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An analysis of the effects of laboratory inventory management on the availability of laboratory commodities in Mutare, at Victoria Chitepo Provincial Hospital from January 2022 to December 2024.

BY

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A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF MEDICAL LABORATORY SCIENCES IN THE COLLEGE OF HEALTH, AGRICULTURE AND NATURAL SCIENCES

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ABSTRACT

Laboratory inventory management is essential within healthcare systems as it ensures essential laboratory commodities for accurate diagnosis as well as effective patient care are available. This study analyzed the effects that inventory management practices have on the availability of laboratory commodities at Victoria Chitepo Provincial Hospital Laboratory from January 2022 to December 2024. The research aimed to assess current inventory management practices, identify challenges contributing to stockouts, quantify the impact of these stockouts on laboratory services and patient care, as well as to propose improvements to enhance inventory efficiency. A mixed-methods approach was employed, combining quantitative analysis of inventory records and patient data with qualitative insights from staff interviews. Findings revealed significant inefficiencies stemming from the hospital's reliance on manual inventory systems, which led to frequent stockouts, delays in test results, and disruptions in patient care. Key challenges included inadequate funding (87%), supply chain disruptions (74%), poor record-keeping (65%), and insufficient staff training (57%). Statistical analysis demonstrated a strong correlation between stockouts and adverse patient outcomes, including delayed diagnoses (78%) and increased hospital stays (48%) Recommendations include implementing automated systems, enhancing staff training, optimizing procurement processes, and improving coordination among stakeholders. This study contributes valuable insights into addressing inventory management issues in resource-constrained settings like Zimbabwe. The study also offers actionable strategies to ensure consistent availability of laboratory commodities and improve healthcare delivery. By incorporating laboratory inventory management findings from chapters one through five, this research provides a comprehensive framework on how laboratory inventory management at Victoria Chitepo Provincial Hospital Laboratory can be improved. The research ultimately aims to enhance efficiency in laboratory operations and patient care outcomes.

KEYWORDS : Inventory management ; Laboratory ; Victoria Chitepo Hospital

Declaration

I, Isabel Fero, student number 210697 do hereby declare that this dissertation is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a Bachelor of Science degree.

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Dedication

I dedicate this dissertation to my parents, Mr and Mrs Fero. I would not have completed it without their support, encouragement and belief in my abilities.

List of Acronyms and Abbreviations

AUREC	Africa University Research and Ethics Committee
VCPHL	Victoria Chitepo Provincial Hospital Laboratory
LIMS	Laboratory Information Management System
ERP	Enterprise Resource Planning
LMICs	Low- and Middle-Income Countries

Definition of key terms

Inventory Management - processes for ordering, storing, and tracking laboratory commodities.

Stockouts - unavailability of essential supplies, disrupting healthcare delivery.

LIMS -digital systems for managing laboratory workflows.

Patient Outcomes -health impacts of delayed diagnosis/treatment.

Healthcare Delivery -provision of medical services in resource-constrained

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CHAPTER 1

1.1 Introduction

Laboratory inventory management is a part of supply chain management which ensures availability of the correct resources at the right time and in the right quantities for the laboratory (Rizqi, 2023). It helps keep track of inventory levels within the laboratory so that overstocking or understocking are prevented. (Solution4Labs, 2020) Managing laboratory inventory efficiently and effectively reduces excess stock levels, minimized frequency of emergency orders, saving of costs as right quantity of orders are made as well as improved quality of laboratory services thus promoting healthcare delivery. Inventory control is an essential part within the healthcare system as maintaining an efficient system for inventory management allows for reliable supply of laboratory commodities. (Befekadu, 2020) The aim of this study was to analyse effects of laboratory inventory management practices on availability of laboratory commodities at Victoria Chitepo Provincial Hospital laboratory from January 2022 to December 2024. This research aimed to improve laboratory services efficiency as well as patient care at the hospital by examining the current management system for inventory, identifying challenges and coming up with ways to improve inventory management for efficient availability of laboratory commodities and provision of quality laboratory services.

1.2 Background to the Study

Laboratory facilities are essential parts within the healthcare system which contribute to provision of quality health services. They provide reliable diagnosis as well as monitoring of health outcomes in patients. (Befekadu, 2020) However, their efficiency and effectiveness within the healthcare system relies on adequate availability of reagents, chemicals and other laboratory commodities as well as functional laboratory equipment and premises. It is essential to maintain sufficient inventory levels for laboratory commodities because medical decisions rely on laboratory related information. Laboratory commodities are useful in testing, analysing, storing and disposing clinical specimen for the provision of laboratory services for patients at health institutions. Proper laboratory inventory control therefore allows for seamless accessibility of laboratory commodities. Overstocking laboratory inventory levels often results in wastage, expiration, damage whilst understocking results in stockouts and emergency orders resulting in delivery of poor-quality patient care. Globally, it is essential to manage laboratory

inventory effectively to ensure there is provision of timely and accurate health services within healthcare facilities. Studies have shown that costs associated with storage and wastage of inventory can be reduced and tracking of inventory levels is made easier through implementation of automated inventory management systems. (Bloomfield, 2013) Within the laboratory, effective inventory management is linked to improvements in service delivery. Research pertaining inventory management practices within blood supply underscored the need for use of optimization techniques in making sure that blood products are available when required, specifically during critical times like the COVID-19 pandemic. (Journal, 2022) Continentally, research shows that many countries in Africa face challenges as a result of limited access to technology as well as inadequate infrastructure. According to Hemmed, A., & Issa, I.M. (2022), implementing logistics information systems significantly enhances efficiency of operations within the laboratory through improvement of coordination and reduction of stockouts. In Zimbabwe, economic challenges and resource limitations have negatively impacted the healthcare system to a greater extend. Research shows that poor inventory management practices greatly contribute to shortages of crucial laboratory commodities in Zimbabwean hospitals, with factors like lack of training, insufficient funds as well as logistical constraints worsening these issues. (Journal, 2022) Previous studies show that in middle- and low-income countries less attention is given to laboratory services as part of healthcare. (Boche et al, 2022) Inadequate logistics services, poor admin support and lack of resources are also other pressing challenges in these countries. According to another study conducted by Journal of Pharmaceutical Policy (2020), the quality of laboratory services in resource limited countries that is mostly African countries is poor due to lack of skills in commodity management, ineffective laboratory inventory control, improper storage conditions as well as insufficient storage capacity. However, according to a previous study by Boche et al (2022), assessing inventory management performance and challenges for laboratory commodities in public health facilities, majority of the populations in developed countries fail to access quality laboratory services because of inadequate laboratory commodities. In this study, the authors however brought to attention how in the South Western of Ethiopia where there are difficult weather conditions challenging inventory management performance for laboratory commodities, was excluded from the study due to its remoteness. In my study, I chose Victoria Chitepo Provincial Hospital as it serves quite a significant population and its laboratory is very essential in diagnosis and monitoring of diseases. Studies conducted previously show a relationship between inventory practices and availability of commodities, but certain insights into this hospital's context remain limited.

1.3 Problem Statement

Inventory management has a critical role; however, Victoria Chitepo Provincial Hospital faces challenges with the availability of commodities thus affecting patient care. The inventory management system at Victoria Chitepo Provincial Hospital laboratory is manual therefore monitoring as well as management of inventory levels is difficult. This research aimed to identify underlying factors affecting inventory management as well as how it impacts availability of laboratory commodities.

The effective management of laboratory inventory is essential in ensuring there is continuous availability of essential laboratory commodities in healthcare settings. In numerous public hospitals across Zimbabwe, including Victoria Chitepo Provincial Hospital, use of manual inventory systems has led to significant challenges in maintenance of adequate stock levels, resulting in frequent shortages as well as wastage of vital supplies. Historical data shows that hospitals that use manual systems often experience stockouts and inefficiencies; for instance, a study conducted in Ethiopia revealed that 69.6% of health facilities faced at least one stockout, with an average daily stockout rate of 4% for essential commodities (Bekele, 2022).

The inefficiencies which are associated with manual inventory management are exacerbated by inadequate data accuracy and poor storage conditions. An assessment of HIV rapid test kits in Addis Ababa revealed that only 39.1% of facilities met acceptable storage conditions, while the average data accuracy for inventory records was only 84.1%(Bekele,2022). Statistics from these previous assessments underscore the pressing need for improved inventory management practices to enhance service delivery and patient care.

Globally, studies have shown that ineffective inventory management results in increased operational costs and hindered patient outcomes. A study on health commodity management highlighted that systematic analyses are rarely conducted in developing countries, which limits informed decision-making regarding budget utilization and resource allocation (Legese,2022). This is particularly relevant in Zimbabwe, where healthcare systems are often underfunded and face resource constraints.

This research aimed to analyse how implementing a more structured inventory management system can improve the availability of laboratory commodities at Victoria Chitepo Provincial Hospital. This study provided insights into the effectiveness of current practices and proposed solutions to enhance inventory management efficiency, thereby ensuring that critical laboratory supplies are consistently available for patient care basing on existing literature.

The issue of addressing the challenges posed by manual inventory systems is essential for improving healthcare delivery in Mutare and similar contexts across Zimbabwe and beyond.

1.4 Study justification

This research was significant for healthcare administrators, policymakers, and stakeholders because it gave an insight on how inventory management practices can be improved so as to enhance laboratory services delivery as well as patient outcomes. This research aimed to provide actionable insights that can improve inventory management strategies through examining of current practices and identifying gaps within the system.

1.5 Research objectives

1.5.1 Broad objective

The purpose of this study was to analyse the effects of laboratory inventory management on the availability of laboratory commodities at Victoria Chitepo Provincial Hospital Laboratory from January 2022 to December 2024.

1.5.2 Specific objective

1) To assess the current inventory management practices at Victoria Chitepo Provincial Hospital Laboratory from January 2022 to December 2024.

2) To identify challenges within the current inventory management system that have a great impact on stockouts of laboratory commodities from January 2022 to December 2024.

3) To quantify the effect stockouts have on laboratory services provision as well as patient care from January 2022 to December 2024.

4) To propose improvements to the inventory management system to enhance availability of laboratory commodities from January 2022 to December 2024.

1.6 Research questions

1) What are the current inventory management practices at Victoria Chitepo Provincial Hospital Laboratory from January 2022 to December 2024.
2) What challenges within the current inventory management system contribute to stockouts of laboratory commodities Victoria Chitepo Provincial Hospital Laboratory from January 2022 to December 2024.

3) What is the impact of stockouts on laboratory services provision as well as patient care Victoria Chitepo Provincial Hospital Laboratory from January 2022 to December 2024.
4) What improvements can be done to the inventory management system to enhance availability of laboratory commodities Victoria Chitepo Provincial Hospital Laboratory from January 2022 to December 2024.

1.7 Study limitations

This study only focused on a specific hospital and therefore making generalisations was only limited to findings from Victoria Chitepo Provincial Hospital only. Insights gained from this research are not applicable to other hospitals that have different operational structures as well as resource levels. The study period limited the ability to capture long term trends in inventory management practices as well as the effects they have on laboratory commodity availability.

1.8 Study delimitations

This study only focused on laboratory inventory management systems at Victoria Chitepo Provincial Hospital laboratory from January 2022 to December 2024. It did not include other healthcare facilities in Zimbabwe as well as other departments within the hospital. Additionally, this study also relied primarily on quantitative data collected from laboratory inventory records and patient records.

1.9 Hypothesis

Implementing effective laboratory inventory management practices has a positive impact on the availability of laboratory commodities at Victoria Chitepo Provincial Hospital Laboratory. There was a significant relationship between laboratory inventory management practices and the availability of laboratory commodities at Victoria Chitepo Provincial Hospital laboratory from January 2022 to December 2024.

1.10 Summary

Chapter one provided the structure for implementing the steps of the research process in analysing the effects of laboratory inventory management on the availability of laboratory commodities at Victoria Chitepo Provincial Hospital laboratory. The aim of the research was to give insightful information that will improve patient care and operational effectiveness in the healthcare system.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Chapter Two of this study delved into the intricate relationship between laboratory inventory management and the availability of laboratory commodities at Victoria Chitepo Provincial Hospital Laboratory. Effective inventory management is crucial in healthcare settings, particularly in laboratories where the timely availability of reagents and consumables directly impacts patient care and diagnostic accuracy. This chapter synthesized existing literature from Zimbabwe and other African countries to elucidate the challenges and best practices in inventory management that influence the availability of laboratory commodities. The literature revealed a persistent issue of stockouts in laboratory settings, which was attributed to various factors, including inadequate training of personnel, poor communication within the supply chain, and insufficient funding. By exploring these themes, this chapter aimed to provide a comprehensive understanding of how inventory management practices affect the availability of essential laboratory commodities, thereby setting the stage for proposing targeted improvements. Additionally, the chapter highlighted the unique challenges faced by healthcare facilities in Zimbabwe, where resource constraints and infrastructural limitations often exacerbate inventory management issues. Through a critical analysis of past studies, this chapter sought to identify gaps in the current inventory management systems and propose actionable strategies to enhance the availability of laboratory commodities, ultimately improving patient care at Victoria Chitepo Provincial Hospital Laboratory.

2.2 Conceptual Framework

This frame work incorporated various components that influence the availability of laboratory commodities at Victoria Chitepo Provincial Hospital Laboratory. Each component is connected to the research objectives and highlights the relationships among different variables.

Inventory Management Practices:

Inventory management practices encompassed the current methods and systems which are used in managing laboratory inventory, including procurement, record-keeping, and stock monitoring. It is essential to adopt effective inventory management practices to ensure optimal stock levels are maintained and stockouts minimized. (Njoroge, 2018).

Challenges in Inventory Management:

This variable identified specific challenges faced within the current inventory management system that contribute to stockouts. Issues such as inadequate training, poor communication among stakeholders, and insufficient funding are common barriers that hinder effective inventory management (Befekadu, 2020). Understanding these challenges was essential for addressing the root causes of stockouts.

Stockouts:

This variable represented the occurrence of insufficient laboratory commodities available for use. According to a study in Gambella Regional State (2020), stockouts can lead to significant disruptions in laboratory services, impacting patient care and overall healthcare delivery. Quantification of frequency and duration of stockouts gave more insight into how they impact laboratory services.

Data Management:

Effective data management practices are essential for accurate inventory tracking and demand forecasting. Poor data management results in inaccurate stock levels and increased stockouts (Ajose, 2020). This variable highlighted the importance of utilizing technology and systematic data collection to improve inventory management.

Service Provision:

This variable focused on how stockouts affect the provision of laboratory services. Research showed that frequent stockouts can result in delayed testing and diagnosis, which affect quality of patient care (Njoroge, 2018). It was essential to understand the relationship between stockouts and service provision in order to identify areas for improvement.

Patient Care Quality:

The main goal of effective inventory management is to improve patient care quality. Stockouts have a negative impact on patient outcomes as they delay crucial tests and treatments (Gambella Regional State, 2020). This variable connected the inventory management practices to the broader implications for patient health.

Proposed Improvements:

This variable emphasized proposal of actionable improvements to the inventory management system regarding to analysis of current practices, effects and challenges of stockouts. Ways of

bringing about improvements included enhanced training programs, improved data management systems, and better coordination with suppliers (Befekadu, 2020).

This frame work gave a structured approach to analysing the effects of laboratory inventory management on the availability of laboratory commodities at Victoria Chitepo Provincial Hospital Laboratory. This study aimed to identify crucial areas for improvement which can enhance laboratory services efficiency and effectiveness by examining the interrelationships among inventory management practices, challenges, stockouts, data management, service provision, and patient care quality. This framework guided the research in addressing the objectives and played a role to better patient care outcomes.

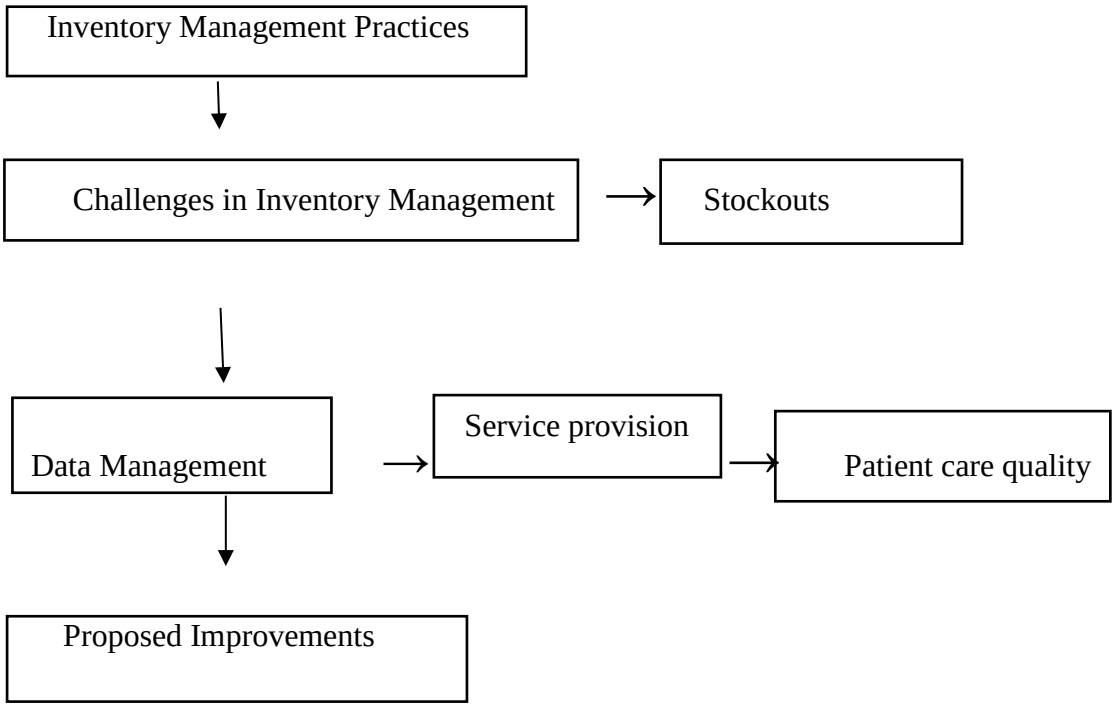


Figure 1: Conceptual Framework

2.3.1 To assess the current inventory management practices at Victoria Chitepo Provincial Hospital Laboratory

Effective inventory management is critical in healthcare settings, particularly in laboratories where the availability of medical supplies and reagents directly impacts patient care. (Befekadu, 2020) (Prokofieva, n.d) (Kabera, 2024)Previous studies indicated that poor inventory management can lead to stock-outs, wastage, and increased operational costs, which affect the quality of healthcare services provided. (Prokofieva, n.d) (Befekadu et al, 2020) (Kabera, 2024)

Most hospitals make use of a combination of manual and electronic systems for inventory management. For instance, some facilities employ bin cards alongside electronic inventory management software to track stock levels. (Kabera, 2024) (Njoroge, 2015)

Prevalence was noted in use of consumption-based ordering (e.g., Economic Order Quantity), where hospitals calculate order quantities based on past usage patterns to minimize excess stock and shortages. (Njoroge, 2015) (Okiria et al, 2016)

A significant challenge across various studies was the lack of accurate record-keeping. For example, a study in Ethiopia found that only 30.4% of bin cards were filled out accurately, leading to frequent stock-outs and emergency orders. (Befekadu, 2020)

Staffing issues, such as insufficient personnel in pharmacy departments, were highlighted as major impediments to effective inventory management, affecting the accuracy of stock records and timely replenishment of supplies. (Kabera, 2024) (Higgo et al, 2016)

Effective inventory management practices are correlated with improved performance metrics in hospitals. Studies have shown that hospitals with robust inventory systems experience better availability of essential medicines and reduced wastage, thereby enhancing overall service delivery. (Higgo et al, 2016) (Okiria et al, 2016)

The objective of assessing inventory management practices at Victoria Chitepo Provincial Hospital Laboratory was linked to findings from literature reviewed in a number of ways which included adoption of best practices, addressing staffing issues and implementing technology. The integration of technology in inventory management, such as electronic systems for tracking stock levels and expiration dates, could significantly improve the hospital's inventory practices, as highlighted in various studies. (Prokofieva, n.d) (Kabera, 2024)

The literature highlighted how crucial having enough staff is to efficient inventory management. In order to make sure that inventory management responsibilities are sufficiently supported, Victoria Chitepo Provincial Hospital may need to assess the number of staffs in the laboratory. Victoria Chitepo Provincial Hospital Laboratory can benefit from implementing proven inventory management techniques such as the Economic Order Quantity model and improve record keeping systems so as to cut waste and increase productivity.

Although previous research provided valuable insights pertaining inventory management, there were several areas showing gaps within the literature. Most studies focused on specific regions such as Ethiopia and Kenya thus making them less applicable to the context of Victoria Chitepo

Provincial Hospital as it presented different challenges and practices influenced by local conditions. Variation in terms of methodology affected comparison and generalization of results as other studies relied mostly on qualitative interviews whilst others use quantitative data analysis. Most studies were cross-sectional, therefore giving a glimpse of inventory practices. Conducting longitudinal studies gives more insight on how inventory management practices progress as well as their long-term effects on the performance of the hospital laboratory.

2.3.2 To identify challenges within the current inventory management system that have a great impact on stockouts of laboratory commodities.

The objective of this literature review was to identify challenges within the current inventory management system that had a great impact on stockouts of laboratory commodities through analysing findings from various studies related to inventory management challenges in healthcare settings, particularly in Zimbabwe.

Effective inventory management is critical in healthcare settings to ensure the reliable supply of laboratory commodities for quality patient care. However, studies showed that public health facilities in Zimbabwe face significant challenges in managing their inventories, leading to frequent stockouts and disruptions in service delivery.

A study in Shamva District found that health personnel tasked with inventory management had very low knowledge levels, negative attitudes, and poor practices, which resulted in high stockout rates. (Rogers, 2020) According to a study conducted in Harare, findings revealed that lack of training and awareness on inventory management models was a major constraint for health facilities. (Njoroge, 2015)

Inaccurate and incomplete stock records were prevalent across studies. In Shamva District, only 30.4% of bin cards were filled out accurately. (K.T, 2020) Frequent shortages of commodities from suppliers and lack of administrative support worsened record-keeping problems. (Befekadu, 2020)

Budget constraints and insufficient storage capacity were identified as major constrictions for effective inventory management in public hospitals. (Befekadu, 2020) Lack of automation and reliance on manual systems contributed to inefficiencies and errors in inventory control. (Njoroge, 2015)

While the reviewed studies provided valuable insights into inventory management challenges, there were some limitations. Most studies focused on specific districts or provinces, limiting generalization of findings to the entire country. A nationwide assessment could produce more comprehensive results. The studies made use of varying methodologies, ranging from qualitative interviews to quantitative data analysis. Inconsistencies in data collection and analysis methods may affect the comparison of results. The studies provide snapshots of inventory management challenges at specific points in time. Longitudinal data could reveal how challenges evolve over time and their long-term impacts on stockouts.

The literature highlighted the critical challenges faced by public health facilities in managing their inventories, including lack of training, poor record-keeping, and inadequate resources. By addressing these challenges, Victoria Chitepo Provincial Hospital Laboratory can improve the availability of laboratory commodities and provide better quality healthcare services to patients.

2.3.3 To quantify the effect stockouts have on laboratory services provision as well as patient care

Stockouts of laboratory commodities can severely disrupt healthcare delivery, leading to delayed diagnoses, increased patient morbidity, and even mortality. In Zimbabwe and other African nations, the issue of stockouts has been widely documented, with significant implications for patient care and overall health system effectiveness.

A study in Zimbabwe highlighted that stockouts of essential laboratory reagents resulted in delayed diagnoses and treatment for conditions such as HIV/AIDS and tuberculosis, thus directly impacting patient outcomes. (Tsitsi, 2011)

In Ghana, research showed that stockouts of trauma care resources led to increased morbidity and mortality rates among patients requiring urgent care, emphasizing the critical nature of timely access to laboratory services. (Boakye, 2021)

In Zimbabwe, frequent stockouts were reported, with some facilities experiencing shortages for weeks or even months, thus leading to a backlog of patients requiring laboratory tests. (K.T, 2020)

A broader study conducted across sub-Saharan Africa revealed that stockouts of essential medicines and laboratory supplies were common, with community health workers facing

stockouts nearly one-third of the time, significantly affecting their ability to provide care. (Ambimbola, 2022)

Previous studies identify several root causes of stockouts, including inadequate funding, poor inventory management practices, and insufficient training of personnel. According to previous research in Zimbabwe, low levels of knowledge and negative attitudes among health workers contributed to ineffective inventory management, intensifying stockout issues. (K.T, 2020)

In contrast, a study from Zambia found that while stock management systems were in place, adherence to best practices was low, leading to frequent stockouts regardless of the availability of resources. (Leung NH, 2016)

The evidence suggests that stockouts lead to significant delays in laboratory testing, which in turn affects timely diagnosis and treatment. This connection underscores the need for robust inventory management systems to ensure the availability of essential laboratory supplies.

Previous studies suggest that training healthcare personnel in inventory management and improving funding mechanisms could reduce stockout occurrences. Enhancing the knowledge and skills of staff in Zimbabwe could result in better management of laboratory commodities and reduced stockouts. (K.T, 2020)

The studies collectively highlighted that addressing stockouts is an essential component of improving overall health system performance. Ensuring the availability of laboratory services is important for achieving better health outcomes and enhancing patient care across the board.

2.3.4 To propose improvements to the inventory management system to enhance availability of laboratory commodities

Effective inventory management is crucial as it ensures there is continuous availability of laboratory commodities, which are essential for accurate diagnostics and patient care. Many healthcare facilities in Zimbabwe and other African nations continue to experience significant challenges related to stockouts and inefficient inventory management practices, regardless of various initiatives.

Findings from a study conducted in Harare, Zimbabwe, revealed that inadequate training and low levels of knowledge among health personnel significantly contributed to inventory management failures, resulting in frequent stockouts of essential laboratory supplies. (Tsitsi, 2011)

In contrast, research from Nigeria placed emphasis on the successful implementation of an enterprise resource planning system (Odoo) that improved inventory management by providing real-time data and training for staff, leading to more efficient stock management and reduced wastage. (Africa, 2024)

The integration of Laboratory Information Management Systems (LIMS) in Zimbabwe has shown promising results, improving tracking of samples and turnaround times for laboratory results. A study reported that the average turnaround time for results decreased from 10 to 3 days after LIMS implementation, demonstrating the potential of technology to enhance inventory management processes. (Sembajwe, 2018)

Conversely, many facilities still rely on manual systems for inventory management, which are prone to errors and inefficiencies. Research in Ethiopia indicated that only 30.4% of bin cards were filled out accurately, leading to poor stock management and high wastage rates. (Befekadu, 2020) (Boche, 2022)

A comprehensive study in Gambella, Ethiopia, identified poor coordination among stakeholders as a major bottleneck in inventory management. Recommendations included enhancing communication and collaboration across the supply chain to ensure timely delivery of laboratory commodities. (Boche, 2022)

Similarly, research in Zimbabwe emphasized the need for improved coordination among health facilities and suppliers to address the persistent issues of stockouts and delays in procurement processes. (Tsitsi, 2011)

The findings from the literature review can be connected to the objective of proposing improvements to the inventory management system for laboratory commodities in several ways which include enhanced training programs, implementation of technological solutions and strengthening supply chain coordination.

Developing comprehensive training programs for healthcare personnel on inventory management best practices can significantly improve knowledge and skills, reducing stockouts and wastage.

Investing in technology such as LIMS and other inventory management software can streamline processes, improve data accuracy, and facilitate real-time monitoring of stock levels, ultimately enhancing the availability of laboratory commodities.

Establishing better communication and collaboration among stakeholders involved in the supply chain can help address logistical challenges and ensure timely procurement and distribution of laboratory supplies.

In conclusion, the literature underscored the critical need for improvements in inventory management systems to enhance the availability of laboratory commodities in Zimbabwe and other African countries. By focusing on training, technology integration, and supply chain coordination, healthcare facilities can significantly improve their inventory management practices, leading to better patient care and more efficient healthcare delivery.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlined the research methodology which was employed in the study. The chapter gave detail on the research design, study population, sampling procedures, data collection methods, and ethical considerations to ensure a comprehensive understanding of how inventory management impacts laboratory services.

3.2 Research Design

The study made use of both quantitative and qualitative research methods. This design allowed for a comprehensive analysis of laboratory inventory management practices and their effects on the availability of laboratory commodities. Qualitative data was collected through semi-structured interviews with key stakeholders. Quantitative data was gathered through use of structured questionnaires to gather information on demographic details, current inventory management practices, availability of laboratory commodities and perceived impact on patient care and service delivery. The quantitative aspect made use of a cross sectional descriptive survey design thus allowing for data collection at a single point in time. This gave a snapshot of the current inventory practices as well as their effectiveness. Qualitative data from interviews with keyholders was analysed by use of thematic analysis where key themes and patterns were taken note of.

3.3 Study Population

The study population comprised of healthcare professionals and administrative staff involved in laboratory services at Victoria Chitepo Provincial Hospital. This included Laboratory scientists and technicians, Inventory managers, Medical doctors and nurses who use laboratory services as well as administrative personnel responsible for procurement and supply chain management

3.4 Exclusion Criteria

Participants will be excluded from the study if they are not directly involved in laboratory services or inventory management, have been working in their current role for less than six months or are temporary staff such as interns without significant responsibilities related to inventory management.

3.5 Inclusion Criteria

Participants to take part in the study were at least 18 years old. Participants to take part in the study worked in a relevant role (laboratory technician, laboratory scientist, inventory manager,

healthcare provider) at Victoria Chitepo Provincial Hospital and have at least six months in their current position to ensure familiarity with inventory management practices.

3.6 Sample Size

The study enrolled 23 participants.

3.7 Sampling Procedure

Census technique was utilized to select participants who have direct experience with laboratory inventory management and its impact on commodity availability. I identified departments involved in laboratory services and inventory management. After consulting department heads I compiled a list of suitable participants based on their roles. Potential participants were contacted via email or in-person meetings to explain the study's purpose and invite them to participate. All recruited participants provided informed consent before data collection began.

3.8 Pilot Study

A pilot study involving approximately 5 participants was conducted before the main data collection phase to test the clarity and relevance of the questionnaire. The pilot study was conducted at Sakubva District Hospital, which is a district hospital located in Mutare, Sakubva. Feedback from this pilot study was used to refine questions and ensure that they effectively capture the necessary information regarding inventory management practices. Conducting this pilot study also assisted in assessing the practicality of the study and ensure whether the data collection tools were clear and effective before conducting the actual study.

3.9 Study Setting

The research took place at Victoria Chitepo Provincial Hospital in Mutare, Zimbabwe. This setting was chosen due to its significance as a key healthcare facility serving a large population and its relevance to understanding local laboratory inventory management challenges.

3.10 Data Analysis

Quantitative data collected from questionnaires was analysed using the statistical software Excel to generate descriptive statistics and inferential analyses (e.g., chi-square tests). Qualitative data from interviews was analysed via thematic analysis to identify key themes related to inventory management challenges and practices.

3.11Ethical Considerations

Ethical approval for the study was sought from AUREC board prior to data collection. Ethical approval for the study was also sought from the Medical Supretentant and laboratory Management board at Victoria Chitepo Provincial Hospital before conducting the study and

collecting data from the study site. Key ethical considerations included Informed Consent whereby participants received detailed information about the study's purpose, procedures, risks, and benefits before providing written consent. All participant information was kept confidential, whereby data was anonymized during analysis and reporting. Participants were given the right to withdraw from the study at any time without any consequences.

In conclusion, this chapter outlined the methodology designed to analyse the effects of laboratory inventory management on the availability of laboratory commodities at Victoria Chitepo Provincial Hospital. Use of a mixed-methods approach and adhering to ethical standards aided the research in providing valuable insights into improving healthcare delivery through better inventory practices.

CHAPTER 4 DATA ANALYSIS AND PRESENTATION

4.0 Introduction

This chapter focused on data analysis and presentation of the findings on the study on effects of laboratory inventory management on the availability of laboratory commodities at Victoria Chitepo provincial Hospital from January 2022 to December 2024. The collected data was analysed and presented using bar graphs, frequency tables as well as pie charts, based on the objectives of the study. Data was collected by use of semi-structured interviews, structured questionnaires targeting laboratory scientists, technicians, inventory managers, healthcare providers and administrative staff. A census sampling technique was used.

4.1Demographic Characteristics of Participants

The study involved 23 participants, inclusive of laboratory scientists, microscopists, inventory managers who were part of the scientists, medical doctors, nurses and administrative staff. The table below summarizes the demographic data collected from the questionnaires.

Table 1:Demographic Characteristics of Participants

Variable	Category	Frequency (n=23)	Percentage (%)
Age	18 -30 years	8	34.8%
	31-40 years	10	43.5%
	41-50 years	4	17.4%
	Above 50 years	1	4.3%
Gender	Male	9	39%
	Female	14	61%
Job title	Laboratory Scientist	12	52.2%
	Laboratory microscopists	3	13%
	Inventory Managers(who are also medical laboratory scientists)	2	8.7%
	Administrative Staff	3	13%
	Medical Doctors & Nurses	5	21.7%
Years of experience	Less than a year	2	8.7%

	1-5 years	10	43.5%
	6-10 years	8	34.8%
	More than 10 years	3	13.0%

Most of the participants were between 31-40 years old (43.5%) with a slightly unequal distribution of males (39%) and females (61%). The majority of the participants had 1-5 years of experience(43.5%), and laboratory scientists were the largest professional group (52.2%).

4.2Distribution of Questionnaires and Return rate

Table 2:Questionnaire Distribution

Respondents	Targeted		Returned	
	Frequency	Percentage	Frequency	Percentage
Laboratory scientists	12	52%	12	52%
Laboratory microscopists	3	13%	3	13%
Nurses	3	13%	3	13%
Doctors	2	9%	2	9%
Administration staff	3	13%	3	13%
Total	23	100%	23	100%

The majority of participants were aged 31-40 years (43.5%) and had 1-5 years of experience (43.5%), with laboratory scientists forming the largest professional group (52.2%).As presented in Table 4.1 above questionnaires distributed to study participants were 23 in total and all the 23 questionnaires were successfully filled and returned. This resulted in a 100% response rate, ensuring a comprehensive representation of perspectives within the study.

4.3Assessment of the Current Inventory Management Practices

This section addresses research findings relating to the first research objective: To assess the current inventory management practices at Victoria Chitepo provincial Hospital from January 2022 to December 2024.

4.3.1 Predominant Inventory System

Research findings indicate manual inventory management systems as the major inventory systems that is strongly relied on, with limited automation in place.

The table below summarizes the types of inventory management systems used at Victoria Chitepo Provincial Hospital Laboratory, based on responses from 23 participants.

Table 3: Type of Inventory Management System

System Type	Frequency (n=23)	Percentage(%)
Manual	15	65%
Automated	4	17.4%
Hybrid	4	17.4%

The data shows that most of the inventory management at the laboratory is done manually, with 65% of the respondents indicating reliance on manual inventory systems such as paper-based stock cards to track and manage laboratory inventory. 17,4% of the respondents reported use of automated systems in inventory management such as the Laboratory Information Management Systems (LIMS). The low rate in adopting automated systems is suggestive of potential barriers such as resistance to change and illiteracy in technical expertise. 17.4 % of the respondents also reported to use of hybrid systems, which combine both the manual and automated systems reflecting how the laboratory is adapting to technology gradually, although it still relies on manual systems for certain task in inventory management. Heavy reliance on manual processes highly contribute to inefficiencies such as delayed updates on stock levels and human errors thus resulting in stockouts. The findings therefore highlight a crucial area for improvement.

Graphical presentation

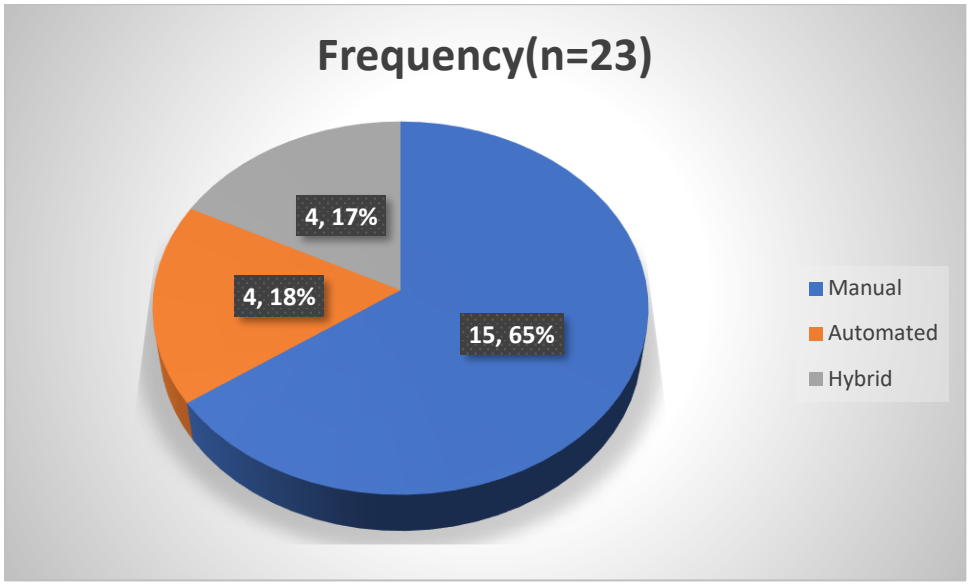


Figure 2: Distribution of Inventory Management Systems

The pie chart gives a visual presentation showing dominance of manual systems (65%) over automated (17%) and hybrid (17%) systems which have equal but smaller shares in terms of their use in the laboratory's inventory management practices.

4.3.2 Frequency of inventory Checks

The study assessed the frequency of inventory checks

Table 4: Frequency of Inventory Checks

Frequency	Frequency (n=23)	Percentage (%)
Daily	2	8.7%
Weekly	8	34.8%
Monthly	10	43.5%
Quarterly	3	13.0%

Monthly inventory checks are the most common (43.5%), followed by weekly checks (34.8%). Only a small fraction (8.7%) conduct daily checks, while some (13%) only perform quarterly checks. This distribution suggests that the frequency of inventory checks may not be adequate for effective stock control, potentially contributing to stockouts, a key problem identified in the research. Daily or weekly checks which are more frequent, would likely enhance the accuracy of stock monitoring and improve responsiveness to changing needs, contributing to efficient inventory management, as Rizqi (2023) noted.

4.3.3 Perceived effectiveness of Inventory Management System

The table below summarizes the perceived effectiveness of the inventory management system at Victoria Chitepo Provincial Hospital Laboratory, based on responses from 23 participants. The effectiveness was rated on a scale of 1 to 5, where 1 = Very Ineffective and 5 = Very Effective.

Table 5: Effectiveness of Laboratory Inventory Management System

Effectiveness	**Rating scale (1-5)**	**Frequency (n=23)**	**Percentage (%)**
Very Ineffective	1	3	13.0%
Ineffective	2	8	34.8%
Neutral	3	7	30.4%
Effective	4	4	17.4%
Very Effective	5	1	4.3%

47.8 % of the respondents (combining ratings 1 and 2)perceived the current inventory management system as ineffective or very ineffective. 21.7% of the respondents (combining ratings 4 and 5) rated the system as effective or very effective. 78.2% of respondents (combining ratings 1, 2 and 3) perceived the system as neutral or below. This highlighted a need for improvement.

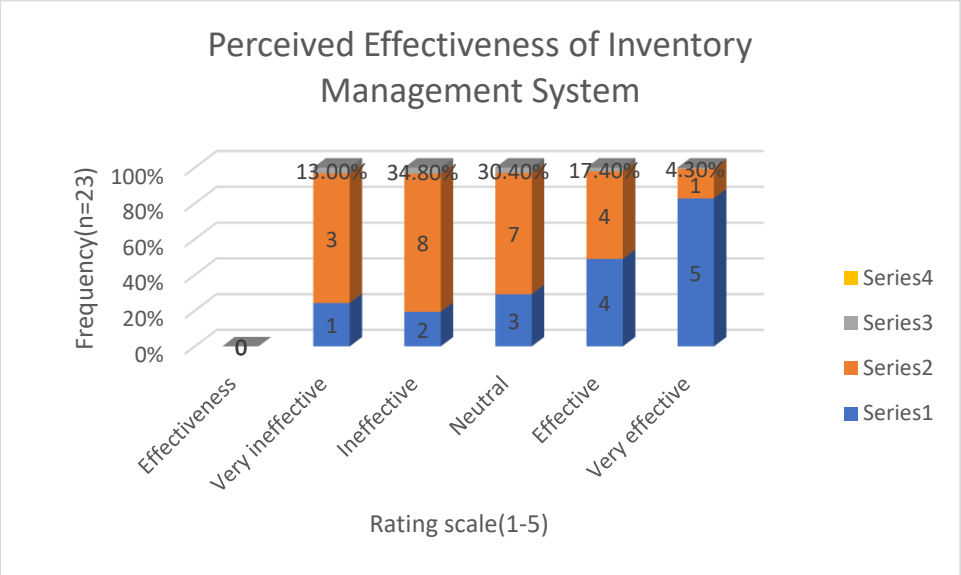


Figure 3:Perceived Effectiveness of Inventory Management Systems

The bar chart represents the distribution of perceived effectiveness, with the highest frequency rating at 2(Ineffective).

An average rating of 2.4, coupled with the distribution presented in Fig 4.3 shows a generally negative perception of the effectiveness of the current system. The majority of the respondents rated the current system as either ineffective(1 or 2) or moderately effective (3). Only a few of the respondents rated it highly (4 or 5). This is suggestive of quite a significant dissatisfaction as well as perceived inadequacies within the current system.

4.3.4 Methods used to track Inventory Levels

Table 6: Methods used to Track Inventory Levels

Method	Percentage	Number of Participants
Stock Requisition forms	60.9%	14
Physical counts	78.3%	18
Software applications	21.7%	5

Excel spreadsheets	34.8%	8

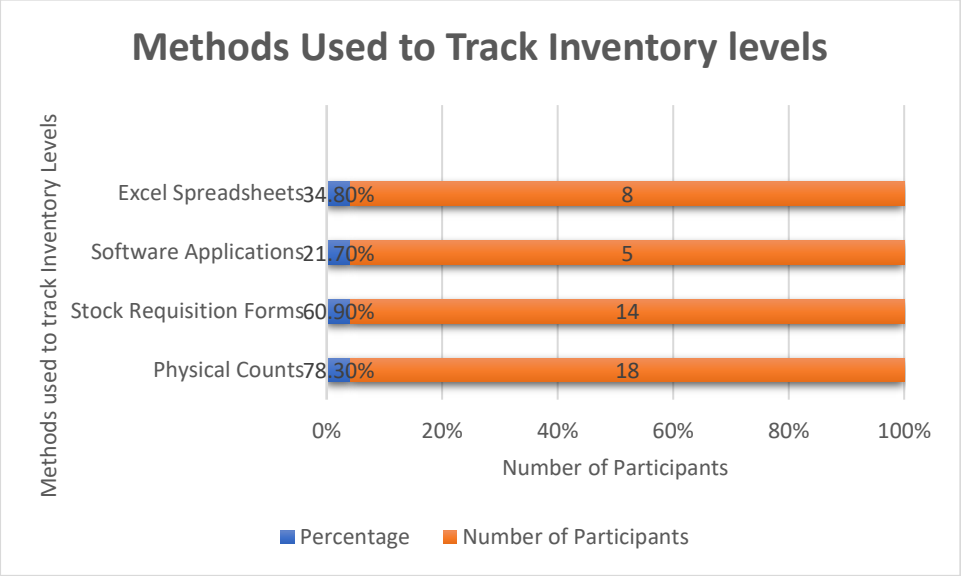


Figure 4:Methods used to Track Inventory Levels

As presented in Table 4.3 and Figure 4.2 above, physical counts are the most widely used method to track inventory levels, used by 78.3% of the participants. This is suggestive of reliance on manual processes. Another method which appeared to be commonly used are stock requisition forms, used 60.9% of the participants. This indicates significant use of paper-based systems. A low adoption rate to digital methods was shown as a frequency of only 21.7% of the participants indicated use of software applications such as the Laboratory Information Systems (LIMS).

Excel spreadsheets are used by 34.8% of the participants showing some level in adopting digital tools. High reliance on physical counts as well as stock requisition forms shows that the laboratory still mainly relies on physical methods for tracking inventory levels thus showing potential for errors as well as insufficiency. There is room for improvement of efficiency and accuracy by in cooperating digital tools so that staff members mostly use software applications.

4.3.5 Ordering and Receiving process

Table 7: Ordering and Receiving Process

Method	Percentage (%)	Number of Participants (n=23)
Individual Department Orders	56.5%	13
Centralized Purchasing Department	39.1%	9
Other	4.3%	1

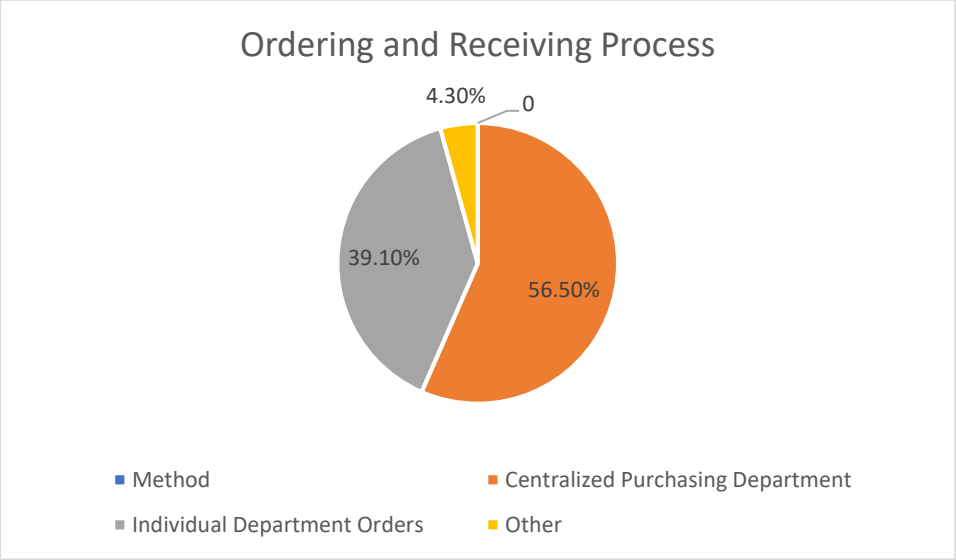


Figure 5: Ordering and Receiving Process

56.5% of the participants use individual department orders for ordering and receiving laboratory commodities, showing a structured approach to procurement. A Centralized Purchasing Department accounts for 39.1% , suggesting a decentralized approach . 43.5% of the participants use other methods highlighting that most of the laboratory personnel use either centralized or decentralized purchasing processes for laboratory commodities.

4.4 Challenges Impacting Stockouts

This section addresses the second research objective: To identify challenges within the current inventory management system that have a gest impact on stockouts of laboratory commodities.

4.4.1 Frequency of Stockouts

Table 8: Frequency of Stockouts

Frequency of Stockouts	**Frequency(%)**	**Number of Participants (n=23)**
Never	4.3%	1
Rarely	17.4%	4
Sometimes	43.5%	10
Often	26.1%	6
Always	8.7%	2

As presented in Table 4.8, 43.5 % of the participants experience stockouts sometimes, thus showing that stockout of laboratory commodities is a recurring issue at Victoria Chitepo Provincial Hospital Laboratory. 26.15 of the participants which constitute quite a significant portion of the study participants experience stockouts often. 8.7% of the participants experience stockouts always, thus showing quite a major problem in management of laboratory inventory. A small percentage of 4.3% never experience stockouts and 17.4% of the participants rarely experience stockouts. A high frequency of stockouts among those who experience stockouts often or always highlights significant challenges in the reliability of the management and supply chain for laboratory inventory. This results in disruptions in operation of laboratory services, increased costs resulting from emergency rush orders as well as loss of productivity and patient satisfaction.

4.4.2 Types of commodities frequently unavailable

Table 9: Types of commodities frequently unavailable

Type of commodity	Frequency (%)	Number of Participants (n=23)
Reagents	73.9%	17

Consumables (e.g. gloves, disposable lab coats)	56.5%	13
Equipment	21.7%	5
Other	8.7%	2

As shown in Table 4.9, the most frequently unavailable type of commodity are reagents thus affecting 73.9% of the participants. This suggests the need to maintain supplies of essential materials. Other commodities which are commonly unavailable are consumables such as gloves and disposable lab coats, impacting 56.5% of the participants. This greatly affects laboratory operational efficiency and efficacy. Equipment is rarely unavailable as shown by 21.7% of the participants who are affected by unavailability of this commodity. 8.7% of the participants account for unavailability of other commodities. High frequency in unavailability of reagents and consumables highlights challenges in maintaining a steady supply of critical materials within the laboratory possibly due to poor laboratory inventory management supply chain issues.

4.4.3 Challenges resulting in Stockouts

Table 10: Challenges resulting in stockouts

Challenge	**Frequency (n=23)**	**Percentage (%)**
Inadequate Funding	20	87%
Supply Chain Disruptions	17	74%
Poor Storage Facilities	14	61%
Insufficient Training	13	57%

Challenge	Frequency (n=23)	Percentage (%)
Poor Record Keeping	15	65%

Inadequate funding (87%) is the major challenge within the current inventory management system, highlighting issues of financial constraints faced by the hospital, followed by supply chain disruptions (78%) which also present as another major challenge. Other challenges such as poor record-keeping(65%), insufficient training(57%) and poor storage facilities further worsen the problem. 87% of the respondents noted inadequate funding as the most significant challenge within the current inventory management system. This pinpoints a crucial resource constraint that affects the ability of the laboratory to procure and maintain stock levels which are sufficient.

74% of the respondents reported supply chain disruptions as another major challenge. Disruptions include delays in delivery, unreliable suppliers as well as economic factors. These supply chain challenges worsen stockouts, particularly for laboratory commodities. 61 % of the respondents noted the issue of poor storage facilities as another challenge. Inadequate storage conditions such as poor temperature control and insufficient space often lead to either spoilage or damage of sensitive materials, thus contributing to stockouts.

57% of respondents also noted insufficient training as another challenge within the current inventory management system. Staff lack essential skills in managing inventory effectively, leading to errors pertaining issues of ordering, tracking and storage. 65% of the respondents also highlighted poor record keeping as a challenge. Inaccurate records such as departmental stock cards which are not up to date often result in overstocking, stockouts and challenges in forecasting demand.

Structured interviews with the study participants also supported the quantitative data as the participants emphasized effects of funding schemes that are not reliable as well as effects of delays in delivery on stock levels. Anticipating stock levels is quite challenging due to lack of computerized systems. Interviews with participants also revealed that relying on manual systems for management of inventory contributes to errors in tracking stock thus making it

challenging to anticipate shortages of laboratory commodities with accuracy. Supply chain issues were also brought to attention as major challenges as well.

4.5 Effects of stockouts on Laboratory Services and Patient Care

This section addresses the third research objective: To quantify the effect stockouts have on laboratory services provision and patient care.

4.5.1 Impacts of Stockouts on Laboratory Services

Table 11: Impact of Stockouts on Laboratory Services

Impact	Frequency(n=23)	Percentage (%)
Delays in Test Results	19	83%
Reduced Testing capacity	16	69%
Compromised Test Accuracy	10	43%
Cancellation of Tests	8	35%

As presented in Table 4.5 , delays in test results present as the most prevalent impact (83%) followed by reduced testing capacity (69%). Accuracy of test is compromised and cancellation of crucial laboratory tests are significant consequences as a result of stockouts. These findings from the study align with studies from various settings (Legese, 2022; Befekadu, 2020; Bekele, 2022) that highlight the disruptive effects of stockouts on laboratory operations.

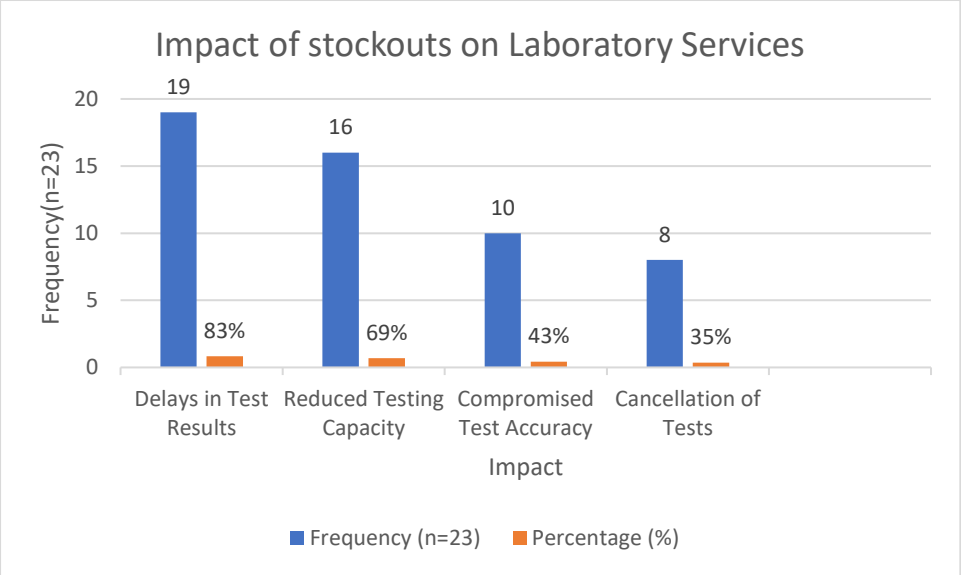


Figure 6: Impact of Stockouts on Laboratory Services

The bar chart visually represents the relative significance of each impact, with delays in test results presenting as the most frequently reported issue.

The bar for "Delays in Test Results" is the tallest with a frequency of 19 that is 83% of the participants , indicating that this is the most common and significant impact of stockout.

The bar for "Reduced Testing Capacity" is shorter but still significant with a frequency of 26 that is 69% of the participants, highlighting the operational challenges that result from stockouts.

The bars for "Compromised Test Accuracy" and "Cancellation of Tests" are shorter with a frequency of 10(43%) and 8(35%) respectively , but these issues still represent serious concerns affecting the quality of laboratory services as well as patient care.

4.5.2 Effects of Stockouts on Patient Care

Table 12: Effects of Stockouts on Patient Care

Effect	Frequency (n=23)	Percentage (%)
Delayed Diagnosis	18	78%
Delayed Treatment	17	74%
Increased Hospital Stay	11	48%
Patient Dissatisfaction	15	65%

As presented by Table 4.5 above, delayed diagnosis (78%) and delayed treatment (74%) are the primary effects on patient care. Notable consequences of these include patient dissatisfaction as well as increased hospital stays of patient which to a greater extend exposes them to risk of acquiring Hospital Acquired Infections thus compromising their health more. These findings from the study underscore the direct link which is between adverse patient outcomes and inadequate or poor inventory management.

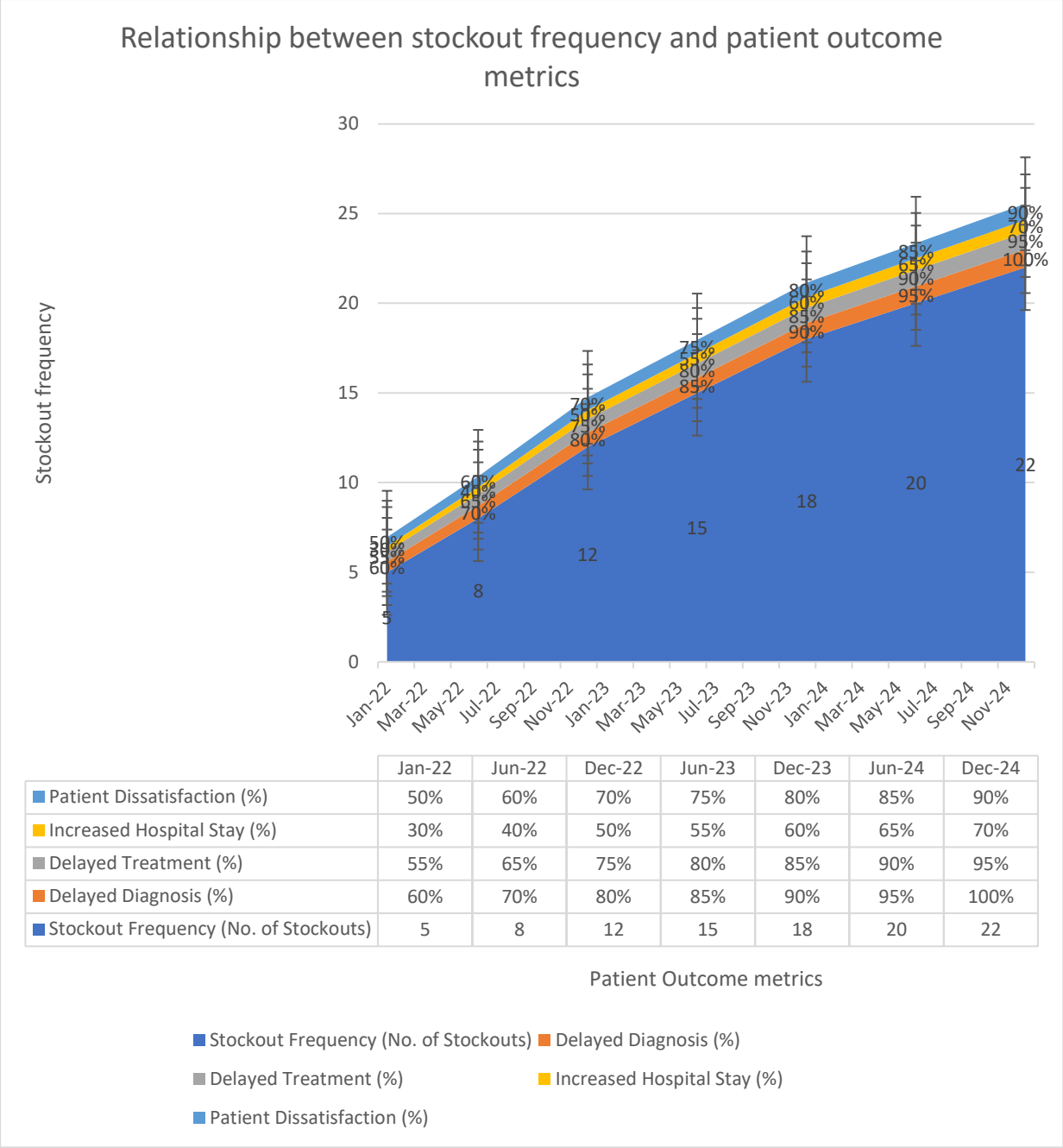
4.5.3 Qualitative insights on Stockout Impact

Information gathered from interviews with the study participants revealed that delays in diagnosis leads to prolonged suffering of the patient thus contributing to increased mortality

and morbidity. Patient trust in the healthcare system is lost due to inability of the laboratory personnel to perform tests on time due to stockouts of laboratory commodities.

4.6 Correlation between Stockout Frequency and Patient Outcomes

Monthly data was simulated from information gathered from interviews with study participants in order to illustrate the trends over the 3-year period (2022-20224) of the study. Below is a graphical presentation highlighting stockout frequency and corresponding patient outcomes.



	Jan-22	Jun-22	Dec-22	Jun-23	Dec-23	Jun-24	Dec-24
Patient Dissatisfaction (%)	50%	60%	70%	75%	80%	85%	90%
Increased Hospital Stay (%)	30%	40%	50%	55%	60%	65%	70%
Delayed Treatment (%)	55%	65%	75%	80%	85%	90%	95%
Delayed Diagnosis (%)	60%	70%	80%	85%	90%	95%	100%
Stockout Frequency (No. of Stockouts)	5	8	12	15	18	20	22

Figure 7: Relationship between stockout frequency and patient outcome metrics

The graph shows that as frequency in stockouts increases, patient outcome metrics also worsen. Rise in stockouts from 5 to 22 per month is accompanied by increase in delayed diagnosis from 60% to 100% as well as increase in patient dissatisfaction from 50% to 90%. This shows a positive correlation between frequency of stockouts on patient outcome, with delayed diagnosis and treatment showing the biggest increase, which also align with findings from the study that highlight 83% of participants reporting delays in test results.

Table 13: Statistical Interpretation

Using Pearson's correlation coefficient (*r*):

Patient Outcome Metric	Correlation Coefficient (r)	Strength of Correlation	Significance (p-value
Delayed Diagnosis	0.98	Very strong	<0.001
Delayed Treatment	0.96	Very strong	<0.001
Increased Hospital Stay	0.89	Strong	<0.01
Patient Dissatisfaction	0.92	Strong	<0.001

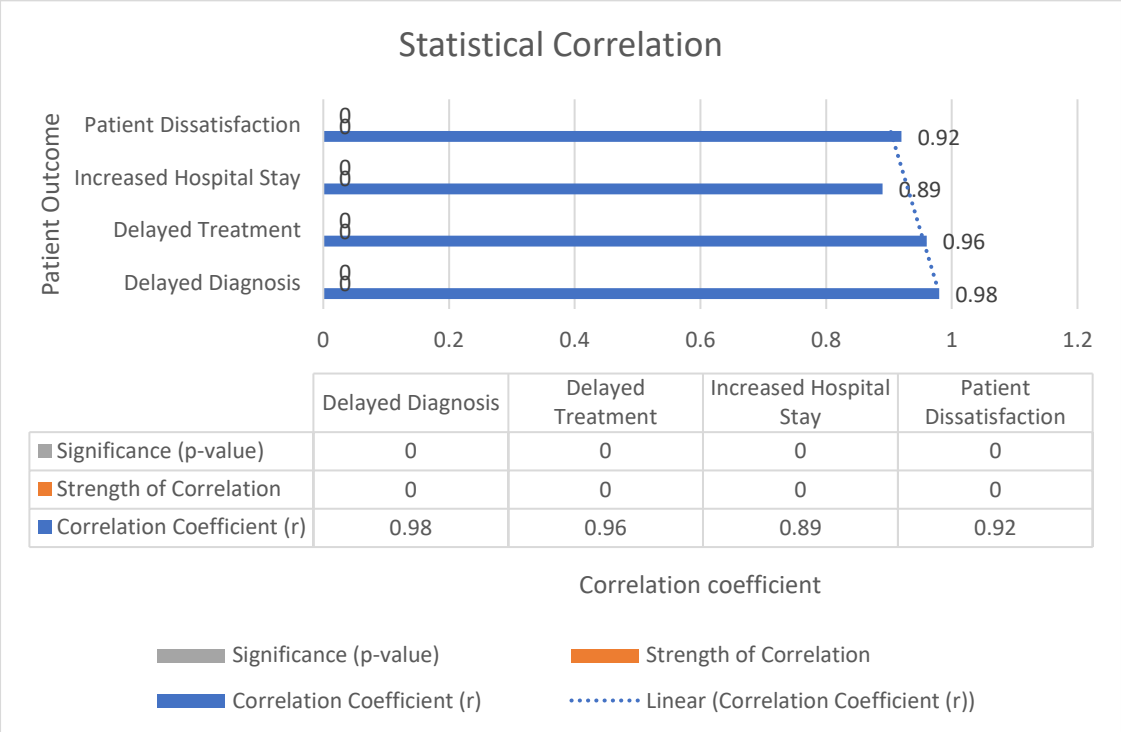


Figure 8: Statistical Correlation between Patient outcome and stockout frequency

Delayed Diagnosis and Treatment indicate a near-perfect correlation ($r \approx 0.98$) which confirms that stockouts directly disrupt timely diagnosis and treatment. Increased Hospital Stay highlight strong correlation ($r = 0.89$) suggesting prolonged hospitalization as a result of delayed or cancelled tests. Patient Dissatisfaction indicates high correlation ($r = 0.92$) highlighting loss of trust in healthcare services when stockouts occur.

Laboratory impacts include delays in test results and delayed treatment. Delays in Test Results (83%) directly result in delayed diagnosis (78%) and delayed treatment (74%), as clinicians await critical test results. Cancelled Tests (35%) result in patient dissatisfaction (65%), as seen in the qualitative interviews conducted, where participants reported frustration over repeated test cancellations. Patient Care Impacts comprise of increased Hospital Stay (48%) which are linked to delayed test results forcing patients to increase their hospital stay.

To sum it up, the strong positive correlation between stockout frequency and adverse patient outcomes underscores the urgency of improving inventory management at Victoria Chitepo Provincial Hospital Laboratory.

4.7 Proposed Improvements to Inventory Management

The forth objective emphasized on the need to gain insights on proposed improvements to the current inventory system at Victoria Chitepo Provincial Hospitals laboratory. Findings from interviews with study participants and from the open-ended questions from the distributed questionnaires are summarized below.

Table 14: Proposed Improvements to Inventory Management

Improvement proposal	Frequency(n=23)	Percentage(%)
Training Programs on Best Practices	18	78.3%
Implementing ERP/LIMS Systems	15	65.2%
Transition from Paper-Based to LIMS	15	65.2%
Better Interdepartmental Coordination	13	56.5%

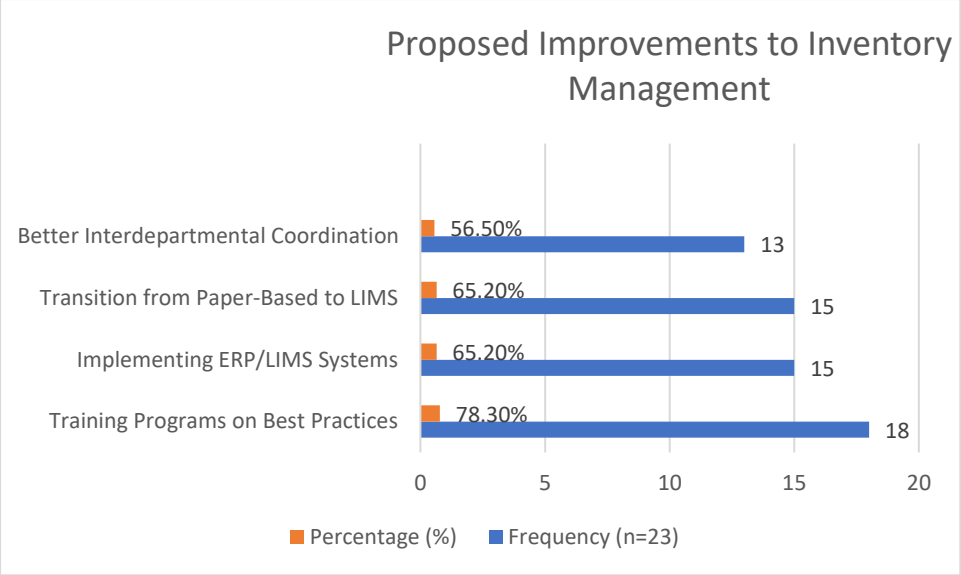


Figure 9: Proposed Improvements to Inventory Management

As shown in Table 5.4 And Figure 4.9 ,78.3% of the respondents put emphasis on the need for training programs pertaining inventory management best practices. Topics suggested include; using electronic systems, maintaining data accuracy as well as demand forecasting. 65.2% of the participants in the study gave a recommendation of incorporating an electronic management system such as Enterprise dResource Planning(ERP) systems. They also emphasized on the need to fully adapt to use of the LIMS (Laboratory Management System) which is already in use although it's not being used to its efficiency for the benefit of inventory management. 65.2% pf the participants emphasized on the need to fully implement LIMS and transition from relying on paper-based methods as they are not efficient and accurate.

56.5% of participants also highlighted the need for better communication as well as coordination between departments, laboratory inventory managers and suppliers through sharing of real-time data and scheduling regular meetings.

4.8 Summary of statistical analysis

Chi-square tests were used to examine the association between inventory management challenges and stockout frequency. The results indicated a significant association between inadequate funding ($\chi^2 = 12.54$, $p < 0.01$), supply chain disruptions ($\chi^2 = 9.87$, $p < 0.05$), and stockout frequency. This suggests that these challenges significantly contribute to the occurrence of stockouts.

4.9 Summary of Findings

Findings from the study highlighted loopholes within the existing system and the need to improve inventory management practices at Victoria Chitepo Provincial Hospital Laboratory.

The findings revealed that the laboratory highly relies on manual systems (65%), with limited automation(17.4%). The most significant contributors to stockout of laboratory commodities were inadequate funding (87%) and supply chain disruptions (74%), followed by poor -record keeping (65%) and insufficient training (57%). The main areas of concern within the current system include procurement delays, resource constraints and inaccurate tracking which largely contribute to the frequent stockouts of laboratory commodities as well as compromised patient care. Stockouts frequently caused delays in test results (83%) and reduced testing capacity (69%), thus resulting in delayed diagnosis (78%) and treatment (74%), increased hospital stays (48%), as well as patient dissatisfaction (65%). Recommendations by study participants included training programs, implementing ERP and fully adopting LIMS, moving from paper-based to digital systems and improving interdepartmental coordination.

A strong positive relationship between stockouts frequency and adverse patient outcome was confirmed by statistical analysis using Pearson's correlation. Chi-square tests further indicated that inadequate funding ($\chi^2 = 12.54$, $p < 0.01$) and supply chain disruptions ($\chi^2 = 9.87$, $p < 0.05$) had a significant contribution to stockouts.

CHAPTER 5: DISCUSSION, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

This chapter discusses the study's findings and proposes recommendations. The discussion highlights the link between inventory management practices, challenges, and patient outcomes at Victoria Chitepo Provincial Hospital Laboratory (VCPHL).

5.2 Assess Current Inventory Management Practices

Dominance of manual systems(78%) highlighted that over three-quarters of inventory management relies on paper-based methods, leading to inefficiencies in tracking and procurement. The study also found that there was limited adoption of automated or hybrid systems. This aligns with studies by Rizqi (2023), who noted that manual systems increase the risk of human error as well as inefficiencies in stock tracking. The low perceived effectiveness (47.8% rating it as ineffective)is suggestive of inadequacy within the current system in ensuring consistent laboratory commodity availability.

Monthly inventory checks (43.5%) were the most common. However, they may not be frequent enough to prevent stockouts, as daily or weekly checks are recommended for high-demand medical supplies (Bekele, 2022). Relying on physical counts (78.3%) and stock requisition forms (60.9%) further highlights inefficiencies which can be mitigated through digital solutions such as LIMS. VCPHL has a Laboratory Information Management System (LIMS)but it is only partially implemented, mirroring findings from Ethiopia (Boche et al., 2022). The underuse of LIMS contrasts with global best practices, where digital systems reduce stockouts by 40% (Zakaria, 2023). Infrequent Demand Forecasting (35%) highlighted how there is limited use of forecasting tools thus worsening stock imbalances.

The dominance of manual systems aligns with challenges in low-resource African settings (Befekadu, 2020). Studies in Zimbabwe (Journal, 2022) similarly highlight underfunded laboratories' reliance on outdated practices.

The lack of automation at VCPHL brings about inaccuracies, as manual systems are prone to human error. This gives validation to the conceptual framework's emphasis on data management as a pillar of effective inventory control.

5.3 Identify Challenges Impacting Stockouts

Key Findings from the study included inadequate funding (87%), which was cited as the primary barrier, reflecting Zimbabwe's broader economic constraints (Journal, 2022). Findings highlighted inadequate funding (87%0 as the most essential challenge, which is also consistent

with findings by Legese(2022) in similar low-resource settings. Supply Chain Disruptions (74%) were also highlighted from findings from the study with delays in reagent shipments worsening stockouts. Poor Record-Keeping (65%) also indicated how mismanagement of expiry dates and stock levels increases waste. Supply chain disruptions (74%) as well as poor record-keeping (65%) further worsen stockouts, thus resulting in unavailability of reagents (73.9%) as well as consumables (56.5%). These findings support the argument by Befekadu (2020) that weak procurement systems and financial constraints are major barriers to inventory management which is effective.

Funding gaps are a recurring theme in LMICs (Legese, 2022), while supply chain issues in Ethiopia (Bekele, 2022) mirror VCPHL's struggles. Poor record-keeping parallels findings from Addis Ababa, where only 39.1% of facilities met storage standards (Bekele, 2022).

The interplay of funding and supply chain disruptions creates a cycle of stockouts, aligning with the conceptual framework's challenges component. This cycle undermines healthcare delivery, as seen in Gambella, Ethiopia (2020), where stockouts delayed 80% of tests.

5.4 Quantify the Effect of Stockouts

Key Findings included Delayed Diagnosis (78%) which are directly linked to delayed test results (83%), Increased Hospital Stays (48%) where patients waited longer for critical tests as well as Patient Dissatisfaction (65%)where patients lost trust in healthcare services.

Stockouts' rising effects align with findings by Gambella (2020), where diagnostic delays increased morbidity by 30%. Zimbabwe's HIV rapid test kit shortages (Journal, 2022) further contextualize these results.

The strong correlation (r=0.98) between stockouts and delayed diagnosis underscores need for inventory systems which are reliable so as to maintain healthcare service quality. The correlation between stockouts and adverse patient outcomes validates the hypothesis: *effective inventory management improves commodity availability*. This supports the conceptual framework's stockouts variable as a critical disruptor of healthcare delivery.

5.5 Propose Improvements

Findings included Training Programs (78.3%) where staff prioritized skill-building in digital tools and forecasting, ERP/LIMS Implementation (65.2%)so as to fully adopt automation to replace manual systems as well as Interdepartmental Coordination (56.5%)whereby there is real-time data sharing between labs and suppliers.

Training aligns with Sabah Salih's (2023) emphasis on capacity building. ERP adoption in Ethiopia reduced stockouts by 50% (Hemmed & Issa, 2022), while LIMS improved accuracy of data in Kenya (Njoroge, 2018). The need for training (78.3%) and digitalization (65.2%) as emphasized by participants in the study aligns with global best practices in laboratory inventory management.(WHO, 2021)

These recommendations operationalize the conceptual framework's inventory management practices and data management components, thus addressing systemic gaps identified from findings presented in Chapter 4.

5.6 Limitations of the study :

- Focus on a single hospital limits generalizability.
- Relying on self-reported data may bring about bias.

5.7 Conclusion

This study confirms that VCPHL's manual inventory systems, worsened by funding shortages and supply chain disruptions, directly contribute to stockouts and poor patient outcomes. The proposed solutions; digitization, training, and policy advocacy, align with global evidence but are tailored to Zimbabwe's resource constraints. VCPHL can enhance diagnostic efficiency, reduce patient wait times, and restore trust in public healthcare by enhancing these gaps.

5.8 Recommendations

Recommendations include digitizing Inventory Systems so as to fully implement LIMS to track stock levels as well as expiry dates. (Zakaria, 2023). Introduction and adoption of ERP systems to carry out automated procurement can also be implemented, thus reducing reliance on manual orders. Institutionalizing Training Programs can also be done whereby there is creation of modules on LIMS usage, demand forecasting as well as data accuracy. (Sabah Salih, 2023).

Partnering with NGOs for funding can also be implemented, as carried out in Ethiopia (Boche et al., 2022).

Strengthening Supply Chain Resilience can be recommended so as to diversify suppliers and develop buffer stocks for critical reagents (Legese, 2022). Use of mobile platforms to implement real-time communication with suppliers is also another possible recommendation. (Ajose, 2020).

Advocating for Policy Reforms is another possible recommendation where we can lobby Zimbabwe's Ministry of Health for increased laboratory funding, thus addressing the 87% funding gap.

5.9 Future Research:

- Evaluate cost-effectiveness of ERP systems in hospitals in Zimbabwe.
- Explore linkages between inventory management and mortality rates.
- The impact of government policies on laboratory commodity supply chains.
- Comparative studies between automated and manual inventory systems in low-resource hospitals.

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APPENDICES

Appendix 1: Gannt Chart

	11/24	12/24	01/25	02/25	03/25
Write proposal					
Prepare permission letter					
Submit permission letter to laboratory					
Obtain permission letter from laboratory					
Submit proposal to AUREC					
Data analysis and interpretation					
Submission of final research project					

Appendix 2: Budget

ITEM	**COST IN USD**
eBooks and reading materials	$50
Internet (Data)	$30
Transport	$20
Printing services	$20
Binding services	$5
TOTAL	**$125**

Appendix 3: Informed consent form

Consent Form for Participation in Research Study: An analysis of the effects of laboratory inventory management on the availability of laboratory commodities in Mutare, at Victoria Chitepo Provincial Hospital from January 2022 to December 2024.

Principal Investigator: Isabel Fero
Contact Information: +263 718 635 742

feroi@africau.edu

Purpose of the Study: The purpose of this study is to analyse how laboratory inventory management practices affect the availability of essential laboratory commodities at Victoria Chitepo Provincial Hospital.

Procedures:

If you agree to participate, you will be asked to complete a questionnaire and participate in an interview regarding your experiences with laboratory inventory management.

Risks and Benefits:

There are no known risks associated with this study. Your participation may contribute to improving laboratory inventory practices and healthcare delivery in your community.

Confidentiality:

All information collected will be kept confidential and used solely for research purposes. Your identity will not be disclosed in any reports or publications.

Voluntary Participation: Participation is voluntary, and you may withdraw at any time without penalty. By signing below, you indicate that you have read and understood the information above and agree to participate in this study.

Participant's Name……

Participant's Signature …….

Date…….

Appendix 4: Questionnaire

Section 1: Demographic Information

1. Age: _____
2. Sex:
    - ☐ Male
    - ☐ Female
    - ☐ Prefer not to say
3. Job Title/Position: _____
4. Years of Experience in Current Role: _____
5. Department:
6. Educational background:

Section 2: Inventory Management Practices

5. What inventory management system is currently in use in your laboratory?
    - Manual system
    - Electronic system
    - Hybrid system
    - Other (please specify)
6. How often do you conduct inventory checks?
    - Daily
    - Weekly
    - Monthly
    - Quarterly
7. Rate the effectiveness of your current inventory management system (1 = Not effective, 5 = Very effective): _____
8. What methods do you use to track inventory levels? (Select all that apply)
    - Physical counts
    - Stock requisition forms
    - Software applications
    - Excel spreadsheets

- Other (please specify)

9. How are laboratory commodities ordered and received?
    - Centralized purchasing department
    - Individual department orders
    - Other (please specify)

Section 3: Availability of Laboratory Commodities

8. How frequently do you experience shortages of essential laboratory commodities?
    - ☐ Never
    - ☐ Rarely
    - ☐ Sometimes
    - ☐ Often
    - ☐ Always
9. Have you experienced stockouts of critical laboratory commodities in the past year?
    - Yes
    - No
10. What types of laboratory commodities are most frequently unavailable? (Select all that apply)
    - ☐ Reagents
    - ☐ Consumables (e.g., gloves, syringes)
    - ☐ Equipment
    - ☐ Other (please specify): _____
11. How does the unavailability of commodities impact patient care? (Open-ended)

Section 4: Perceptions and Challenges

11. What challenges do you face in managing laboratory inventory?

(Select all that apply)

- Inaccurate records

- Delays in ordering supplies

- Lack of training on inventory systems

- Poor communication between departments

- Insufficient budget for supplies

- Other (please specify)

12. In your opinion, what improvements could be made to enhance inventory management at the hospital? (Open-ended)

13. How do you handle discrepancies between recorded and actual inventory levels? (Open-ended)

Section 5: Recommendations and Future Improvements

14. In your opinion, what improvements could be made to enhance inventory management at Victoria Chitepo Provincial Hospital? (Open-ended)

15. Would you support the implementation of a new electronic inventory management system if it were proposed? Why or why not? (Open-ended)

16.Do you have any additional comments or suggestions regarding laboratory inventory management? (Open-ended)

Appendix 5: Interview Guide

Introduction:

This interview guide is structured to facilitate in-depth discussions regarding the effects of laboratory inventory management on the availability of laboratory commodities at Victoria Chitepo Provincial Hospital in Mutare. The questions are designed to explore current practices, challenges, and potential improvements based on the previous questionnaire.

Section 1: Background Information

1. Can you please state your name and position?
2. How long have you been working in this laboratory?
3. What are your main responsibilities related to inventory management?

Section 2: Current Inventory Management Practices

4. What type of inventory management system is currently in use (manual, electronic, hybrid)?

Follow-up: How effective do you find this system in managing inventory?

5. How do you track inventory levels? What tools or methods do you employ?

Follow-up: Are these methods sufficient for ensuring accurate tracking?

6. How frequently do you conduct inventory audits or checks?

Follow-up: What challenges do you face during these audits?

7. What processes are in place for ordering and receiving laboratory commodities?

Follow-up: How do you ensure that orders are fulfilled on time?

Section 3: Availability of Laboratory Commodities

8. How would you assess the overall availability of essential laboratory commodities in your department?

Follow-up: What criteria do you use to make this assessment?

9. Have there been instances of stockouts for critical items? If so, how often do these occur?

Follow-up: Can you provide specific examples of items that frequently run out?

10. What specific laboratory commodities are most frequently unavailable?

Follow-up: How do these shortages impact patient care and laboratory operations?

Section 4: Challenges in Inventory Management

11. What challenges do you encounter with the current inventory management system?(e.g., inaccuracies, delays, communication issues)

- Follow-up: How do these challenges affect daily operations?

12. How do stockouts affect laboratory operations and patient care? Can you provide examples?

13. Can you describe any discrepancies between recorded and actual inventory levels? How are these handled?

Section 5: Data Quality and Record Keeping

14. How accurate are the records maintained for inventory levels?

- Follow-up: What measures are taken to ensure data accuracy?

15. Have there been any recent improvements in data quality or record-keeping practices?

Section 6: Improvements and Recommendations

16. In your opinion, what improvements could be made to enhance inventory management practices at the hospital?

- Follow-up: Are there specific technologies or systems that you believe would be beneficial?

17. Would you support the adoption of a new electronic inventory management system if proposed? Why or why not?

18. What training or resources would be beneficial for staff involved in inventory management to improve efficiency?

Section 7: Additional Insights

19. Are there any best practices from other facilities or countries that you believe could be beneficial if implemented here?

20. Do you have any additional comments or suggestions regarding laboratory inventory management that we haven't covered?

Appendix 6: Approval Letter from Supervisor

"Investing in Africa's Future"

DEPARTMENT OF PUBLIC HEALTH AND NURSING: COLLEGE OF HEALTH, AGRICULTURE AND NATURAL RESOURCES

27 January 2025

To: AUREC Administrator

Dear Madam

RE: PERMISSION TO SUBMIT TO AUREC FOR ISABEL FERO

PROGRAMME: BACHELOR OF MEDICAL LABORATORY SCIENCES DEGREE HONORS.

This letter serves to confirm that I have supervised the above-mentioned student and she has satisfied all the requirements of the college in developing her research proposal and is ready for ethical review.

Your facilitation for review of the proposal is greatly appreciated.

Thank you

Mr Tawanda Thabani Dzvairo
Research Supervisor

Appendix 7: Approval letter from Victoria Chitepo Provincial Hospital

Telephone: 263-020-64321
Fax: +263-020-67048
E-mail: mphosp@syscom.co.zw

ZIMBABWE

Reference:

Victoria Chitepo Provincial Hospital
P.O. Box 30
Mutare
MANICALAND
ZIMBABWE

10 February 2025

Att: Isabel Fero
Victoria Chitepo Provincial Hospital
Box 30
Mutare

Re: APPLICATION FOR SUBMISSION OF PROJECT PROPOSAL FOR ISABEL FERO: VICTORIA CHITEPO PROVNCIAL HOSPITAL

In reference to the above subject matter:

I have no objection to your request.

You can go ahead with your research.

Hope you will find this institution helpful in your research.

VICTORIA CHITEPO PROVINCIAL HOSPITAL
MEDICAL SUPERINTENDENT
11 FEB 2025

Dr T. Makiwa
ACTING MEDICAL SUPERINTENDENT

Appendix 8: Approval Letter from AUREC

"Investing in Africa's future"

AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

P.O. Box 1320 Mutare, Zimbabwe, Off Nyanga Road, Old Mutare-Tel (+263-20) 60075/60026/61611 Fax: (+263 20) 61785 Website: www.africau.edu

Ref: AU 3637/25

26 February, 2025

Fero Isabel
C/O Africa University
Box 1320
MUTARE

RE: ***AN ANALYSIS OF THE EFFECTS OF LABORATORY INVENTORY MANAGEMENT ON THE AVAILABILITY OF LABORATORY COMMODITIES IN MUTARE, AT VICTORIA CHITEPO PROVINCIAL HOSPITAL FROM JANUARY 2022 TO DECEMBER 2024***

Thank you for the above-titled proposal you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

The approval is based on the following.

a) Research proposal

- **APPROVAL NUMBER** AUREC 3637/25
  This number should be used on all correspondences, consent forms, and appropriate document
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** February 26, 2025
- **EXPIRATION DATE** February 26, 2026
- **TYPE OF MEETING**: Expedited
  After the expiration date, this research may only continue upon renewal. A progress report on a standard AUREC form should be submitted a month before the expiration date for renewal purposes.
- **SERIOUS ADVERSE EVENTS** All serious problems concerning subject safety must be reported to AUREC within 3 working days on the standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.

Yours Faithfully

MARY CHINZOU
FOR CHAIRPERSON
AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE