

**YANGON UNIVERSITY OF ECONOMICS**  
**DEPARTMENT OF COMMERCE**  
**MASTER OF BANKING AND FINANCE PROGRAMME**

**ANALYSIS OF QUEUING SYSTEMS AT MAB BANK**  
**(A CASE STUDY: APPLICATION OF QUEUING THEORY)**

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## **ABSTRACT**

This study focuses on the implementing the strategic based on the waiting time and service cost of MAB bank in Mandalay City as a case study. This study contains the analysis of queuing system for single- channel and multi-channel for each counter of MAB bank and economic analysis of waiting line to observe minimum total expected cost for MAB bank. This study persistent the waiting line characteristics such as the average arrival rate, the average service rate, the probability that there are no customers in the system, the average number of customer in the queue, the average number of customers in the system, the average time a customer spends in the queue, the average time customer spends in the system and server utilization based on the single- channel and multi-channel queuing system by using TORA software, determining the optimal server number at total expected cost for each services and implementing the best number of optimal server base on the results. This study include three service counters which is withdrawing counter, and deposit counter, single service counter which are remittance counter respectively. Relating to methodologies, the direct observation method was used to determine customer arrival and service distribution. Furthermore, key informant interview is applied to calculate service cost. Based on the findings, it is highlighted that the existing service counters are reliable for the customers to satisfy. But, if the MAB bank uses the one-stop service counter system, it reduce the average number of customers in the queue, the average number of customers in the system, the average time spends a customer in the queue, the average time spends a customer in the system, and traffic intensity (service utilization). And also it is the more suitable to reduce cost and waiting time for customer and the bank.

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## LIST OF ABBREVIATIONS

ASEAN	Association of Southeast Asian Nations
ATM	Automatics Teller Machine
FCFS	First come, first served
FIFO	First in first out
LIFO	Last –In First Out
MAB	Myanma Apex Bank
MADB	Myanma Agricultural Development Bank
MFTB	Myanma Foreign Trade Bank
MICB	Myanma Investment and Commercial Bank
M/M/1	Single-channel queuing model
M/M/s	Multi-channel queuing model
MPU	Myanmar Payment Union
POS	Point of Sales
PS	Priority Service
SRO	Service for random order
SMEs	Small and medium enterprises
SPSS	Statistical Package of Social Science
TC	Total Cost
TSD	Toxic Substance Distribution
WC	Waiting Cost
KYC	Know your customer

## **CHAPTER I**

### **INTRODUCTION**

In the modern society, competitive business environment is progressively turning into a service dominating one. Customer satisfaction and service operation capabilities represent as a provider of a successful organization. Lack of satisfied service facility would cause the waiting line of customers to be formed. One of the techniques is that making to increase the service capacity increasing the efficiency of the existing capacity to a higher level (Sheikh et al., 2013). If customers wait in a line for hours, they may be dissatisfied for their waiting.

According to the survey of Myanmar's financial sector, Myanmar's banking system was the envy of Asia before 1963. The country had 10 domestically owned banks and 14 foreign- owned banks. This is the largest concentration of foreign banks in Southeast Asia. As the current structure of the financial system, Myanmar's financial system comprises 4 state banks, 27 private banks, 138 foreign bank representative offices, 1 state owned insurance company and 12 private insurance companies licensed only in 2013.

The 4 state banks are the Myanma Economic Bank, Myanma Foreign Trade Bank (MFTB), the Myanma Agricultural Development Bank (MADB) and the Myanma Investment and Commercial Bank (MICB). Private Banks have been permitted to establish and operate by the Financial Institution Law (1990). This was the first of the three- stage reform program initiated in 1990 to liberalize private banking in Myanmar. The next two stages have not been implemented so far.

These two stages are permitting private banks to form joint ventures with foreign banks and ultimately allowing foreign banks to operate independently. It took until 1992 before the first private banks became operational, although not all private banks are fully private. 11 of the 27 banks such as Myawaddy Bank, Small and Medium Industrial Development Bank, Myanmar Citizen's Bank, Cooperative Bank, Global Treasure Bank, Construction and Housing Development Bank, Yangon City Bank, Innwa Bank, Yadanabon Bank, Rural Development Bank and Naypyitaw Sabin Bank are semi-government institutions. The 16 remaining banks are genuine private banks.

Among these banks, Myanmar Apex Bank was incorporated on 2<sup>nd</sup> July, 2010 and opened its first branch office in Naypyitaw on 17<sup>th</sup> August 2010. The branch office in Mandalay was opened on 25<sup>th</sup> June 2012. Since inception, it has extended its branch network steadily to facilities commercial development and investment across all of Myanmar as well as to better serve its growing customer base through a larger banking network. Customer deposits have grown significantly since inception, due to delivery of quality service, reliable performance, customer satisfaction and trust among the general public.

At this point, customers waiting in line to receive services in any service system are inevitable and that is why queue management has been where the manager faces huge challenge. This is because customers who cannot be served immediately have to queue (wait) for service and the time could range from few minutes (acceptable) to long hours (annoying) and time being a resource ought to be managed effectively and efficiently (because time is money) the inefficiency in managing it could result in dissatisfaction of customers. Waiting for a service is generally undesirable for customers. Time-saving and convenience are commonly mentioned by consumers as among the most important motivations for purchasing a service. However, waiting to be served may neutralize potential benefits and negatively affect attitudes toward the quality of service, brand or the product (Ryan and Valverde, 2003). As such management is faced with the problem of reducing waiting time.

Nowadays, customers do not simply demand for quality but they also demand for speed. According to Leoven (2015), customers do not tolerate waiting in line for long periods of time just to receive whatever kind of products or services unless those things are really important or more valuable than the time spent for waiting. And so, the objective of every business is to serve customer at very quick time. The more responsive it can be to customer, it will gain more customer satisfaction. In dynamic business environment, industries in the service sector try to build competitive advantage in the way the customers are served. The operation manager has to find ways to solve various problems arising out of customer's satisfaction. The waiting line problem is not only problem for customers; it is problem even for employees (Deepak, 2016). Waiting-time is a well-documented predictor of perceived service quality and customer satisfaction.

Evidence supports relationships between actual waiting-time, perceived waiting-time, perceived service quality and customer satisfaction (Baker and Cameron, 1996; Davis and Maggard, 1990; Hui and Tse, 1996; Katz et al., 1991; Taylor, 1994). However, customer satisfaction and perceived service quality have been found to be most strongly influenced by actual waiting-times (Durrande-Moreau, 1999).

Problematic queuing systems (i.e., long lines) can lead to the customer's perceptions of excessive, unfair, or unexplained waiting time—resulting in significant detrimental effects on the customer's overall satisfaction with the service transaction. Speed of service has been shown to provide businesses a competitive advantage in the marketplace. In addition; the literature reveals several studies documenting customer dissatisfaction with long waiting times and indicates that this is a pervasive problem and a common source of anxiety and dissatisfaction among customers (Yusuf et al., 2015).

In 1903, the queuing theory (also called waiting line theory) was developed by A.K.Erlang, began the problem on congestion of telephone traffic. Waiting line or queuing theory has been applied to a wide variety of business situations. The difficult was that during busy periods, telephone operators were unable to handle the calls the moment they were made resulting in delayed calls. A.K.Erlang directed his first efforts at findings the delay for one operator and later on the results were extended to find the delay for several operators. After World War II, queues or waiting lines was extended to other general problems.

## **1.1 Rationale of the Study**

Long queues are a big alarm sign for banks and also for the customers. They explain the quality of service and also companies initiative towards making customer experience more favorable. In retail banking industry, queuing remains one of the most common reasons for customer disgust. Despite technological advances such as online and mobile banking, customers still complain about their bank.

Banks' service delivery system is sometimes interrupted by rowdiness of its customers and randomness of their arrival and service time. Population explosion is one of the single largest challenges faced by commercial banks. This scenario, in banks, makes its customers filed up in a queue system for an orderly service

performance. Waiting line or queuing theory is the mathematical application of a statistical model to customers flow management. The queuing system is a day- to- day experience of human endeavor. It is a common experience in factually every economic life. There is hardly any economic activity that waiting time is not essential. Customers wait on line to get attention of the cashiers in the banks.

Queue management systems are specially designed for banks allowing them to reduce queue lengths and increase staff productivity and operational efficiency. In recent years, the banking industry has transformed and banks are now competing for a higher share of customers' wallet. This can only be achieved if banks provide exceptional service with a delightful customer experience. Queue solutions are equipped to make customer journey more superior and seamless.

Waiting in lines seems to be a part of our daily life. Queuing can increase the time of waiting, and induce the customer to complaint and dissatisfy. Checkout stands (service counters) are the service windows of banks, which not only reflect banks' images but also associate with banks' service quality and business efficiency. Waiting time depends on the number of customers (human being or objects) on queue, the number of servers, and the amount of service time for each individual customer. The main goal of queuing management is to maximize the level of customer satisfaction with the service provided. Low level of service may not be expensive, at least in the short run, but may incur high costs of customer dissatisfaction, such as loss of future business. A high level of service will cost more to provide and will result in lower dissatisfaction costs.

Waiting lines occur in many business operations as well as in everyday life. Most service systems, such as Banks and technical support telephone hotlines involve customer waiting. In these systems customers arrive at random times and service times are rarely predictable. The important issue in designing such systems involves the tradeoff between customer waiting time and system cost, usually determined by number of servers. The analysis of waiting lines, called queuing theory, applies to any situations which customers arrive to the system wait and receive service. The commercial bank is one of the important governmental banks that plays an important role in the Myanmar economy. The customers dealing with servers of general transaction section of bank suffer and complain from the long times they spend in the bank to acquire their needed service. This

happens especially in specific days in each week. This problem was the main motive to perform this study. However, more queuing problems in the bank's branch have been discovered through the study.

In banking operations, the most common measure of customer satisfaction is average waiting time, i.e., the time that customers wait before service. The delay in receiving service will lead to queuing and waiting cost to customers. The very important goal of queuing is essentially to minimize the total cost, service cost plus waiting cost, of the system. Therefore, banks' managers are concerned about not only providing the optimal service configuration with optimal service cost and waiting cost but also implementing strategy gets the goal of optimal customer waiting time.

Mandalay city is a city and former royal capital in northern Myanmar. And also one of the cities in the Association of Southeast Asian Nations Smart Cities Network when it was established at the ASEAN summit held in Singapore in April 2018. The city depends on not only its strategic location but also the investment environment for growth. Foreign investors have channeled around US \$ 20 million across the industrial, tourism and agriculture sectors. Banking operation is one of the main sectors to develop Mandalay to becoming the second largest economic engine of Myanmar after Yangon. According to these situations, this study intends to examine waiting line characteristics of customers for MAB Bank in Mandalay.

## **1.2 Objectives of the Study**

The objectives of the study are as follows:

1. To identify the average arrival rate, waiting time and service rate by each service provided by of Myanma Apex Bank in Mandalay.
2. To compare the cost effectiveness of single channel and multi-channel of the Myanma Apex Bank in Mandalay.

## **1.3 Scope and Limitations of the Study**

Data for this study was collected from Myanma Apex Bank (Mandalay Branch). The data was gathered the daily record of queuing system over two weeks, last week of October and first week of November in 2019 because bank functions are more work in

these weeks. The customers who come to the banks between 09:30AM to 03:00 PM will be observed.

#### **1.4 Method of Study**

Direct observation method was used to collect the data during the peak period for a multi-channel of the banks. Direct observation is a method of collecting evaluative information in which the evaluator watches the subject in usual environment without altering that environment. This study was based on the primary data and personal interview. In this study, single-channel and multi-channel queuing theory (M/M/s: FCFS) model was used. Statistical Package of Social Science (SPSS) was used to check the assumption for arrival rate and service rate and TORA software was used to calculate the characteristics of the single-channel and multi-channel queuing model.

#### **1.5 Organization of the Study**

This study is organized by five chapters. Chapter one is an introduction and it describes rationale, objectives, scope and limitations, method and organization of the study. Chapter two presents the literature review which includes application of queuing models in banking system and other organizations. Chapter three reviews the background of MAB bank. Chapter four describes the data analysis using the waiting line models. Chapter five presents conclusions with findings and suggestions.

## **CHAPTER II**

### **LITERATURE REVIEW**

#### **2.1. Definition and Concept of the Waiting line**

In 1908, Copenhagen Telephone Company requested Agner K. Erlang to work on the holding times in a telephone switch. He identified that the number of telephone conversations and telephone holding time fit into Poisson distribution and exponentially distributed. This was the beginning of the study of queuing theory.

Waiting line or queuing theory has become one of the most important, valuable and arguably one of the most universally used tool by operation researchers. It has applications in diverse fields including telecommunications, traffic engineering, computing and design of factories, shops, offices, banks and hospitals. A queuing model of a system is an abstract representation whose purpose is to isolate those factors that relate to the system's ability to meet service demands whose occurrences and durations are random. (J. Sztrik, 2010) The study of queue deals with quantifying the phenomenon of waiting in lines using representative measures of performance, such as average queue length, average waiting time in queue and average facility utilization (H.A. Taha, 2002)

Customer satisfaction/ dissatisfaction has become an important issue for management actioners customer satisfaction usually relates to long term results of a service, so is evaluation is based on comparisons over considerable time, with customer's perception of competitive offering. Organizations need to satisfy customers all the time to assure long term survival.

#### **2.2. Waiting line theory**

Waiting Lines Theory (Queuing Theory) is the Mathematical approach of queue. It is basically considered as branch of Operations Research. The results of Queuing models are often used in the Business decisions. Queues are one of the unpleasant parts of everyday human's life. There is increase in demand of facilities from customer side and if the service facilities is not in a position to satisfy the customer in a specific time, customer requires too much time to get service from service mechanism, result in the



formation of queue. Under such conditions there is increase in the cost of customers waiting time. Where as in some other cases if the service facilities stand in idle condition waiting for the customers and there is too less demand from customer side will increase the cost of service facilities. It is just because of one cannot predicts the inter-arrival time of customers and service time of server. To get optimum level we have to minimize the sum of cost of customers waiting time and cost of service facilities. The expected total cost (TC) is the sum of the expected waiting cost for the arrivals per period (WC) and the expected facility cost (FC) of the service personnel per period. This can be written as(m=mean):

$TC_m = WC_m + FC_m$  The expected waiting cost per period ( $WC_m$ ) is the product of unit waiting cost ( $C_w$ ) for an arrival per period and the average number of units in the system  $E(n)$  during the period.  $WC_m = C_w E(n)$

The study of waiting lines, called queuing theory, is one of the oldest and most widely used quantitative analysis techniques. Waiting lines are an everyday occurrence, affecting people shopping for groceries, buying gasoline, making a bank deposit, or waiting on the telephone for the first available airline reservationist to answer. Queues, another term for waiting lines, may also take the form of machines waiting to be repaired, trucks in line to be unloaded, or airplanes lined up on a runway waiting for permission to take off. The three basic components of a queuing process are arrivals, service facilities, and the actual waiting line.

### **(1) Arrival of Customers**

It is a process of arrival for customers into the Waiting Lines System. Classification of arrival of customers as:

1. Single line or multiple lines,
2. Finite or infinite
3. Single customer or customers comes in bulk,
4. Arriving customers are totally under control or partially or no control,

5. Deterministic or Probabilistic process,
6. Empirical or a Theoretical Probability Distribution,
7. Independent or conditionally dependent variables,
8. Some times arrivals of customers is stationary.

## **(2) Service Discipline**

It works on the rule by which customers are selected from the queue for service. Rules are classified as:

- i. First-In First-Out (FIFO)
- ii. Last-In First Out (LIFO)
- iii. Service For Random Order (SRO)
- iv. Priority Service. (PS)

## **(3) Nature of Customer**

As usual it is depending on the nature of arriving customers whether he is willingly accepted a waiting line or refuses it. If the system is filled up to its capacity, then the arriving customer is naturally rejected. In some other cases if there is a rejection of the primary system, the customer accepted secondary system and 'queue up' in an informal waiting line to enter in to the system. There are mainly four items which must be specified for any given Queuing System.

- i. **Balking:** If the customer experiences that waiting time are very large as the queue is moving very slowly, the customers might balk and refuse to join the queue.
- ii. **Reneging:** After joining the queue customer experience that it will take too much time to enter the system which is worthless then he customer reneges i.e. leaves the queue.
- iii. **Collusion:** Several customers may cooperate and only one of them may stand in the queue to reduce the waiting time and buy the required service.

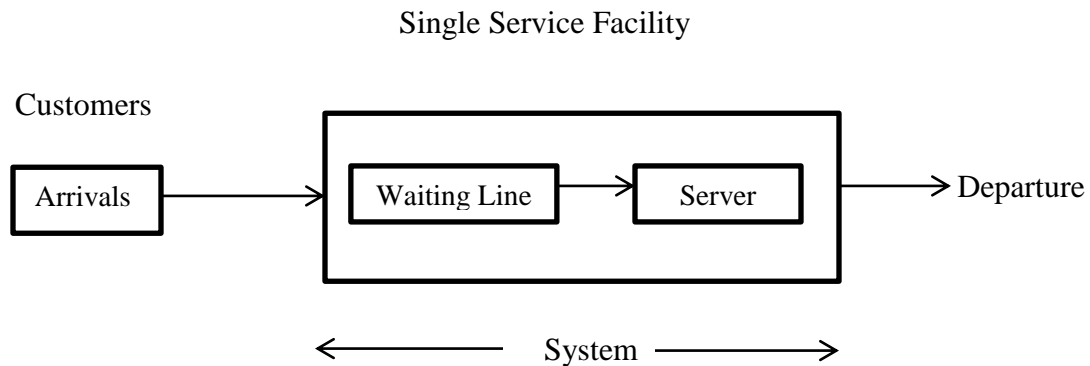
- iv. Jockeying: If there are more number of queues, there is a way for customers to change the queue which gives fast service than the other. In this process the customer scans the lines for the purpose of changing it.

**(4) Service mechanism:**

The service mechanism is worked on the policy decided for the service facility for the customers who are serviced and leave the service system. Service mechanism follows single channel-single phase, single channel-multiphase, multichannel-single phase, and multichannel-multiphase.

**2.2.1 Single-Channel Queuing Model with Poisson Arrivals and Exponential Service Times (M/M/1)**

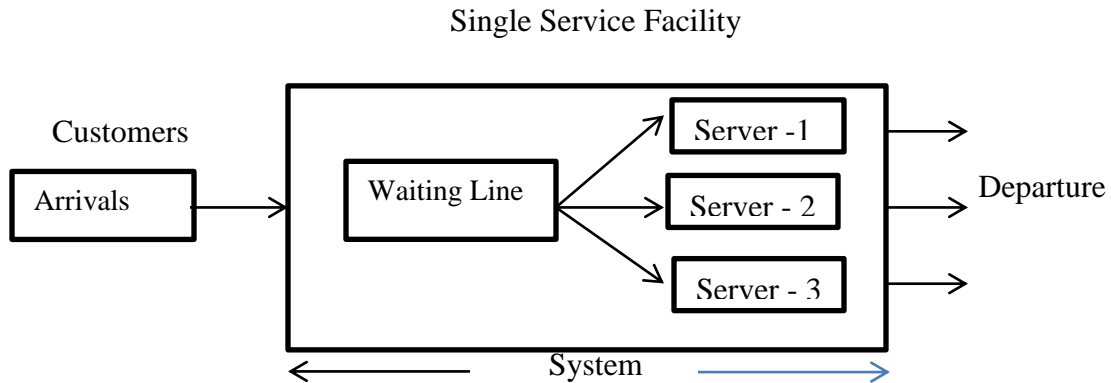
A single channel waiting line consists of only one service channel the arriving wait in single waiting line. Once the first customer was served, the service provider calls the next customer in the waiting line. The formulas of the waiting line are applicable based on the following assumptions.



**Figure 2.1: Single- Server Single- phase System**

**2.2.2 Multi-channel Queuing Model with Poisson Arrivals and Exponential Service Times (M/M/s)**

In the multiple-channel queuing system, two or more servers or channels are available to handle arriving customers. Assume that customers awaiting service form one single line and then proceed to the first available server. The formulas of multiple-channel waiting line are applicable based on the following assumption.



**Figure 2.2: Multi – Server Single – phase System**

### 2.3. Characteristics of a Queuing System

In this sub section, the queuing system was discussed. They are (1) the arrivals or inputs to the system (the calling population), (2) the queue or waiting line itself, and (3) the service facility. These three components have certain characteristics that must be examined before mathematical queuing models can be developed.

#### (1) Arrival Characteristics

The input source that generates arrivals or customers for the service system has three major characteristics. It is important to consider the size of the calling population, the pattern of arrivals at the queuing system, and the behavior of the arrivals.

**Size of the Calling Population:** Population sizes are considered to be either finite or infinite. If there are only a few potential customers, the calling source of population is called finite. When the number of customers or arrivals on hand at any given moment is just a small portion of potential arrivals the calling population is considered infinite. Most queuing models assumed such an infinite calling population. When this is not the case, modelling becomes much more complex.

**Pattern of Arrivals at the System:** Customers either arrive at a service facility according to some know schedule or else they arrive randomly. Arrivals may also be represented by the inter- arrival time, which is the period between two successive arrivals. The rate at which customers arrive to be served, i.e., the number customers

arriving per unit of time is called the arrival rate. Arrivals are considered random when they are independent of one another and their occurrence cannot be predicted exactly. Frequently in queuing problems, the number of arrivals per unit of time can be estimated by a probability distribution known as the Poisson distribution. The mean value of the arrival rate is represented by  $\lambda$ . It may be noted that the Poisson distribution with mean arrival rate  $\lambda$  is equivalent to the (negative) exponential distribution of inter-arrival times with mean inter-arrival time  $\frac{1}{\lambda}$ .

Poisson distribution can be established by using the following formula.

$$P(x) = \frac{e^{-\lambda} \lambda^x}{x!}, \text{ (for } x = 0, 1, 2, \dots \text{)}$$

Where  $P(x)$  = probability of exactly  $x$  arrivals or occurrences

$\lambda$  = average number of arrivals per unit of time (the mean arrival rate)

$e$  = 2.718, the base of natural logarithm

$x$  = number of arrivals per unit of time

The average arrival rate can be calculated as follow:

$$\text{Average arrival rate} = \lambda = \frac{\text{Total number of customers}}{\text{total interarrival time}}$$

**Behavior of the Arrivals:** Most queuing models assume that an arriving customer is a patient customer. Patient customers are people or machines that wait in the wait in the queue until they are served and do not switch between lines. Balking refers to customers who refuse to join the waiting line because it is too long to suit their needs or interests. Reneging customers are those who enter the queue but then become impatient and leave without completing their transaction. When there are two or more parallel queues and the customers move from one queue to the other to reduce waiting time, they are said to be jockeying.

## **(2) Waiting Line Characteristics**

**Length of Queue:** The length of a line can be either limited or unlimited. A queue is limited when it cannot increase to an infinite length. It is unlimited when its size is unrestricted, as in the case of tollbooth serving arriving automobiles.

**Queue Discipline:** A second waiting line characteristic deals with queue discipline. This refers to the rule by which customers in the line are to receive service. The most common discipline is 'first come, first served', according to which the customers are served in the order of their arrival. The other disciplines are 'last come, first serve', 'service in random order (SIRO)', and 'priority'.

## **(3) Service Facility Characteristics**

The third part of any queuing system is the service facility. It is important to examine two basic properties: (1) the configuration of the service system and (2) the pattern of service times.

**Basic Queuing System Characteristics:** Service systems are usually classified in terms of their number of servers and the number of service stops that must be made. A single-channel system is typified by the drive-in bank that has only one open teller. On the other hand, if the bank had several tellers on duty then it would have a multiple-channel system at work.

A single-phase system is one in which the customer receives service from only one station and then exits the system. On the other hand, if the customer receives from one station, pays at a second and picks up the service at another station, it becomes a multiphase system.

**Service Times Distributions:** Service pattern is like an arrival pattern in that they may be either constant or random. If service time is constant, it takes the same amount of time. Management scientists have found that they are best described by the exponential probability distribution. The number of customers served per unit of time is called the service rate. This rate assumes the service channel to be always busy, i.e., no idle time is allowed. The mean value of the service rate is represented by  $\mu$ .

Exponential distribution can be established by using the following formula.

$$f(t) = \mu e^{-\mu t} \text{ for } t \geq 0$$

Where  $t$  = service time (express in number of periods)

$\mu$  = average number of units that the service facility can handle in a specific period ( the mean service rate )

$e = 2.718$ , the base of the natural logarithm

The average service rate can be calculated as follow:

$$\text{Average service rate} = \mu = \frac{\text{total number of customers}}{\text{total service time}}$$

#### **2.4. Assumptions of Queuing Model**

Hiller (2003) summarizes the assumptions generally made by queuing models of a basic queuing system. Each of these assumptions should not be taken for granted unless a model explicitly states otherwise.

1. Inter-arrival times are independent and identically distributed according to a specified probability distribution.
2. All arriving customers enter the queuing system and remain there until service has been completed.
3. The queuing system has a single infinite queue so that the queue will hold an unlimited number of customers.
4. The queue discipline is first-come, first-served.
5. The queue system has a specified number of servers.
6. Each customer is served individually by anyone of the servers.
7. Services times are independent and identically distributed according to a specified probability.

#### **2.5 Benefits and Limitations of Queuing Theory**

Gupta & Garg, (2012) conducted a study in the context of “A View of Queue Analysis with Customer Behavior, Balking and Reneging”. In that study, the author proposed the benefits and limitations of queuing theory as follow.

### **2.5.1 Benefits of Queuing Theory**

Special benefits which this technique enjoys in solving problems are

- (1) Queuing theory attempts to solve problems based on a scientific understanding of the problems and solving them in optimal manner so that facilities are fully utilized and waiting time is reduced to minimum possible.
- (2) Waiting time (or queuing) theory models can recommend arrival of customers to be serviced, setting up of workstations, requirement of manpower etc. based on probability theory.

### **2.5.2 Limitations of Queuing Theory**

Queuing theory provides many organizations as a scientific method of understanding the queues and solving such problems, the theory has certain limitations which must be understood while using the technique, and some of these are:

- (1) Mathematical distribution, which are assume while solving queuing theory problems, are only a close approximation of the behavior of customers, time between their arrival and service time required by each customer.
- (2) Most of real life queuing problems are complex situation and very difficult to use the queuing theory technique, even then uncertainty will remain.
- (3) Many situations in industry and service are multi-channel queuing problems. When a customer has been attended to and the service provided, it may still have to get some other service from another service and may have to fall in queue once again. Here the departure of one channel queue becomes the arrival of another queue. In such situations, the problem becomes still more difficult to analyze.
- (4) Queuing model may not be ideal method to solve certain very difficult and complex problems and one may have to resort to other techniques like Discrete- Event simulation or Monte-Carlo simulation method.



### **2.5.3 Application of Poisson Probability Distribution on Customer Arrival Times**

The Poisson distribution counts the number of discrete events in a fixed time period; it is closely connected to the exponential distribution. Waiting line models assume that customers arrive according to a Poisson probability distribution. The Poisson probability distribution specifies the probability that a certain number of customers will arrive in a given time period. Defining the arrival process for a queue involves determining the probability distribution for the number of arrivals in a given period of time. In many queuing situations the arrivals occur in a random; each arrival is independent of other arrivals, and we cannot predict when an arrival will occur. In this situation, the Poisson probability distribution is used to describe the arrival pattern. The Poisson distribution is a discrete distribution; the random variable can only take nonnegative integer values.

### **2.5.4 Application of Exponential Probability Distribution on Customer Service Times**

The exponential distribution can take any (nonnegative) real value. The exponential distribution describes the service times as the probability that a particular service time will be less than or equal to a given amount of time. The service time is the time that the customer spends at the service facility once the service has started. Service time normally varies according to the individual situations.

### **2.5.5 Introducing Costs into the Model**

In order to solve a queuing problem, service facility must be manipulated to obtain an optimum balance between service cost and waiting cost. The cost of waiting customers includes either the indirect cost of lost business or direct cost of idle equipment and persons. To determine how much business is lost, some type of experimentation and data collection is required. By increasing the investment in labor and service facilities, waiting time and the losses associated with it can be decreased.

To conduct an economic analysis of a waiting line model, a total cost model, which includes the cost of waiting and the cost of service, must be developed. These two

costs, the waiting cost per time period is usually the more difficult to evaluate. The service cost per time period is generally easier to determine. This cost would include the server's wages, benefits, and any other direct cost associated with operating the service channel. To develop a total cost model for a waiting line system, the following notations defined as follow;

$C_w$  = opportunity cost of waiting by the customers

$W_s$  = average waiting time a customer spends in the system

$C_s$  = service cost of each server

$\lambda$  = average arrival rate per hour

$s$  = number of servers

*Total hourly waiting cost* = (6 hours per day)  $\lambda W_s C_w$

*Total hourly service cost* = (6 hours per day)  $s C_s$

The total hourly cost of the system is the sum of the total hourly waiting cost and the total hourly service cost; that is,

*Total hourly cost of the queuing system* = *Total hourly waiting cost* + *Total hourly service cost*.

## **2.6 Empirical Studies**

Ronald Anthony Nosek, Jr., MS\* and James P. Wilson (2001) studied "Queuing Theory and Customer Satisfaction: A Review of Terminology, Trends, and Applications to Pharmacy Practice". The goal of this paper was to give the general understanding of concepts, current technology, and applications of queuing theory as it relates to customer satisfaction and waiting time. This paper provided the general background into queuing theory, its associated terminology, and its relationship to customer satisfaction. The application of queuing theory may be of particular benefit in pharmacies with high-volume outpatient workloads and those that provide multiple points of service.

Amit Mittal (2016) analyzed that "The Influence of Waiting Time Satisfaction on Customer Loyalty towards Multi-Stage Services in a Full-Service Restaurant: Evidence from India". The result found that waiting time in services is an important source of service evaluation by the customer but time is one component of the total cost that the

customer bears and cost is a core component of the perceived cost-benefit equation that the customer uses to evaluate his sustained patronage of a particular service. In most of the service, customers consider waiting as a waste of time. He suggests that when customers think that a wait for service is too long, they become less satisfied with overall service quality.

Kabu Khadka & Soniya Maharjan (2017) emphasized the role and the importance of customer satisfaction and loyalty. This thesis was implemented to analyze the relationship between customer satisfaction and customer relationship. The purpose of this research is to study the concept of customer satisfaction, customer loyalty and its relationship. Moreover, this thesis studies the factors that influence customer satisfaction and loyalty. This thesis also analyzed the factors that have an impact on customer satisfaction and result in customer loyalty.

A study by Obamiro (2010) evaluated the effectiveness of a queuing model in identifying the ante-natal queuing system efficiency parameters. It used Tora Optimization system to analyze data collected from the ante-natal care unit of a public teaching hospital in Nigeria over a three-week period. The study showed that pregnant mothers spent less time in the queue and system in the first week than during the other succeeding two weeks. This implies that there are less average pregnant women in the queue and system in the first week than in the other weeks except on the third week when less expectant mothers waited in the system. The study used the observation technique for the first three days of each week, Monday to Wednesday because they were the busiest. The study was done only for a unit of the hospital, not the entire hospital. It ignored the effect of perception of waiting time on patient satisfaction. However, the study concluded that the knowledge of queuing theory can help service managers to make decisions that increase the satisfaction of all concerned parties – customers, employees and management.

Dharmawirya and Edi (2011) have a case study for a restaurant queuing model. The aim of the paper was to show that queuing theory satisfies the model when tested with a real-case scenario. Data was obtained from a restaurant in Jakarta, Indonesia. Derivation of the arrival rate, service rate, utilization rate, waiting time in

queue and the probability of potential customers to balk based on the data using Little's Theorem and M/M/1 queuing model was done. The derived results showed that the arrival rate at Sushi Teiduring its busiest period of the day is 2.22 customers per minute (cpm) while the service rate is 2.24 cpm. The average number of customers in the restaurant is 122 and the utilization period is 0.991. The conclusion of the paper was discussing the benefits of performing queuing analysis to a busy restaurant.

Daisi (2010), in a study made an attempt to review the analysis of Stochastic Birth-Death Markov processes which turns out to be a highly suitable modelling tool for many queuing systems in general and M/M/1 queuing model in particular. The model, M/M/1, as a single-channel queuing system with Poisson arrivals and exponential service and with queueing discipline of first come first serve basis, was applied to arrivals and waiting times of customers in Intercontinental Bank PLC, Ile-Ife Branch, Osun State, Nigeria. The queue size of customers including traffic intensity and average number of customers in the system and queue; the service/waiting times of customers including the average time spent in the system and queue by a customer, were all obtained. The traffic intensity obtained was 0.8378 which indicated the probability of a customer queuing or waiting for service on arrival. Primary data on arrivals, waiting time, service time and departures was collected for 21 working days from 08:00am to 4:00pm. The research method involves derivation of various M/M/m queue systems and an M/M/1 model has been also applied.

Houda et al (2008) emphasized that waiting lines and service systems are important parts of the business world. In their article they described several common queuing situations and presented mathematical models for analyzing waiting lines following certain assumptions. Those assumptions are that (1) arrivals come from an infinite or very large population, (2) arrivals are Poisson distributed, (3) arrivals are treated on a FIFO basis and do not balk or renege, (4) service times follow the negative exponential distribution or are constant, and (5) the average service rate is faster than the average arrival rate. The model illustrated in the airport for passengers on a level with reservation is the multiple-channel queuing model with

Poisson Arrival and Exponential Service Times (M/M/S).After a series of operating characteristics were computed, total expected costs were studied, total costs is the sum of the cost of providing service plus the cost of waiting time. The study used Linear Programming (LP) models for the solution time of queuing theory. Linear Programming has been used to estimate the performance measures for 46 flights for the 16 branches. The study also used computer simulation because data was too complex and a Hyper-Lindo software for optimization with 801 iterations.

## **CHAPTER III**

### **BACKGROUND OF MAB BANK**

The financial sector is the lifeblood of any country's economy, and its smooth functioning is central to the economy's rapid and inclusive economic growth. A well-functioning financial system must intermediate efficiently between savers and borrowers; manage risks prudently, provide a wide variety of financial services to firms, farms and households; mobilize savings effectively identify and lend for sound investments.

#### **3.1 History of MAB Bank**

Myanma Apex Bank Ltd (MAB) was incorporated on 2nd July, 2010 and opened its first branch office in Naypyitaw on 17th August, 2010. Since inception, they have extended their branch network steadily to facilitate commercial development and investment across all of Myanmar as well as to better serve our growing customer base through a larger banking network. Customer deposits have grown significantly since inception, due to our deliver of quality service, reliable performance, customer satisfaction and trust among the general public.

They have within the bank both local and external talents with many years of professional experience in domestic and international banking. MAB invests extensively in technology and human resources to sustain our future long-term growth and to stay ahead amidst growing competition. At MAB, they invest and nurture both local and external talents with a good mix of professional experiences in domestic and international banking. Technologically, we also keep abreast of disruptive trends and changes so we can plan, upgrade and stay competitive, agile in meeting the future growth and challenges.

Their range of product offerings in the likes of their consumer's deposit offerings, ATM, POS acceptance network using Myanmar Payment Union (MPU), VISA and MasterCard cards, Commercial financing for small and medium businesses with loans, overdraft and hire purchases options, Cross- border trade, that provides businesses with foreign trade finance, gift cheques, payment orders, remittance and other ancillary

services. MAB continues to evolve with ongoing banking needs of Myanmar people. Our people, technology readiness and product development stands ready to grow with you in the years to come.

### **3.2 Banking Services of MAB Bank**

MAB offer three services banking; personal banking, business banking and banking services. To cater to a growing segment of affluent customers, they launched **MAB Wealth Banking** in 2018. It offers tailored financial solutions, preferential privileges and a dedicated Relationship Manager to manage their portfolio.

MAB makes it easier for SMEs (small and medium enterprises) to obtain and manage financial capital. Businesses such as small scale workshops, trading companies, production and services are better able to grow and contribute to the economy. With Myanmar emerging as a frontier economy attracting foreign investments, MAB has proven itself as a trusted, transparent facilitator of trade and commerce.

### **3.3 Deposit Account**

MAB offer the services for individual or organization with five services as follow.

#### **(a) Saving Accounts**

Saving accounts are opened to encourage the people to save money and collect their savings. It enables the depositor to earn income by way of saving bank interest. Most businessmen use saving accounts by linking with Current Account. The interest rate of saving accounts is 8.25 per annual and interest will be calculated for each calendar month on the lowest balance between the close of the fifth day and end of the month. Interest will be deposited quarterly. The minimum initial deposit is 10,000 kyats and the minimum balance is 1,000 kyats (the interest is calculated over 10,000 kyats). It can be able to link current account, MPU card, mobile banking and iBanking

#### **(b) Current Bank Account**

Current bank account is opened by business men who have a higher number of regular transactions with the bank. Customers can use cheque for both cash in/cash out

transactions. The amount of initial deposit is 10,000 Kyats, Minimum Balance is 1000 Kyats, Cash Withdrawal has no limitation and Cheque Passbook is 1600 Kyats.

( c ) Fixed Deposit

The term 'fixed deposit' means that money is deposited for a fixed period. The interest rate of fixed deposit is higher than other deposit accounts; therefore fixed deposit accounts are opened by the customers who are interested to save extra money and the parents who would like to save money for their children. Interest rate of fixed period 30 days, 60 days, 90 days, 180 days, 270 days and 365 days are 8.50%, 8.50%, 9.00%, 9.50%, 9.75%, and 10.00% respectively. For remarks: Interest will be calculated to the nearest of respective terms if premature withdrawal. Initial Deposit must have 10,000 Kyats.

( d ) Call Deposit

In the call deposit interest rate is 6% per annual and the interest is calculated on daily balance. This deposit can be able to link with current account and interest will be deposited quarterly

( e ) Smart Deposit

The customer needs to deposit of minimum 10,000,000 kyats for smart deposit. The interest rate of smart deposit is calculated as 6% for above 100 lakhs and 0% when the amount is below 100 lakhs. Therefore, the interest rate is 6.00%.The interest is calculated on daily balance. It can able to link with current account. The interest will be deposited per month.

### **3.4 Other Services**

(1) Mobile Banking

The bank vision of mobile banking service is to be the most successful Mobile Banking with a visible presence in the Myanmar by offering outstanding service, product innovation and sustained customer experience. MAB mobile banking provides banking service and payment services with branchless banking platform for the deployment of



agent banking that is not only fast and affordable, but secure, simple, reliable and convenient for customer. MAB mobile banking service makes banking, payment, shopping, discovering deals effortless.

#### (2) Domestic Banking

Domestic banking can provide a comprehensive range of deposit products, financing options for large and small businesses through loans, overdrafts and hire purchases, reliable and extensive ATM, POS service via the Myanmar Payment Union (MPU), Visa and Mastercard network.

#### (3) Trade Finance Service

It is trade with Singapore, Indonesia, Malaysia, Thailand, China or any other country, trade specialists team with a complete suite of products covering Imports, Exports, L/Cs ( Guarantees and Collection services as well as payment products, provide our clients with the tools to optimize the opportunities and stay ahead of the competition.

### **3.5 E Banking System**

As smartphones have become prevalent in Myanmar and lifestyles become increasingly busy. Mobile banking service enables customers to bank at their convenience. MAB Mobile Bank is a secure mobile banking service offering Cash Services, Banking Services and Payment Services without constraints such as time, place and mobile device. Mobile Banking service is available 24/7. And convenient innovations include Self KYC, a self-registration and account opening process that's done solely via the app.

- Self-activation of Mobile Account using mobile number.
- Can link with bank accounts (Savings and Current).
- No device constrains to activate Mobile Account.
- Highly secure and reliable.
- Real time transfer and payment.
- Nationwide accessible.
- 24 hours available.
- Reasonable transaction fees.
- Easy to search special promotions and discounts.
- 24 hours call center service.

### **3.6 Cards Services**

MAB VISA Credit Card, Classic Credit Card and prepaid Card are an internationally use credit card which can be used for payment of goods & services (POS), cash withdrawal (ATM) and online payment. Any interested customer, who meets the criteria of eligibility with required documents. The approval of the application and the credit limit is subject to the Bank's discretion. These are

- (i) Eligible to 21 years old and above
- (ii) Must be Myanmar citizen
- (iii) Income must be minimum 1,500,000 kyat for Platinum Card Holders

### **3.7 Employee Situation in MAB (Mandalay)**

There are 59 staffs in MAB (Mandalay). The majority of 34 staffs are female and the remaining 25 of the staffs are male. It has been found that the number of female staff is higher than male staff. There are 1 vice president, 7 assistant vice president, 5 senior officer, 10 officers, 5 senior associate, 16 associate, 4 drivers, 5 security, 4 peon and 2 cleaner.

## **CHAPTER IV**

### **ANALYSIS OF WAITING LINE MANAGEMENT OF MAB BANK**

This chapter focuses on explaining data tables and analyzing cost of services and customer waiting for each counter at MAB bank.. The chapter will present summary statistics, results of relevant characteristics undertaken in the study and final results to be used to conclude the study.

#### **4.1 Research Methods**

Data collection is the process of gathering information about a phenomenon using data collection instruments (Sekaran, 2000). Primary data was collected for the purpose of this study where both customers and operations managers were involved. Self-administered questionnaires were given to both managers and customers. The data was collected primarily by direct observation at the MAB bank. Thus, the researcher recorded the following events as it happened in the system using a wrist watch 1. The time of arrival of each customer. 2. The time service commences for each customer in the system. 3. The time the customer leaves the system. These events were observed at the MAB bank. A form was designed for this exercise and the above required information was recorded in the form. One week of three working days was spent to collect relevant data.

#### **4.2 Application of Waiting Line Model**

In this section, the waiting line characteristics of the single-channel waiting line model were calculated. Earlier the calculation, the arrival rate and service rate were checked whether they follow Poisson probability distribution and exponential probability distribution by using Kolmogorov-Smirnov test with 5% significance level.

There are three types of service counters that are operation for bank service. They are withdrawing counter, deposit counter and remittance counter. Each counters serves by a single channel. According to the observation, the arrival rate and service rate for three counters were computed and shown in Table. Data can be seen in Appendix (A-4).

### 4.2.1 Assumptions of the Single- Channel Queuing Model

The single-channel, single-phase model is one of the most widely used and simplest queuing models. It involves the following seven conditions exist:

1. Arrivals are served on a FIFO basis.
2. Every arrival waits to be served regardless of the length of the line; that is, there is no balking or renegeing.
3. Arrivals are independent of preceding arrivals, but the average number of arrivals (the arrival rate) does not change over time.
4. Arrivals are described by a Poisson probability distribution and come from an infinite or a very large population.
5. Service times also vary from one customer to the next and are independent of one another, but their average rate is known.
6. Service times occur according to the negative exponential probability distribution.
7. The average service rate is greater than the average arrival rate.

Equation for the Single-channel Queuing Model is

Let  $\lambda$  = mean number of arrivals per period, and

$\mu$  = mean number of served per period

When determining the arrival rate ( $\lambda$ ) and the service rate ( $\mu$ ), the same period must be used. For example, if  $\lambda$  is the average number of arrivals per hour, then  $\mu$  must indicate the average number of served per hour.

The queuing equations are as follow:

- 1.The average number of customers or units in the system,  $L_s$ , the number in line plus the number being served:

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

- 2.The average time a customer spends in the system,  $W_s$ , the time spent in line plus, the number being served:

$$W_s = \frac{1}{\mu - \lambda}$$

3. Average number of customer in waiting line for service:

$$L_q = \frac{P_0 \rho^{s+1}}{(s-1)(s-\rho)^2} = \frac{P_0 \lambda \mu \rho^{s+1}}{(s-1)(s\mu - \lambda)^2}$$

4. Average time a customer spends in waiting line waiting for service:

$$W_q = \frac{\lambda}{\mu(\mu-\lambda)}$$

5. The utilization factor for the system,  $\rho$ , the probability that the service facility is being used:

$$\rho = \lambda \mu$$

6. The percent idle time,  $P_0$ , the probability that no one is in the system:

$$P_0 = 1 - \lambda \mu$$

7. The probability that the number of customers in the system is greater than t,  $P_n > t$ :

$$P_n > t = (\lambda \mu)^t + 1$$

#### 4.2.2 Assumptions of the Multi- Channel Queuing Model

Multi-channel, single-phase waiting lines are found in many banks today: A common line is formed, and the customer at the head of the line proceeds to the first free teller. The following assumptions are reasonable for multi-channel waiting line models.

1. The waiting line has two or more channels.
2. The pattern of arrivals follows as Poisson probability distribution.
3. The service time for each channel follows an exponential probability distribution.
4. The mean service rate ( $\mu$ ) is the same for each channel.
5. The arrivals wait in a single waiting line and then move to the first open channel for served.
6. The queue discipline is first-come, first-served (FCFS).

Equations for the Multi-channel Queuing Model is

Let  $s$  = number of channels open,

$\lambda$  = average arrival rate, and

$\mu$  = average service rate at each channel

The queuing equations are as follow:

1. The probability that there are zero customers or units in the system:

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

2. The average number of customers or units in the system:

$$L_s = \frac{\lambda\mu (\lambda/\mu)^s}{(s-1)!(s\mu - \lambda)^2} P_0 + \frac{\lambda}{\mu}$$

3. The average time a unit spends in the waiting line or being serviced (namely, in the system):

$$W_s = \frac{\lambda\mu (\lambda/\mu)^s}{(s-1)!(s\mu - \lambda)^2} P_0 + \frac{1}{\mu} = \frac{L}{\lambda}$$

4. The average number of customers or units in line waiting for service:

$$L_q = L - \frac{\lambda}{\mu}$$

5. The average time a customer or unit spends in the queue waiting for service:

$$W_q = W - \frac{1}{\mu} = \frac{L_q}{\lambda}$$

6. Utilization rate:

$$\rho = \frac{\lambda}{s\mu}$$

These equations are more complex than the ones used in the single-channel model.

### 4.2.3 Operating Characteristics of a Queuing Model

Analysis of a queuing system involves a study of its different operating characteristics. Some of them are

1. Queue length ( $L_q$ ): the average number of customers in the queue waiting to get service. This excludes the customer(s) being served.
2. System length ( $L_s$ ): the average number of customers in the system including those waiting as well as those being served.
3. Waiting time in the queue ( $W_q$ ): the average time for which a customer has to wait in the queue to get service.
4. Total time in the system ( $W_s$ ): the average total time spend by a customer in the system from the moment he arrives till he leaves the system. It is taken to be the waiting time plus the service time.

5. Utilization factor ( $\rho$ ): it is the proportion of time a server spends with the customers. It is also called traffic intensity.

#### 4.3 Waiting Line Characteristics of Withdrawing Counter

Table (4.1) is shown that the multi-channel waiting line characteristics for the withdrawing counter by using the average arrival rate 16.07 customers per hour and average service rate is 8.66 customers per hour. The average arrival rate and service rate and average service rate can be seen in Appendix (A-4).

**Table (4.1)**  
**Multi-channel Waiting Line Characteristics for Withdrawing Counter**

	Waiting Line Characteristics	Calculated Value
$P_0$	The probability that there are no customers in the system	0.14
$L_q$	The average number of customers in the queue	0.61 customers
$L_s$	The average number of customer in the system	2.47 customers
$W_q$	The average time a customer spends in the queue	2.29 minutes
$W_s$	The average time a customer spends in the system	9.22 minutes
$\rho$	Service Utilization	$0.62 < 1$

Arrival Rate:  $\lambda=16.07$ , Service Rate:  $\mu=8.66$

Source: Survey Data (2019)

According to the Table (4.1), the result of arrival rate is greater than service rate and Multi- Channel Waiting Line is suitable for this counter. When Multi-Channel Waiting Line is used, the probability that a customer has to wait for service is 0.62 and the probability that no customers at the withdrawing counter is 0.14. The average queue length is 0.61 (1) customers and the average number of customers in the system of withdraw counters is 2.47 (3) customers. The average time a customer spends in the queue and the system are 2.29 minutes and 9.22 minutes in withdrawing counter of MAB bank respectively. The traffic intensity (service utilization) is less than one. This mean that servers at bank serve quickly and customer satisfy the service of bank.

### 4.3.1 Economic Analysis of Waiting Lines for Withdrawing Counter

To assess and decide the ideal number of servers in the system, the following costs must be considered in settling on these decisions. It should be noted that the hourly service cost of each server is the marginal cost per hour to run a server. It is calculated as the hourly salary of each staff at the service counter. To determine the hourly income of the customers who getting service from the service channel, the waiting cost of a customer is calculated by using the per capita income. This income is converted into hourly income to be consistent with the queuing system (Nahar, Islam, & Islam, 2016).

At the MAB, there are three staffs, senior officer and two officers at withdrawing counters. One of the staff calls the token number to service the customers while other is servicing the customers. The salary of the senior officer is 360,000 Kyats per month and those of officer is 300,000 Kyats per month. Based on the 22 (working) days, the service cost of a service counter is 960,000 Kyats per month. The hourly service cost ( $C_s$ ) of a service counter is nearly 8319 Kyats by adding the hourly service cost for assistant vice president (2863 Kyats), the hourly service cost for senior officer (2046 Kyats) and hourly cost for two officers (3410 Kyats). According to CSO (2018), person is about 141,185 Kyats. Therefore, the hourly income of a person in Myanmar is about 588 Kyats. Since hourly waiting cost ( $C_w$ ) of a customer is about 588 Kyats per hour. The results are shown in Table (4.2).

**Table (4.2)**  
**Determining Optimal Server Number at Minimum Total Expected Cost**  
**for Multi-Channel**

No. of Server (s)	Total hourly service cost, $E(SC)=S.C_s$	Arrival rate ( $\lambda$ per hour)	Expected waiting time in system ( $W_s$ per hour)	Total hourly waiting cost, $E(WC)=\lambda W_s C_w$	Total hourly Expected cost, $E(TC)=E(SC)+E(WC)$
<b>3</b>	<b>8319 Kyats</b>	<b>16.07</b>	<b>0.1537</b>	<b>1452 Kyats</b>	<b>9771 Kyats</b>
4	10024 Kyats	16.07	0.123	1162 Kyats	11186 Kyats
5	11729 Kyats	16.07	0.1172	1107 Kyats	12836 Kyats
6	13434 Kyats	16.07	0.1158	1094 Kyats	14528 Kyats
7	15139 Kyats	16.07	0.1155	1091 Kyats	16230 Kyats

Source: MAB (Mandalay) and CSO (2018)



The hourly service costs and hourly waiting costs are identified as mentioned above to calculate the total cost. According to Table (4.2), the results show that the total expected cost of server 3,4 ,5, 6, and 7 are 9771 Kyats, 11186 Kyats, 12836 Kyat, 14528 Kyats and 16230 Kyats respectively. This means that the number of server more increased, the cost more increased. Therefore, the optimum server for withdrawing counter is server 3.

#### 4.4 Waiting Line Characteristics of Deposit Counter

Table (4.3) is shown that the multi-channel waiting line characteristics for the deposit counter by using the average arrival rate 18.99 customers per hour and average service rate is 9.75 customers per hour. The average arrival rate and service rate and average service rate can be seen in Appendix (4).

**Table (4.3)**

**Multi-channel Waiting Line Characteristics for Deposit Counter**

	Waiting Line Characteristics	Calculated Value
$P_0$	The probability that there are no customers in the system	0.12
$L_q$	The average number of customers in the queue	0.78 customers
$L_s$	The average number of customer in the system	2.73 customers
$W_q$	The average time a customer spends in the queue	2.46 minutes
$W_s$	The average time a customer spends in the system	8.61 minutes
$\rho$	Service Utilization	$0.65 < 1$

Arrival Rate:  $\lambda=18.99$ , Service Rate:  $\mu=9.75$

Source: Survey Data (2019)

Regarding to the Table (4.3), the result of arrival rate is greater than service rate. Therefore, Multi- Channel Waiting Line is used and the probability that a customer has to wait for service is 0.65 and the probability that no customers at the deposit counter is 0.12. The average queue length is 0.78 (1) customer and the average number of customers in the system of deposit counters is 2.73 (3) customers. The average time a customer spends in the queue and the system is 2.46 minutes and 8.61 minutes at deposit counter respectively. In this counter, servers serve quickly because service utilization

(traffic intensity) is less than one. It can conclude that customer satisfy the service of MAB bank.

#### 4.4.1 Economic Analysis of Waiting Lines for Deposit Counter

At the MAB, there are three staffs, senior officer and two officers at deposit counters. One of the staff calls the token number to service the customers while other is servicing the customers. The salary of the senior officer is 360,000 Kyats per month and those of officer is 300,000 Kyats per month. Based on the 22 (working) days, the service cost of a service counter is 960,000 Kyats per month. The hourly service cost ( $C_s$ ) of a service counter is nearly 8319 Kyats. According to CSO (2018), person is about 141,185 Kyats. Therefore, the hourly income of a person in Myanmar is about 588 Kyats. Since hourly waiting cost ( $C_w$ ) of a customer is about 588 Kyats per hour. The results are shown in Table (4.4).

**Table (4.4)**  
**Determining Optimal Server Number at Minimum Total Expected Cost**  
**for Multi-Channel**

No. of Server (s)	Total hourly service cost, $E(SC)=S.C_s$	Arrival rate ( $\lambda$ per hour)	Expected waiting time in system ( $W_s$ per hour)	Total hourly waiting cost, $E(WC)=\lambda W_s C_w$	Total hourly Expected cost, $E(TC)=E(SC)+E(WC)$
<b>3</b>	<b>8319 Kyats</b>	<b>18.99</b>	<b>0.1435</b>	<b>1,602 Kyats</b>	<b>9921Kyats</b>
4	10024 Kyats	18.99	0.1107	1,236 Kyats	11260Kyats
5	11729 Kyats	18.99	0.1043	1,165 Kyats	12894 Kyats
6	13434 Kyats	18.99	0.103	1,150 Kyats	14584Kyats
7	15139 Kyats	18.99	0.1027	1,147 Kyats	16286 Kyats

Source: MAB (Mandalay) and CSO (2018)

The hourly service costs and hourly waiting costs are identified as mentioned above to calculate the total cost. Concerning with Table (4.4), the results show that the total expected cost of server 3,4,5,6, and 7 are 9921 Kyats, 11260 Kyats, 12894 Kyats, 14584 Kyats, and 16286 Kyats respectively. If the bank used server 4,5,6,7, the cost will gradually increase. Therefore, the optimal server for deposit counter is server 3. When

server 3 is used, the bank costs minimum for service cost and customer satisfies with their service.

#### 4.5 Waiting Line Characteristics of Remittance Counter

Table (4.5) is shown that the single-channel waiting line characteristics for the remittance counter by using the average arrival rate 6.35 customers per hour and average service rate is 8.66 customers per hour. The average arrival rate and service rate and average service rate can be seen in Appendix (A-4).

**Table (4.5)**

**Multi-channel Waiting Line Characteristics for Remittance Counter**

	Waiting Line Characteristics	Calculated Value
$P_0$	The probability that there are no customers in the system	0.22
$L_q$	The average number of customers in the queue	2.79 customers
$L_s$	The average number of customer in the system	3.57 customers
$W_q$	The average time a customer spends in the queue	26.33 minutes
$W_s$	The average time a customer spends in the system	33.71 minutes
$\rho$	Service Utilization	0.78 <1

Arrival Rate:  $\lambda=6.35$ , Service Rate:  $\mu=8.13$

Source: Survey Data (2019)

As the result of remittance counter, the arrival rate is less than service rate. Therefore Single-Channel Waiting Line Model is used for this counter and the probability that a customer has to wait for service is 0.78 and the probability that no customers at the remittance counter is 0.22. The average queue length is 2.79 (3) customers and the average number of customers in the system of remittance counters is 3.57 (4) customers. The average time a customer spends in the queue and the system is 26.33 minutes and 33.71 minutes respectively. The service utilization (traffic intensity) is not greater than one and it means that the server at bank can serve quickly. Therefore, it can conclude that the customer satisfy the bank service.

#### 4.5.1 Economic Analysis of Waiting Lines for Remittance Counter

At the MAB, the salary of each staff at the service counter is 300,000 Kyats per month. Based on the 22 (working) days, the hourly salary of each staff is nearly 1715 Kyats. Therefore hourly service cost ( $C_s$ ). The hourly service cost ( $C_s$ ) of a service counter is nearly 4578 Kyats by adding hourly service cost for vice president (2863 Kyats) and hourly service cost for officer (1705 Kyats). According to CSO (2018), person is about 141,185 Kyats. Therefore, the hourly income of a person in Myanmar is about 588 Kyats. Since hourly waiting cost ( $C_w$ ) of a customer is about 588 Kyats per hour. Table (4.6) shows the results of cost and number of server for remittance counter.

**Table (4.6)**  
**Determining Optimal Server Number at Minimum Total Expected Cost**  
**for Multi-Channel**

No. of Server (s)	Total hourly service cost, $E(SC)=S.C_s$	Arrival rate ( $\lambda$ per hour)	Expected waiting time in system ( $W_s$ per hour)	Total hourly waiting cost, $E(WC)=\lambda W_s C_w$	Total hourly Expected cost, $E(TC)=E(SC)+E(WC)$
<b>1</b>	<b>4578 Kyats</b>	<b>6.35</b>	<b>0.5618</b>	<b>2098 Kyats</b>	<b>6676 Kyats</b>
2	6283 Kyats	6.35	0.1452	542 Kyats	6825 Kyats
3	7988 Kyats	6.35	0.1257	469 Kyats	8457 Kyats
4	9693 Kyats	6.35	0.123	459 Kyats	10152 Kyats
5	11398 Kyats	6.35	0.123	459 Kyats	11857 Kyats

Source: MAB (Mandalay) and CSO (2018)

The hourly service costs and hourly waiting costs are identified as mentioned above to calculate the total cost. Regarding with Table (4.6), the results of total hourly expected cost for server 1,2,3,4, and 5 are 6676 Kyats, 6825 Kyats, 8457 Kyats, 10152 Kyats, and 11857 Kyats respectively. According to the results, server 1 is minimum and the optimal server for this counter is server 1.

## 4.6 Implementing One-Stop Service Counter

According to the results of economics analysis, when the bank extend their service counter or rise the server for the best service, the cost of service will increase and bank will face with difficulty for the cost of service. When MAB bank generates One-Stop Service Counter System, it can be best for MAB bank at Mandalay. One-stop service counter system is an arrangement where multiple services are offered. Therefore, customers can get they need in just “one stop”.

### 4.6.1 Waiting Line Characteristics for One- Stop Service Counter

In this sub-section the multi-channel waiting line characteristics for the one-stop service counter by using the average arrival rate 13.80 customers per hour and average service rate is 8.85 customers per hour. The results of the waiting line characteristics for one-stop service counter are shown in Table (4.7).

**Table (4.7)**  
**Multi-channel Waiting Line Characteristics for One-Stop Service Counter in MAB**

	Waiting Line Characteristics	Calculated value
$P_0$	The probability that there are no customers in the system	0.21
$L_q$	The average number of customers in the queue	0.05 customers
$L_s$	The average number of customers in the system	1.61 customers
$W_q$	The average time a customer spends in the queue	0.23 minutes
$W_s$	The average time a customer spends in the system	7.01 minutes
$\rho$	Service Utilization	$0.39 < 1$

Arrival Rate,  $\lambda= 13.8$ , Service Rate,  $\mu=8.85$

Source: Survey Data (2019)

According to the result, arrival rate is greater than service rate. Therefore, Multi-Channel Waiting Line is used. In this Table (4.7), the average queue length is 0.05 (0) customer and the average number of customers in the system is 1.61 (2) customers at one-stop service counter. And also, the average time a customer spends in the queue and the system is 0.23 minutes and 7.01 minutes respectively. Then, the probability that a

customer has to wait for service at one-stop service counter is 0.39 and the probability that no customer is 0.22.

#### 4.6.2 Economic Analysis of Waiting Lines

At the one-stop service counter, there are five staffs, vice president, senior officer and three officers at that counters. The salary of the vice president is 504000 Kyats, senior officer is 360,000 Kyats per month and those of officer is 300,000 Kyats per month. Based on the 22 (working) days, the service cost of a service counter is 1260,000 Kyats per month. The hourly service cost ( $C_s$ ) of a service counter is nearly 10024 Kyats. According to CSO (2018), person is about 141,185 Kyats. Therefore, the hourly income of a person in Myanmar is about 588 Kyats. Since hourly waiting cost ( $C_w$ ) of a customer is about 588 Kyats per hour. Table ( 4.8) shows the results of total hourly expected cost and number of server.

**Table (4.8)**  
**Determining Optimal Server Number at Minimum Total Expected Cost**  
**for Multi-Channel**

No. of Server (s)	Total hourly service cost, $E(SC)=S.C_s$	Arrival rate ( $\lambda$ per hour)	Expected waiting time in system ( $W_s$ per hour)	Total hourly waiting cost, $E(WC)=\lambda W_s C_w$	Total hourly Expected cost, $E(TC)=E(SC)+E(WC)$
4	10024 Kyats	13.80	0.1168	948 Kyats	10972 Kyats
5	11729Kyats	13.80	0.1138	923 Kyats	12652 Kyats
6	13434 Kyats	13.80	0.1132	919 Kyats	14353 Kyats
7	15139Kyats	13.80	0.113	917 Kyats	16056 Kyats
8	16844 Kyats	13.80	0.113	917 Kyats	17761 Kyats

Source: MAB (Mandalay) and CSO (2018)

The hourly service costs and hourly waiting costs are identified as mentioned above to calculate the total cost. Regarding with Table (4.8), the results of total hourly expected cost for server 4,5,6,7 and 5 are 10972 Kyats, 12652 Kyats, 14353 Kyats, 16056 Kyats, and 17761 Kyats respectively. According to the results, server 1 is minimum and the optimal server for this counter is server 4.

## **CHAPTER V**

### **CONCLUSIONS**

This chapter presents a summary of the research findings presented in chapter four above. The conclusion drawn from the findings of the study are also presented in this chapter. Besides, the chapter presents suggestions and areas for further study

#### **5.1 Findings**

The queuing characteristics of the selected MAB branch of Mandalay were analyzed by using a single-channel and multi-channel queuing model and the waiting and service cost were calculated to determine the optimal service level of the selected MAB branch of Mandalay. The optimal service counters were determined based on the minimum total expected cost.

By analyzing the waiting line characteristics of the MAB (Mandalay), single-channel and multi-channel queuing models were used. As stated in data analysis, the optimal server for withdraw and deposit counters were 3 and for remittance counter was 1. As the results of MAB (Mandalay), it was observed that the arrival rate varied from 6.35 to 18.99 customers per hour while overall average arrival rate was 13.8 customers per hour. Similarly, the service rate varied from 8.13 to 9.75 customers per hour for each counter while the overall average service rate was 8.85 customers per hour for each counter.

When One-stop service counter is used, the average number of customers in the queue reduces from (1) to (0) customer, the average number of customers in the system reduces from (3) to (2) customer the average time a customer spends in the queue reduces from 2.29 minutes to 0.23 minutes, the average time a customer spends in the system reduces from 9.22 minutes to 7.01 minutes and traffic intensity reduce from 0.62 to 0.39 for withdrawing counter.

For deposit counter, the average number of customers in the queue reduces from (1) to (0) customer, the average number of customers in the system reduces from (3) to (2) customer the average time a customer spends in the queue reduces from 2.46 minutes to 0.23 minutes, the average time a customer spends in the system reduces from 8.61

minutes to 7.01 minutes and traffic intensity reduce from 0.65 to 0.39 minutes respectively.

And also, for remittance counter, the average number of customers in the queue reduces from (3) to (0) customer, the average number of customers in the system reduces from (4) to (2) customer the average time a customer spends in the queue reduces from 26.33 minutes to 0.23 minutes, the average time a customer spends in the system reduces from 33.71 minutes to 7.01 minutes and traffic intensity reduce from 0.78 to 0.39 respectively.

As the average, the number of servers available reduces from 8 to 5 and the expected cost would reduce from 26368 to 16056. The time a customer spends in the queue could range from 2.29 minutes to 26.33 minutes and those in the system could range from 8.61 minutes to 33.71 minutes. Overall the average time a customer spent in the queue was 0.23 minutes and those in the system were 7.01 minutes. According to the calculated waiting lines characteristics, the probability that 0.39 of the service facility was being used. As mentioned in the above results, the manager should be considered to increase the service counter or to change one-stop service counter. It reduce customers' waiting time and dissatisfaction and on the other hand, server has the lowest total minimum expected cost.

## **5.2 Suggestions**

This research offers a practical model for eatery service optimization. It is based on customers' requirements for shorter waiting time and needs for making best use of resources. Developing an optimal waiting scheme can effectively improve customer service efficiency, which can enhance customers' satisfaction and loyalty.

The study further recommends that commercial banks in Myanmar should increase customer satisfaction by adopting queuing theory application to minimize the customer dropout rate. Bank managers always struggle with the efficiency of operation and improving service quality. Managing waiting time or efficiency and service quality have been challenging in the banking industry because of the difficulty of optimizing service quality and efficiency of service. The service industry should use work-analysis, MS, and OR approaches to improve efficiency and service quality. Possibly,



understanding the relationships between waiting time, service quality, and customer satisfaction should be studied as further studies.

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Appendix (A-4)

Table: Daily Record of Average Arrival Rate and Service Rate

Day Counter	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		Day 8		Average	
	$\lambda$	$\mu$	$\lambda$	$\mu$	$\lambda$	$\mu$	$\lambda$	$\mu$	$\lambda$	$\mu$	$\lambda$	$\mu$	$\lambda$	$\mu$	$\lambda$	$\mu$	$\lambda$	$\mu$
Withdraw	16.18	8.05	16.55	9.71	20.55	8.52	21.45	8.14	15.45	7.75	14.18	13.18	12.55	5.50	11.64	8.40	16.07	8.66
Deposit	16.36	9.28	13.64	10.92	23.64	8.08	30.18	8.83	18	6.61	15.96	14.62	16.36	11.49	17.82	8.15	18.99	9.75
Remittance	4.8	7.93	5.89	7.89	5.63	12	7.09	7.03	6	6.07	6	9.12	6.52	8.84	8.84	6.09	6.35	8.13