ADDIS ABABA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

SCHOOL OF COMMERCE

ANTI TUBERCULOSIS DRUGS DEMAND FORECASTING PRACTICE: THE CASE OF ETHIOPIAN PHARMACEUTICALS SUPPLY AGENCY

FINAL THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ART IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT

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Approved by Board of Examiners

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Declaration

I, the under signed, declare that this thesis entitled “anti-Tuberculosis drugs demand forecasting practice: the case of Ethiopian Pharmaceuticals Supply Agency” is my original work and to the best of my knowledge has not been presented for a degree by any other person and that all the sources of materials used for the thesis have been duly acknowledged.

Name: Abyot Adane Andualem

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Statement of Certification

This is to certify that the thesis carried out by Abyot Adane Andualem on the topic entitled: “anti-Tuberculosis drugs demand forecasting practice: the case of Ethiopian Pharmaceuticals Supply Agency” is his original work. This research project has been submitted to Addis Ababa University, School of Commerce, Department of Logistics and Supply Chain Management for examination with my approval as a university advisor and is suitable for submission for the award of Masters of Art Degree in Logistics and Supply Chain Management.

Name: Matiwos Ensermu (PhD), Signature: _____

Date: _____

Abstract

Interestingly enough, the use of a structured forecasting process may have significant role on companies' performance and not only because forecast accuracy increases. Improving forecast accuracy is often considered a necessity because large forecast errors usually negatively affect companies' operational performance, especially cost and delivery performance. The assessment review report of the EPSA revealed that there was redundant and extended forecasting with high inaccuracy in the procurement of all health commodities including anti TB drugs. The framework structure of this research was designed by the researcher which consists of three categorical variables in which the forecasting practice is the core of the study; adoption of forecasting techniques, the extent of using forecasting in decision making and performance of the forecasting techniques applied by the agency. The research approach applied was a quantitative method. Secondary document review (from HCMIS & routine forecasting and quantification plan of EPSA) was used to gather data for forecast accuracy test. Furthermore, primary data was collected by a structured survey questionnaire designed to a 5 likert scale questions. The purposive sampling technique was used and the total sample size for the survey was 42 for questionnaire and two for document review for five first line anti TB drugs. The data was analyzed by using SPSS and Google sheet. The cronbach's alpha value was 0.804 for all variables which is greater than 0.70, and hence the study instrument was reliable.

The survey result of the study showed that the use of structured forecasting technique was below average; 2.63 for "Regression" and 2.95 for "Exponential Smoothing" and a construct average value of 3.18 including "Expert Judgment" whose individual practice was above average; 3.63. The forecast accuracy obtained from the retrospective document review confirmed that there was high forecast error when tested by both MAPE and MAD. The agency should revise its forecasting trend and focus on adopting both scientific and judgmental practices to reduce the negative role of forecasting on purchasing cost, inventory handling cost, distribution cost and also to improve delivery performance; order fill rate, on time delivery and delivery as promise. This study presents only forecasting practice of first line anti TB medicines. The agency is governmental procurement agent for procuring more than thousands health commodities and it is very possible to conduct the study by the same methodology for other products including some qualitative tools.

Key Terms: *Regression, Exponential Smoothing, Expert Judgment, First line anti TB drugs, Ethiopian Pharmaceuticals Supply Agency, Mean Absolute Deviation, Mean Absolute Percent Error, Forecast Error.*

Acronyms

EFMOH- Ethiopian Federal Ministry of Health

EPSA- Ethiopian Pharmaceuticals Supply Agency

GF- Global Fund

HCMIS- Health commodity Management Information System

HIV- Human Immune Deficiency Virus

INH- Isoniazide

KG- Kilogram

MAD- Mean Absolute Deviation

MAPE-Mean Absolute Percent Error

NTP- National TB Program

RH- Refampicin/Isoniazide

RHZE- Refampicin/Isoniazide/Pyrizinamide/Ethambutol

SPSS- statistical packages for social science

TB - Tuberculosis

WHO- World Health Organization

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Chapter One

1. Introduction

1.1. Back ground of the study

Companies which are involved in manufacturing, sales, procurement, and retailing need to take into account uncertain future conditions when planning the resources allocated to production, distribution, and purchase of inputs or services. Demand forecasting is a fundamental element in the decision-making process of their operation (Claudimar Pereira da Veiga & Luiz Carlos Duclós, 2010).

The demand for pharmaceutical products is a derived one, as desired for the benefits they can provide. They are not demanded for their product value. It is also a directed demand, as the patient has no choice but to take the prescribed drug. The demand for pharmaceuticals is sensitive to quality differences; therefore, a high degree of product differentiation is found. The aim of such differentiation is to cement brand loyalties and establish a secure market share for the product and the company (Craig and Malek, 1995).

Interestingly enough, the use of a structured forecasting process may have significant role on companies' performance and not only because forecast accuracy increases. Improving forecast accuracy is often considered a necessity because large forecast errors usually negatively affect companies' operational performance, especially cost and delivery performance. The more accurate the forecasts, the more confidence users have in the forecast and the forecasting process (Matteo Kalchschmidt, 2014). Kalchschmidt (2014) has described that forecasting management is a complex issue, that includes decisions on information-gathering processes and tools (e.g., what information should be collected, how it should be collected), organizational approaches to be adopted (e.g., who should be in charge of forecasting, and what roles should be designed), inter functional and intercompany collaboration for developing a shared forecast (e.g., using different sources of information

within the company or supply network, joint elaboration of forecasts, etc.), and measurement of accuracy (e.g., using the proper metric and defining proper incentive mechanisms).

The retrospective study (2007-2013) conducted by Scott, et al (2015) showed that there was high discrepancy between the number of pediatric TB patients detected and treated across 17 high TB burden countries including Ethiopia. The number of patients who were treated is below 50,000 and the number of pediatric TB patients detected was over 100,000, which is above 50% discrepant. The same study showed that there are some countries who did not linked reporting of case notification and procurement forecasting for treatment. In this study, there was also observed that there are countries receiving excess of supplies than notified. Among the reasons identified for such discrepancies by the authors were uncoordinated procurement with uncertain volumes and multiple procurement channels and the accuracy of demand forecasting in national TB programs, NTPs was found one of the factors that cause this discrepancy between detected and treated number of tuberculosis patients.

This study will focus on assessing the forecasting practice and will identify which methodologies are applied as well as will assess the performance of the agency in terms of forecasting of first line anti TB drugs.

1.2 Back ground of Pharmaceuticals Supply Agency (EPSA)

Pharmaceuticals supply agency is a public procurement agent for health commodities established by a proclamation number 553/2007. The forecasting practice is done at the head office in collaboration with minister of health. Accordingly, the procurement is conducted per annum in normal circumstances. From the categories of anti TB drugs, the agency procures only first line anti TB drugs and ancillary drugs used for treating side effect of anti TB drugs funded by a grant obtained from Global Fund (GF). These first line anti TB drugs are categorized as adult (2RHZE/4RH-150/75/400/275 mg) and Pediatric (2RHZ, E/4RH-75/50/150,100, 75/50 mg) doses to treat children under 25 kg and adults above 25 kg as per the treatment protocol of WHO. The most recent treatment protocol of TB (WHO, 2017) which recommends fixed dose

combination of Refampicin based treatment (2RHZE/4RH) by daily dose per week for drug susceptible TB is used to forecast first line anti TB drugs since 2017.

1.3. Statement of the Problem

Lack of reliable data on disease epidemiology and consumption patterns is at the core of demand forecasting problems. There is also very little understanding of the demand curve for heavily donor-funded markets and the variables which affect product uptake (C. Scott, et al, 2015). Forecasting error from quantity & value perspective of the Ethiopian Pharmaceuticals Supply Agency (EPSA) was found 42% (PFSA, 2016). The same assessment review report of the agency revealed that there was redundant and extended forecasting with high inaccuracy in the procurement of all health commodities including anti TB drugs. However, this is not scientifically confirmed and the overall forecasting practice of the agency need to be investigated by following scientific procedures and standards.

Though there are many factors to be studied, improper demand forecasting is one factor for the discrepancy (C. Scott,* E. Gardine r, A. de Lucia, 2015).

Improving forecast accuracy is often considered a necessity because large forecast errors usually negatively affect companies' operational performance, especially cost and delivery performance (Kalchschmidt et al., 2003).

There are no studies conducted on forecasting practice of purchasing companies. Maria Elena Nenni, Luca Giustiniano2 and Luca Pirolo (2013), Matteo Kalchschmidt (2008 and 2014), Gökçe Candan, Mehmet Fatih Taşkin & Harun Reşit Yazgan (2014), Craig, A. & Malek, M. (1995), and Claudimar Pereira da Veiga & Luiz Carlos Duclós (2010) have conducted forecasting practices in industrial companies. Biju Augustine P (2013) and Joonas Vitri (2014) have conducted a study on forecasting practice of small and medium size enterprises and Cihat Polat (2014) on marketing management, Rahmlow, H. and R. Klimberg (2002) on businesses and management.

Therefore, this study is intended to assess how demand forecasting is conducted (the extent of using structured forecasting techniques) and how much it is accurate for procurement of anti TB drugs as well as its role in decision making and cost as well as delivery performance .

1.4. Research Questions

This study answers the following basic questions:

a. How much accurate was the forecasting practice in Ethiopian Pharmaceuticals Supply Agency to procure anti Tuberculosis drugs for the last three years (2016, 2017, 2018)?
b. How the structured and qualitative forecasting techniques are applied in Ethiopian Pharmaceuticals Supply Agency to procure anti Tuberculosis drugs?
c. What is the extent of using forecasting in decision making to procure first line anti Tuberculosis drugs?
d. What is the role of forecasting in cost and delivery performance in procuring first line anti TB drugs

1.5 objectives of the study

1.5.1. General objectives of the study

Basically, this research is aimed to assess forecasting practice of anti-tuberculosis drugs in Ethiopian Pharmaceuticals Supply Agency.

1.5.2. Specific objectives of the study

a. To measure the accuracy of forecasting practice of the agency by taking anti tuberculosis drugs as a case for the last three years.

b. To assess the extent of applying structured forecasting and qualitative forecasting techniques in Ethiopian Pharmaceuticals Supply Agency to forecast demand for anti-tuberculosis drugs.

c. To assess how much forecasting is utilized in decision making to avail anti tuberculosis drugs?

d. To assess the role of forecasting on cost and delivery performance in procuring anti-TB drugs in the agency.

1.6. Significance of the study

This research will give a better insight about the forecasting practice of Pharmaceuticals Supply Agency of Ethiopia including how much accurate it is. Furthermore, it will be used as a reference for further analysis of the practice and how it affects the procurement performance of the agency and can give information about the forecasting methodologies applied for any interested researchers who ever are going to conduct on the area. It will be used as a base to investigate the cases for procurement of other health commodities in the agency which have history of both stock out and expire. The management of the agency will be the first body to use the result of this study for further intervention.

1.7. Scope of the Study

Anti TB drugs procured by EPSA are those first line drugs granted by global fund. Second line drugs that are used to treat first line drug resistant TB are being procured by federal ministry of health (FMOH). Forecasting and quantification of first line anti TB drugs has been conducted at head office of EPSA. Therefore, the scope of the study was limited to the head office of the agency and the demand forecasting practice was conducted only for five first line anti TB drugs (1. Ethambutol - 100mg – Tablet, 2. Isoniazid - (INH) 300mg – Tablet, 3. Isoniazid - 100mg – Tablet, 4. RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275mg – Tablet and 5. RH (Rifampicin +Isoniazide)- 150+75mg Tablet) as there was no any data obtained for the rest of first line anti TB drugs for the last consecutive three years. Furthermore, this study was also conducted from March 16 to April 16, 2019.

1.8. Limitation of the study

This study is conducted only on first line anti TB drugs demand forecasting due to very limited time available. It might be difficult to generalize the forecasting practice to the agency as a whole which is procuring more than one thousand items for the country (PFSA, 2016) though gives an indication on the forecasting practice of the agency. Besides, this study was conducted taking the head office of the agency as a study site as it is the only responsible department who conducts forecasting in combination with ministry of health. Therefore, more information might be missed to better extrapolate to the country. Furthermore, this study uses distributed stocks of first line drugs to health facilities as an actual demand. Though, these drugs might expire at health facilities without being consumed.

1.9. Definitions of Terms

1.9.1. Conceptual definition

Forecasting: are a probabilistic estimate or description of a value or future condition. It includes an average, a variation within certain limits, and a probabilistic estimate of the variation.

Demand Forecasting: Within international agencies, demand forecasting often really denotes "needs forecasting" – i.e. the number of people affected by a disease based on epidemiological data and the proportion of those requiring treatment – and is frequently used to advocate for international awareness of the disease (Neelam Sekhri, 2006).

Time Serious Methods: are statistical techniques that make use of historical data accumulated over a period of time. Time series methods assume that what has occurred in the past will continue to occur in the future (Bernard W. Taylor, 2006).

Regression (or causal) methods: attempt to develop a mathematical relationship (in the form of a regression model) between the item being forecast and factors that cause it to behave the way it does (Bernard W. Taylor, 2006).

Exponential smoothing: This forecast method is an averaging method that weights the most recent past data more strongly than more distant past data.

Qualitative methods: It uses management judgment, expertise opinion to make forecasts. Often called "the jury of executive opinion," they are the most common type of forecasting method for the long-term strategic planning process ((Bernard W. Taylor III, 2006).

Forecast error: is the difference between the forecast and actual demand.

Mean Absolute deviation (MAD) is the average, absolute difference between the forecast and the demand. It is one of the methods used to measure forecast accuracy. Forecast accuracy, is measured in terms of the forecast errors.

Mean Absolute Percent Error (MAPE): A variation of MAD is the Mean Absolute percent Error (MAPE). It measures the absolute error as a percentage of demand rather than per period. As a result, it eliminates the problem of interpreting the measure of accuracy relative to the magnitude of the demand and forecast values, as MAD does.

1.9.2. Operational definition

Anti TB drugs: are those medicines used to treat tuberculosis. Mycobacterium tuberculosis, the bacteria which causes TB, might be either drug sensitive or drug resistant (EFMOH, 2011). **First First line anti TB drugs**: Drugs used to treat drug sensitive tuberculosis are named first line anti tuberculosis (WHO, 2017). These first line anti tuberculosis (TB) drugs are of 5 types **Rifampicin, Isoniazid, Pyrazinamide, Ethambutole and Pyrazinamide.**

1.10 Organization of the study

This study will have basically five chapters. The first chapter will consist of an introduction part in which background of the study, problem of the statement, objectives of the study, scope of the study, Limitation, definition of terms and organization of the study will be included. The next chapter will have theoretical and empirical literature review part as well as conceptual framework of the study. The third chapter will be the methodology section in which study description, research approach, study design and settings, source and study population, sampling procedure, data source and types, instruments and data collection procedures, variables and measurement of the study and Ethical considerations are going to be included. The reliability and validity are to be described under this chapter. The fourth chapter will be Data analysis and result discussions section. The last, chapter five, will contain summary of findings, conclusion, recommendation and further study part. Finally, the research will end with the references and appendixes that are attached with this study paper.

Chapter Two

2. Literature Review

2.1 Theoretical Literature

2.1.1 Introduction

This chapter consists of the theoretical and related empirical literatures on demand forecasting practices. It has a brief introduction about forecasting types, the forecast accuracy and forecast error, the role of forecasting on decision making, cost performance and delivery performance.

2.1.2 What is Forecasting?

Neelam Sekhri eta al, (2006) described "Demand forecasting" as it is the ability to predict the future. These authors argue that the simplest forecasts occur in stable environments with plenty of good data and depend on the future resembling the past; the closer the resemblance, the more accurate the forecast. When the future does not resemble the past, demand forecasting becomes especially critical.

A number of different methods can be used in forecasting, but most share the same basic concept: past behavioral patterns will continue in the future, i.e., it is assumed that sales of a product in a given past period will be equivalent to sales in a corresponding period in the future. By and large, almost all forecast models are built on the central idea that the past will repeat itself (Cassia eta al, 2010).

2.1.3 Types of forecasting

A variety of forecasting methods exist, and their applicability is dependent on the time frame of the forecast (i.e., how far in the future we are forecasting), the existence of patterns in the forecast (i.e., seasonal trends, peak periods), and the number of variables to which the forecast is related. Trend, cycle and seasonal pattern affects to which method to choose (Bernard W. Taylor III, 2006).

Improved forecasting methodologies exist, but the methods most commonly used in pharmacy are fairly straightforward, relying on direct human judgments with implicit rather than explicit assumptions and limited quantitative data. Two most commonly used methods are "Consumption Method" and "Morbidity Method" (Gökçe Candan, Mehmet Fatih Taşkin & Harun Reşit Yazgan, 2014). A variety of means to categorize forecasting methods have been proposed over the last decade. In the methodology tree (S. Makridakis, S. C. Wheelwright and R. J. Hyndmanv, 1998),

judgmental and statistical forecasting are the two main categories of forecasting methods. In the category of statistical forecasting (the quantitative and data-driven forecasting method), two subclasses are further identified with the recent advances in computational algorithms. They are 'traditional statistics methods' and 'data mining methods' (A. R. Ganguly (2002).

The basic types of forecasting techniques in demand forecasting are **time series**, **causal (regression), qualitative methods and Simulation**. Time series methods are statistical techniques that make use of historical data accumulated over a period of time. Time series methods assume that what has occurred in the past will continue to occur in the future. As the name time series suggests, these methods relate the forecast to only one factor time. Time series methods tend to be most useful for short-range forecasting, although they can be used for longer-range forecasting. We have two types of time series methods: **the moving average and exponential smoothing**. Regression (or causal) methods attempt to develop a mathematical relationship (in the form of a regression model) between the item being forecast and factors that cause it to behave the way it does (Bernard W. Taylor, 2006).

The exponential smoothing forecast method is an averaging method that weights the most recent past data more strongly than more distant past data.Qualitative methods use management judgment, expertise, and opinion to make forecasts. Often called "the jury of executive opinion," they are the most common type of forecasting method for the long-term strategic planning process ((Bernard W. TaylorIII, 2006).

2.1.4 Forecasting Measurement

Forecasting performance measures can be classified into two types: directional and size. The bias is the primary measure that evaluates the direction of the error and hence the degree by which a forecasting model yields forecasts which either over or under estimate the actual values. The bias is the average of the forecast errors (Armstrong, 2001). A model's forecasts are almost never 100% accurate. A forecast may be slightly higher or slightly lower than the actual value, depending on how good the forecasting model is. The difference between a forecast value and its corresponding actual value is the forecast error: Forecast error = Ft -Yt, where Ft is the forecasted value and Yt is the actual value.

The forecast error is the difference between the forecast and actual demand. The forecast error measures the accuracy of an individual forecast. Forecasting accuracy is measured by a number

of techniques of which “mean absolute deviation” (MAD) is the one of these techniques (Ronald K. Klimberg, eta al, 2010). A variation of MAD is the mean absolute percent Error (MAPE). It measures the absolute error as a percentage of demand rather than per period. As a result, it eliminates the problem of interpreting the measure of accuracy relative to the magnitude of the demand and forecast values, as MAD does (Bernard W. Taylor, 2006).

MAPE is absolute error as a percentage of demand. MAPE is computed according to the following formula:

$$\text{MAPE} = \left(\frac{1}{n}\sum\frac{|Actual - Forecast|}{|Actual|}\right)*100$$

Where **n** is number of times at which forecasting and actual demand is compared for an item.

MAD has the advantage of being easier to understand among non-specialists, partly because that the error has the same dimension as the forecast. MAD is not sensitive to outliers due to the absolute value instead of the quadratic value for each error (Peter Wallström, 2009).

MAD is an average of the difference between the forecast and actual demand, as computed by the following formula:

$$\text{MAD} = \frac{1}{n}\sum_{t=1}^{n}\left|X_t - \hat{X}_t\right|$$

Where, n: is total number of periods during which forecasting and actual demand is compared. for an item, X_t: is forecasted demand in period t and $\hat{X}_t$ is actual demand in period t and

|| = the absolute value

Pavel Bondarev (2012) has observed that10% of the forecasting improvements may result in up to 30% of the company’s saving annually, while forecasting improvement costs are simply negligible compared to the total annual cost savings. The author explained that accurate goods purchase and distribution lead to faster turnover, savings on warehousing and transportation, reduced pent-up demand, higher customers’ loyalty, which finally result in greatly increased

revenue and profit. Thus, right forecasting and resourcing are instrumental for continuous business success. The goal of forecasting is to determine, analyze and estimate a probable future customer demand in order to enable a company to bring its capacity on par with it (Pavel Bondarev, 2012).

Poor forecasting effects are stock outs or high inventory, obsolescence, low service level, rush

Orders, inefficient resource utilization and bullwhip propagating through the upstream supply

chain.Typically, high performance companies focus on robust demand forecasting approaches. However, the challenge of demand forecasting varies greatly according to company and industry (Maria Elena Nenni, Luca Giustiniano2 and Luca Pirolo, 2013).

Matteo Kalchchmidt (2018) has conducted a research to investigate the role of forecast accuracy on the performance of manufacturing and the results showed that there is positive correlation between structured forecasting technic adaptation and the performance of the manufacturing companies.

Country-specific drug procurement data can be used to gauge medication use among patients in countries and to compare with the overall need for treatments (C. Scott, 2015).

Procurement procedures should use accurate demand forecasting of the need for anti-TB medicines to ensure that the correct quantities of medicines are available at the right time at affordable prices, and that they are of an acceptable quality. Procurement should be centralized, and medicines should be ordered annually. Poor demand forecasting mechanisms is of the challenges facing the drug supply chain that links global producers to health facilities via local suppliers and centralized depots (L Bam Eta al, 2017).

Accurate demand forecasting methods match supply with demand in order to eliminate lag time, allow funders to plan purchases and allocate resources efficiently (Institute of Medicine 2009). It also reduces uncertainty about future market potential which improves the reliability of drug supply by encouraging the development of new drugs. Lack of reliable forecasting and low and variable demand are among the reasons for shortages of supplies, stock outs and long lead times. More accurate forecasts improve supplier confidence and production planning and assures timely payment (WHO, 2014).

Most firms attempted to improve forecast accuracy by focusing on different directions; mainly forecasting techniques, information sharing, and forecasting procedures. Quantities of anti TB and other program medicines in Bangladesh were forecasted for five years (2012-2016) based on the estimated number of patients treated during the previous year and the number of patients forecasted in the performance framework (Omer, A. M. eta al, 2012). The same authors used expert opinions, document reviews and morbidity methods to forecast anti TB drugs in Bangladesh. Furthermore, they used more structured forecasting tools named Quantimed and GDF tool for anti TB drugs and found that the difference between the actual consumption in 2011 and the forecasted consumption for 2012 was more than expected.

2.1.5 The role of Forecasting

At the global level, the purpose of forecasting health commodity demand is to influence the supply of medicines and health products. This means that suppliers, who are expected to make investment decisions based on these forecasts, are important customers of forecasts. Ensuring the appropriate availability of drugs at an optimal price requires demand forecasting that has sufficient certainty around funding and timing of orders to allow suppliers to confidently invest in production capacity (Neelam Sekhri eta al, 2006).

Forecasting has a major role and the potential capability to use in many of the decision areas that can easily be used for functional and strategic decision-making. It can be needed for prices, costs, events (such as new laws or regulations, entry of competitors, or the shortage of critical resources), or the advent of new technologies. Forecasting contributes significantly to building up a background and stand for strategic decisions. In this sense, forecasting is more like a collection of essential support procedures in the background, by producing and providing information about the future which is required by strategic managers. However, due to variety of reasons, though it is applied widely in many developed countries, it is not explicitly expressed its importance, functionality, and the problem domains that it can be applied to ((Cihat Polat, 2014).

Kalchschmidt (2014) has described that forecasting management is a complex issue, that includes decisions on information-gathering processes and tools (e.g., what information should be collected, how it should be collected), organizational approaches to be adopted (e.g., who should be in charge of forecasting, and what roles should be designed), inter functional and intercompany collaboration for developing a shared forecast (e.g., using different sources of information within

the company or supply network, joint elaboration of forecasts, etc.), and measurement of accuracy (e.g., using the proper metric and defining proper incentive mechanisms).

Forecasting function requires an extensive analysis of the decision situation. It has the capability to explain the factors that affect the decision problem by using the methods such as regression and time series analysis. Through this way can reveal information about the changes in the data generation mechanism under interest. This is because it has a data production mechanism, is an analytical tool (for the data gathered), and is a systematic approach to reveal system dynamics (Cihat Polat, 2014).

Demand forecasting is also essentially a management analytic tool that will assist each participant in the health products supply chain to make key decisions. It is an important component of the global health value chain. In the most basic terms, a health need can often be satisfied by the purchase and supply of medicines. This may be the simple procurement, manufacturing and distribution of antibiotics for common infections or the development of a new vaccine for a currently untreatable disease based on the ability of designing forecasting (Neelam Sekhri, eta al, 2006). Several operations decisions are based on some kind of future forecasting of the demand. For this reason significant attention is given for researches on demand forecasting. The demand for pharmaceutical products is a derived one, as desired for the benefits they can provide. They are not demanded for their product value. It is also a directed demand, as the patient has no choice but to take the prescribed drug (Craig and Malek, 1995).

2.1.6 Anti TB Drugs

Anti TB drugs are those medicines used to treat tuberculosis. Mycobacterium tuberculosis, the bacteria which causes TB, might be either drug sensitive or drug resistant (EFMOH, 2011). Drugs used to treat drug sensitive tuberculosis are named first line anti tuberculosis (WHO, 2017). These first line anti tuberculosis (TB) drugs are of 5 types Rifampicin, Isoniazid, Pyrazinamide and Ethambutole, which are used in both combination and loose form. Tuberculosis treatment consist of a two month RHZE fixed combination dose and a four month RH two drugs combination treatment regimen (2RHZE/4RH), (WHO, 2017) for adult TB patients treatment protocol. That means the four drug fixed dose combinations will be taken for the first two months, named as "intensive phase" of the treatment course and two drugs fixed dose combination will be taken in the next four months which is called the "continuous phase" of TB treatment. Whereas, in

treatment of pediatric TB patients, the intensive phase is a three drug fixed dose combination and one drug loose duration and the continuous phase is the same as adult TB patients treatment (2RHZ, E/4RH). Therefore, forecasting of first line anti TB drugs consisted of five drugs and a six month duration consumption per patient taken in daily doses based on weight.

2.2 Empirical Literature

Different elements constitute and characterize the forecasting process and some authors have proposed different frameworks of analysis. Armstrong (1987) considered a model based on four dimensions: **forecasting methods** (i.e., the kind and number of techniques used), **data available** (i.e., whether a central database is available which collects information from different sources), **uncertainty analysis** (i.e., upper and lower limits of forecast are provided), **costs and benefits** (i.e., amount spent on forecasting and performance achieved).

J. Scott Armstrong (2001) has used six ways to select forecasting methods; **Convenience** (what is easy), **Market popularity** (what others do), **Structured judgment** (what experts advise), **Statistical criteria** (what should work), **Relative track records** (what has worked in this situation) and **Guidelines from prior research**, (what works in this type of situation). However, selecting by convenience resulted in forecast errors, as he concluded. He also found that statistical criteria are useful for selection only after the decision has been made about the general type of forecasting method, and even then their use is confined primarily to quantitative methods. Using statistical criteria for selection has other limitations. First, the criteria are usually absolute. Thus, the search for methods that are statistically significant can lead analysts to overlook other criteria and to ignore domain knowledge. In his investigations he found that quantitative methods with enough data are more accurate than judgmental methods. When large changes are expected, causal methods are more accurate than naive methods. Simple methods are preferable to complex methods. He also recommended that to select a judgmental method (qualitative methods), determine whether there are large changes, frequent forecasts, conflicts among decision makers, and policy considerations and to select a quantitative method, consider the level of knowledge about relationships, the amount of change involved, the type of data, the need for policy analysis, and the extent of domain knowledge. When selection is difficult, combine forecasts from different methods is the best choice.

Rhyne (1989) examined forecasting practices at 40 hospitals by interviewing senior management. Judgmental methods were commonly used: 87% reported using the 'jury of executive opinion' with 67.5% using expert forecasts. Given the political nature of hospital forecasts, their use of judgmental methods would seem to present serious problems with bias. For quantitative methods, 52.5% of the hospitals used moving averages, 12.5% used exponential smoothing, and 35% used regression. Mentzer and Kahn (1995), in a survey of 207 forecasting executives, found that accuracy was rated important by 92% of the respondents to measure forecasting practice in a case company.

Improving forecast accuracy is often considered a necessity because large forecast errors usually negatively affect companies' operational performance, especially cost and delivery performance (Matteo Kalchschmidt, 2014). This author has conducted a research on forecasting practice of manufacturing companies by focusing on three variables; use of structured forecasting techniques, performance of forecasting and the extent of using forecasting in decision making. Data was collected by using the fourth edition "Global Manufacturing Research Group (GMRG)" tool from 6 different countries and 343 manufacturing companies. The results showed that there is appositive role on manufacturing companies operational performance including forecast accuracy, manufacturing cost, and timely delivery, who adopt the structured technic and the author recommended that proper design of forecasting practice (as it helps to identify forecast problems) may reduce the forecast bias and coordinates forecast users.

Collectively, the empirical evidence indicates that subjective techniques are popular for all types of forecasting situations (i.e., across all time horizons and forecasting levels) (Joonas V., 2014).

Makridakis and Hibon (2000) as cited by Joonas Vitri (2014) have thought the following relations between the forecasting methods and the performance with regard to forecasting accuracy.

- Statistically sophisticated or complex methods do not necessarily produce more accurate forecasts than simpler ones.
- The ranking of the performance of the various methods vary according to the accuracy measure being used
- The accuracy of the combination of methods outperform on average the specific methods being combined and does well in comparison with other methods.

- The performance of the various methods depends upon the length of the forecasting horizon

2.3 Conceptual Framework

The structure of this research was designed by the researcher which consists of thirteen variables under three categories in which the forecasting practice is the core of the study; adoption of forecasting techniques (three sub variables), the extent of using forecasting in decision making (three sub variables) and performance of the forecasting techniques applied by the agency (seven sub variables).

This research was conducted by a 5 likert scale survey questions for the first two variables and for cost and delivery performances. Whereas, Mean Absolute Deviation (MAD) and Mean Absolute Percent Error (MAPE) were used to measure the forecast accuracy. Adoption of forecasting technique was made to be studied by taking three types of forecasting techniques; Exponential smoothing, Regression and Expert Judgment. The extent of using forecasting in decision making was also assessed by taking three elements; Budget preparation, Purchase plan and efficient resource utilization. When come to performance, it was studied by three elements; Forecast accuracy, Cost Performance and delivery performance. Forecast accuracy was measured by conducting retrospective three years document review (from 2016b to 2018).

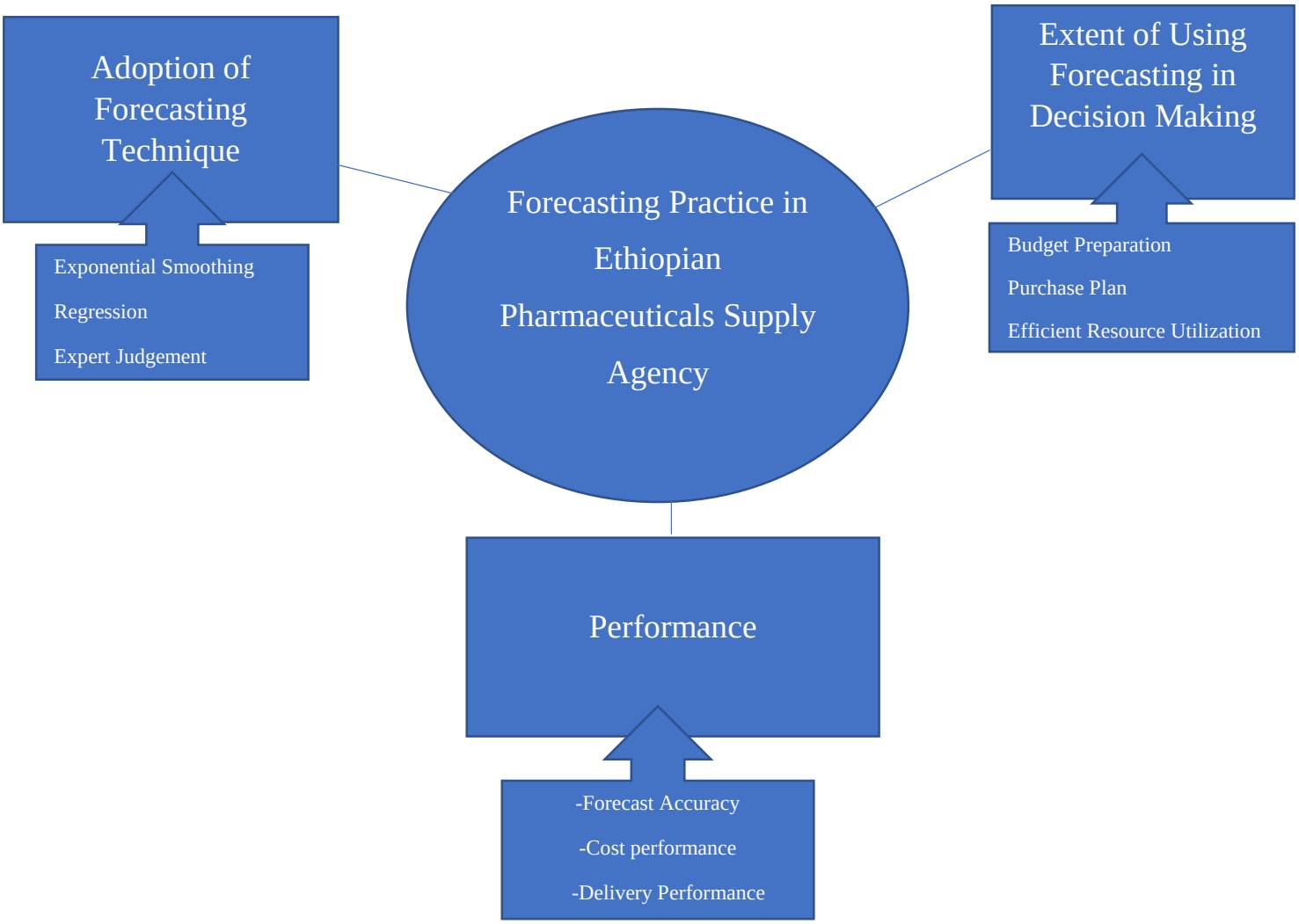


Figure 1. Conceptual Framework: (Source, The author)

Chapter Three

3. Methodology

3.1 Descriptions of the study area

Pharmaceuticals Supply Agency (PSA) was established in 2007 by proclamation number 553/2007 to handle and strengthen the public pharmaceutical supply chain management of the country as proposed by development of Pharmaceutical Logistics Master Plan (PLMP) in 2006. EPSA is organized into nineteen (19) core- and sub-processes at Head Office level (PFSA, 2017). This study focused on the practice of forecasting for procurement of first line anti TB drugs.

3.2 Research Approach

The research approach applied was a quantitative method. Secondary document review (from HCMIS and routine forecasting and quantification plan of EPSA) was used to gather data for forecast accuracy test. Furthermore, primary data was collected by a structured survey questionnaire designed to a 5 likert scale questions.

3.3 Study design

This project used both cross sectional and longitudinal descriptive study design to assess the forecasting practice of the agency. The twelve variables under three categories (adoption of forecasting technique; **Regression, Exponential Smoothing, Expert Judgment**, performance of forecasting; **forecast accuracy**, Cost Performance- **purchasing cost, Inventory handling cost, and distribution cost**, Delivery performance- **Order fill rate, On time delivery and delivery as promised** and the role of forecasting in decision making; **budget preparation, purchasing plan and Efficient budget utilization**), were described after collecting data by 1-5, a continuous or Likert scale questions and one variable, forecast accuracy, was assessed by a retrospective three years data review.

The most popular forecasting performance measures of the size of the error is the "Mean Absolute Deviation" (MAD), (Ronald K. Klimberg eta al, 2010). Furthermore, MAPE is also used to measure forecast accuracy in terms of demand which MAD lacks to do. MAD measures across periods and therefore MAD and MAPE were used to measure the forecast accuracy to measure forecasting method applied in the agency.

3.4 Source Population

The source populations of this study were the pharmacy and other health professionals in federal ministry of health and Pharmaceuticals Supply agency of Ethiopia as well as routine data reporting electronic tools (HCMIS and routine forecasting and quantification plan reports of EPSA.

3.5 Study Populations

One directorates from EPSA head office and one directorate from MOH were the study area of the project. Forecasting and Market Shaping directorate, of EPSA and Pharmaceuticals Supply Chain Management team of FMOH as well as HCMIS and Forecasting and Quantification plan report were the study populations. The study participants list for the survey questionnaire were Revolving drug fund quantification and market shaping team professionals (n=4), TB, HIV and Malaria quantification and market shaping team professionals (n=4), Medical Equipment quantification and market shaping team (n=6), Other health quantification and market shaping team (n=4) and Laboratory reagents, chemicals and medical supplies quantification and market shaping teams (n=3) and the director of quantification and market shaping directorate from EPSA (n=1), one forecasting participant and director from Tender Management Directorate (n=2), Warehouse and Inventory Management directorate (n=1), Distribution and Fleet Management Directorate (n= 1) and professionals from Pharmaceuticals supply chain management team of FMOH (n=12) and as well as forecasting technical advisors from EPSA (n=4) were the study participants.

3.6 Sampling Procedures

The purposive sampling technique was used. This is for the reason that in order to get reliable data, respondents need to have knowhow about the forecasting technique and its practice during procurement of first line anti TB drugs. Thus, the study participants were selected to be those who are practicing the forecasting technique. The study area and study populations were few and hence, there was no sample size determination procedures. However, the total sample size for the survey was 42 as described by the table 1 below.

Table 1. Sample Size

Sample Size			
Organization	**Number of Study Participant**	**Total Number of Study Participants**	**Remark**
EPSA	30	30	
FMOH	12	12	
Total Sample Size		42	

The samples for document review were two for five first line anti TB drugs. Only HCMIS and Forecasting Plan report of the agency were used and five drugs with full information for both forecasting and consumption in the last three years (2016-2018) were used.

3.7 Data sources and types

The sources for the purpose of conducting this research were primary sources of data that were obtained from survey questionnaires as well as secondary data from document reviews. The primary data was gathered through a survey questionnaire adopted from Global Manufacturing Research Group (GMRG) and secondary data was obtained from reviewing routine data electronic tool, HCMIS and forecasting and quantification plan of EPSA.

3.8 Instruments and Data Collection Procedures

Data was collected by survey questionnaires and secondary data reviewing. Document review was used to collect data that help to investigate forecast accuracy. The five scale structured survey questionnaire was employed to assess the forecasting technique applied by the agency, the role of forecasting in decision making and to assess the role of forecasting on cost and delivery performance practices of the agency. The source of data was generated originally by a structured survey questionnaire and secondary routine data from Health commodity management information system (HCMIS, a software which is being used by EPSA) and anti TB commodities forecasting and quantification plan of EPSA. Document review guide was used to review these documents as annexed here with (Annex II). The language for data collection was English. However, before administering and getting in to the data collection, clarification and briefings were given specially regarding the forecasting techniques as there are different terminologies to call them and the purpose of the study was briefed to respondents.

3.9 Data analysis

The data that was collected by the questionnaires was analyzed by SPSS tool and Google sheet and was described by using descriptive statistics in the form of frequencies, percentages, mean, average sums and standard deviations. In addition to these statistical descriptions, both bar chart and pi-chart were used to visually describe the results obtained. The data was analyzed in terms of the extent to which the forecasting process was structured by means of three variables: the extent of use of forecasting techniques, the performance of the techniques applied, and the extent of forecasting role in decision making. The statistical packages for social science (SPSS) statistical analysis tool was employed for doing the analysis. The returned with fully filled and the unreturned or lost questionnaires were described.

3.10 Variables and Measurement of The study

Three categorical variables of Matteo Giacomo Maria Kalchschmidt for forecasting practice and performance assessment were adopted to assess forecasting practice in the agency. The first of these categories was “Adoption of forecasting technique” in the forecasting practice. The second was the “performance of the forecasting” in procurement of first line anti TB medicines and the third one was “the extent of using forecasting models in decision making” in the process of procurement.

To measure the extent of applying forecasting techniques, the respondents were asked to indicate to what extent: (1) quantitative time series models (i.e. exponential smoothing), (2) quantitative causal models (i.e., regressions) and (3) qualitative models (i.e., expert judgmental) are adopted to elaborate the forecast. These items were measured on a 5 point Likert scale ranging from 1 (not at all) to 5 (to a very good extent). Then, the measurement was defined by averaging these three items. It is done by sort out the average level of extent given by a single respondent to the three variables under this category and then this average level of extent was summed for all respondents and finally the average value was calculated to get the average level of agreement for the category.

In addition, data concerning the role of forecasting in decision making was collected by asking respondents to indicate to what extent forecast is used for the following purposes: (1) budget preparation, (2) purchase planning, (3) Efficient Resource Utilization. These items were measured on a 5 point Likert scale ranging from 1 (not at all) to 5 (to a very good extent). Finally, the role value was defined by averaging these three items.

Performance of the forecasting technique was made to have three variables: Forecast error, cost and delivery performance as Matteo Giacomo Maria Kalchschmidt (2014) used to do. Forecast error was used to measure forecasting accuracy. It was designed to measure the accuracy of forecasting practice by, **Mean Absolute Deviations** (MAD) and **Mean Absolute Percent Error** taking three years forecasting data of the agency and three years actual demand of 2016, 2017 and 2018. Therefore, this research was designed to use both MAD and MAPE to measure forecast accuracy. J. Scott Armstrong and Kesten C. Green (2017) strongly recommend to use MAD for the reason that the MAD is easy to calculate, and is easily understood by decision makers. Whereas, Bernard W. recommends MAPE than MAD rationalizing that MAPE measures percent errors based on demand than period. With regard to cost performance, three items were examined. Respondents were asked questions to what extent forecasting affects (1) Purchasing costs, (2) inventory handling costs and (3) distribution costs. Finally, the construct cost was defined by averaging these three items. The final variable, delivery performance was also assessed by asking respondents to give their evaluation of forecasting role on a 5 point Likert scale (1 for "not at all" and 5 "to a very good extent") for (1) order fill rate, (2) delivery time and (3) delivery as promised. Then, the delivery performance was defined by the average value of these three items.

3.11 Reliability and Validity

The reliability of the study was tested by Cronbach's alpha confirmation (greater than 0.70 value). The cronbach's alpha value obtained for the survey result was 0.804 which is greater than 0.70, and hence the study instrument was reliable. The total number of variables tested for reliability by SPSS under the three categories were twelve as described below.

Table 2. Reliability Test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.804	.812	12

The primary data source tool was the standard questionnaire adopted from "Global Manufacturing Research Group (GMRG)" used by Matteo Kalchschmidt, a known forecasting researcher by different times (2008 and 2014) which was validated for these studies. Furthermore,

the senior supply chain advisors from the agency were administered the questionnaire for comment so that validated for using in this study.

3.12 Ethical considerations

The participants that took part to the survey were briefed about the purpose of the study, high confidentiality of the study, and were given freedom to resign themselves at any time in the processes of the data collections if they felt uncomfortable with the survey. Fortunately, all participants were willing to take part in the study. The participants were also given the right to ask and understand their role in the data collection activity to find answers to the research questions and were addressed by explaining the essence of the study to all respondents by the researcher during the survey. They were also briefed about confidentiality of the data to be kept and the data would be used only for the purpose of assessing the contract administration and would not be given for other bodies. The responses collected from the participants were analyzed directly without any change by the researcher but with anonymously.

Chapter Four

4. Results and Discussion

4. 1 Introduction

This chapter presents and discuss the results obtained from the data collected by the structured questionnaire adopted from Global Manufacturing Research Group (GMRG) with regard to forecasting techniques practiced, using forecasting techniques for decision making and the role of forecasting in cost performance and delivery performance by Ethiopian Pharmaceuticals Supply Agency and document review method to measure forecast accuracy of the agency. The discussion is divided in to two section which are data obtained from structured questionnaire and the data collected by document review to answer the research questions of this study.

4.2 Response Rate and Socio demographic characteristics of Respondents

Data was collected during the working hours in person by the researcher. Among 42 expected respondents, only 40 respondents were on work during the survey and one of them was on annual leave and the other one was on field work therefore two questionnaires for these respondents were left unfilled (95.23% response rate).

The background information of the respondents such as age, sex, educational qualification, organization and years of experience were fully filled except the organization where three respondents didn't fill in. The general socio demographic characteristics of the respondents asked to describe were; Age, Sex, Educational Qualification, organization and Years of Service. All 40 respondents gave their socio demographic requests except two who left to fill their educational qualification and organizations they are working for.

Table 3. Socio Demographic Summary

Summary Table for Respondents			
Socio-Demographic Character	Sub Category	Frequency (n)	Percent
Age	below 20 years	0	0.00%
	21-30 Years	15	37.50%
	31-40 Years	21	52.50%
	41-50 Years	4	10%
	Above 50 Years	0	0%
Sex	Male	33	82.50%
	Female	7	17.50%
Educational Qqualification	Diploma	0	0%
	First Degree	22	55%
	Second degree and above	16	40%
	Missed	2	5%
Organization	EPSA	27	67.50%
	Federal Ministry of Health	11	27.50%
	Missed	2	5%
Job Title	Director	2	5%
	Team Leader	5	12.5%
	Officer	27	67.5%
	Advisor	6	15.0%
Years of Service	3 years and below	6	15%
	3- 6 years	17	42.50%
	above 6 years	17	42.50%

Among the respondents, 52.5% were aged between 31-40 years and 37.5 % were between 21-30 years. The rest of the respondents (10.0 %) were between 41-50 years). The following chart displays this frequency percentage. Furthermore, 82.5 % were males and the rest 17.5% were females.

From 40 respondents 38 gave their educational qualification (95.0%) and the rest 5% left filling their educational qualification. From these 38 respondents, 22 were first degree holders (55.0%) and there was no any respondent who is a diploma holder.

This survey study was conducted in two organizations; Pharmaceuticals Supply agency (PSA) and Federal Ministry of Health (MOH). The study participants were asked to indicate their

organization. 38 respondents indicated their organization from 40 participants which is (95.0%). Among these 38 respondents, 67.5% were from PSA and the rest 27.5% were from FMOH.

Furthermore, study participants were asked to indicate their job title (director, Team leader, officer and advisor). Among these least of titles, 67.5% were officers, 15.0 were advisors, 12.5% were team leaders and 5.0% were directors. All the 40 respondents indicated their job title.

The last socio-demographic information that the respondents were asked was; Years of service. All 40 respondents indicated their years of service and it was found that 42.5% were experienced between 3- 6 years and another 42.5% had above six years' experience. Only 15.0% were three years and below.

4.3 The extent of Applying Forecasting Techniques in EPSA

Table 4. Forecasting Technique Statistics

		Regression or quantitative causal models	Exponential Smoothing or quantitative time series models	Expert Judgment or Qualitative Method
N	Valid	40	40	40
	Missing			
Mean		2.63	2.95	3.63
Median		2.50	3.00	4.00
Mode		2	4	4
Std. Deviation		1.275	1.239	1.125
Variance		1.625	1.536	1.266
Range		4	4	4
Minimum		1	1	1
Maximum		5	5	5
Sum		105	118	145

One of the focus of this study was to assess the extent of applying structured and qualitative forecasting techniques in Ethiopian Pharmaceuticals Supply Agency. Three basic and common types of techniques were selected for this purpose.

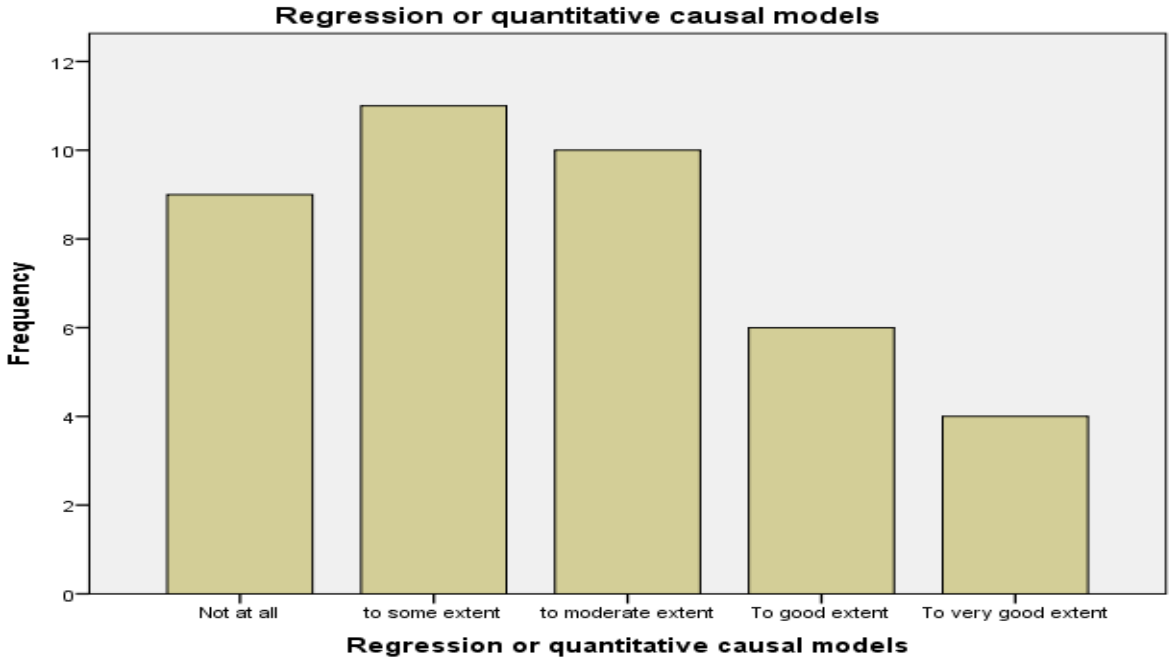
These three forecasting techniques were; 1) Regression or quantitative causal models, 2) Exponential Smoothing or quantitative time serious model and 3) Expert Judgement or Qualitative method. The questions were designed to the respondents to give their level of

agreement on to what extent the agency is practicing these forecasting techniques to forecast first line anti Tuberculosis (TB) drugs. The level of agreement was a likert scale which ranges from one to five (1- Not at all, 2-to some extent, 3-to moderate extent, 4- to good extent and 5-to very good extent). All 40 respondents gave their level of agreements to these three techniques. The mean of level of agreement for regression, exponential smoothing, and Expert judgement techniques were 2.63, 2.95 and 3.63 respectively. The standard deviation from the means for each techniques were 1.275, 1.239 and 1.125 for forecasting technique regression, Exponential smoothing and expert judgment respectively. The maximum level of agreement given for all techniques was five and the minimum was one and hence the range was four for all three techniques. The maximum sum of the levels of agreements for all respondents by forecasting technique category was Expert judgment and the minimum was Regression. The average level of extent with respect to which each forecasting technique to be compared was calculated by computing the average value of the five scale levels (1+2+3+4+5)/5= 3. Hence, by the time of survey the agency was applying expert judgment in a better extent than other techniques and regression was the least practiced technique.

4.3.1 Regression or quantitative causal models

The study participants were asked to give their level of agreement on to what extent the Pharmaceuticals Supply Agency apply regression technique to forecast first line anti TB drugs demand. The survey result showed that the majority of the respondents (25.6%) agreed that the agency applied “regression” to some extent. 23.3 % of the respondents agreed that the agency applied this technique to a moderate extent. However, 20.9% gave their agreement that the agency didn’t use this technique at all. Only 4 respondents (9.3%) agreed that the agency used this technique to the very good extent.

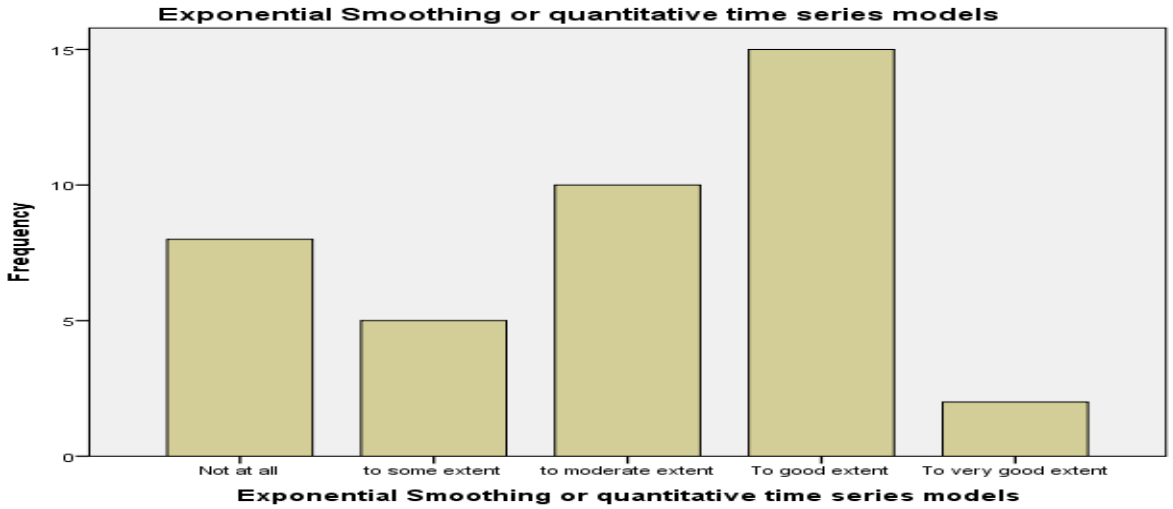
Figure 2. Extent of Applying Regression in forecasting first line anti TB drugs



4.3.2 Exponential Smoothing

From the survey result, 34.9 % of the respondents which is the majority of the study participants agreed that the agency applied Exponential smoothing to good extent. 23.3% agreed that the agency applied this technique to moderate extent. 18.6% replied that the agency did not apply this technique at all to forecast first line anti TB drugs. Only two respondents gave their agreement that the agency applied this technique to very good extent.

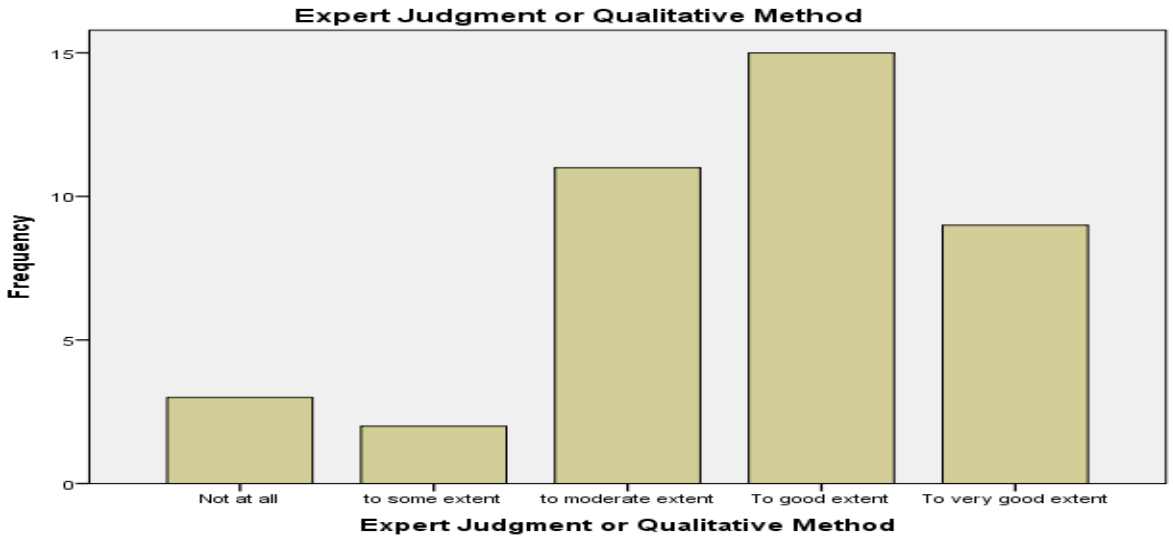
Figure 3 Extent of applying Exponential Smoothing Technique



4.3.3 Expert Judgment

In total sum, this is the technique that is much applied in the agency. The majority of the respondents (34.9%) agreed that expert judgment is applied to good extent and 25.6% agreed that the agency applies the this technique to moderate extent. 20.9 % on the other hand replied their agreement that this technique is applied to very good extent. The least of the respondents (7.0% gave their level of agreement that the agency doesn't apply this technique. Collectively, the empirical evidence indicates that subjective techniques are popular for all types of forecasting situations (i.e., across all time horizons and forecasting levels) (Joonas V., 2014).

Figure 4 Extent of applying Expert judgment in forecasting of First line Anti TB drugs



4.4 The Role of Forecasting in Decision Making

In this study, respondents were also asked to give their agreement on to what extent forecasting is applied in decision making. The levels of agreements were a 5 likert scales which ranges from one to five. Three basic procurement activities were identified to be included under this category to assess how much is the role of forecasting in decision making in the procurement of first line anti TB drugs. These activities were; 1) Budget preparation, 2) Purchasing Plan and 3) Efficient budget Utilization. All 40 respondents gave their agreement for all activities under this category. The means of the level of agreement to each activity were 4.30%, 4.15% and 3.95% for activity, Purchase plan, Budget Preparation and Efficient Budget Utilization respectively. The standard deviation of agreements for these activities from their mean were 0.791 for Purchase plan, 0.770 for Budget Preparation and 1.037 for Efficient Budget Utilization. The maximum level of agreement for all activities by a respondent per activity was five and the minimum was two so

that the range was three. The maximum sum of levels of agreements by the respondents from the three activities was 172 from the expected 200 for purchase plan and the minimum was 158 for Efficient Budget utilization. That is the role of forecasting was better in decision making of purchase plan. The least agreement of respondents was that forecasting had less role in decision making for efficient budget utilization.

Table 5. The Role of Forecasting in Decision making procurement activities

		Purchase Plan	Budget Preparation	Efficient Budget Utilization
N	Valid	40	40	40
	Missing	3	3	3
Mean		4.30	4.15	3.95
Median		4.00	4.00	4.00
Mode		5	4	4
Std. Deviation		.791	.770	1.037
Variance		.626	.592	1.074
Range		3	3	4
Minimum		2	2	1
Maximum		5	5	5
Sum		172	166	158

4.4.1 Using Forecasting in Purchase Plan

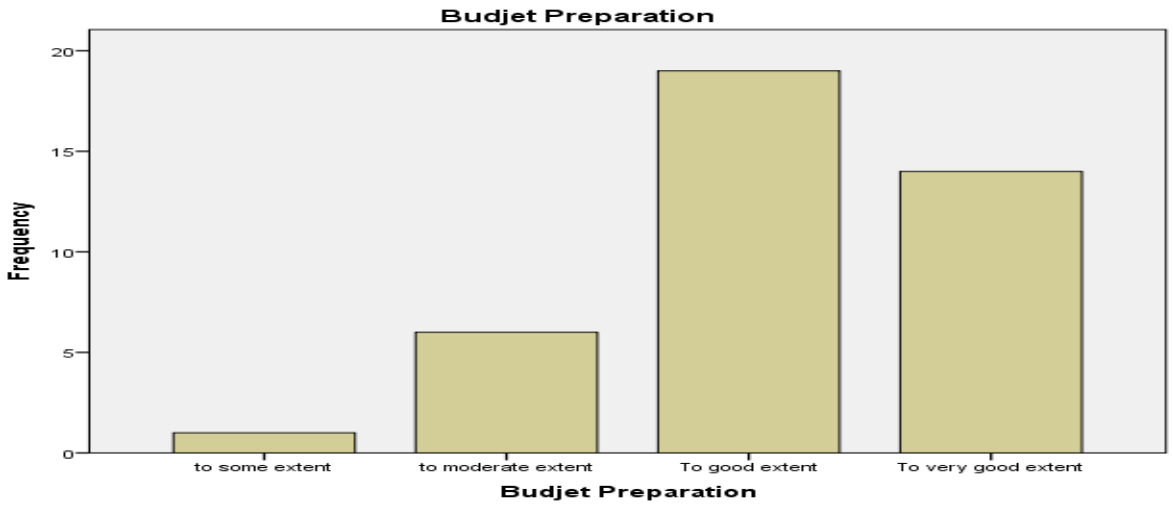
The majority of the respondents (44.2%) agreed that the agency used forecasting to very good extent in purchase plan decision making. The next large number of respondents (34.9%) agreed that the role of forecasting for decision making in purchase plan is applied to good extent by the agency. Only one respondent agreed that the role of forecasting for decision making in purchase plan is to some extent. There was not respondent that agreed on the absence of the role.

Figure 5. The role forecasting for decision making in Purchase plan

4.4.2 The Role of Forecasting for decision making in Budget preparation

44.2% of the survey participants agreed that the role of forecasting in decision making of budget preparation is applied in the agency to good extent. 32.6% agreed that using forecasting in budget preparation of procuring first line anti TB drugs is to very good extent. 14.0% agreed to moderate extent and only one respondent agreed to some extent. No one in the survey gave forecasting is not used in budget preparation decision making in the agency.

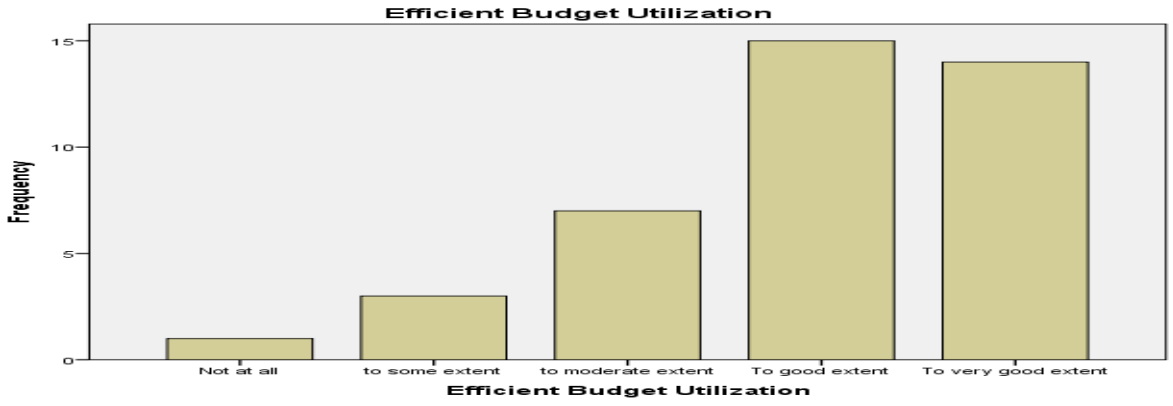
Figure 6. The Role of Forecasting in Decision Making of Budget Preparation



4.4.3 The Role of Forecasting in Decision Making of Efficient Budget Utilization

In the role of forecasting in using decision making for efficient budget utilization in the agency, the majority of respondents gave their level of agreement that the agency used to good extent (34.9%) and 32,6% agreed that the agency used to very good extent. Seven respondents agreed that the agency used to moderate extent. Only one respondent agreed that the agency did not use forecasting to decide in efficient budget utilization.

Figure 7. The Role of Forecasting in Decision Making of Efficient Budget Utilization



4.5 The role of Forecasting in Cost and Delivery Performance

This section of the analysis is focused on analysing the role of forecasting on cost performance and delivery performance in the agency. All the study participants indicated their level of agreement for all performance indicators that were asked to give. The role of forecasting in the agency's Cost performance was designed to be tested by three activity costs. These were; i) Purchasing Cost ii) Distribution cost and iii) inventory handling cost. On the other hand the role of forecasting on delivery performance was assessed by taking three activities: i) Order fill rate, ii) On time delivery and Delivery as promised. The means of agreements for all these activities were 3.88 for Purchasing cost, 3.77 for Distribution cost, 4.13 for Inventory handling cost, 4.08 for order fill rate, 4.15 for on time delivery and 3.90 for delivery as promised. The standard deviation from the means of these activities were 0.911, 1.091, 1.137, 0.859, 0.802 and 1.081 for activities Purchasing Cost, Distribution cost, inventory handling cost, order fill rate, on time delivery and Delivery as promised respectively. The maximum level of agreement of respondents for these activities was five and the minimum was one for distribution cost, inventory handling cost and delivery as per promised and two for Purchasing cost, Order fill rate and on time delivery. The maximum sum of the levels of agreements for all respondents to each activity was 166 which is given for the activity "on time delivery''. The minimum was given for distribution cost.

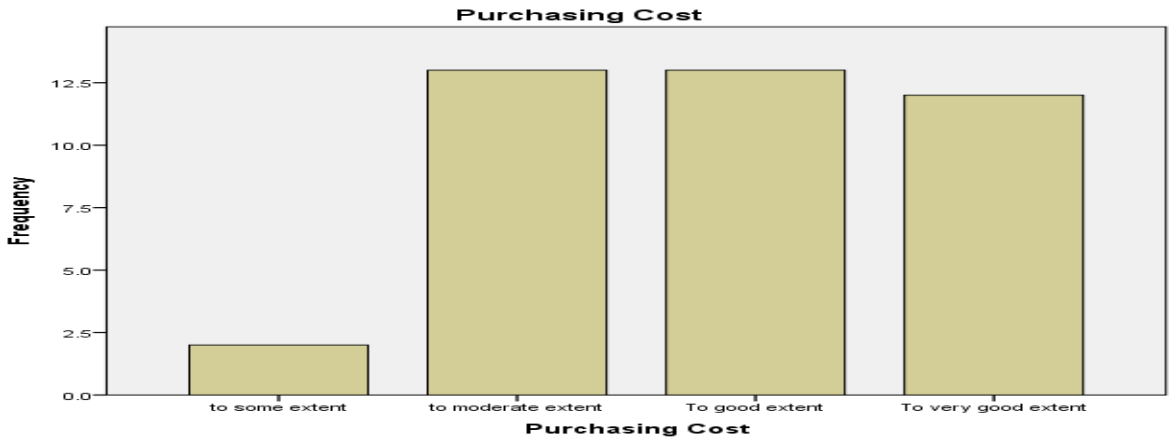
Table 6. The Role of Forecasting on Cost and Delivery Performance

		Purchasing Cost	Distribution Cost	Inventory Handling Cost	Order Fill Rate	On time Delivery	Delivery As promised
N	Valid	40	40	40	40	40	40
	Missing	0	0	0	0	0	0
Mean		3.88	3.70	4.13	4.08	4.15	3.90
Median		4.00	4.00	4.50	4.00	4.00	4.00
Mode		3[a]	4	5	5	4	5
Std. Deviation		.911	1.091	1.137	.859	.802	1.081
Variance		.830	1.190	1.292	.738	.644	1.169
Range		3	4	4	3	3	4
Minimum		2	1	1	2	2	1
Maximum		5	5	5	5	5	5
Sum		155	148	165	163	166	156

4.5.1 The Role of Forecasting in Purchasing Cost

The majority of the respondents (30.2%) agreed that in the agency, the role of forecasting on the purchasing cost is “to good extent” and 30.2% replied “to moderate extent”. 30.0% of the respondents gave their agreement that the role is “to very good extent”. Only two respondents replied the role is “to some extent” and there was no any respondent who said forecasting has no role on purchasing cost.

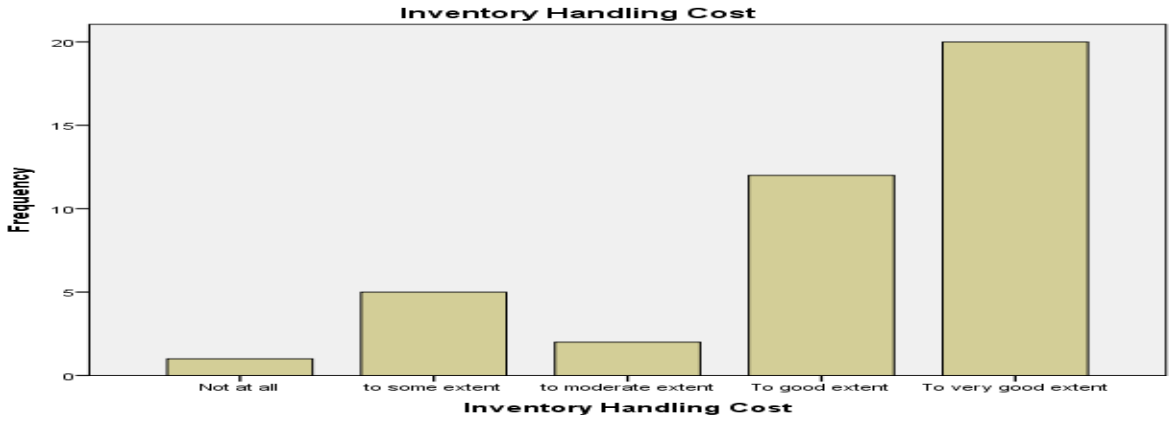
Figure 8. The Role of Forecasting on Purchasing Cost



4.5.2 The Role of Forecasting On Inventory Handling Cost

The role of Forecasting on Inventory handling cost was found to be “to very good extent” supported by 50.0% of the respondents and 30.0% agreed that the role is “to good extent”. Others (12.5) responded that the role is “to some extent”. Only 2 respondents agreed that there is no role of forecasting on Inventory handling cost.

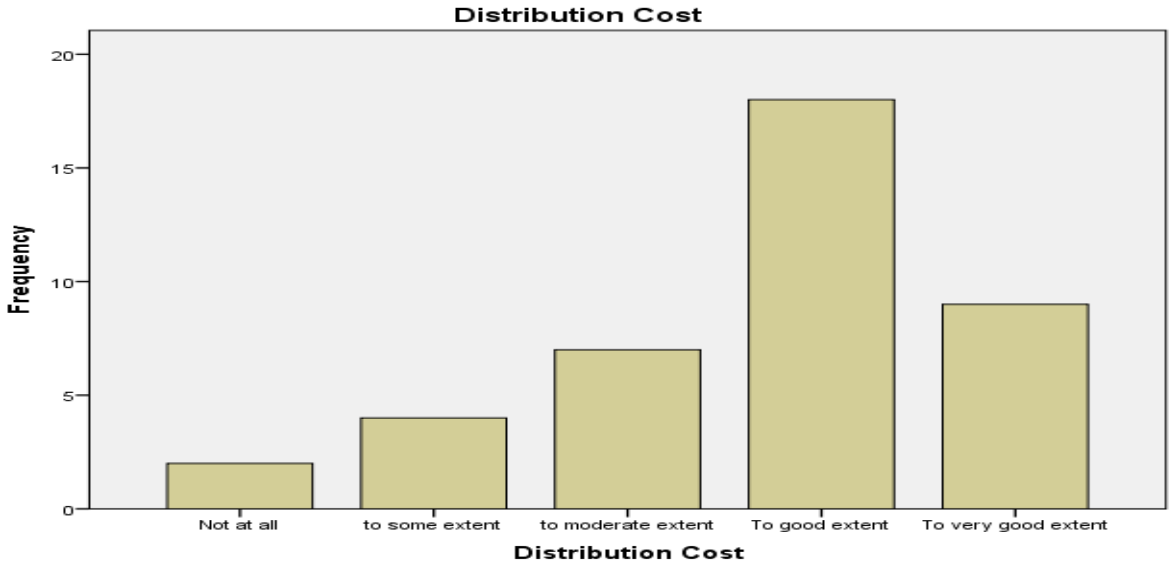
Figure 9. The Role of Forecasting on Inventory Handling Cost



4.5.3 The Role of Forecasting on Distribution Cost

The role of forecasting on distribution cost was found "to good extent" supported by the agreement of 45.0% of the respondents. 22.5% also agreed that in EPSA, forecasting has an role on Distribution cost "to very good extent". 17.5% of the respondents agreed that the role is "to moderate extent". Two respondents agreed that forecasting has no role on distribution cost of first line anti TB drugs.

Figure 10. The Role of Forecasting on Distribution Cost



4.6 The Role of Forecasting on Delivery Performance

All 40 respondents gave their consent on the role of delivery performance. Delivery performance was designed to be assessed by three basic activities. Then, the forecasting role on these activities was tested by asking respondents to give their level of agreement on these three activities. The means for these three activities were 4.08 for order fill rate, 4.15 for on time delivery and 3.90 for delivery as promised. The standard deviation from the mean for these activities were 0.859, 0.802, 1.081 for order fill rate, on time delivery and delivery as promise respectively. The maximum level of agreement for activities was five and the minimum was two for order fill rate and on time delivery. Whereas, it was one for Delivery as per promised. Therefore, the range between the maximum and the minimum level of agreement were three for order fill rate and on time delivery and on the other hand the range was four for delivery as promised. The maximum sum of levels of agreement by the respondents was 166 for forecasting role on "on time delivery".

Table 7. The Role of Forecasting on delivery performance

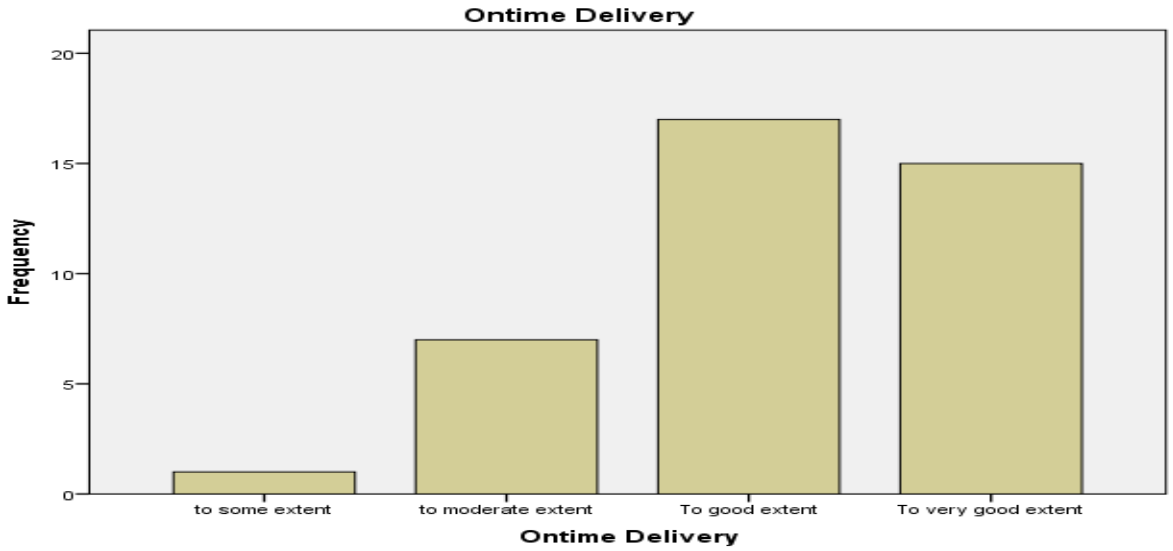
		Order Fill Rate	On Time Delivery	Delivery as promised
N	Valid	40	40	40
	Missing	3	3	3
Mean		4.08	4.15	3.90
Median		4.00	4.00	4.00
Mode		5	4	5
Std. Deviation		.859	.802	1.081
Variance		.738	.644	1.169
Range		3	3	4
Minimum		2	2	1
Maximum		5	5	5
Sum		163	166	156

The forecasting practice of the agency has a very good role on order fill rate. It was observed that 37.5 % of the respondents were agreed that forecasting role on order fill rate is to very good extent. 35.0% agreed that the role is to good extent. Only one individual respond the role to some extent and there was no agreement that stated forecasting has no role on order fill rate. But, 25.0% replied that the role is to moderate extent.

Figure 11. The Role of Forecasting on Order Fill Rate

The survey result also showed that forecasting has an role on "on time delivery" to good extent according to 42.5% respondents' agreement. 37.5% of the respondents however agreed that the role is to very good extent. 17.5 % responded that the role is to moderate extent. Only one respondent replied that the role is to some extent and there was no an agreement given on forecasting has no role at all.

Figure 12. The Role of Forecasting on "on time Delivery"



Thirdly, respondents were asked to give their agreement on to what extent forecasting has an role on delivery as per promised. It was observed that forecasting has an role on "delivery as promised" to very good extent (37.5%). 27.5 % of the respondents agreed that the role is to good extent and the other 25.0% gave their agreement that the role is to moderate extent.

Figure 13. The Role of Forecasting on Delivery as promised

4.7 Measuring Forecasting Practice in EPSA

The detailed discussion above showed that the survey result of the study. Every activity under each category is discussed. To measure the extent of forecasting practice in EPSA, those variables are grouped in three categories while constructing the structured questionnaire. They were leveled as "The extent of using forecasting Techniques in the agency to procure first line anti TB drugs", "The extent of using forecasting in decision making to procure first line anti TB drugs", and "The extent of using forecasting in cost performance of procuring first line anti TB drugs", and "The extent of using forecasting in Delivery performance of procuring first line anti TB drugs". From the survey result, these categories were fed to Google sheet and the extent of practicing given by each respondent was averaged for the category and summed up to define variables by "construct average value".

Table 8. Summary of Forecasting Practice in Ethiopian Pharmaceuticals Supply Agency.

Summary of Forecasting Practice in EPSA		
Variable	Sum of Average Levels of Extent	Average Level of Extent
The extent of Using Forecasting Techniques	127	3.18
Extent of Using Forecasting in Decision Making	170	4.25
Extent of Forecasting Impact on Cost Performance	160	4.01
Extent of Forcasting Impact on Delivery Performance	166	4.16

As described above the measure of the forecasting practice was conducted by taking the variables in to four categories and took the average sum of extents responded by the practitioners and the average level of extent by an individual.

From the survey result, it was found that using forecasting techniques scored less than any other category of variables. The average level of extent that the agency is using structured forecasting techniques is 3.18 which is **"To moderate extent"** and the sum of average extent levels provided by the respondents was found 127 from the ideal 200 points if it were practiced 100%. The highest score from the four categories was the extent of using forecasting in decision making which scored 170 from 200 with an average level of extent 4.25 (above "**To good extent**"). As per the result, the agency is practicing forecasting for decision making above **"To good extent".** The second highest score was obtained in the role of forecasting in delivery performance of the agency. The sum of average levels of extent was 166 with 4.16 average level of extent (above

"To good extent"). This showed that the role of forecasting on delivery performance ("order fill rate", "on time delivery" and "delivery as promised") is above "**To good extent"**. Though practicing structured forecasting techniques were around, "**To some extent**", the agency is still using what was forecasted to decide on budget preparation, purchasing plan and efficient budget utilization above "**To good extent**". The following bar graph described the summary of the categorical variables in terms of sum of average level of extents by all the respondents for that specific variable and average level of extent by a single respondent for each variable. Moreover, the role of forecasting on cost performance was above the mean (4.01) average level of extent which indicated that the role is "**To good extent**". The sum of average levels of extents by respondents was 160.

Figure 14. Sum of Average Levels of Extent by respondents

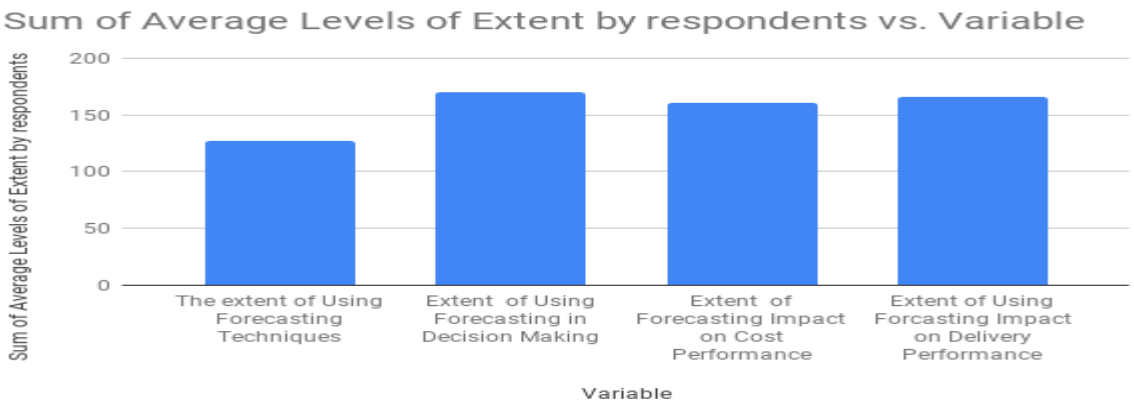
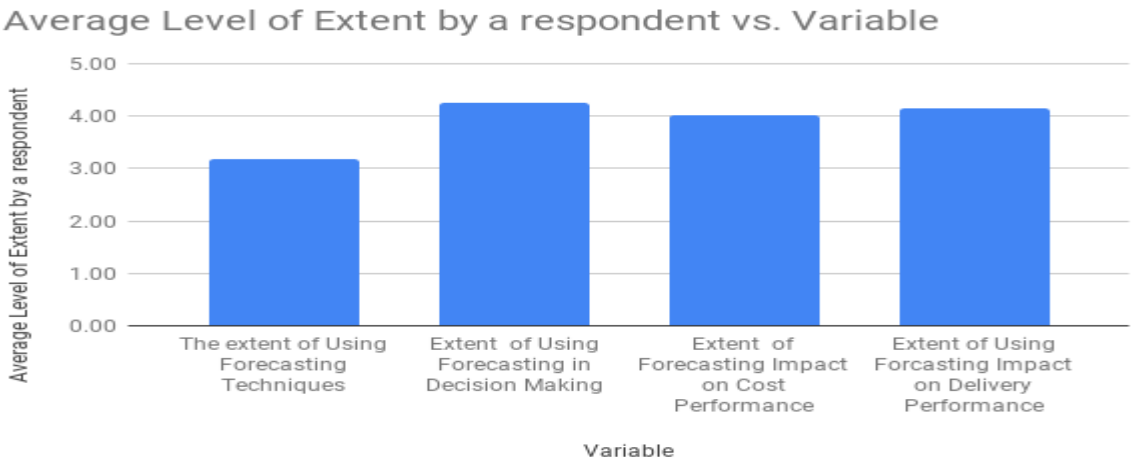


Figure 15. Average Level of extent by a respondent



4.8 Forecast accuracy of first line anti TB drugs Procurement in EPSA

The forecast error measures the accuracy of an individual forecast. In this paper, forecast accuracy was defined in terms of forecast error and was measured by using the mean absolute percentage error (MAPE) and Mean Absolute Deviation (MAD).

Whereas, the MAPE is absolute error as a percentage of demand. MAPE is computed according to the following formula:

$$\text{MAPE} = \left(\frac{1}{n}\sum\frac{|Actual - Forecast|}{|Actual|}\right) * 100$$

Where **n** is number of times at which forecasting and actual demand is compared for an item.

MAD has the advantage of being easier to understand among non-specialists, partly because that the error has the same dimension as the forecast. MAD is not sensitive to outliers due to the absolute value instead of the quadratic value for each error (Peter Wallström, 2009).

MAD is an average of the difference between the forecast and actual demand, as computed by the following formula:

$$\text{MAD} = \frac{1}{n}\sum_{t=1}^{n}\left|X_t - \hat{X}_t\right|$$

Where, n: is total number of periods during which forecasting and actual demand is compared. for an item, X_t: is forecasted demand in period t and $\hat{X}_t$ is actual demand in period t and

|| = the absolute value

Better organized data for both forecasted and actual consumption data of first line anti TB drugs was obtained for three years (2016-2018) in EPSA. The forecasted data was collected by reviewing two documents; 1) National Anti-TB Medicines, Equipment, Supplies and Laboratory Reagents procurement and Supply Plan Ethiopia 2016/17-2017/2018 and 2) Quantification of anti TB Commodities for July 2016 to July 2018. The first document contains the forecasted data of 2016 for all anti TB commodities and the second consists of forecasted data of 2017 and 2018

for all anti TB commodities. This research was conducted to assess and analyze the forecasting practice of first line anti TB medicines. These first line anti TB medicines are Ethambutol - 400mg – Tablet, Isoniazid - (INH) 300mg – Tablet, Pyridoxine HCL (Vitamin B6) - 50mg – Tablet, RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275mg – Tablet, RH (Rifampicin +Isoniazide)- 150+75mg Tablet, Streptomycin Sulphate - 1gm - Powder for injection, Ethambutol - 100mg – Tablet, Isoniazid - 100mg – Tablet, RH (Rifampicin + Isoniazid) - (60mg + 30mg) - Tablet and RHZ (Rifampicin + Isoniazid + Pyrazinamide) - (60mg+ 30mg+150mg) – Tablet (FMOH, 2016).

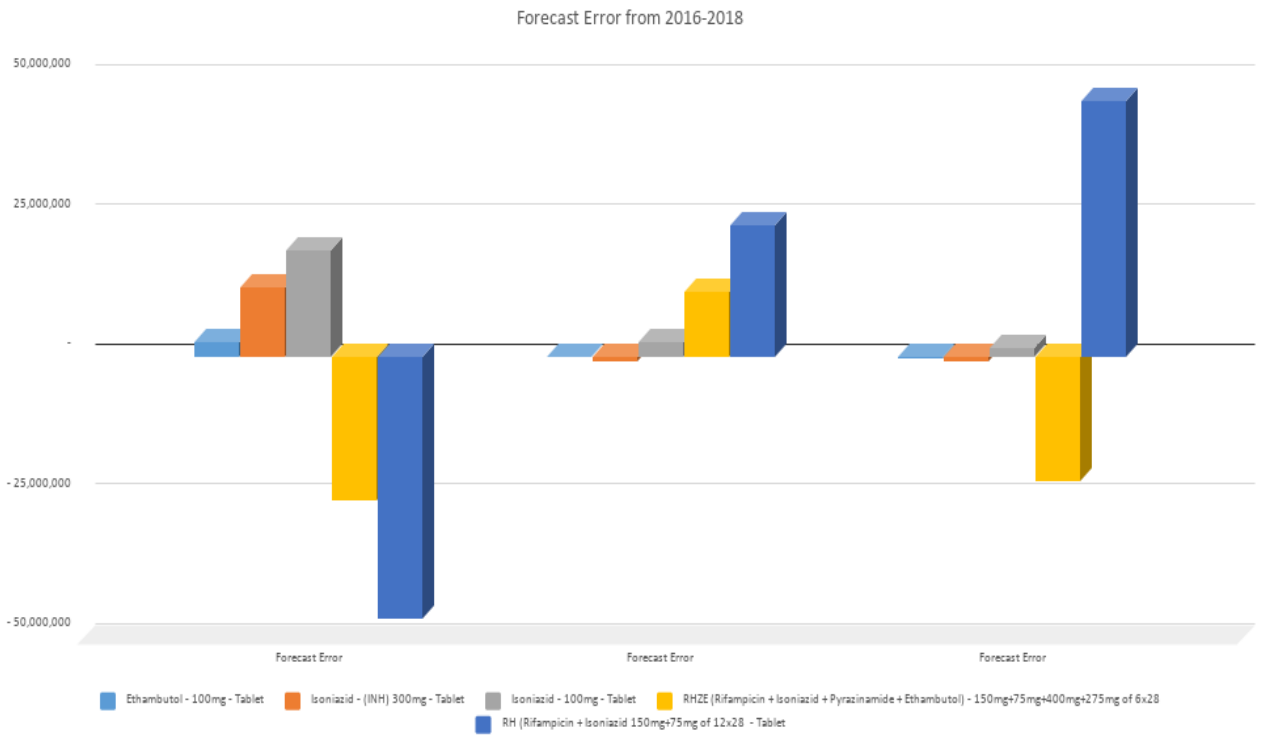
However, the actual consumption data was obtained for only five drugs which were; 1) Ethambutol - 100mg – Tablet, 2) Isoniazid - (INH) 300mg – Tablet, 3) Isoniazid - 100mg – Tablet, 4) RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275mg – Tablet and 5) RH (Rifampicin +Isoniazide)- 150+75mg Tablet. Therefore, the study was focused on measuring forecasting accuracy of the agency to procure these five first line anti TB drugs for three years (2016-2018).

The document review result showed that there was a negative directed forecast error for Ethambutole 100mg tablet and Isoniazide 300mg tablet in 2017 and 2018, RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275mg of 6x28 tablet and RH (Rifampicin + Isoniazid 150mg+75mg of 12x28 - Tablets in 2016. That means they were under forecasted than the actual consumption. RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275mg of 6x28 tablets was also under forecasted in 2018. Isoniazide 100mg tablet has been over forecasted than the actual demand for the last three years. The following table describes the forecast error for each of the five drugs across three years without computing by MAPE and MAD.

Table 9. Forecast Error of First Line Anti TB Drugs from 2016-2018

Drug Name	2016		Forecast Error	2017		Forecast Error	2018		Forecast Error	Total Demand Across Three Years
	Forecasted	Actual Demand		Forecasted	Actual Demand		Forecasted	Actual Demand		
Ethambutol - 100mg - Tablet	5,804,305	3,023,300	2,781,005	2,902,100	2,967,700	-65,600	2,902,200	3,090,403	-188,203	9,081,403
Isoniazid - (INH) 300mg - Tablet	30,412,763	17,779,776	12,632,987	15,206,016	15,942,528	-736,512	15,206,688	15,865,920	-659,232	49,588,224
Isoniazid - 100mg - Tablet	21,237,961	2,043,300	19,194,661	4,775,400	1,934,200	2,841,200	4,775,400	3,029,700	1,745,700	7,007,200
RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275 mg of 6x28	1,412,820	26,947,368	- 25,534,548	27,459,432	15,678,600	11,780,832	28,095,984	5,802,048	-22293936	48,428,016
RH (Rifampicin + Isoniazid 150mg+75mg of 12x28 - Tablet	7,098,672	53,894,736	- 46,796,064	54,918,864	31,357,200	23,561,664	56,191,968	10,361,232	45,830,736	95,613,168

Figure 16. Forecast error of five anti TB drugs per each year.



From the review, it was confirmed that high forecast error was observed in 2016 than any other years for all five products. Finally, to measure the forecast accuracy, the forecasted variances were computed by MAPE and MAD for each of the five drugs across three years.

A. Measuring Forecast Accuracy by MAPE

MAPE measures the absolute error as a percentage of demand rather than per period. From the table above, the MAPE is computed according to the following formula:

$$\text{MAPE} = \left(\frac{1}{n}\sum\frac{|Actual - Forecast|}{|Actual|}\right) * 100$$

Accordingly, the forecast error for each of the five drugs obtained was presented by table 10 below.

Table 10. Forecast Error by MAPE of Five First Line anti TB drugs

Drug Name	Forecast Error in 2016	Forecast Error in 2017	Forecast Error in 2018	Total Demand	MAPE
Ethambutol - 100mg - Tablet	2,781,005	65,600	188,203	9081403	33%
Isoniazid - (INH) 300mg - Tablet	12,632,987	736,512	659,232	49588224	28%
Isoniazid - 100mg - Tablet	19,194,661	2,841,200	1,745,700	7007200	339%
RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275mg of 6x28 tablets	25,534,548	11,780,832	22,293,936	48428016	123%
RH (Rifampicin + Isoniazid 150mg+75mg of 12x28 - Tablet	46,796,064	23,561,664	45,830,736	95613168	122%

It was observed that though the forecasted and actual demand volume of Isoniazide 100mg tablet was relatively small, the forecast error by MAPE value was found greater than the rest of the drugs. Hence, this showed that the Isoniazide 100mg tablet has been forecasted inaccurately for the last three years. Similarly, RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275mg of 6x28 tablets has been forecasted and actually demanded in a quantity lower than RH (Rifampicin +Isoniazide)- 150+75mg Tablet. However, the forecast error by MAPE was found higher than RH. It is therefore possible to say that the forecast accuracy of RHZE was more inaccurate than RH. Totally, the document review showed that the forecast error

for all drugs for all the three years was higher and hence the agency was practicing inaccurate forecasting to procure first line anti TB drugs.

The Monitoring and evaluation framework of the agency developed in 2018 targeted to meet a 75% forecast accuracy and the agency generally accepted a forecast error of 25% or less as a standard margin in its forecasting practice. As the forecasted number deviates from 25%, the forecasts become increasingly inaccurate (PFSA, 2018). However, none of from the five first line anti TB drugs meet the standard margin of the agency as it can be observed from table 10. It was Isoniazide 300mg tablet which is relatively forecasted in a better forecast accuracy (72%).

B. Measuring Forecasted Accuracy by MAD

From the table 8 above, Mean absolute deviation (MAD) can be calculated from the forecast errors obtained per year for each product. The calculation followed the standard formula as follow.

$$\text{MAD} = \frac{1}{n}\sum_{t=1}^{n}\left|X_t - \hat{X}_t\right|$$

According to the documents reviewed, the value of the forecast error obtained by MAD was as described by table 11 below.

Table 11. MAD Value of Five Drugs across Three Years

Drug Name	Forecast Error in 2016	Forecast Error in 2017	Forecast Error in 2018	MAD
Ethambutol - 100mg - Tablet	2,781,005	65,600	188,203	1,011,603
Isoniazid - (INH) 300mg - Tablet	12,632,987	736,512	659,232	4,676,244
Isoniazid - 100mg - Tablet	19,194,661	2,841,200	1,745,700	7,927,187
RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275mg of 6x28 tablets	25,534,548	11,780,832	22,293,936	19,869,772
RH (Rifampicin + Isoniazid 150mg+75mg of 12x28 - Tablet	46,796,064	23,561,664	45,830,736	38,729,488

In general, the smaller the value of MAD, the more accurate the forecast, although, viewed alone, MAD is difficult to access. In this study, the data values were relatively large, and the MAD value

of each drug was judged accordingly. Overall, it would seem to be a "high" value (i.e., the forecast appears to be relatively inaccurate).

It was observed that the forecast error by MAD was highest for RH (Rifampicin +Isoniazide)-150+75mg Tablet and the third higher forecast error was Isoniazide 100mg tablet which was the highest in forecast error by MAPE. This confirmed that the forecast error of Isoniazide 100mg tablet was higher across the three years.

Every instance of demand has two components; systematic component and a random component. A good forecasting method should capture the systematic component of demand but not the random component. The random component manifests itself in the form of a forecast error. The systematic component measures the expected value of demand. The random component measures fluctuations in demand from the expected value. Forecast error measures the random component of demand. The random component is usually estimated as the standard deviation of forecast error. (Sunil Chopra and Peter Meindl, 2007).

Chopra and Meindl used to estimate the standard deviation of random component by multiplying MAD by 1.25; ǿ=1.25xMAD assuming that the random component is normaly distributed. Therefore, by taking the MAD Value above, we can observe the standard deviation of the random component of demand from forecasted value to see how good the forecatsed accuracy is.

Table 12. Standard deviation of Random component

Drug Name	Forecasted Quantity in 2016	Forecasted Quantity in 2017	Forecasted Quantity in 2018	MAD	ǿ
Ethambutol - 100mg - Tablet	5,804,305	2,902,100	2,902,200	1,011,603	1,264,503
Isoniazid - (INH) 300mg - Tablet	30,412,763	15,206,016	15,206,688	4,676,244	5,845,305
Isoniazid - 100mg - Tablet	21,237,961	4,775,400	4,775,400	7,927,187	9,908,984
RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275mg of 6x28 tablets	1,412,820	27,459,432	28,095,984	19,869,772	24,837,215
RH (Rifampicin + Isoniazid 150mg+75mg of 12x28 - Tablet	7,098,672	54,918,864	56,191,968	38,729,488	48,411,860

Accordingly, it was observed that the random component of INH100mg, RH, RHZE and INH300mg tablet were larger when compared with the forecasted demand. Therefore, the forecast accuracy of the agency for these first line anti TB drugs was highly inaccurate. Still, the

random component of the demand forecasted for Ethambutole 100mg was also high though lower relative to other drugs.

From the forecasting technique practice of the agency survey result obtained and described above, the **"expert judgment"** is the most forecasting technique that is being practiced. Matteo Kalchschmidt, (2014) has conducted a study on demand forecasting practices and performance where he confirmed that there is a positive relation between high forecasting error and qualitative forecasting technique. J. Scott Armstrong (2001) who is another scholar recommended that under difficult situation to select qualitative method, it is better to combine more than one method to forecast demand unless otherwise to select a judgmental method (qualitative methods), determine whether there are large changes, frequent forecasts, conflicts among decision makers, and policy considerations and to select a quantitative method, consider the level of knowledge about relationships, the amount of change involved, the type of data, the need for policy analysis, and the extent of domain knowledge. The survey result of this study also confirmed that high frequent expert judgmental forecasting practice was being practiced by the agency with high forecast error.

However, from construct average value of Category one which was practicing forecasting techniques in EPSA, showed that structured forecasting techniques were practiced to some extent. Therefore, the agency, by the time of survey, was practicing high forecast error with less structured forecasting techniques but, with high expert judgment. In addition, from construct average value of the above four categorical variables (Forecasting technique practice, the extent of using forecasting in decision making, the role of forecasting on cost and delivery performance), it was obtained that using forecasting in decision making is above "To good extent" and the role of forecasting on "Cost and delivery performance" were above "To good extent". Therefore, where using inaccurate forecasting technique in decision making to good extent, the agency invests high cost of purchasing, inventory handling, and distribution. Furthermore, since the role of forecasting on delivery performance was found "to good extent", high forecast error will lead to low delivery performance (order fill rate, on time delivery and delivery as promised.

Chapter Five

5. Summary of Findings, Conclusions, Recommendations and Further Study Area

5. 1 Summary of Findings

This study was designed to assess the overall contract administration part of Ethiopian Pharmaceuticals Fund and Supply Agency. The study was done by constructing two tools; structured questionnaire and document review. Under the structured questionnaire, four categorical variables were constructed to be assessed and the level of extent that forecasting technique has been used, the role of forecasting in decision making, the role of forecasting on cost performance of the agency and delivery performance were measured by three elements under each category. Extent of using structured forecasting technique in EPSA was assessed by taking "Regression", "exponential smoothing" and Expert Judgment. The average level of extent for this category was 3.18 ("To moderate extent") which is near to average. The role of using forecasting in decision making was studied by taking decision during "Budget Preparation", "Purchasing Plan" and "Efficient Budget Utilization". The average construct value of this category was 4.25 which was the highest score in the analysis of the variables. Hence, the agency was using forecasting in decision making above "**To good extent**" but below "To very good extent". The role of forecasting on "Cost Performance" was assessed by taking three sub variables; "Purchasing Cost", "Inventory Handling Cost" and "Distribution Cost". The survey result of this average construct value was 4.01 in which the role was **"To good extent".** "Delivery Performance" was the fourth categorical variable assessed by asking respondents to give the role level of forecasting on "Order Fill Rate", "On Time Delivery" and "Delivery as Promised". The average construct value of the survey showed that the role is "To good extent" with a value of **4.16**.

The second section of the study was a document review used to measure forecast accuracy of the agency for the last three years. By using forecast error measurement tools (MAPE and MAD), the forecasting practice of the agency for the last three years were measured and found that the forecast error was high by both MAPE and MAD.

5. 2 Conclusions

Improving forecast accuracy is often considered a necessity because large forecast errors usually negatively affect companies' operational performance, especially cost and delivery performance. This study was conducted by collecting data by two tools; structured questionnaire and document

review. The structured questionnaire was used to assess the extent of practicing structured forecast techniques and their role on cost and delivery performance of the agency in the procurement of first line anti TB drugs. It was also designed to measure to the role of forecasting techniques in decision making to procure first line anti TB drugs. The document review was used to measure the forecast accuracy by applying two forecast error measurement tools; MAPE and MAPE. The survey result of the study showed that the use of structured forecasting technique was below average; 2.63 for "Regression" and 2.95 for "Exponential Smoothing" and a construct average value of 3.18 including "Expert Judgment" whose individual practice was above average; 3.63. It was also found that the role of forecasting in decision making related to budget preparation, purchasing plan and efficient budget utilization in the procurement of first line anti TB drugs is above "to good extent". The role of forecasting on cost and delivery performance was also found above "to good extent".

The document review survey showed that, the forecast error is high for almost all first line drugs included in this study. The forecast error for Ethambutol - 100mg – Tablet by MAPE was found 33%, which was relatively low, Isoniazid - (INH) 300mg – Tablet was 28%, which was the least forecast error from all drugs, Isoniazid - 100mg – Tablet was 339%, which was the largest forecast error by MAPE, RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275mg of 6x28 tablets was 123% and for RH (Rifampicin + Isoniazid 150mg+75mg of 12x28 - Tablets was 122%. The direction of forecast error for these first line anti TB drugs were both under forecasting and over forecasting across three years except Isoniazid - 100mg – Tablet which was over forecasted for across three years. The forecasting error for first line anti TB drugs by MAD were 1,011,603, 4,676,244, 7,927,187, 19,869,772 and 38,729,488 for Ethambutol - 100mg – Tablet, Isoniazid - (INH) 300mg – Tablet, Isoniazid - 100mg – Tablet, RHZE (Rifampicin + Isoniazid + Pyrazinamide + Ethambutol) - 150mg+75mg+400mg+275mg of 6x28 tablets and RH (Rifampicin + Isoniazid 150mg+75mg of 12x28 - Tablets respectively.

Generally, it was observed that the agency was practicing structured forecasting technique to moderate extent and had been practicing forecasting of first line anti TB drugs with high forecast error for the last 2016, 2017 and 2018 years. Pavel Bondarev (2012) has observed that10% of the

forecasting improvements may result in up to 30% of the company's saving annually, while forecasting improvement costs are simply negligible compared to the total annual cost savings.

5.3 Recommendations

From the result section of this study, it was noticed that the structured forecasting technique had been less practiced and the extent of using forecasting for decision making was high. It was also obtained that the role of forecasting on delivery and cost performance was high. Based on the results the author has forwarded the following recommendations.

1. Structured Forecasting Technique

From the survey result, applying statistical forecasting technique in the agency was below **"To moderate extent"** and hence need to transform its forecasting practice to more statistical forecasting techniques or otherwise combine both statistical and qualitative judgmental techniques as the forecast error observed was too high. The agency was found better practicing "Expert Judgment" than more structured and mathematical techniques; **"Regression**" and **"Exponential Smoothing"**. Instead of focusing on Expert Judgment, the agency need to use a mixed approach if not appropriate to apply simple mathematical forecasting techniques.

2. Using Forecasting Techniques in decision Making

Forecasting function requires an extensive analysis of the decision situation. It has the capability to explain the factors that affect the decision problem by using the methods such as regression and time series analysis (exponential smoothing). The agency was found using forecasting to good extent in decision making of budget preparation, purchase plan and efficient resource utilization. However, using forecasting for decision making with high forecast error may cause high cost and failure specially on efficient resource utilization as the country is funded by "**Global Fund"** for procurement of first line anti TB drugs. Therefore, the agency need to clarify and make sure which forecasting technique was followed and should make an assessment on forecast accuracy before making decisions to lessen the worse of procurement.

3. Forecast Accuracy

The forecast accuracy obtained from the retrospective document review confirmed that there was high forecast error when tested by both MAPE and MAD. This might be associated with low structured forecasting practice and high expert judgment practices to procure first line anti TB drugs. Improving forecast accuracy is often considered a necessity because large forecast errors usually negatively affect companies' operational performance, especially cost and delivery performance (Kalchschmidt et al., 2003). The agency should revise its forecasting trend and focus on adopting both statistical and judgmental practices to reduce the role of forecasting error on purchasing cost, inventory handling cost, distribution cost and also to improve delivery performance; order fill rate, on time delivery and delivery as promise.

5.4 Further study Areas

This study presents only forecasting practice of first line anti TB medicines. The agency is governmental procurement agent for procuring more than thousands health commodities and it is very possible to conduct the study by the same methodology for other products including some qualitative tools. Another insight that can be answered by other studies is that the forecast error might not be caused only by the absence of structured forecasting techniques but, there might be other factors for this high inaccuracy. Therefore, conducting a study on investigating these factors might give the agency another version of solutions to improve its forecasting performance.

Furthermore, this study uses distributed stocks of first line drugs to health facilities as an actual demand. Therefore, if an intensive time and budget can be placed, the actual demand shall be collected from the health facilities to avoid proxy estimation so that better forecast accuracy measurement can be made.

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Annex 1. Questionnaires

Addis Ababa University School of Commerce

MA Logistics and Supply Chain Management

Questionnaires for Respondents

Dear respondent: My name is Abyot Adane, pursuing a Master of Arts Degree in Logistics and Supply Chain Management at Addis Ababa University. The research is entitled as **"**anti TB drugs demand forecasting practice: the case of Ethiopian pharmaceuticals supply agency**"** for the partial fulfillment of academic requirement.

This questionnaire is designed to collect primary data for this study only and your genuine responses to the questionnaires are highly demanded on which the success is depending on. I kindly request you to spend a few minutes of your valuable time to answer the questions as per the instruction below:

- You do not need to write your name
- All of the questions are responded by yourselves
- You are required to encircle only one out of the given alternative numbers which is your best choice to say.
- For some of the questions that need your explanations, please try to honestly describe as per the questions on the space provided.

If you need any explanations or description concerning the study and the questions provided, don't hesitate to reach me through the mobile phone number: +251 9138828961 or email: abyot.andu@gmail.com. Please note that the information you are providing will be treated with utmost confidentiality.

Thank you in advance for your participation in the study!

Part-one- General information of the respondents

1. Age: Below 20yrs ☐ Between 31–40yrs ☐

   Between 20-30yrs ☐ Between 41–50yrs ☐ Above 50yrs ☐

2. Sex: Male ☐ Female ☐

3. Educational Qualification: Diploma ☐ second degree and above ☐

   First Degree ☐

4. Organization: Federal Ministry of Health ☐

   Pharmaceuticals Supply Agency ☐

5. Job Title: Director ☐

   Team Leader ☐

   Officer ☐

   Advisor ☐

6. Years of service: 3 years and below ☐ above 6 years ☐

   Between 3-6 years ☐

Part-two- The extent of Applying Forecasting Techniques in EPSA

The purpose of this part is to gather information on to what extent EPSA is applying Forecasting techniques, to what extent forecasting is used in decision making and to what extent forecasting has an role on cost and delivery performance of suppliers in procurement of first line anti TB medicines.

Please indicate your level of agreement to the following statement using the five level scales given below:

To very good extent (VE) =5, to good Extent (GE) =4, to moderate extent (ME) = 3, to some extent (SE) = 2, & Not at all (NA) =1

Extent of Using Forecasting Techniques in The Procurement of First Line Anti TB Medicines						
	Sub Part 2-1- To what extent does EPSA use the following forecasting techniques for Procurement of first line ant TB drugs? (Circle a number for each.)	NA	SE	ME	GE	VE
1	Regression	1	2	3	4	5
2	Exponential Smoothing	1	2	3	4	5
3	Expert Judgment (qualitative method)	1	2	3	4	5
Extent of Using Forecasting in Decision making in The Procurement of First Line Anti TB Medicines						
	Sub Part 2-2- To what extent does EPSA use forecasting for the following purposes in the Procurement of first line anti TB drugs? (Circle a number for each.)	NA	SE	ME	GE	VE
1	Budget Preparation	1	2	3	4	5
2	Purchasing plan	1	2	3	4	5

3	Efficient Budget Utilization	1	2	3	4	5
Extent of Forecasting Role on Cost Performance in The Procurement of First Line Anti TB Medicines						
	Sub Part 2-3.1 To What Extent Forecasting Has an Role on Cost performance?	NA	SE	ME	GE	VE
1	Purchasing cost	1	2	3	4	5
2	Inventory handling cost	1	2	3	4	5
3	Distribution cost	1	2	3	4	5
Extent of Forecasting Role on Delivery Performance in The Procurement of First Line Anti TB Medicines						
	Sub Part 2-3.2 To What Extent Forecasting Affect Delivery performance	NA	SE	ME	GE	VE
1	Order fill rate	1	2	3	4	5
2	On time Delivery	1	2	3	4	5
3	Delivery as promised	1	2	3	4	5

If you have any additional comments or ideas about forecasting practice of EPSA to procure first line anti TB drugs, please express your feelings:

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Thank you!

Annex II: Document Review Guide

Document Review Guide for Forecasting Peformance Measurement of Ethiopian Pharmaceuticals Supply Agency (EPSA), 2019									
Name of Document Reviewed	**First author/Owner year of publication**	**Study area or Report coverage area**	**Study /Reporting period**	**Study population**	**Sample size**	**Study design**	**Type of document (report, article, survey)**	**Indicator and Its definition**	**Remark**
HCMIS	(EPSA, 2013)	Ethiopian Pharmaceuticals Supply Agency	2013-2018	Ethiopian Public Pharmacy Service Facilities		NA	Consumption Report	Total number of drugs distributed to Health Facilities per year	
Forecasting and Quantification Plan	PFSA (2016, 2017 and 2018)	Ethiopia	2016-2028	Expected Number of TB patients	NA	NA	Forecasting Report	Total number of drugs quantified for procurement per year	