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# TO ASSESS THE EFFECT OF THE ELECTRONIC LOGISTICS MANAGEMENT INFORMATION SYSTEM ON THE ARV DRUG SUPPLY CHAIN IN LUSAKA DISTRICT

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***Abstract—***
*Prior to the introduction of the electronic health commodity logistics information systems in Zambia, the logistics system for the reporting and ordering of drugs was entirely paper-based. This often-caused delays in order fulfillment. To meet patient demand and improve health outcomes, the Ministry of Health (MOH), built an electronic logistics management information system (eLMIS), which included most major health programs in the country. The purpose of the study was to assess the effects and contribution of the eLMIS on the Antiretroviral (ARV) supply chain in Health Facilities of Lusaka District. A descriptive cross-sectional study was undertaken to assess the effectiveness and performance of the ARV electronic logistics management information system. Quantitative and qualitative data was collected through the use of structured questionnaires. The study results revealed that the active users of the eLMIS, confirmed an improvement in the quality, accuracy and accessibility of data and reports. Results showed an improvement in the timeliness of reports submission and confirmed an improvement in the stock status of key ARV Drugs. Findings of the study led to the conclusion that, the eLMIS, has improved the service delivery of the ARV Logistics System in Zambia. However, there is need for continuity in providing on-the-job training (OJT) for eLMIS users, so that they effectively use the system without any challenges. In addition to user training needs, effective and continuous technical support sessions should be consistently done, so as to increase the user knowledge based on report generation and data analysis*

***Keywords—****Electronic Logistics Management Information System (eLMIS), Antiritroviral Drugs, Ministry of Health, Logistics System, Supply Chain.*

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## 1.0 INTRODUCTION /BACKGROUND

The ARV supply chain in Zambia includes multiple donors, partners

, and distribution mechanisms. Efforts to collect specific logistics data on Antiretroviral (ARV) Drugs were previously hampered by a poorly functioning logistics management information system (LMIS) and a lack of coordination in managing ARV drugs between cooperating partners of the Ministry of Health (MOH) (USAID|DELIVER PROJECT, 2006).

In May 2006, the Ministry of Health designed, with technical support provided by the USAID |DELIVER PROJECT and in collaboration with local stakeholders, a logistics system to improve the flow of logistics information and commodity distribution of ARVs in Zambia. However, the Ministry of Health faced many challenges in managing procurement and distribution of medical products and supplies. Long lead times, stockouts, and general lack of efficiency characterized the in-country supply chain.

As MOH continued to expand and strengthen the ARV Drug supply chain, there was an increased need for user-friendly tools and software packages to support the timely and accurate collection and reporting of ARV logistics management information data. The importance of this information was to enhance operational decision making, advocacy, and resource mobilization. As well as to improve and facilitate the work of supply chain managers by enabling faster collection, transmission, and aggregation of data; by reducing human error in calculations; and by allowing for visibility of data up and down the ARV supply chain.

Thus, in order to meet patient demand for access to ARV drugs and improve health outcomes, United States Agency for International Development (USAID) implementing partners, in 2014, began working with the Zambian government to develop an electronic logistics management information system (eLMIS). The eLMIS is a revolutionary and cost-effective open-source system of health data management that ensures greater commodity security and better health outcomes for the people of Zambia. It links health facilities with the central store to collect and distribute logistics data in real time. The eLMIS helps program managers determine which Health Facilities are under stocked or overstocked, review trends in consumption on a product-by-product basis, estimate procurement requirements for each product, identify facilities with potential inventory management problems, and plan deliveries to facilities. (AIDSFree Zambia, 2017).

In supply chain management, there is a growing demand for increased visibility and availability of data. Electronic information systems provide better visibility into the logistics information system and enable key stakeholders to make required decisions with that data. Research studies have demonstrated eLMIS also improves the quality of logistics data, thus improving supply chain performance and commodity availability at health facilities, which ultimately leads to better patient health outcomes (Rosen et al., 2014) [3]. According to the most recent estimates in Zambia, that is, by the end of 2017, 75% of people in need of antiretroviral treatment (ART) were receiving it. This equates to 80% of women, 70% of men, and 64% of children living with HIV receiving ART (UNAIDS, 2017).

### 1.1 STATEMENT OF THE PROBLEM

Zambia has attempted to create universal access to antiretroviral therapy. However, barriers still remain at the individual, institutional and national levels to access ARV drugs. Access to ARV Drugs by all Zambians has been hindered by the non-availability of electronic data information systems for the storage and distribution of consumption

patterns, and other relevant data that helps supply chain decision makers to make well informed decisions. Stock outs of ARV drugs have occurred at the health facilities due to the lack of electronic systems that store the data for stock status of key ARV Drugs (Michelo.K, 2017).

With the increase of the HIV pandemic, it has been imperative to develop the eLMIS in order to ensure a consistent supply of ARVs at any time, so that commodity security is attained. By March 2015, MSL had fully migrated to the eLMIS from the previous data management software was in use.

### 1.2 RESEARCH OBJECTIVES

The main objective of the research was to assess the effect and contribution of the Zambian electronic logistics management information system (eLMIS), on the ARV drug supply chain at Health Centers and Hospitals in Lusaka District.

***Specific objectives of the research included:***

i. To identify the effects of the electronic logistics management information system on data quality and use.
ii. To determine improvements in reporting frequency, timeliness and accuracy of submitted reports.
iii. To establish the effects of the electronic logistics management information system on data accessibility and transparency.
iv. To identify the notable improvements in product availability and stock status of key health commodities managed in health facilities.

### 1.3 RESEARCH QUESTIONS

I. How has the electronic logistics management information system improved data quality and use at the health facilities?
II. What is the contribution of the electronic logistics management information system to improving reporting frequency, timeliness and accuracy of submitted health facility commodity requisitions?
III. What are the effects of the electronic logistics management information system on data accessibility and transparency?
IV. What are the notable improvements in product availability and stock status of ARV Drugs?

### 1.4 SIGNIFICANCE OF THE STUDY

A concept introduced by the United Nation's programme on HIV/AIDS in 2013, 90-90-90 is a set of goals. The idea is that by 2020, 90% of people who are HIV infected will be diagnosed, 90% of people who are diagnosed will be on antiretroviral treatment and 90% of those who receive antiretrovirals will be virally suppressed. This contributes to the attainment of targets on the provision of data for decision making (UNAIDS, 2017).

In line with the UNAIDS 90-90-90 goals, the implementation of the eLMIS system in Zambia is aimed at introducing operational efficiency, increasing quick report submissions, and improving order process rates within the health supply chain to ensure product availability and improve health outcomes of anti-retroviral therapy patients.

Globally, the HIV/AIDS community has worked hard to realise the Sustainable Development Goal (SDG) of ending the AIDS epidemic by 2030. One crucial part of this plan is bringing HIV treatment (ARVs) to all who need it. Good health is a prerequisite for progress on ending AIDS.
Hence, the significance of this study was to contribute to the attainment of the UNAIDS 90-90-90 targets on the provision of data for decision making. As well as to realise the Sustainable Development Goal (SDG) of ending the AIDS epidemic by 2030.

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## 2.0 LITERATURE REVIEW

According to the USAID|DELIVERPROJECT (2008) [1], a logistics management information system (LMIS) is a system of records and reports – whether paper-based or electronic – used to aggregate, analyse, validate logistics Information. Uninterrupted supply of antiretroviral drugs for treatment of HIV/AIDS is a pre-requisite and a challenge for ART programs. LMIS is nothing but a part of Management Information System to manage, control and measure the logistical activities. These activities occur within the organization or as well as overall across the supply chain. Logistics information systems are important for achieving logistics efficiency and effectiveness. Logisticians added the word logistics to management information system (MIS) to create logistics management information system. Logisticians want it clear that the collection of data for managing a logistics system is a separate activity from the collection of data for other information systems, including health management information systems. An LMIS collects data about commodities; this information is often used for activities, such as filling routine supply orders for health facilities. An HMIS collects information on the total number of patients seen or diagnosed; data from an HMIS is not used as often as LMIS data— i.e., annually—and it is used for different purposes—i.e., for evaluating program impact. Logisticians emphasize the use of logistics data for making decisions about activities within the logistics cycle (USAID|DELIVER, 2008).

The Supply Chain Management System(SCMS), which is the higher level in the supply chain, uses the LMIS data to track consumption in the facilities to identify whether there are overstock of commodities and therefore redistribute them to prevent wastages, identify exceptionally high levels of product expiry and then initiate action to prevent this situation from recurring or determine the quantity to issue to the facility to bring it up to established maximum stock or under stock and therefore redistribute from neighboring health facilities. The data is also used for the determination of national level consumption and for planning, budgeting and quantification for the procurement of commodities. A failure in any of the levels of the system could result in stock out of health commodities and therefore inability to attend to patients who visit such facilities for their healthcare needs (USAID/DELIVER, 2018).

Without effective and efficient LMIS implementation, HIV/AIDS programmes will inevitably waste valuable resources through prolonged and frequent stock outs, overstocks and losses (Owens&Wanner, 2003). A well implemented LMIS reduces the likelihood of stock outs and overstocks that can waste scarce resources and lead to product expiration, especially given the short shelf life of some HIV/AIDS commodities (USAID|DELIVER, 2008).

A good inventory management of medical supplies is fundamental for the success of the operation in any hospital. Wasike &Mugambi, (2015), reported that in Mombasa County, Public health facilities were reportedly faced with perennial lack of pharmaceutical commodities which impacted on their performance. Most County public health facilities were identified with significant stock outs of key medications. Essential drugs were frequently unavailable to patients visiting the public health facilities. The Coast province general hospital being the biggest referral hospital in the Coast province was no exception. Most of the patients visiting for treatment are normally not satisfied at the end of the hospital service. This was majorly because they are enforced to go and purchase some of the prescribed medication elsewhere which is normally not in their expectations. It was apparent that this situation was associated with

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pharmaceutical inventory management at the Coast Province General Hospital.

According to Squires et al, (2015), technology has become a vital and integral part of every business plan. It has a bigger impact on inventory control in terms of efficiency, ease of accessing information and accuracy thereby affecting organization performance. In a healthcare setup different automated tools can help organizations standardize and improve the quality of their data (Squires et al, 2015). But even with the introduction of inventory management systems in various health institutions, stock out problems still exists.

An efficient and reliable supply chain requires an uninterrupted availability of reagents, supplies, consumables and other related services. However, poor supply chain management at all levels of health systems in developing countries is common and is leading to stock-outs of key reagents, supplies and consumables resulting in interruptions of service delivery (Kagaruki et al., 2013). Effective supply chains help to ensure commodity security and determine the success or failure of any public health programmes (Manso et al., 2013). Available evidence shows that the performance of a supply chain system affects the coverage of services as well as clients seeking behaviours. A strong and well-functioning system of supply chain management which is lacking in most of the low-developing countries provides an assurance for sustainable HIV/AIDS prevention, care and treatment services. An efficient system also helps to link planning, implementation and controls the flow of information, materials and services from the health care providers to suppliers and ultimately to HIV/AIDS patients (Mafinga et al., 2007).

### 2.1 Effects of Electronic Information Systems on Data Quality and Use.

Information quality has been defined in several ways in prior literature and has shown to have varying effects on the information consumer. Operationally, information quality is information that is good, useful, current, and accurate (Rieh, 2002). The meaning of information quality lies in how the information is perceived and used by its customer. Kinney (2000), defined information quality as degree to which measurement methods used to prepare information can represent what a decision maker wants to know (information relevance) and the stated methods have been competently applied and results truthfully displayed (information reliability or credibility). Lillrank (2003), explored the information quality as the successful received what the sender's intended to deliver information to receiver. The expectation is the receiver understood the communication is about. Otherwise, it is not a good of quality information.

According to Geiger (2018), data quality management entails the establishment and deployment of roles, responsibilities, policies, and procedures concerning the acquisition, maintenance, dissemination, and disposition of data. The viability of the business decisions is contingent on good data, and good data is contingent on an effective approach to data quality management. The initial emphasis of many new data quality management initiatives launched in recent years has been on customer data, and technology has stepped up to this challenge by automating solutions to many of the data quality problems associated with customer data. Business data consists of much more than just customer data and the technology to support it.

According to Bates et al., (1998), quality measurement in healthcare has been an elusive goal, and the current routine practice of quality measurement in healthcare is relatively primitive.

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Measuring quality without automated tools is time-consuming and labour-intensive, yet the new focus on lowering costs while maintaining or improving quality demands routine measurement. Also, interventions to reduce costs and improve quality may be most successful if they are focused at the level of individual decisions, yet are non-intrusive, a difficult combination to achieve. Fortunately, information technologies can help with both quality measurement and quality improvement. Information technology was defined by Thong & Yap (1995), as computer software and hardware solutions that provide support of management, operations, and strategists in organizations.

The success of information systems, largely relies on the quality of the information, for instance, the accuracy of the information, presented on the system. In a web-based information system for example, if the accuracy of the information on the system was lower than expected, customers could not get appropriate support and the support system would eventually be abandoned. In such case, the information quality of websites mediates the influence of a web-based customer support system on a firm's business operations and performance. Without high quality of information, a firm's information system, e.g. the web-based customer support system here, could not contribute much to a firm's customer service because the web system might be perceived useless by the firm's customers. Empirical studies have revealed that information quality, among many factors affecting the success of a web-based customer support system, was found to be positively related to the success of such systems (Negash et al, 2003).

A study was conducted in rural Haiti by Berger E.J in 2007, on the implementation and evaluation of a web-based stock management system for pharmacy stock management. The innovative web-stock management system was developed to support nine clinics in rural Haiti. The system allowed pharmacy staff from all clinics to enter stock levels and also to request drugs and track shipments. Use of the system enable to track 450 products supporting care for 1.78 million patient visits annually. Over time, results showed that drug stockouts reduced from 2.6% to 1.1% and 97% of stock requests delivered were shipped within a day. Furthermore, results showed that the system had improved the Pharmacy team's workflow, increased efficiency in stock distribution and dramatically reduced response time. The system's development and successful use was dependent on the constant active involvement and participation of the local pharmacy team who were its end users. This involvement proved essential for system roll-out as the users were equipped with not only technical training and support, but also the ability to shape the system to their specific and at times evolving needs.

Mekdes (2013), conducted a study in Ethopia on the implementation of an Anti-Retroviral Therapy (ART) Pharmacy Management Information System in Public Health Facilities. The participants of the study were Pharmacists and Druggists, who were working at ART Pharmacy. The objective of the study was to assess the presence and utilization of Information Technology (IT), and to identify factors that affected the adoption, utilization and implementation of health information system in the health facilities pharmacies. Results showed that, there were computers at most health facilities, but utilization of information technology to manage ART patients and their medication data, was poor at some health facilities. Factors affecting the utilization of IT as identified by respondents were: lack of interest in utilization of IT, lack of training and shortage of manpower.

A study was conducted by Malunga and Tembo in 2017, in Lusaka, Zambia. The study was about the

challenges and opportunities of the implementation of electronic health (e-health) in Zambia. The research did not however specify the area of e-health, meaning, a gap still exists in the assessment of individual electronic drug supply chains in Zambia. The conclusion of the study however, will give rise to future studies on individual health electronic systems that are currently implemented in Zambia. For example, this study on the effect of the eLMIS on the ARV drug supply chain, will lead to more research being done in this area.

### 2.2 Effects of Electronic Information Systems on the Timeliness and Accuracy of Data.

According to Patterson. A (2005), timeliness Information must be on time for the purpose for which it is required. Information received too late will be irrelevant. Data must be available for the intended use within a reasonable time period. According to Lee & Strong (2002), measures of timeliness entails information is sufficiently timely. This information is sufficiently current for work, and is sufficiently up-to-date. According to Kahn & Wang (2002), timeliness is the extent to which the information is sufficiently up-to-date for the task at hand. Accuracy means how accurate is the information or how much error does it contain (Belle, 2001). Information needs to be accurate enough for the use to which it is going to be put (Patterson. A, 2005). Electronic information systems should be accurate and avoid any inclusions of estimates or probable costs.

One of the important characteristics trade-off that organizations deal with is between accuracy and timeliness. Eppler (2006, p.53), explains this trade-off as "the more current a piece of information has to be, the less time is available to check on its accuracy". To handle the accuracy-timeliness trade-off in organizations, decisions needed to be taken on using current but inaccurate or delayed/outdated but accurate information (Ballou and Pazer, 1995). According to Eppler (2006), the timely and accurate information delivery depends on the process and infrastructure used and organizations are influenced by the cost involved to balance these factors.

Various organisations are working to improve health outcomes through better national health electronic information systems. A well-functioning health electronic information system provides timely and relevant information about health outcomes and performance of the components of the health system (WHO, 2007). Governments and organizations working in low- and middle-income countries (LMICs) are seeking ways to improve health-related information and communication technologies (ICTs) to improve data availability and accessibility (Sanner et.al, 2012).

According to the World Health Organization (WHO, 2005), data quality is determined by several traits: "accuracy and validity of the original source data; reliability, when data are consistent and information generated is understandable; completeness, if all required data are present; legibility, when data are readable; currency and timeliness, if data are recorded at the time of observation; accessibility, if data are available to authorized persons when and where needed; meaning or usefulness, if information is pertinent and useful; and confidentiality and security, both of which are particularly important to the patient and in legal matters. Data quality is proportionate to the attainment of achievable improvements in healthcare."

In Brazil, a prospective cohort study, which was conducted in a tertiary teaching hospital with nursing staff, found that 21% (238/1,119) of the doses of drugs prescribed and dispensed by the pharmacy were not administered (Lit.B. et al, 2016) .The application of information technology

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to healthcare has increased the safety of hospital prescription and administration procedures. Computerized systems with a drug menu standardized by the hospital institution, a clinical decision support system, and electronic medication administration record are key tools for patient drug safety (Seidling HM, 2016).

A study conducted by SIAPS in Lesotho in 2018, showed that incorrect recording of data on stock cards & reports, and delayed report submission, lack of uniform and simple data collection tools made logistics decision very challenging which in turn led to frequent stock-outs of medicines and health commodities. An information system fails because of different factors and challenges including chronic stock outs, poor supervision, and monitoring, the absence of regular reporting of stock level and consumption trends, lack of top management support (Chen.h, 2014). A study conducted in Ghana also revealed that shortage of health service providers, inadequate logistics recording & reporting tools, and lack of appropriate essential data from the service delivery points, lack of commitments are some of the major challenges negatively affecting logistics management in the healthcare facilities.

### 2.3 Effects of electronic pharmacy information systems on data accessibility and transparency

Transparency is considered to be a requirement of businesses and their information systems, as it allows for making them accountable to their stakeholders and measuring their trustworthiness through their disclosure of relevant information (Schnackenberg, 2014).

In an electronic drug dispensing system, data transparency reveals whether reports are visible and data can be accessed by authorized users. In another classification of transparency, transparency can be categorized as identity transparency, which makes transparent the identity of information exchangers, content transparency, which makes transparent the content and the changes to the content, and interaction transparency, which makes transparent the actions performed during the interaction to a third-party observer (Stuart & Dabbish 2012).

The first step in achieving useful transparency is Information availability. It is evident that no transparency is achieved if information providers withhold information from relevant information receivers (Kolstad I, 2009). Correctness, completeness, and timeliness are amongst these information qualities. While information availability and interpretation are provided by information providers, information accessibility focuses on the ability of information to be accessed by the users of information system, who use the data for decision making. This is sometimes referred to as information visibility (Michener G, 2011). Therefore, it must be ensured during the management of transparency requirements that the information is comfortably accessible by users.

Therefore, for achieving useful transparency, information should also be understood and comprehended by information receivers. Meaningful transparency argues that information receivers must know the actions and reasons behind the provided information (Michener G, Bersch K (2011), useful transparency discusses that information provision should lead to information receivers' actionability and help in their decision-making processes, or at least to a change in their perception of the information provider.

A study was conducted by Mayernik in 2017, in the United States, regarding the accountability and transparency of data. Likewise, the study showed

that making data open in a transparent way can involve a significant investment of time and resources with no obvious benefits. This study used differing notions of accountability and transparency to conceptualize ‘‘open data’’ as the result of ongoing achievements, not one-time acts. Uses of differing notions of accountability and transparency to conceptualize “open data”, were done as the result of ongoing achievements, not one-time acts.

### 2.4 The effects of electronic Information systems on product availability and stock status.

According to Zhang & Soumerai (2007), Information Technology in Pharmaceutical advances have to a great extent transformed health care over the last several years. This has made it easier for many disease conditions to be addressed either through prevention, cure, or management by prescription and non-prescription drugs. Public health facilities still lack essential medicines, thereby facing a major problem in delivery of health care. This is particularly evident in African countries. It is estimated that about 30 % of the world’s population lacks medicines they so much need for management of several conditions (WHO, 2008). Health care is so dependent on the availability of drugs and other medical supplies at the right time and quantities for the management of patients. Inventory management of medicines is thus the backbone of healthcare delivery. Having proper inventory management practices in place is required so as to avert the frequent stock outs of medicines particularly in public health institutions (Kazi, 2008).

According the World Health Organization (2010), most people leaving with HIV/AIDS do not have access to Antiretroviral Therapy (ART) medicines and commodities and that most of those most at risk of contracting it do not have adequate preventive measures at their disposal. Friedman (2012), noted that the previous decade witnessed a remarkable increase in the distribution of ART medicines in sub-Saharan Africa. Also noted was the progression from HIV to fully blown AIDS, which has been tremendously reduced by the availability of ART medicines treatment, which also helps in reducing the rate of transmission between those currently infected and those not infected. As at 2013, Global access to ART medicines has improved from 64% to 80% due to significant improvements in the delivery services for the medicines.

Lack of appropriate inventory control and monitoring systems for ART medicines and commodities is one the problems that contributes to inefficiencies of the delivery system and the supply chain (Muthoni & Okibo, 2014). Clark and Barraclough (2010), indicated that inadequate monitoring of medicines as they move through the supply chain leads to health facilities suffering wastages, such as stock outs, expiries and underutilization of the medicines and medical equipment, which in turn leads to the inability to meet the treatment goals of the patients due to inability to obtain adequate medicines.

Kokilam, conducted a study in 2015 in India, to assess the pharmaceutical inventory management and store keeping practices followed at the rural primary health centers in Udupi district, Karnataka. The study was conducted in twenty rural primary health centers located in Udupi district, Karnataka.

Results showed that, the inventory management and store keeping system implemented in primary health care (rural division), is still a piecemeal and ad hoc in nature. With the provided infrastructure, work force, complex procedures, manual system of record maintenance, lack of co-ordination between the activities and players only causes plethora of bottlenecks resulting in irrational usage of limited resources (Kokilam, 2015).

Akwei in 2006, also conducted in Nigeria, on the evaluation of an electronic Laboratory Management Information System in HIV AIDS comprehensive Health Facilities. This study was a facility based cross-sectional descriptive study to assess the status of laboratory logistics management information system for HIV/AIDS laboratory commodities in HIV/AIDS comprehensive health facilities in Bayelsa state. Results showed that one of the identified constraints of LMIS implementation for HIV/AIDS commodities, was lack of adequate computers, lack of training for some laboratory personnel involved in LMIS, and internet for electronic LMIS (Logistics Management Information System) implementation.

A study was conducted in Zambia by Yukich in 2016, on the the impact of inventory management on stock-outs of essential drugs. The objective of the study was to characterize the impact of widespread inventory management policies on stock-outs of essential drugs in Zambia's health clinics and develop related recommendations. The study reports results showed clear evidence that substantial stock-outs of life-saving health products occurred in Zambia's public health facilities in the first quarter of 2010. This was noteworthy because these products were available in the central warehouse at that time, and strict adherence to a max-min inventory control policy used in many low-income countries was enforced. These stock-outs were therefore attributed to the inventory policy, as opposed to procurement or training issues.

### 2.5 Personal Critique Summary

Literature of this study revealed that very minimal studies have been done, on assessing the effectiveness of electronic information systems for ARV Drugs. Hence, in terms of literature about this research, it does not directly relate to the assessment of electronic logistics management information system on ARV Drugs only, also on any other electronic information systems in health and other areas beyond health.

Despite the positive effects of Health Information Systems and Electronic Medical Records use in medical and healthcare practices, the adoption rate of such systems is still low and meets resistance from healthcare professionals. Barriers appear when they approach systems implementation.

## 3.0 METHODOLOGY

### 3.1 Research Design

The study employed a descriptive cross-sectional research study, design using quantitative and qualitative methods. The purpose descriptive cross-sectional design was preferred in this study, was because this was a short study carried out in a single point in time. Hence to be able to assess the effect of the eLMIS on the ARV drug supply chain, so as to be able to create way for more rigorous studies at a later date.

### 3.2 Target Population

The target population was Pharmacy Personnel working from the ART Health facilities in Lusaka District, were the eLMIS is implemented. These are responsible for managing the supply chain for ARV Drugs and are designated in the Pharmacy Storeroom or Dispensary. Thus, involved in activities such as, updating inventory in the eLMIS and completing and submitting reports.

### 3.3 Sample Size

Hundred (100) questionnaires were administered to 100 respondents at the ART Health Facilities in Lusaka District.

The number of facilities rolled-out with the eLMIS for managing ARV Drugs, by the time of this research were 32. Hence the determination of

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the sample size was based on all Pharmacy Personnel who are trained/oriented in the eLMIS for ARV Drugs, in Lusaka District. The number trained/oriented per facility was two to three Pharmacy Personnel.

Calculation for the sample size did not apply, as all the ART Facilities implemented with eLMIS were selected for this research, hence all respondents described above were part of the study.

### 3.4 Sampling Criteria

**Inclusion criteria**

- The study subjects to be included in the study will only be from Lusaka District
- The study subjects will be both male and female who are pharmacy personnel and operate from the Pharmacy Department
- The study will only include Health Facilities that have the eLMIS implemented
- The study subjects will be those who are willing to participate in the study

**Exclusion criteria**

- eLMIS for the management of non-ARV drugs will not be included in the study
- Non-Pharmacy personnel will not be included in the study
- The study subjects who are not willing to participate in the study

### 3.5 Sampling Technique

A Purposeful Random Sampling Technique was used for selecting participants in this study. This was achieved using a structured questionnaire and face-to-face interviews.

Thus, in this regard, the group of knowledgeable individuals applicable to this study that were selected are Pharmacy staff that that use the eLMIS for reporting of essential ARV Drugs.

According to Bernard, H. R. (2002), the purposive sampling technique, also called judgment sampling, is the deliberate choice of a participant due to the qualities the participant possesses. It is a non-random technique that does not need underlying theories or a set number of participants. Simply put, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience.

### 3.6 Instruments for Data Collection

Self-administered Structured questionnaires and face-to-face interviews were used for the study. These were designed to elicit respondent's knowledge of the usability of the eLMIS for ARV drugs, and determination of reporting, timeliness accessibility and details of stock status.

The questions in the questionnaire were structured (closed ended) and unstructured (open ended). The structured questions measured the subjective responses, that was, to clarify the objective responses and at the same time, enhance formulation of recommendations of the study.

### 3.7 Proceedures for Data Collection

After finalizing the questionnaire which was the selected data collection tool, consent from Lusaka District Health Office was obtained, which was granted through the provision of an authorized letter from the District Health Director's Office.

The questionnaire was piloted, that is, tested for feasibility, coherence, consistency and accuracy. This meant testing it out to analyze if feasible results are attained. The questions were then altered accordingly.

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Data was collected over a period of six weeks, beginning mid November 2018 up to end of December 2018. Hard copy questionnaires were printed and distributed to the respondents of this research.

### 3.8 Data Analysis Techniques

The data was collected, cross checked and stored in a Microsoft Excel spreadsheet, were further cleaning and summarizing of background information was generated.

Data was analyzed using Statistical Package for Social Sciences (SPSS) version 22, were it was subjected to cross tabulation summaries and Chi-square tests of independence, between the independent and dependent variables, for our basis of conclusions on the key findings.

### 3.9 Ethical Considerations

Ethical guidelines were observed as stipulated in the Social Research Association (2003). In particular, the aim and objective of the study, as well as the procedures to be followed, were explained upfront to everybody who was taking part in the research.

**Confidentiality:** The participants were guaranteed that the identifying information will not be made available to anyone who is not involved in the study and it will remain confidential for the purposes it is intended for.

**Informed consent**: The prospective research participants were fully informed about the procedures involved in the research and were asked to give their consent to participate.

**Anonymity:** The participants remained anonymous throughout the study to guarantee privacy.

## 4.0 RESEARCH FINDINGS

The section presents findings of the study. Descriptive and inferential statistics analysis was used and summarized using tables and figures. A Chi-Square test was run to determine the associations between the dependent and the independent variables.

### 4.1 Presentation of Findings

#### 4.1.1 Background Demorgraphics

The 100 respondents in this study were all Pharmacy staff in the Health Centers of Lusaka District were the eLMIS is deployed, 69 (69%) being male and 31 (31%) being female. Regarding Educational Qualification in the Pharmacy field, 7 (7%) were Certificate holders (Pharmacy Dispensers), 71 (71%) were Diploma holders (Pharmacy Technologists), 20 (20) were Degree holders (Pharmacists) and 2 (2%) were had no Pharmacy Qualification.

In terms of length of working on the position, 24 (24%) of the staff had less than one year of service, 41 (41%) had one to two years of service, 17 (17%) had three to five of service, 11 (11%) had five to ten years of service, and 7 (7%) of the staff worked for over 10 years.

In terms of respondent's years of experience of working with the eLMIS, 24 (24%) had less than one year experience, 36 (36%) had one to two years experience, 22 (22%) had three to have five years experience, 5 (5%) were newly employed and had minimal experience, hence was undergoing the orientation process. Finally, 13 (13%) were also newly employed and had never used the eLMIS.

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### 4.1.2 Use of the Electronic Logistics Management Information System

**User Roles of the eLMIS**

Usability of the eLMIS relates to the roles and responsibilities that eLMIS users have in the management of ARV drugs. Three types of activites related with usability of eLMIS were given by respondents. These are: Report Generation, Entering Transactions and Dispensing ARV Drugs. The chart below shows that 66% (57/86) use the eLMIS for Dispensing ARV Drugs, 26% (22/86) use eLMIS for Entering transactions and 8% (7/86) use it for Report Generation. There were no responses from 14 respondents, as they are newly deployed staff who have not yet been oriented fully in the eLMIS.

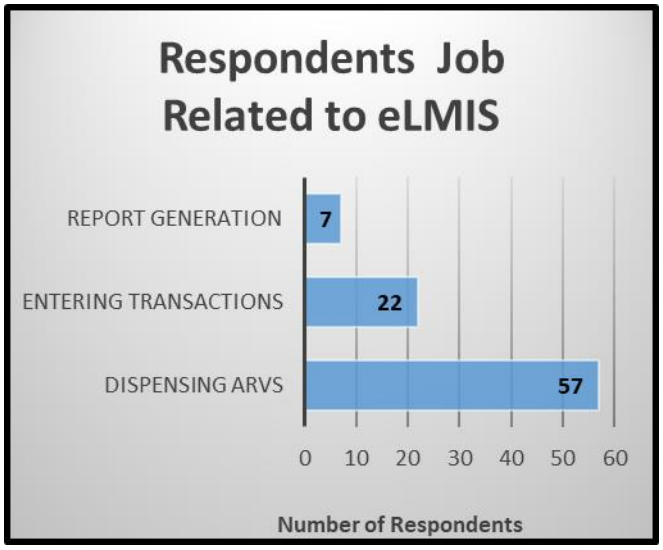


**Fig. 1:** Respondent's job related to eLMIS

**Functionality of eLMIS for the intended use**

The functionality of the eLMIS software was accessed according to the intended purpose of use as displayed in the diagram below: According to the majority 89% (72/81) of respondents, the eLMIS was functioning well whilst the minority 11% (9/81) declared the eLMIS was not functioning well. There were no responses from 19 respondents who have not been included in the diagram, as they are newly deployed staff who have not yet been oriented fully in the eLMIS.

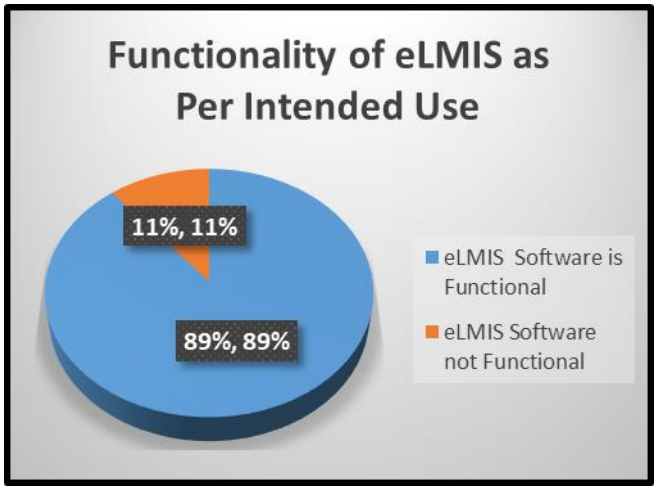


**Fig. 2:** Functionality of the eLMIS as per the intended use

**Effect of eLMIS on overall job responsibilities**

According to the figure below, respondents were asked to give feedback on the effect of the eLMIS towards their overall job responsibilities. That is, if the eLMIS has made their work easier and if it has reduced reporting responsibilities.54% (54/100) confirmed that eLMIS has reduced the workload compared to the period before it was implemented.19% (19/100) reported that eLMIS has increased the workload, 1% (1/100) confirmed there is no effect on the overall workload. There were no responses from 26 respondents, as they are newly deployed staff who have not yet been oriented fully in the eLMIS.

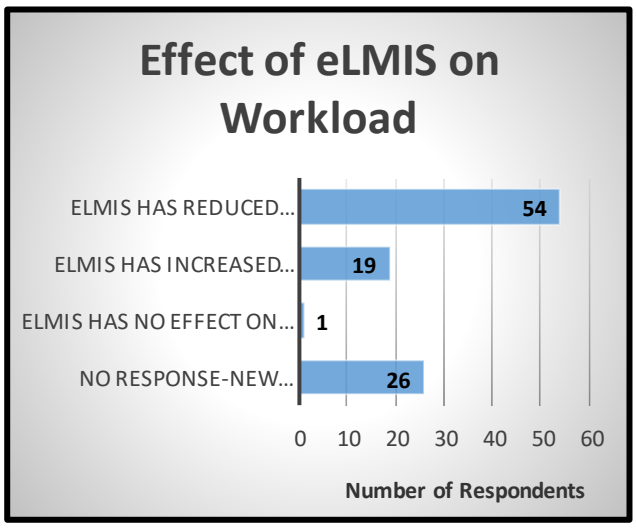


**Fig. 3:** Effects of eLMIS on workload

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**Respondents Recommendation to Roll-Out eLMIS to More Facilities**

According to the figure below, respondents were asked to give a recommendation as to whether eLMIS can be rolled out to other facilities.67% (67/100) proposed to roll-out eLMIS to more facilities. 17% (17/100) were not for the idea of rolling out to more facilities. 1% (1/100) was not sure whether it should be further rolled out and 15% (15/100) did not give any recommendation because they are newly deployed staff and have not been oriented and not interacted with the eLMIS much.

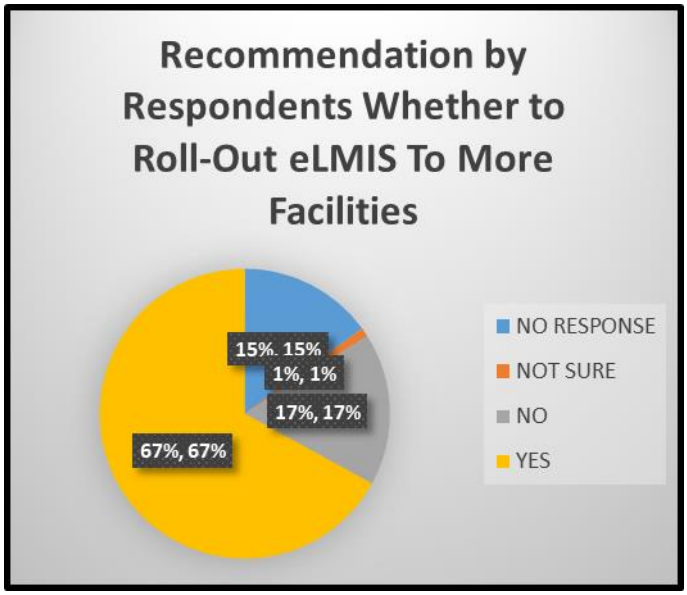


**Fig. 3:** Recommendation by respondents whether to roll-out the eLMIS to more facilities

**Timeliness of Reporting**

Timeliness of reporting in eLMIS is determined by how long it takes between data capture and up to the time the report is submitted. It can be observed from the table below, that 80% (16/20) of the pharmacy staff take beyond one day to submit reports using the eLMIS, 75% (3/4) take one day, 94.7% (18/19) take one to two hours, 100% (17/17) take two to four hours. And a total of 72% (72/72) of the responses acknowledged the functionality of the eLMIS system as intended out of the 100 respondents. Since the observed (p-value=0.000) is less than expected significance level pf (p=0.005), we have evidence to conclude that the variables are independent of each other. (The independent variable has an independent influence on the dependent variable).

**Reporting Frequency**

Reporting frequency relates to how often users of the eLMIS submit their monthly report and requisition for the re-supply of ARV drugs. In terms of submission of reports, the table below shows that 91.4% (53/58) of staff manage to send reports on a monthly basis as per the fulfillment of reporting requirements.

Since the observed (p-value=0.000) is less than expected significance level pf (p=0.005), we conclude that the variables are independent of each other. (They have an independent influence on the dependent variable).

**Reporting Accuracy**

Reporting accuracy in eLMIS compares the accuracy of the data in the eLMIS with the data on the manual Stock Control Card (SCC). It can be observed from the table below, that 92.7% (38/41) of responses confirm an improvement in the accuracy of generated reports from the eLMIS, 77.8% (21/27) found reporting to be inaccurate.

Since the observed (p-value=0.000) is less than expected significance level pf (p=0.005), we conclude that the variables are independent of each other. (They have an independent influence on the dependent variable).

**Stock/Product Availability**

Stock availability is a key component of eLMIS functionality, it means a health facility should have the recommended maximum stock levels of ARV drugs. Hence, as confirmed from the table below, 95.5% (42/44) Pharmacy Staff confirmed improvement of stock availability of key ARV drugs, whilst 75.7% (28/37) confirmed non-

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improvement of key ARV drugs. Two respondents were not sure if there was an improvement in stock availability of key ARV Drugs.16 Respondents did not give any feedback as they are newly recruited and are not familiar with the system.

Since the observed (p-value=0.000) is less than expected significance level pf (p=0.005), we therefor conclude that the variables are independent of each other. (They have an independent influence on the dependent variable).

**Reports/Data Accessibility**

Reports and Data accessibility in eLMIS is essential for the provision of real-time supply chain data that is used to make well informed supply chain decisions. Hence, the table below shows that, reports and data are very accessible by 86.8% (46/43) of the staff that are using the eLMIS have access to key reports.66.7% (2/3) were found to be quiet accessible, 100% (8/8) not very accessible and 11.1% (2/18) confirmed no accessibility at all.33.3% (2/6) were not sure if reports were accessible.

Since the observed (p-value=0.000) is less than expected significance level pf (p=0.005), we conclude that the variables are independent of each other. (They have an independent influence on the dependent variable).

**Data Transparency.**

Data transparency captures the extent of the visibility and easy accessibility of data by end users and any other Supply Chain Managers in a transparent manner. It can be observed from the table below, that 90.5% (38/42) of respondents confirmed that the eLMIS has brought about transparency of data. 8.6.8% (33/38) of Respondents reported that introduction of the eLMIS has not brought about transparency of data.

Since the observed (p-value=0.000) is less than expected significance level pf (p=0.005), we conclude that the variables are independent of each other. (They have an independent influence on the dependent variable).

### 4.2 Discussion & Interpretation of Findings

#### 4.2.1 Discussion

The number of people receiving antiretroviral treatment (ART) has increased considerably in recent years in Zambia and is expected to continue to grow in the coming years. A major challenge is to maintain uninterrupted supplies of ARV drugs and prevent stock outs. Commodity security of ARV drugs in Zambia, is fully attained if each and every client has the ability to obtain and use ARV drugs at any given time, using any of the ART Health Facilities. This is achievable through the availability of an effective and well-functioning electronic logistics system, for the supply and ordering of ARV drugs.

In this Section, the findings will be discussed in light of the main objective of this study, which is to identify the effects and contribution of the electronic logistics management information system for ARV drugs, to the overall supply chain performance at Health Facilities in Zambia.

The discussion is framed around four topics identified as important to approach the research questions: 1. How has the electronic logistics management information system improved data quality and use at the health facilities? 2. What is the contribution of the electronic logistics management information system to improving reporting frequency, timeliness and accuracy of submitted health facility commodity requisitions? 3. What are the effects of the electronic logistics management information system on data accessibility and transparency? 4. What are the notable improvements in product availability and stock status of ARV Drugs?

Findings of this study have shown that, the introduction of the electronic logistics

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management information system has improved HIV service delivery of key essential ARV drugs in Zambia.

### 4.2.2 Interpretation

Availability of electronic information systems for the management of HIV drugs has a substantial role in the implementation of effective and efficient HIV logistics service delivery. The eLMIS indicates some important strengths, as well as system and areas of improvement, as per the responses from the respondents.

In the present study, the eLMIS which is the national tool in Zambia for reporting logistics data, has been made available to selected facilities within Lusaka and other Districts. However, results show that despite the availability of the system in the health facilities, about 14% of staff do not use the eLMIS as they are either newly recruited or have not been provided with orientation/on the job training. This result is similar to the study conducted in Ethiopia by Kefyalewu and Tiye in 2017, on the effect of data quality of the heath information system, for the use of information for decision making and planning. The study identified that, one of the challenges attributed to the poor utilization of the electronic health information system, was because of inadequate training and orientation of the system to users. This shows that HIV service delivery may be affected by failure to use the eLMIS, which is attributed to non-orientation of eLMIS users that are managing the reporting and ordering of ARV logistics in the health facilities.

Regarding data quality and reports, results of the study regarding how the eLMIS has impacted data quality and use of ARV drugs, were measured by the reporting accuracy. Results showed that, 56% active trained users in the eLMIS confirmed an improvement in the quality and accuracy of data and reports. However, the findings in the study of Kefyalewu and Tiye in Ethiopia, recorded a higher percentage of 64.6% accuracy of data and reports. Another study conducted by SIAPS (System for improved access to Pharmaceutical Services) in Cameroon in 2011, reported the quality and accuracy of reports and data being at 75%.

Results of the study regarding reporting frequency and timeliness have shown that 91.4% of respondent's manage to submit their ARV drug reports on a monthly basis for the last six months. The non-responses of 41% were attributed to the lack of knowledge and orientation of staff in the eLMIS, by the newly recruited staff. This is higher than that of a study in done in Malawi and Nigeria by Bock and Tien in 2011, were 58% managed to submit their reports on a monthly basis. Data collected on timeliness revealed that about 40% take at least a day or less to submit their reports through the eLMIS.

Regarding data accessibility and reports, 46%, that is out of the 53 reported had access to reports and data in the systems. Reports accesses and generation is critical to the well-functioning of a stable ARV logistics system. Access to data and reports enables supply chain decision makers to make well informed decisions of ARV drug stock status so as to avoid stock outs and to enable stable continued management of HIV service delivery in Zambia.

Results on product availability and stock status showed that 95% of respondents confirmed an improvement in the stock availability of key ARV drugs. A similar study conducted by David and Bayobuya in Namibia in 2018 regarding the assessment of an integrated pharmaceutical management information system, showed that the electronic system dashboard improved stock levels, and enabled facilities with stock levels above the maximum buffer stock needed, to redistribute accordingly to avert stock outs or wastage.

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## 5.0 CONCLUSIONS & RECOMMENDATIONS

### 5.1 CONCLUSION

Electronic information systems are key to ensure commodity security of key ARV drugs for the successful implementation of HIV service delivery. This study provided evidence that the major challenge that influences the users to manage the eLMIS appropriately is the lack of training/on the job training of newly recruited staff in the Ministry of Health (MOH). Hence, the lack of training by most staff significantly affected the responses, especially from the health facilities, which have been deployed with the eLMIS, but have no trained staff to manage the system.

From this study, it has been concluded that electronic information systems require allocation of resources and time to attain the full change maturity model. The management of ARV drugs is critical for improving HIV service delivery in Zambia. The reporting and ordering of ARV drugs enable an uninterrupted supply to health facilities, which in turn helps improve access to the ARVs and contributes to better health outcomes.

The eLMIS is a national tool in Zambia that collects and stores logistics data for health commodities in real time. It creates a common information platform for decision making. Results have shown that the system has improved the availability and visibility of key ARV drugs in Zambia, contributing to better inventory management and timely decision making of supply chain challenges. There has been improved stock availability and increased visibility of data and reports. Further, it has been concluded that there been an improvement in the quality and accuracy of reports as well as improved frequency of sending monthly reports.

From the findings of this study, it can be concluded that the efficiency and stability of the eLMIS, is key to the success of the provision of key ARV drugs in Zambia. Hence force, this enables the continued availability and accessibility of data and reports in the eLMIS, in order to make key supply chain decisions, as well as transparency of logistics ARV data for key users.

The study also concluded that Training/Onsite Orientation is vital for eLMIS users, so that they effectively use the system without any challenges.

### 5.2 RECOMMENDATIONS

Based on the findings of this study, the following recommendations are suggested:

I. The study provides evidence on how consistent training of the users can contribute to effective use of the system. Thus, new users who come on board should immediately be provided on the job training, so that there is system continuity, regardless of the user being newly recruited or has been in the system for a long time. Training is an important intervention that affects not only procedural knowledge but also plays a role in change management by influencing users' beliefs and intentions to use the system efficiently.

II. In addition to user training needs, effective and continuous technical support sessions should be consistently done, so as to increase the user knowledge based on report generation and data analysis. Findings showed that most respondents had minimal knowledge on access and generation of key reports in the eLMIS.

III. There is need for the continued support and improvement of internet for the electronic logistics management information system's functionality, which enables users to submit their reports at the end of the month. Internet bundles should be consistently provided and efficient

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follow ups made to health facilities on the stability of the internet.

IV. Future studies of this nature should take in account an assessment of user's knowledge of the manual (paper based) logistics system, so as to ascertain the knowledge gaps in the usability of the eLMIS. For a user to confidently use the system efficiently, there should be a thorough understanding of the manual business process, as the electronic system functionality has been developed based on the paper-based logistics system business process.

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