CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Zambia, has over the last few years witnessed health system changes that have largely been influenced by HIV/AIDS, and related health problems. This has necessitated the increased resource allocation to health care management with observed positive outcomes (ZNHSP 2006-2010). These justifiable scale-ups in enrolment for treatment and consequent increase in supply of medical supplies have also complicated the management of the health system by the consequent imbalance among influencing factors such as infrastructure, human resource availability and training, technical advancement, and technology. As a result, it has become increasingly important for countries to take a holistic view of public health systems and optimize their supply chains in order to most efficiently and effectively use scarce resources and to ensure commodity security for all health commodities (USAID | DELIVER PROJECT, Task Order 1. 2008).

In this light, the country, under the National Health Strategic Plan 2006-2010, prioritised systemic intervention areas which were meant to facilitate the efficient and effective management of the health sector. Of these, there has been a great emphasis on the human resource crisis that the health sector has been experiencing. This is compounded by inadequate infrastructure and equipment necessary for quality and cost effective healthcare service delivery. To mitigate some of these consequences, the Plan provided for the establishment of the pharmaceutical Logistics Management Information System (LMIS), which was rolled out in 2008, and was intended to help personnel collect and

manage the information necessary to support sound and objective decision making in managing the supply chain, and therefore an effective inventory control system for pharmaceuticals.

From the 2011 to 2015 National Health Strategic Plan, it was observed that during the period 2006 to 2008, the supply of essential drugs and medical supplies remained erratic, however, during the years, 2009 and 2010, drug availability improved to over 80%. The Plan also showed that the emergence of new programmes, limitations in human resources, weak supply chain management at certain levels, growing demand on services, and lack of appreciation of the logistics function as a core activity in health delivery system, negatively affected performance in this area (ZNHSP 2011-2015).

1.2 Problem Statement

There have been reports of pilferage and seized government drug products in the media in most cases with no corresponding reports of loss of inventory from public health facilities. Published media reports have quoted arrests for theft and seizures of ARV drugs (Chibulu, 2011). In some cases however, it could be inferred that facilities lose drug inventory, but are either not able to detect it or that there is rampant theft in the health facilities, as media reports do not correspond with any reported loses (Chakwe, 2012).

Currently, the Zambia National Health Strategic Plan (ZNHSP, 2011-2015) has highlighted personnel shortages and lack of storage space as some of the reasons why pharmaceutical management is not up to date. The plan has given strategic direction in these areas to complement the Logistics Management Information System (LMIS).

Notwithstanding, it is needful to determine whether health facilities are accountable for

the products they receive, and whether accountability challenges are explained by other factors, besides pilferage.

1.3 Rationale

The study was intended to explore possible causes of inventory errors in Co-trimoxazole 480mg tablet management, other than theft. The study also hoped to show how factors such as product density, staff to client ratio, use of inventory tool, product turn-over, cycle counting frequency and training in LMIS related to the Co-trimoxazole 480mg tablet inventory record accuracy, hence, inform system design amendments to present LMIS for more efficiency.

1.4 Research Question

Are the facilities recording inventory errors for the Co-trimoxazole 480mg tablet supplies they receive and what are the major factors associated with these inventory record errors?

1.5 Research Objectives

1.5.1 General Objective

To assess accountability for Co-trimoxazole 480mg tablets in antiretroviral therapy in Primary Health Facilities in Lusaka and explore how it is influenced by product density, staff-to-client ratio, use of inventory tool, inventory turnover, training, and cycle counting.

1.5.2 Specific objectives

a. To determine the number of facilities unable to account for 1% or more of Co-trimoxazole 480mg (Inventory record error > 1%).

b. To quantify the total value of Co-trimoxazole 480mg tablets not accounted for.

c. To model how staff to client ratio, product density, use of control tool, product turn-over and cycle counting frequency affect inventory record errors

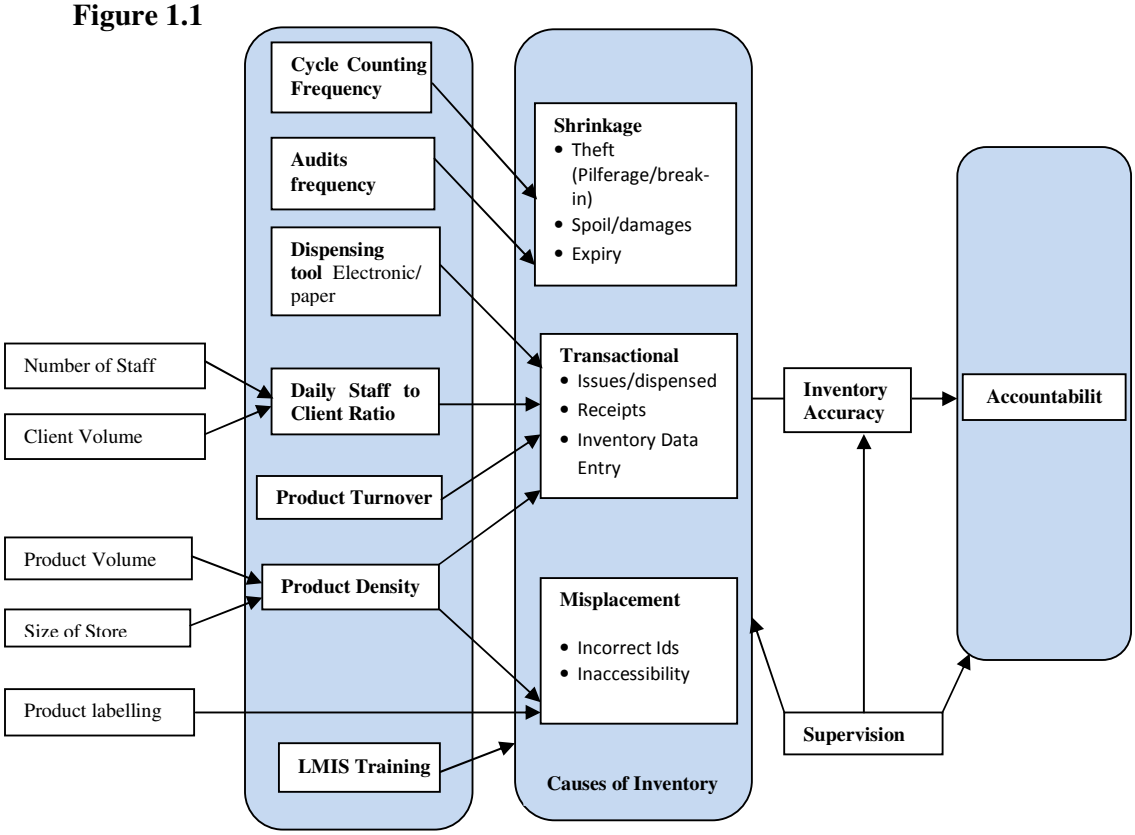
1.6 Measurements

Table 1.1: Variable Measurements

Type	Variable	Description	Measurement
Dependent	**Inventory Record Error**	**$\frac{\text{Calc. Cons. – Recorded Cons.)}}{\text{Calculated Consumption}}$**	**Ratio Scale**
Independent	**Product Density**	**$\frac{\text{Total units/month}}{\text{Storage space}}$**	**Ratio Scale**
	Staff to Client ratio	**$\frac{\text{Total clients enrolled}}{\text{No. of staff in department}}$**	**Ratio Scale**
	Use of Inventory Tool	**$\frac{\text{No of Days of entries}}{\text{Total No. of working days}}$**	**Ratio Scale**
	Indicator Product turn-over	**Total No. of units handled/month**	**Ratio Scale**
	Cycle Counting Frequency	**$\frac{\text{No. of cycle counts in period}}{\text{No. of months in period}}$**	**Ratio Scale**
	Training in LMIS	**$\frac{\text{No. of staff trained}}{\text{Total No. of staff}}$**	**Ratio Scale**

1.7 Conceptual Framework

Figure 1.1



CHAPTER TWO

2.0 LITERATURE REVIEW

Good accountability for resources is the pinnacle for the effective management of any institution in any area of industry. Though seemingly straightforward, it is however a far more complex concept to execute amidst the other organisational dynamics of an institution.

Though literature on inventory accuracy in various industrial institutions is vast, studies that directly relate to healthcare facilities such as hospitals are very few, not withstanding that the accountability requirements are similar.

Brinkerhoff (2003) defines accountability as either financial, performance or political. He defines financial accountability as the process that concerns tracking and reporting on allocation, disbursement, and utilization of financial resources, using the tools of auditing, budgeting, and accounting, while performance accountability as demonstrating and accounting for performance in light of agreed-upon performance targets. These definitions are linked in the sense that financial resources to be accounted for are intended to produce goods, services, and benefits for citizens. They both affect the political arena also, by the requirement of responsiveness to citizens and achievement of service delivery targets that meet their needs and demands.

Brinkerhoff (2003) highlighted the gravity of accountability demands on developing countries, as a large proportion of health funding in these countries is donor funded. This has resulted in pressure for health system accountability arising from the International Monetary Fund, World Bank, WHO, and various bilateral agencies such as USAID. Brinkerhoff (2003) demonstrated that accountability challenges are multilevel, and his

paper showed how that accountability enhancing strategies could be level specific, targeting the health system, the facility, or the individual health service provider. Inferring from a study, Brinkerhoff (2003) observed that regardless of the level, the strength of the information system was the hallmark of accountability-enhancing interventions in any organisation (Bloom, 2000). It is reported that medicines are the second largest expenditure after staff cost in any health system, according to the World Health Organisation (WHO *Medicine Strategy* 2002-2003).

The World Bank (1994) further noted that over 80% of the original budget on health in most African countries is lost through inefficient practices at various levels, by various accountability failures in the supply chain for medical supplies.

At facility level, the biggest highlight of accountability challenges is shown by inaccuracy or errors of inventory records. Inventory record error, may be defined here as difference between the physical and informational inventory expressed as a percentage. That is, the recorded inventory quantity of an item fails to match the quantity found in the store (DeHoratius and Raman, 2004).

Observations in Tanzania showed that inventory record errors were because dispensing registers were not routinely and systematically utilised. It was observed that five out of eight hospitals assessed had poor records that made efficiency measuring difficult. In inspection carried out in private pharmaceutical outlets, it was reported that 5% of 1396 drug stores inspected in 2006 had items that were meant for the public sector. These findings were attributed to reasons such as poor record keeping in health facilities, same people receiving and also dispensing, staff also owning drug stores and poor overall drug management (Tanzania drug tracking study, 2007)

Elimination of inventory record errors can reduce supply chain costs as well as reduce the level of stock out even if the level of factors such as processing quality, theft and expiries were to remain unchanged. Performance of an organisation is even increased further when the factors that cause inventory record errors are curbed (Fleisch and Tellkamp, 2004).

While similar challenges were observed in Nazareth Mission Hospital in Kenya, Mogere et al., (2004) demonstrated that the accountability challenges were alleviated with the use of electronic dispensing tools.

Fleisch and Tellkamp (2004) observed that upgrade to Radio Frequency Identification (RFID) may be a very good option to track stolen or unsalable items, or bar coding technologies, but this would usually come at a high cost and with technical limitations. They noted that upgrade to technological inventory management would still rely heavily on frequency of inventory checks of physical counts against the information system inventory. The study showed that bar coding would not be able to detect whether something was stolen or unsalable, unless by the more expensive radio frequency identification (RFID).

In retail settings, where there is routine use of information systems to monitor inventory, it was observed that more than 65% of the inventory records did not match the physical inventory (Raman et al., 2001). This showed that perfect inventory records would still remain a real challenge, howbeit smaller.

Studies have also shown that inventory record errors can also be drastically reduced by overall counts which may be deeper audits annually or biannually. This further improves awareness and visibility of such measures among those working in the supply chain, and

hence serves as a deterrent. Regular inventory counts also help pin-point origin of operational issues which need intervention.

In most hospitals, small level inventory variances is accepted, but while it differs from organisation to organisation, experts say variances should not be more than 1% of each product line. Where pilferage is suspected to be occurring in a hospital, it is recommended that outsourcing of personnel with no affiliation to the hospital personnel be done as it is thus easier to identify inventory inaccuracies (MHS, 2002).

Causes of inventory inaccuracy have been discussed extensively in literature. Kang and Gershwin (2008) categorises them broadly as either being known or unknown causes. Known causes refer to those causes that would subsequently be known to the manager because of documentation, such as spoilages or generally becoming unsalable or unusable. Unknown causes are those that would show loss but without any indication of where the products went, e.g. due to theft.

More specific categorisation of causes included stock loss (or shrinkage), transactional errors, inaccessible products and incorrect product identification. Unknown stock losses were identified as the dominant factor causing inventory errors in most industries (Kang and Gershwin, 2008).

Bensoussan et al., (2007), in another study looked at the causes of inventory record errors; classified the causes as due to transactional errors, misplacement, spoilage, product quality and yield, and theft. They observed that inventory record errors were explained by many factors and concluded that treating these factors would also reduce the problem.

Atali et al., (2006) looked at the issue of causes of inventory record errors in the retail

industry and classed some of the causes as due to misplacement, shrinkage and transactional errors. They acknowledged the problem to be costly to any industry if left untreated, and assessed the benefits of radio frequency identification device (RFID) technology in inventory management by better traceability and improved visibility of products, hence offsetting the challenge of label identification errors. They also showed an increase in the efficiency and speed of processes, improvement on information accuracy, reduction of inventory losses and showed that RFID helped reduce inventory record errors when other influencing factors are under control.

Impact of inventory record errors on supply chain performance varies by factor that causes the inaccuracy. Of all the causes, theft remained the dominant factor, as shown by Fleisch and Tellkamp (2004).

Rossetti et al., (2008) examined the subject of inventory record error and showed that with dedicated resource allocation and computer system support, companies in the retail industry achieved around 99% performances in inventory record accuracy. This was with emphasis of funding the inventory management processes and deliberately eliminating process errors. This demonstrated that companies without deliberate inventory control policy had an increased cost business and high shrinkage, and would therefore benefit from increased cycle counting.

In a survey of manufacturing company inventory accuracy, Springsteel (1994) highlighted the benefit of cycle counting. He reported that 20% of those firms that used cycle counting achieved an overall individual item inventory record accuracy of 98% or higher and more than 60% reached accuracies of 90% to 97%, in spite the acknowledging the fact that accuracy could be seen differently from facility to facility.

Morey (1986), in a modelling study, suggested that there is a minimum required frequency period between audits that is adequate to maintain an accurate inventory record with measures of increasing the safety stock. Graff (1987), however, gives an alternative view, emphasizing that the frequency of cycle counts merely provides a measurement of the inventory, and it alone is inadequate to control or improve the inaccuracy. Opolon et al., (2009), in the simulation model shares this notion after the study model demonstrated that many service level metrics become inaccurate under imperfect recording, even when relatively frequent periodic counts are implemented as a countermeasure.

DeHoratius and Raman (2004) in their empirical analysis of inventory record error demonstrated that frequency of cycle counts did not impact inventory accuracy as expected. They observed that inventory record error was associated with the density of the inventory. This, however, did not imply that the complexity of high volume inventory management could not be managed, but simply that there was need for managers to focus more on the causes of these inaccuracies.

While the causes of inventory record error are similar from industry to industry, the degree to which such causes occur is dependent on the understanding of the factors causing them and the interventions that are made. It is almost unanimous that the upgrade to technological methods is able to improve inventory accuracy to a large degree, howbeit, not flawless. It is widely agreed that technology improves processing time and ease of error identification in both the retail and hospital setups. While such advancements are desirable, they would still remain costly and technically challenging, though surmountable, in the developing world.

Cycle counting has been inherent in the LMIS in Zambia's health system, but with the lingering inventory challenge, outsourced audit counts would be a better addition to strengthen the inventory management process, with possible deterrent benefits on perpetrators.

With the experiences of inventory management in the Zambian health system, it is apparent that inventory record errors need a full context approach, as opposed to single factor rectification.

CHAPTER THREE

3.0 METHODOLOGY

3.1. Study Population

The study population was Pharmacy Departments of public health facilities that were offering primary healthcare in Lusaka, under the supervision of the Lusaka District Health Office of the Ministry of Community Development, Mother and Child Health.

3.2. Study Setting

The study was conducted in primary healthcare facilities, servicing over 1,737,206 people in Lusaka District (CSO 2010; Pre-Report). These facilities comprised five (5) first-level hospitals and twenty-two (22) health centres. The first-level hospitals included Chipata, Kanyama, Chawama, Chilenje and Matero Referral. Of the twenty-two health centres, seventeen were offering full ART services, while five were PMTCT-only sites. Three, of the eighteen full ART health centres, namely Kara, Bwafwano Home Based Care and SOS Medical Centre were private health facilities. All of the pharmacy departments in the facilities were managed by Pharmacy Technologists, who were assisted by Nurses and other health workers in situations of personnel shortfall.

3.3. Study Design

The study design was an analytical cross-sectional study. The choice of study helped in the assessment of prevalence of the problem at a point in time. The study was conducted in retrospect.

3.4. Sampling

There were only 23 facilities offering full ART services under Lusaka DCMO, therefore, convenience sampling was the most appropriate sampling method.

Inclusion Criteria

- Must have been at least a health centre
- Must have been supported by CIDRZ, in data management.
- Must have been supported by USAID | Deliver, in logistics services
- Must have been offering full ART services.

3.5. Sample size

There were twenty-one facilities, after subjection to the inclusion criteria. To increase the sample size to observe effect, retrospective panel data from cross-sectional points of first quarters of 2011, 2012 and 2013 were used to run regressions using fixed effect estimators. A panel data (or longitudinal data) set consists of a time series for each cross-sectional member in the data set. This brought the sample size observations to sixty-three (n = 63). Panel data sets are most useful when controlling for time-constant unobserved features of people, firms, cities, and so on, which may be correlated with the explanatory variables in the model. One way to remove the unobserved effect is to difference the data in adjacent time periods using fixed effect estimators (Wooldridge, 2003). In principle, the mean of time series data from each observation was subtracted (differenced) from each observation of each year. This was expected to give observations that had no adulteration of factors that did not change over time, to fulfil the condition of variability in the explanatory variable for regression.

3.6. Data management

The type of data employed in the study was secondary. The data was sourced from the Lusaka District Community Medical Office (LDCMO): namely facility enrolment and active patient numbers generated by CIDRZ for LDCMO; the storage space analysis by USAID | DELIVER for LDCMO; and Facility supply vouchers, from LDCMO ART Warehouse. The transactions required from Daily Activity Register (DAR) and Stock Control Cards (SCC) were obtained from the respective facility pharmacy departments.

A data compilation form (Appendix 1) was used for each facility under study. The data collected spanned three months periods of Jan – Mar, of 2011, 2012 and 2013, with respect to Co-trimoxazole 480mg tablet. Where the specified three months period was without data, a proxy three months period with data in the same year was used. This was Co-trimoxazole that was ordered and delivered from the DHO ARVs Warehouse, in the period under review. The choice of Co-trimoxazole and not an antiretroviral drug was on the basis that it is a high volume consumption drug, and that its use cuts across the ARV regimen. The best alternative, the Fixed Dose Combination tablet of Tenofovir-Emtricitabine-Efavirenz, had a shortfall of having been rolled out late into the preferred study period to give reliable estimates.

The data was entered into Excel and checked for completeness on a daily basis. The cleaned data was loaded into STATA version 11.0 for analysis. Variables were summarized and univariate analyses were performed. P-values below 0.05 were considered.

3.7. Ethical Considerations

The study did not have any contact with patients. Since the study address possible inefficiencies in commodity management at the service delivery point, the identities of the facilities were concealed by using a coded data collection tool. The participant facilities were made to understand the safeguards.

Ethical approval was obtained from the Excellence in Research Ethics and Science (ERES) Ethics Committee. Further letters of permission were secured for the use of data from the Ministry of Community Development, Mother and Child Health, through the Lusaka District Health Office. Particular data obtained did not bear any personal attachment, but basic statistic counts.

CHAPTER FOUR

4.0 RESULTS

The histogram of measure of inventory error across all facility observations reveals both under accounting and over accounting normally distributed about zero (Fig. 4.1). The inventory error ranged from 46% more inventory than expected to 60% short of the expected, with an average of about 4.89% not accounted for.

Figure 4.1: Frequency Distribution of Inventory Error

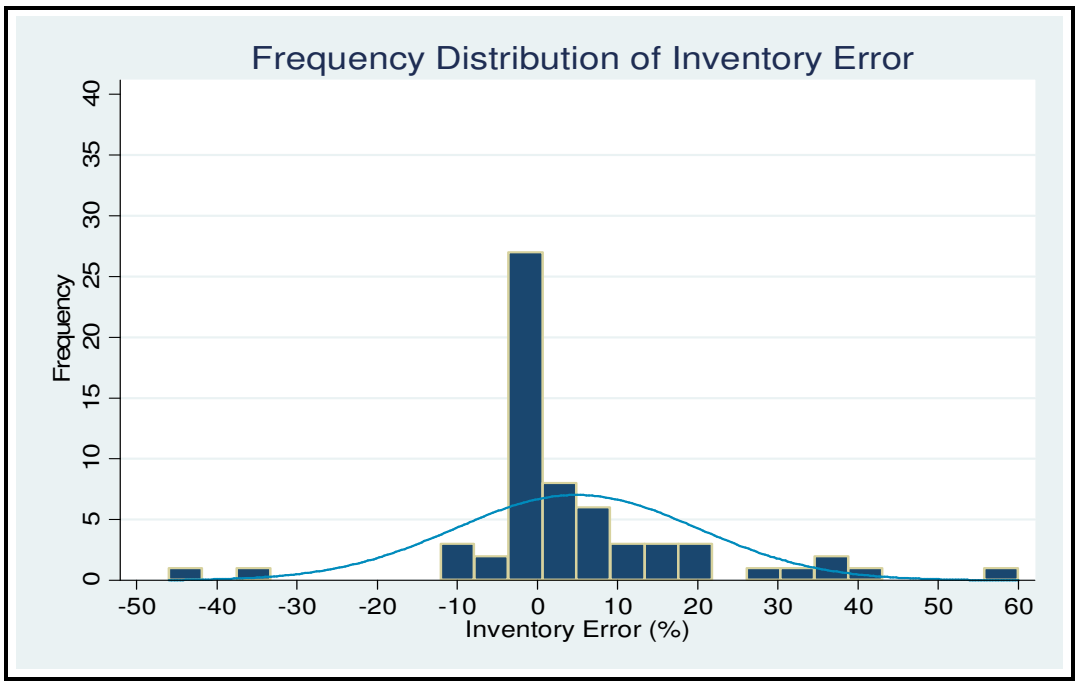


Table 4.1: Number of Facility observations recording Inventory Error

	Number of facilities (%)
Facility Observations with Inventory Error	42 (66.7)
Facility Observations without Inventory Error	21 (33.3)
Total	**63 (100.0)**

Table 4.1 reveals that 42 (66.7%) of all inventory records for Co-trimoxazole 480mg tablet had errors.

Further review showed that 27 (64.3%) of the 42 facilities that recorded inventory errors could not account for more than 1% of the Co-trimoxazole 480mg tablet expected to be in inventory (Table 4.2).

Table 4.2.: Observations with inventory error, showing those greater than 1%

	Number of Observations (%)
Observations with Inventory Error > 1%	27 (64.3%)
Observations with Inventory Error <= 1%	15 (35.7%)
Total - observations with inventory errors	**42 (100.0)**

The amount of Co-trimoxazole 480mg tablet in facility observations with inventory error greater than 1% uncounted for, translated to 1958 bottles by 1000 tablet. This represents 19% of the total amount of Co-trimoxazole 480mg tablet (10,185 bottles) that was issued to the forty-two facilities. By Central Medical Stores Limited Dispatch Note (June 2014) pricing, this gave a monetary value of KR 84, 585.60, unaccounted for, (Table 4.3).

Table 4.3.: Total Amount of Co-trimoxazole 480mg tablet not accounted for, for Observation of inventory error > 1%.

	Units difference (1000 tabs)	Unit Cost (Kr) According to current MSL pricing (June, 2014)	Total Cost (Kr)
Jan – Mar 2011	682	43.20	29,462.40
Jan – Mar 2012	486	43.20	20,995.20
Jan – Mar 2013	790	43.20	34,128.00
Total	**1958**		**84,585.60**

4.1. Univariate Regression Analysis

Table 4.4.: Variable Definition and Sample Summary Statistics

Variable	Obser.	Mean	Std. Dev.	Min	Max
Inventory record Error	63	4.89	15.16	-46	60
Product Density	63	1332.23	1000.82	122.8	6017.2
Staff to Client Ratio	63	76.9	79.4	2.6	466
Proportion Use of Inventory Tool	55	0.89	0.97	0.5	1
Indicator Product Turn-over	63	127.43	87.62	0	354.3
Cycle Counting frequency	63	0.84	0.28	0	1.33
Prop. Of Personnel Trained in Inventory Management	63	0.75	0.34	0	1

Table 4.5.: Univariant Analysis

Independent Variable	Regression Coefficient	Standard Error	p-value	95% CI
Product Density	0.00096	0.00204	0.638	(-0.003,0.005)
Staff to Client Ratio	0.00764	0.02689	0.776	(-0.045,0.060)
Proportional Use of Inventory Tool	-57.512	23.611	0.015	(-103.8,-11.23)
Indicator Product Turn-over	0.00710	0.02442	0.771	(-0.041,0.055)
Cycle Counting frequency	10.063	6.9323	0.147	(-3.523,23.65)
Prop. Of Personnel Trained in Inventory Management	-1.896	6.176	0.759	(-14.0,10.21)

Product Density

As from Table 4.5, the univariate regression of inventory error on product density gave a statistically insignificant P-value (p-value = 0.639) and a regression coefficient that was very close to zero (0.00096). The scatter plot of the two variables showed a line with almost zero gradient, hence no graphical relationship between inventory error and product density was observed.

Staff to Client Ratio

Staff to Client ratio also showed an insignificant p-value of 0.776 (Table 4.5). As was with product density, regression diagnostics for relationship using a scatter plot showed no graphical relationship between inventory error and staff to client ratio.

Proportion of Use of Inventory Tool

From Table 4.5, the univariate regression of inventory error on proportion of use of invetory tool shows an indirect relationship. The result show that a unit increase in the proportion of use inventory tool, decreases the inventory error by a 57.512% and this decrease could be as high as 103.3% to as low 11.23%, bearing in mind that there were cases of over, and under-accounting. This relationship was highly statistically significant with a p-value of 0.015.

Indicator Product Turn Over

In addition to being statistically insignificant by p-value of 0.771 (Table 4.5), a scatter plot also showed no relationship between inventory error and indicator product turn-over.

Average Cycle Counting Frequency

The regression of inventory error on cycle counting frequency gave a direct relationship contrary to what was expected from literature, showing an increase of inventory error of

10.063 for every unit increase of the avarage cycle counting frequency, howbeit statistically insignificant, with a p-value of 0.147 (Table 4.5).

Proportion of Staff Trained in Inventory Management

The univariate regression of inventory error on proportion of staff trained was statistically insignificant (p-value = 0.759), and showed no graphical relationship after performance of regression diagnostics (Table 4.5).

CHAPTER FIVE

5.0 DISCUSSION

The study showed that inventory error is still a big challenge in the management of healthcare logistics. About sixty-seven percent (66.7%) of all observations made revealed presence of inventory error, which would pose a big challenge to operational progress. The total amount of Co-trimoxazole 480mg tablets delivered to all the facilities over the periods under review in the study was 18,593 bottles. Of these, 10,185 were issued to the forty-two facilities that recorded inventory error of more that 1%, therefore, about nineteen percent (1958 bottles) of this was lost to unknown causes. This loss can be related, though not in magnitude, to World Bank (1994) report that according to their analysis showed that 80% of the total health budget was lost due to system inefficiencies. DeHoratius and Raman (2004) cited inventory error as the largest contributor to these losses.

Proportion of use of inventory tool

The relationship of proportion of use of inventory tool to inventory error demonstrated statistical significance. Consistent with literature, the analysis showed that increased use of inventory tools reduced the errors in inventory. This is consistent with the Tanzania Drug Tracking Study (2007) that showed that inventory errors were caused by dispensing registers not being routinely and systematically utilised. Review of Daily Activity Registers, the primary record of antiretroviral drug consumption, showed that only 14% of the 63 facility observations had actual dispensed to patient consumption data for the Co-trimoxazole 480mg tablet, notwithstanding that the other products were entered, as expected. This could have affected the precision of the dependent variable, which was

derived from the next best data source, drug stock control cards.

Product Density, staff-to-client ratio, product turn-over and training

In this analysis, product density, staff to client ratio, indicator product turn-over and proportion of personnel trained in inventory management, were found to be unrelated to Inventory record error.

Inconsistent as these results may be, it would appear lack of significant variations in storage space, and its disproportionate allocation against the facilities' demand could have compromised the product density analysis.

Integration and Invariant personnel numbers

It was also noted that the personnel numbers were almost invariant, with an average of 2 (calculated 1.95) persons per facility, in the ART section. The ratio was further compromised by failure of the daily activity registers to capture enrolled clients (above CD4 thresh-hold of 350), who were about 50% of total clients in any of the facilities. Other possible confounder could have been that 11 (50%) of the facilities were 'integrated', implying all clients were seen from one point for medication regardless of the ailment. This could have accounted for the 20 (31.5%) facility observations that reported inventory error of more inventory than expected, possibly owing to having received Co-trimoxazole 480mg tablets from the non-ARV medicines warehouse also. The product turn-over also could have been affected by facilities supplies being driven by availability and not demand.

Basic guidelines for Inventory Cycle Counting

The average number of inventory cycle counts was limited to once per month, the

minimum required by the inventory management standard operating procedures. It therefore could not give enough variability to observe effect relative to inventory error. DeHoratius and Raman (2004), on the other hand, observed that cycle counting does not impact Inventory Error as would be expected.

Owing to the statically insignificant results from univariate regressions and diagnostics, other for than proportion of use of inventory tool, a multivariate regression was not fitted to control for factors that could have effect on inventory error.

CHAPTER SIX

6.1 CONCLUSION

The finding of the study revealed accountability challenges in inventory management at this level of service delivery. Majority of facilities recorded inventory irregularities that this study could not conclusively attribute to factors such as product density, staff to client ratio, proportion of use of inventory tool, indicator product turn-over, cycle counting frequency, and Proportion of Personnel Trained in Inventory Management.

The study could not conclusively state presence or absence of relationship between the Inventory error and the variable factors due to the challenges inherent in the data and system characteristics. The study, however, did show that consistent use of the inventory tool would reduce the Inventory error in the facilities; however, the inability to control for other factors also casts doubt on the strength of this evidence.

After the elimination of the factors analysed in this study, unknown causes, inclusive of theft, remain the dominant cause of Inventory Error in inventory management. This view is shared in the studies by Kang and Gershwin (2008), and Fleish and Tellkamp (2004).

6.2. LIMITATIONS OF THE STUDY AND FUTURE RESEARCH

Some limitations are acknowledged in this study. Firstly, the data records in most facilities were largely incomplete, and were a deterrent to any audit attempts, while some records of financial implication could not be traced from some of the facilities.

Secondly, the study failed to control for other immeasurable factors inherent in the public system. The study could not rule out personnel and facility specific factors that have shown to have significant influence in other studies.

Future research could consider an experimentally prospective approach to control for System flaws.

6.3. RECOMMENDATIONS

- Record keeping system in the facilities should be reassessed to ensure they reflect a true picture of inventory status.
- Systematic financial and operational audits need to be extended to this level of public service to help enhance record keeping and also act as a deterrent, in the event the Inventory Errors were as a result of unknown causes
- Human resource allocation should be proportioned to the service demand in most of the facilities.

REFERENCES

Atali, A., Lee H., and Ozer O. (2006). If the inventory manager knew: Value of visibility and RFID under imperfect inventory information, *Working Paper*.

Bensoussan, A., Cakanyildirim, M. and Sethi, S. (2007) Partially Observed Inventory Systems: The Case of Zero-Balance Walk. *SIAM Journal on Control & Optimization*, 46(1), pp. 176-209. Available at SSRN: http://ssrn.com/abstract=1082935

Bloom G. 2000. *Equity in health in unequal societies: towards health equity during rapid social change*. IDS Working Paper No. 112. Brighton: University of Sussex, Institute for Development Studies

Brinkerhoff, D. (2004). Accountability and health systems: toward conceptual clarity and policy relevance*, Health Policy and Planning*; **19**(6). pp 371–379

Brinkerhoff, D. (January 2003). *Accountability and Health Systems: Overview, Framework, and Strategies.* Bethesda, MD: The Partners for Health Reform*plus* Project, Abt Associates Inc.

Chakwe, M. (2012, 15th February) TALC regrets theft of ARVs. *The Post Newspaper*, Available from: < http://www.postzambia.com/post-read_article.php?articleId=25168&highlight=TALC regrets theft of ARVs> [Accessed 16th October 2012.]

Chibulu, H. (2011, 30th December) Mazabuka health board suspends 3 over pilfered ARVs. *The Post Newspaper*, Available from: <http://www.postzambia.com/post-read_article.php?articleId=24455&highlight=Mazabuka health board suspends 3 over pilfered ARVs> [Accessed 18 October, 2012.]

DeHoratius, N. and Raman, A. (2004) Inventory Record Inaccuracy: An Empirical Analysis. *Working paper*. Graduate School of Business. University of Chicago.

Fleisch, E. and Telkamp, C. (2005) Inventory inaccuracy and supply chain performance: a simulation study of a retail supply chain, *International Journal of Production Economics,* 95 (3) pp 373-385.

Graff, R. T. (1987). The limitations of cycle counting. *Production and Inventory Management Journal* Fourth Quarter, pp 39-43.

Hollinger, R.C. and Davis, J.L. (2001) National *Retail Security Survey Report*, Department of Sociology and the Centre for Studies in Criminology and Law, University of Florida.

Kang Y., and Gershwin, S. B. (2005) Information Inaccuracy in Inventory Systems: Stockloss and Stock-out, *IIE Transactions,* 37 (9) pp 843-859.

Ministry of Health, Zambia National Health Strategic Plan 2006-2010

Ministry of Health, Zambia National Health Strategic Plan 2011-2015

Mogere, P., et al. (2004) Nazareth Managing HIV Pharmaceutical Supply Chain Challenges in Resource-Limited Settings: Nazareth Mission Hospital, Kenya: Catholic Relief Services, Kenya.

Morey, R. (1986) Determining optimal Cycle Count Frequency, *Production and Inventory Management,* 27(1) pp 66-74.

MSL Dispatch Note (June, 2014)

Opolon, D., Schumacher, K., & Sheffi, Y. (2009), Impact of imperfect demand recording on service levels: the case of hospital supplies. *Paper presented at the POMS 20th Annual Conference*.

Rossetti, M. D., Buyurgan, N., Bhonsle, A., Gumrukcu, S., Chittoori, K. (2008) An Analysis of the Effect of Inventory Record Inaccuracy in a Two-Echelon Supply Chain, accepted for publication in the *International Journal for Inventory Research.*

Springsteel, I. (1994) Let's get physical – Not, *CFO*, 10(10) pp 18.

Tanzania drug tracking study; final report 2007. Euro Health Group, Denmark.

USAID | DELIVER PROJECT, Task Order 1. 2008. *Building Blocks for Logistics System Design for HIV Tests and ARV Drugs: Inventory Control Systems, Logistics Management Information Systems, and Storage and Distribution*. Arlington, Va.: USAID | DELIVER PROJECT, Task Order 1.

Wooldridge, J.M. (2003) Introductory Econometrics: A modern approach, Cambridge MA: MIT Press.

White Paper, (2002) Physical inventory in clinical areas; why accuracy is critically important. *Management Health Solutions*. Retrieved on 26th October, 2012, from http://www.mhsinc.com/assets/pdf/case-study/physical-inventories-and-clinical-areas.pdf

World Bank Report. *Better Health in Africa*. Washington: World Bank, 1994

World Health Organization. *Highlights- Who Medicine Strategy*. WHO. Geneva: 2002-2003.

APPENDIX

Annex 1: Data Collection Tool

FACTORS ASSOCIATED WITH HIV DRUG INVENTORY CONTROL

DATA COLLECTION TOOL

Geo-location:

District: ..... **Facility ID:** .....

1 Demographic Data

	Jan – Mar 2011	Jan – Mar 2012	Jan – Mar 2013
Catchment Population			
Number of cumulative service yrs of Pharmacy staff			
Number of pharmacy staff by establishment			
Gender distribution of ART Pharmacy	M ( ) F ( )	M ( ) F ( )	M ( ) F ( )
Total number of ART clients enrolled			

2 Variable Data

2.1 Inventory Inaccuracy (Percentage Error)

	Jan – Mar 2011	Jan – Mar 2012	Jan – Mar 2013
Month 1 Beginning Balance			
Month 3 Ending Balance			

a. Quantity of Co-trimoxazole 480mg issued to facility

	Jan – Mar 2011	Jan – Mar 2012	Jan – Mar 2013
Jan			
Feb			
Mar			
Total			

	Jan – Mar 2011	Jan – Mar 2012	Jan – Mar 2013
Beginning Balance in Jan			
Ending Balance in Mar			

b. Quantity Consumed of Co-trimoxazole 480mg tablets

	Jan – Mar 2011	Jan – Mar 2011	Jan – Mar 2011
Total issues to patient on Bin Cards.			
Total Issued to others departments (Bin Cards)			
Total			

2.2 Staff to client ratio

a. Client Data (HMIS, CIDRZ)

	Jan – Mar 2011	Jan – Mar 2011	Jan – Mar 2011
Average Daily Clinic attendance			
Total number of clients on active ARV treatment at end of period			

b. Personnel Data (HR, Facility)

	Jan – Mar 2011	Jan – Mar 2011	Jan – Mar 2011
Total Staff designated to ART pharmacy			
Total current working number of Qualified Pharmacy Staff in the period			
Number of proxy (unqualified) staff			
Number trained in ART Logistics			

2.3 Average volume of all products managed per month (Issue Voucher) and Proportion of product volume to storage space

a. Total cumulative number of units **(Product turn-over)** of all products supplied over the period

	Jan – Mar 2011	Jan – Mar 2011	Jan – Mar 2011
Total units			

b. Pharmacy store space

	Present	Recommended
Size of Pharmacy Store Area (m^2)		

c. **Product Density** (units/present space)

	Jan – Mar 2011	Jan – Mar 2011	Jan – Mar 2011
Units/m^2			

2.4 Use of Dispensing Tools

	Jan – Mar 2011	Jan – Mar 2011	Jan – Mar 2011
Use of DAR	Y ( ) N ( )	Y ( ) N ( )	Y ( ) N ( )

2.5 Level of Use

	Jan – Mar 2011	Jan – Mar 2011	Jan – Mar 2011
Proportion of days of DAR use			

2.6 Physical Counts/month

	Month 1	Month 2	Month 3
Monthly Physical Counts	Y ( ) N ( )	Y ( ) N ( )	Y ( ) N ( )

End of Tool

Annex 2: Letter of Permission