UNIVERSITY OF RWANDA

ASSESSING ANTIRETROVIRAL INVENTORY MANAGEMENT DATA
QUALITY BY ADOPTING POTENTIAL DIGITAL SOLUTIONS CASE STUDY
OF ART CLINICS IN WESTERN EQUATORIA STATE, SOUTH SUDAN

By

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A Dissertation submitted to the University of Rwanda in the partial fulfilment of the requirements for the award of the degree of Master of Health Supply Chain Management

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Thesis Title ASSESSING ANTIRETROVIRAL INVENTORY MANAGEMENT DATA QUALITY BY ADOPTING POTENTIAL DIGITAL SOLUTIONS CASE STUDY OF ART CLINICS IN WESTERN EQUATORIA STATE, SOUTH SUDAN

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December 2021

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This proposal has been submitted for evaluation and examination with our approval as University Supervisors.

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ABSTRACT

Background, the human immunodeficiency virus (HIV) response in South Sudan has been to the country's situation, which is indicated as recovering from devastating civil conflicts. The People Living with the human immunodeficiency virus (PLHIV) who are on antiretroviral drugs, will need access to quality drugs to improve their health and prolong their lives, sustainable access to drugs depends on available inventory data quality. **This research aims** to examine the quality of inventory management data in antiretroviral treatment Clinics in the context of South Sudan with a particular focus on Western Equatoria health facilities**. Methodology: T**his research study adopted a descriptive cross-sectional design, it's descriptive because it is looking at challenges faced by the inventory management process, the approach was a mixed-method, qualitative and quantitative. 20 antiretroviral therapy (ART) Clinics in Western Equatoria State were the target for this study. **Findings:** the demographic analysis was employed and most of the respondents were male which constituted 75% of response opinion, it was also observed that most of the interviewed were those with good experiences in providing services to people living with HIV 10 years of services delivery. To measure data quality six items were developed in table 4:11 and their grand mean showed that most of the respondents agree with the accuracy, completeness, consistency, relevancy, validity, and genuineness of consumption data at ART clinics in WES. And in search for factors that affect inventory management, infrastructures took the leading amongst the respondents as the essential challenge followed by the capacity of Human resources at public facilities and tools for managing data came among the challenges   **Conclusion:** Conclusively, the findings traced out the satisfaction of data quality in Western Equatoria ART clinic according to respondents who had opportunities to participate in this finding. Based on the views of the majority, the Antiretroviral therapy units used to compile accurate, consistent, relevant, valid, and complete data of its inventory and clinical services. **Recommendations:** The ART clinic should employ competent and potential employees who have acquired sufficient knowledge and skills to rendered effective services to the patients in the clinic. And based on the information, The MOH lacks a national Logistics Management information system for collecting real-time data on the

Approved on 18 February 2014

distribution and consumption of health commodities for timely decision-making to guide commodities management at the national and sub-national levels. The ongoing challenges resulted in the existence of fragmented logistics information systems being used to track the distribution of commodities at the national and sub-national levels by implementing partners. This study is recommending the Ministry of health and particularly the directorate of pharmaceutical services who is the custodian consumptions commodities data should go for the deployment of the DHIS2 Logistics module and engaged implementing partners to start using it.

Keywords: *HIV, AIDS, Antiretroviral therapy, public health priority, public health information system.*

Dedication

The fruits of this research are dedicated to the soul of my beloved Father Late, Ocay Amykeui, my wife, and my Kids for their moral support.

Acknowledgment

Foremost, I would like to express my sincere gratitude to my advisors Prof. Shiferaw and DR. Kashi for their continuous support, which help me finish this work.

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Approved on 18 February 2014

Table of contents

Approved on 18 February 2014

Approved on 18 February 2014

Approved on 18 February 2014

List of Tables

Approved on 18 February 2014

Abbreviation and acronyms

HIV: Human immunodeficiency virus

AIDS: Acquired Immune Deficiency Syndrome

MOH: Ministry of Health

CD4:   Cluster of Differentiation 4 (is a glycoprotein found on the surface of the cell, T cell)

ARV: Antiretroviral Drug

ART: Antiretroviral Therapy

UNDP: UNITED NATION DEVELOPMENT PROGRAM

LMIS: Logistic management Information System

HIS: Health Information System

EDT: Electronic Dispensing Tool

FESC: Facility Electronic Stock Card

mSupply: pharmaceutical supply chain software created by Sustainable Solutions

CHAPTER ONE
INTRODUCTION

1.1. Background of the study

Human immunodeficiency virus(HIV) and acquired immunodeficiency syndrome, (AIDS) are still a public health priority in the Republic of South Sudan with a prevalence of 2.5% among adults aged 15- 45 years (1). The country has made some achievements with 24% of the estimated 200,000 people living with HIV knowing their status, and from which 67% of those who know their status are initiated on lifesaving antiretroviral therapy. The HIV response in South Sudan has been to the country's situation, which is indicated as recovering from devastating civil conflicts. access to life-saving antiretroviral therapy was challenging, especially in hard-to-reach resident groups including highly mobile refugees residing in neighboring countries and internally displaced populations (2). The first national guideline for use of antiretroviral drugs in South Sudan was launched in 2008, at which to start initiation CD4 was 200cell/mm3. by December 2016 there were 35 accredited antiretroviral therapy (ART) sites nationally with the number of clients receiving treatment to be 20,000 people by the end of 2016 treatment coverage was estimated to be 11 %.

The epidemic is geographically concentrated in the Equatoria States which comprise an estimate of 46% (89,891) of People living with HIV of the national estimate for 2020, HIV prevalence in these states is 5.8% in Western Equatoria, 2.3% in Central Equatoria, and 3.1% in Eastern Equatoria. (1)

The People living with HIV, who are on antiretroviral do need access to quality drugs to improve their health and prolong their lives, antiretroviral drugs need efficient and effective management of Inventory management and managing their flow is crucial to ensure uninterrupted supply, ineffective inventory management was observed in some facilities where frequent stock-out was registered due to problems with data collection and data reporting tools. (3)

Approved on 18 February 2014

This research aims to examine the quality of inventory management data in antiretroviral treatment units in Western Equatoria health facilities. (4) This study will use a descriptive cross-sectional study design to assess antiretroviral data types and data record tools and to assess factors facing inventory management activities, and to identify associated discrepancies between data recorded on the stock cards and the physical count process, as well as to identify factors contributing to poor data capturing and reporting, and also to assess the potential digital solution(5)(2).

Common problems in inventory management

Poor inventory management in public facilities always ends up in huge losses. These losses can be either financial or ARV. (6)

Poor inventory management can be an indicator of inaccurate stock records, lack of continuous stock monitoring, and lack of knowledge to forecast actual needs and maintain records, which an observed in a study conducted in Uganda. (5)

Antiretroviral supply chain system in Western Equatoria

The United Nations Development Fund (UNDP) and the Global Fund in South Sudan are the (7) custodians responsible for the purchase and delivery of ARVs to ART clinics in the country and in particular in Western Equatoria State. The ART clinics determine their needs and submit their orders to the Ministry of Health for validation and data verification, and then send them to the warehouse, where they are processed using the "mSupply" software. (8)

1:2 Problem statement

HIV is a public health priority in the Republic of South Sudan, and it is being reported that the (1) epidemic is concentrating in Equatoria states, with Western Equatoria state taking the lead in the country with a prevalence of 5.6%. Continuous efforts are being deployed to provide quality ARVs to people living with HIV. This is to suppress their viral load and improve their lives, but reports of frequent stock out (9) are still being registered, and due to weak reporting system, the flow of inaccurate information and

Approved on 18 February 2014

incorrect recording of data on stock cards, and reports of lacking simple data collection tools and delayed report submission has made the logistic decision very hard. This always results in distributing fewer quantities to the facility which will lead to a frequent shortage of ARVs. (10)

1:3 Significance of the study

This study will look at the inventory management practices at the ART clinics, determine factors affecting inventory management data quality, identify measures used for measuring data quality, and assess the potential digital solution to improve the data quality of data.

1:4 Research questions

1. How is inventory management being practiced to ensure the effectiveness of ARVs consumption data quality?
2. What are the factors affecting inventory management data quality at ART clinics in Western Equatoria?
3. How effective is the inventory management data quality in terms of accuracy, completeness, timeliness, consistency validity, and uniqueness?

1:5 OBJECTIVES

1:5:1 General objectives

To assess inventory management data quality of antiretroviral (ARVs) In Antiretroviral therapy (ART) clinics in Western Equatoria and propose a potential digital solution

1:5:2 Specific Objectives

1. To assess the inventory management practices ensuring the effectiveness of ARVs consumption data quality.
2. To determine the challenges affecting inventory management data quality of ARVS medicines in public hospitals facilities in Western Equatoria.
3. To assess the inventory management data quality in terms of accuracy, completeness, timeliness, consistency, validity, and uniqueness).

Approved on 18 February 2014

1.6. Limitation

The study is targeting a population of health professionals working in ART public facilities, although Western Equatoria state covers an area of 79,343 kilometers and it has 10 counties the study will be conducted in five counties, and findings may not give a general overview of the inventory management data quality challenges for the remaining counties and the entire South Sudan Public facilities (ART units),(1)

The study is also been conducted on ARVs inventory management in five counties, which are Yambio, Nzara, Ezo, Tambura, and Maridi therefore findings may not be generalized to inventory management of other commodities. (5)

1.7. Operational terms,
Bin card is a measure of discrepancies between the stock card and physical count.

Data quality, it's the accuracy, timeliness of logistic data

A feedback report is a type of report used by national authorities to inform lower-level facilities about their performance.

A drug dispenser is a qualified nurse or midwife that has knowledge or is authorized to give drugs to the patients

Drug dispensing registers are a ledger book used to register to giveaway drugs.

Supervision is the act or process of directing a person or group of people

1.8. Organization of the study (Thesis)

This study is composed of five chapters. The first chapter is an introduction that captures the background of the study, problem statement, research objectives, scope of the study, delimitation of the study, the significance of the study, and organization of the study. The second chapter reviews relevant literature used to help the study. The methodology of the study will be presented in the third chapter and chapter four is composed of results, discussion, and interpretation the fifth chapter of the study will present the summary,

Approved on 18 February 2014

conclusion, and recommendations as well as future research forward. Finally, references and an appendix are also presented. (4)

CHAPTER TWO
REVIEW OF RELATED LITERATURE

2.1. Theoretical Literature Review

2.1.1. Inventory management practices for the effectiveness of ARVS consumption data quality

Inventory management is the activity that organizes the availability of commodities to the customers, it also coordinates the purchasing, distribution to meet the customer's demand. (10). There is a close relationship between data provided by logistic management information system LMIS required to keep inventory control system data quality. Data gathered by LMIS will allow the product manager to know the current stock at the facility determine whether the stock is above, below, or within the estimated maximum stock levels, and know whether the facility is in a good position to place an emergency order(7). LMIS can also be used to trace consumption and to adjust national procurement as needed because it has made it easy to identify overstock of ARVs, and redistribute the product and anticipated expiries. (12)

In South Africa, there was a study about poor inventory management which was due to incorrect stock records or un-updated stock records and lack of continuous supervision, but a study conducted in Uganda and Kenya reveal that the suitable intervention was strengthening inventory management at the ART level by ensuring availability of adequate stock levels and other medical supplies. (13)

2.1.2. Challenges of Inventory management data quality of ARVs medicines

The basis for all LMIS data collected and organized is to provide data for decision making, (14) which must always be based on reliable data, carefulness must be applied to ensure data integrity, and avoid duplication and collect only data to be used for decision making, there are three essentials data items. (8)

- Consumption data, which is defined as quantities of ARVs used by clients
- Stock on Hand is quantities of stock available in the facility at the moment.
- Losses and adjustments, are quantities of stocks in the pipeline or that are dispensed to users. (15)

Approved on 18 February 2014

Records and Reports, the inventory management system aims to collect data and process them to help the process of decision making, the three types of inventory management data records can correspond to three basic data items. (5)

- Consumption records, they collect data of product being used or dispensed to clients (dispensing registers).
- Stock keeping records, they collect information about product in-store (bin cards, store ledgers)
- Transaction records, collect distribution information or movement of products from the national warehouse to the facility.

2.1.3. Effectiveness of inventory management data quality,

Data quality is being challenged by the following factors,(12)

- ❖ Diversity of data sources brings data complex structures and increases difficulties in data integration, in the past many businesses were using data generated from their system such as inventory data, but there appear conflicts and inconsistent in data from different sources(16).
- ❖ Data volume is tremendous, and it's difficult to judge data quality within a period.
- ❖ Data change very fast 'timeliness, due to the fast change in big data timeliness of some data is very short, if the collection of data in real-time is difficult and takes a long time then they may be outdated or invalid information. (15)
- ❖ For their effectiveness digital solution must be applied to improve data quality, like

Health information systems refer to any system that capture, store, manages, or transmits information related to individuals or activities, information systems at the lower levels of the health system need to be simple and sustainable and not overburdened. (3)

Digital health intervention is based on a discrete function of digital technology to achieve health sector objectives,

Digital health intervention is classified into clients, healthcare providers, health system managers, and data services (2)

Approved on 18 February 2014

7

Interventions for data services is a crosscutting functionality which is supporting a wide, range of activities related to data collection, management use, and exchange

The health system challenge (HSC) is insufficient supply of commodities and (DHI) digital health intervention is for managing inventory distribution of health commodities and notify stock levels of health commodities and the system to categorize for that is Logistics management information system. (9)

Inventory management software

- Barcode scanning, they are used for the exchange of data by scanning to maintain inventory.
- Lot tracking is used whenever there is a recall of a product from the market, lot tracking help in identifying the items in stock and the one to be pulled out from the inventory.
- Mobile access is an inventory system used to monitor stock on hand.
- Inventory bend analysis, assist in prediction, help analyzed data based on inventory. (17)

2. 2. Empirical Literature Review

Inventory management is the core of the pharmaceutical supply chain, which is all about the process of ordering, receiving, storing, issuing, and their reordering failure,(4)

Poor inventory management is about ad hoc decisions of order frequency and quantity(18).

Inaccurate stock records lack continuous monitoring and ineffective management(11)and tools used in stocks record and reports areas

2.2.1. Inventory management practices for the effectiveness of ARVs consumption data quality.

There are three kinds of logistic records to trace and supervise product status in the pipeline which include consumption records, stock keeping records, and transaction records, which act as the base of records in inventory management system they are primary sources of information, stock records can be manual or computerized (19), stock

Approved on 18 February 2014

keeping records they hold information for products in storage, example bin card or stock card, where transaction record keep information of product movement, report and resupply forms. Consumption records keep information of products being consumed at the health facility, patient's registration books, uninterrupted supply chain of ARVs requires timely availability of accurate patient's data and commodity information. (20)

Examples of Manual stocks records are:

a. Vertical file cards and this is the Kardex system.
b. Bin cards file cards keep with the stock it's easy visual or inspected, it works as backup records of information
c. Ledger system, record keep on ledger sheets in many supply systems it maintains two stock records to improve accuracy and accountability

2.2.2. Challenges of inventory management data quality of ARVs Medicines.

Managing drug supplies is a very complex process that needs well-established institutions and collaborated supply chain, poor data quality of ARVs can undermine people to get ARVs and can contribute to hindering the availability of ARVs at all times, (21)

The paper-based systems at services delivery points with unreliable stock and patients data are inaccessible for decision making,(22)incorporating components of logistic management information system LMIS in dispensing stocks and collecting patients data.

This move has allowed facilities to maintain continuous supplies of ARVs drugs while enrolling new patients in treatment. (16)

2.2.3. Effectiveness of inventory management data quality.

Logistics management information can increase program influence keep stock availability and improve services delivery, through Accuracy of Data Entry(23)

Stocks record whether manual or computerized must be current and accurate, and factors that contribute to inaccurate stock records are. (24)

- High volume can duplicate entries for receipt or issues, duplicate paperwork.
- Theft produces inaccurate records.

- Physical count may be rarely or never taken

- Sloppy warehouse practices.

Automation and new technology such as barcoding can reduce inaccurate of data entries,(25) but cannot solve all the problems, the best way to solve all the problems is to promote training and continuous supervision with a close check of records and stock status, the stock count is important for reordering purposes and tracking quantities in stocks. (19)

2.3.1. Inventory management for the effectiveness of ARVs consumption data quality.

There is a close relationship between data provided by LMIS and data required to keep an inventory control system. Data gathered by LMIS will allow the product manager to know the current stock at the facility, determine whether the stock is above, below, or within the estimated maximum stock levels, and know whether there is a need to place an order. Good inventory management is a requirement of a Multi-month dispensing system because periodic inventory management will ensure the availability of local stock from 3-6 months. (26) .The information systems can also be used to track consumption and adjust national procurement because LMIS has made it easy to identify overstock of ARVS redistribute the product and predict anticipated expiries, LMIS can identify incorrect prescriptions or dispensing practices. (12)

2.3.2. Challenges of inventory management data quality of ARVs medicines

Negative effects of poor data quality are due to poor quality of documentation which will lead to inappropriate stock availability and stockout, the establishment of information system for single disease program always causes huge demand for fragmented PHIS system which will eventually undermine data quality .so data assessment has been recommended for improving data quality in PHIS.(27)

The public health data system is the basis of the health and well-being of the people, data are pillars of public health policy, they help in making appropriate decisions. (28)

Approved on 18 February 2014

Public health information system (PHIS) whether paper paper-based or electronic is the public health data system, computerized PHIS is being established to provide alerts or alarms in a timely.

2.3.3. Effectiveness of inventory management data quality.

All LMIS data collected and organized aim to provide information for good decision making, which just be based on reliable data and carefulness to be applied to ensure data integrity and to avoid duplication and collect only data used for decisions. LMIS should not collect relevant for logistic decisions, it should collect only data used for supply chain decision making, below are examples of records being used as tools for collecting commodities data

1. **Electronic Dispensing Tool (EDT)**
Is a health facility computer software for antiretroviral therapy (ART)?

The tool capture ART patient's demographic data, dispensing history, and antiretroviral inventory data including stock orders, receipt, issues, and stock-taking (17)

It registers daily transactions and produces monthly ART reports that will be fed into the Dashboard.

2. **Facility Electronic Stock Card (FESC)**
Is a simple electronic stock control card, its records data on stock taking, ordering, receiving, issuing, and adjusting of each stocked pharmaceutical item and produces monthly reports on stock status reports.

3. **Pharmaceutical information management dashboard,**
Is a web application for collating and visualizing aggregated ART, other commodities, and information on the performance of indicators for various sources including EDT and (FESC)?

2.4. Identified Literature gaps

According to Johnson Anyone (10) who was the author of Inventory management practices and supply chain performance in Kenya, the researcher realized and recommend that the same study should be conducted to manage the inventory management practices

Approved on 18 February 2014

of lower-level facilities like health centers and health units. (26). The researcher also recommended the use of electronic dispensing and inventory tracking tools, to be adopted in all public facilities to promote data visibility. (29). Regular training on inventory management should be planned for the facilities to improve the capacity of new staff and existing ones. And according to Hong Chen who wrote the research about a Review Data Quality assessment method for public health, the researcher found out data use and data collection process haven't been given adequate attention although they are important in determining data quality. Concerns and lack of triangulation of mixed-method for data assessment, reliability, and validity of data quality assessment were rarely acknowledged. (30)

2. 5: CONCEPTUAL FRAMEWORK

Independent

Dependent Variables

Inventory   management

Stock Records

New Technology

ASSESSING ANTIRETROVIRAL INVENTORY MANAGEMENT DATA QUALITY BY ADOPTING POTENTIAL DIGITAL SOLUTIONS

Improved   commodities management

Data Quality is improved

Minimizing factors affecting inventory

Source: Researcher 2021

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3.1. Description of the study area,

The study was carried out in Western Equatoria State which covered an area of 79,343 kilometers, it's the state which has the highest prevalence 5.6% of PLHIV, it is divided into 10 Counties, but the research was carried out in Five counties: Ezo county, Nzara County, Yambio county and Tambura County and Maridi county. The counties selected for the study were selected at a random base, the public health facility selected are those which have Antiretroviral Therapy Unit (ART). (13)

3.2. Research approach and Design,

This research adopted a descriptive cross-sectional design, it's descriptive because it was looking at challenges faced by the inventory management process and the approach was a mixed-method, qualitative and quantitative. 20 ART Units were targeted facilities for the study. (15) The location provided a convenient sample in terms of accessibility and getting clearance

3.3. Population and sample Design,

The target population is health professionals who were in close contact with ARVs management, like ARV dispensers, data clerks, Art clinicians, and Facility directors. (29) .Sample size ;

TABLE 2. 1: Population and sample Design

Respondent	Number of respondents
ARV dispenser	20
Data clerk	10
ART clinician	5
ART facility Director	5
Total of respondents	**40**

Approved on 18 February 2014

Inclusion criteria,

In this proposal health workers in Western Equatoria who were dealing or in close contact with ARVs management were included, after signing the consent letter.

Exclusion Criteria,

In this study Health workers who were not dealing with ARVs management or ARVs data reporting were excluded.

3.4. Data sources and type

There was one type of data source which were primary data, and the primary data was obtained using semi-structured questionnaires, interview, checklist. (10)

3.5. Data collection procedures

Data collection tools are an instrument used for the collection of data, in this research we have employed semi-structured questionnaires, and semi-structured interview data collection process was cascaded in two phases using data collecting instruments as follow:

1. Questionnaires: this is for collecting primary data, closed-ended questionnaires were administered to the respondents, the investigator used this method because it was reliable, simple, and was a quicker way to collect data.
2. Interview: the semi-structured interview was carried out to gather information from the ART in charge, the ART facility director, this method was useful because it investigates issues and identifies challenges of inventory management practices.

   - *Phase one* was the distribution of closed-end questionnaires to the participants using "the drop -and pick later" procedures, the respondents were given enough time to answer the questions.
   - *Phase two*, was a collection of filled questionnaires from the respondents.
   - *Phase three*, was intent interviews with ART clinicians and the ART Unit in charge. (19)

Approved on 18 February 2014

3.6. Ethical considerations

Ethical clearance to run the study was sought from the Ministry of Health ethical committee in the Republic of South Sudan to allow research activity to kick off, and a written letter of recommendation from the University of Rwanda was acquired.

3.7. Method of Data Analysis and Presentation,

Questionnaires were gathered, edited, coded, and entered into the computer software Statistical Package for Social Sciences (SPSS). To identify inventory management data quality for ARVs, data analysis was done through a combination of descriptive, inferential statistics and Likert scale analysis.

Descriptive analysis, descriptive statistics such as percentage, frequency distribution mean, chart and graphs will be used to analyzed data obtained via closed-end questionnaires.

Inferential analysis, the inferential statistic will be used to analyzed data obtained from the analysis of the relationship between variables. (9)

Likert scale analysis, is a rating scale uses to assess opinion ,attitudes or behaviors , using Likert type items and asking Likert questions

3.8. Validity and Reliability Test

Validity:

The data collection tools were reviewed by the supervisors to check whether the tool is clear, and language is easy and understood. To find out that the tool will capture content to meet the study's objectives and is free from bias.

Reliability:

To find out the reliability of the proposed data collection tool, the pre-test was carried out at Juba Teaching Hospital to the study population with similar knowledge in the management of ARVs. To carry out the reliability coefficients analysis, Cronbach's Alpha (α) is the most common measure of scale reliability and a value greater than 0.70 is very acceptable.

Approved on 18 February 2014

4.1 Introduction

This chapter presents data analysis and discussion of the findings being generated from the responded questionnaire regarding the topic of the study. The analysis centered on the views and suggestions given by respondents who turned up to respond to the formulated questionnaires being administered to them during the field survey. Out of 40 questionnaires that were distributed to participants, only 33 questionnaires were returned while 7 were considered non-responded.

4.2 Reliability Coefficients of the Study:

To carry out the reliability coefficients analysis, Cronbach's Alpha (α) is the most common measure of scale reliability and a value greater than 0.70 is very acceptable. Reliability coefficients where, N cases = 40, and N items = 33. This is the solution to the questions of the hypothesis. The reliability coefficient is none to Alpha which is = 0.517 for the Assessing antiretroviral inventory management data quality by adopting potential digital solutions case study of art clinics.

TABLE 4. 1: Respondent's demographic data.

Particulars	Variables	Frequency	Percent
Gender of Respondents	Male	25	75.8
	Female	8	24.2
	Total	33	100.0
Age of respondents	18-25 Years	2	6.1
	26-35 Years	26	78.8
	40 years and above	5	15.1
	Total	33	100.0
Experience of	0<1 year	4	12.1

Approved on 18 February 2014

respondents	1-5 years	13	39.4
	6-10 years	14	42.4
	11+ years	2	6.0
	Total	33	100.0
The educational level of respondents	Diploma	24	72.7
	Degree	8	24.2
	Postgraduate	1	3.0
	Total	33	100.0

Table 4.1: Demographic Data of the Respondents,

As the respondents were accordingly required to specify their gender, males took lead with 75.8% while 24.2% constituted several males who have participated in this research. About what has been projected in figure 4.1 above, the number of males who have participated was high compared to females because most of the women are confined to house affairs and they lack adequate education access due to the unwillingness of their parents.

According to the result in figure 4.2 above, 78.8% of the respondents were those whose ages ranged from 26 to 35 years old, followed by those whose ages fall under 40 years and above have constituted 15.1% while the minority among others were those whose ages ranged from 18 to 25 years old with 6.3% only. The finding revealed that most of the participants were believed to be those whose ages fall under the classification of 26-35 years old according to an indication given by the majority.

Regarding years of experience, 42.4% comprises of those who had 6-10 years' experience, 39.4% were those who have 1-5 years' experience while 12.1% and 6% made up several respondents who have less than a year and those who have over 11 years' experience. However, the findings implied that most of the respondents were having sufficient experience and knowledge in their respective duties, meaning that the majority were able to deliver effective services that can meet the demands of the beneficiaries.

Approved on 18 February 2014

As the participants were asked to specify the years of experience in the clinic, 39.4% were found to be those who have 1-5 years, 36.4% were those who have 6-10 years in the clinic meanwhile those who have less than a year and 11 years plus have constituted 18.2% and 6.1% respectively. According to the result, the majority among others were those who had 1-5 years' experience in the clinic, meaning that they have learned more and become too familiar with clinical services.

According to figure 4.5 above, the Diploma holders were the majority with an average of 72.7%, followed by 24.2% of Degree holders while postgraduate owned 3% out of the total respondents. In comparison, most of the respondents who have contributed positively to this research were Diploma holders who have attained various Diploma Certificates in different learning institutions, meaning that they are qualified to render health services to the people in their capacities.

Inventory Management Data Quality Measurement Tools,
In descriptive data analysis, average(mean) was calculated for each Likert scale dimension, from strongly disagree = 1 to strongly agree = 5, the scale was calculated to understand the mean values

The below table is the interpretation of the average categories (mean values) with the degree of agreement for each factor based on Alfarra, W.A., (2009) suggestion as a weighted average between the values (please refer to table 2).

TABLE 4. 2: weighted average for 5-point Likert Scales,

Weighted average	Result	Result interpretation
1.00 - 1.79	Strongly disagree	Very low
1.80 - 2.59	Disagree	Low
2.60 - 3.39	Neutral	Moderate
3.40 - 4.19	Agree	High
4.20 – 5.00	Strongly agree	Very high

(Source: Alfarra, W.A, .2009)

TABLE 4. 3: Inventory management best practices,

Dimension	Variable	Frequency	Percentage
Stock keeping tools	All ARVs have a stock card.	27	81.8%
	All stock cards are updated	23	69.7%
	There is a regular count for ARVs	26	78.8%
	Stock count is divided into grouping	30	90.9%
Reports	ARVs reports are compiled end of the reporting period	26	78.8%
	Consumption data are captured &reported	28	84.8%
	Stock on hand is included	23	69.7%
	Stock expiring & losses are included	26	78.8%
Advantages of stock tools	Has increased report rate	18	60.6%
	Has reduced stock out rate	25	75.8%
	Has reduced the order lead time	22	66.7%

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In the above table reference is made to changes adapted to reduce the table so the variables have been reduced into three dimensions which are the stock-keeping tools, stock reporting contents, and the advantages of using stock-keeping tools,

from the table above we can observe that the respondent realized ARVs medicines all have updated stock card, 27 of 33 assured that which represent 81.8% hence regular stock count is affirmed to be part of supply chain SOPs at the facility, 78.8% confirm that.

Respondent has also assured those reports are compiled by every end of the reporting period and the report must contain data on consumption, stock on hand, and information about losses and expiries, this was shown by percentages of 78.8%, 84.8% 69.7%, and 78.8% respectively.

When coming for advantages of using stock-keeping tools, the consensus was realized in some improvement as an increase in reporting rate was realized as 60.6%, reduction of stock out rate was 75.8% and reduction in order lead time by 66.7%.

Tracking stock level all the time can help in forecasting demand and stress on the statement of having the right product in the right quantity on hand and avoid stock out and funds being tied up in excess stock to avoid expiries and returned inventory.

TABLE 4. 4: Factors affect inventory management @facility level.

: Factors affecting inventory management.			
Dimension	**Factors affecting inventory management**	**Mean**	**SD**
Stock infrastructure	Lack of proper storage	3.6	1.9
	Lack of inventory control system	3.5	1.9
	Poor inventory infrastructures	3.5	1.9
Data tools	Poor record-keeping	3.2	1.6
	Poor reporting of data	3.1	1.5
HR capacity	Incompetent staffing	3.3	1.7
	Unreliable supplies of medicines	3.5	1.8
	Inadequate training on stock	3.8	2.1

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	management		
	Lack of commitment by managers	3.4	1.7
	Inadequate staff	3.8	1.9
Grand mean		**3.47**	**1.8**

The above table explains the factors affecting inventory management practices at the facilities, this table was divided into three dimensions stock infrastructures, data management tools, and Human resources, the respondent's response which was interpreted by grand mean and St. dev, is 3.47and 18. (5.14 & 3.47) indicated that the majority of respondents agreed with the challenges faced by inventory management that are listed in the table above lack of infrastructures, stock management tools, and human resources,

TABLE 4. 5: measuring data quality

Dimension	Items	Mean	St. Dev
Data accuracy	ART data in the clinic is accurate	3.2	2.9
Data completeness	ART data in the clinic is accurate	3.1	2.7
Data consistency	ART data in the clinic is consistent.	3.2	2.7
Data relevancy	ART data in clinic relevant	2.9	2.5
Data genuineness	ART data in the clinic is genuine	2.8	2.3
Data validity	ART data in the clinic is valid.	3.1	2.7
Grand mean for data quality		**3.06**	**2.6**

Data quality from the perspective of data producers and managers focuses on data matching their sources, and data quality dimensions serve as a guide for selecting the most suitable data set and will lead to choosing the data set with higher accuracy to ensure trust and confidence. From the grand mean and ST. dev. 3.52 and 3.06 respectively, tell that there is an agreement when it comes to the dimension of data quality that the data are accurate, complete, and consistent with their sources and that the data are valid, and less agreement with data relevancy and genuineness which mean they may be some duplication in data and data errors.

CHAPTER FIVE
SUMMARY, CONCLUSION, AND RECOMMENDATIONS OF THE FINDINGS

5.0. Introduction

This chapter gives an inclusive summary of the findings in line with responses given by participants to satisfy the objectives of the study. The chapter has assembled the collective views and suggestions to ease comprehension of the nature of the study.

5.1. Summary of the Findings

To measure data quality six items were developed in table 4.3 above, the grand mean was 3.06 which indicate moderate opinion about data quality, from the result in table 4.3 indicated that most of the respondents have certified that the data Accuracy, completeness, consistency, relevancy, validity, and genuineness, is not a matter of doubts, though some views were against doubting the accuracy of the ART data kept in the clinics, the voices of the majority have ensured the accurateness of the ART data kept in various clinic operating in the country. This concurred with Hanson (7) where the findings observed effective inventory management include, keeping accurate information about the available inventory in the stock. The finding also concurred with Kumar (4) where he stated that effective inventory management includes completing the required framework and systematic arrangement of the stock to trace and avoid overstocking or understocking of commodities.

Based on the findings revealed in table 4.4 above, the ten items of factors affecting inventory management, the grand mean was 3.47, which represents the infrastructure as the leading cha. And it agrees with Nesha et al, who pointed out that inventory control is the best means by which stock challenges can be addressed. The study also has revealed that inadequate staffing has been among challenges hindering effective inventory management and that has been affirmed by finding, while few who have participated in this finding have underlined poor records keeping being among weaknesses detected which contribute to poor inventory management. Zhu (30) found out that the biggest problem is the data era in inventory management.

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The findings unveiled the negative impacts of not using data tools, which resulted in poor reporting and record-keeping, plus the incompetency of working staff to produced effective reports the statement has been approved by 51.5% and 57.6% of the respondents who have agreed that poor reporting and incompetent of staffs owned negative parts in inventory management due inconsistent of the reports. Meanwhile unreliable supplies and inadequate training on inventory management were strongly believed by 66.7% and 84.8% to be among the leading factors that affect proper inventory keeping in most clinics that are operating in the country. The findings also agreed that lack of management commitment, incompetent staff are the moderate factors affecting inventory management, and these findings concurred with (18) where it is stated that poor inventory management is about ad hoc decision of order frequency and quantity.

Regarding the effectiveness of inventory management data quality, 81.8% have responded positively that all ARVs medicines have stock cards and 69.7% said 'Yes' Stock records of ARVs were accurate and up to date.

While the statement that regular stock count is done a minimum once a year every reporting period of ARVs has been agreed by 78.8% of the respondents in the table above. 90.9% on other hand constituted several respondents who have responded 'Yes' that the entire inventory of ARVs medicines is counted at once go in each stock take. This complies with the findings which state that stocks record whether manual or computerized must be current and accurate, and factors that contribute to inaccurate stock records are. (24) Based on what has been revealed in this finding, 57.6% of respondents have implied their support in regards to the statement that the inventory of ARVs is divided into counting groups with each group being counted per stock-taking session (cyclical count). While those who have responded 'Yes' that reports for ARVs are medicines compiled at the end of each reporting period have made up the leading average among others with 78.8% of the respondents. As the respondents were accordingly asked whether they included data consumption in every report as well as data of stock on hand, 84.8% affirmed that they do include data consumption in every report while 69.7% also agreed that they usually considered data of stock on hands in every report they compiled.

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This concurred with the findings in which it is stated that inadequate data information can result in fewer quantities to the facility which will lead to a frequent shortage of ARVs. (10)

The result also indicated that 66.7%, 63.6% comprise of those who have agreed that the use of reports has reduced order lead time and has increased reporting rate respectively. These findings were in contradiction with Sado (7) who stated that order lead time without proper accountability cannot improve health services.

5.2. Conclusion

According to the findings, the majority among others were those who compile their consumption data appropriately for future reference using drug records to compute their consumption by the end of the day. Simply, most of the participants indicated that they have received formal training on data management which provided them with adequate knowledge to compile consistent and accurate reports. Based on the fact which has been unveiled by the majority, the respondents were so vocal that the data they generated were consistent, accurate, relevant, genuine, valid, and complete.

Despite positive responses given by the majority, the finding ruled out and affirmed challenges affecting inventory management which were not only limited to lack of proper storage, lack of inventory control system, inadequate of staffs, incompetency of employees, the unreliability of medical supplies, and lack of management commitment. As the result, the finding agreed that challenges are affecting effective inventory management in most of the clinics, which are operating particularly in Western Equatoria state.

Conclusively, the findings traced out the satisfaction of data quality in Western Equatoria ART clinic according to respondents who had opportunities to participate in this finding.

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5.3. Recommendations of the Study

Based on recent studies shared by intra-health which is one of the implementing partners supported by PEPFAR in South Sudan, where they say most of the facilities, especially those which are providing ART services, uses the paper-based system at the national and subnational level for documenting information on the request and usage of the commodities, these requests are initiated at the national level for commodities which are distributed through the push system while for the pull system, the requests are generated from the facility level. The hard copies of the request forms are manually uploaded into the different electronic systems once the requests are processed but none of these systems can be used for tracking data on commodity consumption at the facility level.

The country lacks a national Logistics Management information system for collecting real-time data on the distribution and consumption of health commodities for timely decision making to guide commodities management at the national and subnational levels, in addition, the paper-based systems have a bureaucratic process that requires MOH to allocate financial resources for both costs of materials and labor of managing them, including printing, distribution and filing costs. The ongoing challenges resulted in the existence of fragmented systems being used to track the distribution of commodities at the national and sub-national levels.

To transform the paper-based system into an electronic system, this research is recommending the deployment of the DHIS2 Logistics module. Many countries have moved to the use of the DHIS2 Logistics module for managing aggregate data on the commodity at the facility level.

Generally, putting an end to the prevalence of fragmented logistic Management Information systems in the country has been believed to be the best solution to deal with matters to do with data quality, which would allow effective services delivery not only in ART clinics in Western Equatoria state but also in another part of the country.

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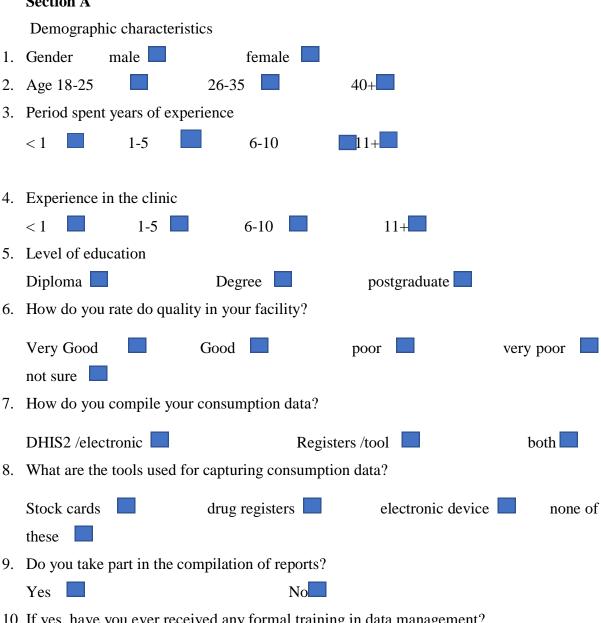
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ANNEXES

Annex I: Questionnaires

This questionnaire has been designed to collect data on assessing inventory management data quality in Public facilities' ART clinics in Western Equatoria State, the data collected will be for academic purposes and will be handled with serious confidentiality. Please tick the suitable option provided in the box and I will humbly appreciate your response,

Section A

 Demographic characteristics

1. Gender   male ☐   female ☐

2. Age 18-25 ☐   26-35 ☐   40+☐

3. Period spent years of experience

    < 1 ☐   1-5 ☐   6-10 ☐   ☐11+☐

4. Experience in the clinic

    < 1 ☐   1-5 ☐   6-10 ☐   11+☐

5. Level of education

    Diploma ☐   Degree ☐   postgraduate ☐

6. How do you rate do quality in your facility?

    Very Good ☐   Good ☐   poor ☐   very poor ☐

    not sure ☐

7. How do you compile your consumption data?

    DHIS2 /electronic ☐   Registers /tool ☐   both ☐

8. What are the tools used for capturing consumption data?

    Stock cards ☐   drug registers ☐   electronic device ☐   none of

    these ☐

9. Do you take part in the compilation of reports?

    Yes ☐   No☐

10. If yes, have you ever received any formal training in data management?

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Yes ☐   No ☐

11. How do you measure data quality at the facility?

…………………………………………………………….

12. What are indicators used for measuring data quality?

………………………………………………………………

Section B

Data quality in Western Equatoria ART Clinics

Data quality measurement (indicators)			Response		
Item	*Strongly disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
ART data in the clinic is accurate					
ART data in the clinic is complete					
ART data in the clinic is consistent					
ART data in clinic relevant					
ART data in the clinic is Uniqueness					
ART data in the clinic is valid					

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In your opinion what other measures can indicate data quality and are not mentioned here up?

………

……

What could be the solution to Delayed reporting of data?...

......

How do you measure data accuracy at the facility?

……

……..

Section C

Major factors affecting inventory management data quality.

Challenges facing inventory management
Please indicate the rate of challenges being experienced during inventory management of

ARVs medicines, like disagree, neutral, and agree

Challenges affecting inventory management	*Disagree*	*Neutral*	*Agree*
Lack of proper storage			
Lack of inventory control system			
Inadequate staff			
Poor record-keeping			
Poor reporting			
Incompetent staff			
Unreliable supplies of medicines			
Inadequate training on inventory management			
Lack of commitment top management			
Poor inventory infrastructures			

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Please list any inventory challenges you see is not here

?……………………………………………………………………………

what are the percentages of stock records that are

accurate?...

..

 what could improve the traceability of

ARVs?...

Annexes .2. Interview Guide for ART clinics (ART director and ART clinician)

Date of interview ……………………………….

Organization of the respondent ………………………………….

Title of the respondent …………………………………. sex………………….

How do you collect data at the ART clinic?

……………………………………………………………………………………
…

How do you use data collection in this clinic?

…………………………………………………………………………………..

What are the challenges you face at the clinic when collecting data?

……………………………………………………………………………………
….

What is a suitable digital solution for collecting inventory management data at the clinic?

……………………………………………………………………………………
……

What can be done to improve the quality of data at the ART clinics?

……………………………………………………………………………………
……

How frequent are ARVs medicines ordered by your facility?

……………………………………………………………………………………
……

Which stock-keeping record is mostly used in managing inventory of ARVs medicines?...
......

Are stock keeping records of ARVs medicines accurate and current in the public health facilities in western Equatoria?

....

What data from ARVs do you use for decision-making?

……………………………………………………………………………………
…….

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How do you think inventory management affects the reporting rates?

………………………………………………………………………………………………………
….

Inventory management data quality checklist

Effectiveness of Inventory management data quality	*Yes*	*No*
All ARVs medicines have a stock card		
Stock records of ARVs are accurate and up to date		
Regular stock count is done minimum once every reporting period for ARVs		
The entire inventory of ARVs medicines is counted at one go in each stocktake (full count)		
Inventory of ARVs is divided into counting groups, with each group being counted per stock-taking session (cyclical count)		
Reports for ARVs are medicines are compiled at the end of each reporting period		
Data on consumption is included in every report		
Data on stocks on hand is included in every report		
Data on commodities near to expiry is included in every report		
Data on losses and adjustment is included in every report		
The use of stock-keeping records has reduced stock out rate		
The use of stock-keeping records has reduced order lead time		
The use of stock records has an increased reporting rate		
Use of report has reduced stock out rate		

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Use of report has reduced order lead time		
The use of reports has increased reporting rate		

Annexes .4. Research work plan

No.	Activity	Deadline	Deliverable
1	Submission of zero draft	20th May	Research proposal Without a data collection tool
2	Final proposal ready for submission to the ethics committee	20th July	Research protocol including data collection tools
3	Getting ethical approval	20th August	Ethical approval
4	Data collection	20th September	Dataset
5	Data Analysis	30th September	Results and interpretation
6	Writing dissertation	10st October	Complete dissertation
7	Submission of dissertation and a draft manuscript	15th October	A final copy of a dissertation and draft manuscript
8	Defense	25th October	PPT for Presentation

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37

Annexes .5. Research Budget

NO.	Item	Unit cost USD	Total cost USD
1	Return Ticket Western Equatoria state Yambio	300x2	6000
2	Printing documents and their services	50	50
3	Data collections cost	100	100
4	Data analysis cost	150	150
5	Dissertation documents printing and	200	200
6	Grand Total, only one thousand one hundred USD		**1,100 USD**

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Annexes .6. Informed consent
Title of the study: Assessing ARV inventory management data quality

Student name: Odol O. Anyaljock Amykeui

Affiliated institution: the University of Rwanda, center of excellence for vaccine, immunization, and health supply chain management, Kigali -Gikondo -street KK-737

P. O. Box 4285-Kigali Rwanda

Introduction

The purpose of this consent form is to give you the information you will need to help you decide whether to participate in the study. you are free to ask questions about the purpose of this study, you are allowed to ask anything which is not clear about the study until you are satisfied. you are also free to be part of this study or not, and this process is called informed consent, when you decide to be in the study I will request you to sign your name on this form and your decision is completely voluntarily, you are free to withdraw from the study at any time.

I understand that all my information regarding this research will be kept confidential.

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CONSENT FORM

Participant's statement

I have read this consent form and had discussed this research study with the investigator, I have had my question answered in a language that I know and understand. The risk and benefits have been explained to me. I understand that my participation is voluntary and I may choose to withdraw anytime. I freely agree to participate in this study, I also understand that all the answers I give here will be kept confidential

Signing this consent doesn't mean I have given up all the legal rights that I have as a participant in the research study ………………… I agree to participate in this research study

Participant   name

……………………………………………………………………………………………

…………………….

Participant   signature   ……………………………………….

date……………………………………………………….

Annex 7: Letter of Data Collection

REPUBLIC OF SOUTH SUDAN

Ministry of Health, Research Ethics Review Board (MOH-RERB), Juba.

RERB NO:42/08/2021-MOH/RERB/ A/45/2021   Date: 6th Sept. 2021

Principal Investigator: Odol Ocay

University of Rwanda

Research Approval Letter

Dear All;

Sub: "Assessing ARVS Management, Data quality by adopting digital solution in South Sudan"

This is in response to the request for authorization of the study Assessing ARVS Management, Data quality by adopting digital solution, South Sudan".

As part of public health assessment and response in ARVS Management and proffering digital solution.

The Ministry of Health Research Ethics Review Board(MOH-RERB) at its 15th meeting held on 23rd August 2021 reviewed your research proposal and has given a favorable ethical opinion for implementation.

The approval was based on the quality of your application form, protocol and supporting documents that complied with the conditions and principles established by the International and National guidelines for carrying out research involving humans as research participants.

This approval shall be valid until 30th/12/2021. In this regard, you are expected to commence implementation of this research. Please note that the preliminary report and the request for renewal, should be submitted to the MOH-RERB one month before the expiry of the approval time. The progress report should not exceed five pages.

In addition, any serious problem related to implementation of this research protocol should be promptly reported to the MOH-RERB, and any changes to the protocol should not be implemented without the MOH-RERB approval except in instances where such a change is necessary to eliminate or prevent an immediate hazard to the research participants. I wish you all the best in implementing this research.

Amanya Jacob Kasio Iboyi, MPH/SM

\#. Deputy Director for Research-MOH, Juba & Deputy Chairperson MOH-RERB/Juba/RSS

\#. Cc: Director General, Policy Planning, Budgeting & Research, MOH-Juba

\# Cc: DG/SMOH-WES

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41