

EVALUATION OF PHARMACEUTICALS INVENTORY
MANAGEMENT IN SELECTED PUBLIC HEALTH FACILITIES OF
WEST ARSI ZONE, OROMIA REGIONAL STATE, ETHIOPIA

BY:

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ABSTRACT

Background: Effective inventory management ensures uninterrupted supply of safe, effective and affordable pharmaceuticals which could be achieved through developing ABC-VEN and FSN-XYZ matrix analysis.

Objective: To evaluate inventory management and assess knowledge and practice of conducting inventory analysis in selected public health facilities of West Arsi zone, Oromia regional state for the year 2016-2018.

Method: Facility-based cross sectional descriptive study complemented with qualitative study was conducted in fourteen health facilities. Data were collected from goods issuing voucher for the year 2016-2018 to perform ABC-VEN matrix analysis. Frequency of issue was collected to perform FSN analysis and the value of each closing stock was taken to get XYZ analysis. Moreover, self administered questioners and interview guide were used to assess pharmacists' knowledge and practices of inventory matrix analysis.

Result: From ABC-VEN matrix analysis, majority of items were category I of which its highest proportion were in class A and V items. Based on FSN-XYZ matrix analysis findings, XF utilized the highest budget (56.8%) in 2016 and (44.7%) in 2017. However, XN group had the highest value 41.3%. Percentage based on the level of knowledge of pharmacy professionals about purpose of inventory management system indicated 30% as good, 55% as average and 15 % as poor knowledge rank.

Conclusion: Public health facilities should identify those inventories which needs top priority for close monitoring. Items under class A, V, F and X require attention either for having high values or for their criticality in clinical importance. Yet, those items under group XN would rather be transported to other facilities to be utilized timely. On the other hand, most of the professionals have a knowledge gap on performing different inventory matrix analysis. Thus, PHFs should arrange to provide training on FSN and XYZ analysis in addition to ABC-VEN matrix analysis.

Key words: ABC-VEN, FSN-XYZ matrix analysis, inventory management

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ACRONYMS AND ABBREVIATIONS

ABC	Always, Better, Control
ADE	Annual Drug Expenditure
APTS	Auditable Pharmaceutical Transaction Services
CEO	Chief Executive Officer
EB	Ethiopian Birr
EDRS	Electronic Drug Record System
EFY	Ethiopia Fiscal Year
FSN	Fast moving, Slow moving, Non moving
HC	Health Center
HCMIS	Health Commodity Management Information System
KIs	Key Informants
LIAT	Logistic Indicator Assessment Tool
ORHB	Oromia Regional Health Bureau
PHCU	Primary Health Care Unit
PHF	Public health facilities
PI	Principal Investigator
RDF	Revolving Drug Fund
ROP	Reorder Point
TOR	Turn Over Ratio
VEN	Vital, Essential, Non essential
W/Arsi	West Arsi zone

1. INTRODUCTION

1.1 Background

In the world today, every organization wants not only to mitigate the system wide cost, but also to maintain minimum inventories along the supply chain while maximizing the service level requirements of the customer. The goal of any hospital supply system is to ensure that there is adequate stock of required items, so that uninterrupted supply of all essential items is maintained (1).

In Ethiopia, the pharmaceuticals supply management system of the country has several problems including non availability, unaffordability, poor storage and stock management and irrational use. To solve these problems in public health facilities, Pharmaceuticals Fund and Supply Agency (PFSA) was established in 2007 by Proclamation No. 553/2007 based on the Pharmaceuticals Logistics Master Plan (PLMP) (2).

Currently, inventory management is one of the most important tasks an enterprise is faced with, on a daily basis. The main focus of inventory management is to minimize the volume and the time of the engagement of working capital in inventories (3). Consequently, if inventories are treated in a poor manner, interruptions in production are possible, as well as, the loss of inventories due to being stored for too long. In order to avoid that loss, there are numerous systems and methods for inventory management, the ABC analysis being one of the most popular (4).

Rational utilization of resources is an important aspect of functioning of all organizations including hospitals. About one third of the annual hospital budget is spent on buying materials and supplies, including medicines (5). The drugs consume approximately 60% of total consumable budget. Therefore, pharmaceuticals are the most extensively used in a health facility, where a large amount of money is spent on purchases on a recurring basis (6, and 7).

Pharmaceutical inventory management is a complex but critical process within the healthcare delivery system. Without adequate pharmaceutical inventory management practices, hospitals run the risk of not being able to provide patients with the most appropriate medication when it is most needed (8). Inventory management is a trade-off between the costs of keeping an inventory versus the benefits of holding it. High inventory levels result in increased carrying costs but lower the possibility of lost sales

because of stock-outs and slowing production, which can result from inadequate stocking (9).

Materials management is an important issue for healthcare systems because it influences clinical and financial outcomes (10). Inventory management refers to all the activities involved in developing and managing the inventory levels of raw materials, semi-finished materials (work-in-progress) and finished good so that adequate supplies are available and the costs of over or under stocks are low(9). Inventory is defined as a stock or store of goods. These goods are maintained on hand at or near a business's location so that the firm may meet demand and fulfill its reason for existence (11). Inventory is defined as raw materials, work- in- progress, finished goods and supplies required for creation of a company's goods and services (12).

There are so many reasons for requiring inventory holding. The first is to enable the firm achieve economies of scale. Secondly, it balances supply and demand. Seasonal supply and/or demand may make it necessary for a firm to hold inventory. The ultimate goal of inventory management is to balance the stock out and over stock of essential medicines which are the cause for decline in the quality of patient care, medicines wastage and financial loss. Hence there should be proper inventory management of medicines (9). Fourthly, it provides protection from uncertainties in demand and order cycle. Finally, inventory acts as a buffer between critically interfaces within the supply chain (11).

There are several inventory techniques used in company such as FSN, XYZ, ABC, HML, VED and S-OS. ABC analysis of the annual drug expenditure (ADE) of individual drugs was arranged in descending order. The cumulative cost of all the items was calculated. The cumulative percentage of expenditure was calculated as well as the cumulative percentage of number of items. Then this list was subdivided into three categories based on the cumulative cost percentage. Approximately, 10% of drugs consuming 70% of ADE constituted category A, 20% of drugs consuming about 20% value constituted category B while, the remaining 70% of drugs consuming 10% of ADE formed category C. The cutoffs were not exactly at 10/20/70 but differed marginally (3).

VEN analysis

VEN analysis of pharmaceuticals is based on criticality and utility for the patients. Based on their criticality, the items could be classified into three categories: vital, essential and non-essential (9).

ABC and VEN matrix analysis formulated by coupling of ABC and VEN analysis and have a key role in assisting decisions making in medicine selection, purchasing and inventory management and hence help in reducing cost, identifying medicine use problems and improve efficiency in the pharmaceutical supply system. Combining ABC and VEN analysis forms a powerful tool for a critical analysis of medicine use and assists in containing the cost especially by restricting the expenditure on non-essential items(13,14).It also helps to simplify monitoring and control strategy for the management of drug at the health centers (3).

XYZ analysis

XYZ Analysis is always done for the current stock in inventory and aims at classifying the items into three classes on the basis of their inventory values. Generally first 70% of the total inventory value corresponds to X Class, the next 20% are of Y Class and the last 10% of the value corresponds to the Z Class (15).

FSN analysis

When analysis is carried out on the basis of the rate of movement of materials in the stores, or on the basis of rate of consumption pattern of the components, it is known as the fast moving, slow moving and non-moving (FSN) analysis (16).

Movement (demand) of item during a period is the basis of this classification. There is no general rule for categorizing an item as fast moving or slow moving, but several authors have their criteria for categorization. Peterson & Silver suggested that if an item has a demand for more than 10 units during its lead time it should be treated as fast moving and demand less than 10 units during the lead time should be treated as slow moving items (17). Gopalkrishnan & Sandilya suggested that an item with Zero issue during last 2 years should be treated as non-moving, up to 10 issues during past 2 years as slow moving and more than 10 issues, as fast moving items (18). On the other hand, Bivash Mallick carried out the analysis of FSN on the basis of the rate of movement of raw materials in the stores in which items issued 15-30 times per month classified as F class,

those which were issued 5-14 times per month classified as S class and those which were issued less than 5 times classified as N class (16).

FSN analysis is part of inventory management in logistics and supply chain management system (19). F-class item: fast moving, those items whose stock turnover ratio is greater than 3. It is generally item used in large amount. It is 10-15% of total item. S-class Item: slow moving (S), those items whose stock turnover ratio is between 1 and 3. It is used in minimum amount as compared to F- class item. It is generally 30-35% of total item. N-class item: non moving (N), those items whose stock turnover ratio is below 1. It is generally 60-65% of total item (20).

The pharmacy store is one of the most extensively used sections of any hospital and health center where a large amount of money is spent on purchases on a recurring basis. This emphasizes the need for planning, designing and organizing the medical store in a manner that results in efficient clinical and administrative service. To minimize the inventory expenditure, the health facilities may keep the medicines inventory low, but on the other hand, maximum service to the patients cannot be provided and the lack of medicines for patients in critical condition may cause serious problem. Therefore, effective inventory management is required to balance inventory expenditure against demands for medicines (21).

To satisfy the need of the community, the concerned body at each health facilities can think of how to control inventory in the hospitals and health centers to ensure availability of medical supplies at the right time and at their right quantity in order to avoid shortage and overage of drugs. Because resources are limited and hence it is very crucial to find the possible and effective ways of reducing cost of purchase and the cost of holding inventory in health sector

For inventory management of vital drugs, only ABC and VEN matrix classification are insufficient to control the stock in appropriate level with minimum shortage and oversupply. Thus, categorization of vital drugs according to FSN analysis benefits hospital to determine the level of inventory in dead-stock or slow-moving items (22). But in the previous study, this analysis was not addressed. Therefore, the main purpose of this study will focus on the identification of those drugs included in category I, II, III based

on the ABC-VEN matrix analysis and FSN-XYZ matrix analysis. These two matrix analysis can be summarized by the following tables.

Table 1: Categories of drugs obtained by the coupling of ABC and VEN analysis (9)

	A	B	C
V	AV	BV	CV
E	AE	BE	CE
N	AN	BN	CN

Therefore; Category I includes the following classes AV, AE, AN, BV and CV, category II includes BE, BN and CE finally category III includes only class CN. The detail is displayed by the table below.

Table 2 : ABC-VED inventory decision matrix

ABC-VED Matrix		Criticality of item							
		High ←————→ Low							
		V			E	N			
Consumption Value	High	A	Continu ous Review	High Safety Stock	Low Order Quantity		Continu ous Review	Low Safety Stock	Low Order Quantity
			B						
	Low		C	Periodic Review	High Safety Stock	High Order Quantity		Periodic Review	Low Safety Stock

Source: Ceylan Z.et al. Drug inventory management of a pharmacy using ABC-VED analysis (39).

Table 3 : Categories of drugs obtained by the coupling of XYZ and FSN analysis (18)

	F	S	N
X	FX	SX	NX
Y	FY	SY	NY
Z	FZ	SZ	NZ

Therefore; Category I includes the following classes FX, FY, FZ, SX and NX, category II includes SY, SZ and NY finally category III includes only class NZ.

1.2 Statement of the problem

Public hospitals across developing countries mostly leave inventory decision to departments as well as store managers, as a result there are relating problems in terms of high cost of inventory, selection of suppliers, delivery problems, etc (19). However, health care demand and supply cannot be left to be regulated solely by a single hand of the market (13).

In Africa poor inventory management is worsen due to limited financial resources ,lack of proper infrastructure of warehousing, lack of skilled manpower in pharmacy, lack of appropriate stocking policy and lack of appropriate controlling mechanisms of the medicine (1). Storing excess inventory can cost a lot of money, and reducing the amount of inventory you keep on hand can reduce your carrying costs as well as the number of warehouses they maintain, or even allow them to eliminate those warehouses altogether. According to Dai and Kauffman, lack of trained and competent professionals who understand the concept of inventory management is a major challenge to most organizations that seek to effectively manage their inventory systems. (23)

The logistic skills levels of personnel involved in medicines supply as well as inventory management of medicines in public hospitals was assessed by Kagashe et al, in Dar es Salaam region, Tanzania. They observed a need for the supply of medicines to be managed efficiently in order to prevent all types of wastage including overstocking, pilferage and expiry. This wastage may influence the quality of health care provided to patients. Problems of stock outs or overstocking and expiry of medicines in public hospitals were reported. Their results also revealed that logistic skill level was poor and

inventories were not well managed. Lack of funds and poor logistic skills contributed to stock outs. They recommended that personnel dealing with medicines supply should be trained in procurement and inventory management (24).

In most organizations, employees have become habituated with high levels of commodity availability resulting in higher stock holding levels. The basic reason why stock is held is so as to avoid stock out but it result in inventory holding problems (25). According to the study conducted in Kenya, the typical problems faced by hospitals in relation to stock management are; shortages of items, the holding of excessive stock, large amount of obsolete stock and stock losses (19).

Similarly some problems in Ethiopia were reported regarding inventory management inefficiencies that includes non-availability of essential drugs, poor storage, poor stock management, irrational use, poor dispensing and prescribing practices, Low level of patient knowledge about drugs dispensed to them; long stock out period of essential drugs in public health care facilities; wide variation in storage conditions of public health care facilities, some of them falling below acceptable level, and high percentage of wastage rate (8.2%) due to expiration (26).

Health facilities must provide 24 hour services and accordingly, they need to keep stocks of certain medicines and other medical supplies in order to perform their duties effectively. But it is generally believed that where stock management by health facilities is poor, delivery of healthcare is normally affected.

At present, health facilities maintain their own inventory methods, but they are still experiencing problem in achieving effective inventory management. Pharmaceutical supply chain is the area in which alternative and compromise are not acceptable when unavailability arises. Thus, a health care cost is in an increasing phase, organizations are pressurized to give quality of care (11).

Inventory management has now become the major concern of the public sector since inventory is said to be the solid cash of resources been expanded annually without proper accountability (19). Likewise inventory control problem is frequently reported as a major gap in a supply chain performance in a number of public health facilities in West Arsi zone as part of Oromia region. Therefore, at the hospital level, many researchers pay

attention in supply of medicines and inventory management using statistical, mathematical and modeling approach for inventory control.

Moreover, traditional methods such as ABC (Always better control), VEN analysis (Vital, essential and non-essential), and FSN analysis (Fast, slow and non-moving), etc. are the most widely used inventory control classification in both hospitals and pharmaceutical industry (20). However; very few studies had undertaken the assessment of inventory management problems in a health centers and almost none had not been addressed about the assessment of knowledge and practice of pharmacy professionals about ABC-VEN and FSN-XYZ matrix analysis specially in West Arsi zone

Thus, this study is designed to answer the following research questions.

1. How are the medicines in the hospital and health center classified with respect to the ABC, VEN, XYZ and FSN classification?
2. How are medicines expenditures controlled?
3. What proportion of medicines and their categories require higher supervisory monitoring?
4. What is the knowledge status of pharmacy professionals regarding inventory management?
5. How do pharmacy professional in public health facilities practice toward inventory control?

1.3 Significance of the study

Managing stock effectively is important for any organization, especially for hospitals and health centers. Because without enough stock, delivery of quality health care services to patients will come to be in danger. On the other hand, stock represents the largest single investment in assets for most organizations. Therefore, unless we manage it properly the public or the organization may loss a huge budget apart from the loss of precious life of a patient. However, it is widely observed while employees have been demanding high levels of commodity availability resulting in higher stock holding levels. This will result in a high stock holding cost. In order to overcome this problem, a research into this area is relevant (10, 16).

Although there have been several research in the area of inventory and supply chain management using ABC-VEN matrix analysis in ensuring organizational performance, little studies have been done to view the role of inventory control using multi dimensional analysis like ABC-VEN matrix and FSN-XYZ matrix analysis in healthcare delivery point especially in Ethiopia.

Therefore; this research is aimed at assessing the categories of drug based on ABC-VEN matrix analysis and FSN-XYZ matrix analysis on healthcare service delivery at West Arsi zone of Oromia regional state. The main difference of this paper from earlier work is not only the combination of FSN and XYZ analysis but also the involvement of assessing knowledge and practice of pharmacy professionals about matrix analysis. So it might be helpful first, to the health center and hospital to identify drugs which need stringent control based on their category. Thus, management can use the results to determine how best to run operations particularly for those hospitals and health centers planning to improve their control techniques. On the other way, the study will bring out result to the zonal and regional health department, on how the health facilities will manage its inventory and also provide areas of improvement in procurement of medicines and its management so as to be responsive and efficient.

The study will also be beneficial indirectly to the general public and the entire population because it will come up with appropriate suggestions on how timely and in the right quantities that inventory would be managed in healthcare delivery point so as to be able to satisfy their requirement. Thus the information provided in the study will be useful to administrative body that can intervene with the problem. Furthermore, the study will serve as a guide for the stakeholders in the health sector since the study will reveal the state of the hospital's and health center's ABC, VEN, FSN and XYZ analysis practices.

Eventually, it can serve as a reference for those researchers who might want to undertake further study into the area of ABC, VEN, FSN and XYZ analysis in the public health facilities. The findings of study will also be useful in proposing areas of improvement regarding inventory management practice across all selected public health facilities, especially by planning for training of professionals involved in drug supply management.

2. Literature review

Inventory management is a trade-off between the costs of keeping an inventory versus the benefits of holding it. High inventory levels result in increased carrying costs but lower the possibility of lost sales because of stock-outs and slowing production, which can result from inadequate stocking (27). Of the various explanations for non availability of even simple medicines in the third world countries, a large number are related to materials management (3, 28). In East Asia study was conducted to show the drug management through the application of inventory control techniques like ABC, VED and ABC-VED matrix analysis (28).

All the Inventory Control Methods have their own limitation in terms of the usage and applicability when they stand alone. FSN analysis fails when used in manufacturing environment where raw materials may be issued for production and eventually the produced items may remain in inventory giving a wrong picture of consumption.

XYZ analysis is done on inventory in the stores which can vary dramatically every month for which the analysis is done. Various external factors like lost or delayed sales orders and supplies can influence the analysis. Hence it becomes necessary to combine more than one classification scheme and make use of them to further sub-categorize the inventory and devise appropriate inventory control system for each of them. In practice, organizations have utilized a variety of these combinations to implement appropriate inventory control system for the items.

Study conducted in India revealed, There were 625 items under NZ (non-moving item found in Z category), 62 items under NY (non-moving item found in Y category) and 33 items under NX (non-moving item found in Z category) that were to be discarded. Total Stock value of all NX items was Rs. 22575608. By salvaging these items space as well as money could be saved (2). Here, attention of the management should focus on the non-moving items to enable decision as to whether they are required in the future or they can be salvaged. All non-moving items (N) identified using FSN analysis cannot be disposed of. The disposal should be taken based on the value of each item of spare by conducting XYZ analysis on the N category items (15).

According to the study conducted in Thailand for FSN analysis, the highest inventory turnover rate was 21, which meant hospital had to purchase drugs in fast-moving item

nearly twice a month. The average inventory turnover rate was 10. Below 10 was slow-moving item and drugs which had inventory turnover rate zero or nearly zero were non-moving item (22). Study in St. Martin's hospital, Agroyesum, Amansie-West showed there were 625 items under NZ (non-moving item found in Z category), 62 items under NY (non-moving item found in Y category) and 33 items under NX (non-moving item found in Z category) that were to be discarded (11).

Study in Thailand revealed most of the drugs with a high consumption value and vital clinical importance (AV drug category) are not steadily consumed; they are only used for severe cases. These drugs should be at minimal shortages as they are critical for life saving; their availability must be ensured even though the holding costs are high. Inventory ordering should be conducted at fixed intervals. Safety stock and ROP are calculated based on mean and variance from the normal distribution in order to ensure particular levels of stock. Conversely, the drugs with high consumption value and essential clinical importance (AE drug category) are quite common and are prescribed steadily all through the year. Min/Max is the suitable inventory policy for most drugs in this category, which can minimize average inventory levels. Interestingly, for those drugs with the characteristics of normal distribution with trend, the inventory policy should be based on a simple regression model. The order quantity is calculated from the average demand plus the trend. Most drugs with high consumption value and nonclinical importance (AN drug category) fit very well with the Min/Max inventory policy in order to minimize average inventory levels (31).

In the same way, the 2010 result showed a significant difference in budget assignment between class A items and rest classes. However, class A items accounted only 25 (10%) of total 250 items and they covered 97.57% (58103131.4 birr) of the budget. 80.2% of these items were occupied by class C items but it takes only 1.17% (700151.00 birr) budget, the rest taken by class B pharmaceuticals. In 2011 TASH got pharmaceuticals which cover 209697453.29 birr. 99.6% of this money covered by Class A items which were 12 (10.52%) in number. Class B and Class C items showed very small portion of the budget, only 0.27% and 0.13% respectively, and in quantity, class C took 78.95% (13).

All of these analyses were used as a scientific inventory management tools to develop selective inventory management policy for each medical item.

The study done in Muhimbili national hospital, Tanzania explored the challenges involved in inventory management by pharmacy personnel and the results showed that 94% of the interviewed pharmacy personnel, complained about the shortage of staff, 54.5% saw a problem with electric power on and off.

Regarding Knowledge of pharmacy professionals, the respondents were asked whether they knew about different concepts used in inventory management such as economic order quantity, safety stock and review period. Majority (63.0%) knew about those concepts involved in inventory management and that they had learned from on-job training. A big proportion (70.0%) also knew the purpose of medicine inventory management.

According to the study conducted in university of Missouri-Rolla, survey findings revealed that 50% have excellent skills and knowledge, 26% lack such skills and knowledge in their institution, and 24% responses were neutral. In addition 60% of vendors and 45% of healthcare providers have skills and knowledge about supply chain, indicating that vendors are more educated about SCM than healthcare providers. Moreover, participants from the healthcare providers group were asked about the existence of skills and knowledge regarding SCM practices at the executive level (CEO and directors). Responses revealed that 42.8% of executive have skills and knowledge, 31.5% lack the skills and knowledge, and 25.7% responses were neutral. Findings from this question can be further compared with previous results, where a significant high percentage of respondents (73.5% of healthcare providers) are experiencing executives support for SCM practices (36).

Conceptual frame work

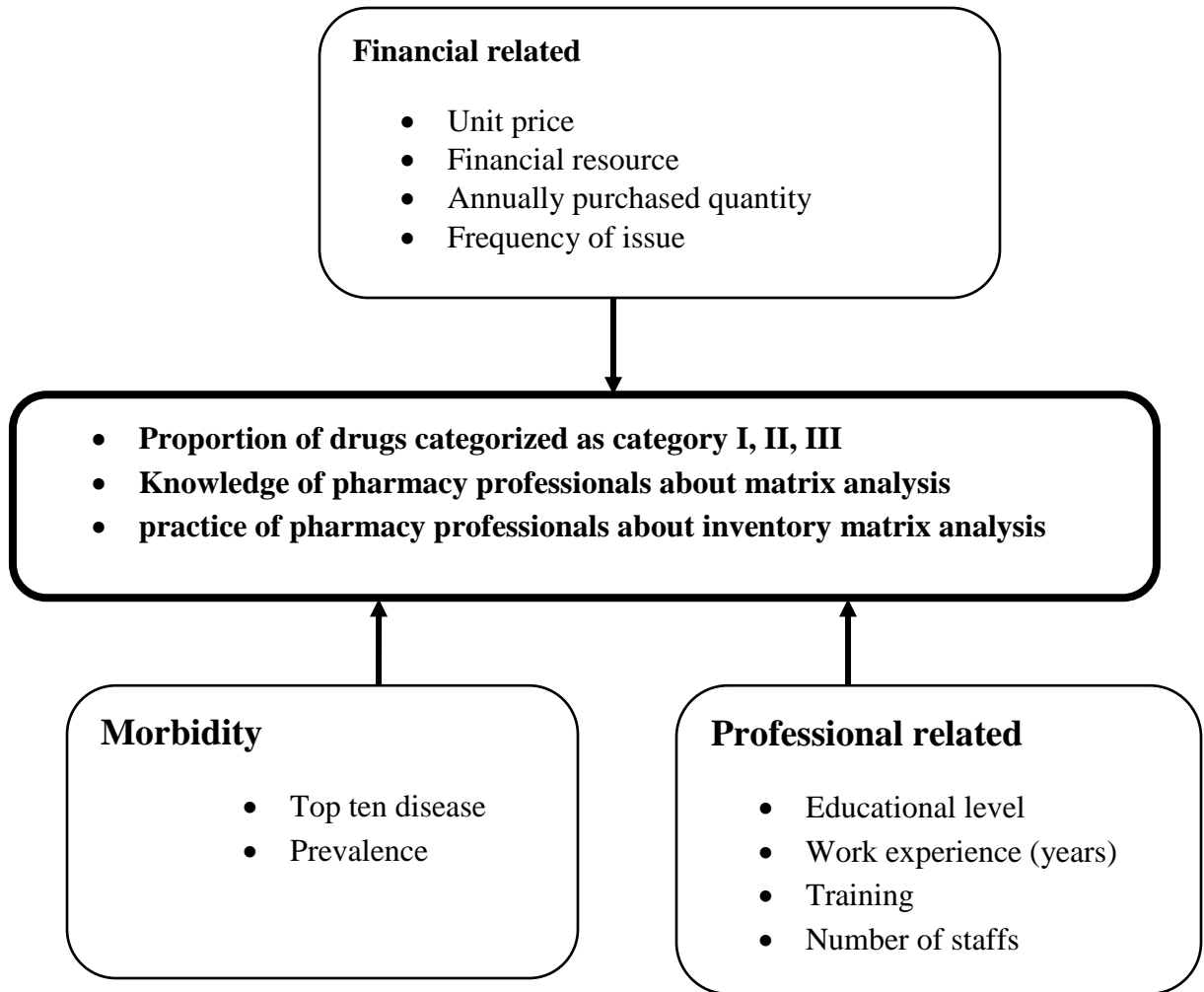


Figure 1: Conceptual framework.

3. Objectives

3.1. General objective

To evaluate inventory management and assess knowledge and practice of pharmacy professionals about conducting matrix analysis in selected public health facilities of West Arsi Zone, Oromia regional state for the year 2016-2018.

3.2. Specific objectives

- ✓ To assess the consumption trend of pharmaceuticals for the year 2016-2018.
- ✓ To identify the categories of pharmaceuticals requiring stringent management control by using ABC - VEN matrix
- ✓ To identify priority items during storage and distribution based on FSN-XYZ Matrix analysis
- ✓ To assess the knowledge of pharmacy personnel regarding inventory matrix analysis
- ✓ To assess the pharmacy professionals practice of inventory matrix analysis

4. METHODS AND MATERIALS

4.1. Study area and period

The study was conducted in selected public health facilities of West Arsi zone, Oromia regional state from 19st April 2019 to 19th May 2019. West Arsi zone covered the South and South East part of the region. Administratively, there were 13 districts with a total population of over 2 million people. There were 2 public hospitals, 82 health centers and 410 health posts in the zone. Out of 84 health facilities one of the hospitals and seven health centers were established in the mid year of 2017 and beginning of 2018 (West Arsi Zonal Health Department). The study was conducted from 19th April, 2019 to 19th May, 2019.

4.2. Study design

Facility based quantitative descriptive cross-sectional study was conducted using structured and semi-structured questioner and supported with qualitative study.

4.3. Populations

4.3.1 Source Population

All public health facilities in West Arsi zone, all model 22 used within 8th July, 2015-7th July, 2018, all annual inventory record at budget closure of each year (2016-2018) and all drugs included within hospital and health centers list of medicines and all pharmacy professionals working in public health facilities of the zone.

4.3.2 Study Population

Selected public health facilities of W/Arsi zone, all model 22 used within 2016-2018 in selected facilities, all RDF medicines issued within 2016-2018, all annual inventory record at budget closure of each year 2016-2018 and all pharmacy professionals involved in inventory management during data collection period in selected public health facilities.

4.4. Inclusion and exclusion criteria

4.4.1 Inclusion criteria

- All hospitals and health centers started service before 8st July, 2015
- All model 22 used for issuing RDF drugs within 8th July, 2015- 7th July, 2018.
- All RDF drugs issued within 8th July, 2015- 7th July, 2018

- All annual inventory records of three years 7th July,2016, 7th July 2017 and 7th July 2018.

4.4.2 Exclusion criteria

- Health post, since they were considered as dispensing units of HCs, and most of their inventory management activities were conducted at HCs.
- All program drugs, since they did not consume facilities' budget.

4.5 Sample size determination and sampling technique

4.5.1 Sample size determination

i. Sample size determination for health facilities

The determination of the sample size of the health facilities was based on the USAID delivery project logistics indicators assessment tool (LIAT) where a minimum of 15% of the total health facilities are recommended (33). There were 2 public Hospitals and 82 HCs in West Arsi zone. Among the two hospitals one hospital started services in late 2017, was not included. Regarding HCs, one HC from each district (13 HCs) was included. Finally, 14 health facilities were taken from the total of 84 health facilities.

ii. Sample size for documents

All issuing voucher (168) which were utilized from 8th July, 2015-7th July 2018 were included for ABC and FSN analysis.

All annual inventory record (42) at budget closure of each year (2016-2018) were used for XYZ analysis

All drug list (14) of selected facilities

iii. Sample size for medicine

All RDF (budget pharmaceuticals) were included in the study

iii. Sample size for professionals

For quantitative study all pharmacy professionals of the assessed health facilities were included. For qualitative data 10 KIs (6 pharmacists and 4 druggists) were interviewed. The KIs were selected based services year.

4.5.2 Sampling procedure

First, health facilities were stratified as health centers and hospitals. One of the two hospitals that fulfilled the criteria was included. Regarding health centers, one health

center by simple random sampling technique was taken from each district to get a representative sample for all districts in the zone.

For review of documents, all Model 22 (56 issuing vouchers) used in the period of 8th July, 2015-7th July, 2018 were reviewed for ABC and FSN analysis. 42 Forty two (42) annual inventory conducted ahead of each budget closure year (2016-2018) were used for XYZ analysis. For qualitative data ten (10) KIs were selected from pharmacists and druggists, based on their service year to obtain deep information. The KIs were interviewed until information was saturated.

4.6. Study variables

4.6.1. Dependent variables

- Proportion of drugs categorized as category I, II, III
- Knowledge of pharmacy professionals about matrix analysis
- practice of pharmacy professionals about inventory matrix analysis

4.6.2. Independent variables

Financial related factor

- Unit price
- Annual purchased quantity
- Financial resource
- Annual consumption
- Frequency of issue

Professional related

- Educational level
- Work experience (years)
- Trainings
- Number of staffs

Morbidity Related factors

- Top ten disease
- Prevalence

4.7 Data collection Tool and procedures

Data collection tool

Structured data collection format adopted from MSH was used to collect the necessary data for ABC and VEN analysis (37) while standard data collection check list adapted from (18, 20) were used to collect data for XYZ and FSN analysis. On the other hand, to assess knowledge and practice a semi-structured questioners adapted from (35) were used.

Data collection procedures

First for ABC analysis, the annual expenditure of each drug were collected from issuing voucher (Model 22) and electronic database system known as DAGU and entered into excel spread sheet for analysis. Whereas, VEN category was obtained from the facilities' drug lists and for health facilities that lack drug list, information collected from medical staff using a pretested semi structured questioner was used to classify medicines as VEN. In case of XYZ, first total inventory at end of each EFY were obtained from physical inventory record of respective year(2016-2018). Then the value of each closing stock was collected and analyzed using excel spread sheet. Finally data for FSN were obtained by reviewing the issuing voucher and calculating the frequency of issue by excel spread sheet.

Secondly for the knowledge assessment, the data were collected by trained data collectors with close supervision by the principal investigator. Apart from demographic data questions, a zero (0) point was given for an incorrect answer and one (1) point was given for the correct answer. The levels of knowledge were graded as poor (0-49%), average (50-74%) and good (75-100%). Criteria used for ranking these levels were: when someone scored less or equal to 7 questions ranked to be of poor knowledge, on answering correctly greater than 8 to less or equal to 12 questions designated as having average knowledge and lastly, on responding correctly to greater than 12 to 16 questions designated to have a good knowledge (34).

Qualitative data: The qualitative data were gathered by interview guide adopted from LSAT tool, which were designed to probe essential questions regarding the issues of ABC-VEN matrix, FSN-XYZ matrix, knowledge and practice of those professionals concerning the two matrices analysis. The interview guide was prepared in English language and translated into

Afaan Oromoo, the region's working language. Then the KIs were interviewed for 15 to 20 minutes on average and the interview was audio recorded.

4.8. Data management and analysis

Analysis of the quantitative data was done by using Microsoft Excel® spreadsheets and SPSS version 20.

The ABC analysis: The process of analysis was done through the following steps;

- All drugs issued in the last three years (from 8th July,2015-7th July,2018) were extracted from model 22 and then checked and edited for any inconsistency.
- The unit cost for each medicine and the total quantities issued were used to calculate the value of each item.
- The value of consumption were furthermore calculated; by multiplying the unit cost by the number of units of each drugs issued to obtain the total value.
- Then the percentage of total value represented by each medicine was also calculated; by dividing the value of each medicine to the total value of all medicines.
- The list were then rearranged, ranked in descending order by total value
- Cumulative percentage of total value for each medicine were calculated
- Cut-off points or boundaries for Class A, B and C medicines were determined. “A” class – 10 to 20% of items that takes 70-80% of the overall total cost ,“B” class – 10 to 20 % of items that takes 15-20% of the overall total cost ,“C” class – 60-80% of items that takes 5-10% of the overall total cost(37)
- Lastly the results were presented into tables showing proportions of items in different classes and the proportion of budget utilized.

VEN analysis

Criticality analysis of all the purchased pharmaceuticals during a fiscal year in the medical store were conducted and then classified based on VEN classification criteria into three groups. Those drugs which were critically needed as the lifesaving drugs and those that must be available at all times were included in the V category. The items having lesser criticality needs as well as those that may be available in the hospital were included in the E group. The items with lowest criticality or those whose shortage may not pose a threat to the health of the patients were included in the N group.

Coupling of ABC-VEN analysis

ABC and VEN analyses were combined by cross-tabulation to get an ABC-VEN matrix and different categories of medicines.

Table 4: Table used to obtain ABC-VEN matrix

	Vital	Essential	Non-essential
Class A	AV	AE	AN
Class B	BV	BE	BN
Class C	CV	CE	CN

From ABC-VEN matrix, a total of 9 sub-categories were obtained (table 4) and from these, 3 main categories were formed as follows: Category I comprises of all the expensive and vital medicine items: AV+AE+AN+BV+CV, Category II included the remainder of the items in B and E items: BE+BN+CE and Category III included the cheapest and non-essential medicine items: CN (3).

XYZ analysis

XYZ Analysis was after annual stock-taking is over, arrange the closing stock values of items in descending order, enter the respective cumulative values against each item; the descending number of item is computed as a percentage of the total of all items in stores; the cut-off points were set depending on the distribution. Generally first 70% of the total inventory value was corresponding to X Class, the next 20% were of Y Class and the last 10% of the value was corresponding to the Z Class (15).

FSN analysis

Medicines were categorized into FSN according to their frequency of consumption. First, the frequency of each item issued was obtained and rearranged in descending order. Accordingly, those items which were issued more than 15 times within a year were classified as fast moving items(F), those issued 5-15 times were considered as slow(S) and those items issued less than 5 times were classified as non moving(N) items (15).

Qualitative data

The qualitative data were analyzed manually using the thematic content analysis technique. Accordingly, the investigator familiarized with the audio recorded data by listening and taking notes of the interview. Then, the data were coded using a table in a

MS word document and translated into English. The coded data were organized to search for subthemes. Finally similar subthemes were combined, named and described. Finally, the report was produced in narration form.

4.9. Data Quality assurance

The collected data were checked for completeness and cleaned every day during data collection. Incomplete data were discarded and data collectors were redirected. On the other hand pharmacy professionals were recruited for data collection and they were supervised by principal investigator.

4.10. Ethical Consideration

Ethical approval with **Reference No ጤ/ኢ/ጥ/ዳ/ 787/2011** was obtained from Institutional Review Board (IRB) of Jimma University and submitted to Oromia regional health bureau along with one hard copy of the proposal. Then authorization letter was received from Oromia regional health bureau, West Arsi zone health department and from each Wereda health office sequentially. Prior to data collection, permission was obtained from hospital CEO and PHCU director. For qualitative study a verbal consent was obtained from each key informant and confidentiality of the information was re-assured to them.

4.11 Data Dissemination plan

As this is master's thesis, it will be publically defended, and soft and hard copies of the final document will be submitted to Jimma University, school of Pharmacy. The feedback will be given to administrative office of woreda and Zonal health department, ORHB, and other stake holders based on the study results. Also efforts will be undertaken to publish the finding on reputable journals for scientific communities.

4.12 Operational definitions or definitions of terminologies

Medicines: In this study medicines include all RDF drugs, medical supplies and laboratory reagents in the health facilities. For the purpose of this research the word medicine is used interchangeably with drug.

Public health facilities: Health facilities including hospitals and health centers owned by the public health sector or government that is operated or designed to provide health care service.

Category I: is high priority group, requires greatest attention. It contain all the vital and costly items, whose shortage may adversely affect the functioning of the hospital or whose over stocking /pilferage may lead to financial loss to the hospital.

Category II: is under moderate management and moderate attention is devoted. These items are essential but are less costly and can have lesser stringent controls.

Category III: is under simple management and receives loose attention. Here items are desirable but would not affect the functioning of the hospital even if they are not available for a long time.

Inventory: is an ideal stock of physical goods that contain economic value, and are held in various forms by an organization in its custody awaiting, packing, processing, transformation, use or sale in a future point of time.

Inventory management: involves planning, organizing and controlling the flow of materials from their initial purchase unit through internal operations to the service point through distribution. It involves the recording and monitoring of stock level, forecasting future demand and deciding on when and how to order.

Inventory control: investigating the situation of inventory and finding a solution to inventory related problems such as costs of procurement, storage, handling, distribution and other charges.

5. RESULT

5.1 Socio demographic characteristics

Fourteen public health facilities (13 HCs and 1 hospital) were surveyed with a response rate of 100% to evaluate inventory management using matrix analysis and knowledge and practice of pharmacy professionals in West Arsi zone, Oromia regional state. Among individuals surveyed for quantitative study, 10 (50%) were pharmacists and 11(55%) of participants had a work experience of 6-10 years. Regarding training, majority (85%) took the IPLS training (See table 5)

Table 5 : The socio-demographic profile of the respondents at selected public health facilities of West Arsi zone, Oromia regional state, May 19, 2019

Variables	Characteristics	Frequency (%)
Length of year on work	<1 years	0(0)
	1-5 years	9(45)
	6-10 years	11(55)
	>10 years	0(0)
	N	20(100)
Profession	Pharmacist	10(50)
	Druggist	10(50)
	N	20(100)
Type of training taken by professionals	IPLS	17(85)
	LMIS and APTS	3(15)
	N	20(100)

5.2. Consumption trend of pharmaceuticals for the year 2016-2018 EFY

In the past three years from 2016-2018, a total of 546 different types of items were issued and a total of 17,444,512.8 EB were consumed (Table 6).

Table 6 : Annual expenditures on drugs at public health facilities in W/Arsi zone for 2016-2018

Year	Total No of items issued in each year	ADE in EB	%
2016	423	5,493,840.99	31.5
2017	380	5,915,882.9	33.9
2018	338	6034,788.91	34.6
	546 *	17,444,512.8	100

* It is not the sum rather it is total number of items after aggregation of the three years issued items (2016-2018).

5.3 ABC Analysis

ABC analysis shows that, 66 (12.1%) medicines were found to be class A while class B had 10.2 (10.8%), where as class C constituted 424(77.7%) of total items. These costed 80.1%, 10.8% and 9.1% of total ADE correspondingly. (Table 7).

Table 7 : ABC analysis of the different medicine types at a public health facilities in W/Arsi zone from 2016-2018.

Category	Number of item	Annual value	% of item	% value
A	66	13976851.33	12.1	80.1
B	56	1882695.9	10.2	10.8
C	424	1584965.55	77.7	9.1
Total	546	17,444,512.78	100	100

As shown on the figure 2 below, among class A items (66), only 10 (1.8%) of them accounted for 39.8% (6,947,823.56) of annual consumption value. Of these, only three drugs (Amoxicillin 500mg capsules, Cloxacillin 500mg capsules and ceftraxone 1gm injections) contributed for highest value (23.6 %) of total annual drug expenditure.

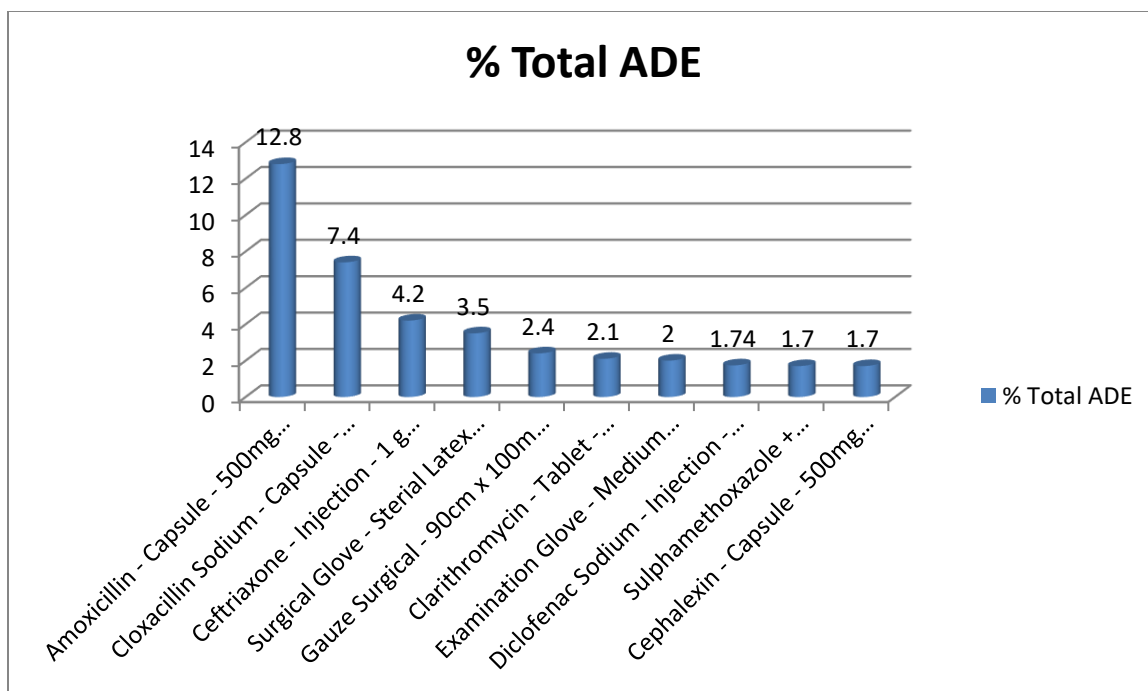


Figure 2: The total value of Top 10 items of class A, in W/Arsi PHF for 2016-2018

5.4 VEN Analysis

The VEN categorization revealed that 77 items (16.9%) classified as V consumed 2,130,208.25 EB (35.1%), 309 items (67.9%) grouped as class E constitute 3,720,294.11 EB (61.3%) of ADE and 69 items (15.2%) grouped as N class constitute 219,234.92EB (3.6%) of total ADE (**Table 8**).

Table 8: VEN Analysis of medicines at public health facilities of W/Arsi zone for 2016-2018

	No	%	ADE	%
V	77	16.9	2,130,208.25	35.1
E	309	67.9	3,720,294.11	61.3
N	69	15.2	219,234.92	3.6
Total	455	100	6,069,737.28	100

5.5 ABC-VEN Matrix analysis

The ABC-VEN matrix classification of the inventory showed that 121 items (26.6%) classified as category I accounted for 84.7 % of the total annual budget, 224 items (49.2%) classified as category II constituted 13.2 % of total expenditure while 110 (24.2%) account for only 2.1% of the total expenditure. Among category I, items with high consumption value and vital clinical importance (AV) constituted 24 items (5.2 % of

total items) accounted for 26.3 % of total ADE while items with high consumption values and with essential clinical importance (AE) constituted 41 items (9% of total items) and 52.8 % of total ADE. (**Table 9**).

Table 9: ABC-VEN Categorization of medicines at public health facilities of W/Arsi zone for 20016-2018EFY.

Categories	No of items	%	Total value	%
I	121	26.6	14770278	84.7
II	224	49.2	2295773.4	13.2
III	110	24.2	365296.8	2.1
Total	455	100	17431348.2	100

5.6 FSN Analysis

For FSN analysis 35.3 %, 19.2% and 36.9% of different types of issued items were classified as fast moving. However; 29%, 18.4% and 23.7 % were classified as slow moving while the remaining 35.7%, 62.4% and 39.3% were classified as non-moving items for the year 2016, 2017 and 2018 respectively. Regarding their value, F class items accounted for 78.4%, 63.7% and 93.6% in 2016, 2017 and 2018 correspondingly. (**Table 10**).

Table 10 : FSN analysis of issued drugs at selected public health facilities of W/Arsi zone from 2016-2018.

Classification	Frequency	2016				2017				2018			
		No of items	%	Total value in EB	%	No of items	%	Total value in EB	%	No of items	%	Total value in EB	%
F	>15	150	35	4,309,579	78	73	19.2	3,679,843.39	64	125	37	5,291,061	94
S	5-15	123	29	934,253.5	17	70	18.4	1,307,071.45	23	80	24	267,876.9	4.7
N	<5	151	36	250007.6	5	237	62	785,791.35	13	133	39	95,181.4	1.7
Total		424	100	5,493,841	100	380	100	5,772,706.19	100	338	100	5,654,119.19	100

5.7 XYZ Analysis

The total closing stock value for each item was arranged in descending order and the cumulative total closing stock value was calculated for each item. Then 70% of the total inventory value corresponds to X Class, the next 20% are of Y Class and the last 10% of the value corresponds to the Z Class (**table 11**).

Table 11 : XYZ analysis of closing stock value at selected public health facilities of W/Arsi zone for the year 2016-2018 EFY.

Category	2016				2017				2018			
	No of item	% of total drug	Total value In EB	% of Total value	No of item	% of total drug	Total value In EB	% of Total value	No of item	% of total drug	Total value In EB	% of Total value
X	100	23.8	4,175,705.74	80.2	56	20.4	2842770	79.4	63	24.7	1550006	79.7
Y	111	26.5	793404.99	15.2	41	14.9	413346.3	11.6	69	27	296957.2	15.3
Z	208	49.7	237335.91	4.6	178	64.7	322,266.6	9.0	123	48.3	97827.43	5
Total	419	100	5,206,446.64	100	275	100	3578383	100	255	100	1944791	100

First, one hundred (23.8%) of total items were classified in X class contributing 80.2 % of the total closing stock value in 2016. Similarly, 56 items (20.4%) classified as X class accounted for 79.4 % of total value in 2017 and 63 items (24.7%) in class X accounted for 79.7 % of total value in 2018 (**Table 11**).

5.8 FSN-XYZ Analysis

The results FSN-XYZ matrix analysis showed that 192(45.8%),107(38.9%) and 136(38.6%) items in category I accounted for 88% ,85.4% and 86.1% of total closing stock value in 2016,2017 and 2018 respectively. On the other hand,166(39.6%),97(35.3) and 94(26.7%) of items in category II were accounted for 11.1% , 11.6 % and 11.3% of closing stock value in the above respective years. Finally,61(14.6%),71(25.8%) and 122(34.7%) of items in category III were accounting for 0.9%,3% and 2.6% of closing stock value in 2016,2017 and 2018 correspondingly. (**Table 12**).

Table 12 : Coupled XYZ-FSN matrix analysis of drugs in selected public health facilities of W/Arsi zone for the year 2016-2018.

	Number & (%) of items in closing stock						% closing stock Value		
	2016		2017		2018		2016	2017	2018
	No	%	No	%	No	%	%	%	%
XF	65	15.5	24	8.7	25	7.1	56.8	44.7	32.3
XS	30	7.2	16	5.8	16	4.5	20.9	17.2	10.4
XN	5	1.2	16	5.8	23	6.5	2.5	16.2	41.3
YF	47	11.2	18	6.6	69	19.6	6.7	5.4	1.9
YS	54	12.9	12	4.4	28	8	7.4	2.9	4.9
YN	10	2.4	11	4	30	8.5	1.2	2.9	5.2
ZF	45	10.7	33	12	3	0.9	1.1	1.9	0.2
ZS	102	24.3	74	26.9	36	10.2	2.5	5.8	1.3
ZN	61	14.6	71	25.8	122	34.7	0.9	3	2.6
Total	419	100	275	100	352	100	100	100	100
Category I	192	45.8	107	38.9	136	38.6	88	85.4	86.1
Category II	166	39.6	97	35.3	94	26.7	11.1	11.6	11.3
Category III	61	14.6	71	25.8	122	34.7	0.9	3	2.6

The present study showed that there was a similarity in the pattern of drug consumption from year to year even though slight variation was seen related to the movement of some

stocks. For instance, Sulphamethoxazole+Trimethoprim suspension, surgical glove size 7.5, Gauze surgical-90 cmx100m exhibited slight rise and fall in their pattern of consumption (**Figure 3**)

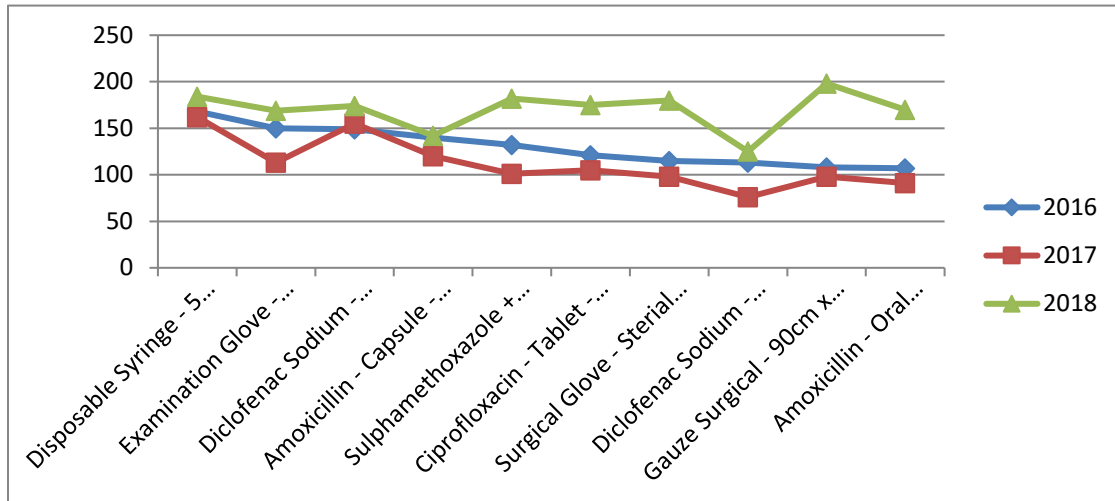


Figure 3: Trends of top 10 Fast moving drugs at selected PHFs of W/Arsi zone

5.9. Assessment of Knowledge and practice of pharmacy personnel regarding inventory matrix analysis

The respondents were asked whether they had a concept of inventory management such as ABC analysis, VEN analysis, XYZ analysis, FSN analysis, ABC-VEN matrix analysis, and FSN-XYZ matrix analysis. Majority (90%) knew about those concepts involved in VEN analysis and 70% of respondent knew about ABC analysis. However, none of them had a concept of FSN and XYZ analysis. From the respondents, 75% of them had gained knowledge of VEN and ABC analysis by formal training, 10% of them learned from on-job training whereas 15% of them acquired through other means. On the other hand, they were also asked whether they knew about the methods of inventory control, most (60 %) responded as they did not hear about inventory control method. But 40% responded that they know however on being asked to mention at least one method of it, majority (80%) could not correctly mention the methods used in inventory control (**Table 13**).

Table 13: Assessment of Knowledge of pharmacy personnel towards ABC, VEN, XYZ and FSN analysis and inventory management

Question		frequency	Percentage
Have you heard of the following concepts, as far as inventory management of pharmaceuticals is concerned?			
Concept of ABC analysis	Yes	14	70.0
	No	6	30.0
	Total	20	100.0
Concept of VEN analysis	Yes	18	90.0
	No	2	10.0
	Total	20	100.0
Concept of FSN analysis	No	20	100.0
	Total	20	100.0
Concept of XYZ analysis	No	20	100.0
Do you know inventory control methods?	Yes	9	45.0
	No	11	55.0
	Total	20	100.0
What is the purpose of inventory management?	Yes	19	95.0
The purpose of inventory management system is to know when to order stock	No	1	5.0
	Total	20	100.0
The purpose of inventory management system is to know when to issue stock	Yes	18	90.0
	No	2	10.0
	Total	20	100.0
The purpose of inventory management system is to know how much stock to order	Yes	18	90.0
	No	2	10.0
	Total	20	100.0
The purpose of inventory management system is to know how much to issue	Yes	17	85.0
	No	3	15.0
	Total	20	100.0
The purpose of inventory management system is to know what inventory level to maintain in order to avoid shortages	Yes	9	45.0
	No	11	55.0
	Total	20	100.0

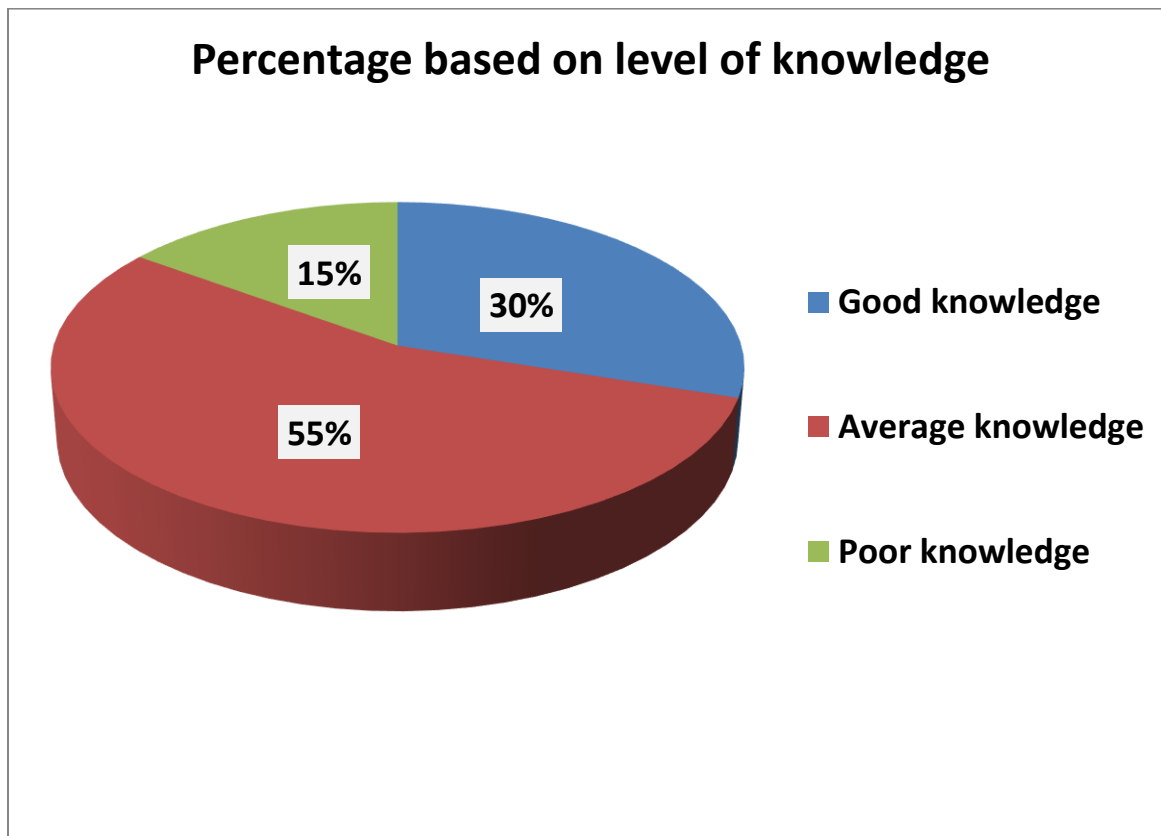


Figure 4: Knowledge rank of pharmacy personnel on inventory management system (n=20)

The assessment of knowledge of pharmacy professionals on the purpose of a medicine inventory management was ranked as poor, average and good on scoring 0-49%, 50%-74% and $\geq 75\%$ respectively. Based on this, 30% of the respondents scored good, 55% of them scored average and 15% of the respondents were scored poor result (**figure 4**).

5.10 Result of Practice of pharmacy personnel

Concerning the practice of professionals on the application of ABC-VEN matrix analysis, majority (75%) respondents had practiced ABC-VEN matrix analysis. Conversely, all of them did not apply FSN-XYZ matrix analysis at all (**Table 14**).

Table 14: Frequency of practice of pharmacy professionals in ABC-VEN & FSN-XYZ matrix analysis.

	Response	Frequency	Percent	Cumulative Percent
Practice of pharmacy professionals on the application of ABC-VEN matrix analysis	no	5	25.0	25.0
	yes	15	75.0	100.0
	Total	20	100.0	
Practice of pharmacy professionals on the application of FSN-XYZ analysis	no	20	100.0	100.0
	Total	20	100	100.0

5.11 The challenges involved in inventory management system

The qualitative data was collected through in-depth face to face interview of key informants (pharmacists and druggists) and categorized in to three thematic areas based on the characteristics of the result. These are: price related, training related, human resource related, and managerial related factors.

Price related

Key informants were asked about the medicines consumption trend and they responded as the number of items consumed was decreased across each year due to the decrement in number of items purchased. This can be exemplified by as one of the KIs stated;

“... in 2009 and 2010 the price of medicines increased but the budget allocated by the government was not increased proportionally to increment of the price of medicines. So, we reduced number of items by eliminating some less prescribed medicines”

Training related problems

Majority of them reported that they had taken a single training on IPLS and even a large number also responded as they were not participated on the formal training. One of the respondent reported that *“ I had participated on a workshop arranged by Zonal health office. It was not given only for pharmacy professional. There were many topics of discussion integrated in one training session. In my opinion that was not enough. I couldn't get sufficient knowledge from that session.”*

Some of them again responded that the training they took on the topic of inventory management were not adequate. Particularly, on the topic of XYZ and FSN analysis they stressfully suggest that they need to get training on such topics. For instance, one of the respondents said that,

''I have heard about the two analysis ABC and VEN but I don't know about its application and its use. Moreover, I haven't heard about the terminologies of XYZ and FSN analysis.''

The other also reported as they had never been practicing the inventory matrix analysis. One of them said, *'' Most of the time I had exposed to the theoretical part of training, I had never encounter with a training session that could allow us to practice.''*

Human resource Related.

Most of the KIs complained lack of human resources as a challenge for conducting ABC-VEN analysis. This can be explained as one of the HCs store manager stated:

''...I'm a store manager, but I'm also dispensing drugs for patients whenever the personnel at dispensary have night duty, because he takes a day break after night duty. So I have no time to conduct ABC-VEN analysis. Concerning the FSN-XYZ analysis we do not have any information and we cannot conduct the analysis at all. We are druggists. Had we have pharmacist he/she would have conducted this analysis.'' HC store manager

Managerial Related factors

KIs also complained lack of top management commitment and support as another challenge for conducting the matrix analysis and upgrading their knowledge on these issues. These can be exemplified by the response of one of the KIs:

''...Our facilities management does not encourage us to conduct such analyses. They do not send us trainings. Even if I ask them stationary materials to conduct ABC-VEN analysis, they complain lack of budget. They do not consider such activities as important. So how can I conduct with my own stationeries?'' HC Pharmacist.

6. Discussion

The drug consumption trend indicated that there was a decrement in the number of items procured while there was increment in total value of the products. The reduction in number of available pharmaceuticals might be due to the political instability during the past three years (2016-2018) while the rise in price might be due to economic inflation observed in past three years. This result is similar with the previous study conducted in Addis Ababa (TASH) in which the budget utilization showed increment from 2009-2013. This result was also supported by qualitative result, as KIs explained they had limited the number of items they purchased due to increased price.

6.1. ABC Analysis

In this study, class A medicines were consumed the highest percentage (80.1%) of total ADE over three years. This result also agree with the study conducted in India, where class A items accounted for 70 % of the annual expenditure (20) and another similar study conducted in Kenya, that revealed, out of the 812 different types of medicines procured, 13.2%(107) medicines types consumed 79.9% of the total ADE comprising group A (11). This finding is supported by another result of studies conducted in India, which showed A category items comprising 6.77% (104) expendable items consuming 70.03% of the total stores expenditure (41) and the study done in Ethiopia, TASH in 2009-2013 that showed 24 medicine items (9.6%) consumed 81.2 % of the total ADE (class A), in 2013, 32 items (12.17%) consumed 76.15% of ADE (class A), 47 items (17.9%) consumed 76.15% of ADE (class A) (14).

Medicines belonging to class A require more stringent control, accurate data driven forecasting of demand, close check on budgetary control, minimum safety stock, frequent stock taking, issuing and inspection policy. Class B require moderate control whereas class C require only minimum control measure for order and purchase and this activities can be accomplished by mid-level and lower level managers respectively (12,15).

6.2. VEN Analysis

This study shows 77 items (16.9%) were Vital, 309 items (67.9 %) were Essential and the remaining 69 items (15.2 %) were Non Essential. This is similar with the study conducted in Tanzania by Tumaini H.L, in which, 17% vital medicines represented 67(17%) of different medicines procured, essential medicines 270 (68.5%) and non essential

medicines at 57(14.5%) of total medicines procured (33). But vital medicines were slightly less than the finding of the study conducted in Kenya, which showed, vital medicine accounting 24.8%, essential drugs for 53.4 % and non essential drugs for 21.8 %, of 811 different items (39). Study conducted in India, which revealed that 101(47%) of the consumables as Vital, 81(37.6%) as Essential and 33(15.4%) as Desirable (20). Moreover, study obtained by Mannas et al., which revealed that out of 156 items, 50.9% were considered 'Vital' by the constituted medical panel; 40.2% were 'Essential' and the rest 8.9% were considered 'Desirable' (40). The difference might be due to the study setting. The current study included many health facilities, including health centers, whereas the previous studies were conducted at single referral hospital.

In this regard, medicine belonging to the vital category requires continuous availability and reasonable safety stock, while class E requires reduced stock level and the N class require minimum managerial control over their availability. In general, the result of VEN analysis in this study indicated that the majority of medicines belonged to the vital (V) and essential (E) groups, pointing out that expenditure in the public health facilities is targeting at serving the health care needs of the populations which is encouraging.

6.3. ABC-VEN Categorization

The ABC analysis is not enough to use when evaluating the inventory of medicines and should be used in conjunction with a tool that takes non-monetary factors in to consideration. Combining the ABC and VEN analyses lead to categories of medicines that require different inventory control management.

This study revealed 121(26.6%), items in category I accounted for the highest (84.7%) value. However, the large number 224(49.2%)) of items in category II accounted for lower value (13.2%). This study had comparable result to the study conducted in Kenya which showed that medicines belongs to category I, II and III accounting for 85%, 14% and 0.9% of ADE in 2013 respectively(39). But this differs from the results of a study done in India, which revealed that 51.6% of the consumables constituted Category-I items, 33.5% Category- II items, and 14.8% were category-III (20). The difference might be due to the difference in study setting, prevalence of disease and medicines price difference.

Most of the drugs with a high consumption value and vital clinical importance (AV drug category) should be at minimal shortages as they are critical for life saving; their availability must be ensured even though the holding costs are high. Inventory ordering should be conducted at fixed intervals. Safety stock and ROP should be calculated in order to ensure particular levels of stock. The drugs with high consumption value and essential clinical importance (AE drug category) constituted high proportion of total consumption value should be prescribed steadily through the year. The priority classification narrowed down the drugs requiring good control to just 65 items thus simplifying monitoring and control strategies for the management of drugs at the health centre. This prioritization is in line with the study done in Goa state (3).

It will be a great concern for health facilities DTC and other pharmacy managers to make selective control over medicines under category I due to its few number (on average 26.6 % of total types of items) amounting the highest (averagely 84.7% of total ADE).The majority of medicines in W/Arsi public health facilities belongs to category II (49.2%) of total medicine types having intermediate value (13.2%) of total annual drug expenditure are requiring close supervision by middle level managers in the health facilities. This is comparable with result of study conducted in Kenya in which category I accounted for 84.7% and category II accounted for 14 % of ADE (31).

6.4. FSN analysis

From the FSN analysis, the values of fast moving F items are by far greater than S and N items. In 2016, only 35.3 % of total items accounted for 78 % of total value. The finding was also agreed with the study done in India in which F class items (10%) accounted for 81.52 % of total value (20). This indicates that the managers have to give due attention to fast moving items. More over the current result revealed that the pattern of consumption of medicines was varied from year to year across some specific drugs depicted on the above figure. However, when we look at the trends on the proportion of items and their corresponding value, the finding showed that the percentage values were very close across each year (2016-2018). On the other hand this result revealed the minimum frequency of issue for class F is 15 times per year of which most of them had a frequency of 48 times per year. This indicates, either the dispensaries were not completing internal facility report or resupply form (IFRR) correctly or there were a problem of loss.

Conversely, the N class items having greatest proportion of items but least in their consumption value should be identified and their list would be counter checked with items to be purchased in order to avoid the over stocking of the non moving class of drugs. Exceptionally, the highest percentage of N class value (62.4%) in 2017 can alarm pharmacists to follow their expiry date closely and enforce them to find other possible options in order to minimize the risk of wastage due to overstocking.

Here, attention of the management should focus on Fast moving items due to the fact that it requires high stock, strict control and high safety stock (20). Regarding non-moving items low stock and low control is required. All non-moving items (N) identified using FSN analysis could be either transferred to other health facilities where it can be utilized or disposed early. If disposing is the only option, it will be performed based on the value of each item of drugs by conducting XYZ analysis on the N category items.

6.5. XYZ Analysis

XYZ analysis helps to control the value of inventory leftover at each fiscal year. It tells how the values are distributed amongst pharmaceuticals in stores. This study revealed that very few number of total closing items (on average 23.1%) had the highest percentage (79.8%) of total closing stock value and in contrast to this a huge number of drug types (on average 55.5% of total drug types) had very little amount (6.1%) of total closing stock value .This shows that the health facilities managers, DTC and pharmacy professionals have to focus on the monitoring of the utilization of specially class X items in order to minimize the wastage due to expiry as the items pass from year to year. This study has comparable result to the study conducted at a Cardiology department of a tertiary care hospital, in India, which revealed 10% of items contributing 59% of total closing stock value (10). It has a similarity also with study done in India of which 10% of items account for 59% of total stock value(class X) , 20% of items account for 35% of total closing stock value (class Y) while 70 % of items account for only 6% of total closing stock value (class Z) (37).

6.6. XYZ – FSN Matrix Analysis

When we look at the XYZ and FSN matrix analysis , XF group which represents high closing stock value and fast moving items utilized the highest budget(56.8%) in 2016 and (44.7 %) in 2017. In this case the health facilities can minimize the maximum stock level

up to reorder point to optimize the inventory level. But in 2018, XN group had the highest value (41.3%), at which the health facilities would plan to take fast action on it. Moreover, the managers have to review their drug selection and quantification in order to avoid investing on non-moving and high cost drugs. Similar study done in India revealed there were 625 items under NZ (non-moving item found in Z category), 62 items under NY (non-moving item found in Y category) and 33 items under NX (non-moving item found in Z category) that were to be discarded (19).

Out of 85.4 % and 86.1 % of category I in 2017 and 2018, the XN group account for 16.2 % and 41.3% of total consumption value. This result is in line with the study done in India of which the combined FSN-XYZ analysis identified 33 items came under NX category and are chosen for discarding (19). The current study implies that the items having high cost were being stored with no movement throughout the year. This can probably lead to an increment in carrying cost due to rise in cost of deterioration and cost of pilferage. So, there must be strict control over non-moving and slow moving items.

Therefore, categorization of drugs according to XYZ-FSN matrix benefits the PHFs to determine the level of inventory with high value in dead-stock or slow-moving items. For inventory management of vital drugs, only ABC and VEN matrix classification are insufficient to control the stock in appropriate level with minimum shortage and oversupply. Moreover, consideration of consumption patterns and their closing stock value in forecasting and setting inventory level give an accurate stock level for optimization of vital drugs inventory management (38).

Since Category I utilized the highest total drug expenditure, special attention of inventory control is required for medicines with irregular consumption patterns. Moreover appropriate forecasting can minimize the overestimate and underestimate of drugs for different consumption patterns (41).

6.7. Knowledge of pharmacy personnel regarding inventory matrix analysis

Concerning the knowledge on pharmaceutical inventory management, Majority (90%) knew on the purpose of medicine inventory management. However most of the pharmacists' respondents (85%) could not correctly explain the application of vital, essential and non-essential analysis. This finding is comparable with the study done in Tanzania, where in Majority (70%) knew the purpose of medicine inventory management

and (85.7%) could not correctly explain the application of vital, essential and non-essential analysis (34).

With regard to the methods of inventory control, most (55%) respondents didn't know the methods and majority (80%) could not correctly mention. This pointed out that there was a knowledge gap in the area of inventory control method and this was also supported by qualitative method as most of the KIs complained lack of training as one of challenges.

On top of these, they were asked whether they knew about the application of the two matrix analysis .Yet, all of them could not correctly explain the application of XYZ and FSN analysis though some (75%) of them responded as they can do ABC and VEN analysis. This result indicates that the professionals demand a means of acquiring knowledge concerning the matrix analysis specially the FSN-XYZ matrix analysis. The personnel should acquire an intensive formal training and regular workshops or seminars related to the subject for effective inventory management.

6.8. Limitation of the study

Lack of previous researches on this area, especially locally conducted researches were not available. Thus, findings could not be compared well as we could not find any published literature regarding Knowledge and practice of professionals on conducting Matrix analysis.

7. Conclusion and Recommendation

7.1 Conclusion

For inventory management different inventory control methods can be used. The matrix analysis is one of the inventory control techniques in which we can identify items requiring close monitoring. By coupling ABC with VEN and FSN with XYZ analysis A, V, F, X and N class items can be identified so that the control can be simplified. Moreover, medicines classified as XN and AN needs fast action like transferring to other health facilities.

As most of the public health facilities in West Arsi zone were obtaining a limited budget for pharmaceuticals, strict inventory control must be practiced in each PHF. However, the finding shows that the pharmacy professionals had a knowledge gap regarding the implementation of matrices analysis. Therefore, the regional health bureau, W/Arsi zone and partners working in collaboration with MOH should plan for capacity building on performing matrices analysis.

7.2 Recommendation

To West Arsi Zone health department

They should arrange trainings and workshops for facilities' store managers on the area of ABC-VEN and FSN-XYZ analysis

To facilities store managers

They should conduct the ABC and VEN analysis periodically so as to manage the medicine expenditures effectively and efficiently.

To academicians and partners

They should further investigate this important and overseen area by conducting different researches.

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Data collection tools for categorizing pharmaceutical used in hospitals and health centers according to VEN analysis.

Dear Respected Clinicians: - This is just to request your professional experience in rating the different type of cases treated in your specific department. I am very grateful for your cooperation

S/ N	Condit ions treated	Occurrence of target condition			Persons tt/day			Severity of Target Condition					
		ov er 5 %	1 – 5 %	<1 %	>5 %	1– 5 %	< 1 %	Life Threatening			Disabling		
								y es	occasio nally	Rar ely	y es	occasio nally	Rar ely
1													
2													
3													
4													
5													
6													
7													

Please would you rate the medications used for the treatment of each of the above cases.

S/N	Name, strength, dosage/vol. of medications	Prevents serious diseases (A)	Cure serious diseases (B)	Treat minor, self-limited symptoms and conditions (C)	Has proven efficacy (D)	Has unproven efficacy (E)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						

NB. Choice for the above parameter/options are given below... so fill each of the box with one of the given choices

- A) Yes/No
- B) Yes/No
- C) Possibly/No
- D) Always/Usually/May or May not
- E) Never/Rarely/May or May not

Good day. My name is _____.

My colleague and I are conducting a survey regarding knowledge and practice of pharmacy personnel in inventory management of public health facilities. We are looking at the availability of inventory recording tools and their utilization. We are visiting selected health facilities throughout the zone; this facility was selected to be in the survey. The objectives of the survey are to collect current information on knowledge and practice of inventory management. This is not a supervisory visit and the performance of individual staff members is not being evaluated.

The results of this survey will provide information to decision maker and to promote improvements. The survey has been/will be conducted again in the future to measure changes in the logistics system. We would like to ask the store manager a series of questions about the products and inventory recording tools availability at this facility. Do you have any questions?

Name of the facility _____

District _____

Facility Type: _____ (1=Hospital; 2=Health center)

Information about Interview

Date: _____

Interviewer/s: _____

Date _____

1. Gender: _____ a. Male _____ b. Female _____

2. Job title: _____

No.	Question	Code Classification
01	Who is the principal person responsible for managing medical supplies at this facility?	Pharmacist1 Pharmacy Technician2 Other (Specify) _____3
02	Have you heard of the following concepts, as far as inventory management of pharmaceuticals is concerned?	a. ABC analysis Yes No b. VEN analysis Yes No c. XYZ analysis Yes No d. FSN analysis Yes No
03	If the answer(s) of any of the above is / are Yes, Where did you learn about these?	a. Formal training b. On-job training c. Others(mention) _____
04	Which topics have you trained on?	IPLS _____1 LMIS _____2 APTS _____3 Others _____4
05	The purpose of a medicine inventory management system is to know	a. When to order stock Yes No b. When to issue stock Yes No c. How much stock to order Yes No d. How much to issue Yes No e. What inventory level to maintain in order to avoid shortages. Yes No
06	How did you train to perform ABC analysis	Never trained.....A During a logistics workshopB On-the-job trainingC Other (specify) _____ D

07	Do you know the application or use of concepts of Vital, Essential, Non essential classification as well as ABC analysis of medicines in inventory control management?	a. Yes b. No
08	If the answer is yes, what is their use?	-----
09	Do you know about the methods of inventory control?	a. Yes b. No
10	If the answer is Yes, mention at least one type of inventory control methods	-----
11	Do you have a predetermined time for ordering medicines from the main store?	a. Yes b. No
12	Are there written standard operating procedures for inventory management that you use?	a. Yes b. No
13	Are you involved in assessing and estimating the quantities of medicines required per year?	a. Yes b. No
14	Have you ever conducted ABC-VEN matrix analysis?	a. Yes b. No
15	If yes, who conducted it?	a. Pharmacy head b. DTC c. Store manager d. Others(specify)
16	Have you ever conducted FSN-XYZ matrix analysis?	a. Yes b. No
17	If yes, who conducted it?	a. Pharmacy head b. DTC c. Store manager d. Others(specify)

Question for Key Informant

1. How would you describe your medicines consumption from year to year in the past three years (2016-2018)?
2. What do you think are the main problems related to your inventory management today?
3. Where do you see that you have the largest problems with regard to inventory management?

Assurance of Principal investigator

The undersign certify that he has read hereby recommended for acceptance by school of pharmacy, institute of health ,Jimma university a research thesis entitled; **‘Evaluation of pharmaceuticals inventory management in selected public health facilities of West Arsi zone,Oromia regional state’** in partial fulfillments of requirements for the degree of Master of science (MSc) in pharmaceutical supply chain management.

Name of the student: Tadesse Jobira Wakjira (B.Pharm) ID: RM0066/2010

Signature_____Date_____

Approval of the Advisor

Name of Advisor: Awol Jemal (B.Pharm,MSc)

Signature_____Date_____

Name of the internal examiner: Tadesse Gudeta (B.Pharm,MSc)

Signature_____Date_____

Name of the external examiner: Edao Sado (B.Pharm,MSc)

Signature_____Date_____