	Wednesday	March 01	376 people
11	Thursday	March 02	478 people
12	Friday	March 03	271 people

13	Saturday	March 04	425 people
14	Sunday	March 05	423 people

Source: Primary Research Data

Table 4.2. Average Hourly Arrival Rate

Time Period	***Consumer Arrival (λ) (Person)***	
09.00-09.59	20,43	20
10.00-10.59	24,36	24
11.00-11.59	28,14	28
12.00-12.59	24,57	25
13.00-13.59	25,64	26
14.00-14.59	31,43	31
15.00-15.59	41,21	41
16.00-16.59	41,57	42
17.00-17.59	37,64	38
18.00-18.59	29,00	29
19.00-19.59	31,86	32
20.00-20.59	30,07	30

Source: Research Primary Data

Table 4.3. Average Arrival Rate Formula

$$\text{Average arrival rate } (\lambda) = \frac{\text{Total consumers per the same period}}{\text{Total time period}}$$

In optimizing the XYZ Supermarket queue model, it is necessary to first know the average service level (μ) at the XYZ Supermarket cashier. The following is the average service level (μ) at the XYZ Supermarket cashier in South Lampung.

Table 4.4. Average Service Level

Time Period	***Number of Consumers***	***Working Hours***	***Service Level***
09.00-09.59	286 people		
10.00-10.59	341 people		
11.00-11.59	394 people	14 days x	**30,49**
12.00-12.59	344 people	12 hours	**or 30**
13.00-13.59	359 people		
14.00-14.59	440 people		
15.00-15.59	577 people		
16.00-16.59	582 people		
17.00-17.59	527 people		
18.00-18.59	406 people		
19.00-19.59	446 people		
20.00-20.59	421 people		
Total	5123 people	168h	

Source: XYZ Supermarket

4.2. Queuing System Analysis with the M/M/S Model

At XYZ Supermarket there are three cashier lines provided. On weekdays only operate two cashier lines while on religious holidays 3 (three) cashier lines are used. Queuing system analysis with the M / M / S model is as follows:

Table 4.5. Queuing System Performance Results

Period Time	***Queuing System Performance***								
	M	***λ***	***μ***	***Po***	***ρ***	***Lq***	***Ls***	***Wq***	***Ws***
09.00-09.59	2	20	30	50%	33%	0	1	15s	2m 15s
10.00-10.59	2	24	30	43%	40%	0	1	22s	2m 22s
11.00-11.59	2	28	30	36%	47%	0	1	33s	2m 33s
12.00-12.59	2	25	30	41%	42%	0	1	25s	2m 25s
13.00-13.59	2	26	30	40%	43%	0	1	27s	2m 27s
14.00-14.59	2	31	30	32%	52%	0	1	43s	2m 43s
15.00-15.59	2	41	30	19%	68%	1	3	1m 45s	3m 45s
16.00-16.59	2	42	30	18%	70%	1	3	1m 55s	3m 55s
17.00-17.59	2	38	30	22%	63%	1	2	1m 20s	3m 20s
18.00-18.59	2	29	30	35%	48%	0	1	36s	2m 36s
19.00-19.59	2	32	30	30%	53%	0	1	48s	2m 48m
20.00-20.59	2	30	30	33%	50%	0	1	40s	2m 40s

Source: Primary data processed with QM-POM for Windows V4 Software (Appendix 3)

The data in Tables 4.4 and 4.5 are processed using the QM- POM for Windows V4 program with the data in Table 4.4 and Table 4.5 and the number of cashiers operating (M) is 2 cashier lines. The calculation aims to optimize the queuing system as a whole so that the average time spent by a consumer in the system (Ws) ≤ 3 minutes and the average number of consumers in the system (Ls) ≤ 4 people in accordance with the established SOP. The addition of lines continues until the average time spent by a consumer in the system (Ws) ≤ 3 minutes and the average number of consumers in the system (Ls) ≤ 4 people is achieved.

4.2.1 Probability that there are 0 people in the system (Po)

The probability that there are 0 people in the largest system occurs at 09.00-09.59, which

is 50%. At 09.00-09.59 the queue conditions are not too crowded so the possibility of the cashier being empty is very large. This condition is caused owing to in that time period there are very few consumers waiting for service in the queuing system. The smallest probability of there being 0 people in the system (Po) occurs at 16.00-16.59 which is 18%. The possibility of the cashier being empty at 16.00-16.59 is very small. In this time period, the queuing system conditions are filled with consumers waiting for service. The probability that there are 0 people in the system (Po) describes the possibility of the cashier being empty. The greater the percentage value, the more likely it is that the cashier is empty.

4.2.2 Cashier utilization rate or cashier busy rate (ρ)

The cashier utilization rate or cashier busy rate at 09.00-09.59 the cashier's situation is very relaxed with a cashier busyness utilization rate (ρ) of 33%. At 09.00-09.59 the cashier's situation was very relaxed for the sake of the majority of consumers who were employees were at work hours, namely at 07.30-15.30 and users on one of the main roads in Lampung province were more dominated by motorized vehicles. Cashier utilization rate (ρ) describes the busyness of cashiers in serving consumers.

The greater the percentage of cashier utilization rate (ρ), the greater the busyness of the cashier. The highest utilization rate occurred at 16.00-16.59 which was 70%. At 16.00- 16.59 the queue system conditions are very crowded as a result of the accumulation of consumers to get services. At 16.00-16.59 it is time to go home from work for employees as well as the arrival time of buses from Java Island to Sumatra Island or vice versa that stop for a break or drop off passengers. Bus passengers at the same time enter to buy their needs and result in increased cashier bustle.

4.2.3 Average number of consumers in queue (Lq)

The shortest average number of consumers in the queue (Lq) occurred at 09.00-09.59, 10.00-10.59, 11.00-11.59, 12.00-12.59, 13.00-13.59, 14.00-14.59, 18.00-18.59, 19.00-19.59 and 20.00-20.59, namely 0 people. In these conditions the queuing system is quiet so that every consumer who will make a transaction does not need to queue in obtaining services. The longest average number of consumers in the queue (Lq) occurred at 15.00-15.59, 16.00-16.59 and 17.00-17.59, namely 1 person. This condition is due to the large number of consumers waiting to get service at the XYZ Supermarket cashier. In this time period, it is office hours for employees as well as the arrival time of buses from Java Island to Sumatra Island or vice versa that stop for a break or drop off passengers. The average number of consumers in the queue (Lq) describes the length of the queue when someone gets service in the queuing system.

4.2.4 Average number of consumers in the system (LS)

The shortest average number of consumers in the system (Ls) occurred at 09.00-09.59, 10.00-10.59, 11.00-11.59, 12.00-12.59, 13.00-13.59, 14.00-14.59, 18.00-18.59, 19.00-19.59 and 20.00-20.59, namely 1 person. In these conditions the queuing system is quiet so that every consumer who will make a transaction does not need to queue in obtaining services. The longest average number of consumers in the system (Ls) occurs at 15.00-15.59 and 16.00-16.59, namely 3 people. In this condition consumers are required to queue to get service from the cashier.
In this time period, it is office hours for employees and the arrival time of buses from Java Island to Sumatra Island or vice versa that stop for a break or drop off passengers. The average number of consumers in the system (Ls) is defined as the length of the queue when someone enters the queuing system to get service.

4.2.5 Average time spent by consumers in queue (Wq)

The shortest average time spent by consumers in the queue (Wq) occurred at 09.00-09.59, namely for 15s minutes. In these conditions consumers do not need a long time to get service. This condition is due to the majority of consumers who are employees during working hours, namely at 07.30-15.30 and motorized vehicle users on the main roads of South Lampung which are dominated by four-wheeled motorized vehicles that do not stop.

The average time spent by consumers in the queue (Wq) occurs at 16.00-16.59, namely for

1m 55s. At 16.00-16.59 it is office hours for employees and buses arrive from Java to Sumatra Island which stop for a break or drop off passengers. Bus passengers at the same time enter to buy their needs and result in increased cashier busyness. The average time spent by consumers in the queue (Wq) is the time spent by a consumer when getting service at the cashier.

4.2.6 Average time a customer spends in the system (Ws)

The shortest average time spent by consumers in the queue (Wq) occurs at 09.00-09.59 which is 2m 15s. This condition is due to the majority of consumers who are employees during working hours, namely at 07.30-15.30 and users on the main roads of South Lampung which are dominated by motorized vehicles. The longest average time spent by consumers in the queue (Wq) occurred at 16.00-16.59, namely for 3m 55s. In these conditions the queuing system is busy as long as many consumers are waiting to get service from the cashier. At 16.00-16.59 it is office hours for employees and buses arrive from Java to Sumatra Island which stop for a break or drop off passengers. Based on the explanation above, it can be seen that the performance of the queuing system is optimal at 09.00-09.59, 10.00-10.59, 11.00-11.59, 12.00-12.59, 13.00- 13.59, 14.00-14.59,18.00-18.59,19.00-19.59 and 20.00-20.59 for the reason that the average time a consumer spends in the system (Ws) ≤ 3 minutes and the average number of consumers in the system (Ls) ≤ 4 people.

The queue system is not optimal at 15.00-15.59, 16.00-16.59 and 17.00-17.59 on the ground that the average time a consumer spends in the system (Ws) is more than 3 minutes and the average number of consumers in the system (Ls) is less than 4 people. In maintaining performance according to the SOP which has not been fulfilled in the time periods 15.00- 15.59, 16.00-16.59, and 17.00-17.59, a greater service rate is needed than before, namely by adding cashiers in time periods that are not optimal.

4.3. XYZ Supermarket Queuing System Improvement

To answer these three hypotheses, an explanation is needed in sub-chapter 4.3 which discusses improvisation and implementation based on data collection of the queuing system at XYZ Supermarket.

***Table 4.6** Queuing System Performance Results after Addition of One Queue Lane at 15.00 15.59, 16.00-16.59 and 17.00-17.59*

Period Time	Queuing System Performance								
	M	λ	μ	Po	ρ	Lq	Ls	Wq	Ws
09.00-09.59	2	20	30	50%	33%	0	1	15s	2m 15s
10.00-10.59	2	24	30	43%	40%	0	1	22s	2m 22s
11.00-11.59	2	28	30	36%	47%	0	1	33s	2m 33s
12.00-12.59	2	25	30	41%	42%	0	1	25s	2m 25s
13.00-13.59	2	26	30	40%	43%	0	1	27s	2m 27s
14.00-14.59	2	31	30	32%	52%	0	1	43s	2m 43s
15.00-15.59	3	41	30	24%	46%	0	2	14s	2m 13s
16.00-16.59	3	42	30	24%	47%	0	2	15s	2m 15s
17.00-17.59	3	38	30	27%	42%	0	1	11s	2m 11s
18.00-18.59	2	29	30	35%	48%	0	1	36s	2m 36s
19.00-19.59	2	32	30	30%	53%	0	1	48s	2m 48m
20.00-20.59	2	30	30	33%	50%	0	1	40s	2m 40s

Source: Primary data processed with QM-POM Software for Windows V4

Based on table 4.6 the results of the queuing system performance above show that:

4.3.1 Probability that are 0 people in the system (Po)

After the addition of 1 (one) cashier lane causes the probability of there being 0 people in the system (Po) at 15.00-15.59 to increase from 19% to 24%, 16.00-16.59 it increases from 18% to 24% and at 17.00-17.59 it increases from 22% to 27%. The increase in the percentage of probability that there are 0 people in the system (Po) in that time period causes a greater possibility that the cashier is empty so that consumers can be served properly.

4.3.2 Cashier utilization rate or cashier busy rate (p)

After the addition of 1 (one) cashier lane, the cashier utilization rate or cashier busyness rate (ρ) at 15.00-15.59 dropped from 68% to 46%, at 16.00-16.59 dropped from 70% to 47%, at 17.00-17.59 dropped from 63% to 42%. The decrease in the percentage of cashier

utilization rate (ρ) in that time period caused the cashier to be less busy in providing services.

4.3.3 Average number of consumers in queue (Lq)

After the addition of 1 (one) cashier line, the average number of consumers in the queue (Lq) at 15.00-15.59 dropped from 1 person to 0 people, at 16.00-16.59 dropped from 1 person to 0 people, at 17.00-17.59 dropped from 1 person to 0 people. The decrease in the average number of consumers in the queue (Lq) in that time period causes the length of the queue in waiting for the cashier service to decrease so that the length of the queue can be minimized.

4.3.4 Average number of consumers in the system (Ls)

After the addition of 1 (one) cashier line, the average number of consumers in the queue (Lq) at 15.00-15.59 dropped from 1 person to 0 people, at 16.00-16.59 dropped from 1 person to 0 people, at 17.00-17.59 dropped from 1 person to 0 people. The decrease in the average number of consumers in the queue (Lq) in that time period causes the length of the queue in waiting for the cashier service to decrease so that the length of the queue can be minimized.

4.3.5 Average time spent by consumers in queue (Wq)

After the addition of 1 (one) cashier line, the average time spent by consumers in the queue (Wq) at 15.00-15.59 dropped from 1m 45s to 45s, at 16.00-16.59 it dropped from 1m 55s to 15s, at 17.00-17.59 it dropped from 1m 20s to 11s. The decrease in the average time spent by consumers in the queue (Wq) in that time period causes the waiting time when consumers get service to be reduced.

4.3.6 Average time a customer spends in the system (Ws)

After the addition of 1 (one) cashier line, the average time spent by consumers in the queue (Wq) at 15.00-15.59 dropped from 3m 45 s minutes to 2m 13s, at 16.00-16.59 it dropped from 3m 55s minutes to 2m 15s, at 17.00-17.59 it dropped from 3m 20s to 2m 11s. The decrease in the average time spent by consumers in the queue (Wq) in that time period causes the waiting time for consumers to complete the service to be reduced. Based on the results of the queue model analysis in Table 4.6, it can be seen that adding 1 cashier line at 15.00-15.59, 16.00-16.59 and 17.00-17.59 to serve consumers can reduce the average time spent by a consumer in the system (Ws) to less than 3 minutes and the average number of consumers in the system (Ls) to less than 4 people.

5. *CONCLUSION*

According to the results of the analysis carried out, it can be seen that the queue structure model applied by XYZ Supermarket is Multi Channel-Single Phase (M / M / S), meaning that the service provided by XYZ Supermarket is one stage and the number of lines owned by more than one is optimal. The use of the Multi Channel-Single Phase model is said to be optimal furthermore the service model provided by XYZ Supermarket is only one process without any further processes. The use of more than one service line can reduce the average time a consumer spends in the system (Ws) and the average number of consumers in the system (Ls). On weekdays the number of cashiers serving consumers is 2 cashier lines while on Eid al-Adha and Eid al-Fitr the number of cashiers serving consumers is 3 cashier lines.

During the service, the time it takes for customers with other customers to get service is random. This happens because the needs of each customer are different. The peak crowd of XYZ Supermarket visitors occurs at 15.00 -17.00 pm, namely when buses arrive from Java Island to Sumatra Island or vice versa and office hours for employees. In addition, XYZ Supermarket is also a gathering place for city transportation heading to areas around Bandar Lampung such as Natar, Tegineneng and Metro. At certain times, often bus or city transportation passengers simultaneously enter and buy their needs so that the buildup of queues at the cashier cannot be avoided.

Based on the results of the above calculations, it can be seen that the performance of the queuing system implemented with the number of cashiers (M) of 2 cashier lines at XYZ Supermarket is good at 09.00-09.59, 10.00-10.59,

11.00-11.59, 12.00-12.59, 13.00-13.59, 14.00-14.59, 18.00-18.59, 19.00-19.59 and 20.00-20.59 because the average time a consumer spends in the system (Ws) ≤ 3 minutes and the average number of consumers in the system (Ls) ≤ 4 people in accordance with the SOP. The queuing system is not optimal at 15.00-15.59, 16.00-16.59 and 17.00-17.59 because the average time a consumer spends in the system (Ws) is more than 3 minutes. It is necessary to increase the number of cashiers at XYZ Supermarket so that the queuing system becomes optimal.

The following are the results obtained by increasing the level of service with the addition of 1 cashier lane. At 15.00-15.59 the average time spent by a consumer in the system (Ws) with 2 cashier lines is 3m 45s while with 3 cashier lines the time required is 2m 13s. At 16.00-16.59 the average time a consumer spends in the system (Ws) with 2 cashier lines is 3m 55s while with 3 cashier lines the time required is 2m 13s. At 17.00-17.59 the average time spent by a consumer in the system (Ws) with 2 cashier lines is 3m 20s while with 3 cashier lines the time required is 2m 11s. The addition of the number of cashier lines at 15.00-15.59, 16.00-16.59 and 17.00-19.59 makes the queuing system optimal with the average time spent by a consumer in the system (Ws) ≤ 3 minutes and the average number of consumers in the system (Ls) ≤ 4 people.

6. *LITERATURE*

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