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บทความวิจัย

Queuing System Analysis: A Case Study of Fast Fashion Business

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Abstract: The purpose of this research paper is to study the theory of queuing to be used to analyze the appropriate number of the service unit, and the sufficient number of customers for the retail store in the shopping mall. Today, the retail selling in the case of study found the problem that the store has too many customers. They must be waited in a long line for casher. This might affect customers satisfaction. The study explains the examples that is more suitable to use are Model queuing length and who use services to receive services indefinitely (M/M/s: FCFS/∞/∞). The result of the study shows that the pattern of customers coming in service and explained in detail by Poisson Distribution with the rate of service 0.30 persons per minute. The pattern of service for customer at the counter 3 units with the average number of customers waiting in line are 0.75 persons per minute. The average number of customers in the queuing system are 2.75 persons per minute. The average time a customer spends in line are 1.26 minutes per person, and average time a customer spends in the system are 4.57 minutes per person. The analysis data of waiting time for customers, the average customers that satisfy are 0.59 minutes per person. If changed the counter from 3 service units to 4 service units and relevant to model M/M/4: FCFS/∞/∞ which the average time a customer spends in line decrease to 0.26 minutes per person, and average time a customer spends in the system decrease to 3.57 minutes per person. This showed that if increased the number of counter service from 3 service units to 4 service units will affect the customer to be able to decrease the waiting time and more satisfied with the service.

Keywords: Queuing Theory; M/M/s Queuing Model; Fast Fashion Business; Customer; Service Unit

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1. Introduction

The glowing of the textile industry and clothes are very important to Thailand structure of economy because they are classified as basics necessary life support. It has a value added for the products all included as the 4th in the country. It's below the other industries such as food and drink industry, machinery industry, and automotive industry. In 2554 calculated value to 245 billion bath or 2.2 percent of all GDP and still improving.

The clothes business is one of the end chain of the clothing and textile industry. The number of business registered from 2559 to 2560 increased to 64% value as 281 million baths [1]. It showed the possibility of growth in the industry. The strategic used to improve the clothing business is brand loyalty for that business which the important strategy is to impress the customer with the speed of service, and less waiting time. If the waiting time is too long it will affect the opportunity to selling the service.

Waiting in line is a part of everyday life because every prosses have several important functions. Queuing theory is a branch of mathematics that studies and models the act of waiting in lines. This system based on the theory of the probability which the number of the customers entering the service and the performance of the system. The results of this system showed the performance measure or the performance measurement of the queuing system, and it will be used to support decision making to improve the service system or reduce the work process in the system to be more appropriate and efficient. It's able to find suitable services units and make the customer satisfied for the service.

Today, the retail selling in the case of study found the problem that has too many customers. They must be waited in a long line for casher. This might affect the customers satisfaction. This problem leads into the case of study to initiate the customer or retail store satisfaction. The researcher uses and applies Queuing theory to analyze the appropriate and sufficiency number of services to match the incoming customers in the retail store at one of the shopping malls.

In the literature review studied, the theory and the case study for guideline of the research found that they use the theory of Queuing theory to learn the process, the work environment, and the problem with the service to use it to resolve the problem.

Jarupong Banthao et al., [2] were analyzed alternatives based on the results of simulation technique to provide for servicing patients, and to reduce the waiting time of patients and their relatives. The results of simulating those three alternative showed that the second alternative, which is adding one more pharmacist for medicine verification during 10:30 a.m. - 2:30 p.m. provided

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the optimum: the average time of the queuing system is equal to 557.13 seconds, which decreases from the current step by 14.68%, and average time of queuing is equal to 463.97 seconds, which decreases from the current step by 25.93%. Therefore, it can be concluded that simulation can be used to develop alternatives suitable for real situations under the given employee condition of the case study.

Thaniya Chanapia and Piriya Putthasri [3] were studied research aimed to know about the present working status and queuing system of Bank for Agriculture and Agricultural Co-operatives. The analysis results of the working conditions in the current system shows that if the service counters increase from 3 service units to 4 service units and according to queuing model M/M/4: FCFS/∞/∞, the waiting period time in the queue will be 0.2891 minutes/person which less than the customer's satisfied period. Therefore, Increase the service counters will make the customers more satisfied.

Nithipat Kamolsuk [4] was studied to analyze the queuing system at the 7-Eleven branch, Muangthai - Patthara, with computer simulation to indicate the optimal server for a daily lot of customers. The results show there were many customers during 7:30 – 9:30 a.m. The distribution of the number of customer is Poisson with the average arrival rate of 2.42 persons per minute; the distribution of service time was exponential with the average service time being 1.72 persons per minute and the optimum number of server units is two.

N. Itsaraphong, W. Jitmongkol, A. Malikan, P. Toaon, P. Kamlar and A. Chalaingratchai [5] were studied to analyze the working conditions and study the waiting system. The current postal service system and analyzing the number of service channels that are appropriate for the number of people receiving services according to the satisfaction of the service recipients. The results found that the service arrival pattern of service recipients is poisson distribution with an average access rate of 0.3083 people per minute. There is an exponential distribution with an average service rate of 0.4062 per person. Minutes to add service units from the original 4 units to 5 units which correspond to the waiting line model. M/M/5: FCFS /∞ /∞ will reduce the waiting time for the average service in the waiting line to 0.4078 minutes, less than the time that the service provider is satisfied with the waiting queue equal to 1.4750 minutes.

Mana Promrueng et al., [6] were studied to analyze queuing systems of a banking case study and develop a queuing system of services at different times of a banking case study. The results showed that the queuing system for the banking deposit-withdrawal service of the case

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study is a queuing model M / M / 1. It was reported that the arrival rate of the customer and the service rate offered by staff are 7.81 and 15.20 person per hour respectively. The service recipients provide information about the average desired waiting time to receive services to be equal to 11.25 minutes.

Nattapol Chaiarwut et al., [7] were explained about ideas Queuing basic model is Model M/M/1 and Model M/M/S will suggest which to choose Queuing model to apply to their system and will show their statistics and explained their results which are information from Queuing system to make a discussion to increase more convenient to their customers for their company system.

Inthawadee Chantaksinopas et al., [8] were studied to reduce the service of the public health services at government hospitals with application. The application is tested at Ban Phaeo Hospital RAMA II branch, which found that it may reduce unnecessary cases by 60% . The relationship between dropping in unnecessary cases and the health service time reduction is indicated by using a queueing model of the hospital, which showed the health service time decrease from 33 minutes/person to 6 minutes/person. Thus, it is possible to apply this application to improve the health services in the hospital where the queue model is similar to the Ban Phaeo Hospital.

2. Materials and Methods

2.1 Queuing Theory

Queuing theory refers to the mathematical study of the formation, function, and congestion of waiting lines, or queues. Queuing is happening as in the waiting stage for the service usually referred to as the customer, job, or request. The service request is more than the service could do usually referred to as the server. The classification of the queuing and the number of customers are very important to use to calculate [9]. There are another effects such as the behave of the customer is the system etc. the 3 basic structures of queuing in Fig. 1 are (1) Customers (2) Queuing (3) Service facility or Server unit.

2.1.1 Model queuing length and who use services to receive services indefinitely (M/M/s: FCFS/∞/∞)

The rate of service system average λ_n is constantly equal to λ for the number of customers n persons. It's used for the problem of Multiple-channel, Single-phase with the equation [10].

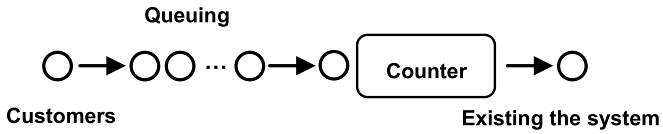

Fig. 1 Queuing System

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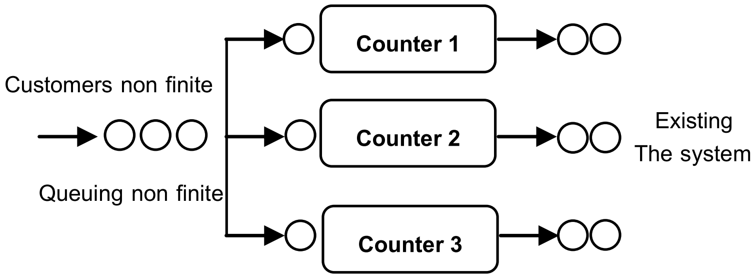

Fig. 2 Multiple-channel, Single-phase

Fig. 2 shows Multiple-channel, Single-phase model.

Probability with no customer in the queuing system in equation (1)

$$P_0 = \frac{1}{\left[\sum_{n=0}^{s-1} \frac{(\lambda/\mu)^n}{n!}\right] + \left[\frac{(\lambda/\mu)^s}{s!} \frac{1}{1-(\lambda/s\mu)}\right]} \quad (1)$$

Probability with customer in the queuing system n person, $n =$ 0, 1, 2, 3...in equation (2)

$$P_n \begin{cases} = \dfrac{(\lambda/\mu)^n P_0}{n!} & ; 0 < n < s \\ = \dfrac{(\lambda/\mu)^n P_0}{s!\, s^{n-s}} & ; n \geq s \end{cases} \quad (2)$$

Ratio time of each services provider works or the utilization measure of the service unit in equation (3)

$$\rho = \frac{\lambda}{s\mu} \quad (3)$$

2.1.2 Performance measure or the performance measurement of the queuing system

The average number of customers present in the queuing system in equation (4)

$$L = \lambda W = \lambda\left(W_q + \frac{1}{\mu}\right) = L_q + \frac{\lambda}{\mu} \text{ (unit/time)} \quad (4)$$

Average number of customers waiting in line in equation (5)

$$L_q = \frac{P_0(\lambda/\mu)^s}{s!}\left(\frac{\rho}{(1-\rho)^2}\right) \text{ (unit/time)} \quad (5)$$

Average time a customer spends in the system in equation (6)

$$W = W_q + \frac{1}{\mu} \text{ (time/unit)} \quad (6)$$

Average time a customer spends in line with equation (7)

$$W_q = \frac{L_q}{\lambda} \text{ (time/unit)} \quad (7)$$

2.2 Methodology

The purpose of the study on the retail store, business in one of the shopping mall, has the purpose to analyze the appropriate and sufficient service system related to the number of incoming customers in the retail store in one of the shopping mall.

Studying and analyzing the service system used in that store, studied from the field, survey,

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observations, and interviews from service staffs about the service system, found that there were 3 service units already and can also be another one.

Collecting the information of the customers, the customer arrives in the counter service, and time spend at the counter service. Collecting the data for 30 customer satisfactions in service.

Analyze the collected data according to the queuing theory from the store which is the distribution model, the data of the customers and time spending of service. Therefore, choosing the appropriate queuing model that corresponds to the service system and analyzed for various statistics.

Example of model (M/M/s: FCFS∞/∞)

M = Poisson arrival distribution

M = Exponential interarrival distribution

s = Number of servers

FCFS = Fist come first served

∞ = Queuing non-finite or finite

∞ = Customers non-finite or finite

Parameters

λ = Average number of arrivals entering the system per unit time (service unit/time)

μ = Rate of service (unit/time)

L_q = Average number of customers waiting in line (unit/time)

L = Average number of customers present in the queuing system (unit/time)

W_q = Average time a customer spends in line (time/unit)

W = Average time a customer spends in the system (time/unit)

P_0 = Probability with no customer in the queuing system

Fig. 3 shows the flow chart of a system simulation with 1 service unit and Fig. 4 shows the flow chart of simulation of a system with more than one service unit.

3. Results

From the survey site, found the model to use in the study M/M/s: FCFS/∞/∞. Today the retail store in the case study has model M/M/3: FCFS/∞/∞ and 3 units service. It is a first come first serve. The system supports the unlimited number of customer. From the analyses of the average waiting time for customers that is satisfaction at 0.59 minutes per person.

Table 1 showed that model M/M/3: FCFS/∞/∞ has average time a customer spends in line 1.26 minutes per person and average time a customer spends in the system 4.57 minutes per person.

Table 2 showed that model M/M/4: FCFS/∞/∞ has average time a customer spends in line 0.26 minutes per person and average time a customer spends in the system 3.57 minutes per person.

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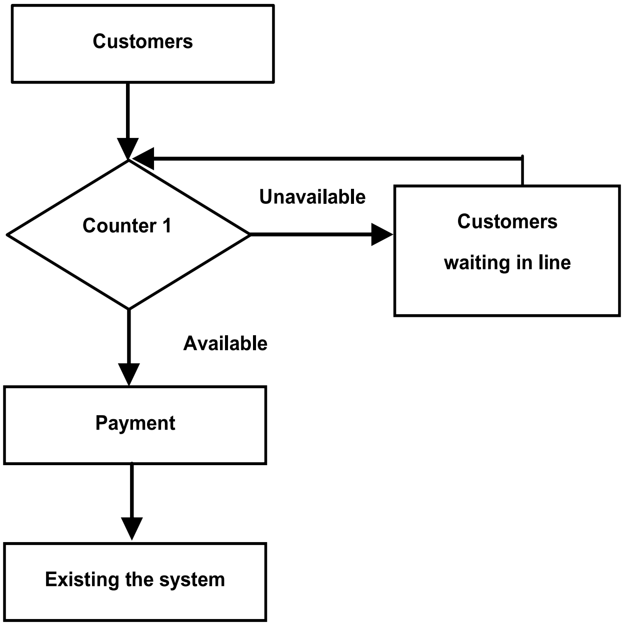

Fig. 3 Flow chart of a system simulation with 1 service unit

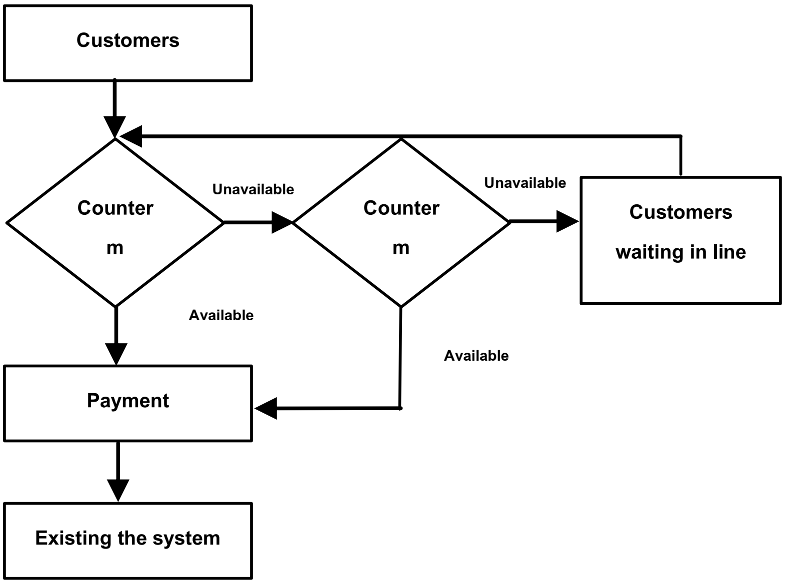

Fig. 4 Flow chart of simulation of a system with more than one service unit

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Table 1 Analysis results from the collected data with model M/M/3: FCFS/∞/∞

Model	M/M/3: FCFS/∞/∞
Number of service unit	3
Service unit	Counter
Average number of arrivals entering the system per unit time (person/minute)	0.60
Rate of service (person/minute)	0.30
Average number of customers waiting in line (person/minute)	0.75
Average number of customers present in the queuing system (person/minute)	2.75
Average time a customer spends in line (minute/person)	1.26
Average time a customer spends in the system (minute/person)	4.57
Probability with no customer in the queuing system	0.10

Table 2 Analysis results from the data when increased the counter with model M/M/4: FCFS/∞/∞

Model	M/M/4: FCFS/∞/∞
Number of service unit	4
Service unit	Counter
Average number of arrivals entering the system per unit time (person/minute)	0.60
Rate of service (person/minute)	0.30
Average number of customers waiting in line (person/minute)	0.16
Average number of customers present in the queuing system (person/minute)	2.15
Average time a customer spends in line (minute/person)	0.26
Average time a customer spends in the system (minute/person)	3.57
Probability with no customer in the queuing system	0.12

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Servicing of the counter service in detail:

1. Time starts as zero seconds with no customer in the service system.

2. Customer entering the system. If the system is unavailable, the customer will be waiting in line.

3. The customer gets service, payment and exits the system.

Fig. 5 shows servicing of the counter service in detail.

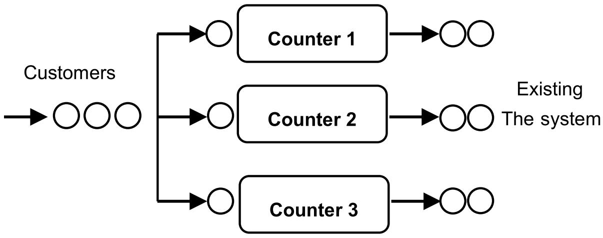

Fig.5 Service of the payment counter

4. Conclusion and Discussion

The study of the theory and the research that applied Queuing theory in the services, there was an unrelated between the unit for service and the unit of being serviced. This created queuing. This research is supported the strong point of the business in one of the retail store in the shopping malls with elevated a better service. Improving queuing system to support the activity and elevated the limit of the sale commercial is the important benefits in decision making in increase-decrease to match the appropriate unit of service to the waiting time for the customer. To change the strategy to responds to the requirement and customer satisfaction which is the important policy to focus.

This research is the queuing analysis. Case study of the retail store in one of the shopping malls. The research study the queuing system rate of service and rate of being serviced that appropriate and satisfaction for the customer. This research uses M/M/s queuing model to improve in the business in the shopping mall. Found that the model queuing length and who use services to receive services indefinitely (M/M/s: FCFS/∞/∞) relevant to model M/M/3: FCFS/∞/∞with average time a customer spends in line 1.26 minutes per person. The analysis data of waiting time with customer, the average customer that satisfy is 0.59 minutes per person. When increased the counter from 3 service units to 4 service units it’s matched with model M/M/4: FCFS/∞ /∞ found that the averages time a customer spends in line decrease 0.26 minutes per person with 79.37% . The opener of all 4 service units will create more customer satisfaction.

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