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Department of Logistics and Supply Chain Management

Investigating the Queuing System of Dashen Bank S.C Main Branch

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Logistics and Supply Chain Management

By: Eyasu Meteku Lambamo

Advisor: Matiwos Ensermu (PhD)

June, 2016

Addis Ababa

Investigating the Queuing System of Dashen Bank S.C Main Branch

(Empirical Study in Addis Ababa Ethiopia)

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Eyasu Meteku

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Declaration

I declare that the thesis entitled 'Investigating the Queuing System of Dashen Bank S.C Main Branch' submitted for the M.A. degree in logistics and supply chain management at the University of Addis Ababa School of commerce, herby submitted by me, is my original work and has not previously been submitted for a degree at this or any other University, and that all references materials contained therein have been duly acknowledged.

Name: Eyasu Meteku

Signature-------------------

Date ------------------------

Advisor's Name: Mathiwos Enserm (PhD)

Signature----------------------------------

Date--

Certification

Addis Ababa University

School of Graduate Studies

This is to certify that the thesis prepared by Eyasu Meteku, entitled 'Investigating the Queuing System of Dashen Bank S.C Main Branch' and submitted in partial fulfillment of the requirements for the award of the Degree of Master of Arts (Logistics And Supply Chain Management) compiles with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the Examining Committee:

Examiner ___________________________ Signature ______________Date____________

Examiner ___________________________ Signature ______________Date_____________

Advisor: Dr. Mathiwos Enserm Signature ______________Date_____________

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Chair of Department of Graduate Program Coordinator

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Abstract

This research was aimed at investigating the queuing system of Dashen bank S.C, main branch, using multiple-server queue model, Monte Carlo simulation & standard questionnaire. The paper has investigated the waiting line system of the branch which is located in Addis Ababa. An infinite calling population assumed such a large number of the branch customers that are likely to arrive & get served at random from the city or any corner of the globe. The arrival rates of customers are assumed to be independent of each other, randomly vary over time and determined using Poison's probability distribution. The service rates are exponentially distributed. A descriptive approach to research design has been adopted in the study. Both primary & secondary data were incorporated which were collected using well structured standard observation check lists, questionnaire and from review of relevant records maintained in the branch. The entire customers randomly visiting the branch within the sampled time-intervals have been accounted for data gathering; and independent variables such as customers' arrival rates & service rates were recorded to analyze the queuing system. Questionnaire, which was intended to assess customers queue psychology & their satisfactions regarding the waiting time experiences, was dispatched to a random of 384 customers of which 17 were sent out during the pilot test period. Among the sampled respondents 357 have filled the questionnaire that was designed for study but 27 were not returned. The raw data collected was analyzed using spreadsheet bearing the multiple-server mathematical equations aided with statistical package for social studies (SPSS). Analytical formulas of single queue multi servers were used since DB main branch serves customers on first-come-first-served queue discipline from a single line pool of customers sequenced using automatic queue managing machine. Finally the result was validated using Monte Caro simulation and simulated to three hours. The result of assessment depicted that Dashen bank main branch maintained adequate server capacity to respond the existing customer demand. With this service capacity & current arrival rate, no customers spend time in waiting line & the average length of waiting time in the branch is also zero. The average servicing time was found to be 8.33 minutes per customer; this same figure represents the total time used up in the branch since zero waiting time. But in contrary to this, 75.4% of customers witnessed that the actual time spent in the branch service (waiting + being served) lapses more than 10 minutes. As understood from survey of customers' actual services time experiences, larger portion of respondents, 110 customers (30.8%) revealed that service in the branch is consuming more than 15 minutes; 44.6% (159) responded between 10 and 15; and only 77 customers (21.6%) enjoyed service minutes less than 5 minutes. Still greater portion of respondents ranked their overall satisfaction regarding the waiting time as: 4.2% "very dissatisfied", 34.7% "dissatisfied", 27.2% "somehow dissatisfied", 22.7% being "indifferent" besides only 11.2% which are somehow satisfied. And so, since there is adequate service capacity maintained in the branch, the researcher has recommended to effectively utilizing the existing server capacity without adding any extra counter, to meet customers' expectations with economic balance. Furthermore, it's also advisable working towards ways that improve service time per counter by segmenting customers according to their needs, motivating tellers, training & instilling the concept of customers' value in the minds bank attendants.

Key words: Bank, Bank queuing, Monte Carlo Simulation, Area bank, Functional counters

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Acronyms

ATM: - Automated teller machine

CBE: - commercial bank of Ethiopia

DB: - Dashen bank S.C

FCFS: - First comer first served

LCLS: - Last comer last served

Lq: - the average number of customers in the queue

Ls: - the average number of customers in the branch

In M/D/C queuing model:

- M:- Markov and means arrivals occur according to a poison process
- D:- Deterministic and means jobs arriving at the queue require a fixed amount of service
- C: - The number of servers at the queuing nodes (C=1, 2…). If there are more customers at the branch than there are servers then customers will queue and wait for service.
- M/M/1 queue: - Single server serves jobs that arrive according to a poison process and have exponentially distributed service requirements.
- M/M/C queue: - Multiple servers serve jobs that arrive according to a poison process and have exponentially distributed service requirements.

Pn : - the probability of n customers in the queuing system of the branch

POS: - Point of sale machine that is used to pay for consumptions at merchant outlets.

P0: - the probability that there are no customers in the system (all counters are idle)

Pw: - the probability that a customer arriving in the system must wait for service (i.e., the probability that all tellers are busy)

SPSS: - statistical package for social sciences

Wq: - the average time of customers in the waiting line, waiting to be served

Ws: - the average time a customer spends in the queuing system (waiting and being served)

CHAPTER ONE

INTRODUCTION

1.1. Background of the study

Globalization has made business system to have undergone a number of changes in recent years. These changes are accompanied by growth in number, size and magnitude of businesses. However, their multidimensional growth didn’t grant their customers not to wait for longer hours before getting services. People rush to common service areas randomly to get services & are observed to wait longer before getting services. In developing countries due to different reasons the case is more serious and customers are exposed to queue longer until get services. Observing long queues in bank halls become the real phenomena of the days’ business activities. (Jacobs, et.al. 2006)

Now a day queues have become ordinary goings-on in most banks as banks become the life blood of the modern economy. They are one of the most important units of customers concerns. Due to the essences of banks in safe & healthy flow of funds, the modern society is getting aware of using banking products/services. As a result it’s becoming common to see a mass of customers queuing in bank halls to get banking services & products. Queues are inevitable as banks provide a wide range services to their customers, such as open an account, transaction, send money, deposit funds, balance, etc (Huda & Jobori, 2011).

The most important in recent years is enhancement of service with respect to waiting time, because of the increased emphasis on quality, especially in service related operations like banks. When customers go in to banks to get different services they increasingly equate quality service with quick services. More & more banks are getting aware of this fact & putting their focuses on reducing waiting times of their customers as an important element of quality enhancement (Bernard W., 2006, p.573).

Queue analysis has received an increased consideration worldwide, partly due to the fact that speed of service has been shown to provide a firm with a competitive edge in queuing systems (Stalk, 1988). This is largely due to the intense competition that is related to the emergence of a single global economic village and the increased relevance of time to consumers. As the standard of living in a country increases, the value of customers' time also increases, and consequently they seek out those goods and services which will minimize the expenditure of their time (Mark and Heineke, 1994).

Queuing in Banks has much negative consequence apart from leading to chaos & wasting of man hours per day. It's undeniable that customers while waiting to cash money get bored, disappointed, crashed with bankers and bombarded by armed robbers. Cases have witnessed where armed robbers killed and collected huge sums of money from people on queues in banking halls. In view of all these many new generation banks are licensed with a view to reducing congestion in the old generation bank. Despite all these, we still have queues in some of these banks. It is therefore necessary to carry out appraise the performance if banks can address their queuing problems. (Anubav, 2010)

1.2. Banking Industry in Ethiopia

The use of modern money in Ethiopia has a long history. It can be traced back to 2000 years (Sylvia Pankhrust 1986, cited in Alemayehu Geda 2006). As witnesses depict this had boom in what is called the time of Axumite kingdom, which has elongated from 1000BC to around 975 AD. However, modern banking in Ethiopia was introduced during the time of Emperor Minilik II in 1905. Following the agreement reached in 1905 between Emperor Minilik II and Mr.Ma Gillivray, the representative of the British owned National Bank of Egypt, the first bank called Bank of Abysinia was inaugurated in Feb.16, 1906. The Bank was totally managed by the Egyptian National bank (Alemayehu Geda, 2006).

The establishment of Bank of Abyssinian as the pioneer bank in Ethiopia (in 1905) was based on a 50 years agreement with the Anglo-Egyptian National Bank. A new development bank (named Societe Nationale d'Ethiope Pour le Development de l' Agriculture et du Commerce) and two other foreign banks (Banque de l'Indochine and the Compagnie de l' Afrique Oreintale) were also established in 1908. These banks were criticized for being wholly owned by foreigners. In 1931 the Ethiopian government purchased the Abysinian Bank, which was the dominant bank in the country, and renamed it the 'Bank of Ethiopia' which was the first nationally owned bank on the continent of Africa (Gedey 1990, pp. 83, cited in Alemayehu Geda 2006).

An active expansion of banking activity which specially favored the Italian banks took place in the 5-year period of Italian regime in Ethiopia (1936-1941). The role of British was paramount for the independence struggle of Ethiopia from Italy's brief occupation owing to strategic consideration in World War II. Then Barclay's bank had established and was in operation in our country from 1941 to 1943 just aftermath of colony (Belay 1990; Befekadu, 1995). The subsequent years from 1943 in Ethiopia was time for the establishment of government owned bank, the 'State Bank of Ethiopia'. The establishment of this Bank by Ethiopia was a painful process since Britain was against it for an interesting neo-colonial story. This bank was operating both as commercial and central bank until 1963 when it was dissolved into today's National Bank of Ethiopia (the central bank, reestablished in 1976) and 'The Commercial Bank of Ethiopia', CBE henceforth. After this period many other banks were established; and just before the 1974 revolution the aforementioned banks were in operation.

The 1974 revolution brought major changes to the banking system. Prior to the emergence of the socialist government, Ethiopia had several state-owned banking institutions. The National Bank of Ethiopia (the country's central bank and financial adviser), the Commercial Bank of Ethiopia (which handled commercial operations), the Agricultural and Industrial Development Bank (established largely to finance state-owned enterprises), the Savings and Mortgage Corporation of Ethiopia, and the Imperial Savings and Home Ownership Public Association (which provided savings and loan services) were the major state-owned banks. On the other hand the major privately owned banks, many of which were foreign owned, included the Addis Ababa Bank, the Banco di Napoli, and the Banco di Roma (Alemayehu Geda, 2006).

All privately owned banks, the three commercial banks were nationalized on 1 January 1975. The nationalized banks were reorganized and one commercial bank (the Commercial Bank of Ethiopia), a National Bank (recreated in 1976), two specialized banks (the Agricultural and Industrial Bank– renamed recently as the Development Bank of Ethiopia; and a Housing and Saving Bank– renamed recently as the Construction and Business Bank) were formed. Following the regime change in 1991 and the liberalization policy in 1992, these financial institutions were reorganized to work on market-oriented policy framework. Moreover, new privately owned banks were also allowed to work along with the publicly owned ones just after this regime change.

Recently, there are 19 commercial banks in operation of which 16 are privately owned in Ethiopia. Being the capital city, Addis Ababa mentioned to host the largest percentage of the total number of commercial banks in the country. Addis Ababa people now a day are also being more & more familiar with the understandings & benefits of using banking services. In most banks it's being not uncommon to see long waiting lines of customers for such services; i.e. it's becoming common to see a mass of customers queuing in bank halls to get banking services & products. These waiting lines of customers are referred to as queues. A queuing system consists of one or more servers that provide service to arriving customers. So the mandate for queue analysis has received increased consideration these years in our country.

Dashen bank is one of the most progressive privately owned banks in Ethiopia. It's a bank which granted a world prize award, "the most progressive bank Ethiopia award 2014" in the year. It usually scores 2nd place taking commercial banks profit margins as parameter of comparison, next to CBE since its establishment. It's also been the leading company in profit makings from the private banking industry. The bank has opened more than 185 branches throughout the country of which 11 are Forex service bureaus as of May 2016. (Sources: Brochures, internal portal, Certificate of award 2014, Dashen Bank)

1.3. Statement of the problem

Despite all the efforts being made by banks, queues continue to plague bank halls such as Savings account holders coupled with those making cash deposits, cheque deposits and others gets different banking functions form queues in banks. Queues are usually long in most times in banks (Mbuvi, 2013).

A number of academic research papers have been carried out in the concept of queuing analysis in banks worldwide; even though narrow range of researches are conducted in our country to analyze the queue management practices in different banks. Gezahegn Mekonnen (2012) can be mentioned, conducting a case study in Hawassa branch of CBE to assess the modeling of multi-servers queuing system of the bank. These research works depict that those banks which have an enhanced queue management system remain competitive in customer service initiative. Banks which have not yet improved queue management practices are rated poorly by clientele who feel not satisfied with the current method of service delivery. Thus, it is imperative for those banks to train employees on the current method of service delivery taking into consideration the theory of queuing (Ndungu, 2013).

Once customers start being served, their transaction with the service organization may seem efficient, courteous and complete; but the bitter taste of how long it took to get attention (a call to service counters) pollutes the overall judgments that they make about the quality of service (Master, 1985)

Significant queue management gap is also observable in Dashen bank S.C main branch. DB main branch, the pioneer of Dashen bank branches is located around Temenja yazje in Addis Ababa. The queuing system in the branch is composed of 8 counters of which only 6 are functional (in average hours) that provide service to arriving customers. There are large number of customers entertained a day; and due to many unknown (not well researched) reasons queues are usually there & apparent in the branch hall.

As customers get more familiar with understandings of using banking services, they are facing more sufferings in waiting for services. It's regularly observed to be customer congested area bank most in time. The branch management also is not new to entertain complaints about queues from both internal (the staff users) as well as external customers. It's customary to see customers queuing for services in the branch hall at random moment of time. The branch queue management needs to demonstrate sound queue management practices for efficient operations to realize customer satisfaction, higher returns on investment & appear competitive. And as a particular case in focus, the student researcher has investigated the queuing system of DB main branch taking large concern & increased consideration.

Hence, this study has focused on investigating the queuing system of the branch (with researcher's special motivation) to determine the operating characteristics, length of queue & service capacity of its waiting system; and in a prospect to reach on empirical findings of the persisting problems, recommend possible remedial alleviations as well as establish a standard service time for the current operation of the branch. The topic is relatively new for the branch & no previous studies have been carried out bearing the same or similar themes. Therefore, the current research aims to investigate the operating characteristics of the queuing system & arrive at new empirical findings.

1.4. Research Questions

In terms of the queuing assessment in Dashen bank main branch, the paper has found answers for such questions as:

- What are the average values of operating characteristics in the branch at a random moment?
- What are the average arrival & service rates of customers at DB main branch?
- What is the level of customers' queue psychology and customers' satisfaction regarding queues in the branch?
- How many counters should be employed to offer the customers an effective & efficient service?

1.5. Research Objectives

1.5.1. General objective

The general objective of the study was to investigate the queuing system of Dashen bank main branch in Addis Ababa.

1.5.2. Specific objectives

The aim of conducting this study was to:-

- Determine the average length of waiting time (Ws) a customer is likely to experience in the branch (from arrival to departure)
- Assess the customers queue psychology, queue performance, queuing capacity, service capacity and customers satisfaction regarding queues in the branch.
- Measure & compute the average arrival rates of customers, the average queue lengths, the average time a customer must wait in the queues, service rate; the average time customers spend while getting service in the counters, the probability that the facility will be busy and idle in DB main branch.

1.6. Significance of the study

Since indifferent product differentiations, there is a growing concern in banking industry by domestic banking brands for substitutes that will boost competition especially through branded service provision (Komal, 2012). Based on earlier findings, the study is used by the bank management to improve queue management practices and service delivery to customers in the forecasted future. With sound queue management banks gain more opportunities after retaining and attracting new customers thus nurturing the bottom line. Where it is inevitable to have long waits, the management can be appropriately advised to apply the principles of queuing psychology as postulated by Larson and Schaak (1989). Banks use the findings to determine the optimal service capacity versus cost levels (Chase and Aquiliano, 1973). Banks can also utilize the findings to formulate customer arrival control mechanisms (Sherman, 2010). Queue management is a practical operation management technique commonly used to determine staffing, scheduling, and service levels in banking businesses.

According to Peter J. Sherman, 2013; understanding the nature of waiting lines or "queues" and learning how to manage them is one of the most important sources of competitive advantage. As overall analyzing queuing in banks can be used to speed up customer throughput in bank halls and increase sales with profitability, improve operational efficiencies and most important of all is to minimize customer-waiting time and reduce frustrations.

The findings of research will also be used by management scientists as reference to validate queuing theory and literature as applied by banks. In short bank managers can use queuing analysis conclusion as indicator for control and improvement. The findings will also be useful to the regulatory body and other authorities to update policies geared towards efficient and hassle free banking services in queues. The City government, the branch under study, the national government and other stakeholders' will also use the information in fiscal planning, management and any other decision makings.

1.7. Scope of the study

The boundary of the research is limited to the case of DB main branch which is located in Addis Ababa city administration. The research also relied on consent of bank authorities to access the branch due to high sensitivity of the business environment thus leading to less than anticipated scope.

1.8. Limitation of the Study

The findings would have been more empirical if the data had been collected at all the working hours of a day during data collection period, than limited to randomly selected hours. Conducting the study in pick hours (busy hours) might add better weight on more practicality of the situation. But since the intention of the study was investigating the queuing system to generalizing the findings for all working hours of a day, the student researcher has not limited the data collecting period to pick hours alone (i.e. data was collected not on judgmentally selected pick hours but on randomly selected arbitrary intervals of time in a day). Best problem fit tools may also not be employed due to the following limitations:

- **The field workers expertise**: quality of the results obtained from field research depends on the data gathered in the field, the data as well depending upon the field worker, his/her level of expertise & involvement as well as ability to see & organize things. The field workers used in the study were technical school graduates (not MA or degree holders in the field of statistics or data collection due inability to pay satisfactory fee for the professionals in the field.
- **The research topic:** is new & no sufficient preceding studies conducted by well skilled researchers (journalists) in the branch, or even in the country. The student researcher may get challenged dealing with relatively new issue in the area of insufficient contextual findings by experienced scholars and these may have affected the finding of this study.
- **The service providers:** the tellers at counters might have altered their speed or style of services in case knowing they are under observation.

The above constraints may have occurred to affect the best performance of the study. The student researcher was aware of the above factors that may influence the outcome of the study among the most important limiting factors in this study. Since the researcher is unable to obtain complete solution for the factors, they are acknowledged as a limitation of this study. However, despite the above limitations, the student researcher made his maximum effort to design the research as properly as possible and achieved the specified objectives by going deep, devoting passion and providing all the required details, as is expected to face the above limitations.

1.9. Outline of the Thesis (Details of Chapters)

The study is organized in five chapters including the present one. Chapter one introduces the study, giving an overview idea on queuing analysis in banks and spells out the statement of the problem, objectives, significance of the study, scope, and limitations of the study. Chapter two consists of reviews relevant literatures on empirical studies of bank queuing system. It consisted assessment of researches done on queues & queuing systems as well as related topics. The methodology part together with research design, data collecting tools, research procedures and data analysis technique is presented in Chapter three. Chapter four presents the results of analysis done and discussions on the findings. Chapter five finally presents drawn conclusions from the empirical findings and suggests recommendations.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1. Introduction

The banking environment all over the world is facing stiff competitive pressures due to the key drivers that are significantly changing globalization, regulatory, structural and technological factors (Grigoroudis, et al., 2002). Customer satisfaction has come to be regarded as a key business strategy of every business and a yardstick against which many banks have to set their standards. Sustaining existing customers for organizations is ever more important than the ability to capture new ones because customers are vital for any organization's success (Anubav, 2010). Without customers, organizations would have no resources, no profits and therefore no market niches that can enable them compete in the global arena (Mburu, et al., 2013). These customers all seek quickly & value added services when they rush to banking halls. Competition and the constant revolution in technology and ways of life have changed the face of banking.

In recent times, banks are in search of substitute performance to offer and distinguish amongst their diverse services. Customers, both companies level as well as individuals, are not willing to queue in banks for the most essential of services. They always anticipate meeting convenience, deserving & modest business transactions (Komal, 2012).

Sarel and Marmorstein (1998) also observed that more affluent customers would not tolerate delay in service delivery and were even willing to pay a premium due to the opportunity cost of waiting. Queuing is psychologically stressing to the customer especially if the customer is doing nothing. The expected waiting time is much less than the actual time in the mind of the customer. For example an idle customer waiting for 9sec may interpret it to be a spectacular 3 minutes! According to the famous philosopher Berkeley "perception is essence" i.e. how long customers believe they wait matters more than how much they actually take.

2.2. Queuing

People wait in line to get services, products queue up in production plants, merchandizes wait in line to be serviced, planes wait to take off or land because time is available resource and the reduction of waiting time is an important topic of analysis. As queuing is inevitable in every move of our daily lives, providing quicker, efficient & effective services is a competitive weapon in every business. The improvement of services with respect to waiting time has become important in recent years because of the increased emphasis on quality, especially in service related operations. Aware of these, more & more banks are focusing on reducing waiting time as an important component of quality improvement. In general, almost all companies are able to reduce waiting time & provide faster service, such as more tellers at bank, etc. (Wallac et al., 2015).

Providing services in banks is personal and thus customers are either served immediately at a cost or join the waiting line in a busy system (Olaniyi, 2004). Queues form because of less service capacity than demand, variance in arrival pattern, variance in service time from service point to point and from time to time. To strike an economic balance between the cost of providing service and the cost of waiting, the queuing model seeks to find the optimum service rate and the optimal number of servers. The study reinforced that queuing systems can be broken down into individual subsystems composed of entities queuing for some activities. The arrival process in a sub-system seeks to address whether customers arrive singly or in groups, the inter arrival time distribution and whether the customer population is finite or infinite. The Poisson's model which corresponds to arrival at random is very important because it is a reflection of what happens in real life even though queuing systems are described by average arrival rate.

2.3. Queue Theory

Queuing theory is the mathematical study of waiting lines, or queues. Waiting lines (queues) are frankly obvious & an inevitable phenomenon of our everyday life. Queues are usually seen at almost all service stations like bus stops, hospitals, bank counters, petrol filing stations, post offices, etc. Queues are formed when customers (human or object) demanding service have to wait because their number exceeds the number of servers available; or the facility does not work efficiently or takes more than the time prescribed to service a customer. Some customers wait when the total number of customers requiring service exceeds the number of service facilities, some service facilities stand idle when the total number of service facilities exceeds the number of customers requiring service. Queue defined simply as a waiting line. (Wallac et al., 2015)

Queuing system in banks is described by its input or arrival process, its queue discipline, and its service mechanism. The usual description of the pattern of arrivals into a queuing system is given by the probability distribution of time between successive arrival events and the number of individuals or units that appear at each of these centers. The input arrivals are usually assumed to be described by a Poisson probability distribution. The queue discipline describes the order in which customers entering the system are eventually served. Most frequently, the discipline is first come, first served (FCFS). The service mechanism includes a description of time to complete a service, and the number of individuals whose requirements are satisfied at each service center. The service rate is usually described by an exponential probability distribution. If the arrival rates, queue discipline and service rates are known, characteristics of the queue in a steady state can be analytically calculated. They include the average waiting time experienced by the customer, the average number of customers waiting to be served in the queue and the servers. (Siddharthan, Jones and Johnson, 1996)

As defined by Daintith (2013) queue management is characterized by the manner in which customers join a queue in order to wait for service, and by the system in which customers already in the queue are selected for servicing. Queuing theory is the study of waiting lines which is a common feature in organizations providing services where customers arrive randomly to purchase service at a service point.

Chase and Aquiliano (2006) outlined three factors used in queue system management, such as length of a line (queue length), number of waiting lines and queue discipline. Most service facilities have limited line capacity whereas some have infinite potential length. In single line multiple-server queue models there is no jockeying whereas in multiple lines, arrivals often shift lines/jockey. The choice of priority rule affects factors like the number of customers in line, average waiting time and efficiency of the service facility. It is usually difficult to ensure customers know and follow the adopted rule and that a system exists to enable servers to manage the lines.

Kira (2009), noted that queuing theory which is a branch of operations research, also known as stochastic service system theory or wait for the line theory, is used to study the object of a service request generated by the randomness of customer arrivals and services rate. There is several performance metrics of queuing theory put together for these research purpose such as:

- The average queue length (Lq) of customers,
- The average waiting time (Wq) of customers in the queue,
- The average length of stay (Ws) in the branch,
- The average number of customers (Ls) in the branch. And other several commonly used quantitative indicators such as:
- Average arrival rate;

- The average service rate;
- The average service time;

Banking customer service system is arranged in parallel multi-server system now a day and common practice for banks to use windows because of automatic calling system; where all the same service needs of customers' come in to the same queue. In order to facilitate analysis of issues & offer quicker responses to customers, the services capabilities can be multiple-server as a whole. Then the queuing system is suitable for single-queue multiple counter (teller) models, as the practical case studied in DB main branch.

2.4. Waiting lines and queuing system

As Hiray (2008) summarized waiting in lines is a part of our everyday life. Waiting in lines may be due to overcrowded, overfilling or due to congestion. Any time there is more customer demand for a service than can be provided, a waiting line forms. We wait in lines at the movie theater, at the bank for a teller, at a grocery store. Waiting time depends on the number of people waiting before the new comer, the number of servers serving line, and the amount of service time for each individual customer. Customers can be either humans or an object such as customer orders to be process, a machine waiting for repair. Mathematical analytical method of analyzing the relationship between congestion and delay caused by it can be modeled using Queuing analysis. Queuing theory provides tools needed for analysis of systems of congestion. Mathematically, systems of congestion appear in many diverse and complicated ways and can vary in extent and complexity.

Sundarapandian, V. (2009) states that a waiting line system or queuing system is defined by two important elements: The population source of its customers and the process or service system. The customer population can be considered as finite or infinite. The customer population is finite when the number of customers affects potential new customers for the service system already in the system. When the number of customers waiting in line does not significantly affect the rate at which the population generates new customers, the customer population is considered infinite. Customer behavior can change and depends on waiting line characteristics. In addition to waiting, a customer can choose other alternative. When customer enters the waiting line but leaves before being serviced, process is called Reneging. When customer changes one line to another to reduce wait time, process is called Jockeying. Balking occurs when customer do not enter waiting line but decides to come back latter. Another element of queuing system is service system.

i. The number of waiting lines,
ii. the number of servers,
iii. the arrangements of the servers,
iv. the arrival and service patterns, and
v. The service priority rules (the Queue discipline) characterize the service system.

Queue system can have channels or multiple waiting lines. Examples of single waiting line are bank counter, airline counters, restaurants, amusement parks. In these examples multiple servers might serve customers. In the single line multiple servers has better performance in terms of waiting times and eliminates jockeying behavior than the system with a single line for each server. System serving capacity is a function of the number of service facilities and server proficiency. In queuing system, the terms server and channel are used interchangeably. Queuing systems are either single server or multiple servers. Single server examples include gas station, food mart with single checkout counter, a theater with a single person selling tickets and controlling admission into the show. Multiple server examples include gas stations with multiple gas pumps, grocery stores with multiple cashiers, and multiple tellers in a bank. Services require a single activity or services of activities called phases. In a single-phase system, the service is completed all at once, such as a bank transaction or grocery store checkout counter. In a multiphase system, the service is completed in a series of phases, such as at fast-food restaurant with ordering, pay, and pick-up windows. Queuing system is characterized by rate at which customers arrive and served by service system. Arrival rate specifies the average number of customers per time period. The service rate specifies the average number customers that can be serviced during a time period. The service rate governs capacity of the service system. It is the fluctuation in arrival and service patterns that causes wait in queuing system. Waiting line models that assume that customers arrive according to a Poisson probability distribution, and service times are described by an exponential distribution. The Poisson distribution specifies the probability that a certain number of customers will arrive in a given time period. 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. A waiting line priority rule determines which customer is served next. A frequently used priority rule is first-come, first-served (FCFS). Other rules include best customers first, high-test profit customer first, emergencies first, and so on. Although each priority rule has merit, it is important to use the priority rule that best supports the overall organization strategy. The priority rule used affects the performance of the waiting line system.

Waiting line models are important to a business because they directly affect customer service perception and the costs of providing service. If system average utilization is low, that suggests the waiting line design is inefficient. Poor system design can result in over staffing. Long waits suggest a lack of concern by the organization or can be view as a perception of poor service quality. Queuing analysis has changed the way businesses use to run and has increased efficiency and profitability of businesses (Hiray, 2008).

2.4.1. Little's Theorem

This Theorem describes the relationship between throughput rate (arrival and service rate), cycle time and work in process (the number of customers in the system).The expected number of customers (L) for a steady state system is given by,

$$\mathbf{L = \lambda\, T}$$

Where;

λ is average arrival rate

T is the average service time per customer

2.4.2. Multi-Channel Queue Model

The arrivals are served by more than one server on FCFS queue discipline and one can shift from a given queue to the next. In banking halls the most common system comprises a single queue and multiple service stations where balking (shifting from one queue to the other) is impossible (Mayhew, et al., 2006).

2.4.3. Limitations of queuing theory

The assumptions of classical queuing theory may be too restrictive to be able to model real-world situations exactly. The complexity of production lines with product-specific characteristics cannot be handled with those models. Therefore specialized tools have been developed to simulate, analyze, visualize and optimize time dynamic queuing line behavior. For example; the mathematical models often assume infinite numbers of customers, infinite queue capacity, or no bounds on inter-arrival or service times, when it is quite apparent that these bounds must exist in reality. Often, although the bounds do exist, they can be safely ignored because the differences between the real-world and theory is not statistically significant, as the probability that such boundary situations might occur is remote compared to the expected normal situation. Furthermore, several studies show the robustness of queuing models outside their assumptions. In other cases the theoretical solution may either prove intractable or insufficiently informative to be useful. Alternative means of analysis have thus been devised in order to provide some insight into problems that do not fall under the scope of queuing theory, although they are often scenario-specific because they generally consist of computer simulations or analysis of experimental data (Chinwuko et al., 2014).

2.4.4. Single-channel waiting line

The way the customers are served in bank is an example of a single-channel waiting line. That is, the customer request is taken and as the transaction is completed, the request of the next customer in the waiting line is taken. Thus, each customer of the bank goes through a single-channel where he places the request and is being attended to. If there are more customers than can be served, a waiting line arises. The diagram in figure 2 shows a single-channel waiting line for First Bank transaction (Olusola et al., 2013)

2.4.5. Poisson's Distribution of Arrivals

A feature of the arrival process is the probability distribution of arrivals in a given time period. In many situations, arrivals occur randomly and independently of other arrivals, such that the estimation of an arrival occurrence is difficult to determine. Thus, the Poisson distribution is the best solution to describe the arrivals pattern in banks (Maitanmi et al., 2013).

The Poisson point process is one of the most studied stochastic processes in both the field of point processes and in more applied disciplines concerning random phenomena due to its convenient properties as a mathematical model as well as being mathematically interesting. Depending on the setting, the process has several equivalent definitions as well definitions of varying generality owing to its many applications and characterizations. It may be defined, studied and used in one dimension (on the real line) where it can be interpreted as a counting process or part of a queuing model. As noted in several literatures & witnessed by W.

Taylor and others in their book of Introduction to scientific management (2006) there are two key properties of Poisson's distribution.

2.4.5.1. The distributed number of points property

The Poisson point process is related to the Poisson distribution, which implies that the probability a Poisson random variable N is equal to n is given by:

$$P(N = n) = \left[\frac{{}^{n}\mathrm{e}^{-}}{\mathrm{n!}}\right]$$

Where $n!$ denotes n factorial; and **λ** is the single Poisson parameter (arrival rate) that is used to define the Poisson distribution. If a Poisson point process is defined on some underlying mathematical space, called a state space or carrier space, then the number of points in a bounded region of the space will be a Poisson random variable with some parameter**λ**.

2.4.5.2. Complete independence property of poison's distribution

The other key property is that for a collection of disjoint and bounded sub-regions of the underlying space, the number of points in each bounded sub-region is completely independent of all the others. This property is known under several names such as complete randomness, complete independence, or independent scattering and is common to all Poisson point processes. In other words, there is a lack of interaction between different regions and the points in general, which motivates the Poisson process being sometimes called a purely or completely random process. For instance if a specific point in time 12:30 in a 24 hours time format is deemed by chance, it's only found in the bounded region of (12:00,13;00) not others.

2.4.5.3. Different definitions

The Poisson point process is often defined on the real line in the homogeneous setting, and then extended to more general settings with more mathematical rigor. For all the instances of the Poisson point process, the two key properties of the Poisson distribution and complete independence play an important role. Homogeneous Poisson point process if a Poisson point process has a constant parameter, say, λ, then it is called a homogeneous or stationary Poisson point process. The parameter, called rate or intensity, is related to the expected (or average) number of Poisson points existing in some bounded region. In fact, the parameter λ can be interpreted as the average number of points (arrivals) per some unit of extent (time) such as length, area, volume, or time, depending on the underlying mathematical space, hence it is sometimes called the mean density; the extent is sometimes called the exposure (Hiray, 2008).

2.4.5.4. Defined on the real line

Consider two real numbers a and b, where $a \leq b$, and which may represent points in time. Denote by $N(a, b]$ the random number of points of a homogeneous Poisson point process existing with values greater than a but less than or equal to b, or in other words, the number of points of the process in the interval $(a, b]$. If the points form or belong to a homogeneous Poisson process with parameter $\lambda > 0$, then the probability of n points existing in the above interval $(a, b]$ is given by:

$$P\{N(a, b] = n\} = \frac{[\lambda(b-a)]^n}{n!} e^{-\lambda(b-a)},$$

In other words, $N(a, b]$ is a Poisson random variable with mean $\lambda(b-a)$. Furthermore, the numbers of points in any two disjoint intervals, say, $(a_1, b_1]$ and $(a_2, b_2]$ are independent of each other, and this extends to any finite number of disjoint intervals. In the queuing theory context, one can consider a point existing (in an interval) as an event, but this is different to the word event in the probability theory sense. It follows that λ is the expected number of arrivals that occur per unit of time, and it is sometimes called the rate parameter. For a more formal definition of a stochastic process, such as a point process, one can use the Kolmogorov theorem which essentially states a stochastic process is characterized (or uniquely defined) by its finite-dimensional distribution, which in this context gives the joint probability of some number of points existing in each disjoint finite interval. More specifically, let $N(a_i, b_i]$ denote the number of points of (a point process) happening in the half-open interval $(a_i, b_i]$, where the real numbers $a_i < b_i \leq a_{i+1}$. Then for some positive integer, k, the homogeneous Poisson point process on the real line with parameter $\lambda > 0$ is defined with the finite-dimensional distribution:

$$P\{N(a_i, b_i] = n_i, i = 1, \ldots, k\} = \prod_{i=1}^{k} \frac{[\lambda(b_i - a_i)]^{n_i}}{n_i!} e^{-\lambda(b_i - a_i)},$$

2.4.5.5. Law of large numbers

The quantity $\lambda(b_i - a_i)$ can be interpreted as the expected or average number of points occurring in the interval $(a_i, b_i]$, namely:

$$E\{N(a_i, b_i]\} = \lambda(b_i - a_i),$$

Where E denotes the expectation operator. In other words, the parameter λ of the Poisson process coincides with the density of points. Furthermore, the homogeneous Poisson point process adheres to its own form of the (strong) law of large numbers. More specifically, with probability one:

$$\lim_{t\to\infty} \frac{N(t)}{t} = \lambda,$$

Where $\lim$ denotes the limit of a function. N (t) denoting a time function of N.

Counting process interpretation, the homogeneous Poisson point process, when considered on the positive half-line, is sometimes defined as a counting process, which can be denoted as $\{N(t), t \geq 0\}$. A counting process represents the total number of occurrences or events that have happened up to and including time t. A counting process is a Poisson counting process with rate $\lambda > 0$ if it has the following three properties:

$N(0) = 0$;

Has independent increments; and the number of events (or points) in any interval of length t is a Poisson random variable with parameter (or mean) λt. The last property implies

$$E[N(t)] = \lambda t.$$

The Poisson counting process can also be defined by stating that the time differences between events of the counting process are exponential variables with mean $1/\lambda$. The time differences between the events or arrivals are known as inter-arrival or inter-occurrence times. These two definitions of the Poisson counting process agree with the previous definition of the Poisson point process.

2.5. Applications of Poisson interval

There have been many applications of the homogeneous Poisson point process on the real line in an attempt to model seemingly random and independent events occurring. It has a fundamental role in queuing theory, which is the probability field of developing suitable stochastic models to represent the random arrival and departure of certain phenomena. For example, customers arriving and being served or phone calls arriving at a phone exchange can be both studied with techniques from queuing theory (Hiray, 2008).

2.6. Elements of Waiting Line Analysis

Mathew (2014) states that waiting lines form because people or things arrive at the servicing function, or server, faster than they can be served. However, this does not mean that the service operation is understaffed or does not have the overall capacity to handle the influx of customers. In fact, most businesses and organizations have sufficient serving capacity available to handle their customers in the long run. Waiting lines result because customers do not arrive at a constant, evenly paced rate, nor are they all served in an equal amount of time. Customers arrive at random times, and the time required to serve them individually is not the same. Thus, a waiting line is continually increasing and decreasing in length (and is sometimes empty), and it approaches an average rate of customer arrivals and an average time to serve the customer in the long run. For example, a teller counters at a bank may have enough tellers to serve an average of 100 customers in an hour, and in any particular hour only 60 customers might arrive. However, at specific points in time during the hour, waiting lines may form because more than an average number of customers arrive, and they make more than an average number of transactions.

Operating characteristics are average values for characteristics that describe the performance of a waiting line system. Decisions about waiting lines and the management of waiting lines are based on these averages for customer arrivals and service times. They are used in queuing formulas to compute operating characteristics, such as the average number of customers waiting in line and the average time a customer must wait in line. Different sets of formulas are used, depending on the type of waiting line system being investigated. For example, a bank drive-up teller window that has one bank clerk serving a single line of customers in cars is different from a single line of passengers at an airport ticket counter that is served by three or four airline agents (Mathew, 2014).

2.7. Virtual Queuing

With virtual queuing, there is no physical line of customers. Instead, customers either check in, or are otherwise identified upon arrival. They then generally receive a ticket and will be called to meet with a service provider at an appropriate time. But they are free to move about a waiting room and do not have to stand and remain focused on how a “line” in front of them is moving.

They can fill out forms, read, or carry out personal conversations on their phone. Or, service providers can direct video or audio messages to them designed to capture their attention while they are waiting. Virtual queuing is most ideal for hospitals and the offices of other health care providers, as well as financial service providers (banks). If a company wants to identify customers (or give them number tags) before they reach a staff member (service center), virtual queuing is under use (Chuka et al., 2014).

Queuing models, like in banks often assume infinite number of customers, infinite queue capacity, or no bounds on inter-arrival or service times; where it's apparent that these bounds must exist in reality. Although the bounds do exist, they can be safely ignored because the difference between the real world & theory is statistically insignificant, as the probability that such boundary situations might occur is remote compared to the expected normal situation. Furthermore, several studies show the robustness of queuing models outside their assumptions (Mathew, 2014).

2.8. Empirical Studies of Queuing Model

Waiting lines will continue to feature for the longest time because the service managers have to assess the cost of expanding capacity vis-à-vis the opportunity cost in waiting time wasted (Olaniyi, 2004). A case in question is customers queuing in the bank hall predominantly for securing loan whereas the institution runs the risk of bad debts on the one hand and stiff competition from other banks. There is a positive correlation between arrival rates of customers and bank's service rate according to a study carried out in Nigeria by Oladapo (1998). Elsewhere; Ashley (2000) confirmed that even if service system can provide service at a faster rate than arrival rate, waiting lines can still form if the arrival and service rates are random. Elegalam (1978) also carried out a one week survey in bank hall and noted that 59.2% of the 390 persons making withdrawals from their accounts spent 30–60 minutes while 7% spent between 90 and 120 minutes. According to Juwah (1986) customers spent between 55.27 and 64.56 minutes making withdrawals from their accounts. One of the findings of the study by Mburu, Van Zyl, and Cullen (2013) in banks across Kenya, is that 34.4% of 2000 customers interviewed disagree with the fact that waiting period is minimal and hardly noticeable; indicating a lot needs to be done to improve on waiting time. Safe Associates (2002) observed that the service mechanism describes the resources required for the service to begin and analyses how long the service will take, the number of servers available, whether the servers are in series or in parallel and whether preemption is allowed. Queue characteristics seek to address queue discipline to be applied to waiting customers in an effort to reduce congestion for instance FIFO, LIFO. Chase et al. (2006) noted that customer behavior is studied for balking, reneging, jockeying and capacity finiteness. Uncertainty of inter arrival times and service times implies application of statistics and probability to analyze queuing situations is a must. Analytical models are used to analyze simple queuing situations while simulation is used for complex situations. Social injustice is experienced by a customer who despite arriving earlier, slips and receives service after a later customer who skips queue Ceteris Paribus (Larson and Schaak, 1989). Combining several short queues into one long one with several counters helps to solve this problem. A customer is also likely to join along queue rather than a short one if he believes those ahead have inside information about availability of service/product. The study further identified the factors that affect customer perception of and experience of queues as the environment, the level of information and the measure of social justice. Some customers are more averse to queuing and thus will exhibit behavior like jockeying, jumping queue and barging for those who cannot tolerate especially long queues. The most commonly used rule in queue management is first come first served (FCFS) because it ensures fairest treatment of arrivals. Conversely buildup of queues serves to send a signal to service managers of the need to be efficient and also serve to "market" the service given the popularity. Chase et al. (2006) observed that over the years ways have been devised to make queuing an else phenomena, while good experience distinguished for the customer. Entrepreneurs also recognize the potential for marketing goods and services to those standing in queue in public places e.g. newspaper vendors. TV commercials and adverts are also used to reach those in bank queues by having screens in the environment.

Katz, Larson and Larson (1991) developed several rules for management of psychology of queuing i.e. perception is more important than reality, unoccupied time feels longer than occupied time, preprocess waits feel longer than in process waits, uncertain or unexplained waits feel longer than known waits and unfair waits feel longer. One suggested solution is to segment the customers according to specific needs. Waiting line problem is inherently nonlinear and therefore difficult for the manager to understand solutions to queue situations.

According to Metters, King-Metters, Pullman and Walton (2006) the queuing model can be used for simple situations whereas simulation is used for complex situations. To customers queuing is a bad thing that is the most time consuming due to management fault. Boredom resulting from queuing is said to generate restlessness, tension and anxiety and to encourage the customer to dwell on the possible adverse consequences of being late for his or her next intended activity.

Crucially, it has been claimed by Katz, Larson(1991) and Taylor (1994) that longish waits impact negatively on customer evaluations of an outlet's quality because long queues affect the customer's perceptions of the "punctuality" of a service (i.e. how promptly customer requirements are satisfied) and hence the customer’s ratings of the service provider's overall efficiency and reliability.

2.9. Queuing Simulation

The queuing system is when classified as M/M/c with multiple queues where number of customers in the system and in a queue is infinite, the solution for such models are difficult to compute. When analytical computation of T is very difficult or almost impossible, a Monte Carlo simulation is appealed in order to get estimations. A standard Monte Carlo simulation algorithm fix a regenerative state and generate a sample of regenerative cycles, and then use this sample to construct a likelihood estimator of state. (Nasroallah, 2004)

Although supermarket sales do not have regenerative situation but simulation here is used to generate estimated solutions. Simulation is the replication of a real world process or system over time. Simulation involves the generation of artificial events or processes for the system and collects the observations to draw any inference about the real system. A discrete-event simulation simulates only events that change the state of a system. Monte Carlo simulation uses the mathematical models to generate random variables for the artificial events and collect observations (Nafees, 2007).

Discrete models deal with system whose behavior changes only at given instants. A typical example occurs in waiting lines where we are interested in estimating such measures as the average waiting time or the length of the waiting line. Such measures occur only when the customer enters or leaves the system. The instants at which changes in the system occurs identify the model’s events, e.g. arrival and departure of the customers. The arrival events are separated by the ‘inter-arrival time’ (the interval between successive arrivals), and the departure events are specified by the service time in the facility. The fact that these events occur at discrete points is known as “Discrete-event Simulation” (Taha, 1997).

2.10. Managerial Applications of Queuing Theory

As noted by Mohammad S., Rahman C., Toufiqur R., and Rokibul K. in their journal of business and management (2013); queuing theory is a valuable tool for business decision-making. It can be applied to a wide variety of situations for scheduling. Some of these are given below:-

a) Mechanical transport fleet

b) Scare defense equipment

c) Issue and return of tools from tool cribs in plants

d) Aircrafts at landing and take-off from busy airports

e) Jobs in production control

f) Parts and components in assembly lines

g) Routing sales persons

h) Inventory analysis and control

i) Replacement of capital assets

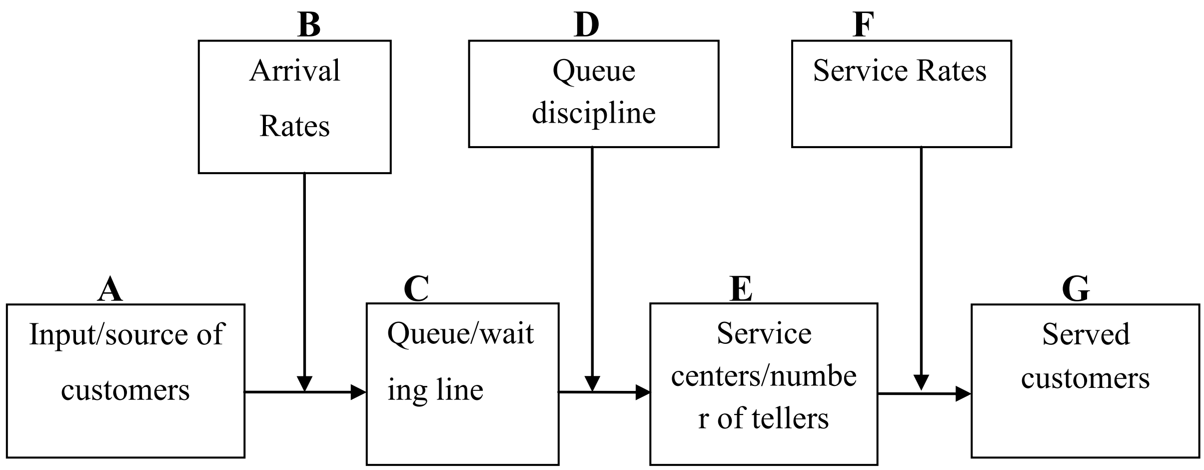
j) Minimization of congestion due to traffic delays at booths.

Queuing theory has generally been applied by factories, transport companies, telephone exchanges, computer centers, retail stores, cinema houses, restaurants, banks, insurance companies, traffic control authorities, hospitals, etc.

2.11. Conceptual framework

Any time there is more customers' demand for a service than can be provided, a waiting line forms. The waiting time system in Dashen bank main branch is based on first-come-first-served (FCFS) queue discipline and depends on the number of people waiting before the new comer, the number of servers serving line (number of tellers/counters), and the amount of service time taken for each individual customer. Customers come to this branch from any corner of the city/country/globe. They are inputs/sources to the branch's queuing system. While they arrive the branch there is possibility to get all counters idle and get served without stay in queues or get long queue and should stay longer in a waiting line. In the later case customers join the queuing area in the branch until their turn calls because all the tellers are occupied at that moment. When one of the six functional tellers from any of the counters completes the task of serving current customer, turn calls for the next user/customer based on first-come-first-served queue discipline; (i.e. a call is made to the next person from the waiting line pool so that s/he gets service from the calling counter). Finally every served customer leaves the queuing system (the branch) after receiving the required services. Schematic presentation of the conceptual framework for queuing systems is shown on the diagram (fig: 2.1) below.

Figure 2-1 Components of basic queuing system



(Source: “Traffic Engineering & Management”, 2014)

Key:

A= the arrival of customers from any corner of the city/country/world. B= the average arriving rates of newly coming customers. Arrival rate specifies the average number of customers per time period. C= the branch’s queuing area for a teller where new comers wait in line until their turn calls. D= the discipline that which customer to serve first, next and which at last. In DB main branch’s case the customer that arrives first is the one served first (FCFS) or (1st comer, 1st served) basis and last comer served last. This queue discipline is most common and convenient. E= the number of counters (tellers) to serve arriving customers. In DB main branch there are 6 functional counters (service centers) that are serving the arriving customers. F= the service rate specifies the average number customers that can be serviced during a time period. The service rate governs capacity of the service system. It is the fluctuation in arrival and service patterns that causes wait in queuing system. And, G= final departure of served customers from the area bank.

CHAPTER THREE

METHODS OF THE STUDY

3.1. Introduction

This chapter outlines the methods used by the student researcher to formulate the extraction and analysis of data from the source population. It gives the roadmap towards analysis and conclusion of true queuing system scenario as it's observed in DB S.C main branch. The chapter includes research design, selection of research participants, sampling technique and sample size, methods of data collection and instruments, method of data analysis and presentation and ethical considerations.

3.2. Research Design

A descriptive approach to research design is adopted in the study. The actual data obtained from the sources are analyzed using analytical method & descriptively interpreted. The findings from observation analysis are validated using Monte Carlo simulation & generalized. The questionnair e data is also descriptively processed using statistical package for social studies (SPSS)

3.3. Sampling, Sampling Techniques and Sampling Strategy

Hiray (2008) provided evidence that when the number of customers waiting in line does not significantly affect the rate at which the population generates new customers, the customer population is considered infinite.

In probability, statistics and related fields, a Poisson point process or Poisson process (also called a Poisson random measure, Poisson random point field or Poisson point field) is a type of random mathematical object known as a point process or point field that consists of randomly located points located on some underlying mathematical space. The process has convenient mathematical properties, which has led to it being frequently defined in Euclidean space and used as a mathematical model for seemingly random processes in numerous disciplines. The Poisson point process is often defined on the real line playing an important role in the field of queuing theory where it is used to model certain random events happening in time such as the arrival of customers at a store. In all settings, the Poisson point process has the property that each point is stochastically independent to all the other points in the process, which is why it is sometimes called a purely or completely random process.

Taking in to consideration an infinite calling population base of the bank customers as a source of study population, sample was selected based on Poisson's process. The 10 working hours (8:00am to 6:00pm) of the branch was grouped in to 10 disjoint time-intervals called Poisson points each consisting a duration of 1 hour. The framed times (1 hour each) are randomly selected aided with a random number table, by picking the lower boundary value of each interval from a pool of random numbers generated by computer. Then, a census of customers arrive the branch within the stochastically determined (sampled) time-interval were taken as samples of the study for observation.

Probability sampling technique was adopted since each customer in the population has an equal and independent chance of being selected. The arrival times of all customers as they arrive randomly were recorded, the time they start being served and eventually the time they depart from the branch. Bank customers are naturally uniform and their arrival is random, so determined using poisons probability distribution. As also noted by Larson and Schaak (1989), events occur at random instant of time at an average rate of $\boldsymbol{\lambda}$ events per second. The nature of bank customers' arrival (λ) is random by its nature and no one can certainly predict which specific customer will arrive next. Arrival of customers to service stations in general is random. Uncertainty of inter-arrival times and service-times implies that application of statistics and probability to analyze queuing situations is a must.

In the mean time, random samples of 384 respondents were also selected from the entire calling population using Freud & Williams sample selection formula, as also used by Scott Smith for infinite population. Here standard questionnaire was administered to this randomly determined number of customers in queue to enquire their overall queue perceptions and satisfaction about the branch service times. Therefore, any reachable customer within the stochastically determined time interval period is a random customer at end.

The Necessary Sample Size = $(\text{Z-score})^2$ * Std. Dev*(1-StdDev) / $(\text{margin of error})^2$

$$N = \left[\frac{Z^2 PQ}{E^2}\right]$$

$= ((1.96)^2 x.5\ (.5))/\ (.05)^2$

$= (3.8416x.25)/.0025$

= 0.9604/0.0025

= 384 respondents are needed

where N= The sample size needed

Z= standard error of the mean(1.96); Z value for 95% confidence level

P= probability of success (0.5)

Q= probability of failure (0.5)

E= level of significance (0.05)

3.4. Data collecting instruments

To find out the inputs or measure independent variables for the study, a well structured standard observation check lists and standard questionnaire were adopted. Secondary data was accessed from the review of relevant records maintained in Dashen bank S.C. Both the questionnaire and observation check lists used for actual data collection were standard. The questionnaire was adopted from Amoah Mensah, (2010) who conducted a comparative study on customer satisfaction of Ghana & Spain banks. Whereas the structured observation check lists from Henry Ndungu, 2013 the author of 'queue management' in Mombasa banks. Furthermore, Cronbach's-Alpha test was attempted to confirm the reliability of the standard questionnaire, and the value 0.850 obtained and this conformed same (See table 3.4.1).

Table 3-4-1 Empirical data on arrival rate obtained through observation

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.850	.875	25

Therefore, the question of sound measurement testing techniques to indemnify the reliability and validity issues of the data collection tools are well addressed in this study.

3.5. Questionnaire Technique Discussion

Questionnaire was prepared in both Amharic & English languages to collect specific data on customers' queue psychology and customer satisfaction regarding waiting time (see appendix A.1 & 2). This helps the student researcher make comparison between the outcome of observation data and a brief result of the questionnaire. It was also to be very rich with data about the behavior of customers in relation to the operating characteristics of the branch. The questionnaire comprised of 40 questions, which were deemed enough to explore the need for the research and helped to answer some of the research questions in addition to the observation. The type of bank customers usually visit & the number of years they stayed in the branch as customers were enquired so as to check the level of awareness of customers about the branch queuing system in their long time exposures.

3.6. Data collecting procedure

Using the selected data collection tools, the independent variables like customer arrival rate and service rates were recorded. It was envisaged to rely on the accuracy of data collectors (field workers) to collect reliable data and represent the correct situation in the branch. The field-workers were armed with digital watches, clip board, pen and suitably designed entry forms to record time. Those customers, visiting the branch within the stochastically determined time-intervals were subsequently approached and asked to fill out the questionnaire regarding their queuing experiences. Conditions were arranged so that customers can fill it in branch hall during the queuing process if possible, or after the completion of service in the nearby office, and at their homes to the last end. The nearby office was arranged in communication with the branch manager. In ethical consideration, questions that the respondent didn’t feel comfortable answering have refrained from asking. This ensured the researcher gets the consent of the sample participants; and they were reassured that the confidentiality of their information is kept.

Data was collected through field work assistants and by the researcher within 20 working days over a period of one month. Wherein, a single data person was accountable for no more than three counters (service centers) at a time. There were separately dedicated individuals (data collectors) for recording the time of customer’s arrivals alone while another data collector(s) recording the service started and service ended times in dedicated counters. The researcher was responsible to handle three days field work in the study spot. The primary data collected is complemented with secondary data acquired through exploration of relevant documents and records kept by the case company. The issue of data validity is handled by use of both primary & secondary data. Lack of responses to certain questions is considered in the final data analysis. The student researcher has secured authority to the branch manager at the area bank by way of introductory letter due to sensitive nature of the study environment and created awareness on the field workers.

3.7. Methods of Data analysis

The single queue multiple-server queuing model was applied to analyze the raw data and all the established operating characteristics using different sets of mathematical formulas (analytic method or queuing theory. Monte Carlo simulation technique was employed to validate the results and make inferences to larger number of customers. After clearing non response data the collected raw data using questionnaire was organized, coded to suitable formats, filled on SPSS, labeled, defined and then descriptively processed to meaningful information. Descriptive statistics (SPSS) was used to aid the multiple-server queue model & simulation in analyzing frequencies, means, validity tests, graphs, tables and standard deviations, etc of the collected data and make analysis simpler. Well structured tables are used to show the results of key queue analysis parameters.

3.8. Definition of terms

Area bank: - the branch at which the research work is conducted

Arrival rate: - the frequency at which customers arrive at a waiting line according to a probability distribution

Automated teller machine (ATM):- an electronic banking outlet to collect cash

Balking: - customers decide not to join the queue if it is to long

Calling population: - is the source of customers; it may be infinite or finite

Jockeying: - customers switch between queues if they think they will get served faster by so doing

Multiple-server models: - Two or more independent servers in parallel serve a single waiting line

Operating characteristics: - are average values for characteristics that describe the performance of a waiting line system; such as:

- the probability that there are no customers in the system (all servers are idle) (P0)
- the probability of n customers in the queuing system (Pn)
- the average number of customers in the queuing system (Ls)
- the average time a customer spends in the queuing system (waiting and being served) (Ws)
- the average number of customers in the queue (Lq)
- the average time a customer spends in the queue, waiting to be served, (Wq)

- the probability that a customer arriving in the system must wait for service (i.e., the probability that all the servers are busy) P(w)

Parameter: - the summary measure describing the population

Parallel servers: - customers line up and there are several servers.

Point of sale (POS) machine: - is used to pay for consumptions at merchant outlets.

Poisson distribution: - a probability distribution that describes the occurrence of a relatively rare event in a fixed period of time; often used to define arrivals at a service facility in a queuing system

Queue discipline: - is the order in which waiting customers are served

Queue psychology: - 5 minutes appears as more than 5 hours for waiting customers.

Queue: - refers to waiting in line

Random numbers: - numbers that are equally likely to be drawn from a large population of numbers

Reneging: - customers leave the queue if they have waited too long for service

Server: - the counters together with tellers ready to deliver required services to arriving customers. In this paper server is interchangeably used with counter or teller.

Service rate: - is the average number of customers who can be served during a time period

Single servers: - customers line up and there is only one server.

Tandem queue: - there are many counters and, customers can decide going where to queue.

CHAPTER FOUR

DATA ANALYSIS & INTERPRETATION

4.1. Introduction

Research service management experts believe that customer service is one of the most important issues. Customer is characterized by random arrival and call for an immediate access to services. If customers arrive more frequently than service rates, all the service capabilities are already being used, then the customer need to wait patiently in queues. Customers waiting in line to get services in any of service systems are inevitable. Banks queue management has been facing a huge challenge for over many decades because nature cannot be avoided. Waiting for a long time on queues has been the subject of several theoretical researches, and results of domestic banks queuing management problem is very serious. This research in DB main branch's queuing system is with aim of determining the operating characteristics & recommending down-to-earth findings for improving customer satisfaction in relation to service time management.

4.2. Basic Assumptions of queuing theory (model)

The analytical derivation of even the simplest queuing model is relatively complex and lengthy. Thus, it's better to refrain from deriving the model in detail and consider only the resulting queuing formulas. The reader must keep in mind, however, that these formulas are applicable only to queuing systems having the following conditions (Daintith, 2013).

- Arrivals rates (λ) are determined by Poisson's probability distribution.
- First come first served(FCFS) queue disciple
- An infinite calling population bases, i.e. any customer can visit the area bank from any corner of the city.
- Service time varies from one customer to the next and is independent of another, but their average rate is known
- Service rates are determined exponentially.
- The service providers are working at their full capacity
- The average arrival rate is greater than the average service rate
- Every customer waits to be served regardless of the length of the queue (i.e. there is no reneging or balking).

- The waiting space available for customers in the queue is infinite

4.3. Appropriate Queue analysis formulas

As noted in literatures, queue analysis in banks made using appropriate mathematical equations & Monte Carlo simulation. The following single queue-multiple server queuing formulas are used for the analytical work in this research.

The probability that there are no customers in the system (all servers are idle) is given by:

$$\mathbf{Po} = \frac{1}{\left[\Sigma_{n=0}^{n=c-1} \cdot\frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^{n}\right] + \frac{1}{c!}\left[\frac{\lambda}{\mu}\right]^{c}\left[\frac{\lambda\mu}{\lambda\mu-\lambda}\right]}$$

Average number of customers in the system (waiting or being served) is given by:

$$\mathrm{Ls} = \frac{\lambda\mu(\frac{\lambda}{\mu})^{c}}{(\mathrm{C}-1)!(\mathrm{C}\mu-\lambda)^{2}}\mathbf{Po} + \frac{\lambda}{\mu}$$

The average time a customer spends in the queuing system (waiting and being served) is:

$$\mathrm{Ws} = \frac{\mathrm{Ls}}{\lambda}$$

Average number of customers waiting in the queue:

$$Lq = Ls - \frac{\lambda}{\mu}$$

Expected amount of waiting time in the system is;

$$Wq = Ws - \frac{1}{\mu} = \frac{Lq}{\lambda}$$

The probability that a customer arriving in the system must wait for service (i.e., the probability that all the servers are busy) is:

$$Pw = \frac{1}{c!}\left[\frac{\lambda}{\mu}\right]^{c}\left[\frac{c\mu}{c\mu-\lambda}\right]Po$$

In the queuing model formulas presented above:

λ: is the mean arrival rate (average number of arrivals per time period)

μ: the mean service rate (average number of customers served per time period) per server (counter)

c: number of service centers (counters)

n: number of customers

Ls: average number of customers in the system (waiting or being served)

Lq: average number of customers waiting in the queue

Ws: average time customers spend in the system (in the branch)

Wq: average time customers wait in the queue (only in the waiting line)

P_0: The probability that there is no (zero) customer in the system (in the branch)

Pw: The probability that a customer has to wait before getting services

Pn: The probability that there are n customers in the system

cμ: The mean effective service rate for the system, which must exceed the arrival rate; $c\mu > \lambda$: the total number of servers available must be able to serve customers faster than they arrive.

These formulas, like single-server model formulas, have been developed on the assumption of a first-come first-served (FCFS) queue discipline, Poisson arrival rates, exponential service times, and an infinite calling population. Since similar scenario in banks queue management practices, queuing analysis in DB main branch also follow the foregoing assumptions.

4.4. Data Computations, Analysis, Interpretations and Discussions

4.4.1. Analysis of Observation Data

In this research the student researcher observed the queuing system of DB main branch consisting 6 functional counters as bank attendants serve customers on arrival in the hall. Since 384 sample sizes were determined, a pilot study was made to be apparent with deciding the data collection period. From observations of an hour range for 3 distinct days; 23 customers arrival during the 1st hour, 17 customers the 2nd hour and 29 the 3rd hour were recorded whose average yielding 23 customers per hour. So the remaining observations were made over a period of 17 working days, the total observation period comprising 20 working days [(384/23≈ 20) and (3+17 = 20)], starting from 28th March to 23rd April 2016 for a random of 1 hour each day. Dear readers, please get informed that the values are rounded off to the nearest appropriate decimal places and the time format of 24 hours is considered for convenience.

To use M/M/6 Queue model for a multiple-server queuing system analysis, 1st the following inputs (independent variables) were computed.

Inputs:

A) Average arrival rate

B) Average service rate

The average arrival rate (λ)**:**

The average arrival rate (λ) was computed as follows from the data obtained through observation (see the data in Appendix B.1).

$$\boldsymbol{\lambda} = \frac{\sum_{i=1}^{i=20} Di}{\sum_{i}.}$$

Where λ = lambda = the arrival rate,

D*i*= the dates at which observation was made (i=1, 2, 3…20)

$$\boldsymbol{\lambda} = \frac{15+29+19+16+16+21+24+22+21+26+22+21+30+15+12+26+16+20+30+18}{20}$$

$$\boldsymbol{\lambda} = \frac{419}{20}$$

$$\boldsymbol{\lambda} = \mathbf{20.95}$$

≈ 21 customers on average, visit the branch every hour(arrival rate is 0.35 customers per minute)

A) **The average service rate (μ)**:

Average service rate is defined as average number of customers served per time period per server (channel) in a queuing system.

Prior to determining the representative service rate in the branch, the average number of functional counters per hour was determined by adding the total number of functional counters which have been effectively in operation during the data collection period, and then dividing this sum by 20 hours so as to obtain the actual server capacity in the branch (116 counters/20 hours).

Table: 4-4-1-1. Empirical data collected on service time intervals, as obtained through observation of 8 servers in 20 hours (Over an interval of 1 hour a day)

Dashen Bank S.C Main Branch: Data Obtained On Service Time Durations From Observation										
Day	Time-Intervals randomly selected	# of functional counters per hour	Server 1	Server 2	Server 3	Server 4	Server 5	Server 6	Server 7	Server 8
			Minute/ person	Minute/ person	Minute/ person	Minute/ person	Minute/ person	Minute/ person	Minute/ person	Minute/ person
1	8:00-9:00	4	8	-	9	7	-	4	-	-
2	9:00-10:00	8	2	3	4	4	3	3	2	3
3	11:00-12:00	4	3	-	8	6	-	5	-	-
4	14:00-15:00	8	3	5	4	2	6	8	3	3
5	14:00-15:00	8	3	8	9	4	8	6	3	7
6	14:00-15:00	8	3	6	4	3	7	4	3	10
7	10:00-11:00	8	8	4	3	7	3	10	8	4
8	8:00-9:00	4	-	10	-	-	5	-	10	9
9	9:00-10:00	8	8	3	8	9	2	5	8	9
10	16:00-17:00	8	6	5	5	5	2	5	4	4
11	8:00-9:00	4	-	5	-	-	6	-	4	9
12	11:00-12:00	8	7	5	3	6	2	9	7	9
13	12:00-13:00	4	-	9	-	-	8	-	2	10
14	15:00-16:00	4	-	3	-	-	5	-	7	6
15	14:00-15:00	8	6	6	8	8	8	8	7	9
16	13:00-14:00	4	-	5	-	-	2	-	10	8
17	16:00-17:00	4	-	5	-	-	2	-	6	8
18	16:00-17:00	4	6	8	5	7	3	5	6	8
19	15:00-16:00	8	6	5	5	5	2	5	9	8
20	11:00-12:00	4	-	5	-	-	2	-	2	8
Sum of functional counters in 20 hours		116								
Average # of functional counters per hour (116 counters/20 hours)		5.8								

The result was found to be 6 functional counters/servers per hour even if the branch has planned to utilize 8 servers per hour each day (as shown in table 4.4.1.2). This helps determine the service rate under actual/empirical serving capacity of the branch & validate the findings of the survey.

The above table 4-4-1-1 shows the number of tellers working in the time intervals observation was made in the branch. The missed values indicated by dash (-) are the empty counters at the time of observation.

Table 4-4-1-2 Service rate computation: Time taken per customers served (over an interval of 1 hour) using the data from table 4.4.1.1.

Dashen bank S.C main branch: Average service time computation					
Day	Time-Intervals observations made. (A)	No. of functional counters per hr. (B)	Total customers served per hr. (C)	Total minutes utilized in serving customers per hour (D)	Average Minutes per customers served per hour per teller (E)
1	8:00-9:00	4	23	28	7
2	9:00-10:00	8	29	24	8
3	11:00-12:00	4	19	45	7
4	14:00-15:00	8	30	34	4
5	14:00-15:00	8	16	48	7
6	14:00-15:00	8	21	40	5
7	10:00-11:00	8	24	47	7
8	8:00-9:00	4	22	34	9
9	9:00-10:00	8	21	52	7
10	16:00-17:00	4	26	36	9
11	8:00-9:00	4	22	24	6
12	11:00-12:00	8	21	48	10
13	12:00-13:00	4	30	29	7
14	15:00-16:00	4	15	21	8
15	14:00-15:00	8	12	60	8
16	13:00-14:00	4	26	25	9
17	16:00-17:00	4	16	43	10
18	16:00-17:00	4	20	48	8
19	15:00-16:00	8	30	45	6
20	11:00-12:00	4	18	38	10
Sum of average minutes per customers served per counter in 20 hours					152
Service Rate^{-1} (1/) = 152/20 (service minutes per person), or					7.7 Minutes/person
Service Rate ( ) = customers per minute per counter					0.12

In the above table column (A) represents the time intervals (Poisson points) observation has been made for the study. Column (B) is the available number of operational counters at the date of observations. (C): represents the total number of customers served in all available counters within the time period (as obtained through observation). (D): is the summation of minutes spent in serving customers in all the available counters within the observation interval. Whereas, column (E) represents the average minutes spent in serving customers per counter.

Therefore, the average service time per customer (1/) computed as follows using the data in tables: 4.4.1.2 & 4.4.1.3.

$$\frac{1}{\mu} = \frac{\sum_{n=1}^{n=20} \boldsymbol{Dn}}{\sum_{n}.}$$

Where 1/ = the average service time per customer, D*n*= the dates observation was made (n=1, 2, 3…20)

$$\frac{1}{\mu} = \frac{7+8+7+4+7+5+7+9+7+9+6+10+7+8+8+9+10+8+6+10}{20}$$

$$\frac{1}{\mu} = \frac{152}{20} \text{ minutes per customer}$$

$$\frac{1}{\mu} = 7.7 \text{ minutes per customers}$$

$$\text{Therefore, the number of customers per minute ( ) = 0.12 customers, or}$$

= (0.12*60) customers per hour

= 7 customers per hour per counter

$$\text{i.e. 6 counters can serve on average } (6 * 7) = 42 \text{ customers per hour}$$

Based on the results of the above computations DB main branch has:

An average service rate: μ = 0.12 customers/minute i.e. 7 customers an hour.

An average arrival rate: λ = 0.35 customers /minute i.e. 21 customers per hour

Number of functional server = 6 (see table 4.4.1.2).

4.4.1.1. The Poisson distribution

The formula for a Poisson distribution is

$$P(X) = \left[\frac{^{x}\mathrm{e}^{-}}{\mathrm{X}!}\right]$$

Where,

λ = average arrival rate (i.e., arrivals during a specified period of time)

x = number of arrivals during the specified time period

e = 2.71828

X! = the factorial of a value, x [i.e. x! = x (x-1) (x-2) . . . (3) (2) (1)]

As an example of this distribution, consider the DB main branch's service facility that has an average arrival rate of 21 customers per hour (λ = 21). The probability that exactly thirty customers will arrive at the service facility is found by letting x = 30 in the preceding Poisson formula:

$$P(X) = \left[\frac{^{x}\mathrm{e}^{-}}{\mathrm{X}!}\right]$$

$$P(X = 30) = \left[\frac{21^{30}\mathrm{e}^{-21}}{30!}\right]$$

$$= 0.01$$

The value 0.01 is the probability of exactly thirty customers arriving at the service facility (branch) within an hour.

4.4.1.2. The Exponential Distribution

The formula for the exponential distribution is:

$f(t) = \mu e^{\mu t}$, $t \geq 0$

Where,

μ = average number of customers served during a specified period of time

t = service time

e = 2.71828

For example, in the practical case in point (in DB main branch), the average service rate is 7 customers per hour per counter, so the probability that a customer can be served within 10 minutes (0.17hour) is determined below. The probability that a customer will be served within the specified time period can be determined by using the Poisson's exponential distribution as:

$P(T \leq t) = 1- e^{\mu t}$

$P(T \leq 0.17) = 1- e^{-7(0.17)}$

$= 1- 0.304$

$= 0.696$

Thus, the probability of a customer being served within 10 minutes is 0.70. This represents the exponential probability distribution for service facilities having service rate (μ = 7).

4.4.1.3. Application of the single-queue multiple server queue formulas

Using the M/M/6 queuing analysis model and in response to the specific objectives of this study stated in chapter one, the operating characteristics (i.e. the probability of getting no customer in DB main branch (P_0), the average number of customers in the queuing system (Ls), the average time a customer spends in the queuing system (waiting and being served) denoted by Ws, the average number of customers in the queue (Lq), the average time a customer spends waiting to be served (Wq) and the probability that a customer arriving the branch must wait for service (i.e., the probability that all the counters are busy) are computed and the following results obtained.

The probability that there are no customers in the system (all servers are idle), Po is:

$$\mathbf{Po} = \frac{1}{\left[\sum_{n=0}^{n=c-1} \frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^{n}\right]+\frac{1}{c!}\left[\frac{\lambda}{\mu}\right]^{c}\left[\frac{c\mu}{c\mu-\lambda}\right]}$$

$$Po= \frac{1}{\left[\sum_{n=0}^{n=6-1} \cdot\frac{1}{5!}\left(\frac{0.35}{0.12}\right)^{5}\right]+\frac{1}{6!}\left[\frac{0.35}{0.12}\right]^{6}\left[\frac{(6)(0.12)}{[(6)(0.12)-(0.35\,)]}\right]}$$

$$Po= \frac{1}{\left[\frac{1}{0!}\left(\frac{0.35}{0.12}\right)^{0}+\frac{1}{1!}\left(\frac{0.35}{0.12}\right)^{1}+\frac{1}{2!}\left(\frac{0.35}{0.12}\right)^{2}+\frac{1}{3!}\left(\frac{0.35}{0.12}\right)^{3}+\frac{1}{4!}\left(\frac{0.35}{0.12}\right)^{4}+\frac{1}{5!}\left(\frac{0.35}{0.12}\right)^{5}\right]+\frac{1}{6!}\left[\frac{0.35}{0.12}\right]^{6}\left[\frac{(6)(0.12)}{[(6)(0.12)-(0.35\,)]}\right]}$$

$$Po \quad \frac{1}{[1+2.92+4.25+4.12+3.02+1.80]+[0.90]^{*}[1.95]}$$

$$Po \quad \frac{1}{18.86}$$

$=$ 0.05 Probability that there is no customer in the branch’s hall

The average number of customers in the queuing system (**L**) at a random point in time is

$$L= \frac{\lambda\ (\frac{\lambda}{-})^{c}}{(C-1)!(C\ \ -\lambda)^{2}}\ Po + \left(\frac{\lambda}{-}\right)$$

$$L= \frac{0.35*0.12\left(\frac{0.35}{0.12}\right)^{6}}{(6-1)!((6*0.12)-0.35)^{2})} *0.05 + \left(\frac{0.35}{0.12}\right)$$

$=$ 3 customers on average in the branch

The average time a customer spends in the queuing system (waiting and being served) denoted by W is

$$Ws = \frac{L}{\lambda}$$

$$Ws = \frac{3}{21}$$

$=$ 0.14 hours (8.4 minute)on average , customers spent in the branch (queuing system)

The average number of customers in the queue (Lq) is:

$$Lq = L - \frac{\lambda}{-}$$

$$Lq = 3 - \ 3$$

$=$ No customer on average, should be waitng to be served

The average time a customer spends in the queue, waiting to be served (Wq) is

$$Wq = \frac{Lq}{\lambda}$$

$$Wq = \frac{0}{21}$$

$= 0$ hour (No minute)on average shouldcustomers spent in queue before gretting service

The probability that a customer arriving the branch must wait for service (i.e., the probability that all the counters are busy) is:

$$Pw = \frac{1}{c!}\left[\frac{\lambda}{}\right]^{c}\left[\frac{c}{c\ \ -\lambda}\right]Po$$

$$Pw = \frac{1}{6!}\left[\frac{21}{7}\right]^{6}\left[\frac{6*7}{(6*7)-21}\right]*0.05$$

$= 0.10$ probability that a customer must wait for service in the branch

So, substituting the values along with λ=21 customers per hour, and μ=7 customers per hour per counter and C=6 functional counters, the queuing formulas resulted in operating characteristics summarized in table 4-4-1-3.

Secondary Data

The daily number of customers visiting the branch, whether the automated queue managing machine segment customers according to their specific needs or not, and standard service times adopted in the branch were obtained from secondary data source. The daily customer arrival data was obtained through review of the branch directory maintained by the automated queue managing machine and 254 customers were recorded the 1st day, 203 the 2nd day & 187 the 3rd day, their average being 214 customers a day; which means around 22 customers per hour. The value (22 customers per hour) is closely equal with the value obtained from observation analysis result (λ=21 customers per hour). This holds the data validity to be convincing since both secondary & primary data confirmed approximately same value of arrival rate. A standard time of 3 minutes for service in the branch was also coined from the branch operating manual.

Table 4-4-1-4 Summary of results obtained from mathematical analysis

λ	Average arrival rate to the branch	21
μ	Average service rate in the branch	8.33
P_0	Probability that no customers are in the branch queuing system	0.05
Ls	Average customers in the branch queuing system	3
Ws	Average minutes in the branch per customer	8.33
L_q	Average customers waiting to be served	0
W_q	Average time customers should wait in line before service	0
P_w	0.10 probability that a customer must wait for service	0.10

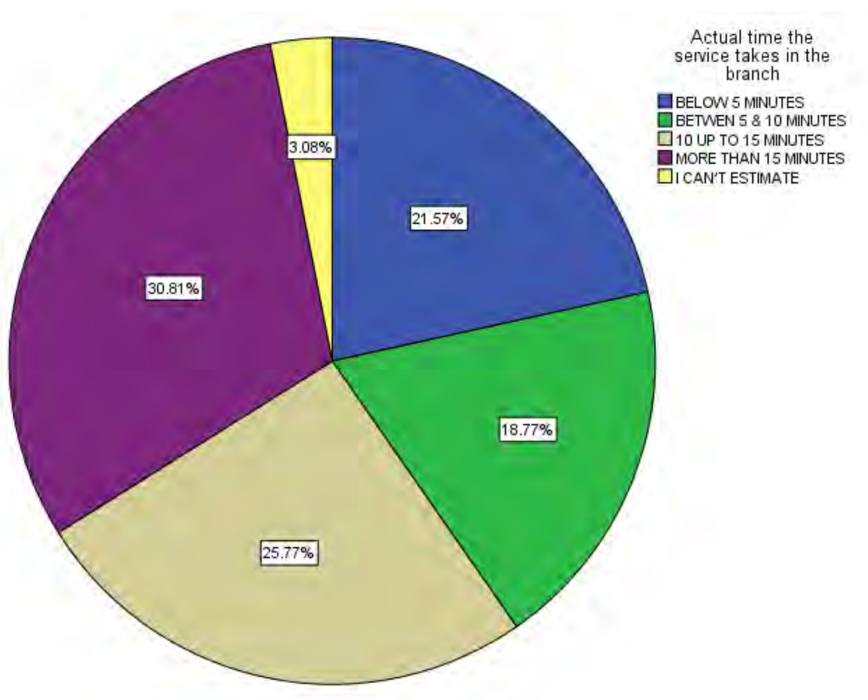
4.4.2. Interpretation of Observation Results

In this study, the student researcher investigated the queuing system at the banking hall of Dashen bank S.C main branch as Multiple-counter queuing model with Poisson arrivals and Exponential services times to reflect the queue characteristics at the branch. It was with aim of finding the optimal number of teller points that helps ease congestion at the banking hall. From the analysis of data obtained through observation (see Tables 4.4.1.1, 4.4.1.2, & 4.4.1.3), the results revealed that on average, every 3 minutes a new customer arrive at the branch on a random hour of a day between 8:00AM to 6:00AM and based on the 10 bank working hours. The mean arrival rate as computed above is around 21 customers per hour; (i.e. at a mean rate of lambda = 0.35 customer per minute, on average one customer appear every 1/lambda = 1/0.35 = 3 minutes) and the service time distribution, with a mean service rate of 0.12 customer per minute per each counter equals to 7 customers per hour per counter or around 8 minutes of average service time per customer per customer in the branch.

At a random visit of the branch, customers may come across an average number of no people waiting in queue, average number of 3 people in the queuing system (the branch) at a given point in time. Under normal operation, the average waiting time spent in queue is 0 (zero) minutes and average time spent in the branch service is approximately 8 minutes per customer because there is no time spent in waiting line.

The mathematical analysis results revealed that the service capacity of 6 functional counters is built in the branch; it somehow meets customers' expectations. The length of queue and waiting times of customers at the branch service provisions according to the result obtained from the observation data were both zero. In contrary to this, the survey of customers queuing perceptions revealed that, largest portion of the branch customers 181 (51%) were willing to spend no more than 5 minutes in banking services. Whereas, 75.35% of the respondents confirmed that the actual service time in the branch lengthens more than 5 minutes of which 56.6 % viewed as it actually costs more than 10 minutes to get service in the branch. At the same time, this portion of customers witnessed that they are getting bored of the service time length, by indicating services in this branch are consuming more than 15 minutes of their invaluable times. This figure can still be reduced to lesser minutes of service according to world class banks practical set-ups. As noted by J. clemmer (1990), in service stations the average waiting time for a given customer before s/he is served & the average length of the line are two factors that can greatly affect their satisfaction. International banks are working towards customers' response by ensuring that on average, customers must wait no longer than 2 minutes before receiving services and the waiting line is no more than 2 people long. However, now that all the major foreign banks have signed deals with post offices, so that on average people live 2.1 minutes away from somewhere they can carry out basic banking services, face to face.

Figure 4-4-1 Actual service time in DB main branch as viewed by 357 customers



Therefore, services in this branch can better be rendered in average time less than 5 minutes from arrival to departure. The outcome is not also considered reasonable as compared to customers' expectations extracted from the questionnaire end result and so would probably result in frustration, dissatisfaction and loss of customers in the long run. This shows that customers in DB main branch service system are spending somehow longer time in the branch and get frustrated by the relatively longer service time of 8.33 minutes even if the probability of waiting for service under normal operating conditions is 0.10.

The analysis of existing queuing system also shows that the numbers of teller points currently maintained at the branch hall is adequate & able to reduce the waiting time of customers in the queuing system. This is due to the fact that the average arrival rate of customers per hour, 21 customers can fairly be distributed around 4 customers per hour among the 6 counters. Each customer requiring an average service rate of 8.33 minutes (60/7) under the existing operating condition; So when 4 customers are allocated to a given counter with each customer taking 8.33 minutes per customer, 34 minutes (8.33*4) of an hour is utilized in rendering service to such customers with the determined average arrival rate of 21 customers per hour. On the other hand, if a counter is serving 7 customers on average per hour, the existing 6 functional counters can serve 42 customers within an hour. In the former case, a counter is still capable to render the service 3 more extra of customers (i.e. without 26 minutes left surplus). From the queue performance measures, increasing the number of teller points to any number greater than 6 (see table 4.4.1.2) is not recommended & result in extra cost to the branch. As a result of the likelihood that each teller is busy was 56.7 %(34/60); tellers may not call the next customer just upon completion of the current one.

Excess capacity

As disclosed in the earlier sections, the total number of functional counter per day in DB main branch was estimated to 6. The number of optimum counters was found 4 servers (tellers) to effectively entertain the existing demand. Here, it can be observed that 2 more counters left excess without being involved in rendering service to the coming customers to the branch. Therefore, excess capacity is the amount of idle capacity left idle (unused) by customers at the time of service in the branch, without being utilized. The portion of idle (excess) capacity in the branch can be computed as $\frac{\text{2 idle counters}}{\text{6 functional counters}} \text{ x } 100 = 33.33\%$. This figure indicates there is a 33.33% idle capacity at the branch in an average measure of time.

4.4.3. Simulation of DB Main Branch Queuing System

Some queuing situations, however, are so complex that it is impossible to develop an analytical model. When these situations occur, an alternative form of analysis is simulation, in which the real-life queuing system is simulated via a computerized mathematical model. The operating characteristics are determined by observing the simulated queuing system. Here, the queuing system of Dashen bank main branch is simulated to validate the findings of analytical model demonstrated in section 4.4.1. As the branch has got 6 functional servers at which arriving customers can get services, customers visit the branch at the rate of 1, 2, 3, 4, 5, 6, 7 or 8-minute intervals, with probability distributions shown in table 4.4.3.1.

Table 4-4-3-1 Probability distribution of arrival intervals

P(X=1)	P(X=2)	P(X=3)	P(X=4)	P(X=5)	P(X=6)	P(X=7)	P(X=8)
0.22	0.21	0.20	0.15	0.08	0.05	0.07	0.02

(Source: own computation, see Appendix B.4)

Where, X= the length of minute interval in which customers arrive at the bank branch. It represents, P(x=1) is 0.22 means the probability that a customer arrives within 1 minute interval is 22%, and similar interpretations for the rest of others.

Table: 4-4-3-2. Probability distribution of arrival intervals

Arrival Interval (Minutes), x	Probability, P(x)	Cumulative Probability	Random Number Range, r1
1	0.22	0.22	1-22
2	0.21	0.43	23-43
3	0.20	0.63	44-63
4	0.15	0.78	64-78
5	0.08	0.86	79-86
6	0.05	0.91	87-91
7	0.07	0.98	92-98
8	0.02	1	99-,00

(Source: own computation, May 2016)

Once a customer arrives at the serving counters, it also takes an average of 4.0, 5.0, 6.0, 7.0, 8.0, 9.0 and 10.0 minutes to complete the services (see probability distributions shown in Table 4.4.3.3 or 4.4.3.4).

Table 4-4-3-3 Probability distribution of service times

P(X=4)	P(X=5)	P(X=6)	P(X=7)	P(X=8)	P(X=9)	P(X=10)
0.05	0.05	0.1	0.30	0.20	0.15	0.15

(Source: own computation, May 2016)

Where, X= the length of minute duration taken in serving a given customer
P(X) = probability of X.

Table 4-4-3-4 Distribution of service times & corresponding probabilities

Service Time (Minutes), y	Probability, P(y)	Cumulative Probability	Random Number Range, r2
4	0.05	.05	1-5
5	0.05	.10	6-10
6	0.1	.20	11-20
7	0.3	.50	21-50
8	0.2	.70	51-70
9	0.15	.85	71-85
10	0.15	1.0	86-99

(Source: own computation, May 2016)

Developing the cumulative probability distribution helps to determine random number ranges. Although the cumulative probability goes up to 1.00, appendix B.2 contains only random number values from 0 to 99. Thus, the number 0 is used in place of 100 in the last random number range of each table.

Table 4.4.3.2 defines the inter-arrival time, or how often customers arrive at the branch. For example, there is a 0.22 probability of one customer arriving 1 minute after the previous customer. Table 4.4.3.3 defines the service time for a customer. Notice that cumulative probabilities have been included in both tables 4.4.3.2 and 4.4.3.3. The cumulative probability provides a means for determining the ranges of random numbers associated with each probability. For example, in table 4.4.3.2 the first random number range for r_1 is from 1 to 22, which corresponds to the cumulative probability of 0.22. The second range of random numbers is from 23 to 43, which corresponds to a cumulative probability of 0.43.

Table 4.4.3.5 illustrates the manual simulation process of customer arrivals & service times at DB main branch for three hours. The process can be interpreted as follows: 1st Customer arrives at time 0, which is recorded on an arrival clock. Since there are no customers in the system at the beginning of working hour, customer 1 approaches the counter (teller) immediately, also at time 0. The waiting time is 0. The next, a random number, $r_2 = 49$, is selected from the third column in appendix B.2. Observing table 4.4.3.4, it can be seen that the random number 49 results in a service time, y, of 7 minutes. After getting served, the customer departs within a time of 7 minutes from a counter, having been in the queuing system a total of 7 minute. The next random number, $r_1 = 52$, is selected from appendix B.2, which specifies that the 2^{nd} customer arrives 3 minutes after customer 1, or at time 3.0, as shown on the arrival clock. Because customer 1 departs the counter at time 6.0, customer 2 can be served immediately and thus incurs no waiting time. The next random number, $r_2 = 17$, is selected from appendix B.2, which indicates that batch 2 will spend 6.0 minutes being served and will depart at time 9.0. Likewise, this continues until the 6 functional counters (tellers) get busy & after that queue starts to form.

Table 4-4-3-5 Simulation of queuing system in DB main branch

Customer	**r_1**	**Arrival Interval, x**	**Arrival Clock**	**Enter Counter Clock**	**Waiting Time**	**r_2**	**Service Time, y**	**Departure Clock**	**Time in System**
1			0.0	0.0	0.0	49	7.0	6.0	7.0
2	52	3.0	3.0	3.0	0.0	17	6.0	9.0	6.0
3	15	1.0	4.0	4.0	0.0	57	8.0	12.0	8.0
4	18	1.0	5.0	5.0	0.0	10	5.0	10.0	5.0
5	47	3.0	8.0	8.0	0.0	30	7.0	15.0	7.0
6	49	3.0	11.0	11.0	0.0	34	7.0	18.0	7.0
7	10	1.0	12.0	12.0	0.0	86	10.0	22.0	10.0
8	28	2.0	14.0	14.0	0.0	44	7.0	21.0	7.0
9	41	2.0	16.0	16.0	0.0	27	7.0	23.0	7.0

Customer	r_1	Arrival Interval, x	Arrival Clock	Enter Counter Clock	Waiting Time	r_2	Service Time, y	Departure Clock	Time in System
10	14	1.0	17.0	17.0	0.0	71	9.0	26.0	9.0
11	15	1.0	18.0	18.0	0.0	3	4.0	22.0	4.0
12	75	4.0	22.0	22.0	0.0	40	7.0	29.0	7.0
13	34	2.0	24	24	0.0	61	8.0	32.0	8.0
14	88	6.0	30	30	0.0	88	10.0	40.0	10.0
15	46	3.0	33.0	33.0	0.0	93	10.0	43.0	10.0
16	73	4.0	37.0	37.0	0.0	33	7.0	44.0	7.0
17	30	2.0	39.0	39.0	0.0	19	6.0	45.0	6.0
18	58	3.0	42.0	42.0	0.0	24	7.0	49.0	7.0
19	1	1.0	43.0	43.0	0.0	12	6.0	49.0	6.0
20	41	2.0	45.0	45.0	0.0	78	9.0	54.0	9.0
21	92	6.0	51.0	51.0	0.0	55	8.0	59.0	8.0
22	17	1.0	52.0	52.0	0.0	62	8.0	59.0	8.0
23	95	7.0	59.0	59.0	0.0	53	8.0	67.0	8.0
24	67	4.0	63.0	63.0	0.0	81	9.0	72.0	9.0
25	96	7.0	70.0	70.0	0.0	18	6.0	76.0	6.0
26	73	4.0	74.0	74.0	0.0	3	4.0	78.0	4.0
27	35	2.0	76.0	76.0	0.0	95	10.0	86.0	10.0
28	86	5.0	81.0	81.0	0.0	34	7.0	88.0	7.0
29	2	1.0	82.0	82.0	0.0	98	10.0	92.0	10.0
30	12	1.0	83.0	83.0	0.0	72	9.0	92.0	9.0

Customer	r_1	Arrival Interval, x	Arrival Clock	Enter Counter Clock	Waiting Time	r_2	Service Time, y	Departure Clock	Time in System
31	51	3.0	86.0	86.0	0.0	30	7.0	93.0	7.0
32	21	1.0	87.0	87.0	0.0	11	6.0	93.0	6.0
33	82	5.0	92.0	92.0	0.0	90	10.0	102.0	10.0
34	75	4.0	96.0	96.0	0.0	46	7.0	103.0	7.0
35	60	3.0	99.0	99.0	0.0	84	9.0	108.0	9.0
36	9	1.0	100.0	100.0	0.0	27	7.0	107.0	7.0
37	20	1.0	101.0	101.0	0.0	49	7.0	108.0	7.0
38	32	2.0	103.0	103.0	0.0	81	9.0	112.0	9.0
39	26	2.0	105.0	105.0	0.0	65	8.0	113.0	8.0
40	42	2.0	107.0	107.0	0.0	20	6.0	113.0	6.0
41	79	5.0	112.0	112.0	0.0	24	7.0	119.0	7.0
42	9	1.0	113.0	113.0	0.0	8	5.0	118.0	5.0
43	8	1.0	114.0	114.0	0.0	47	7.0	131.0	7.0
44	28	2.0	116.0	116.0	0.0	28	7.0	123.0	7.0
45	62	4.0	120.0	120.0	0.0	66	8.0	128.0	8.0
46	32	2.0	122.0	122.0	0.0	83	9.0	131.0	9.0
47	60	3.0	125.0	125.0	0.0	84	9.0	134.0	9.0
48	40	2.0	127.0	127.0	0.0	49	7.0	134.0	7.0
49	34	2.0	129.0	129.0	0.0	61	8.0	137.0	8.0
50	96	7.0	136.0	136.0	0.0	18	6.0	142.0	6.0
51	52	3.0	139.0	139.0	0.0	17	6.0	145.0	6.0

Customer	r_1	Arrival Interval, x	Arrival Clock	Enter Counter Clock	Waiting Time	r_2	Service Time, y	Departure Clock	Time in System
52	88	6.0	145.0	145.0	0.0	88	10.0	155.0	10.0
53	73	4.0	149.0	149.0	0.0	4	4.0	153.0	4.0
54	9	1.0	150.0	150.0	0.0	27	7.0	157.0	7.0
55	15	1.0	151.0	151.0	0.0	57	8.0	159.0	8.0
56	46	3.0	154.0	154.0	0.0	93	10.0	164.0	10.0
57	35	2.0	156.0	156.0	0.0	95	10.0	166.0	10.0
58	20	1.0	157.0	157.0	0.0	49	7.0	164.0	7.0
59	40	2.0	159.0	159.0	0.0	49	7.0	166.0	7.0
60	52	3.0	162.0	162.0	0.0	17	6.0	168.0	6.0
61	15	1.0	163.0	163.0	0.0	57	8.0	171.0	8.0
62	18	1.0	164.0	164.0	0.0	10	5.0	169.0	5.0
63	47	3.0	167.0	167.0	0.0	30	7.0	174.0	7.0
64	49	3.0	170.0	170.0	0.0	34	7.0	177.0	7.0
65	10	1.0	171.0	171.0	0.0	56	8.0	179.0	5.0
66	29	2.0	173.0	173.0	0.0	58	8.0	181.0	8.0
67	28	2.0	175.0	175.0	0.0	44	7.0	182.0	7.0
68	41	2.0	177.0	177.0	0.0	27	7.0	184.0	7.0
69	75	4.0	181.0	181.0	0.0	40	7.0	188.0	7.0
							514		**511.0**

The process of selecting random numbers as well as generating arrival intervals and service times has continued until 69 customers arrivals have been simulated, as shown in 4.4.3.5. This is done with the intention to simulate the results obtained using data of one hour interval into three hours. Manual simulations are more time consuming tasks. Once the simulation is completed, the operating characteristics can be computed from the simulation results, as follows:

Average Arrival rate at the branch $= \frac{69 \text{ customers}}{3 \text{ hours}}$

$= 23$ customers per hour

Average time spent in the branch(Ws) $= \frac{511 \text{ minutes}}{69 \text{ customers}}$

$= 7.4$ minutes per customer per counter

Average servic time per customer (μ) $= \frac{514 \text{ minutes}}{69 \text{ customers}}$

$= 7.5$ minutes per customer per counter

Average waiting time (Wq)as can be observed from the simulation table 4.4.3.6. is 0 minute.

It can be observed that the entire values of simulation table in column 6 are all zero (0).

Hence no waiting time spent in the branch (Ws $= 0$)

And so the length of queue (Lq)is also zero

But the length queue in the branch (the number of customers in the branch at a given time) is given by:

The average Lengh of queue (Ls) $= \frac{181 \text{ customers}}{3 \text{ hours}}$

$= 2.67$ customers per hour

≈ 3 customers

Table: 4-4-3-7. Comparison of results obtained from analytical method & Simulation of queuing system in DB main branch

Symbol	Variables	Analytical method	Simulation method
λ	Average arrival rate	21	23
μ	Average service rate	8.33	7.5
Ls	Average customers in the branch queuing system	3	2.6
Ws	Average minutes in the branch per customer	8.33	7.4
L_q	Average customers waiting to be served	0 (No)	0 (No)
W_q	Average time customers should wait in line before service	0 (No)	0 (No)

As can be seen from the above table the simulation results are almost all the same (closest) to the result obtained using mathematical computation of observation data. Taking Ws = 8.33 minutes in the branch as an example, slight difference of one minute (8.33-7.4 = 0.93) is resulted from the fact that not enough number of simulations is undertaken. The more the number of items included in simulation, the better the two results become alike. As the number of random trials is increased, the probabilities in the simulation will more closely conform to the actual probability distributions. That is, if we simulated the queuing system for 1,000 arrivals, we could more reasonably expect that 22% of the arrivals would have an inter-arrival time of 1 minute. It's also seen from table 4.4.3.5 that both the length of queue (Lq) & waiting times (Wq) for services are found to be zero under the existing operating conditions. No customer spends time in the waiting line of the branch.

An additional factor that can affect simulation results is the starting conditions. If we start our queuing system with no customers in the system, we must simulate a length of time before the system replicates normal operating conditions. In this practical case, it is logical to start simulating at the time the counters starts operating in the morning.

From the above simulation table it can also be clearly observed that 4 counters (tellers) are adequate for efficient & effective operation of the branch. Up to this point (4 counters) there is no customers' congestion under the observed operating condition. So the branch can still perform activities economically without strain consisting 4 counters. On the other end the branch has an option to strive for increasing customer inputs as possible due to surplus server capacity at hand besides the stiff competition of the time. Nevertheless, since mankind cannot operate like machine continuously & consistently, decision makers should simultaneously consider (incorporate) other human factors/elements like tea breaks, sickness, annual leaves, rest- room minutes and other inevitable life scenarios. Considering all this, the number of tellers currently maintained in the branch is adequate to effectively handle the existing operation. So what the branch needs to do is, striving to maximize the customers' response especially with respect to service time improvement. This is because businesses this time are getting more & more sophisticated with high-tech technologies, customer are being more time sensitive due to the increased competition. In support of this theme David, et.al, (2012) noted that the past recent years have been a time of unprecedented pressure in the banking sector. Customers have become ever more demanding – and less forgiving; regulators' risk management expectations are more onerous than ever before; investment in new technology has become a business-critical decision; banks in developed countries are providing more options for customers.

4.4.4. Analysis of Data obtained through Questionnaire

The queuing system of Dashen bank S.C main branch is also assessed using standard questionnaire to investigate the queue characteristics, the expectation levels of customers (queue psychology) and their current actual satisfactions with regards to the waiting time experiences. This section involves presentation of the data gathered through questionnaire in the process of conducting the study. It includes the analysis made using the outputs provided by the SPSS software version 20.0 made with the aim of measuring the waiting time perception of the branch customers.

Descriptive statistics was applied to describe the basic features of the data and summarize means of each of the three dimensions: the general information/profile of the respondents, customers queue psychology and the overall customer satisfaction regarding the queuing system.

In order to start the analysis of this study the student researcher considered the validity and reliability of the instrument.

4.4.4.1. Validity and Reliability Analysis

4.4.4.1.1. Validity Analysis

Validity according to Carmines and Paul R. (1998) is defined as how much any measuring instrument measures what it is intended to measure. It's a critical aspect of measurement that must be considered as part of an overall measurement strategy. Validity focuses on what the test or measurement strategy measures. Admonitions such as those of Singer and McClelland (1990) are particularly appropriate for newly collected data sets, which have not existed for long periods of scholarly use and which have not been subjected to extensive reliability and validity tests.

However, in this study the researcher adopted tested standard instruments to indemnify the issue of data validity in the research process for each of the three queuing system dimensions (the general information of the respondents, customers queue psychology and the overall customer satisfaction regarding the queuing system).

4.4.4.1.2. Scale Reliability Analysis

Reliability can be defined as the degree to which measurements are free from error and, therefore, give in consistent results. In other words, reliability concerns the extent to which an experiment, test, and any measuring procedure yields the same results on repeated trials (Carmines and Zeller, 1979).

Internal consistency involves correlating the responses to each question in the questionnaire with those of other questions in the questionnaire (Saunders, 2000). Although there are variety of methods for calculating internal consistency, Cronbach's alpha is one of the most frequently used, which is the degree of inter-correlations among the items that constitute a scale.

Although reliability is a necessary and essential consideration when selecting an instrument or measurement approach, it is not sufficient in and of itself. That is why the researcher was considered the validity of the measurement approach or instruments.

Reliability analysis was conducted to check whether a scale used in this paper consistently reflects the subset it measures. For this study, the Cronbach's α is used as a measure of internal consistency using SPSS (Statistical Package for Social Sciences). The overall Cronbach's α for the survey designed for the study is 0.85, which is well over the accepted limit of 0.70, which is highly reliable (Alpha=0.900>0.70 standard). Therefore, the result shows that the results extracted from the questionnaire are highly reliable.

Table 4-4-4-1 Scale Reliability (Cronbach's alpha) for 25 items

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.850	.875	25

Source: Own computation, April 2016

4.4.4.2. Response rate

Out of 384 set of questionnaires, 357 were returned, yielding 92% of response rate and all used for the analysis. The remaining 27 (8%) were not collected back & excluded from analysis, since acceptable and enough for conducting the necessary statistical test. However, skipped questions were represented by the missing value 0, zero.

4.4.4.3 Respondents' General Information

This part of questionnaire was designed to obtain general information on the number of years the respondents have been the customers of the branch under investigation. This includes the type of bank the respondents usually visit, the number of years they have been customer of this branch, the distribution of DB branches in the country, the branch respondents usually visit, the frequency of visiting the main branch and the mode of dealing with the branch. The analysis shows that (46.5%) of the respondents deal with both private & government banks. This enables the respondents to compare service times with practical experiences of other banks. As respondents general information, 58 % of the respondents visited DB main branch for more than 5 years, 170 (47.6%) rated the distribution of DB branches as fairly distributed & conveniently accessible, among all the respondents enquired, 300 (84%) usually deal with DB main branch; (with frequencies 33: once to trice a day, 107 once to trice a week, 23 responded daily, 38 once in 3 weeks, 77 monthly and the remaining 79 respondents answered other than mentioned).

Where the largest percentages 213 (59.7%) have office contact & ATM service deal with the bank. (See appendix C or table 4.4.4.2)

Table 4-4-4-2 frequency of customers using DB main branch

Frequency of using main branch

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Once To Thrice A Day	33	9.2	9.2	9.2
	Once To Thrice A Week	107	30.0	30.0	39.2
	Daily	23	6.4	6.4	45.7
	Once In 3 Weeks	38	10.6	10.6	56.3
	Monthly	77	21.6	21.6	77.9
	Other	79	22.1	22.1	100.0
	Total	357	100.0	100.0	

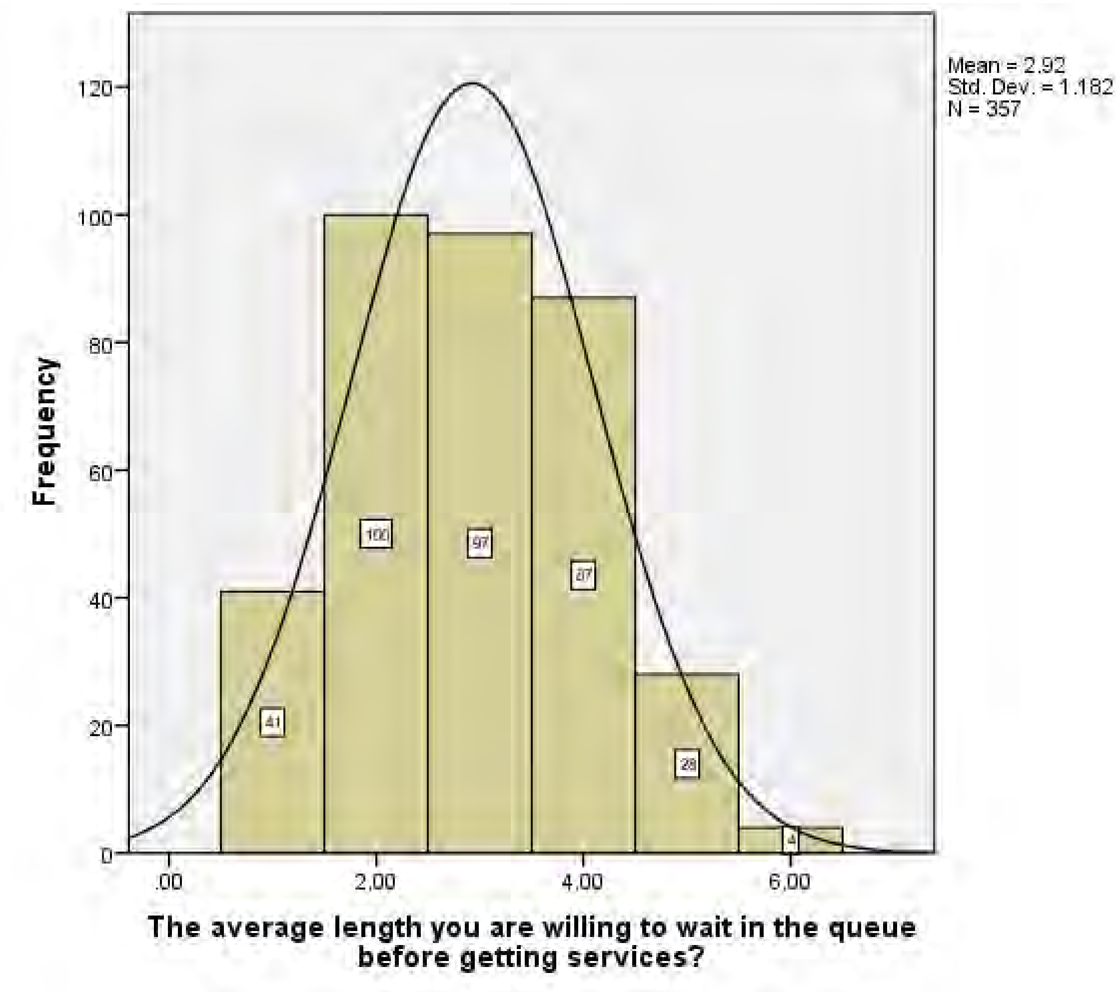
Source own SPSS, April 2016

The analysis also shows that 79.9 cumulative percent of the respondents (sum of frequencies except "responded other") have frequency of using the branch once to trice up to once monthly. Therefore, majority of the respondents are knowledgeable enough to give information about service time perceptions of DB main branch.

4.4.4.4. Respondents' Queue Psychology

In terms of investigating customers queue psychology in DB main branch, empirical assessments on customers queuing perception were made. At the time, points like: average time customers are willing to spend in banks queuing system (waiting and being served), the estimated duration of actually service time in this branch, how do customers compare the waiting time for service of this branch with other branches and whether they have ever been turned away due to longer queue in the branch or not including their happiness states with the serving times were evaluated.

Figure: 4-4-4-1. The average lengths of time customers are willing to spend in banks



As can be seen from the analysis result of questionnaire (table 4.4.4.3 or fig. 4.4.4.1), more than 50% of respondents (181 respondents) are willing to spend less than 5 minutes in bank services. The second larger portion is willing to spend 5 to 10 minutes, and very few percent (8%) are time insensitive.

Table 4-4-4-3 Average time customers are willing to spend for service

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below 5 Minutes	181	50.7	50.7	50.7
	Between 5 & 10 Minutes	122	34.2	34.2	84.9
	10 Up To 15 Minutes	51	14.3	14.3	99.2
	More Than 15 Minutes	3	0.8	0.8	100.0
	Total	357	100.0	100.0	

When customers were enquired to know the actual time the branch is taking for services, still the largest portion of respondents 110 customers (30.8%) revealed that service in the branch is consuming more than 15 minutes. 44.6% (159) responded between 5 and 15; and only 77 customers (21.6%) enjoyed service minutes less than 5 minutes. In the long run, this may in turn make customers unhappy dealing with the branch, upset their queue psychology and may result in a general slump of the business; even if the largest portion of customers 170 (47.6%) ranked the service to be average as compared to others branches. Because as many management science practitioner agreed, customers this time are becoming more time sensitive than ever before, service quality improvement with respect to time is vital businesses (See table 4.4.4.4).

Table 4-4-4-4: Actual time the service takes in the branch

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below 5 Minutes	77	21.6	21.6	21.6
	Between 5 & 10 minutes	67	18.8	18.8	40.3
	10 Up To 15 Minutes	92	25.8	25.8	66.1
	More Than 15 Minutes	110	30.8	30.8	96.9
	I Can't Estimate	11	3.1	3.1	100.0
	Total	357	100.0	100.0	

Here customers' call for service time improvement is also made to the branch management, 237 customers (66.4%) confirming the moments they have returned away due to longer queues (see table 4.4.4.5). regarding the current practice of service time in the branch, 62.2% customers are neither happy nor unhappy, but they can't tell their happiness (neutral), where only 15.4 % are happy (see Appendix C).

Table 4-4-4-5 Frequency of customers ever turned away due to long queues

Have you ever turned away due to long queue?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	237	66.4	66.4	66.4
	No	119	33.3	33.3	99.7
	I Can't Remember	1	.3	.3	100.0
	Total	357	100.0	100.0	

(Source; own computation: April 2016)

4.4.4.5. Customers satisfaction regarding the queuing system

As per the operational manual maintained in the branch, the standard time for service is 3 minutes. However, this established time is not well communicated to customers because 21.6 % of the respondents are somehow satisfied, the remaining portion (78.4%) bearing responses ranging from "indifferent" to "very dissatisfied". This shows that larger percentage of respondents don't know service time standard in the branch.

Only 3.6% of the respondents are satisfied, another 3.6% somehow satisfied and the remaining percent (92.8%) range from "somehow satisfied" to "very dissatisfied" regarding the branch's fulfillment of service at the time indicated. And only 3.6% are very dissatisfied, 3.1% dissatisfied and 25.2% are somehow dissatisfied; the remaining 68.1% range from "indifferent" to "very satisfied" with the branch's staffs knowledge sufficiency to answer all their questions on time. Distance from customers place to the branch (premises) was the other factor that; very dissatisfied only 5.9%, dissatisfied 9.2%, somehow dissatisfied 18.2%, and kept the rest of 66.7% on the opposite side of the continuum. This shows that distance to bank branch disappointed only lesser portion of the customers. Also as Anubav, (2010) the point in time that frustrates customers waiting for services is the only time they spent in queues at service stations.

Table 4-4-4-6 Customers' response as related to distance to the branch

Levels of customers satisfaction related to distance to the Branch (Premises)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Dissatisfied	21	5.9	5.9	5.9
	Dissatisfied	33	9.2	9.2	15.1
	Somehow Dissatisfied	65	18.2	18.2	33.3
	Indifferent	39	10.9	10.9	44.3
	Somehow Satisfied	69	19.3	19.3	63.6
	Satisfied	98	27.5	27.5	91.0
	Very Satisfied	32	9.0	9.0	100.0
	Total	357	100.0	100.0	

(Source; own computation: April 2016)

Documents associated with services like forms, pamphlets, vouchers, etc dissatisfied only 9.2% percent, easily understood by 42.6% & so cannot be considered as a time consuming factor. Larger percent (55.3%) made their responses on satisfaction side because they know that the branch performs the services exactly at the first time. 50% range from "very dissatisfied" to 'somehow dissatisfied", due to the branch lucks their interest at heart.

Table 4-4-4-7 Customers' response as related to staffs' prompt service

The branch's staff give you prompt service

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Dissatisfied	49	13.7	13.7	13.7
	Somehow Dissatisfied	43	12.0	12.0	25.8
	Indifferent	115	32.2	32.2	58.0
	Somehow Satisfied	92	25.8	25.8	83.8
	Satisfied	47	13.2	13.2	96.9
	Very Satisfied	11	3.1	3.1	100.0
	Total	357	100.0	100.0	

(Source; own computation: April 2016)

13.7% of the respondents are dissatisfied, 12.0% somehow dissatisfied, 32.2% are indifferent because the branch's staff did not give them prompt service. The student researcher also enquired the average length customers are willing to wait in queue in terms of satisfaction, of which largest portion: 11.5% responded they are "very dissatisfied", the next 28% are "dissatisfied", 27.2% "somehow dissatisfied.

Table 4-4-4-8 Satisfaction levels of customers' regarding time willingness to wait

The average length of time you are willing to wait in queue before getting services

		frequency	percent	valid percent	cumulative percent
Valid	very dissatisfied	41	11.5	11.5	11.5
	Dissatisfied	100	28.0	28.0	39.5
	somehow dissatisfied	97	27.2	27.2	66.7
	Indifferent	87	24.4	24.4	91.0
	somehow satisfied	28	7.8	7.8	98.9
	Satisfied	4	1.1	1.1	100.0
	Total	357	100.0	100.0	

(Source; own computation: April 2016)

As compared to the outcome obtained from time range enquiry of willingness (see table 4.4.4.3), 84.9% (50.7%+34.2%) responded they were willing to wait less than 10 minutes; therefore, the figure (66.7%) indicating "dissatisfaction" level of customers is reliable story. Still 35.7% (2.8% very satisfied, 7% satisfied, and 26.1% somehow satisfied), which accounts for far less than 50% percent, justified their satisfaction levels; where the other 64.1% being on the dissatisfaction side of the band related to the chance of getting served without spending time in queue. As coined from observation findings, the branch has adequate capacity to address customers' requisition on time. On the other hand customers are showing their real feelings that their needs are not yet met. This indicates a mismatch (service gap) between the real customers' experiences and the embedded operating situation. Such tradeoffs may result from various reasons; according to concept Graydon and John C., (2008), discussed on 'success argument for software development' they explained that adequate server capacity in service stations in itself does not create customers response. In a waiting line system, managers must decide what level of service to offer customers. A low level of service may be inexpensive, at least in the short run, but may incur high costs of customer dissatisfaction, such as lost future business and actual processing costs of complaints. A high level of service will cost more to provide and will result in lower dissatisfaction costs. Because of this trade-off, management must consider what the optimal level of service to provide.

The practical situation serves as a yellow light for DB main branch management to check whether it's operating in line with customers' perceptions get well addressed. But this paper instills the proverb “customer is always king” as obviously known that they are the decisive grounds for the going concerns of every businesses; and let the task of reconciling the actual server capacity vs. customers-perceptions to the branch management.

The other theme point this paper underlines is, only lesser percent of the respondents (40.3%) expressed their satisfactions (3.4% very satisfied, 12.3% satisfied and 24.6% somehow satisfied) regarding the waiting area for customers adequate & conveniently complement their queue psychology. The average length of service time in the branch is also satisfied only 4.8% of the respondents & somehow satisfied 14%; the remaining largest percentage ranging from “very dissatisfied” to “indifferent.” Table 4.4.4.9: also signifies the empirical situation customers have been experiencing related to length of queues in DB main branch.

Table: 4-4-4-9. The average length of queue in DB main branch at a random moment a day

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Dissatisfied	23	26.4	6.4	6.4
	Somehow Dissatisfied	60	36.8	16.8	23.2
	Indifferent	136	18.1	38.1	61.3
	Somehow Satisfied	75	11.0	21.0	82.4
	Satisfied	53	4.8	14.8	97.2
	Very Satisfied	10	2.8	2.8	100.0
	Total	357	100.0	100.0	

(Source; own computation: April 2016)

As displayed there, larger portion of respondents expressed their dissatisfaction (26.4% “dissatisfied” and 36.8% “somehow dissatisfied”,) with the average length of queue at random moment a day in the branch. Greater portion of the respondents are friendly with the branch operating hours; 71.4% of which 39.8% are somehow satisfied, 24.9% satisfied and 6.7% are very satisfied) by the convenience of the branch operating hours. Smaller percentage of customers also showed satisfaction (3.6% “very satisfied” 5.6% “satisfied”, and 21.6% “somehow satisfied”) for the branch showing keen interest in solving their problems. Greater portion of respondents (63.6%) are on dissatisfaction side, of which 37.5% “somehow”, 15.7 “dissatisfied” and 10.4% “very dissatisfied” since the branch did not handle their queue psychology well.

The analysis output in table 4.4.4.10: shows that more than average number of respondents believe and expressed their satisfaction in line with customers serving discipline (FCFS queue discipline) maintained in the branch.

Table 4-4-4-10 Frequency of respondents showing the percentages of satisfaction regarding the serving discipline of the branch

The branch serves all customers in first-come-first-served queue basis

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Dissatisfied	12	3.4	3.4	3.4
	Dissatisfied	46	2.9	12.9	16.2
	Somehow Dissatisfied	65	8.2	18.2	34.5
	Indifferent	68	19.0	19.0	53.5
	Somehow Satisfied	55	15.4	15.4	68.9
	Satisfied	69	29.3	19.3	88.2
	Very Satisfied	42	21.8	11.8	100.0
	Total	357	100.0	100.0	

(Source; own computation: April 2016)

As can be seen from this table 21.8% are very satisfied, another 29.3% satisfied, and 15.4% somehow satisfied a total of 66.5% voting for “the branch serves all customers in first-come-first-served queue basis”. Whereas, larger portion ranked their dissatisfaction against the variable “branch staffs tell them the exact time the service is performed”; this response quantifying 7.0% “very dissatisfied”, 40.6% “dissatisfied”, and 30.8% “somehow dissatisfied” respectively.

Table: 4-4-4-11. The overall satisfaction of DB main branch on the queuing system

The overall satisfaction with the branch on the queuing system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Dissatisfied	15	14.2	4.2	4.2
	Dissatisfied	124	34.7	34.7	38.9
	Somehow Dissatisfied	97	27.2	27.2	66.1
	Indifferent	81	12.7	22.7	88.8
	Somehow Satisfied	38	10.6	10.6	99.4
	Satisfied	2	.6	.6	100.0
	Total	357	100.0	100.0	

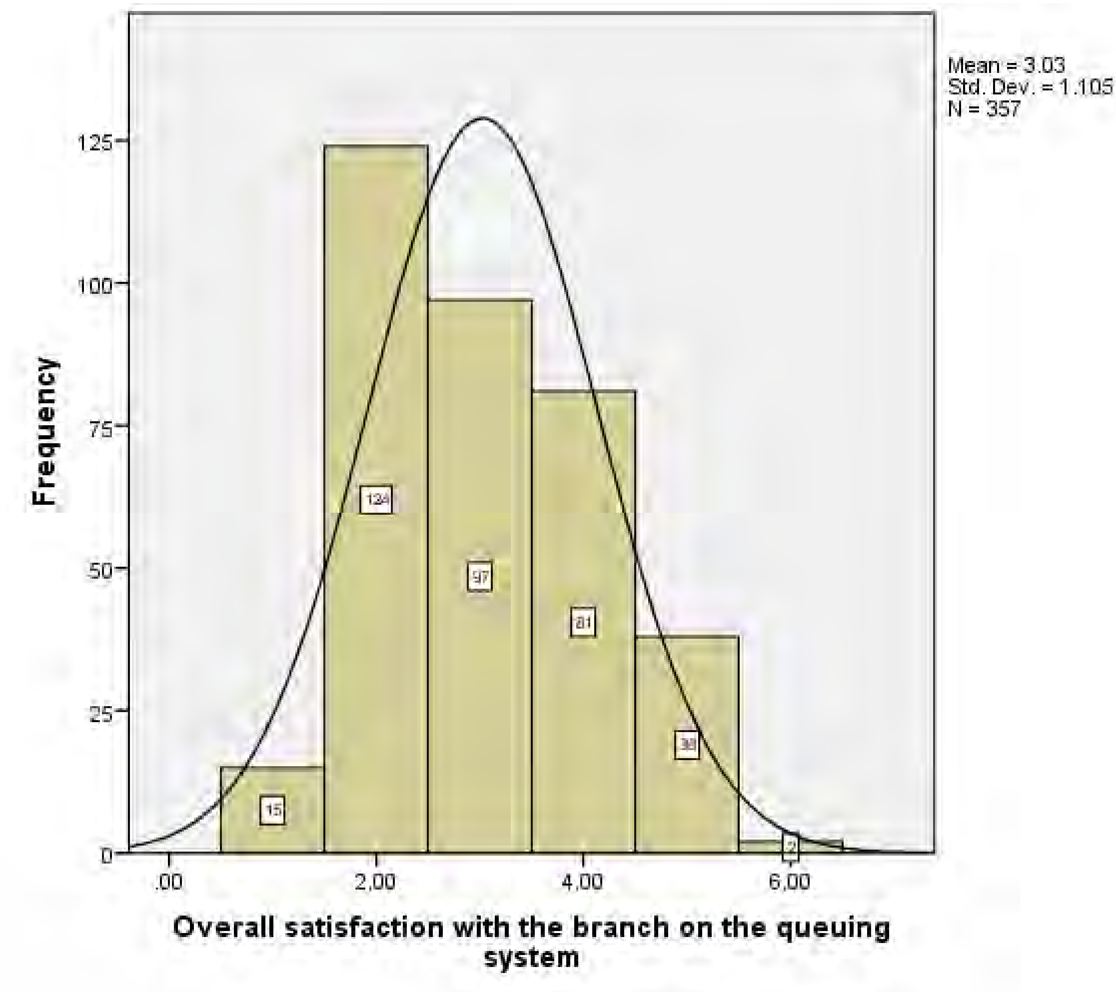
(Source; own computation: April 2016)

According to the findings of this survey and as displayed in table 4.4.4.11 & fig 4.4.4.2, DB main branch customers' have ranked their overall perceptions, exceedingly greater portion being in the dissatisfaction continuum. Of the respondents enquired 14.2% very dissatisfied, 34.7% are dissatisfied, 27.2% are somehow dissatisfied, the remaining few percent 23.9%) ranging from "indifferent to "satisfied". The percentage of respondents who disclosed their feeling as "satisfied" is very insignificant (0.6%). Therefore, the largest percentage indicated that customers in DB main branch service are dissatisfied concerning the overall queuing system.

With regards to handling of queuing psychology of customers, Katz, Larson and Taylor (1991) developed several rules, (i.e. perception is more important than reality, unoccupied time feels longer than occupied time, preprocess waits feel longer than in process waits, uncertain or unexplained waits feel longer than known waits and unfair waits even feel longer). One suggested solution is to segment the customers according to specific needs & win their perceptions. Waiting line problem is inherently nonlinear and therefore difficult for the manager to understand solutions to queue situations. So even if customers' dissatisfaction may not be real, but merely perception, the student researcher suggested working towards converting this negative perception in to positive & maintaining their queue psychology.

Crucially, it has also been claimed by Katz, Larson(1991) and Taylor (1994) that longish waits impact negatively on customer evaluations of an outlet's quality because long queues affect the customer's perceptions of the "punctuality" of a service (i.e. how promptly customer requirements are satisfied) and hence the customer's ratings of the service provider's overall efficiency and reliability.

Figure: 4-4-4-2. The overall perceptions of DB main branch customers regarding the queuing system in terms of satisfaction levels



4.5. Advantages and Limitations of Queuing Theory

4.5.1. Advantage of queuing theory

As noted in several related literatures & academic materials, it offers the following benefits:

- Queuing theory provides models that are capable of determining arrival pattern of customers or most appropriate number of service stations.

- Queuing models are helpful in creating balance between the two opportunity costs for optimization of waiting costs and service costs.
- Queuing theory provides better understanding of waiting lines so as to develop adequate service with tolerable waiting.

4.5.2. Limitations of Queuing Models

Anubav, (2010) reminded that queuing models have several limitations and are used in conjunction with the other decision analysis methods like simulation and regression. Most of these limitations are the basic assumptions for application of queuing models.

Some of the limitations of queuing models are enumerated below:

- Takes average of all variables rather than the real numbers itself
- Assumes steady state
- Based on assumption that service time is known
- Service times are independent from one another
- Service rate is known
- Service rate is greater than arrival rate
- Arrivals are served on first come first served basis
- Service times are described by exponential probability distribution

Most of the queuing models are very complex and cannot be easily understood. The element of uncertainty is there in almost all queuing situations.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION & RECOMMENDATIONS

5.1. Introduction

“Wait time – not prices, not selection, not product quality – is the number one factor impacting customer satisfaction” (Tamis, 2013)

According to Metters, King-Metters, Pullman and Walton (2006) to customers queuing is a bad thing that is the most time consuming due to management fault. Boredom resulting from queuing is said to generate restlessness, tension and anxiety and to encourage the customer to dwell on the possible adverse consequences of being late for his or her next intended activity.

Crucially, it has been claimed by Katz, Larson(1991) and Taylor (1994) that longish waits impact negatively on customer evaluations of an outlet's quality because long queues affect the customer's perceptions of the "punctuality" of a service (i.e. how promptly customer requirements are satisfied) and hence the customer’s ratings of the service provider's overall efficiency and reliability.

5.2. Summary of Findings

The study noted that, even if adequate server capacity is maintained in DB main branch, the ability of the branch to deliver timely service on a consistent basis has diminished. The available functional counters of 6 are quite sufficient to meet even more than the existing demand. But customers’ expectations are not yet met as supposed. Thus, DB main branch management should be engaged in search of substitute performances to offer and distinguish amongst customers diverse service requirements. Customers, both companies level as well as individuals, are not willing to queue in banks for the most essential of services.

The numerical values for independent variables of this analysis were: the arrival rate (λ=21) customers per hour, and service rate (μ=7) customers per hour per counter and an average of C=6 functional counters. The other operating characteristics are: $P_{0,}$ 0.05 probability that no customers are in the branch queuing system, the length of queue (Ls) is 3 customers, on average, in the branch queuing system, Ws 0.14 hr. (8.4 min.) average time in the branch per customer; Lq was found to be Zero (No customers on average) waiting to be served, Wq is also Zero hr. (No minute on average) time customers should wait in line before getting service, there is a probability (P_w) of 0.10 that a customer must wait for service; which indicates there is a greater likelihood for some of the branch counters to be idle at random moment in time.

The other finding is a given customer visiting DB main branch can get service within average of 8.33 minutes (standard time for service) under the current performance, which means around 7 customers get service per counter per hour in effective counter utilization. So the 6 available functional counters can render service for 42 (6*7) customers per hour. This is because the average length of queue & waiting time at a random moment in time were both found to be nil. In contrary to this, assessment of customers' real experiences showed that they get frustrated due longer queues & waiting times in the branch. Thus, the branch service capacity is underutilized & failed to address customers' expectations.

Queuing is psychologically stressing to the customer especially if the customer is doing nothing. The expected waiting time is much less than the actual time in the mind of the customer. For example an idle customer waiting for 30sec may interpret it to be a spectacular 3 minutes! According to the famous philosopher Berkeley "perception is essence" i.e. how long customers believe they wait matters more than how much they actually take. Sarel and Marmorstein (1998) also observed that more affluent customers would not tolerate delay in service delivery and were even willing to pay a premium due to the opportunity cost of waiting. What the paper uncovered in DB main branch was also same; customers' perceptions as obtained from queue psychology analysis revealed that customers are much frustrated and most of them were willing to spend no more than 5 minutes in queuing for banking services.

5.3. Conclusion

Mathew (2014) states that waiting lines form because people or things arrive at the servicing function, or server, faster than they can be served. However, this does not mean that the service operation is understaffed or does not have the overall capacity to handle the influx of customers. In fact, most businesses and organizations have sufficient serving capacity available to handle their customers in the long run. Waiting lines result because customers do not arrive at a constant, evenly paced rate, nor are they all served in an equal amount of time. Customers arrive at random times, and the time required to serve them individually is not the same. Thus, a waiting line is continually increasing and decreasing in length (and is sometimes empty), and it approaches an average rate of customer arrivals and an average time to serve the customer in the long run. For example, a teller counters at a bank may have enough tellers to serve an average of

100 customers in an hour, and in any particular hour only 60 customers might arrive. However, at specific points in time during the hour, waiting lines may form because more than an average number of customers arrive, and they make more than an average number of transactions.

What's observed in DB main branch was also not far from the above theme. There was arrival of 21 customers an hour & the average capacity of serving was 42 customers per hour; but incredibly customers were frustrated due to longer queues & waiting times. So this might have confirmed same with Mathew's memo presented on top; or brings a conclusion that tellers in the branch might not called next customers up on completion service at hands. This created service time gaps, forced customers to queue longer, frustrated customers queue psychology & significantly affected the effective utilization of the service capacity even if there had been sufficient server capacity maintained in the branch. The average service time of customers (8.33 minutes) per person was also longer as compared established standard (3 minutes) per individual. Customers were suffering from longer queues while there was greater likelihood to get counters idle; and besides possibility of zero minutes in waiting lines (no waiting customer) under the current server capacity.

However, according to Komal (2012), customers always anticipate meeting convenience and deserving modest business transactions. Other management scientists also believe that customer satisfaction has come to be regarded as a key business strategy of every business and a yardstick against which many banks have to set their standards. Sustaining existing customers for organizations is ever more important than the ability to capture new ones because customers are vital for any organization's success (Anubav, 2010). So since it's customary to see customers queuing for services in the branch hall at random moment of time, the branch queue management needs to demonstrate sound queue management practices for efficient operations to realize customer satisfaction, higher returns on investment & stay competitive.

Without customers, organizations would have no resources, no profits and therefore no market niches that can enable them compete in the global arena (Mburu, et al., 2013). These customers all seek quickly & value added services when they rush to banking halls. Competition and the constant revolution in technology and ways of life have changed the face of banking. This research uncovered the applicability and extent of usage of queuing models in achieving customer satisfaction at the lowest cost. The branch management should become aware of the actuality that customers are unhappy due to delay in service delivery by the branch even though the existing server system eliminates waiting.

The standard time of service in DB main branch service system was 8 minutes and found to be relatively longer as compared to the customers perceived standards. Although the probability of waiting for service in the branch was 0.10, customers were facing greater probabilities than designed. As can also be seen from the analysis result of questionnaire (4.4.4.3), more than 50% of respondents (181 respondents) were willing to spend less than 5 minutes in bank services. The second larger portions were willing to spend 5 to 10 minutes, and very few percent (8%) are time insensitive.

Queuing models have found widespread use in the analysis of service facilities, production and many other situations where congestion or competition for scarce resources may occur. This paper has introduced the basic concepts of queuing models, and shown how simulations, and in some cases a mathematical analysis, can be used to estimate the performance measures of queuing systems in banks.

5.4. Recommendations

To improve matters, the student researcher has recommended consider implementing effective counter utilization without addition of an extra service counters and work towards ways that improve service time per counter. To mention some, segmenting customers according to their needs, establishing & well communicating standard service times per individual to customers (like 8.33 service minute as investigated in this paper), motivating, training & instilling the concept of customers' value in the minds bank attendants.

Advantages of segmenting customers according to their specific needs is that it enables the bank to set more accurate standard service times for each specific service as well as counter per customer. Then customers can estimate the time they can reach their turn and await patiently. This can significantly maintain the customers queue psychology. So since uncertain or unexplained waits feel longer than known waits and unfair waits feel longer, the student researcher suggested segmenting customers according to specific needs as optional solution. Otherwise, waiting line problem is inherently nonlinear and therefore difficult for managers to understand solutions to queue situations. In the mean time the branch is also recommended to strive for increasing customer inputs per hour, assess for mechanisms that triggers tellers to call the next customer upon the completion of the current one at hand, because the number of existing service capacity (8 actual counters in the branch) exceed the optimum & disrupt the economic vs. service to customer equilibrium.

The following recommendations are also suggested for efficiency improvement and responsiveness of service to customers' in the branch:

- The management should educate their operation managers and other staff on the application of queuing models to operational problems.
- Trusting employees, empowering them, enrich their jobs by making them multi-skilled through continuous training to enable them eliminate unnecessary counter-check handoffs while allowing them to complete many processes in the front line.
- The queue characteristics should be viewed from the stand point of customers as to whether the waiting time is reasonable and acceptable by making queue discipline fair and varying the number of service counters according to the queue circumstances.
- Reengineering the banking operations through advanced IT solutions, faster operating system (than Flex cube) e.g. voicemail and online deposit & withdrawal systems to complement the queuing model, significantly reduces system or network disruption problems.
- Making customers comfortable and unaware of the waiting time by providing comfortable seats, air conditionings and toilet facilities in the waiting room and;
- Improvement of staff-customers relationship, investigating the factors contributing to the teller's underperformance and creating a sense of ownership in the hearts of the bank attendants.

The following areas of further investigations are also recommended to be carried out in the future since of higher significance to the branch management. Specific research to pick/off pick hours is better conducted. The factors that are responsible for the ineffective service delivery of the branch under adequate server capacity maintained also need to be investigated. Researches should also be conducted on the motivation levels of the branch tellers, their interest towards serving customers in time more efficiently & effectively. In general participatory survey shall be conducted on how to add service value to customers by practicing efficient queue management system.

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APPENDICES

Appendix A.1: Amharic questionnaire

<u>ትምህርታዊ ጥናት</u>

<u>መጠይቅ</u>

አዲስ አበባ ዩኒቨርሲቲ ቢዝነስና ኢኮኖሚክስ ኮሌጅ ንግድ ስራ ት/ቤት

ሎጀስቲክስና ሰፕላይ ቼይን አስተዳደር ት/ት ክፍል

የተከበራችሁ መላሾች፤

እኔ በአዲስ አበባ ዩኒቨርሲቲ ቢዝነስና ኢኮኖሚክስ ኮሌጅ ንግድ ስራ ት/ቤት ሎጀስቲክስና ሰፕላይ ቼይን አስተዳድር ት/ት ክፍል የድህረ ምረቃ ተማሪ ስሆን በአሁን ሰዓት የምረቃዉን ከፊል መስፈርት ለማሟላት በዳሸን ባንክ አብይ ቅርንጫፍ አገልግሎት አሰጣጥ ላይ ወረፋን በተመለከተ ትምህረታዊ ጥናት እያካሄድኩ ነዉ። የጥናቱም ርዕስ የዳሸን ባንክ አብይ ቅርንጫፍ አገልግሎት አሰጣጥ ወረፋ ስርዓትን ማጥናት ነው፡፡ ስለሆነም እርሰዎ የባንኩ አብይ ቅርንጫፍ ደንበኛ እደመሆንዎ የመጠይቁ ዋና ተሳታፊ እንዲሆኑ በክብር ተመርጠዋል፡፡ ለጥያቄዎቹ ተገቢዉን ምላሽ መስጠትዎ ለጥናቱ ዉጤት ከፍተኛ ጠቀሜታና አስተዋፅዖ ስለሚኖረው የእርስዎን ዉስጣዊ ስሜት የሚገልፁ ምላሾች ስለሚሰጡኝ ምስጋናዩ የላቀ ነው፡፡

በተጨማሪም መጠይቆቹ የተዘጋጁት በቅርንጫፉ አገልግሎት የወረፋ ቆይታ ሰዓትና ሥርዓት ዙሪያ ያለዎትን አመለካከት

ለትምህርታዊ አላማ ብቻ መሰብሰብ ሲሆን እርስዎ የሚሰጡት ምላሽ ሚስጥራዊነቱ በሚገባ የተጠበቀ መሆኑን ላረጋግጥሎት እወዳለሁ፡፡ መጠይቁን ሲሞሉ ስምዎትን መጥቀስ አይጠበቅቦትም፡፡ ስለ ትብብርዎና ዉድ ጊዜዎ በቅድሚያ አመሰግናለሁ፡፡ መጠይቁ ከ 10 ደቂቃ የበለጠ ጊዜ አይወስድም፡፡

ኢያሡ ምትኩ ኢ.አ.ዩ. 2016 ዕጩ ተመራቂ፡፡

ሞባይል ስልክ፡ 091-199-23-73

ክፍል አንድ፡ አጠቃላይ መረጃ፡ተገቢ ምላሽ የሚሉት ላይ ያክቡበት ወይም ምልክት ያድርጉበት፡

1. በብዛት የሚጠቀሙት ባንክ ዐይነት?

ሀ. የመንግስት ንግድ ባንኮች
ለ. የግል ንግድ ባንኮች
ሐ. የመንግስትና የግል ንግድ ባንኮች
መ. ልማት ባንክ
ሠ. ብሔራዊ ባንክ
ረ. ሌላ

2. የዳሸን ባንክ ደንበኝነት ከጀመሩ ምን ያህል ጊዜ ይሆናል?

ሀ. ከአምስት ዓመት በላይ
ለ. በ 2 እና 5 ዓመት መካከል
ሐ. ከ 2 ዓመት በታች
መ. ቋሚ ተጠቃሚ አይደለሁም፤ ባጋጣሚ መጥቼ ነው

4. የዳሸን ባንክ ቅርንጫፎች ስርጭትን እንዴት ይመለከቱታል?

ሀ. በሚገባ የተሰራጨና አመቺ፤

ለ. በሚገባ ያልተሰራጨና አመቺ ያልሆነ፤

5. በተደጋጋሚ የሚጠቀሙት የትኞቹን የዳሸን ባንክ ቅርንጫፎች ነው?

ሀ. ዳሸን ባንክ አብይ ቅርንጫፍ

ለ. ዳሸን ባንክ አብይ ቅርንጫፍ ዉጪ ሌላ ቅርንጫፍ

6. የዳሸን ባንክ አብይ ቅርንጫፍን የሚጠቀሙት?

ሀ. በቀን እስከ ሦስት ጊዜ

ለ. በሳምንት እስከ ሦስት ጊዜ

ሐ. በየቀኑ

መ. በሣምንት አንድ ጊዜ

ሠ. በ ወር አንድ ጊዜ

ረ. ሌላ

7. ከዳሸን አብይ ቅርንጫፍ ጋር የአገልግሎት ግንኙነት የሚያከናዉኑት?

ሀ. በአካል ቅርንጫፍ በመሄድ

ለ. በATM አገልግሎት

ሐ. በATM እና በPOS አገልግሎት

መ. በአካል, ATM እና በPOS አገልግሎት

ሠ. ሌላ

ክፍል ሁለት: የደንበኞች የአገልግሎት ወረፋ ስርዓት-ሂደት ስነ-ልቦና(ሣይኮጂ)

ወረፋ ስርዐተ-ሂደት**: -** ደንበኞች ከባንኩ ቅርንጫፍ ከደረሱበት ደቂቃ አንስቶ አገልግሎት አግንተው ከቅርንጫፉ እስከ ሚወጡጠበት ደቂቃ ድረስ ያለውን ሥርዓትና ሂደት ይወክላል፡፡ የእርስዎን አመለካከት የሚወክለውን አማራጭ ይምረጡ፡፡

8. በቅርንጫፉ ወረፋው ሥርዓተ-ሂደት ውስጥ ምን ያህል ደቂቃ ለማጥፋት/ለመጠበቅ/ ፍቃደኛ ነዎት?

ሀ. ከ 5 ደቂቃ በተች

ለ. 5 እስከ 10 ደቂቃ

ሐ. በ10 እና 15 ደቂቃ መካከል

መ. ከ 15 ደቂቃ በላይ

ሠ. ግድ የለኝም

9. የባንኩ አገልግሎት ቅልጥፍና በተግባር ምን ያህል ደቂቃ እየፈጀ ነው ብለው ይገምታሉ?

ሀ. ከ 5 ደቂቃ በታች

ለ. 5 እስከ 10 ደቂቃ

ሐ. በ10 እና 15 ደቂቃ መካከል

መ. ከ 15 ደቂቃ በላይ

ሠ. መገመት አልችልም

10. በቅርንጫፉ ወረፋ ሥርዐተ-ሂደት ወቅት ወደ አገልግሎት መስኮቶቸ ከመጠራትዎ በፊት የሚፈጀውን ጊዜ ከሌላ ባንክ ቅርንጫፎች ጋር እንዴት ያወዳድሩታል?

ሀ. በጣም አጭርና አርኪ

ለ. አጭርና ተገቢ

ሐ. መካከለኛ

መ. ረዥም

ሠ. በጣም ረዥምና አሰልቺ

ረ. ሌላ

11. አገልግሎት ከጀመሩ በኋላ አገልግሎቱ እስከ ሚጠናቀቅ የሚፈጀውን ጊዜስ?

ሀ. በጣም አጭርና አርኪ

ለ. አጭርና ተገቢ

ሐ. መካከለኛ

መ. ረዥም

ሠ. በጣም ረዥምና አሰልቺ

12. በረዥም ወረፋ ምክንያት ተመልሰው ያውቃሉ?

- ☐ አዎን
- ☐ አልተመለስኩም
- ☐ አላስታዉስም

13. ለ12ኛ ጥያቄ ምላሸዎ አዎን ከሆነ፤ ለምን ያህል ጊዜ ተመልሰዋል?

- ☐ ብዙ ጊዜ
- ☐ ትንሽ ቀናት
- ☐ በጣም ትንሽ ቀናት
- ☐ አላስታዉስም

14. በአገልግሎት ቅልጥፍናው ደስተኛ ነዎት?

- ☐ አዎን
- ☐ በመጠኑ
- ☐ የለም አይደለሁም
- ☐ ሌላምላሽ

15. ደስተኛ ካልሆኑ፤ የአገልግሎት ቅልጥፍና ለማሻሻል ምን ይጠቁማሉ?

- ☐ ጠንክሮ መስራት
- ☐ እርግጠኛ አይደለሁም
- ☐ ሰራተኛ መጨመር
- ☐ ሌላ ምላሽ

ክፍል ሦስት፤ የደንበኞ አገልግሎት የወረፋ ሠርዓተ-ሂደት እርካታ፤

የሚከተሉት ጥያቄዎች ደንበኞች በቅርንጫፉ አገልግሎት በሚያገኙበት ወቅት ስለ ወረፋው ሥርዓትና አጠቃላይ ሂደት ያላቸውን እርካታ ለመለካት የተዘጋጁ ናቸው፡፡ስለዚህ ከባንኩ ቅርንጫፍ ከደረሱበት ደቂቃ አንስቶ አገልግሎት አግኝተው

ከቅርንጫፉ እስኪወጡ ድረስ ስላለው ሥርዓትና ሂደት እርካታዎን ከ 1- 7 ባሉት ልኬቶች መሠረት ይግለፁ፡፡

7=በጣም ረክቻለሁ

6=ረክቻለሁ

5=በመጠኑ ረክቻለሁ

4=እርግጠኛ አይደለሁም

3=በመጠኑ አልረካሁም

2=አልረካሁም

1=ፈፅሞ አልረካሁም

መስፈርቶች		ልኬት						
16	ቅርንጫፉ እያንዳነዱን የአገልግሎት ዐይነት የሚፈጀውን የጊዜ ገደብ/ኢታሎኖች/ አስልቶ ለደንበኖቹ በማሳወቁ	1	2	3	4	5	6	7
17	ቅርንጫፉ ባስቀመጠው ጊዜ ገደብ መሠረት አገልግሎት በማግኘቴ	1	2	3	4	5	6	7
18	የቅርንጫፉ ሰራተኞች በቂ እውቀት ስላላቸውና ለጥያቄዎቼ ሁሉ ቀልጣፋ ምልሽ ስለሚሰጡኝ	1	2	3	4	5	6	7
19	የባንኩ ቅርንጫፉ ለቤቴ/ድርጅቴ/ ባለው ርቀት	1	2	3	4	5	6	7
20	በቅርንጫፉ ዉስጥ ያሉትን ሰነዶች፤ፎርሞች፤ደረሰኞች ግልፅ በመሆናቸውና ሰዓት ስለማይወስድብኝ	1	2	3	4	5	6	7
21	ቅርንጫፉ አገልግሎቶቹን ልክ በተጠራሁበት ሰዓት ስለሚያከናውንልኝ	1	2	3	4	5	6	7
22	ቅርንጫፉ የፍላጎቶቼ መገኛ በመሆኑ	1	2	3	4	5	6	7
23	ቅርንጫፉ የሚገባኝን ትኩረት ሰጥቶ ስለሚያስተናግደኝ	1	2	3	4	5	6	7
24	ቅርንጫፉ ዘመናዊ ቴክኖሎጂዎችንና መሳሪያዎችን ስለሚጠቀም	1	2	3	4	5	6	7
25	የቅርንጫፉ ሰራተኞች ቀልጣፋ(ያልተንዛዛ) አገልግሎት ስለሚሰጡኝ	1	2	3	4	5	6	7
26	የቅርንጫፉ ወረፋ ሥርዓተ-ሂደት የምገምተውን ደቂቃ ገደብ በመፍጀቱ	1	2	3	4	5	6	7
27	በቅርንጫፉ ወረፋ ላይ ምንም ሰዓት ሳላባክን የመገልገል እድል ስለሚገጥመኝ	1	2	3	4	5	6	7
28	ወረፋ መጠበቂያው ስፍራ በቂና ምቹ በመሆኑ ወረፋ መጠበቄን ሳላውቅ ተራዬ ስለሚደርስልኝ	1	2	3	4	5	6	7
29	የቅርንጫፉ አገልግሎት በሚወስደው ጊዜ ገደብ	1	2	3	4	5	6	7
30	ቅርንጫፉን በጎበኘኋቸው ወቅቶች ባጋጠመኝ የወረፋ እርዝማኔ	1	2	3	4	5	6	7
31	በቅርንጫፉ የስራ ሰዓት	1	2	3	4	5	6	7
32	ቅርንጫፉ ችግሮቼን ለመፍታት በሚያሳየው ተነሳሽነት	1	2	3	4	5	6	7
33	በቅርንጫፉ ወረፋ ስርዓት ባለመሰላቸቴ	1	2	3	4	5	6	7
34	በቅርንጫፉ እንደአመጣጥ ቅደም ተከተል በመስተናገዴ	1	2	3	4	5	6	7
35	አገልግሎት የማገኝበትን ትክክለኛ ሰዓት ስለሚነገረኝ	1	2	3	4	5	6	7
36	ሰራተኞቹ እኔን ለመርዳት ሁሌም ዝግጁና ፍቃደኛ በመሆናቸው	1	2	3	4	5	6	7
37	በቅርንጫፉ ሁሌም ከስህተት የፀዳ አገልግሎት ስለማገኝ	1	2	3	4	5	6	7
38	ቅርንጫፉ ልዩ ፍላጎቴን በሚገባ ስለሚረዳልኝ	1	2	3	4	5	6	7
39	የቅርንጫፉ ሰራተኞች ስራ ጫና ስለማይበዛባቸውና ጥያቄዎቼን ለመመለስ ፍቃደኛ በመሆናቸው	1	2	3	4	5	6	7
40	በቅርንጫፉ አጠቃላይ የወረፋ ሥርዓተ-ሂደት	1	2	3	4	5	6	7

ክፍል አራት: ተጨማሪ አስተያየቶችና መረጃዎች ካለዎት፤

ተጨማሪ አስተያየቶችና መረጃዎችን ለመስጠት ከዚህ በታች ያለውን ክፍት ቦታ ይጠቀሙ፡

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የጥናቱ ዉጤት እንድላክልዎት ከፈለጉ ፖስታ ሳጥን ቁጥርዎን ወይንም ኢ-ሜይል (e-mail) አድራሻዎን ከዚህ ቀጥሎ ይፃፉ፡..

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አመሰግናለሁ!

Appendix A.2: English Questionnaire

RESEARCH QUESTIONNAIRE

ADDIS ABABA UNIVERSITY
BUSINESS AND ECONOMICS COLLEGE
SCHOOL OF COMMERCE DEPARTMENT OF LOGISTICS & SUPPLY CHAIN MANAGEMENT

Dear Respondents,

This is Eyasu Meteku, a graduate studies student at Addis Ababa University School of Commerce Department of Logistics & Supply Chain Management. Currently, I am conducting a research on the title **'Investigating the Queuing System of Dashen Bank S.C Main Branch'.** An empirical study conducted in partial fulfillment of the requirements for Master Arts Degree in Logistics & Supply chain Management. You as esteemed customer of the branch have been nominated to participate in this research survey, and I would like to be grateful for answering all the questions. Please answer the following questions as frankly as possible! It may take only 10 minutes.

Dear respondents, also be informed that this questionnaire is intended to gather information on **waiting time perceptions of the branch customers** for academic purposes only and don't mention your name on the questionnaire. I would like to assure you that any information that you provide in this questionnaire will be kept confidential and no individual's single answers alone will be considered for analysis. If you find any question that you don't feel comfortable, you may refrain from answering. Your genuine response is of high importance for the outcome of the project.

Thank you in advance for devoting your precious time in filling the questionnaire.

Eyasu Meteku Tel. 091-199-23-73 Email: joshua.eyasu@gmail.com

PART I: GENERAL INFORMATION:

Please tick or circle where appropriate

1. Type of bank you often deal with:

   A. Government commercial banks B. Private commercial banks

   C. Both government & private commercial banks D. Development bank

   E. NBE F. Other

3. Are you long time customer of Dashen bank S.C?

A. Yes, more than 5 years

B. Medium, between 2 & 5 years

C. No, only less than two years

D. Just a walking customer

4. The distribution of Dashen bank branches in the country

A. Evenly distributed and conveniently accessible

B. Poorly distributed and not conveniently accessible

5. To which branch(es) of Dashen bank you usually go?

A. To the main branch

B. To other branches than the main branch

6. Frequency of using main branch: How often do you visit this branch?

A. Once to thrice a day

B. Once to thrice a week

C. Daily

D. Once in 3 weeks

E. Monthly

F. Other

7. Mode of dealing with the branch?

A. Office contact

B. Office contact & ATM contact

C. ATM & POS services contact

D. Office contact, ATM & POS services contact

E. Others

PART II: CUSTOMERS QUEUE PSYCHOLOGY

Queue**: -** refers to waiting in line. Please choose the best alternative that provokes your waiting time perceptions in the branch.

8. As a customer of this branch the average time you are willing to spend in the queuing system (waiting and being served) is:

A. Less than 5 minutes

B. 5 to 10 minutes

C. 10 to 15 minutes

D. more than 15 minutes

E. I can't estimate

9. How long in average do you estimate it actually takes to get service in this area bank/branch?

A. Less than 5 minutes

B. 5 to 10 minutes

C. 10 to 15 minutes

D. more than 15 minutes

E. I can't estimate

10. How do you compare the waiting time for service (the time before being called to the counters) of this branch with other branches?

A. Very short & attractive
B. Short & reasonable
C. Average
D. Long
E. Very long & frustrating
F. other

11. How do you compare the service time (from start to finish) of this branch with other branches you usually go?

A. Very short & attractive
B. Short & reasonable
C. Average
D. Long
E. Very long & frustrating

12. Have you ever turned away due to longer time being taken to be served?

- ☐ Yes
- ☐ No
- ☐ Can't remember

13. If yes to 12, how many times have you done such?

- ☐ Many times
- ☐ Not many
- ☐ Can't remember

14. Are you happy with the serving time?

- ☐ Yes
- ☐ Average
- ☐ No
- ☐ other

15. If not happy, what do you think the branch should do to increase serving time?

- ☐ Work harder
- ☐ Increase staff
- ☐ Not sure

PART III: CUSTOMERS SATISFACTION ON QUEUING SYSTEM

Here, customers' satisfaction in relation to overall waiting time perceptions in the branch is intended to be measured. Please rank your views using the 1- 7 scales on whether you are satisfied or not regarding the queuing system (from arrival to departure) of the branch.

Scale:
7=Very satisfied
6=satisfied
5=Somehow satisfied
4=Indifferent
3=Somehow dissatisfied
2=Dissatisfied
1=Very dissatisfied

Items		Scale						
16	Since the branch has established & communicated standard time for services to customers	1	2	3	4	5	6	7
17	Since the branch fulfils its promises at the time indicated	1	2	3	4	5	6	7
18	Because the branch's staffs have the adequate knowledge to answer all my questions on time	1	2	3	4	5	6	7
19	As distance to the branch (premises) is time saving	1	2	3	4	5	6	7
20	Documents associated with service like forms, pamphlets, vouchers, etc are easily understood & not time consuming	1	2	3	4	5	6	7
21	For the branch performs the services exactly at the first time	1	2	3	4	5	6	7
22	Because the branch has your interest at heart	1	2	3	4	5	6	7
23	Because the branch gives you individual attention	1	2	3	4	5	6	7
24	Because the branch adopted modern technology, equipment & tools	1	2	3	4	5	6	7
25	Since the branch's staff give you prompt service	1	2	3	4	5	6	7
26	The average length you are willing to wait in the queue before getting services?	1	2	3	4	5	6	7
27	A chance of getting served without spending time in queue	1	2	3	4	5	6	7
28	Because the waiting area for customers adequate & convenient to complement your queue psychology	1	2	3	4	5	6	7
29	The average length of service time in this branch	1	2	3	4	5	6	7
30	The average length of queue in this branch at a random moment a day	1	2	3	4	5	6	7
31	The convenience of branch's operating hours	1	2	3	4	5	6	7
32	Due to the branch's keen interest in solving your problems	1	2	3	4	5	6	7
33	Since the branch handles customers Queue psychology well	1	2	3	4	5	6	7
34	Because the branch serves all customers in first-come-first-served queue basis	1	2	3	4	5	6	7
35	Because the branch's staff tells you exactly the time the service will be performed	1	2	3	4	5	6	7
37	Because the branch insists on error free records	1	2	3	4	5	6	7

38	As the branch's staffs understand your specific needs	1	2	3	4	5	6	7
39	Since the branch staffs are not too busy and are willing to respond to your requisition	1	2	3	4	5	6	7
40	Overall satisfaction with the branch on the queuing system	1	2	3	4	5	6	7

PART IV: COMMENTS OR ADDITIONAL INFORMATION

Please use the space provided below for any comment or additional information that you think is relevant.

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Please include your postal or e-mail address if you want to receive the results of the study..

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Thank you!

Appendix A.3: Data entry form for customer arrivals & service times

Number of customers	Dashen bank main branch: Data entry form for arrival & service times							
	Server 1	Server 2	Server 3	Server 4	Server 5	Server 6	Server 8	Server 8
	HrMinSec	HrMinSec	HrMinSec	HrMinSec	HrMinSec	HrMinSec	HrMinSec	HrMinSec
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								

Appendix: B.1. Empirical data on arrival rate obtained through observation

Days Observation Conducted										
DAYS	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10
Arrival Rates (No of Arrivals/Hour)	15	29	19	16	16	21	24	22	21	26
Queue Length @ the Start Of Observation	0	9	8	18	15	13	9	0	21	7
Arrival Interval(Minutes)	0	4	0	3	7	3	3	0	1	7
	0	3	2	1	3	3	1	2	1	2
	8	1	1	2	6	7	1	1	5	0
	5	1	2	5	7	0	2	2	0	0
	7	1	2	4	0	5	4	1	5	6
	3	2	1	8	6	0	1	6	1	2
	6	3	5	0	7	8	7	2	1	0
	3	1	2	2	6	3	4	1	5	6
	1	2	1	4	0	2	4	5	3	2
	6	0	7	5	3	10	2	10	7	2
	7	5	7	4	4	0	3	1	3	2
	5	2	3	2	3	2	4	1	4	3
	4	0	5	5	4	2	1	7	0	0
	5	5	0	4	2	1	3	3	6	3
		1	3	3	1	4	7	1	0	1
		1	7	7	4	3	0	2	3	2
		2	3			0	0	3	9	0
		5	1			0	2	2	0	3
		3	6			4	1	2	1	3
		6				3	3	5	4	3
		1				1	1	1	1	3
		1					7	2		4
		2					3			1
		3					0			3
		1								2
		0								0
		1								
		1								
		5								
Time Observation Started @	8:00	9:00	11:00	14:00	14:00	14:00	10:00	8:00	9:00	16:00:00
Time Observation Ended @	9:00	10:03	11:58	14:59	15:03	15:01	11:04	9:00	10:00	17:00:00
No Of Functional Counters	4	8	8	8	8	8	8	4	8	8
Total Minutes Observed	60	63	58	59	63	61	64	60	60	60

Continued table…

DAYS	DAY 11	DAY 12	DAY 13	DAY 14	DAY 15	DAY 16	DAY 17	DAY 18	DAY 19	DAY 20
Arrival Rate (No of Arrivals/Hour)	22	21	30	15	12	26	16	20	30	18
Queue Length @ the Start Of Observation	0	14	5	4	1	6	2	0	20	5
Arrival Interval(Minutes)	2	1	0	3	10	2	3	0	0	6
	1	5	4	2	1	1	5	3	4	1
	6	0	3	8	2	3	4	5	3	2
	3	6	4	5	4	2	0	1	4	4
	4	1	6	1	10	1	5	5	6	5
	6	2	0	8	7	3	3	4	0	7
	5	4	1	9	4	2	7	2	1	4
	0	4	2	2	4	4	3	2	2	4
	4	7	3	4	2	1	4	3	3	2
	5	4	1	5	3	7	4	0	1	3
	2	4	3	3	4	3	2	3	3	4
	3	2	4	2	1	5	1	4	4	1
	1	3	2	0	8	1	1	2	2	3
	3	4	1	6		3	3	6	1	4
	2	2	1	2		0	2	4	1	2
	0	1	1	0		1	5	1	1	1
	1	3	0	2		2	8	7	0	2
	4	1	0			4		2	0	4
	3	1	2			0		3	2	
	2	2	3			1		4	3	
	1	2	2			4			2	
	2		3			4			3	
			4			2			4	
			0			3			0	
			0			2			0	
			1			1			1	
			3						3	
			1						1	
			2						2	
Time Observation Started @	8:00	11:00	11:00	12:00	15:00	14:00	13:00	10:00	15:00	17:00
Time Observation Ended @	9:00	11:59	12:00	13:02	16:00:	15:02	14:00	11:01	16:00	17:59
No Of Functional Counters	4	8	8	4	4	8	4	8	8	4
Total Minutes Observed	8:00	11:00	11:00	12:00	15:00	14:00	13:00	10:00	15:00	17:00

Appendix B.2: Random number table used in queuing system simulation

Random Numbers Used For Simulation									
66	40	49	60	84	34	61	77	96	18
11	59	34	55	21	38	34	42	19	13
89	52	17	9	27	88	88	73	73	3
68	40	95	18	44	16	43	24	97	0
66	15	57	20	49	46	93	58	35	95
22	31	61	77	1	10	92	37	91	30
77	18	10	32	81	73	93	99	86	34
49	4	65	56	78	66	77	13	94	1
3	47	30	26	65	30	19	24	2	98
71	33	47	45	66	3	91	27	20	70
77	49	34	42	20	58	24	85	12	72
13	92	42	84	17	15	18	74	42	68
2	10	86	79	24	1	12	6	51	30
52	9	23	64	46	34	88	47	13	36
14	29	58	9	8	41	78	4	21	11
62	46	0	65	4	12	53	28	15	54
4	28	44	8	97	92	55	57	82	90
75	29	39	53	11	10	84	49	59	51
62	41	27	28	28	17	62	16	75	96
60	11	41	50	88	55	91	22	21	26
27	14	71	62	66	95	53	7	6	83
75	62	67	69	7	28	6	10	2	65
16	75	40	32	83	67	81	46	73	65
81	70	76	22	6	62	77	17	52	8

Appendix B.3: Random number table used in Poison interval selection

8	21	14	15	24
9	13	16	9	8
11	18	14	12	12
14	9	13	8	21
14	13	23	22	19
14	10	9	22	8
10	12	23	18	21
8	24	11	23	11
9	9	18	22	8
16	11	14	10	19
8	20	8	19	8
11	13	22	16	12
12	20	17	23	11
15	19	21	18	14
14	16	20	24	13
13	8	11	15	8
16	14	20	16	21
16	23	21	17	12
15	12	18	15	22
11	24	22	8	20

Appendix: B.4. Frequencies & Probabilities

Appendix B.4.1: Frequencies & probabilities of arrival time intervals

	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10
Frequency of arrival in (1) minute interval	11	4	1	1	2	6	7	6	2	4
Frequency of arrival in (2) minute interval	5	4	3	1	3	3	7	0	7	5
Frequency of arrival in (3) minute interval	4	3	2	3	5	5	2	3	7	4
Frequency of arrival in (4) minute interval	1	0	4	3	2	4	0	2	1	3
Frequency of arrival in (5) minute interval	5	0	3	0	1	0	2	3	0	2
Frequency of arrival in (6) minute interval	1	1	3	3	1	0	1	1	2	2
Frequency of arrival in (7) minute interval	0	3	1	3	1	3	1	1	1	0
Frequency of arrival in (8) minute interval	2	0	1	0	0	0	0	0	0	0

Appendix: B.4.2: Frequencies & probabilities of arrival time intervals

	DAY 11	DAY 12	DAY 13	DAY 14	DAY 15	DAY 16	DAY 18	DAY 19	DAY 20	SUM	P(X)
Frequency of arrival in (1) minute interval	5	7	1	2	7	2	2	7	3	80	0.22
Frequency of arrival in (2) minute interval	5	5	5	2	6	2	4	5	4	76	0.21
Frequency of arrival in (3) minute interval	2	7	2	1	5	4	4	7	2	72	0.20
Frequency of arrival in (4) minute interval	5	4	1	4	4	3	4	4	6	55	0.15
Frequency of arrival in (5) minute interval	1	1	2	0	1	3	2	1	1	28	0.08
Frequency of arrival in (6) minute interval	1	1	1	0	0	0	1	1	1	21	0.06
Frequency of arrival in (7) minute interval	1	2	0	1	1	1	1	2	1	24	0.07
Frequency of arrival in (8) minute interval	0	0	2	1	0	1	0	0	0	7	0.02
										363	1.00

Appendix C: Frequency tables of some independent variables

Appendix C.1

Type Of Bank Customers Usually Visit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Government Commercial Banks	103	28.9	28.9	28.9
	Private Commercial Banks	87	24.4	24.4	53.2
	Both Government & Private Commercial Banks	166	46.5	46.5	99.7
	Others	1	.3	.3	100.0
	Total	357	100.0	100.0	

Appendix C.2

The number of years respondents have been customer of DB main branch

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	More Than 5 Years	207	58.0	58.0	58.0
	Between 2 & 5 Years	65	18.2	18.2	76.2
	Below 2 Years	85	23.8	23.8	100.0
	Total	357	100.0	100.0	

Appendix C.3

The distribution of dashen bank branches in the country

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Evenly Distributed And Conveniently Accessible	170	47.6	47.6	47.6
	Poorly Distributed And Not Conveniently Accessible	165	46.2	46.2	93.8
	5	22	6.2	6.2	100.0
	Total	357	100.0	100.0	

Appendix C.4

The branch respondents usually visit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	The Main Branch	300	84.0	84.0	84.0
	Other Branches Than The Main Branch	57	16.0	16.0	100.0
	Total	357	100.0	100.0	

Appendix C.5

The frequency of using main branch

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Once To Thrice A Day	33	9.2	9.2	9.2
	Once To Thrice A Week	107	30.0	30.0	39.2
	Daily	23	6.4	6.4	45.7
	Once In 3 Weeks	38	10.6	10.6	56.3
	Monthly	77	21.6	21.6	77.9
	Other	79	22.1	22.1	100.0
	Total	357	100.0	100.0	

Appendix D: Time schedule

	Activities	Duration in Months (M)						
		Dec. 2015	Jan. 2016	Feb. 2016	Mar. 2016	Apr. 2016	May. 2016	Jun. 2016
1	Review of Related Literature							
2	Methodology Design							
3	Proposal Writing							
4	Proposal Defense							
5	Data Collection, Analysis, Interpretation & Discussion							
6	Summary, Conclusion & recommendation							
7	Research Report Writing							
8	Submission of Final Draft Report							
9	Defense Period							