Original Research Article

Procurement Practice of Program Drugs and Its Challenges at the Ethiopian Pharmaceuticals Supply Agency: A Mixed Methods Study

INQUIRY: The Journal of Health Care Organization, Provision, and Financing
Volume 59: 1–16

DOI: 10.1177/00469580221078514
journals.sagepub.com/home/inq
SAGE

Bekele Boche[1], Tidenek Mulugeta[1], and Tadesse Gudeta[1]

Abstract

Background: Effective drug procurement guarantees the sustainable supply of products for health and eliminates excessive costs. However, there is limited information on the area of pharmaceutical procurement practice in Ethiopia. Thus, this study aimed at assessing the procurement practices of program drugs and its challenges at the Ethiopian Pharmaceuticals Supply Agency.

Methods: A cross-sectional study accompanied by qualitative assessment was conducted between February 21 and April 20/2020 to examine the procurement practice of the Ethiopian pharmaceutical supply agency. The quantitative data were gathered by reviewing documents and electronic records. Mean forecast error, price paid to international price reference, number of emergency orders placed, and lead time variability were the measurements used to assess the procurement practice. A statistical package for the social sciences version 23 was used to analyze the data. The results were then summarized using tables and texts. The qualitative data were collated through face-to-face in-depth interviews to explore the challenges behind the procurement practice. And the data were analyzed manually using the thematic analysis technique.

Results: The agency had its own procurement list which defines the items to be procured. The overall mean forecast error in the 2018/19 budget year was 27.8%. Of the 70 program commodities included in the study, 52 (74.3%) items had a mean price less than the international price reference. Three of the 14 orders (21.4%) placed in the aforementioned year were emergency purchases made through direct procurement. The mean lead time for the suppliers of the agency was 137.3 days. Poor data quality from service delivery points, staff capacity constraints, communication problems, and policy issues became the major challenges to implement an effective procurement system in the agency.

Conclusion: The procurement practice at the agency has strong side. However, it was not without weaknesses. Using a procurement list is a worthwhile practice. Despite this, much remains to improve lead times and forecasting accuracy.

Keywords

Ethiopia, procurement practice, program commodities, quantification, selection

[1]Department of Social and Administrative Pharmacy, School of Pharmacy, Faculty of Health Sciences, Jimma University, Jimma, Ethiopia

Corresponding Author:
Bekele Boche, Department of Social and Administrative Pharmacy, School of Pharmacy, Faculty of Health Sciences, Jimma University, Jimma, Ethiopia.
Email: boche.bekele@ju.edu.et

What do we already know about this topic?

- Procurement of health commodities is the most crucial aspect of pharmaceutical logistics management. It is particularly important for low- and middle-income countries, because these countries import majority of their drug requirements from other countries and devote one-third of their health-care expenditure on it.

How does your research contribute to the field?

- The study came up with an analysis of the drug procurement practice and its challenges at Ethiopian pharmaceutical supply agency. The finding pinpoints the source of the problem in the procurement process and paves a way to address product stockouts and service disruptions resulting from ineffective procurement.

What are your research's implications towards theory, practice, or policy?

- One of the outcomes of efficient procurement is the availability of products. Thus, the finding has an implication on EPSA's goal of achieving 100% product availability in the country. Product availability, in turn, has an influence on the quality of service provided by the lower-level health institutions supplied by the agency.

Introduction

Procurement is an important step in the pharmaceutical logistics system and ensures the availability of the right pharmaceuticals, in the right quantities, at reasonable prices, and accepted standards of quality.[1]

A procurement process for health commodity begins with the selection and specifications of products, followed by forecasting and tender preparation.[2] World Health Organization (WHO) recommends the selection of drugs based on a list of common diseases and standard treatment guidelines. With fewer selected products, the service delivery points and central warehouses can become familiar with the items and manage them well.[3] Designated essential drug list guides the procurement process and simplifies the supply of medicines in public health facilities.[1,4]

After selection, the quantity and cost of each commodity must be estimated. The estimation outputs then used to advise higher-level decision-makers on the funding and priorities of purchase.[5] Given the complexities of forecasting processes across multiple industries, supply chains of many organizations aim to achieve a reasonably accurate estimate of potential demands for sustainable service delivery.[6]

Pharmaceutical purchase accounts for the largest healthcare costs in any country in the world, varying from 5% to 12% in developed countries and up to 40% in developing countries. Despite such heavy spending, one-third of the world population lacks access to essential health commodities, which goes up to 1 half in Asia and Africa.[7,8] A report from Kenya shows that weak procurement practices have resulted in high procurement expenditure, and increased lead times. In 2016, the average lead time from tendering to initial delivery at Kenya Medical Supplies Agency (KEMSA) was 6 months. Delayed deliveries resulting in loss of life were also among the complaints of the health facilities.[9]

In recent decades, the complexities of the public health supply chains, the volumes, and varieties of health commodities have significantly increased. It led to disrupted procurement and supply systems. The problem is much worse in low-and middle-income countries where the supply chain is fragile.[10] Especially, drugs and supplies for the management of Tuberculosis (TB), malaria, HIV (Human Immuno Deficiency Virus), and maternal and child health are not easily accessible.[11,12] They are acquired from international vendors through the sponsorship of donor agencies such as the Global Fund and United States Agency for International Development (USAID).[11-14] Thus, coping with the risk of non-availability and wastage of pharmaceuticals is a daily concern for the logistics officers.[15,16]

In 2017, the Global Fund (GF) spent US$ 32.6 billion to support HIV, Tuberculosis, and malaria services, accounting for nearly 40% of grant expenses.[16] Even though such huge amount of fund is spent, the GF's executive director emphasized that the world is not on track to achieve the Sustainable Development Goal 3 (SDG3) to end these 3 epidemics by 2030.[17]

There is also a lack of access to life-saving maternal and child health products globally.[18] A survey from 8 countries in sub-Saharan Africa shows that the mean availability of priority essential medicines for women and children ranged from 22% to 57%.[19] Ethiopia is the sub-Saharan African countries and the second highly populated next to Nigeria, with a population size of 112.07 million.[20] The country is not immune to the problems in the supply chain that other developing nations face.[21] The service delivery points including health facilities experience frequent shortage of vital items, lower inventory turnover, expiration, and damage of essential medicines.[22,23]

Ethiopian Pharmaceutical Supply Agency (EPSA) is mandated at the national level to provide all public health facilities in a sustainable manner with affordable and reliable pharmaceuticals.[22] It is a public agency and is accountable to the Federal Ministry of Health (FMoH).[23]

Review of literatures reveals that previous studies in Ethiopia gave prominence to inventory management, storage conditions, and information systems.[21-26] The procurement of program drugs in Ethiopia is nationally pooled. However, primary research settings for majority of these previous studies were public health facilities. As to the best search of

the investigators, no study has yet evaluated how procurement activities are carried out by EPSA. The study, thus, investigated the procurement practices of program commodities and its challenges at the Pharmaceuticals Supply Agency of Ethiopia.

Methods

Study Area, Design, and Period

A cross-sectional study accompanied by qualitative assessment was conducted between February 21 and April 20/2020 at Ethiopian Pharmaceutical Supply Agency (EPSA) head office which is based at the capital city of the country, Addis Ababa. EPSA was established in 2007 through restructuring the former PHARMID (Pharmaceuticals and Medical Supplies Service and Distributer). It was known by a name Pharmaceuticals Fund and Supply Agency (PFSA) until recently (2019) renamed to EPSA. The agency has 19 hubs in all regions of Ethiopia but only the head office carries out the procurement practices. Within the main hub, there are 19 directorates. Among these directorates, six of them focus on core logistic operations. Namely, quantification and market shaping, distribution and fleet management, contract management, management information systems, tender management and warehouse and inventory management.[27]

Source Population, Study Population, and Data Sources

The source population included staffs of EPSA as well as all pharmaceuticals currently managed by EPSA. All program commodities for HIV/AIDS, TB, malaria, and maternal and child health were assessed (Appendix D). And professionals involved in managing the procurement of those commodities were the study populations. The data sources were documents used to manage the procurement of the program commodities.

Sample Size Determination and Sampling Procedures

Sampling of Pharmaceuticals: All program pharmaceuticals, used for HIV/AIDS, TB, malaria, and maternal and child health (Appendix D) as specified on EPSA 2018 pharmaceutical procurement list were considered. These comprised 17 HIV/AIDS, 31 TB, 12 MCH, and 10 malaria items.[28]

Document Selection and Sampling: All documents used for quantification and procurement activities of the mentioned program pharmaceuticals in 2018/19 budget year were reviewed. Accordingly, 14 contract management documents, 39 purchase order documents, 39 receiving documents (model 19), and 108 issuance documents (model 22) were reviewed. In addition to model 22, the agency's Health Commodity Management Information System (HCMIS) software was also checked for accessing consumption data to quantify forecast errors.

Participant Selection and Sampling for In-depth Interview: was employed to recruit study participants from the directorates of quantification and market shaping as well as from tender and contract management. The participants were selected based on their role and service year as they are more familiar in practice and challenges in the agency. Sixteen informants of various profiles were enrolled in the interviews. The number of interviewees was determined based on assumed information saturation. The interviews get completed when the participants began repeating what has been said.

Data Collection Procedures

Checklists and in-depth interview guides were used as a tool to gather the relevant data (Supplementary Appendix E). The checklists were adapted from the USAID/deliver project's Logistics Indicator Assessment Tool and Methodology for Assessing Procurement Systems.[29,30] These checklists were used to capture data from quantification and procurement documents/electronic records. Accordingly, Model 22 and HCMIS software were consulted to obtain data for calculating forecast errors. Moreover, purchase orders, contract management documents, and Model 19 were used to extract data like opening date of a letter of credit (LC), frequency of deliveries, number of emergency purchases, methods of procurement and quantifications, sources of commodities, and arrival time of the commodities.

The second tool used was an interview guide adapted from the USAID/deliver project's Logistics System Assessment Tool (LSAT).[31] The tool contained in-depth and probing questions. The interviews were conducted face-to-face with informants, and the principal investigator moderated the discussion to ensure data consistency. The response of each participant was audio-recorded and notes were taken. Each interview on the average lasted for 25 minutes, and a local language Amharic was used for discussions. The interviews were held at each participant's workplace, and rapport was built with each.

Measurements

The following key indicators were adapted from Logistics Indicator Assessment Tool (LIAT) to characterize the agency's procurement activities.[29]

Forecasting Errors: metric helps to measure the proportion of the disparity between the previous year's projection and the actual demand for that year. It can be determined by applying the following formula:

$$\frac{\text{Forecasted consumption} - \text{actual consumption}}{\text{actual consumption}} * 100.$$

Data were obtained from Model 22 and HCMIS for calculation of this indicator.

International Price Reference: measures the unit cost per commodity billed by the external supplier as a

proportion of the mean international unit price. It is calculated as follows: International prices references =

$$\frac{\text{Average unit cost of item}}{\text{Average international unit cost of item}} * 100$$

Lead time :[Date of opening the letter of credit - Date the products become ready for use after arrival]

Supplier Lead-time Variability: is the average of the absolute percentage variations between the estimated lead time of the supplier and the actual lead time of each order spent by the supplier. It can be calculated using the following Formula:

$$\frac{\text{Forecasted lead time} - \text{actual lead time}}{\text{actual lead time}} * 100$$

Average suppliers lead time: It is determined by dividing the sum of the vendors' lead times by the number of orders in days.

Data analysis: The quantitative data were cleared, coded, and entered into the Statistical Package for Social Sciences (SPSS) version 23 for analysis. To estimate the forecasting error and procurement price variation, descriptive statistics including mean, standard deviation, and minimum and maximum values were computed. The results were presented using tables and texts. The qualitative data were transcribed with verbatim transcription after the audio-record listening. Repetitive readings were made to get accustomed with the data. Then, codes were assigned and inter-code consistencies were checked. A code book manual was developed, and then, the principal investigator re-coded the whole data by refining from the code book. The codes were clustered into categories and themes were developed by linking related categories. The themes were summarized and opinions among interviewees were quoted to explain some important issues. Finally, the quantitative findings were triangulated with the quantitative results at the discussion phase and thus a partial mixed method.

Data Quality Assurance and Trustworthiness

A pre-test was conducted to check the clarity and validity of the tools. Besides, the investigators closely monitored the data collection process and every time after data collection, the checklists were reviewed for completeness. To maintain trustworthiness of the qualitative data, in-depth interview was conducted with participants who have relevant experience and expertise. Member checking was done at the end of data collection by summarizing major thematic areas that have emerged during the interview. Team members of the research also reviewed and gave their comment on the report. Audit trail was done by an experienced researchers to verify the interpretations of the findings. To ensure transferability, the whole research process, were explained extensively. To ensure dependability, the methodological approaches followed were clearly described. A detailed chronology of research activities was audited by the research team and other experts. Conformability of the study was ensured through research team's self-reflectivity and bracketing. The investigators were pharmacists who have experience of working in health facilities and an academic institution. Moreover, they had participated in trainings related to pharmaceutical procurement. Currently, they had a master's degree in pharmaceutical supply chain management. Besides this, they had also experience in both qualitative and quantitative research data collection and supervision.

Operational Definitions

Agency; refers to Ethiopian Pharmaceuticals agency (EPSA)

Dashboard: is a web-based tool that shows the stock status in the central and regional warehouses

Health commodities: include products for HIV/AIDS, TB, MCH, and malaria; generally, program commodities.

Lead time: the time period between opening of the letter of credit and delivery of goods to warehouses and making them ready for use. The forecasted lead time of EPSA was 90 days.[32]

***Supplier's competitiveness*:** If EPSA invited all potential suppliers and evaluated them without any prejudice based on specific parameters it was considered as supplier's competitiveness.

Transparency: is the procurement protocol of the EPSA, which will allow the authorized body to learn and recognize the specific procedures and processes used.

Products: *Refers to Program Commodities*

Program commodities: in this document, program commodities are interchangeability used with health commodities.

Results

Quantitative results: Procurement Practices of Program Commodities

Selection and quantification. A national treatment protocol and World Health Organization guidelines were used to select the required commodities. EPSA had its own procurement list and updates it regularly. It had also standard operating procedures (SOPs) for all directorates. To determine the required quantities nationally, the agency used a combination of consumption and morbidity methods. For the consumption method, the agency used reports of EPSA hubs and health facilities as a data source. For the morbidity method, disease information was obtained from the Ministry of Health. The 2018/19 budget year data review showed that the average forecast error for program products was 27.8%. Items used for malaria management had comparatively higher forecast errors, 37.3 (Table 1 and Appendix A).

Procurement Methods

In the past year (2018/19), EPSA purchased program commodities from international and national vendors through a competitive bidding process, 67 (78.6%) except for some products and emergency purchases, 3 (21.4%). The agency had placed 14 orders in divided delivery schedules, 3 of which were emergency orders (Appendix A and C).

Table 1. Percentage of Forecasted Error of Program Commodities at the Central EPSA for Items Procured in 2018/19 Budget Year.

Statistics	forecast error for HIV/AIDS in %	Forecast error of MCH in %	Forecast error of Malaria in %	Forecast error for TB in %
Mean	31.7	22.9	37.3	24.4
SD	17.2	16.6	31.7	16.0
Maximum	67.4	66.6	85.1	62.2
Minimum	0.6	3.3	2.9	0.3

SD: standard deviation.

Table 2. Price comparison against international price paid for program commodities at the central EPSA for items procured in 2018/19 budget year.

Variables	Value
No of products	70
Mean of international price paid (IPP)	.995
Standard deviation of IPP	.924
Minimum of IPP	.04
Maximum of IPP	4.878
Median price < IPP	52 (74.4%)
Median price >IPP	18 (25.7%)

Table 3. The suppliers' lead time for program commodities at the central EPSA for items procured in 2018/19 budget year.

Suppliers lead times	
No of deliveries	36.0
$\overline{X}_{LT}$	137.3
STD_{LT}	70.9
Min_{LT}	52.0
Max_{LT}	294.0
Deliveries in acceptable LT, (%)	12 (33.3)
Deliveries not in acceptable LT, (%)	24 (66.7)

$\bar{X}$: mean, STD: standard deviation, Min: minimum, Max: Maximum, LT: supplier lead time in days, EPSA accepted LT: ≤ 90 days.

International Price Paid

Of the seventy program commodities chosen for the study, 52 (74.4%) of them had a median price lower than the international price paid. The highest ratio (4.878) obtained was for artemether + lumefantrine - (20 mg+120 mg) tablet (6x1) (Table 2 and Appendix B).

Lead Times

Within the given year, except emergency supplies, 36 deliveries of the products were made. All of these deliveries arrived at various times in the warehouses and became ready for use. The mean suppliers' lead time was 137.3 days, and 24 (66.7%) of the deliveries were not within the acceptable duration, 90 days. The mean lead time variability of the suppliers was estimated to be 33.3% (Table 3 and Appendix C).

Qualitative results. The findings of this study were organized into 4 major themes including data quality problems, inter and intra-institutional communication related issues, staff capacity, and policy-related challenges. All these themes were described as follows.

Data Quality Related Problems

Across the interviews, participants mentioned that sound decision-making on planning, procurement, and provision of health services needs reliable information. However, most of the interviewees; in particular, quantification officers reported that the consumption and morbidity data were not quality enough to make appropriate decisions. Though trainings were delivered to enhance the reporting skills of practitioners working in health facilities, the problem still remained unresolved.

> *"The major problems encountered in the quantification of program commodities were inaccurate and incomplete consumption reports from service delivery points. It led to unacceptable forecasting errors, and mostly the forecasts depend on assumptions." (40-45 years old, male, focal person of program commodities)*

The participants mentioned that health facilities were expected to submit their consumption reports regularly to their respective hubs. It is a must to understand customers' demand to make reliable forecast. The agency can only be successful if customers are submitting their demands on time. However, there were delays. Due to this problem, the agency fails short of making timely forecast. The interviewees recommended provision of frequent on job trainings and supervisions. Health facility workers shall have adequate awareness regarding quality reports and its significance in supply chain management.

> *"The pharmaceutical supply of the country is governed by integrated pharmaceutical logistic system. The system has set a predefined schedule of reporting for all level of health facilities and the agency's hubs. Despite this, many facilities rarely adhere to the schedule." (30-35 years old, male, HCMIS officer)*

Communication-related issues: The participants mentioned that it is vital to have an effective communication in an

organization. Especially, for firms engaged in supply chain, information is an engine that drives the whole operation. Efficient communication creates transparency and trust, and contributes to sustainable supply. However, the communication between the directorates within the EPSA and the central agency and its hubs was not as it should be. In particular, the communication problem is considerable especially between the distribution and the warehouse management units. Their communications have usually been unplanned. One of the central EPSA officers elucidated the issue as follow,

> *"I believe that weak coordination between departments would have a direct effect on procurement and overall organizational performance. There is no clear line of communication between the directorates of the agency and the EPSA hubs, and sometimes communications are made during the needs only." (40-45 years old, male, procurement officer)*

Additionally, the participants reported communication problems resulting from lack of staff motivation to update the dashboards regularly.

> *"The dashboard is not updated periodically, and even after updating, most of the time, it does not display the right quantity of items available. As a result, the hubs are not sure how much to request; they submit large orders in anticipation of receiving at least the minimum amount that covers their demand." (35-40 years old, male, procurement officer)*

Besides, some of the respondents reported late response from the drug regulatory authority of the country that is responsible for approving the purchase and import of pharmaceuticals. This ultimately results in delay of processing purchases.

> *"The national regulatory authority which is mandated to grant pre-import permit has multiple duties. This caused delayed response which could be alleviated by establishing resilient and technology assisted communication system." (50-55years old, male, contract management officer)*

Staff-Capacity Building Related Issues*:* Effective procurement requires skilled professionals having theoretical knowledge, prolonged training, and competence. The agency however, had shortage of well-trained human resources. Junior workers were participating in sourcing activities, but EPSA works with foreign vendors which need a comprehensive understanding of the supply chain. Professionalism in pharmaceutical procurement does not relate only to having basic knowledge about pharmaceuticals, but also to specialization in the area.

One of the EPSA officers explained the issues as follows,

"The Agency has a shortage of qualified professionals in the field of supply chain management, especially in procurement practices. Almost all of the workers are health practitioners with no specialties or specializations other than supply chain management." *(30-35 years old, male, contract management officer)*

Further the participants mentioned that long term professional trainings are not usually served for the workers.

> *"I think that professionalism had a great influence on the procurement performance of the agency. Not only our agency, but also every organization should focus on professionalism in order to enhance its performance. Employment of professionally trained and qualified procurement staff should be emphasized and implemented. Majority of the staff needs to have a graduate level training on supply chain and logistics management. However, these educational opportunities are rarely facilitated by the agency." (40-45 years old, male, contract management officer)*

Procurement Policy Related Challenges

Pharmaceutical purchasing has its own special features which makes it different from any other ordinary purchase. However due to lack of a separate customized procurement policy, the agency is obliged to abide to the national public procurement policy which does not consider the special nature of pharmaceuticals.

> *"It is good to have an abiding policy framework. However, the public procurement manual currently in effect is less flexible and is not customized to pharmaceutical purchase. The procurement in the health sector requires a tailored approach. Sometimes, pandemics and emergency calls might arise that need abrupt response. Such situations usually don't give time to follow the whole principles of the manual." (45-50years old, male, procurement officer)*

Discussion

The procurement of selected essential medicines enables one to recognize and maintain the availability of medicinal products in supply chain facilities.[1] In the present report, EPSA had established lists for the purchase of program commodities and updated regularly. It is good practice and coincided with the WHO concept of essential medicines.[33]

The quantification findings allow program managers to assess the financing and procurement of the products needed so that supplies become available continuously, and resources used effectively.[34] In the current study, the mean percentage forecast error of the program commodities was 27.8%. It is a little bit higher than the acceptable threshold that is less than 25%.[35] Though forecast errors cannot be totally avoided, there is a need for stringent oversight of the quantification procedures to avoid overage and stock out. A small fraction of discrepancy of these critical program items may cost

significant resources. To make up this problem, working on data quality improvement is indispensable. From in-depth interviews, the major challenges in the quantification of program commodities were erroneous, incomplete, and late reporting from service delivery points.

There was, also, variation in forecast accuracy among individual items. For example, the forecast errors for HIV/AIDS and malaria commodities were 31.71% and 37.25%, respectively, which deviate from the normal range. The results of this report are higher than those of the study done in Tanzania[36] and Benin with a mean forecast error of 19% for program items.[37] The disparity may be attributed to data quality issues and communication problems resulting from lack of staff motivation to update the dashboards regularly in the current study. This underscores a need to alert the staffs working on dash boards about their role in ensuring sustainable supply and its impact on the survival of many more patients.

In this study, the ratio of average international price charged (IPP) for the selected program commodities were 0.995 and 52 (74.3%) of the products had the mean price paid less than the international price index (1). It is comparable to the international price paid by Kenya Medical Supplies Agency (KEMSA) for both locally produced and imported medicines.[37] The lesser the proportion of the average international price paid, the greater the cost savings.[38] A ratio of average international price paid less than 1, indicates more cost savings and acceptable level of price. In contrast, a ratio of average international price paid greater than 1, is not tolerable. It is taken as the agency is paying superior to international prices and is one of poor procurement practice indicators.[32] The current finding is acceptable as it showed negotiation power is on the side of EPSA. Hence, the firm was successful in lowering purchase prices. However, the price charged for Artemether + lumefantrine (20 mg+120 mg) tablet, 4.878, was around 5 times higher than the international price reference. The reasons were malaria outbreaks which necessitate emergency orders. Emergency procurement purchases might have increased the price of the product.

Concerning procurement lead time, on average, it took 137.3 days from the opening of the letter of credit to the availing products for use in the EPSA warehouse, which was longer than the duration fixed by EPSA.[39] And the orders might delay up to 294 days. It is also higher than the expected lead time of 120 days for the 2015 Ethiopian Health Sector Development Program (HSDP-4).[40] It suggests that EPSA may not expedite suppliers to meet the delivery time, or that there may be weak coordination among units within the agency as evidenced by in-depth interviews. Extended lead times, especially, for items sourced from foreign suppliers can lead to prolonged stock out, emergency supply, increased logistics costs, and customer dissatisfaction.[41] Findings from the in-depth interview showed that extended time taken to get pre-import permit has also contributed to the delays. The finding suggests the need to develop a system of communication and coordination in between directorates as well as with the national drug regulatory authority. Moreover, the delayed delivers might be attributed to lack of enough professionals having specialized training on sourcing and supply chain management. The findings imply the need to strengthen long term capacity building programs to equip professionals in the agency with adequate knowledge and skill.

Procurement by public bodies should apply the principles of sound procurement practices, like competitive tender process.[42] In the present study, EPSA purchased majority of the program commodities from international and national vendors through a competitive bidding except for some products and emergency purchases. The finding is comparable to the reports from South Africa where procurements proceed through open tender except for emergency cases.[43] The in-depth interview participants, however, reported the need for public procurement manual that considers special features of pharmaceutical purchases and emergency needs. Therefore, further initiatives should be made to develop a procurement manual tailored for pharmaceutical purchase.

The current study has limitations. Lack of similar study for comparisons is a challenge for this study

Conclusions

In general, EPSA had both strong and weak sides regarding the procurement practices of program commodities. The selection procedure was encouraging as it depended on the national and WHO guidelines. The average price charged for the commodities was optimal and cost-saving. However, issues like forecast errors and the average procurement lead time require substantial improvements.

Appendix A

Forecast error of program commodities at the central EPSA for items procured in 2018/19 budget year

Lists of Products	Forecasted quantity (A)	Actual consumption(B)	Absolute value of forecast difference/ A-B/	Percentage of forecast error
HIV-AIDS drugs				
ABC 300 mg tab	41 279	33 781	7498	22.2
Atazinavir/r300 mg + 100 mg tab	165 050	117 130	47 920	40.9
Efavirenze 200 mg capsule	23 548	30 848	7300	23.7
Efavirence 50 mg capsule	84 897	59 184	25 713	43.5
Efavirence 600 mg tab	601 966	805 893	203 927	25.3
Lamivudine (3 TC) 150 mg tab	70 239	47 093	23 146	49.2
3 TC +EFV + TDF (300 + 600 + 300)mg tab*	3683641	3193578	490 063	15.3
3 TC + NVP + AZT (150 + 200 + 300)mg tab*	794 864	1361341	566 477	41.6
3 TC + NVP + AZT (30 + 50 + 60)mg tab*	279 603	281 272	1669	0.6
3 TC + TDF (300 mg + 300 mg) tablet	675 676	696 869	21 193	3.0
3 TC + AZT (150 + 300)mg tablet*	677 856	854 037	176 181	20.6
3 TC + AZT (30 + 60)mg tab	95 945	161 106	65 161	40.5
3 TC + ABC (30 + 60)mg tab	74 324	57 175	17 149	30.0
LPV + RTV (100 + 25)mg tab	5712	4224	1488	35.2
LPV + RTV (200 + 50)mg tab	28 553	59 125	30 572	51.7
NVP 10 mg/mL, 20 mL oral suspension*	64 746	198 880	134 134	67.4
NVP 200 mg tablet	593 323	828 962	235 639	28.4
Anti-malarial drugs				
Artemether + lumefantrine - (20 mg+120 mg) tablet (6x1)	6622	34 627	−28005	80.9
Artemether + lumefantrine (20 +120)mg 6x2 tablet	7510	50 403	−42893	85.1
Artemether + lumefantrine - (20 mg+120 mg) tablet (6x3)	3907	11 936	−8029	67.3
Artemether + lumefantrine - (20 mg+120 mg) tablet (6x4)	75 953	55 787	20 166	36.2
Artesunate - 60 mg – vial – injection	176 289	129 076	47 213	36.6
Chloroquine phosphate - 50 mg – syrup	121 098	85 053	36 045	42.4
Primaquine 7.5 mg tablet	96 109	93 010	3099	3.3
Chloroquine phosphate - 150 mg – tablet	68 235	70 238	2003	2.9
Quinine sulfate −300 mg – tablet	29 081	31 234	2153	6.9
Rapid diagnostic test (Malaria AGPF/PV)	229 186	257 645	28 459	11.1
MCH drugs				
Condom male latex - 180mmx53 mm	28046947	24305280	3741667	15.4
Condoms (Female)	12 754	10 854	1900	17.5
Etonogestrel - -68 mg capsule	1205457	1022324	183 133	17.9
IUCD(Intrauterine contraceptive device) - long acting	495 580	380 448	115 132	30.3
Levonorgestrel - 75 mg/rod of 2rods – implant rods (sub dermal) with sterile insertion trocar	338 980	393 384	54 404	13.8
Levonorgestrel (D-Norgestrel) - .03 mg tablet	281 912	438 792	156 880	35.8
Levonorgestrel (D-Norgestrel) - .75 mg tablet	389 420	424 122	34 702	8.2
Levonorgestrel (D-Norgestrel) + ethinylestradiol + ferrous fumerate - (.15 mg + .03 mg + 75 mg) – Tablet	1848974	2171040	−322066	14.8
Medroxyprogesterone acetate - 150 mg/mL in 1 mL vial - Injection with 3 mL syringe (Aqueous suspension)	10171390	12960392	2789002	21.5
Mifepristone + misoprostol - (200 mg (1tablet) + 200mcg (4 tablets)) – tablet	4290000	3300000	990 000	30.0
Misoprostol - 200mcg – tablet	1861776	1117548	744 228	66.6
Misoprostol 25mcg tablet	36 864	35 700	1164	3.3

(continued)

(continued)

Lists of Products	Forecasted quantity (A)	Actual consumption(B)	Absolute value of forecast difference/ A-B/	Percentage of forecast error
Anti-TB drugs				
Isoniazid - (INH) 300 mg – tab	98 645	71 507	27 138	38.0
RHZE (150 mg+75 mg+400 mg+275 mg) of 6x28 tablets + (150 mg + 75 mg) of 12x28 tablets – tablet	120 677	139 203	18 526	13.3
Pyridoxine HCL - 25 mg – tablet	354 089	289 444	64 645	22.3
Ethambutol - 400 mg – tablet	224	286	62	21.7
Ethambutol - 100 mg – tablet	29 337	33 882	4545	13.4
Isoniazid - 100 mg –tablet	82 645	77 488	5157	6.7
RH - (75 mg + 50 mg) – tablet	69 773	90 765	20 992	23.1
RHZ -(75 mg + 50 mg + 150 mg) – tablet	34 530	34 044	486	1.4
Amino salicylic acid delayed - release granules, 4gms – solution	1492	1050	442	42.1
Amoxicillin + clavulanic acid - (500 mg +125 mg) – tablet (film coated)	15 606	11 528	4078	35.4
Capreomycin - 1g in vial – powder for injection	154 710	126 107	28 603	22.7
Cycloserine - 250mg – capsule	14 180	25 178	10 998	43.7
Kanamycin sulfate - 1gm/4 mL – injection	3361	4634	1273	27.5
Levofloxacin - 250 mg – tablet	15 241	13 640	1601	11.8
Moxifloxacin-400mg – tablet	1278	788	490	62.2
Prothionamide - 250 mg – tablet	15 011	9767	5244	53.7
Pyrazinamide - 400g – tablet	3167	5766	2599	45.1
Bedaquiline - 100mg –tablet	259	174	85	48.9
Linezolid - 600mg – tablet	5480	4658	822	17.7
Clofazimine - 100mg – tablet	4	6	2	33.3
Clofazimine - 50mg – tablet	819	732	87	11.9
Delamanid - 50 mg – tablet	42	50	8	16.0
Auramine - O 50 mg	4222	4209	13	0.3
Auramine - O - 1000 mg	42	51	9	17.7
Basic fuchsine – crystal 25gm	500	450	50	11.1
Ethanol - 96% RL 1000 mL	5257	5809	552	9.5
Hydrochloric Acid - concentrated 37%	146	199	53	26.6
Immersion oil 100 mL	1100	1411	311	22.0
Methylene Blue - powder 25g	194	315	121	38.4
Phenol – crystal 500 mg	1679	2007	328	16.3
Phenol – crystal 1000 mg	180	174	4	3.5
Mean percentage forecast error 27.8%				

* = products purchased by emergency procurement.

Appendix B

International price paid reference of program commodities at the central EPSA for items procured in 2018/19 budget year.

Lists of products	EPSA Price paid (in $)	International price ($)	Ratio of international price reference
HIV-AIDS Drugs			
ABC 300 mg tab	.134	.29	.462
Atazinavir/r300 mg + 100 mg tab	.468	.904	.518
Efavirenze 200 mg capsule	.035	.0457	.766
Efavirence 50 mg capsule	.0357	.0442	.808
Efavirence 600 mg tab	.0987	.1333	.59
Lamivudine (3 TC) 150 mg tab	.023	.0274	.839
3TC +EFV + TDF (300 + 600 + 300)mg tab*	.201	.326	.617
3TC + NVP + AZT (150 + 200 + 300)mg tab*	.1035	.1442	.718
3TC + NVP + AZT (30 + 50 + 60)mg tab*	.0597	.0643	.928
3TC + TDF (300 mg + 300 mg) tab	.1047	.1573	.666
3TC + AZT (150 + 300)mg tab	.076	.1208	.629
3TC + AZT (30 + 60)mg tab	.0243	.0348	.698
3TC + ABC (30 + 60)mg tab	.0485	.0711	.682
LPV + RTV (100 + 25)mg tab	.1189	.073	1.629
LPV + RTV (200 + 50)mg tab	.1235	.203	.608
NVP 10 mg/mL oral suspension	.0132	.013	1.015
NVP 200 mg tab	.0268	.0583	.46
Anti-malarial drugs			
Artemether + lumefantrine – (20 mg+120 mg) tablet (6x1)	2.43	.4982	4.878
Artemether + lumefantrine (20 +120)mg 6x2 tablet	.602	1.1419	.527
Artemether + lumefantrine – (20 mg+120 mg) tablet (6x3)	.729	1.2303	.593
Artemether + lumefantrine – (20 mg+120 mg) tablet (6x4)	1.031	1.4862	.694
Artesunate - 60 mg – vial – injection	1.26	1.91	.66
Chloroquine phosphate – 50 mg – syrup	.0162	.0208	.779
primaquine 7.5 mg tablet	.0263	.0228	1.154
Chloroquine Phosphate - 150 mg – tablet	.00614	.027	.227
Quinine Sulfate - 300 mg – tablet	.044	.0591	.745
Rapid diagnostic test (Malaria AGPF/PV)	.2932	.6085	.482
Condom male latex - 180mmx53 mm	.03	.0335	.896
Condoms (Female)	.831	.8412	.988
Etonogestrel - 68 mg – capsule	2.74	9.415	.291
IUCD(intrauterine contraceptive device) – long acting	.29	7.2999	.04
Levonorgestrel - 75 mg/rod of 2rods – implant rods (sub dermal) with sterile insertion trocar	7.43	5.55	1.323
Levonorgestrel (D-Norgestrel) – .03 mg tablet	.7356	.5667	1.298
Levonorgestrel (D-Norgestrel) – .75 m	.203	.225	.902
Levonorgestrel (D-Norgestrel) + Eehinylestradiol + ferrous fumerate – (.15 mg + .03 mg +75 mg) – tablet	0.3	1.198	.25
Medroxyprogesterone acetate - 150 mg/mL in 1 mL vial – injection with 3 mL syringe (aqueous suspension)	.41	.5824	.704
Mifepristone + misoprostol – (200 mg (1Tablet) + 200mcg (4 tablets)) – tablet	2.862	1.53	1.871
Misoprostol - 200mcg – tablet	.0125	0.2	.063
Misoprostol - 25mcg – tablet	.342	.325	1.052

(continued)

(continued)

Lists of products	EPSA Price paid (in $)	International price ($)	Ratio of international price reference
HIV-AIDS Drugs			
ABC 300 mg tab	.134	.29	.462
Anti TB drugs			
Isoniazid - (INH) 300 mg – tablet	.0175	.0429	.408
RHZE (150 mg +75 mg + 400 mg + 275 mg) of 6x28 tablets + (150 mg + 75 mg) of 12x28 tablets – tablet	.031	.0693	.447
Pyridoxine HCL - 25 mg – tablet	.031	.0081	3.827
Ethambutol - 400 mg – tablet	.1578	.0402	3.925
Ethambutol - 100 mg – tablet	.0293	.0886	.331
Isoniazid - 100 mg –tablet	.0084	.0182	.462
RH - (75 mg+50 mg) – tablet	.014	.0331	.423
RHZ - (75 mg+50 mg+150 mg) – tablet	.0188	.0233	.807
Amino salicylic acid delayed – release granules, 4gms – solution	1.1748	2.5996	.452
Amoxicillin + clavulanic Acid – (500 mg + 125 mg) – tablet (film coated)	.135	.117	1.154
Capreomycin - 1g in vial – powder for injection	4.47	5.3293	.839
Cycloserine - 250mg – capsule	.3742	.4238	.883
Kanamycin sulfate - 1gm/4 mL – injection	2.139	1.0589	2.02
Levofloxacin - 250 mg – tablet	.467	.1395	3.348
Moxifloxacin - 400mg – tablet	1.622	1.7562	.924
Prothionamide - 250 mg – tablet	.1326	.1775	.747
Pyrazinamide - 400g – tablet	.0169	.0251	.673
Bedaquiline - 100mg – tablet	9.125	15.957	.615
Linezolid - 600mg – tablet	6.873	5.48	1.254
Clofazimine - 100mg – tablet	.0777	1.2672	.062
Clofazimine - 50mg – tablet	.04329	.15	.289
Delamanid - 50 mg – tablet	6.61	.165	1.092
Auramine - O 50 mg	1.99	.999	1.991
Auramine - O 1000 mg	2.03	8.896	.228
Basic fuchsine – crystal 25gm	1.911	1.94	.985
Ethanol – 96% RL 1000 mL	2.94	.0022	1.131
Hydrochloric acid – concentrated 37%	1.99	8.896	.224
Immersion oil 100 mL	1.1	1.2	.913
Methylene Blue – powder 25g	1.74	.558	3.12
Phenol – crystal 500 mg	5.23	2.12	2.466
Phenol – crystal 1000 mg	9.02	16.26	.555
Mean of ratio of international reference prices			**.995**

Appendix C

EPSA's suppliers lead time for program commodities for items procured in 2018/19 budget year

No of deliveries	Suppliers lead time (days)	Supplier lead-time variability (%)
1	107	15.89
2	125	28
3	52	38
4	134	32.84

(continued)

(continued)

No of deliveries	Suppliers lead time (days)	Supplier lead-time variability (%)
5	66	36.36
6	69	30.43
7	266	66.16
8	266	66.16
9	78	15.38
10	88	2.27
11	100	10
12	208	56.73
13	93	3.22
14	284	68.31
15	82	9.76
16	191	52.88
17	95	5.26
18	225	60
19	127	29.1
20	131	31.3
21	58	55.2
22	294	69.4
23	71	26.8
24	76	18.4
25	105	14.3
26	153	41.2
27	153	41.2
28	88	2.3
29	88	2.3
30	256	64.8
31	73	23.3
32	94	4.3
33	150	40.0
34	149	39.6
35	208	56.7
36	141	36.2
Average suppliers lead time 137.3days		
Average % suppliers lead time variability 33.3%		
Commodities purchased by emergency 17 (24.3%)		

Appendix D

Lists of program drugs procured in 2018/19 budget year and their categorization at the central EPSA

Lists of drugs	Basic units
HIV/AIDS drugs	
Abacavir (ABC) - 300 mg – tablet	60
Atazanavir (ATV) + ritonavir (RTV) - (300 mg + 100 mg) – tablet	30
Efavirenz (EFV) - 200 mg – capsule	90
Efavirenz (EFV) - 50 mg – capsule	30
Efavirenz (EFV) - 600 mg – tablet	30
Lamivudine (3 TC) - 150 mg – tablet	60

(continued)

(continued)

Lists of drugs	Basic units
Lamivudine (3 TC) + efavirenz (EFV) +tenofovir (TDF) - (300 mg 600 mg+300 mg) – tablet	30
Lamivudine (3 TC) + nevirapine (NVP) + zidovudine (AZT) - (150 mg + 200 mg + 300 mg) – tablet	60
Lamivudine (3 TC) + nevirapine (NVP) + zidovudine (AZT) - (30 mg + 50 mg + 60 mg) – tablet	60
Lamivudine (3 TC) + tenofovir (TDF) - (300 mg + 300 mg) – tablet	30
Lamivudine (3 TC) + zidovudine (AZT) - 150 mg+300 mg) – tablet	60
Lamivudine (3 TC) + zidovudine (AZT) - (30 mg + 60 mg) – tablet	60
Abacavir (ABC) + lamivudine (3 TC) - (60 mg + 30 mg) – tablet	60
Lopinavir + ritonavir - (100 mg + 25 mg) – tablet	120
Lopinavir + ritonavir - (200 mg + 50 mg) – tablet	120
Nevirapine - 10 mg/1 mL – oral suspension	100 mL
Nevirapine - 200 mg – Tablet	60
Anti-malaria drugs	
Artemether + lumefantrine - (20 mg+120 mg) tablet (6x1)	30
Artemether + lumefantrine (20 +120)mg 6x2 tablet	30
Artemether + lumefantrine - (20 mg+120 mg) tablet (6x3)	30
Artemether + lumefantrine - (20 mg+120 mg) tablet (6x4)	30
Artesunate - 60 mg – vial – injection	Vial
Chloroquine phosphate - 50 mg – syrup	60 mL
Primaquine 7.5 mg tablet	1000
Chloroquine phosphate - 150 mg – tablet	100x10
Quinine sulfate - 300 mg – tablet	10*10
Rapid diagnostic test (Malaria AGPF/PV)	25
MCH drugs	
Condom male latex - 180mmx53 mm	Piece
Condoms (Female)	Piece
Etonogestrel – 68 mg – capsule	Each
IUCD(intrauterine contraceptive device) - long acting	Each
Levonorgestrel - 75 mg/rod of 2rods – implant rods (sub dermal) with sterile insertion trocar	Each
Levonorgestrel (D-Norgestrel) - .03 mg tablet	Cycle
Levonorgestrel (D-Norgestrel) - .75 mg – ablet	Cycle
Levonorgestrel (D-Norgestrel) + ethinylestradiol + ferrous fumerate - (.15 mg + .03 mg +75 mg) – tablet	Cycle
Medroxyprogesterone acetate - 150 mg/mL in 1 mL vial – injection with 3 mL syringe (Aqueous suspension)	Vial
Mifepristone + misoprostol - (200 mg (1 tablet) + 200mcg (4 tablets)) – tablet	20
Misoprostol - 200mcg – tablet	28
Misoprostol - 25mcg – tablet	4
Anti- TB drugs	
Isoniazid - (INH) 300 mg – tablet	24x28
Rifampicin + isoniazid + pyrazinamide + ethambutol) + RH (rifampicin + isoniazide (RHZE) (150 mg + 75 mg + 400 mg +275 mg) of 6x28 tablets + (150 mg + 75 mg) of 12x28 tablets – tablet	Kit
Pyridoxine HCL - 25 mg – tablet	100
Ethambutol - 400 mg – tablet	10x10
Ethambutol - 100 mg – tablet	10x10
Isoniazid - (INH) 100 mg – tablet	10x10
RH (rifampicin + isoniazid) - (75 mg+50 mg) – tablet	28 x 3
RHZ (Rifampicin + isoniazid + pyrazinamide) - (75 mg + 50 mg + 150 mg) – tablet	28 x 3
Amino salicylic acid delayed - release granules, 4gms – solution	25
Amoxicillin + clavulanic acid - (500 mg + 125 mg) – tablet (film coated)	2 x10
Capreomycin - 1g in vial - powder for injection	vial
Cycloserine-250mg-capsule	100
Kanamycin Sulfate - 1gm/4 mL – injection	10
Levofloxacin - 250 mg – tablet	100
Moxifloxacin - 400mg – tablet	5

(continued)

(continued)

Lists of drugs	Basic units
Prothionamide - 250 mg – tablet	100
Pyrazinamide - 400g – tablet	24x28
Bedaquiline - 100mg – tablet	188
Linezolid - 600mg – tablet	10x10
Clofazimine tablet	1000
Clofazimine tablet	500
Delamanid - 50 mg – tablet	672
Auramine - O	50gm
Auramine - O	100gm
Basic fuchsine – crystal 25gm	25gm
Ethanol - 96% RL 1000 mL	1000 mL
Hydrochloric Acid - concentrated 37%	1 L
Immersion oil 100 mL	100 mL
Methylene Blue – powder 25g	25gm
Phenol – crystal 500 mg	500 mg
Phenol – crystal 1000 mg	1000 mg

Acknowledgments

We thank Jimma University for creating this opportunity. We extend our heartfelt gratitude to our data collectors, study participants, and central Ethiopian Pharmaceuticals Supply Agency for their cooperation.

Authors' contributions

BB participated in the designing of the study, reviewed articles, involved in the data collection process, analyzed data, interpreted data, participated in the sequence alignment and communicated for publication. TM involved in data analysis, interpretation, and drafting of the manuscript. TG participated in the design of the study, reviewed articles, involved in the data collection process, analyzed data, interpreted data, participated in the sequence alignment and drafted the manuscript. All authors read and approved the final manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Jimma University has covered the stationery and data collection costs only

Ethical Approval

thical clearance has been received from the Institutional Review Board of Jimma University (IRB) (Ref.no.IHRPGD/607/2020) on 17 April 2020). Then letters of permission were received from the EPSA. Throughout the data collection, professional and social principles were preserved.

Informed consent

An oral consent was also received from the respondents to ascertain the willingness of the participants.

Data Availability

The data sets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

ORCID iD

Bekele Boche https://orcid.org/0000-0002-9218-9669

Supplemental Material

Supplemental material for this article is available online.

References

1. USAID | DELIVER PROJECT. *The Logistics Handbook: A Practical Guide for the Supply Chain Management of Health Commodities*. Arlington, Va: USAID | DELIVER PROJECT, Task Order 1; 2011. Available from: http://deliver.jsi.com/dlvr_content/resources/allpubs/guidelines/LogiHand.pdf. Accessed on 5 Jan.2020.
2. Rao R, Peter M, David S. *Procurement Strategies for Health Commodities: An Examination of Options and Mechanisms within the Commodity Security Context*. Arlington, Va: DELIVER, for the U.S. Agency for International Development; 2006.
3. World Health Organization. *Essential Medicines and Health Products Information Portal*. World Health Organization; 2015. Available from https://www.who.int/medicines/services/essmedicines_def/en/. Accessed on 27 Jul.2020.

4. USAID DELIVER Project. *Guidelines for Managing the Malaria Supply Chain A Companion to the Logistics Handbook*. Arlington VA; 2011. Available from https://www.psmtoolbox.org/wp-content/uploads/2017/11/GuidManaMalariaSC.pdf. Accessed on 5 Jan.2020.
5. Management Sciences for Health. *MDS-3: Managing Access to Medicines and Health Technologies*. Arlington, VA: Management Sciences for Health; 2012.
6. Merkuryeva G, Valberga A, Smirnov A. Demand forecasting in pharmaceutical supply chains: A case study. *Procedia Comput Sci*. 2019;149(1):3-10.
7. USAID | DELIVER PROJECT. *Addressing Procurement Bottlenecks; A Review of Procurement Bottlenecks in Public Sector Medicine Supply Chains and Practical Approaches Taken to Resolve Them*. Arlington VA; 2013. Available from https://toolkits.knowledgesuccess.org/sites/default/files/addrprocbottl.pdf. Accessed on 04 Jan.2020.
8. World Health Organization. *The World Medicines Situation 2011; Access to Essential Medicines as Part of the Right to Health*. Geneva, Switzerland: World Health Organization; 2011. Available from http://digicollection.org/hss/documents/s18772en/s18772en.pdf. Accessed on 22 Jan.2020.
9. Ngetich DT. *Outsourcing and Supply Chain Performance of Kenya Medical Supplies Agency*. University of Nairobi; 2014. Available from http://erepository.uonbi.ac.ke/bitstream/handle/11295/77304/Ngetich_Outsourcing and supply chain performance of Kenya medical supplies agency.pdf?sequence=3&isAllowed=y. Accessed on 30 Jul.2020.
10. Printz N, Amenyah J, Serumaga B, Van Wyk D, Usaid D. *Tanzania: Strategic Review of the National Supply Chain for Health Commodities*. Dar es Salaam; 2013. Available from http://deliver.jsi.com/dlvr_content/resources/allpubs/countryreports/TZ_StraRevi_SC.pdf%5Cnfile:///C:/Users/GHFP/Documents/Realist Review/Original Docs/Eval Assessment Docs/TZ_StraRevi_SC.pdf. Accessed on 05 Feb.2020.
11. Vitoria M, Granich R, Gilks CF, Gunneberg C, Hosseini M, Were W, et al.. The global fight against HIV/AIDS, tuberculosis, and malaria: Current status and future perspectives. *Am J Clin Pathol*. 2009;131(6):844-848.
12. Zakiyah N, Van Asselt ADI, Roijmans F, Postma MJ. Economic evaluation of family planning interventions in low and middle-income countries; A systematic review. *PLoS One*. 2016;11(12):1-19.
13. Reich MR. *Expanding Global Access to ARVs: The Challenges of Prices and Patents*. New YorkNew York: Academic Press; 2004. Available from: https://cdn1.sph.harvard.edu/wp-content/uploads/sites/480/2013/01/Reich_Bery_AIDS_drugs.pdf. Accessed on 9 Feb.2020.
14. *USAID from the American People. USAID's Maternal and Child Health Programs*. 2018 [cited 2020 Jul 28]. Available from: https://www.usaid.gov/global-health/health-areas/maternal-and-child-health. Accessed on 28 Jul.2020
15. United Nations. *UN Commission on Life-Saving Commodities for Women and Children: Commissioners' Report 2012*. New York; 2012. Available from https://www.unicef.org/media/files/UN_Commission_Report_September_2012_Final.pdf. Accessed on 05 Jan. 2020.
16. Global Fund. *The Office of the Inspector General 2017 Annual Report*. Geneva, Switzerland; 2018. Available from https://www.theglobalfund.org/media/7401/bm39_08-oigannualreport2017_report_en.pdf?u=636784019960000000. Accessed on 28 Jan.2020.
17. Global Fund. *The Global Fund; Results Report 2019*. Geneva, Switzerland; 2019. Available from https://www.theglobalfund.org/media/8752/corporate_2019resultsreport_report_en.pdf. Accessed on 03 Aug.2020.
18. United nations. *Global Strategy for Women's and Children's Health*. New York: United Nations; 2010. Available from https://www.unfpa.org/sites/default/files/pub-pdf/Final UN Commission Report_14sept2012.pdf. Accessed on 15 March 2020.
19. Droti B, O'Neill KP, Mathai M, Yao Tsidi Dovlo D, Robertson J. Poor availability of essential medicines for women and children threatens progress towards Sustainable Development Goal 3 in Africa. *BMJ Glob Heal*. 2019;4(9):e001306.
20. https://www.worldometers.info/world-population/ethiopia-population/ Accessed on, January, 2022
21. Nega M. *Assessment of Challenges of Pharmaceutical Supply Chain in Public Hospital and Health Center in Addis Ababa, Ethiopia*; 2017. Available from http://etd.aau.edu.et/bitstream/handle/123456789/13353/Mekuwanint%20Nega%20Fiseha.pdf?sequence=1&isAllowed=y. Accessed on Jan. 2020.
22. Ethiopia Pharmaceutical Supply Agency.Ethiopia. *National Survey of the Integrated Pharmaceutical Logistics System: AIDS*: Free, and Pharmaceutical Supply Agency (EPSA); 2019
23. Kefale AT, Shebo HH. Availability of essential medicines and pharmaceutical inventory management practice at health centers of Adama town, Ethiopia. *BMC Health Serv Res*. 2019;19:254.
24. Desale A, Taye B, Belay G, et al. Assessment of laboratory logistics management information system practice for HIV/AIDS and tuberculosis laboratory commodities in selected public health facilities in Addis Ababa, Ethiopia. *Pan Afr:Med.J*. 2013; 15:46.
25. Gurmu TG, Ibrahim AJ. Inventory management performance of key essential medicines inhealth facilities of East Shewa Zone, Oromia Regional State, Ethiopia. *Cukurova Medical Journal*. 2017;42(2):277. doi:10.17826/cutf.322908.
26. Logistics management information system performance for program drugs in public health facilities of East Wollega Zone, Oromia regional state, Ethiopia.*BMC Med.Info.and Decis. Mak* 2018; 18:133
27. EPSA Ethiopian. *Pharmaceuticals Supply Agency Historical Background*. Ethiopian Pharmaceuticals Supply Agency; 2020. Available from: https://epsa.gov.et/about-us-2/. Accessed on 26 May 2020. https://www.researchgate.net/profile/Fantaye_Teka/publication/335207169_Ethiopia_National_Survey_on_the_Integrated_Pharmaceutical_Logistics_System_IPLS/links/5d56b1dca6fdccb7dc40be0b/Ethiopia-National-Survey-on-the-Integrated-Pharmaceutical-Logistics-System-IPLS.pdf. Accessed on Dec.2020.

28. EPSA. Pharmaceuticals. Procurement List. Addis Ababa, Ethiopia. 2018. Available from. https://www.ghsupplychain.org/sites/default/files/2019-07/PFSA_s Pharmaceuticals List.pdf https://www.ghsupplychain.org/sites/default/files/2019-07/PFSA_s Pharmaceuticals List.pdf Accessed on 01 Jan. 2020
29. USAID | DELIVER PROJECT. *Logistics Indicator Assessment Tool (LIAT)*. Arlington, VaArlington VA: USAID | DELIVER PROJECT, Task Order 1; 2005. Available from: https://pdf.usaid.gov/pdf_docs/Pnade735.pdf Accessed on 13 Dec.2020.
30. OECD. Methodology. *For Assessing Procurement Systems*; 2016. Available from https://www.oecd.org/gov/public-procurement/Methodology-Assessment-Procurement-System-Revised-Draft-July-2016.pdf. Accessed on 03 Feb.2020.
31. *USAID | DELIVER PROJECT. Logistics System Assessment Tool (LSAT)*. Arlington, Va.: USAID | DELIVER PROJECT, Task Order 1. Arlington VA; 2009. Available from: http://iaphl.org/wp-content/uploads/2016/05/Logistics-system-assessment-tool.pdf. Accessed on 13 Dec.2020.
32. Ethiopian Pharmaceuticals Supply Agency. *Standard Operating Procedures (SOP) Manual for the Integrated Pharmaceuticals Logistics System*; 2014.
33. World Health Organization. *Promoting the Rational Use of Medicines: Core componentsWHO Policy Perspectives on Medicines*; 2002. Available from http://archives.who.int/tbs/rational/h3011e.pdf. Accessed on 23 Sep.2020.
34. Akhlaghi L, Mwencha M, Printz N. *Strengthening HIV/AIDS Commodity Forecasting Factors and Considerations for Increasing Accuracy*; 2011. Available from https://publications.jsi.com/JSIInternet/Inc/Common/_download_pub.cfm?id=17498&lid=3. Accessed on 20 Jul.2020.
35. Federal Ministry of Health. *National Pharmacy Service, Pharmaceuticals Supply Chain, and Medical Device Management Monitoring and Evaluation Framework*. Addis Ababa; 2019. Available from http://repository.iifphc.org/bitstream/handle/123456789/526/National%20Pharmacy%20Service%2c%20Pharmaceuticals%20Supply%20Cain%20and%20Media%20Equipment%20Managment%20Monitering%20and%20Evaluation%20Framework.pdf?seqence=1& isAllowed=y. Accessed on 12 Jun.2020.
36. USAID| *DELIVER PROJECT. Health Logistics in Tanzania: Timeline of Accomplishments for Supply Chain Interventions*. Arlington VA; 2016. Available from: https://www.jsi.com/JSIInternet/Inc/Common/_download_pub.cfm?id=17395&lid=3. Accessed on 08 Mar.2020
37. NforE ML, GbaguidiA LM, ConesaS. *Benin National Supply Chain Assessment*. Arlington, VA: Management Sciences for Health; 2016.
38. Health Action International. *Report Prices & Availability of Locally Produced & Imported Medicines in Kenya Survey Report July 2018 Report Prices & Availability of Locally Produced & Imported*. Amsterdam, Netherlands; 2018. Available from: https://haiweb.org/wp-content/uploads/2018/07/Locally-Produced-and-Imported-Medicines-in-Kenya.pdf. Accessed on 03Aug.2020
39. Aronovich D, Marie T, Collins E, Sommerlatte A, Allain L. *Measuring Supply Chain Performance: Guide to Key Performance Indicators for Public Health Managers*. Arlington, Va: U.S. Agency for International Development.USAID | DELIVER PROJECT, Task Order 1; 2010. Available from: https://www.ghsupplychain.org/sites/default/files/2017-03/Measuring SC Perf.pdf. Accessed on 24 Oct. 2020.
40. FMOH. *Health Sector Development Program IV Final draft.2010/11 – 2014/15*. Addis Ababa; 2014. Available from: https://phe-ethiopia.org/admin/uploads/attachment-721-HSDP IV Final Draft 11Octoberr 2010.pdf. Accessed on 27 Jan. 2020.
41. World Health Organization. *Local Production for Access to Medical Products: Developing a Framework to Improve Public Health*. Geneva, Switzerland; 2011. Available from https://www.who.int/phi/publications/Local_Production_Policy_Framework.pdf?ua=1. Accessed on 02 Feb.2020.
42. Ministry of Finance and Economic Development. *Public Procurement Manual. Proclamation No. 649/2009 Ethiopia*; 2011:249.
43. Berger J, Hofmeester N, Makhadho M, Miot J, Moller H, Pharasi B, et al.. *Challenges and Opportunities for Improvement of Medicines Procurement in South Africa's Public Sector – March 2010*. Pretoria; 2010. Available from http://ipasa.co.za/Downloads/Policy and Reports - Medicines/procurement/Medicines Procurement Task Team Report- Final 29 04 2010.pdf. Accessed on 25 Jan.2020.