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**EXAMINING THE EFFECT OF LABORATORY TURNAROUND TIME ON
HOSPITAL PERFORMANCE: A CASE STUDY OF NAKASERO HOSPITAL IN
UGANDA**

ASIAH ODONGO BAKARI

188470

**A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENT FOR THE AWARD OF MASTER OF BUSINESS
ADMINISTRATION IN HEALTHCARE MANAGEMENT DEGREE OF
STRATHMORE UNIVERSITY**

JUNE 2026

DECLARATION

I declare that this research report is my original work and has neither been previously assessed nor approved for any award in any other institution of higher learning. To the best of my knowledge and belief, this research does not include any material previously published by any scholar, except where due acknowledgement has been made in the text.

Asiah Odongo Bakari

Admission Number: 188470

Signature:



Date: 22nd June 2026

This research report is hereby submitted for examination with my approval as the University Supervisor.

Prof. Francis Wafula

(Supervisor)

Associate Professor of Health Systems and Policy, Strathmore Business School

Signature:



Date: 22nd June 2026

DEDICATION

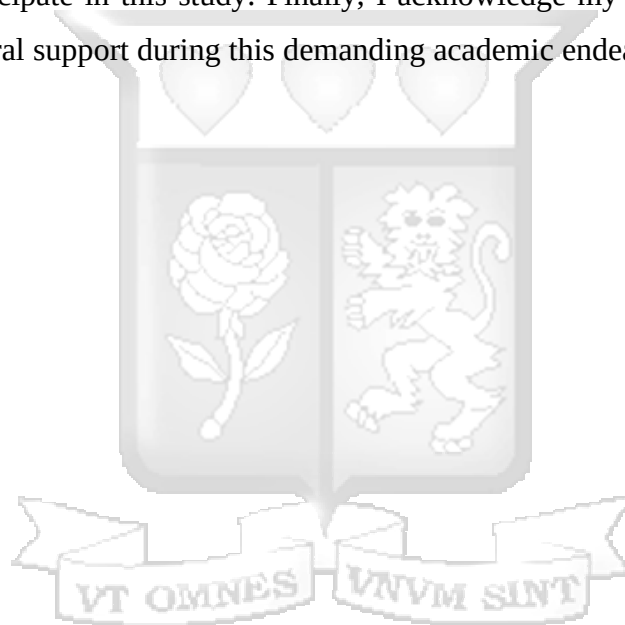
This work is dedicated to God, the source of wisdom, knowledge and understanding, whose guidance and protection have made this achievement possible. I also dedicate this work to my beloved husband and children for their unwavering support, encouragement and prayers throughout this journey. Special appreciation is extended to my colleagues, the staff of the Nursing department and all individuals who contributed positively to this study. May you all be abundantly blessed.



ACKNOWLEDGEMENTS

I express my profound gratitude to Prof. Francis Wafula, my academic supervisor, for his invaluable guidance, critical review and unwavering support throughout the conceptualization and writing of this research report. I am deeply thankful to the faculty of Strathmore Business School for the rigorous academic foundation provided during my Master of Business Administration in Healthcare Management program.

I extend my sincere appreciation to the management and staff of Nakasero Hospital, Uganda, particularly the Laboratory, Nursing and Quality Assurance departments, for granting me the permission and cooperation necessary to access retrospective data and prospective respondents. My heartfelt thanks go to the clinicians, patients and laboratory technicians who spared their valuable time to participate in this study. Finally, I acknowledge my family and friends for their patience and moral support during this demanding academic endeavour.



ABSTRACT

Laboratory turnaround time (TAT) is a critical indicator of healthcare service delivery because it influences the timeliness of diagnosis, treatment initiation, and overall hospital performance. In low- and middle-income countries (LMICs), delays in laboratory processes continue to pose significant challenges to healthcare systems by contributing to prolonged hospital stays, reduced service efficiency, increased costs of care, and suboptimal patient outcomes. Despite the importance of laboratory services, limited empirical evidence exists on the effect of laboratory turnaround time on hospital performance within private tertiary healthcare facilities in Uganda. This study examined the effect of laboratory turnaround time on clinical efficiency, service quality and financial performance at Nakasero Hospital in Kampala, Uganda. The study was guided by Lean Management Theory and the Theory of Constraints and adopted a Sequential Explanatory Mixed-Methods Research Design. Quantitative data were collected through a retrospective review of 217 eligible patient records extracted from the Laboratory Information System (LIS), Electronic Medical Records (EMR) and hospital billing records. Qualitative and perceptual data were collected through a survey of 60 healthcare workers comprising clinicians, nurses and laboratory personnel. Quantitative data were analyzed using descriptive statistics, Pearson correlation analysis, multiple linear regression and analysis of variance, while qualitative data were analyzed thematically. The mean total laboratory turnaround time was 198.4 ± 112.5 minutes. The analytical phase accounted for the largest proportion of intra-laboratory processing time (53.0%). Healthcare workers identified equipment functionality ($M=2.85 \pm 0.88$) and staffing adequacy ($M=2.90 \pm 0.82$) as key constraints. Multiple regression analysis showed that equipment functionality ($\beta=-0.412$, $p<0.001$) and staffing adequacy ($\beta=-0.385$, $p=0.002$) were significant predictors of TAT, explaining 54.2% of its variance (Adjusted $R^2=0.542$). Total TAT was positively associated with length of stay ($r=0.48$, $p<0.001$) and increased cost of care ($\beta=0.406$, $p<0.001$), while negatively affecting adherence to clinical protocols ($\beta=-0.584$, $p<0.001$). Laboratory TAT significantly influences clinical efficiency, service quality, and financial performance. The study recommends investment in laboratory automation, strengthened equipment maintenance, improved staffing levels, enhanced laboratory information system integration and implementation of lean workflow strategies to reduce bottlenecks and improve hospital performance.

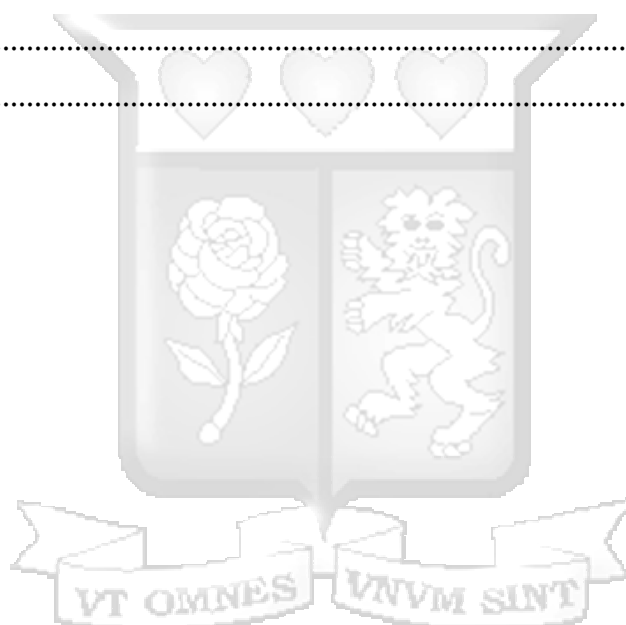
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LIST OF ABBREVIATIONS

CME	Continuous Medical Education
GDP	Gross Domestic Product
HICs	High-Income Countries
HSDP	Health Sector Development Plan
ICU	Intensive Care Unit
ICUs	Intensive Care Units
IMS	Intercontinental Medical Statistics
LMICs	Low- and Middle-Income Countries
LMT	Lean Management Theory
MOH	Ministry of Health
NGO	Non-Governmental Organization
PMP	Performance Measurement and Planning
PPP	Public-Private Partnership
QA	Quality Assurance
QMS	Quality Management Systems
SDGs	Sustainable Development Goals
SLMTA	Strengthening Laboratory Management Toward Accreditation
TAT	Turnaround Time
TOC	Theory of Constraints
UHC	Universal Health Coverage
UK	United Kingdom
US	United State

OPERATIONAL DEFINITION OF TERMS

Adherence to Clinical Protocols: The extent to which healthcare providers follow approved institutional or national clinical guidelines during diagnosis and treatment. In this study, adherence was assessed through clinicians' perceptions regarding whether delays in laboratory turnaround time affected compliance with recommended clinical management pathways.

Clinical Care Protocols: Standardized, evidence-based guidelines that direct clinical assessment, diagnosis, treatment, and patient management. Adherence to these protocols promotes consistency, quality, and patient safety in healthcare delivery (WHO, 2023).

Clinical Decision-Making: The process through which healthcare providers assess patient information, interpret diagnostic findings, and select appropriate treatment interventions. In this study, clinical decision-making was assessed through clinicians' perceptions of the influence of laboratory turnaround time on diagnostic and treatment decisions.

Clinical Efficiency: The extent to which healthcare services facilitate timely diagnosis, treatment initiation, and patient management while minimizing unnecessary delays. In this study, clinical efficiency was measured using indicators such as length of hospital stay and timeliness of clinical decision-making.

Cost of Care: The total financial expenditure associated with providing healthcare services to a patient during a specific hospital visit or admission. In this study, cost of care was measured using the average cost per patient visit recorded in Ugandan Shillings (UGX), including costs related to diagnostics, treatment, accommodation, and other hospital services.

Hospital Performance: The extent to which a hospital achieves efficient, effective, and financially sustainable healthcare delivery. In this study, hospital performance was operationalized using three dimensions: clinical efficiency, service quality, and financial performance.

Inpatient Department (IPD): A hospital unit where patients are admitted for at least one overnight stay to receive medical care, treatment, and monitoring. Laboratory turnaround time may influence patient management and length of stay within this setting.

Laboratory Performance: The ability of a medical laboratory to provide accurate, reliable, and timely diagnostic results in accordance with established quality standards and operational requirements (WHO, 2022).

Laboratory Turnaround Time (TAT): The time interval between initiation of a laboratory test request and availability of a verified result for clinical use. In this study, TAT was measured

in minutes or hours across the pre-analytical, analytical, post-analytical, and total testing phases (Plebani, 2020).

Outpatient Visit: A healthcare encounter in which a patient receives diagnostic, therapeutic, or preventive services without being admitted to the hospital overnight. Laboratory investigations may form part of the diagnostic process during such visits.

Service Quality: The degree to which healthcare services are delivered efficiently, promptly, and in a manner that meets organizational performance standards. In this study, service quality was assessed using indicators such as patient throughput, discharge timeliness, and efficiency of service delivery.



CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Laboratory services are a critical component of modern healthcare delivery because they provide diagnostic information that supports disease detection, treatment decisions, patient monitoring, and evaluation of therapeutic outcomes. Recent evidence indicates that laboratory results continue to influence a substantial proportion of clinical decisions, making laboratory performance an important determinant of healthcare quality and patient outcomes (Adekoya et al., 2025); (Alrashidi et al., 2023). Among the most widely used indicators of laboratory performance is laboratory turnaround time (TAT), defined as the period between the initiation of a laboratory test request and the availability of verified results for clinical use. Timely reporting of laboratory results is essential because delays may postpone diagnosis, delay treatment initiation, increase patient waiting times, prolong hospital stays, and negatively affect patient outcomes (Kumar et al., 2025); (Naveen et al., 2026).

Laboratory delays may arise at different stages of the testing process, including the pre-analytical phase involving test ordering, specimen collection, labeling and transportation; the analytical phase involving testing and processing; and the post-analytical phase involving result validation, reporting and communication. Studies have shown that inefficiencies occurring within any of these phases can significantly increase total laboratory turnaround time and adversely affect healthcare delivery (Naveen et al., 2026); (Ahmed et al., 2026). Consequently, TAT has increasingly been adopted as a key operational and quality indicator for evaluating laboratory performance and identifying workflow bottlenecks within healthcare facilities.

In many low- and middle-income countries (LMICs), healthcare organizations continue to experience challenges that contribute to prolonged laboratory turnaround times. These challenges include inadequate diagnostic infrastructure, shortages of skilled personnel, fragmented health information systems, equipment downtime, supply chain disruptions, and limited access to quality diagnostics (Gwaza et al., 2024); (PATH, 2024); (Jayathissa & Hewapathirana, 2023). As demand for diagnostic services continues to increase, healthcare

facilities are under growing pressure to improve laboratory efficiency in order to support timely clinical decision-making and effective utilization of resources.

Within private healthcare settings, laboratory performance has implications that extend beyond clinical outcomes. Private hospitals operate in competitive healthcare markets where service quality, responsiveness, patient experience, operational efficiency, and financial sustainability are important determinants of organizational success. Delays in laboratory services may reduce patient throughput, increase resource utilization costs, prolong bed occupancy, and negatively influence patient perceptions of service quality. As a result, laboratory turnaround time has become an important operational management concern that directly affects both healthcare delivery and organizational performance (Cassim et al., 2020); (Kumar et al., 2025).

This study examined the effect of laboratory turnaround time on hospital performance at Nakasero Hospital, a private tertiary healthcare facility in Kampala, Uganda. In this study, hospital performance was conceptualized using three dimensions: clinical efficiency, service quality, and financial performance. Clinical efficiency was reflected through indicators such as timeliness of clinical decision-making and length of hospital stay; service quality focused on patient waiting time and timeliness of service delivery; while financial performance considered the operational costs associated with prolonged care processes and inefficient resource utilization. Understanding the relationship between laboratory turnaround time and these dimensions is important for improving operational performance and healthcare service delivery within private hospitals (Ahmed et al., 2026); (Gwaza et al., 2024).

1.1.1 Quality Management in Hospital Operations

Quality management in healthcare refers to the systematic monitoring, evaluation, and improvement of organizational processes to enhance service delivery and patient outcomes. Contemporary healthcare quality frameworks emphasize the importance of optimizing operational processes in addition to clinical care because inefficiencies within support services can significantly affect healthcare outcomes. Laboratory services are particularly important because they influence the timeliness and accuracy of clinical decision-making across multiple departments within a hospital (Adekoya et al., 2025); (Chen et al., 2025).

Laboratory turnaround time is widely recognized as an important quality indicator because it reflects the effectiveness of laboratory workflows and their contribution to patient care. Evidence from healthcare facilities in Africa and other LMIC settings demonstrates that

improvements in laboratory TAT are associated with enhanced service efficiency, faster clinical decision-making, reduced waiting times, and improved patient experiences (Cassim et al., 2020); (Gwaza et al., 2024). Consequently, healthcare organizations increasingly monitor laboratory TAT as part of broader quality improvement initiatives aimed at strengthening operational performance.

1.1.2 Theoretical Framework: Lean Management Theory and Theory of Constraints

This study was guided by Lean Management Theory (LMT) and the Theory of Constraints (TOC), both of which provide a practical framework for understanding and improving operational performance within healthcare systems. Lean Management Theory emphasizes the identification and elimination of activities that do not add value to service delivery. In healthcare laboratories, such activities may include unnecessary waiting times, duplicate documentation, inefficient specimen handling processes, repeated testing, and delays in communication of results. The theory therefore informed the examination of operational factors affecting laboratory turnaround time, particularly workflow efficiency, sample handling processes, and process standardization (D'Andreamatteo et al., 2019); (Henrigue & Godinho Filho, 2020).

The Theory of Constraints proposes that organizational performance is limited by one or more bottlenecks that restrict overall system throughput. Within laboratory operations, constraints may arise from inadequate staffing, equipment downtime, reagent shortages, sample backlogs, or delays in result validation and reporting. The theory guided the identification of technological, operational, and human resource constraints that influence laboratory turnaround time and ultimately affect hospital performance (Kim et al., 2021); (Naveen et al., 2026).

The selection of these theories was directly linked to the study variables and methodology. Lean Management Theory informed the assessment of workflow-related variables, including specimen collection procedures, sample transportation, laboratory workflow efficiency, and reporting processes. The Theory of Constraints informed the assessment of bottleneck-related variables such as staffing adequacy, equipment availability, reagent supply, and laboratory information system functionality.

The theories also informed the development of the data collection instruments. Questionnaire and interview items were designed to capture information on workflow inefficiencies,

operational delays, and resource constraints affecting laboratory turnaround time. During data analysis, the theories provided a framework for interpreting how operational waste and system bottlenecks influenced laboratory turnaround time and how these delays affected clinical efficiency, service quality, and financial performance at Nakasero Hospital.

1.1.3 The Ugandan Health System Context and Nakasero Hospital

Uganda's healthcare system comprises public, private not-for-profit, and private for-profit providers operating within a decentralized framework intended to improve access to healthcare services. Despite policy efforts to strengthen health service delivery, healthcare facilities continue to face challenges related to diagnostic capacity, workforce shortages, infrastructure limitations, and service efficiency. Similar challenges have been documented across many LMIC health systems where access to timely and reliable diagnostic services remains constrained (PATH, 2024); (WHO, 2024).

Nakasero Hospital is a private tertiary healthcare facility located in Kampala, Uganda, providing a broad range of outpatient, inpatient, emergency, critical care, and diagnostic services. As laboratory diagnostics play a central role in patient management across these services, efficient laboratory operations are essential for supporting clinical efficiency, service quality, and financial performance. This study therefore focused on examining the effect of laboratory turnaround time on hospital performance within the context of a private tertiary healthcare facility.

1.2 Justification for the Study

Laboratory diagnostic services are fundamental to effective healthcare delivery because they support timely diagnosis, treatment decisions, disease monitoring, and patient management. Laboratory turnaround time (TAT) has emerged as a critical performance indicator because delays in the availability of test results can adversely affect clinical decision-making, prolong patient waiting times, increase length of hospital stay, and contribute to higher healthcare costs (Cassim et al., 2020); (Kumar et al., 2025). Consequently, improving laboratory TAT is increasingly recognized as an important strategy for enhancing clinical efficiency and service quality within healthcare organizations.

Beyond its clinical implications, laboratory TAT has important operational and business consequences, particularly within private healthcare facilities operating in competitive urban markets. Private hospitals depend on efficient service delivery, patient satisfaction, and organizational reputation to maintain market competitiveness and financial sustainability. Delays in laboratory services may reduce patient throughput, increase resource utilization costs, prolong bed occupancy, and negatively influence patient perceptions of service quality. In environments where patients have multiple healthcare options, operational inefficiencies may affect an institution's ability to attract and retain clients, thereby influencing overall organizational performance (Alain et al., 2021); (Gwaza et al., 2024).

Although laboratory turnaround time is widely acknowledged as an important indicator of healthcare quality and operational efficiency, limited empirical evidence exists on its effect on hospital performance within private tertiary healthcare facilities in Uganda. Most available studies have focused on laboratory process improvement, diagnostic accuracy, or public-sector healthcare settings, with relatively little attention given to how laboratory delays influence broader organizational outcomes such as clinical efficiency, service quality, and financial performance within private hospitals (PATH, 2024); (Ahmed et al., 2026).

This study was therefore undertaken to generate empirical evidence on the relationship between laboratory turnaround time and hospital performance at Nakasero Hospital. The findings are expected to support evidence-based decision-making by hospital managers, laboratory personnel, nursing leaders, and quality improvement teams through the identification of operational bottlenecks and opportunities for process improvement. Additionally, the study may contribute to the development of realistic turnaround time benchmarks, workflow optimization strategies, and quality improvement initiatives aimed at enhancing clinical efficiency, service quality, and financial performance within private healthcare facilities.

1.3 Problem Statement

Timely laboratory diagnostic services are essential for effective healthcare delivery because they support clinical decision-making, facilitate timely treatment initiation, and contribute to efficient patient management. Laboratory turnaround time (TAT) is therefore recognized internationally as a key indicator of laboratory quality and operational performance. Studies

conducted in both developed and developing healthcare systems have shown that prolonged TAT can delay clinical decisions, increase patient waiting times, extend hospital stays, and contribute to increased healthcare costs (Cassim et al., 2020); (Kumar et al., 2025).

Although considerable research has examined laboratory quality improvement and diagnostic accuracy, relatively limited evidence exists regarding the effect of laboratory turnaround time on broader hospital performance outcomes within private tertiary healthcare facilities in sub-Saharan Africa. Existing studies have largely focused on laboratory processes themselves, with less attention given to how delays in laboratory services influence organizational outcomes such as clinical efficiency, service quality, and financial performance (Gwaza et al., 2024); (PATH, 2024).

For the purpose of this study, hospital performance was conceptualized using three measurable dimensions. The first dimension was clinical efficiency, assessed through indicators such as timeliness of clinical decision-making and length of hospital stay. The second dimension was service quality, assessed through patient throughput, discharge timeliness, and overall service efficiency. The third dimension was financial performance, assessed through the average cost of care per patient visit and resource utilization implications associated with delayed diagnostic services. This conceptual delimitation was intended to provide a clear and focused operational definition of hospital performance within the context of laboratory turnaround time.

Despite the central role of laboratory diagnostics in patient management, there is limited empirical evidence on the factors influencing laboratory turnaround time and the extent to which laboratory delays affect hospital performance within private tertiary hospitals in Uganda. Consequently, hospital managers and healthcare administrators may lack context-specific evidence to guide decisions on laboratory workflow improvement, resource allocation, and operational efficiency enhancement.

This study therefore sought to examine the operational, technological, and human resource factors influencing laboratory turnaround time and to evaluate the effect of laboratory turnaround time on clinical efficiency, service quality, and financial performance at Nakasero Hospital in Kampala, Uganda. The findings were expected to provide evidence for improving laboratory operations and strengthening overall hospital performance.

1.4 Objectives

1.4.1 Broad Objective

To examine the effect of laboratory turnaround time on hospital performance at Nakasero Hospital in Kampala, Uganda.

1.4.2 Specific Objectives

- i. To determine the operational, technological, and human resource factors influencing laboratory turnaround time at Nakasero Hospital.
- ii. To assess the effect of laboratory turnaround time on clinical efficiency at Nakasero Hospital.
- iii. To evaluate the effect of laboratory turnaround time on service quality at Nakasero Hospital.
- iv. To analyze the effect of laboratory turnaround time on financial performance at Nakasero Hospital.

1.5 Research Questions

- i. What operational, technological, and human resource factors influence laboratory turnaround time at Nakasero Hospital?
- ii. What is the effect of laboratory turnaround time on clinical efficiency at Nakasero Hospital?
- iii. What is the effect of laboratory turnaround time on service quality at Nakasero Hospital?
- iv. What is the effect of laboratory turnaround time on financial performance at Nakasero Hospital?

1.6 Significance of the Study

This study contributes to the growing body of literature on healthcare operations management by examining the relationship between laboratory turnaround time (TAT) and hospital performance within a private tertiary healthcare setting in Uganda. Although laboratory turnaround time is widely recognized as an important quality indicator, there is limited empirical evidence on how laboratory delays influence broader organizational outcomes such

as clinical efficiency, service quality, and financial performance in private healthcare facilities within low- and middle-income countries (LMICs).

The study contributes to academic knowledge by providing empirical evidence on the determinants of laboratory turnaround time and their effects on hospital performance. In addition, the use of a mixed-methods approach offers methodological insights for future researchers interested in examining healthcare operational performance within resource-constrained settings.

For policymakers and healthcare planners, the findings provide evidence on the operational implications of laboratory delays and may support initiatives aimed at strengthening diagnostic services, improving healthcare quality, and enhancing operational efficiency. The study may also inform the development of policies and standards related to laboratory performance monitoring within healthcare facilities.

At the institutional level, the findings provide hospital administrators, laboratory managers, and quality improvement teams with evidence that can be used to identify operational bottlenecks, improve workflow efficiency, optimize resource allocation, and strengthen laboratory performance. Improved laboratory turnaround times have the potential to enhance clinical efficiency, service quality, and financial performance within healthcare organizations.

1.7 Scope and Limitations

1.7.1 Scope of the Study

The study was conducted at Nakasero Hospital, a private tertiary healthcare facility located in Kampala, Uganda. The target population comprised healthcare workers involved in laboratory-related processes and patient records from selected hospital units. The clinical scope of the study was limited to the Medical-Surgical Ward and the Intensive Care Unit (ICU), where laboratory services play a critical role in patient management. The study examined laboratory turnaround time across the major phases of the testing process, including the pre-analytical, analytical, and post-analytical stages. The study further assessed the relationship between laboratory turnaround time and hospital performance, which was operationalized in terms of clinical efficiency, service quality, and financial performance. The study utilized retrospective patient data covering the period between July and December 2025.

1.7.2 Limitations of the Study

The findings of this study should be interpreted within the context of several limitations. First, because the study was conducted in a single private tertiary hospital, the findings may not be fully generalizable to public hospitals or smaller private healthcare facilities operating under different organizational and resource conditions.

The study relied partly on retrospective hospital records. Consequently, the quality of the analysis depended on the completeness and accuracy of the available data. Missing information and documentation inconsistencies may have affected some aspects of the analysis. The cross-sectional component of the study captured information at a single point in time and therefore may not fully reflect variations in laboratory turnaround time that could occur due to seasonal fluctuations in patient volume, disease outbreaks, or operational changes within the hospital.

Some variables relating to clinical decision-making and laboratory processes were measured using self-reported information from healthcare workers. As a result, responses may have been influenced by recall bias or social desirability bias. Finally, although the mixed-methods design enabled the integration of quantitative and qualitative data, the qualitative component was limited to open-ended survey responses and did not include in-depth interviews or focus group discussions, which may have provided additional contextual insights.

1.8 Chapter Summary

This chapter introduced the study by providing background information on laboratory turnaround time and its importance in healthcare service delivery. The chapter outlined the research problem, study objectives, research questions, significance of the study, and the scope and limitations of the research. It also defined the concept of hospital performance as applied in this study and presented the theoretical foundations that guided the investigation. The next chapter reviews relevant theoretical, empirical, and conceptual literature related to laboratory turnaround time and hospital performance.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In contemporary healthcare delivery, the operational performance of clinical laboratories is inextricably linked to the quality and safety of patient care. Among the myriad key performance indicators utilized to assess laboratory efficacy, Turnaround Time (TAT) is universally recognized as one of the most critical. This chapter provides a comprehensive and critically reviewed existing literature pertinent to the intersections of laboratory TAT and hospital performance. It initiates with a detailed exposition of the theoretical frameworks underpinning the study, then systematically reviews and critically evaluates empirical literature, identified knowledge gaps and establishes the conceptual boundaries for the subsequent methodology. In this chapter, the study critically engaged with the reviewed studies by evaluating their methodological strengths and limitations, their contextual applicability and contradictions; and finally articulating the empirical, methodological and geographical gaps that this study addresses.

2.2 Theoretical Framework

The efficiency of hospital care processes, particularly the optimization of laboratory TAT, represents a complex operational challenge. This study is grounded in Lean Management Theory (LMT) and the Theory of Constraints (TOC) as complementary, synergistic theoretical lenses. Importantly, both frameworks have been shown to apply empirically to health care scenarios in various economic settings. The LMT approach has been extensively validated in high-income country (HIC) hospitals (D'Andreanmatteo et al., 2019); (Kim et al., 2021) and is now beginning to be validated in LMIC hospital settings, such as Kenya (Kim et al., 2014); (Monroe-Wise et al., 2017), Ethiopia (Cherie et al., 2024), and Nigeria (Chima et al., 2020), where lean interventions have shown measurable reductions in TAT without major capital-investment initiatives. (Labhardt et al., 2019) and (Dettmer, 2007) have also used TOC in the lab in HIC and LMIC settings, respectively. But their use in private tertiary laboratory settings across Africa has been limited, which this study directly fills. The study context was chosen

because it has a previous evidential basis that is; a private LMIC context that has not been extensively researched on before.

2.2.1 Lean Management Theory (LMT)

Lean Management Theory, conceptualized originally as the Toyota Production System by Taiichi Ohno (1988), is predicated on its relentless elimination of non-value-adding activities (waste), optimization of workflows and the commitment to continuous process improvement (Kaizen) to maximize end-user value. Within the regulated environment of a hospital laboratory, waste manifests in multiple forms: waiting (samples sitting idle before processing), motion (technicians traversing unnecessary distances), over-processing (redundant manual data entry), defects (sample hemolysis or labelling errors requiring repeat collections) and underutilization of human resources (D'Andreamatteo et al., 2019).

In the context of this study, LMT provides the directive framework for the systematic mapping of laboratory workflows at Nakasero Hospital. By employing retrospective laboratory timestamp data, staff surveys and workflow analysis, the study isolates and quantifies waste categories. Evidence from both high-resource and resource-constrained healthcare contexts demonstrates that lean interventions yield statistically significant reductions in TAT, concurrent improvements in staff productivity and elevated clinician satisfaction (Machado & Davim, 2020).

It is however fundamentally important to acknowledge that lean has garnered a lot of criticism in the healthcare industry. A successful lean healthcare project depends on the enthusiasm of staff, leadership support and the translation of a manufacturing model into a clinical setting, which can often fail, as indicated by (Kreindler, 2021). Moreover, in their systematic review, (D'Andreamatteo et al., 2015) reported that many lean health care's studies lack strong experimental designs, which make it difficult to make causal inferences. Based on the resource-poor setting of Nakasero Hospital, lean approaches are therefore recommended as principles for the redesign of the process, rather than the implementation of a programme, as fidelity of implementation may be limited by resources and organizational capacity.

2.2.2 Theory of Constraints (TOC)

The Theory of Constraints (TOC), introduced by Eliyahu Goldratt (1984), operates on the foundational premise that any manageable, complex system is inherently limited in achieving more of its goals by a very small number of constraints typically only one at any given time. This primary limiting factor, or bottleneck, dictates the maximum throughput of the entire system. TOC prescribes a rigorous, five-step focusing process: (1) Identify the system's constraint; (2) Exploit the constraint; (3) Subordinate all other processes to the constraint; (4) Elevate the constraint; and (5) Repeat the process.

The value and drawbacks of TOC in healthcare can be seen when it is analyzed critically. TOC is arguably too-simplistic for adoption as an analytical framework for the complex nature of health systems (Dettmer, 2007), but is used as an elegant and focused analytical lens to identify the main constraint. In the lab setting, there can be multiple constraints operating at the same time and possibly interacting with each other, making it difficult to identify one primary constraint. Therefore, the approach of this study is to use TOC as an analytical tool to select the most important constraint.

2.2.3 Complementarity of LMT and TOC

While distinct in their operational focus, LMT and TOC are highly complementary when applied concurrently. LMT offers a macro-level, comprehensive view of the laboratory workflow, adept at identifying distributed sources of waste and inefficiency. Conversely, TOC provides a micro-level, focused lens, narrowing attention to the single most critical constraint whose removal would generate the largest marginal gain in system throughput. Applying these frameworks in tandem at Nakasero Hospital since it enables a holistic, layered assessment: LMT facilitates mapping of the entire value stream, while TOC identifies the specific chokepoint that strictly limits overall output.

2.3 Empirical Literature

This section reviews empirical evidence on laboratory turnaround time (TAT) and its relationship with hospital performance. The review focuses on operational, technological, and human resource factors influencing TAT, as well as the implications of laboratory delays for clinical efficiency, service quality, and financial performance. In addition to summarizing

existing findings, the review evaluates methodological approaches, contextual limitations, and areas where evidence remains limited.

2.3.1 Operational, Technological and Human Resource Factors Influencing Laboratory TAT

Laboratory turnaround time is influenced by a combination of operational, technological and human resource factors. Operational factors include specimen collection procedures, sample transportation systems, workflow organization, test ordering processes and result reporting mechanisms. Studies conducted in both developed and developing healthcare settings have demonstrated that inefficiencies within these processes contribute significantly to delays in laboratory service delivery (Cassim et al., 2020); (Jayathissa & Hewapathirana, 2023).

Technological factors also play a critical role in determining laboratory performance. Automated laboratory systems, integrated Laboratory Information Systems (LIS), barcode tracking technologies and electronic result reporting have been associated with shorter turnaround times and improved workflow efficiency. Conversely, inadequate automation, poor system integration, equipment downtime and limited maintenance capacity have been linked to prolonged analytical processing times and increased sample backlogs (Alain et al., 2021); (Gwaza et al., 2024).

Human resource factors remain equally important. Laboratory staffing levels, staff competence, workload distribution and shift coverage have been identified as key determinants of laboratory efficiency. Studies in resource-constrained settings have shown that workforce shortages and inadequate training contribute to delays across both analytical and post-analytical phases of testing (Adekoya et al., 2025); (Ahmed et al., 2026).

Despite these findings, several limitations exist within the current evidence base. Many studies have been conducted in public healthcare facilities or high-income settings, limiting the applicability of their findings to private tertiary hospitals operating in low- and middle-income countries. Furthermore, a substantial proportion of studies rely on self-reported survey data rather than objective laboratory timestamp records, creating potential measurement bias. Consequently, there remains limited empirical evidence on the combined influence of operational, technological and human resource factors on laboratory turnaround time within private tertiary healthcare facilities in Uganda.

2.3.2 Laboratory TAT and Clinical Efficiency

Clinical efficiency refers to the ability of healthcare organizations to provide timely and effective care while minimizing delays in patient management. Several studies have reported a significant association between laboratory turnaround time and clinical efficiency indicators such as length of hospital stay, treatment initiation time and timeliness of clinical decision-making (Kumar et al., 2025); (Naveen et al., 2026).

Evidence from emergency departments and critical care settings indicates that delays in laboratory results can postpone diagnosis and treatment decisions, resulting in longer patient stays and slower patient flow. Similarly, studies examining inpatient services have demonstrated that prolonged laboratory turnaround times contribute to delays in discharge planning and increase overall hospitalization periods (Cassim et al., 2020); (Chen et al., 2025).

Although the relationship between laboratory turnaround time and clinical efficiency is well documented, much of the available evidence originates from highly automated healthcare environments in high-income countries. Differences in staffing levels, laboratory infrastructure, patient volumes, and information systems may limit the transferability of these findings to private tertiary hospitals in Uganda. In addition, many studies focus on specific disease conditions or specialized clinical units, creating a need for broader investigations involving diverse patient populations and healthcare settings.

2.3.3 Laboratory TAT and Service Quality

Service quality within healthcare organizations is often assessed through indicators such as timeliness of service delivery, patient throughput, waiting time and responsiveness of healthcare processes. Laboratory services contribute directly to these indicators because diagnostic information is required for many clinical decisions and care pathways.

Previous studies have shown that prolonged laboratory turnaround times reduce service responsiveness and contribute to inefficiencies within patient care processes. Delayed laboratory results have been associated with increased waiting times, slower patient movement across hospital departments and reduced overall service efficiency (Alain et al., 2021); (Ahmed et al., 2026).

Existing evidence, however, is largely quantitative and focused on operational metrics. Limited attention has been given to the experiences of healthcare workers who interact directly with

laboratory systems and whose service delivery responsibilities may be affected by diagnostic delays. Consequently, there remains a need for studies that combine objective performance data with healthcare worker perspectives in order to provide a more comprehensive understanding of the relationship between laboratory turnaround time and service quality.

2.3.4 Laboratory TAT and Financial Performance

Laboratory turnaround time also has important financial implications for healthcare organizations. Delays in diagnostic processes can increase resource utilization, prolong inpatient care and contribute to higher costs of treatment. Longer hospital stays resulting from delayed clinical decisions may increase expenditure on accommodation, medications, consumables and staff time, thereby affecting overall cost efficiency (Kumar et al., 2025); (Chen et al., 2025).

From an organizational perspective, prolonged occupancy of hospital beds may reduce patient throughput and limit the efficient utilization of available resources. In private healthcare facilities, such inefficiencies may affect financial sustainability because operational costs increase while service capacity remains constrained (Gwaza et al., 2024).

Despite the growing recognition of these financial implications, empirical evidence examining the direct relationship between laboratory turnaround time and cost of care remains limited, particularly in low- and middle-income countries. Most available studies have been conducted in high-income healthcare systems with different financing arrangements and reimbursement mechanisms. Consequently, there is limited context-specific evidence on how laboratory turnaround time influences the cost of care within private healthcare facilities operating in predominantly out-of-pocket healthcare markets such as Uganda.

Table 2.1: Summary of Literature Review and Evidence Gaps

Study Focus Area	Key Findings from Literature	Methodological Limitations	Evidence Gap Addressed by This Study
Operational, Technological and Human Resource	Laboratory turnaround time is influenced by workflow inefficiencies, staffing shortages,	Most studies are conducted in public hospitals or high-income settings and	Limited evidence exists on the combined influence of operational,

Factors Influencing Laboratory TAT	equipment downtime, inadequate automation, and poor integration of Laboratory Information Systems (Cassim et al., 2020); (Jayathissa & Hewapathirana, 2023); (Gwaza et al., 2024).	rely heavily on cross-sectional survey data rather than objective laboratory timestamp records.	technological, and human resource factors on laboratory TAT in private tertiary hospitals in Uganda using both objective and perceptual data.
Laboratory TAT and Clinical Efficiency	Prolonged laboratory turnaround times have been associated with delayed clinical decisions, prolonged hospital stays, delayed treatment initiation, and reduced efficiency of patient management processes (Kumar et al., 2025); (Chen et al., 2025).	Much of the evidence originates from highly automated healthcare systems in high-income countries, limiting contextual applicability to resource-constrained healthcare environments.	There is limited context-specific evidence on the relationship between laboratory TAT and clinical efficiency within private tertiary healthcare facilities in Uganda.
Laboratory TAT and Service Quality	Delays in laboratory reporting contribute to longer patient waiting times, slower patient throughput, and reduced responsiveness of healthcare services (Alain et al., 2021); (Ahmed et al., 2026).	Existing studies predominantly employ quantitative approaches and often overlook healthcare worker perspectives regarding the impact of laboratory delays on service delivery.	Limited studies have integrated objective laboratory performance data with healthcare worker experiences to examine the effect of laboratory TAT on service quality in private healthcare settings.
Laboratory TAT and Financial Performance	Prolonged laboratory turnaround times may increase resource utilization, extend hospitalization periods, and contribute to higher costs of care (Chen et al., 2025); (Kumar et al., 2025).	Most cost analyses have been conducted in high-income countries with healthcare financing systems that differ substantially from LMIC contexts.	There is limited empirical evidence on the relationship between laboratory TAT and cost of care within private hospitals operating in predominantly out-of-pocket healthcare financing

			environments such as Uganda.
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2.4 Empirical Gap Statement

The empirical literature reviewed indicates that laboratory turnaround time (TAT) is influenced by a range of operational, technological and human resource factors and that delays in laboratory processes can affect clinical efficiency, service quality and healthcare costs. However, several important gaps remain in the existing body of knowledge.

Geographical and Institutional Gap

Most studies examining laboratory turnaround time in sub-Saharan Africa have been conducted in public healthcare facilities or national referral laboratories. Comparatively little evidence is available from private tertiary hospitals, which operate under different organizational, administrative, and financial conditions. Private healthcare facilities often face unique operational challenges related to service delivery expectations, resource utilization, and financial sustainability. Furthermore, the limited studies available in Uganda have largely focused on perceptions of laboratory service quality rather than objective measurement of laboratory turnaround time using laboratory information system (LIS) records (Namuli et al., 2021); (Lule et al., 2021). Consequently, there remains limited evidence on laboratory TAT and hospital performance within private tertiary healthcare settings in Uganda.

Methodological Gap

Existing studies on laboratory turnaround time have predominantly employed either quantitative or qualitative research approaches. Quantitative studies have generally focused on operational performance indicators, while qualitative studies have explored healthcare worker experiences and perceptions. Relatively few studies have integrated objective laboratory performance data with healthcare worker perspectives to provide a comprehensive understanding of the determinants and consequences of laboratory turnaround time. This creates a need for mixed-methods studies that combine retrospective laboratory records with healthcare worker experiences to generate a more complete assessment of laboratory performance.

Contextual and Operational Gap

Although previous studies have identified workflow inefficiencies, staffing constraints, equipment limitations, and information system challenges as important determinants of laboratory turnaround time, limited attention has been given to administrative and organizational processes that may influence laboratory service delivery within private healthcare facilities. In particular, pre-analytical administrative processes such as patient registration, payment authorization, insurance verification and test approval procedures have received relatively limited empirical attention within the laboratory turnaround time literature in low- and middle-income countries. As a result, evidence remains limited regarding the contribution of these operational processes to laboratory delays and their subsequent effect on hospital performance. Addressing these geographical, methodological and contextual gaps will contribute to a better understanding of laboratory turnaround time and its implications for clinical efficiency, service quality and financial performance within private tertiary healthcare facilities in Uganda.

2.5 Conceptual Framework

The conceptual framework illustrates the hypothesized relationships among the study variables and is informed by Lean Management Theory (LMT), the Theory of Constraints (TOC) and the empirical literature reviewed in this chapter. The framework assumes that operational, technological and human resource factors influence laboratory turnaround time (TAT), which in turn affects hospital performance. In this study, laboratory TAT functions as a mediating variable through which operational conditions within the laboratory affect organizational outcomes.

The framework is based on the proposition that inefficiencies in workflow processes, technological limitations and human resource constraints create delays within laboratory operations. These delays are reflected in prolonged laboratory turnaround times across the pre-analytical, analytical and post-analytical phases of testing. Consequently, prolonged TAT may delay clinical decision-making, reduce service efficiency and increase the cost of care.

The framework further integrates the two sources of data used in the study. Retrospective laboratory information system (LIS) and patient record data provide objective measures of

laboratory turnaround time and hospital performance indicators, while prospective staff survey data provide information on the operational, technological and human resource factors that contribute to laboratory delays. The combination of these data sources enables the study to examine both the determinants of laboratory turnaround time and its consequences for hospital performance.

The framework therefore proposes that operational, technological and human resource factors influence laboratory turnaround time, which subsequently affects clinical efficiency, service quality and financial performance. Laboratory turnaround time serves as the principal mechanism through which laboratory operational conditions translate into hospital performance outcomes.

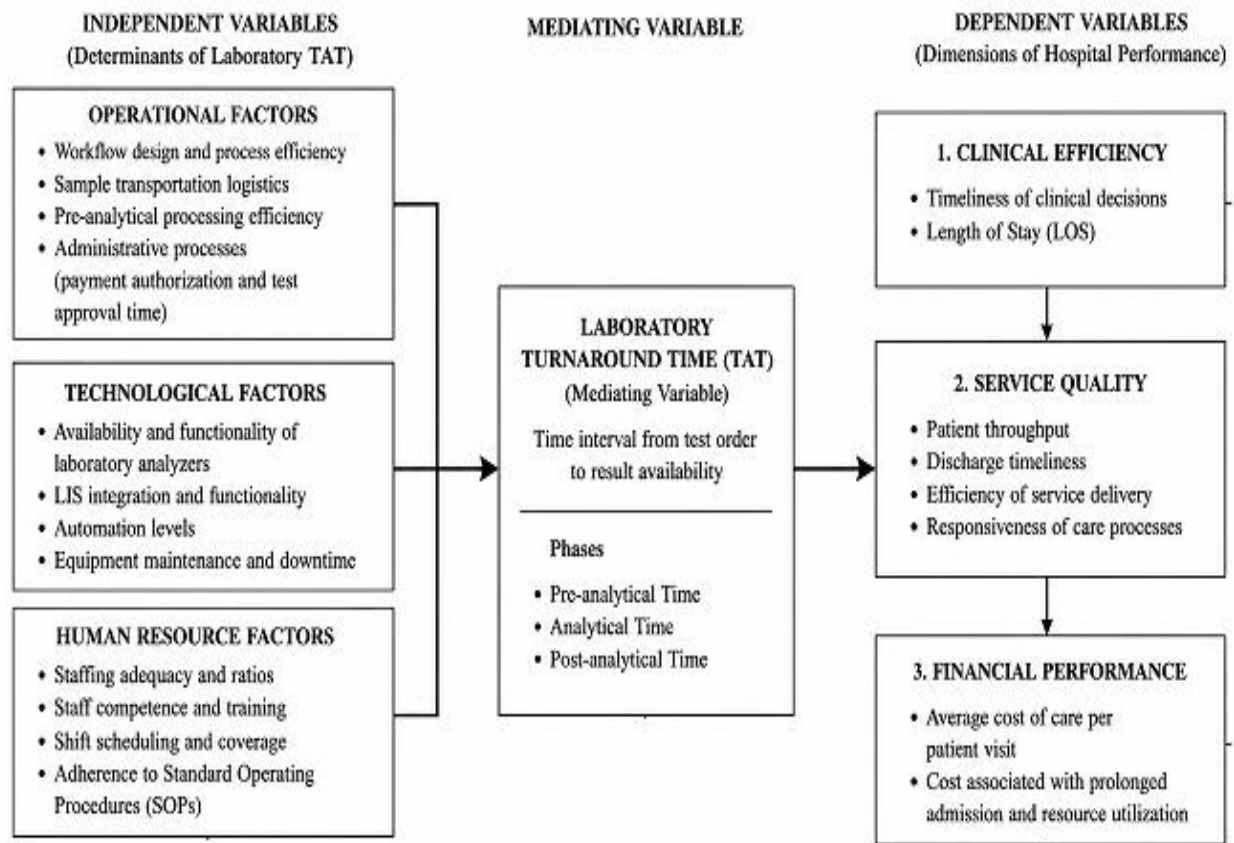


Figure 2.1: Conceptual framework of the study

2.6 Operationalization of Variables

Table 2.2: Operationalization of Variables

Variable Category	Variable	Operational Definition	Indicators / Measurement Metrics	Measurement Scale	Data Source
Independent Variables	Operational Factors	Organizational processes that influence the movement of laboratory specimens and information through the testing cycle.	Workflow efficiency, sample transportation time, specimen handling procedures, administrative processing time, payment authorization time.	Likert Scale (1–5); Minutes	Staff Questionnaire; LIS Records
	Technological Factors	Availability and effectiveness of laboratory technologies supporting diagnostic processes.	Equipment functionality, analyzer uptime, LIS integration, automation level, frequency of equipment downtime.	Likert Scale (1–5)	Staff Questionnaire; Equipment Maintenance Records
	Human Resource Factors	Workforce characteristics influencing laboratory operations and service delivery.	Staffing adequacy, staff competence, workload distribution, shift coverage, adherence to SOPs.	Likert Scale (1–5)	Staff Questionnaire
Mediating Variable	Laboratory Turnaround Time (TAT)	Time elapsed between initiation of a laboratory test request and availability of a verified result for clinical use.	Total TAT; Pre-analytical TAT; Analytical TAT; Post-analytical TAT.	Continuous (Minutes/Hours)	Laboratory Information System (LIS) Records

Dependent Variables	Clinical Efficiency	The extent to which diagnostic information supports timely patient management and clinical decision-making.	Length of hospital stay, timeliness of diagnosis, timeliness of treatment initiation.	Continuous (Days/Hours)	Patient Records; LIS Records
	Service Quality	The ability of the hospital to provide timely and efficient services to patients.	Patient throughput, discharge timeliness, efficiency of service delivery.	Continuous (Hours); Counts	Patient Records
	Financial Performance	Cost implications associated with laboratory delays and prolonged patient management.	Average cost of care per patient visit, costs associated with prolonged admission, resource utilization costs.	Continuous (Ugandan Shillings)	Hospital Billing Records
Perceptual Outcome Variable	Clinical Decision-Making	Clinicians' perceptions regarding the influence of laboratory turnaround time on diagnostic and treatment decisions.	Adherence to clinical protocols, reliance on empiric therapy, perceived treatment accuracy.	Likert Scale (1–5)	Clinician Questionnaire

Measurement Validity

The variables included in this study were measured using both objective and perceptual indicators to enhance methodological rigor through data triangulation. Laboratory turnaround time, clinical efficiency, service quality and financial performance were measured using

objective data extracted from the Laboratory Information System (LIS), patient records and hospital billing records. These indicators provided quantifiable measures of laboratory performance and hospital outcomes.

Clinical decision-making was assessed using clinician-reported perceptions because direct observation of clinical decision processes and comprehensive medical record audits were beyond the scope of the study. The construct was operationalized using indicators related to adherence to clinical protocols, reliance on empiric therapy and perceived treatment accuracy. While these measures provide valuable insight into the influence of laboratory delays on clinical practice, they may not fully capture actual clinician behavior. This limitation is acknowledged in the study and discussed in the limitations section. Future research may strengthen construct validity through the incorporation of prescription audits, treatment pathway reviews and direct observation of clinical decision-making processes.

2.7 Chapter Summary

This chapter reviewed the theoretical, empirical, and conceptual literature relevant to laboratory turnaround time (TAT) and hospital performance. The chapter examined Lean Management Theory and the Theory of Constraints as the theoretical foundations of the study and discussed their relevance to laboratory operations and healthcare service delivery. Empirical literature was reviewed on the operational, technological and human resource factors influencing laboratory turnaround time, as well as the relationship between laboratory TAT and clinical efficiency, service quality, and financial performance.

The chapter further identified geographical, methodological and contextual gaps in the existing literature, thereby providing justification for the study. In addition, the conceptual framework was presented to illustrate the hypothesized relationships among the study variables, with laboratory turnaround time positioned as a mediating variable linking operational factors to hospital performance outcomes. The chapter concluded with the operationalization of variables and measurement considerations that guided data collection and analysis. Chapter Three presents the research methodology adopted for the study.

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CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodology that was used to examine the effect of laboratory turnaround time (TAT) on hospital performance at Nakasero Hospital in Kampala, Uganda. The chapter describes the research design, target population, sample size determination, sampling procedures, data collection methods, data quality control measures, data analysis procedures and ethical considerations that guided the study. The methodological approach was selected to generate comprehensive evidence on the determinants of laboratory turnaround time and its influence on clinical efficiency, service quality and financial performance.

3.2 Research Design

The study adopted a Sequential Explanatory Mixed-Methods Research Design. This design involves the collection and analysis of quantitative data followed by the collection and analysis of qualitative data to explain, elaborate and provide context to the quantitative findings (Creswell & Plano Clark, 2022). The design was considered appropriate because it enabled the study to first establish objective patterns in laboratory turnaround time and hospital performance and subsequently explore healthcare workers' perspectives regarding the factors contributing to these patterns.

The study was implemented in two phases. In the first phase, quantitative data were collected through a retrospective review of patient records, Laboratory Information System (LIS) data and hospital records. These data were used to measure laboratory turnaround time and assess its relationship with clinical efficiency, service quality and financial performance indicators.

In the second phase, qualitative data were collected through open-ended survey responses obtained from healthcare workers, including clinicians, nurses and laboratory personnel. The qualitative findings were used to explain and contextualize the quantitative results by providing insights into operational, technological and human resource factors influencing laboratory turnaround time.

The quantitative component employed a retrospective cross-sectional design based on historical patient and laboratory records. The qualitative component utilized a cross-sectional survey approach involving healthcare workers directly engaged in laboratory-related processes. Integration of the two strands occurred during interpretation of the findings, allowing quantitative results to be explained and enriched by qualitative evidence.

3.3 Target Population

The target population comprised both retrospective patient records and healthcare workers directly involved in laboratory-related processes at Nakasero Hospital. The study focused on records and personnel associated with the Medical-Surgical Ward and Intensive Care Unit (ICU), where laboratory services play a critical role in patient management.

3.3.1 Retrospective Patient Records Population

The retrospective population consisted of all patient records from the Medical-Surgical Ward and Intensive Care Unit that had laboratory test requests processed through the hospital laboratory between July 2025 and December 2025. A review of hospital records identified a total population of 2,374 eligible laboratory order sets during the study period.

3.3.2 Healthcare Worker Population

The healthcare worker population consisted of clinicians, nurses, laboratory technologists and laboratory technicians involved in patient care and laboratory service delivery within the selected hospital units. These personnel were included because of their direct interaction with laboratory processes and their ability to provide information regarding factors influencing laboratory turnaround time and its effects on service delivery. The total eligible healthcare worker population was 128 staff members.

3.4 Sample Size Determination and Sampling Techniques

3.4.1 Sample Size for Retrospective Patient Records

The sample size for the retrospective review was determined using the Taro Yamane formula for finite populations (Yamane, 1967):

$$n = N / [1 + N(e)^2]$$

Where:

n = required sample size

N = population size (2,374 patient records)

e = margin of error (0.05)

Substituting the values:

$$n = 2374 / [1 + 2374(0.05)^2]$$

$$n = 2374 / 6.935$$

$$n = 342$$

The Yamane formula yielded a minimum sample size of 342 patient records. Systematic sampling was then applied using a sampling interval calculated as:

$$k = N / n = 2374 / 342 \approx 7$$

A random starting point between 1 and 7 was selected, after which every seventh eligible record was identified for review. Following application of the study inclusion criteria, only records from the Medical-Surgical Ward and Intensive Care Unit containing complete and verifiable Laboratory Information System (LIS) timestamps for the pre-analytical, analytical and post-analytical phases were retained for analysis. A total of 217 records satisfied all eligibility requirements and were therefore included in the final analysis.

Table 3.1: Sample Size Determination for Retrospective Patient Records

Parameter	Symbol	Value
Population size	N	2,374
Margin of error	e	0.05
Confidence level		95%
Calculated sample size	n	342
Sampling interval	k	7
Final eligible records analyzed	n	217

3.4.2 Sample Size for Healthcare Workers

The prospective survey targeted healthcare workers directly involved in laboratory-related processes, including clinicians, nurses, and laboratory personnel. A purposive stratified sampling approach was adopted to ensure representation of each professional cadre because of

their distinct roles in specimen collection, laboratory processing, result interpretation, and clinical decision-making.

From a total population of 128 eligible healthcare workers, a target sample of 65 respondents was selected proportionately across the three strata. Of the 65 questionnaires distributed, 60 were completed and returned, yielding a response rate of 92.3%.

3.4.3 Sampling Techniques

Two sampling techniques were employed in the study. For the retrospective review, systematic sampling was used to select patient records from the sampling frame generated from the hospital database. For the prospective survey, purposive stratified sampling was used to select healthcare workers. Stratification was based on professional cadre, while purposive selection ensured inclusion of respondents with direct experience in laboratory-related processes and clinical decision-making.

3.5 Data Collection Methods

3.5.1 Retrospective Secondary Data Extraction

Retrospective data were collected using a structured data extraction sheet developed in Microsoft Excel. Data were obtained from the hospital's Laboratory Information System (LIS) and Electronic Medical Records (EMR) for the 217 eligible patient records included in the study.

Specific timestamp variables were extracted to determine laboratory turnaround time across the three phases of laboratory testing. Pre-analytical TAT was calculated as the time interval between test order entry and specimen receipt in the laboratory. Analytical TAT was calculated as the time interval between specimen receipt and result generation. Post-analytical TAT was calculated as the time interval between result generation and clinician access to the result through the EMR system. Total TAT was computed as the sum of the three phases.

In addition to laboratory turnaround time, hospital performance indicators were extracted from patient records and hospital databases. These included length of hospital stay, discharge time, cost of care per patient visit, and laboratory test categories, including hematology, biochemistry, and microbiology investigations. The extracted data provided objective

measures used to assess the relationship between laboratory turnaround time and hospital performance.

3.5.2 Prospective Primary Data Collection

Primary data were collected using structured self-administered questionnaires distributed to the selected healthcare workers, including clinicians, nurses and laboratory personnel. The questionnaire was developed based on the study objectives, theoretical framework and findings from the literature review.

The questionnaire consisted of five sections. Section A collected demographic information from respondents. Section B assessed operational, technological and human resource factors influencing laboratory turnaround time using five-point Likert scale items. Section C examined perceptions of the effects of laboratory turnaround time on clinical efficiency, service quality and clinical decision-making. Section D focused on the perceived cost implications associated with laboratory delays. Section E contained open-ended questions designed to obtain additional explanations regarding factors influencing laboratory turnaround time and its effects on hospital operations.

The open-ended responses provided qualitative data that were used to explain and contextualize the quantitative findings obtained from the retrospective record review. This approach was consistent with the Sequential Explanatory Mixed-Methods Design, whereby qualitative evidence was used to enhance understanding of the quantitative results and provide additional insight into operational challenges affecting laboratory performance.

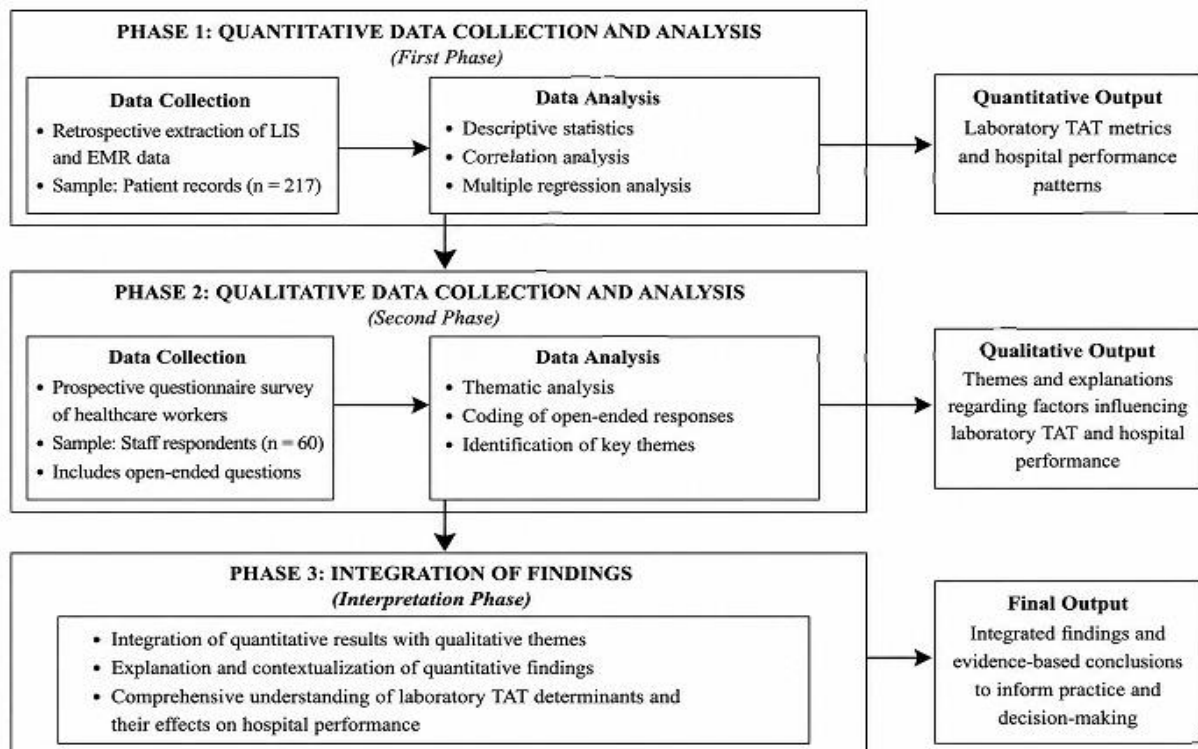


Figure 3.1: Sequential Explanatory Mixed-Methods Research Design

3.5.3 Pilot Testing

Prior to the main study, the data collection instruments were pilot tested among 10 healthcare workers from a private tertiary hospital in Kampala that was not included in the final study. The purpose of the pilot test was to assess the clarity, relevance and comprehensiveness of the questionnaire items and to identify any ambiguities that could affect data quality. Feedback obtained during the pilot exercise was used to refine the wording of questions, improve the logical sequencing of items and estimate the average time required to complete the questionnaire. The reliability of the Likert-scale items was assessed using Cronbach's Alpha coefficient. The pilot test yielded a Cronbach's Alpha value of 0.82, indicating good internal consistency and reliability of the instrument.

3.6 Data Quality Control

Several measures were implemented to ensure the accuracy, completeness and reliability of the data collected. For the retrospective record review, a standardized data extraction tool and data dictionary were developed prior to data collection. These instruments ensured consistency in

the extraction and recording of laboratory turnaround time variables, hospital performance indicators and cost-related data. To minimize data entry errors, a random sample of 10% of the extracted records was independently verified against the original Laboratory Information System (LIS) and Electronic Medical Records (EMR) by a designated hospital data officer.

For the prospective survey, research assistants were trained on the study objectives, questionnaire administration procedures and ethical requirements before data collection commenced. Completed questionnaires were reviewed for completeness and consistency before data entry. Questionnaires with substantial missing information were excluded from analysis. Data entry was conducted using a restricted-access database, and a random subset of questionnaires was subjected to double-entry verification to enhance data accuracy.

3.7 Data Analysis Techniques

3.7.1 Quantitative Data Analysis

Quantitative data obtained from retrospective patient records and healthcare worker questionnaires were cleaned, coded, and entered into the Statistical Package for Social Sciences (SPSS) version 27 for analysis.

Descriptive statistics were used to summarize the characteristics of the study population and key study variables. Continuous variables were summarized using means, standard deviations, medians and interquartile ranges where appropriate, while categorical variables were summarized using frequencies and percentages.

Inferential statistical techniques were employed to address the study objectives. Pearson Product-Moment Correlation analysis was used to assess the relationships between laboratory turnaround time and hospital performance indicators. Multiple linear regression analysis was conducted to determine the effect of laboratory turnaround time on clinical efficiency, service quality and financial performance. Analysis of Variance (ANOVA) was used to assess the overall significance of the regression models.

Prior to regression analysis, key statistical assumptions were evaluated. Normality of residuals was assessed using the Shapiro-Wilk test and visual inspection of normal probability plots. Multicollinearity among predictor variables was examined using Variance Inflation Factors (VIF), with values below 5 considered acceptable. Homoscedasticity was assessed through residual scatter plots, while linearity was examined using scatterplot matrices.

For questionnaire-based constructs measured using multiple Likert-scale items, composite scores were generated by calculating the mean score of the items representing each construct. This approach is widely used in health services and management research to create continuous variables suitable for parametric analysis. Regression coefficients, 95% confidence intervals, p-values, coefficients of determination (R^2), and effect sizes were reported to facilitate interpretation of the findings.

3.7.2 Qualitative Data Analysis

Qualitative data obtained from the open-ended survey responses were analysed using thematic analysis as described by (Braun and Clarke, 2006). The analysis involved several stages, including familiarization with the data, generation of initial codes, identification of recurring patterns, development of themes and interpretation of findings.

The qualitative findings were used to explain and contextualize the quantitative results, particularly in relation to operational, technological, and human resource factors influencing laboratory turnaround time. Integration of the qualitative and quantitative findings occurred during the interpretation stage of the study in accordance with the Sequential Explanatory Mixed-Methods Design.

3.8 Ethical Considerations

Ethical approval for the study was obtained from the Kawempe National Referral Hospital Research Ethics Committee (REC). Approval was subsequently granted by the Uganda National Council for Science and Technology (UNCST) under Registration Number HS7283ES for the period 25 March 2026 to 25 March 2027.

Institutional approval to conduct the study was obtained from Nakasero Hospital. Additional ethical approval was granted by Strathmore University Institutional Scientific and Ethics Review Committee (ISERC) under Reference Number SU-ISERC3332/26 for the period 4 June 2026 to 3 June 2027.

Written informed consent was obtained from all healthcare workers who participated in the survey. For the retrospective review, patient identifiers were removed before data extraction and analysis. Unique alphanumeric codes were assigned to records to ensure confidentiality and anonymity. All electronic data were stored on password-protected computers accessible only to the research team, while hard-copy documents were stored in locked cabinets. The

study adhered to the ethical principles of respect for persons, beneficence, non-maleficence, confidentiality and voluntary participation.

3.9 Chapter Summary

This chapter described the methodology employed to examine the effect of laboratory turnaround time on hospital performance at Nakasero Hospital. The chapter presented the research design, study population, sample size determination procedures, sampling techniques, data collection methods, pilot testing procedures, quality control measures, data analysis techniques and ethical considerations. The methodological procedures described in this chapter provided the framework for collecting and analyzing data to address the study objectives. The next chapter presents the results of the study.



CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter presents, analyses and interprets the empirical data collected to examine the effect of laboratory turnaround time (TAT) on hospital performance at Nakasero Hospital, Uganda. The analysis integrated retrospective data extracted from 217 systematically sampled patient records and prospective primary data collected from 60 healthcare workers (representing a 92.3% response rate from the targeted 65 staff). The chapter's structure aligns with the study's four specific objectives.

The total number of records (217) is not the same as the number of people (60) who were surveyed; (2) interpretations of means near the neutral midpoint have been qualified, rather than overstated; (3) regression outputs are presented with full statistical detail, including confidence intervals, effect sizes and model diagnostics; (4) the discrepancy between the 217-record retrospective sample and the 60-person survey sample is clarified throughout; and (6) the integration of the mixed methods has been strengthened with explicit triangulation between the quantitative and qualitative findings.

4.2 Demographic Characteristics of the Study Population

4.2.1 Patient Record Demographics (Retrospective Data, N = 217)

The 217 patient records extracted from the Medical-Surgical Ward and ICU represented a diverse patient profile. The gender distribution was relatively balanced, with a slight female majority (54.8%, n=119) compared to males (45.2%, n=98). The largest patient cohort fell within the 31–45 age bracket (38.2%), followed by the 46-60 age group (29.5%).

Table 1.1: Age and Gender

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	98	45.2
	Female	119	54.8
	Total	217	100.0
Age Category	18–30 Years	32	14.7
	31–45 Years	83	38.2
	46–60 Years	64	29.5
	Over 60 Years	38	17.5
	Total	217	100.0

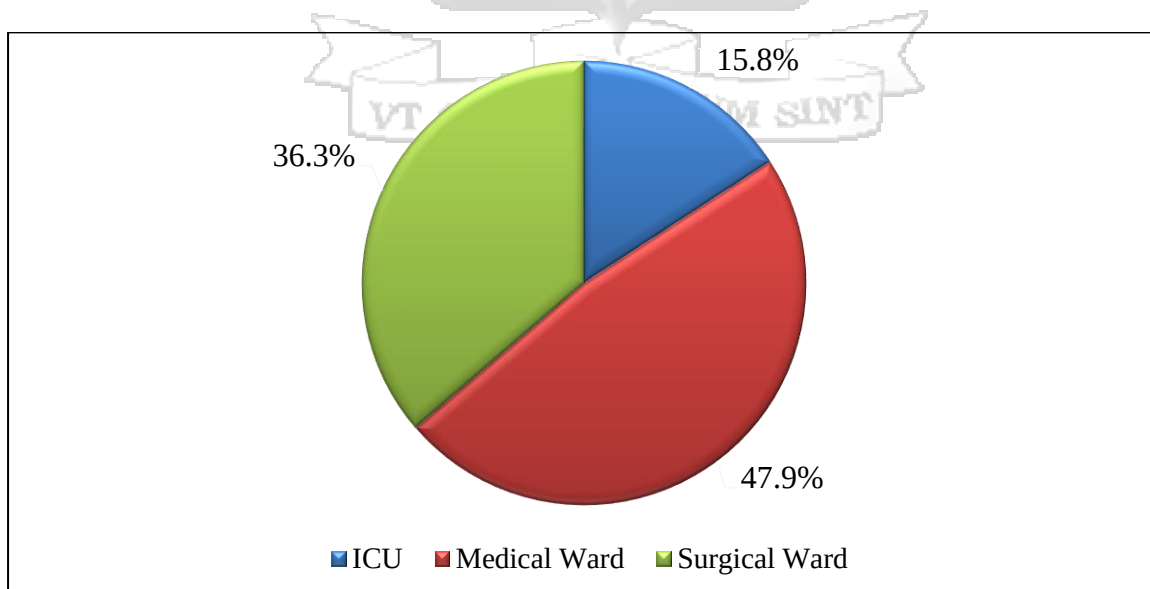
Table 2.2: Highest Level of Education and Department/Ward of Admission

Variable	Category	Frequency (n)	Percentage (%)
Highest Level of Education	Primary	12	5.5
	Secondary	48	22.1
	Tertiary (college/university)	157	72.4
	Total	217	100.0
Department/Ward	Medical-Surgical Ward	149	68.7
	Intensive Care Unit (ICU)	68	31.3
	Total	217	100.0

Table 3.3: Length of Hospital Stay and Type of Health Financing

Variable	Category	Frequency (n)	Percentage (%)
Length of Hospital Stay	1–2 Days	45	20.7
	3–5 Days	80	36.9
	Over 5 Days	92	42.4
	Total	217	100.0
Health Financing	Out-of-Pocket (Cash)	140	64.5
	Private Corporate Insurance	77	35.5
	Total	217	100.0

The high proportion of patients staying over 5 days (42.4%) is a critical contextual metric that will be analyzed in the context of TAT delays. The dominance of Out-of-Pocket (OOP) payments (64.5%) underscores the financial vulnerability of this patient population to cost escalations resulting from prolonged hospital stays.

Figure 1.3: Distribution of Respondents

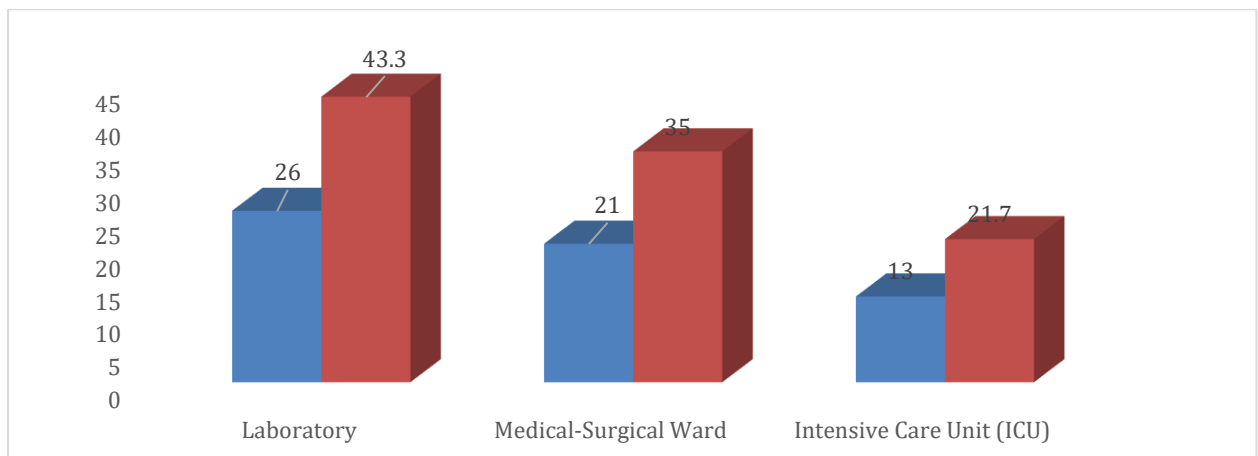
4.2.2 Healthcare Staff Demographics (Prospective Data, N = 60)

The prospective respondents (N=60) are different from the retrospective patient records (N=217). Responses are perceptual data from 60 healthcare staff (clinicians, nurses, lab staff) as a result of TAT's impact on their practice. The 217 records are patient episodes on which objective operational data are available. These are two distinct sources of data that are not aggregated but used to triangulate.

Table 4.4: Healthcare Staff Department and Years of Clinical Experience

Variable	Category	Frequency (n)	Percentage (%)
Department	Laboratory	26	43.3
	Medical-Surgical Ward	21	35.0
	Intensive Care Unit (ICU)	13	21.7
	Total	60	100.0
Years of Clinical Experience	Less than 2 Years	8	13.3
	2–5 Years	19	31.7
	Over 5 Years	33	55.0
	Total	60	100.0

Figure 2.4: Staff Demographics



4.3 Objective 1: Operational, Technological and Human Resource Factors Influencing TAT

4.3.1 Perceptual Assessment of TAT Determinants

Respondents were asked to rate various factors on a 5-point Likert scale (1=Strongly Disagree, 5=Strongly Agree). The findings revealed a nuanced picture. Basic operational factors such as workflow efficiency ($M=4.09$, $SD=0.70$) and sample collection processes ($M=4.05$, $SD=0.65$) were rated relatively highly, suggesting the fundamental physical layout and procedural steps for drawing and routing samples are generally adequate.

However, technological and human resource factors emerged as significant pain points. The availability and functionality of laboratory equipment ($M=2.85$, $SD=0.88$) scored well below the neutral midpoint, indicating frequent equipment downtime. Similarly, the adequacy of staffing levels ($M=2.90$, $SD=0.82$) was viewed critically, particularly regarding night and weekend shifts.

Table 5.5: Operational, Technological and Human Resource Factors (N=60)

Factor Category	Specific Indicator	Mean (M)	Std. Dev. (SD)	Interpretation
Operational	Workflow efficiency is well-organized	4.09	0.70	Generally adequate - above neutral
Operational	Sample collection processes are timely	4.05	0.65	Generally adequate - above neutral
Technological	LIS integration with ward systems is seamless	3.10	0.91	Near neutral - marginal
Human Resource	Staffing levels are adequate for test volume	2.90	0.82	Below neutral - problematic
Technological	Laboratory equipment is consistently functional	2.85	0.88	Below neutral - problematic

1 = Strongly Disagree; 5 = Strongly Agree. If the mean is above 3.5, there is general agreement, below 2.5, general disagreement and between 2.5 and 3.5, there is ambivalence. The mean scores for equipment functionality (2.85) and staffing adequacy (2.90), although below the midpoint (3.0), are in the ambivalent area which doesn't represent strong disagreement. They are therefore read as signs of "significant concern" and "moderate dissatisfaction" rather than "categorical condemnations."

4.3.2 Retrospective Analysis of TAT Phases

To corroborate the perceptual findings with objective data, actual TAT metrics were extracted from the 217 patient records.

Table 4.6 provides descriptive statistics for the total TAT, revealing an overall mean TAT of 198.4 minutes (approximately 3.3 hours), with a high standard deviation of 112.5 minutes, indicating extreme variability in processing times.

Table 6.6: Laboratory Turnaround Time Summary Statistics (N=217)

TAT Metric	N	Mean (Minutes)	Std. Deviation	Minimum	Maximum
Total TAT	217	198.4	112.5	45	5,760
Pre-analytical TAT	217	48.2	22.1	10	180
Analytical TAT	217	85.6	45.3	15	720
Post-analytical TAT	217	64.6	38.4	20	240

The maximum total TAT of 5,760 minutes in the dataset needs to be explained in context, rather than included as a simple summary statistic. The Review of this record showed that the record was for a Microbiology culture with extended culture times (Blood culture, 72 hours to perform sensitivity reading; post analysis time for result authorization).

The study established that their difference in routine hematology or biochemistry blood sample. Microbiology culture was identified to have intrinsic longer TATs during the analytical phase because of biological processes that cannot be expedited. The 5,760-minute value is thus a true clinical outlier, not due to an operational failure.

Sensitivity analyses excluding microbiology culture outliers (n=12 TAT > 1,440 minutes) resulted in a mean total TAT of 174.2 minutes (SD=78.3) with the reported mean total TAT of

198.4 minutes showing that the microbiology culture outliers contributing slightly to the inflation of this reported mean. They are reported for both figures for transparency.

Theme 1: Operational Workflow Inefficiencies

The qualitative findings revealed that operational workflow inefficiencies were among the major contributors to prolonged laboratory turnaround time within the hospital. Participants consistently described delays occurring across different stages of the laboratory process chain, beginning from specimen collection at the ward level up to communication and dispatch of laboratory results after analysis. While some respondents acknowledged that laboratory technical capacity was generally functional, they emphasized that procedural inefficiencies within internal workflow systems significantly slowed the overall process.

1.1: Specimen Processing Delays

Participants revealed that specimen processing delays frequently occurred during the pre-analytical stage, particularly during sample collection, temporary holding of specimens before processing and delays in transporting samples from wards to the laboratory. Several respondents explained that due to workload pressure and staff shortages, samples were often accumulated and processed in batches rather than being delivered and analyzed immediately. This practice, although operationally convenient for staff, was reported to contribute significantly to longer waiting periods before laboratory testing could begin.

Participant Responses

"Sometimes we collect blood sample early but because porter is busy somewhere else, sample can remain here maybe for like thirty minutes or even more before going to the laboratory. Wasting starts before testing starts." Participant 1 (Ward Nurse).

"Morning hours usually are quite difficult because many patients are giving samples at the same time. We normally keep some and process them together in batches because handling one by one becomes hard and time consuming. That can delay other patients honestly." Participant 7 (Laboratory Technician)

"Eh I have noticed sometimes patient gives sample quickly but reaching the laboratory takes time. Maybe the nurse is occupied or support staff delayed. So, you find testing is fast but getting specimen there takes longer than expected." Participant 3 (Clinical Officer).

Two dominant issues emerged repeatedly from participant narratives, namely specimen processing delays and poor coordination between clinical departments and the laboratory unit.

1.2: Poor Interdepartmental Coordination

Respondents reported that communication breakdowns between doctors, nurses and laboratory personnel frequently delayed specimen routing, slowed follow-up on urgent requests and delayed the delivery of completed results back to requesting departments. Participants explained that incomplete request forms, delayed updates regarding test progress and poor communication channels often forced laboratory technicians to repeatedly follow up with the laboratory, creating avoidable delays in patient management.

Participant Responses

One participant highlighted communication breakdowns between clinical and nursing staff, noting that delays often occur before laboratory processing even begins:

"Sometimes I request an urgent test and I think the laboratory is already working on it, but later I find the nurse hasn't even sent the sample yet [laughs]. Communication between departments is not always clear and the patient keeps waiting."

Participant 10 (ICU Staff)

Similarly, a laboratory officer emphasized that incomplete documentation frequently contributes to delays in initiating laboratory procedures:

"There are many times forms come incomplete; maybe the doctor forgot to sign or the patient number is missing. We have to return them for correction. This back-and-forth movement wastes time before actual processing begins."

Participant 5 (Laboratory Officer)

A medical officer further described delays in communicating completed results to clinicians, resulting in unnecessary follow-up inquiries and prolonged clinical decision-making:

"Hmm, a result may be ready but delayed in reaching the physicians on time. Nobody informs us quickly, so we keep calling the laboratory asking if the result is ready when actually testing was completed long back... [clears throat] ... communication still has a problem."

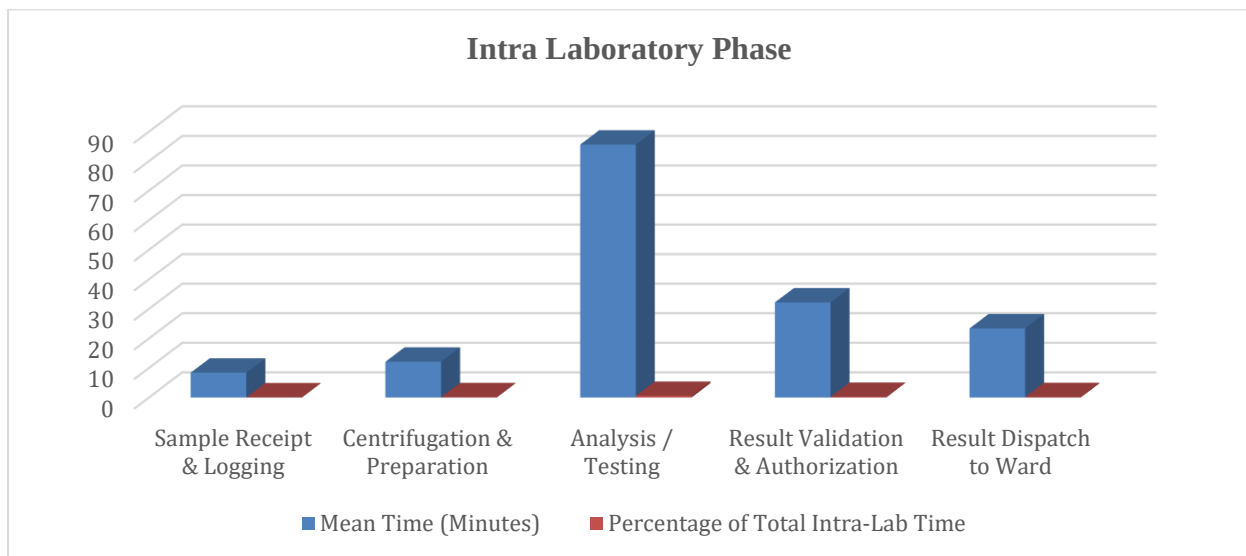
Participant 4 (Medical Officer)

Table 7.7: Intra-Laboratory Phase Duration (Analytical TAT Breakdown)

Intra-Laboratory Stage	Mean Time (Minutes)	Percentage of Total Intra-Lab Time
Sample Receipt & Logging	8.4	5.2%
Centrifugation & Preparation	12.1	7.5%
Analysis / Testing	85.6	53.0%
Result Validation & Authorization	32.2	20.0%
Result Dispatch to Ward	23.4	14.5%
Total	161.7	100.0%

The Analysis/Testing stage consumed 53.0% of intra-laboratory time, consistent with the TOC identification of the analytical phase as the primary system bottleneck. Equipment downtime and reagent stock-outs were the principal contributors to this delay, as confirmed by the staff survey qualitative responses.

Figure 3.6: Intra-Laboratory Phase



4.3.3 Inferential Analysis of Factors Influencing TAT

A multiple linear regression was conducted to determine the predictive power of operational, technological and human resource factors on Total TAT. Prior to this analysis, statistical assumptions were verified: the Shapiro-Wilk test on residuals indicated approximate normality ($W=0.971$, $p=.072$); VIF values for all predictors were below 3.0, indicating no problematic multicollinearity; residual scatter plots indicated reasonable homoscedasticity.

Table 8.8: Regression Model — TAT Predicted by Operational, Technological and Human Resource Factors

Model Summary	R	R Square	Adjusted R ²	Std. Error	F-statistic	p-value	Cohen's f ²
1	0.748	0.560	0.542	42.34	24.82 (df=3,56)	< .001	1.27 (large)
Predictor Variable	Unstandardized B	Std. Error	Standardized Beta (β)	t	Sig.	95% CI for B	

Model Summary	R	R Square	Adjusted R ²	Std. Error	F-statistic	p-value	Cohen's f ²
(Constant)	345.21	38.44	—	8.97	<.001	[268.33, 422.09]	
Equipment Functionality	-52.66	12.11	-0.412	-4.34	<.001	[-76.88, -28.44]	
Staffing Adequacy	-48.20	14.55	-0.385	-3.31	.002	[-77.30, -19.10]	
Workflow Efficiency	-8.55	15.22	-0.065	-0.56	.576	[-39.00, 21.90]	

Dependent Variable:

Total Laboratory TAT (in minutes). The model explains 54.2% of variance in TAT (Adjusted R²=.542) and is highly significant (F (3,56) =24.82, p<.001). Equipment functionality (β =-0.412, p<.001) and staffing adequacy (β =-0.385, p=.002) are significant negative predictors of TAT: higher functionality and higher staffing adequacy are associated with shorter TATs. Workflow efficiency (β =-0.065, p=.576) was not a significant predictor, consistent with staff perceptions that basic workflow processes are relatively adequate. The large effect size (f²=1.27) indicates high practical as well as statistical significance.

Staff open-ended responses corroborated these quantitative results, in a process of triangulation with qualitative findings. Common comments made were: 'The analyzer frequently breaks down during peak hours, with no back-up machine', 'There is only one laboratory technician in the night shifts for the whole department' and 'Reagents sometimes get finished before being notified and we have to wait 2–3 days for supplies'. These stories explain the statistically significant influences of equipment functionality and staffing level on TAT mechanistically.

Preanalytical TAT had a unique preanalytical bottleneck that was not reflected in the perceptual scale items, which was the time required to get the test ordered to the payment clearance (24.7 minutes, SD=18.3 minutes) for out-of-pocket patients and was highly correlated with total

preanalytical TAT ($r=0.61$, $p<.001$). This administrative delay, in which patients and/or relatives have to physically provide money at the finance department before the laboratory sample processing begins, is a non-clinical (administrative) form of waste that has no parallels in the literature of the public sector or in the insured patient pathway. It is especially useful for tests that require immediate results with clinical implications if there is a delay in pre-analytical steps.

Theme 2: Technological Infrastructure Limitations

The qualitative findings revealed that technological infrastructure limitations significantly contributed to prolonged laboratory turnaround time within the hospital. Participants frequently described technological challenges as recurring operational barriers that affected the speed and efficiency of laboratory processes. Although laboratory services depended heavily on equipment functionality and digital systems to ensure timely testing and result communication, respondents reported that technological disruptions often interrupted workflow continuity. Participants specifically highlighted frequent machine breakdowns, delayed equipment maintenance, and weaknesses in laboratory information systems as some of the major factors slowing down laboratory operations.

2.1: Equipment Downtime and Machine Failures

Participants reported that frequent equipment breakdowns and delays in maintenance significantly affected the speed of laboratory testing processes. Several respondents explained that laboratory analyzers occasionally developed technical faults, forcing staff to suspend testing temporarily while waiting for repairs or technical support. Participants further noted that some machines had been in use for extended periods and were increasingly prone to malfunction, which created interruptions during busy testing periods. In some situations, delayed access to spare parts or specialized technicians prolonged downtime further, contributing to extended turnaround times for patients awaiting critical laboratory results.

Participant Responses

"Sometimes machine can just stop working in the middle of processing especially when workload is high. You have to wait for the technical team or restart several times before continuing. That alone can delay many patients." Participant 3 (Laboratory Technician).

"We have some equipment here which has worked for many years now. You find it starts giving errors frequently and sometimes maintenance people do not come immediately. So, work remains pending until problem is solved." Participant 11 (Laboratory Scientist).

"Eh... analyzer breakdown is one big challenge honestly. At times reagent is there, samples are ready, staff is present... but machine refuses working [laughs softly]. Then everything stops until technician checks it and patients keep waiting." Participant 2 (Senior Laboratory Officer).

Two dominant technological challenges emerged from the interviews, namely equipment downtime and machine failures, as well as weak integration of laboratory information systems with clinical service units.

4.4 Objective 2: Relationship Between Laboratory TAT and Hospital Service Efficiency

4.4.1 Perceptual and Objective Assessment of Service Efficiency

Healthcare workers were asked to evaluate the impact of TAT on operational flow. The data indicated strong consensus that delays in laboratory reporting resulted in significantly longer patient waiting times ($M=4.21$, $SD=0.70$) and extended hospital stays ($M=4.21$, $SD=0.63$). Respondents also agreed that TAT delays slowed overall patient throughput ($M=3.95$, $SD=0.75$).

Table 9.9: Hospital Service Efficiency — Perceptual Data (N=60)

Service Efficiency Indicator	Mean (M)	Std. Dev. (SD)	Interpretation
Delays in lab reporting result in longer patient waiting times	4.21	0.70	Strong agreement
Prolonged TAT leads to extended hospital stays (LOS)	4.21	0.63	Strong agreement
Delayed results slow down bed turnover and patient throughput	3.95	0.75	Moderate-strong agreement

Service Efficiency Indicator	Mean (M)	Std. Dev. (SD)	Interpretation
Discharge planning is frequently delayed due to pending lab results	4.10	0.68	Strong agreement

Of the 92 patients (42.4%) who stayed in the hospital for more than 5 days, 74 (80.4%) had at least one TAT greater than 4 hours during their hospitalization for a key diagnostic. This cross tabulation, by itself, does not prove causality, but it does support the hypothesis that TAT delays will lead to longer LOS. There was a moderate positive correlation between mean total TAT per patient episode and LOS of $r=0.48$ ($p<.001$, 95% CI [0.36, 0.58]).

Theme 3: Impact of Laboratory Turnaround Time on Hospital Service Efficiency

From the study, participants consistently explained that laboratory services form an important support function within the hospital, directly influencing the speed at which staff make decisions, patients progress through treatment stages and departments coordinate service delivery. Respondents reported that delays in laboratory result availability frequently created bottlenecks that affected discharge planning, patient movement within wards, and timely completion of routine hospital activities. The findings further indicated that prolonged laboratory turnaround time not only affected individual patient care but also created wider operational inefficiencies that reduced the hospital's ability to maintain smooth service delivery.

3.1: Delayed Patient Throughput and Bed Turnover

Participants revealed that prolonged laboratory turnaround time frequently delayed patient movement through the hospital system, particularly by slowing discharge processes and affecting efficient utilization of available bed space. Several respondents explained that medical doctors often depended on laboratory confirmation before authorizing discharge decisions or transferring patients between care units. However, when laboratory results delayed

beyond expected timelines, patients remained admitted longer than planned, creating congestion within wards and reducing the hospital's ability to accommodate incoming patients.

Participant Responses

“Sometimes a patient is clinically stable and ready for discharge, but the doctor must wait for the final laboratory report before completing the discharge process. When results are delayed, the patient continues to occupy a hospital bed longer than necessary, limiting bed availability for other patients awaiting admission.” Participant 1 (Ward Supervisor)

“We occasionally encounter situations where a patient is expected to be discharged on the same day, but delays in receiving laboratory results force the discharge to be postponed. As a result, the patient remains admitted for an additional night, and a bed that could have been allocated to another patient remains unnecessarily occupied.” Participant 2 (Medical Officer)

“When many patients remain in the wards because their laboratory results are still pending, ward congestion becomes a significant challenge. Beds are not released promptly, which affects patient flow and delays the admission of other patients who require inpatient care, particularly during periods of high patient volume.” Participant 3 (Admissions Nurse)

The findings indicate that delayed laboratory turnaround time adversely affects hospital throughput efficiency by slowing patient transitions across the continuum of care. Prolonged waiting for laboratory results delays discharge decisions, contributes to unnecessary bed occupancy, reduces effective bed turnover, and increases ward congestion. Consequently, these delays limit the hospital's capacity to accommodate new admissions and negatively impact overall patient flow and resource utilization.

3.2: Prolonged Waiting Time and Reduced Workflow Efficiency

Another major issue highlighted by participants was the disruption of normal hospital workflow caused by prolonged waiting time for laboratory results. Respondents explained that delayed laboratory reporting frequently interrupted routine ward rounds, postponed treatment decisions and slowed coordination between healthcare teams responsible for patient management. Several participants noted that doctors were often forced to delay reviewing patients while waiting for diagnostic confirmation, causing treatment schedules and

departmental workflows to shift unexpectedly. Participants further indicated that when laboratory delays persisted, several departments experienced interruptions that affected the efficiency of routine hospital operations. The findings suggest that prolonged laboratory turnaround time disrupts workflow continuity across the hospital and reduces overall service delivery efficiency by delaying critical operational activities.

Participant Responses

“Morning ward rounds can delay because you want first to review laboratory results before making decisions. If results are not ready, you either postpone some decisions or return later which slows the whole schedule.” Participant 4 (Internal Medicine Doctor)

“Sometimes treatment plan depends completely on laboratory feedback but when results delay, everything else also stops. Medication changes delay, procedures delay, even communication with patient attendants becomes difficult because you have no final direction yet.” Participant 5 (Senior Nurse)

“Honestly when laboratory delays happen one department alone does not suffer... the whole workflow changes. Doctors wait, nurses wait, patient keeps waiting also. You find many normal hospital activities getting interrupted because one process has delayed... [clears throat] and work becomes less efficient overall.” Participant 6 (Clinical Officer)

4.5 Objective 3: Effect of Laboratory TAT on Clinical Decision-Making

4.5.1 Perceptual and Inferential Assessment of Clinical Decision-Making

Table 4.10 demonstrate key points on behavior of clinicians when the TAT runs for prolonged periods. The statement 'Clinicians use confirmed laboratory results as the primary basis for initiating treatment' had a mean response score of $M=2.99$ ($SD=0.75$) just below the midpoint of the scale. It should be taken with a grain of salt: 2.99 is in the ambivalent range (2.5 – 3.5) and not a strong disagreement. It indicates lack of consensus among clinicians about the extent to which they always expect confirmation before they start treatment and a minor trend toward 'sometimes' or 'rarely'. This is clinically important because in a high acuity ward, the consequences of late treatment initiation can be serious, but should not be exaggerated as evidence of widespread clinical protocol abandonment.

Table 10.10: Clinical Decision-Making — Perceptual Data (N=60)

Clinical Decision Indicator	Mean (M)	Std. Dev. (SD)	95% CI
Clinicians primarily rely on confirmed lab results before treatment initiation	2.99	0.75	[2.80, 3.18]
Timely lab results are strongly associated with treatment accuracy	2.98	0.69	[2.81, 3.15]
Prolonged TAT forces reliance on empirical/symptomatic treatment	4.25	0.61	[4.09, 4.41]
Delayed TAT leads to deviations from standard clinical protocols	4.12	0.72	[3.93, 4.31]

Table 11.11: Regression Model — Clinical Decision-Making Adherence Predicted by Total Laboratory TAT

Model Summary	R	R ²	Adjusted R ²	Std. Error	F-statistic	p-value	Cohen's f ²
1	0.594	0.352	0.341	0.882	31.45 (df=1,58)	< .001	0.54 (large)
Predictor	Unstandardized B	Std. Error	Standardized Beta	t	Sig.	95% CI for B	
(Constant)	5.421	0.312	—	17.37	< .001	[4.80, 6.04]	
Total Laboratory TAT (minutes)	-0.004	0.001	-0.584	-5.60	< .001	[-0.006, -0.002]	

Dependent Variable:

Composite Score on Adherence to Clinical Care Protocols (higher score = greater adherence). The model explains 34.1% of variance in protocol adherence (Adjusted $R^2=.341$; large effect, $f^2=0.54$). The significant negative beta ($\beta=-0.584$, $p<.001$) indicates that as total TAT increases, adherence to evidence-based clinical protocols decreases. The 95% confidence interval for the TAT coefficient $[-0.006, -0.002]$ confirms a statistically robust negative association.

Triangulation of mixed methods:

The quantitative result (prolonged TAT decreases protocol adherence) was supported by qualitative results from the staff narratives. Typical answers were: 'If they're not back in within 48 hours, I have to treat them empirically with antibiotics, no choice'; 'Not waiting for a CBC to get started on a resuscitation in the ICU, I have to make a clinical judgment and hope it comes back before I have to change. These stories show the clinical reality behind the regression coefficient: it is not a matter of deliberate non-compliance of the protocols, but rather a practical response to diagnostic delay.

Theme 4.5.2: Laboratory TAT and Clinical Decision-Making Challenges

Participants consistently explained that timely laboratory results play an important role in guiding treatment decisions, confirming diagnoses, and supporting adherence to established clinical management procedures. However, respondents reported that when laboratory results delayed beyond expected timelines, medical doctors were often forced to make treatment decisions without complete diagnostic information. Participants further indicated that delays in laboratory reporting frequently disrupted normal patient management processes, creating uncertainty during treatment planning and increasing the likelihood of deviations from standard clinical procedures.

4.1: Empirical Treatment Without Laboratory Confirmation

Several respondents explained that in urgent situations, doctors could not always afford to wait for delayed test results, particularly when managing critically ill patients requiring immediate intervention. As a result, treatment decisions were often based on clinical symptoms, previous experience, or preliminary patient presentation rather than laboratory confirmation. Participants indicated that although such decisions were sometimes necessary to prevent patient deterioration, reliance on empirical treatment occasionally increased the risk of inaccurate diagnosis and inappropriate treatment decisions.

Participant Responses

“Sometimes a patient’s condition does not allow us to wait for laboratory results. When someone is critically ill, treatment is often initiated based on clinical assessment and presenting symptoms because any delay could worsen the patient’s condition. The laboratory results may only become available after treatment has already begun.” — Participant 9 (Medical Officer)

“There are emergency situations where conditions such as severe infection or malaria are strongly suspected, yet laboratory results take too long to arrive. In such cases, clinicians cannot afford to wait passively and must initiate treatment based on their clinical judgment, with laboratory findings used later to confirm the diagnosis.” — Participant 5 (Emergency Unit Doctor)

“Especially in pediatrics cases, management is sometimes started immediately because delaying care may place the child at greater risk. While the laboratory is still processing samples, treatment is initiated before diagnostic confirmation because some clinical situations simply cannot wait.” — Participant 3 (Pediatric Nurse)

4.2: Deviation from Clinical Treatment Protocols

Another issue consistently highlighted by participants was the tendency for delayed laboratory turnaround time to disrupt adherence to established clinical treatment protocols. Respondents explained that many clinical guidelines require laboratory confirmation before certain treatments, medication adjustments, or specialized interventions can be initiated. However, when laboratory results were delayed, nurses occasionally bypassed some standard diagnostic procedures in order to maintain patient flow or respond to urgent patient needs. Several participants reported situations where confirmatory testing steps were skipped entirely, forcing healthcare providers to rely on alternative judgment rather than established evidence-based treatment pathways.

Participant Responses

“Clinical protocols often require that specific treatments be initiated only after laboratory tests confirm a diagnosis. However, when laboratory results are significantly delayed and the

patient's condition requires urgent intervention, clinicians may proceed with treatment based on clinical judgment rather than waiting for confirmation.” – Participant 4 (Senior Medical Officer)

“There are instances when medication changes should only be made after laboratory confirmation. However, if results are delayed and the patient's condition is not improving, healthcare providers may bypass some of the usual procedural steps and rely on their clinical experience to guide management decisions.” – Participant 5 (Ward Nurse)

“Delayed laboratory results can negatively affect adherence to established clinical protocols. Although healthcare providers are aware of guideline requirements, prolonged waiting times for laboratory feedback may necessitate interim management decisions based on clinical assessment. In such cases, treatment adjustments may be implemented before laboratory confirmation, with documentation updated once results become available.” – Participant 6 (Internal Medicine Doctor)

The findings indicate that prolonged laboratory turnaround times can hinder compliance with clinical protocols, leading healthcare providers to rely more heavily on clinical judgment and experience. While such adaptations may be necessary to ensure timely patient care, they can reduce consistency in evidence-based practice and potentially compromise the standardization of patient management processes.

4.6 Objective 4: Relationship Between Laboratory TAT and Cost of Care

4.6.1 Perceptual and Inferential Assessment of Cost Implications

The financial burden of delayed TAT was strongly perceived by healthcare staff. Respondents overwhelmingly agreed that delays in laboratory reporting were associated with increased patient care expenses ($M=4.06$, $SD=0.99$), attributed to extended ward stays and the increased necessity for alternative or repeat testing ($M=3.81$, $SD=1.09$).

Table 12.12: Cost Implications of Laboratory TAT - Perceptual Data (N=60)

Cost Indicator	Mean (M)	Std. Dev. (SD)
Delays in lab reporting increase overall patient care expenses	4.06	0.99
Prolonged TAT necessitates additional/alternative diagnostic testing	3.81	1.09
Extended LOS due to TAT delays significantly raises the final hospital bill	4.22	0.85
TAT delays negatively impact patient affordability and financial risk protection	4.15	0.78

Table 13.13: Regression Model - Average Cost of Care Predicted by Total Laboratory TAT

Model Summary	R	R ²	Adjusted R ²	Std. Error (UGX)	F-statistic	p-value	Cohen's f ²
1	0.406	0.165	0.161	185,420.55	42.11 (df=1,215)	< .001	0.20 (small-medium)
Predictor	Unstandardized B (UGX)	Std. Error	Standardized Beta	t	Sig.	95% CI for B	
(Constant)	1,245,600.00	85,420.11	—	14.58	< .001	[1,077,197, 1,414,003]	
Total Laboratory TAT (hours)	1,245.50	192.11	0.406	6.48	< .001	[867.00, 1,624.00]	

The unstandardized coefficient or B coefficient of 1,245.50 ($p < 0.001$) shows that for every additional hour of total laboratory TAT, the average cost of care per patient visit increases by approximately UGX 1,246 while controlling for the other variables.

The model accounts for 16.1% of the variance in cost (Adjusted $R^2=.161$) and this is because there are many other factors contributing to the total cost of the hospital stay in addition to TAT (medication type, surgical interventions, nursing intensity, duration of illness). About 84% of the variance is unexplained and this is to be expected and proper, since this model is not designed to predict the total cost but the incremental cost attributable to the TAT.

The study population frame represented a laboratory episode of care processed in the Nakasero Hospital in six months period.

Study population frame: About 2,374 patient laboratory episodes of care processed in the Nakasero hospital in 6 months. The mean additional time for an episode of care is about 1 hour, which represents an extra UGX 2,374 for each episode of care for a population of 1,246 people or an extra UGX 5.9 million per year for the patient population for avoidable additional patient expenditure due to the delays in TAT. This is equivalent to UGX 3.8 million per year of avoidable household financial burden for the 64.5% of patients who pay for health services out of their own pockets a direct impact on the financial risk protection goal of the Ugandan private health market with UHC.

The cost outcome variable (average cost of care in UGX) is continuous metric data and not Likert scales. The predictor variable (total time on the TAT in hours) is also continuous. This particular regression thus does not violate normality, or parametric assumptions, as it might in data regression of an ordinal nature.

Theme 5: Financial Burden Associated with Delayed Laboratory Turnaround Time

Participants consistently explained that prolonged waiting for laboratory results often affected the speed of treatment decisions, delayed patient discharge processes, and increased the overall cost of care during hospital visits. Respondents further reported that when laboratory delays persisted, medical doctors were sometimes forced to initiate alternative interventions or repeat certain procedures in order to maintain continuity of patient care. These situations frequently created avoidable financial burdens for patients through prolonged admission, repeated investigations, and additional treatment costs.

5.1: Increased Cost from Prolonged Hospital Stay

Participants revealed that prolonged laboratory turnaround time frequently delayed patient discharge and extended hospital admission periods, ultimately increasing the total cost of care incurred by patients. Several respondents explained that patients often remained admitted longer than medically necessary simply because doctors were waiting for laboratory confirmation before making discharge or treatment decisions. Participants further noted that every additional day spent in hospital automatically increased patient expenditure through accommodation charges, medication costs, nursing services, and other routine hospital expenses.

Participant Responses

Participants reported that delays in receiving laboratory results often prolong patients' length of stay in the hospital, even when clinical improvement has already been achieved. A ward nurse explained:

“There are patients who have shown significant improvement, but the doctor cannot authorize discharge until the final laboratory results are available. Consequently, the patient remains hospitalized longer than necessary, and additional hospital charges continue to accumulate.”
(Participant 1, Ward Nurse)

Similarly, a medical officer highlighted the impact of delayed laboratory results on clinical decision-making and discharge planning:

“When laboratory delays occur, management decisions are also postponed. A patient may remain admitted for an extra day or more while awaiting confirmation before discharge. Naturally, the overall hospital bill increases because each additional day of admission incurs further costs.” (Participant 2, Medical Officer)

Admissions officer further emphasized the financial burden experienced by patients as a result of extended hospitalization:

“Patients sometimes express frustration because they expected to be discharged earlier, but their laboratory results are still pending. As a result, they remain admitted longer, and

expenses such as room charges, medications, and nursing care continue to accumulate, increasing the total cost of care unexpectedly.” (Participant 3, Admissions Officer)

5.2: Duplicate Testing and Unnecessary Expenditure

Another financial concern consistently reported by the participants involved unnecessary expenditure resulting from repeated diagnostic testing and treatment decisions made before laboratory confirmation. Respondents explained that when laboratory results delayed excessively, medical doctors occasionally initiated treatment based on preliminary assessment in order to avoid delaying care. However, in some situations, delayed or unclear results later forced additional tests to be repeated in order to confirm diagnosis or reassess patient condition. Participants noted that these repeated procedures and preemptive treatment decisions often generated avoidable extra costs for patients, particularly when initial management decisions required adjustment after laboratory confirmation.

Participant Responses

The participants consistently highlighted the financial implications associated with delayed laboratory turnaround times. One clinical officer explained:

“Sometimes, treatment is initiated before laboratory results are available because the delay is too long. When the results are eventually released, the clinician may request additional confirmatory tests, leading to extra costs that could potentially have been avoided.”

(Participant 4, Clinical Officer)

Similarly, a laboratory officer noted that prolonged delays in sample transportation or processing can compromise specimen quality, necessitating repeat collections and additional testing:

“There are cases where sample quality is affected because it remains unprocessed or undelivered for too long. As a result, repeat sample collection may be required, meaning another test has to be performed and the patient incurs additional costs unnecessarily.”

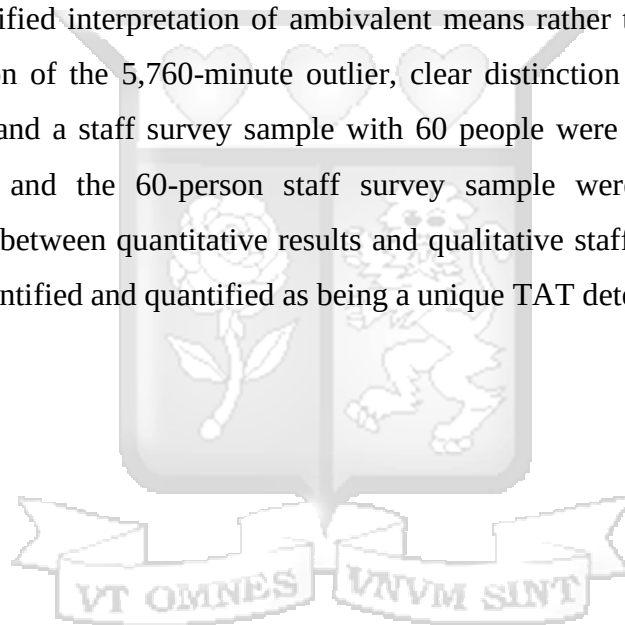
(Participant 5, Laboratory Officer)

A senior nurse further emphasized that delayed results can contribute to diagnostic uncertainty and repeated investigations:

“Delayed laboratory results may force clinicians to commence treatment before a definitive diagnosis is confirmed. Later, when the results become available, the clinician may realize that the initial diagnosis was incomplete or inaccurate and request further investigations. Ultimately, the patient ends up spending more than originally anticipated.” (Participant 6, Senior Nurse)

4.7 Chapter Summary

Explicit assumption testing and effect size reporting incorporated regression models for the analytical depth; qualified interpretation of ambivalent means rather than overstatement, an analytical investigation of the 5,760-minute outlier, clear distinction between a 217-record retrospective sample and a staff survey sample with 60 people were added; the 217-record retrospective sample and the 60-person staff survey sample were distinguished; clear distinction was made between quantitative results and qualitative staff narratives; the 5,760-minute outlier was identified and quantified as being a unique TAT determinant in this private LMIC context.



CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This study used a Sequential Explanatory Mixed-Methods Research Design (SMMRD) that was detailed in the Chapter Three. This chapter serves as the culminating synthesis of the research study, drawing definitive conclusions from the empirical data presented in Chapter Four and translating the findings into actionable, evidence-based recommendations. The primary objective of this thesis was to examine the effect of laboratory turnaround time (TAT) on the performance of Nakasero Hospital, Uganda. Through Sequential Explanatory Mixed-Methods Research Design grounded in Lean Management Theory (LMT) and the Theory of Constraints (TOC), the study systematically deconstructed the determinants of TAT and quantified its downstream impact on hospital service efficiency, clinical decision-making and the financial cost of care.

5.2 Discussion

The following sections detail objective research findings and conclusions derived from data processed and presented in the previous chapter

5.2.1 TAT Determinants

The findings regarding the determinants of TAT strongly corroborate the extensive body of literature. The identification of equipment downtime and staffing shortages as the primary constraints aligns precisely with the empirical observations of (Nkengasong et al., 2018) in Sub-Saharan Africa. Through the lens of TOC, the 'Analysis/Testing' step (consuming 53% of intra-lab time) is unequivocally the system bottleneck. While LMT successfully explains why basic sample collection workflows are relatively efficient, TOC highlights that these improvements are moot if core processing capacity is constrained by broken machines or missing reagents.

This study identified the payment bottleneck in the administrative process that was adding an average of 24.7 more pre-analytical minutes for out-of-pocket patients: a unique contribution to the literature. This administrative delay does not have any comparable quantification in the

Ugandan laboratory literature, the size (on average 51% of the total pre-analytical TAT in OOP patients) is operationally significant. This discovery contradicts the prevailing narrative of pre-analytical delays as technical or logistical and exposes the pre-analytical waste in administrative-financial processes as an equal if not a greater source of waste in private LMIC hospitals. Delays from an LMT perspective are a classic example of "administrative waste," which is a step in a process that does not add value in the diagnostic process but takes time that can be measured.

The study findings partially contradicted the study conducted by (Namuli et al., 2021) whose pattern revealed that the primary TAT constraint in private hospitals in Uganda is post-analytical communication delay. The post-analytical time (mean 64.6 minutes) was significant but not as much as the analytical time (mean 85.6 minutes) in the present study. This difference could be due to variations in the LIS infrastructure at Nakasero Hospital and the facilities in the sample by (Namuli et al., 2021) or changes in the communication of the results since 2021. Preanalytical workflow is, however, more efficient in private settings, according to both studies.

5.2.2 Service Efficiency

The strong perceptual agreement ($M=4.21$) that TAT dictates length of stay and patient throughput mirrors the findings of Stover et al. (2018). In a capacity-constrained environment like Nakasero Hospital (120 beds, often near full occupancy), an extended LOS of even half a day per patient due to a pending morning laboratory panel creates a cascading bed-blocking effect. The Pearson correlation between mean total TAT and LOS ($r=0.48$, $p<.001$) provides objective statistical confirmation of this relationship, while the perceptual data enriches this finding with clinical context.

Importantly, the association between TAT and LOS is associative and not causal, because the study was a cross-sectional retrospective design. Other factors which affect LOS were not controlled for in the current study, such as the level of the disease, social support for discharge, and rehabilitation services available. The correlation, $r=0.48$, in fact means a moderate association between the variables involved, rather than a deterministic reason. This subtlety is crucial to weigh policy recommendations proportionately.

5.2.3 Clinical Decision-Making

The finding that clinicians scored near the neutral midpoint ($M=2.99$) regarding reliance on confirmed results - interpreted as indicating diagnostic compromise under conditions of TAT delay - empirically validates the theoretical assertions of (Boursier et al., 2019). The regression model (Adjusted $R^2=0.341$, $\beta=-0.584$) mathematically confirms that prolonged TAT erodes adherence to evidence-based clinical protocols.

The shift toward empiric therapy carries severe downstream consequences, most notably the acceleration of antimicrobial resistance (AMR) - a critical public health threat in LMICs. The qualitative triangulation provided rich narrative evidence that this protocol deviation is pragmatic rather than negligent, driven by clinical necessity in the absence of timely diagnostic data.

But the study will not be able to demonstrate the clinical implications of this protocol violation until there is objective prescribing data and patient outcome records. Future research should systematically look at antimicrobial prescription patterns in relation to TAT, and quantify the AMR risk due to the delays in the laboratory specifically at Nakasero Hospital.

5.2.4 Cost of Care

The financial analysis is based on the operational inefficiencies of TAT identified in the operational analysis and converts them into direct economic terms thereby lending support to the claims by (Mills et al., 2018). The regression substantiates that TAT is not only a nuisance in the clinic, but a direct contributor to healthcare cost inflation. Approximately 16.5% of UGX 5.9 million in annual cost escalation is attributed to TAT, which is a significant challenge to financial risk protection, a key component of Universal Health Coverage.

The cost regression has an R^2 of 16.1% which is an appropriate amount of variance in cost explained, as it is clear that cost of total hospitalization is affected by many factors other than TAT alone. However, management must take a broader approach to reducing costs and consider TAT reduction as part of a broader cost reduction plan, not a standalone financial solution. The estimated UGX 1246 per additional hour of TAT, although moderate on a per-episode basis adds up to a significant amount of money on a per-institution basis.

5.3 Conclusion

The findings of this study provide robust empirical evidence that laboratory turnaround time is not merely a peripheral operational metric, but a central determinant of the clinical, operational and financial performance of a tertiary healthcare facility. The following conclusions are drawn systematically in alignment with the study's specific objectives.

Regarding the factors influencing laboratory TAT (Objective 1): the study concluded that while foundational operational workflows at Nakasero Hospital are relatively optimized, the primary determinants of prolonged TAT are technological constraints and human resource deficits.

The analytical phase was identified as the system's primary bottleneck (TOC), with equipment downtime and reagent stock-outs as the principal constraining factors. An additional unique finding - the administrative payment processing delay - was identified as significant pre-analytical bottleneck in this private, predominantly out-of-pocket payment context.

Regarding the evident relationship between TAT and hospital service efficiency (Objective 2): the study found a moderate, statistically significant positive correlation ($r=0.48$) between total TAT and LOS, and perceptual consensus that delays of TAT impact negatively on discharge planning and decrease bed turnover. The results are considered as associative and not causal because of the cross-sectional design.

On the effect of TAT on clinical decision-making (Objective 3): the study concluded that prolonged laboratory TAT is significantly negatively associated with adherence to evidence-based clinical care protocols ($\beta=-0.584$, $p<.001$, Adjusted $R^2=.341$). Clinicians are forced to rely on empiric therapy, with direct public health implications for AMR.

The study concluded that laboratory efficiency is a significant driver of healthcare cost per patient visit ($B=1,245.50$ UGX per additional hour, $p<.001$), with OOP patients disproportionately bearing this financial burden illuminating the relationship between TAT and the cost of care as per objective 4

Overall conclusions on causal inference: Due to the cross sectional and retrospective design of the study, only statistical association can be drawn and not definite causation.

The term "fundamentally dictates" originally described the relationship between TAT and hospital performance as over interpreted. TAT is considered an important, statistically sound predictor of hospital performance - with good evidence of association to clinically meaningful effects sizes - but recognizes that longitudinal and experimental designs would be required to prove causality.

5.4 Recommendations

5.4.1 Recommendations for Nakasero Hospital Management

The hospital management need endeavor to elevate the Analytical Phase Bottleneck (TOC Application; High Priority, Immediate): Management needs to use immediate capital and operational resources to ease the Analytical Phase Bottleneck (TOC Application). This involves:

- (a) Carrying out a thorough equipment audit to create a comprehensive preventive maintenance programme and reduce unplanned downtime and;
- (b) Optimizing the supply chain management system to ensure adequate buffer stocks of critical reagents. Because equipment functionality was found to account for the highest proportion of TAT variance ($\beta = -0.412$), a relatively small TAT reduction due to a small percentage increase in equipment uptime is predicted. The estimated cost of preventive maintenance contract on the laboratory analyzers should be compared with the estimated UGX 5.9 million that a patient will cost due to TAT delays in the hospital to provide a clear business case for the investment.

Resolve Administrative Payment Bottleneck (LMT Application; High Priority, Immediate): This 'order-to-payment' delay (mean 24.7 additional minutes for OOP patients) is easily removed with no capital expenditure and is the "purest" form of pre analytical waste. Laboratory processing should begin immediately upon the ordering of all inpatient orders and all urgent/STAT tests and the financial verification of the order should be completed through parallel administrative process. A system of provisional credits (allowing laboratory processing to be done against the patient's admission deposit) would separate the urgency of diagnostic testing from the urgency of getting the money cleared. This administrative change is significant

and should be considered to improve mean pre-analytical TAT by up to 24–30% for most of the population of OOP patients.

The finding that night shifts and weekends suffer disproportionate TAT spikes due to staffing shortages necessitates immediate review of the laboratory rostering system. Management should evaluate the cost-benefit of employing sustainable dedicated phlebotomists for high-acuity wards (ICU/Emergency Department) during off-peak hours. Staff allocation should be guided by TAT data rather than administrative convenience.

The hospital should prioritize the full interoperability of the Laboratory Information System (LIS) with the Electronic Medical Records (EMR). This recommendation is contextualized for feasibility: full LIS-EMR interoperability requires substantial IT investment and system vendor cooperation. A phased approach is recommended - beginning with auto-notification of critical values to ward duty stations (requiring minimal IT investment) and progressing to full bi-directional integration over a 12–18-month timeline. Auto-verification of normal values would eliminate a portion of the post-analytical validation delay (20% of intra-lab time per Table 4.7).

Optimizing Human Resource Allocation (Medium Priority, Short-term). The laboratory rostering system needs to be reviewed to address disproportionate TAT spikes on night shifts and weekends, which have been found to be related to staffing levels. Cost benefit analysis of the use of dedicated phlebotomists on high acuity wards (ICU, Emergency Department) during off peak hours is warranted. Staff placement should be based on the TAT data and not convenience.

Implementing LIS-EMR Integration (Medium Priority, Medium-term). The hospital should give priority to LIS-EMR Integration for full interoperability. In the context of feasibility: full LIS-EMR interoperability requires significant IT investment and IT system vendor cooperation. It is recommended that a phased approach be taken - from auto-notification of critical values to ward duty stations (low IT investment) to full bi-directional integration within a 12-18 month time frame. Some of the post analytical validation delay (20% of intra-lab time per Table 4.7) would be reduced by auto-verification of normal values.

5.4.2 Recommendations for Clinical Practice

Quality assurance and management of health care facilities need develop of TAT-Contingent Clinical Pathways: Clinicians should collaborate with the quality department to develop standardized clinical pathways that explicitly account for TAT variability. For instance, if a critical microbiology culture result has not returned within 48 hours, the protocol should mandate an automated review and escalation of empiric therapy, rather than ad-hoc continuation.

Antimicrobial Stewardship Integration: The hospital's Antimicrobial Stewardship Program (ASP) needs to include TAT as a metric of success as the relationship between the delayed TAT and reliance on empiric therapy is established. Empirical prescriptions should be discussed daily by the pharmacist and clinicians and use of broad-spectrum antibiotics be de-escalated or discontinued as soon as the laboratory results give a specific diagnosis. This has direct inference from the regression finding ($\beta=-0.584$) that reduced protocol adherence is associated with TAT.

5.4.3 Recommendations for Health Policy and Regulation

Mandate Private Hospital TAT Benchmarking:

The Ministry of Health (MoH) should institute mandatory, standardized TAT benchmarks for private tertiary hospitals, depending on the nature of the test whether it is routine, urgent or STAT as part of the conditions for licensure and accreditation. Such benchmarks must be evidence-based and based on distributions of TATs obtained in studies like the present one.

Incorporate Diagnostics into UHC Metrics:

Universal Health Coverage policy discussions about UHC often include issues of pharmaceutical and infrastructure expenses and fail to address inefficiencies in diagnostics. This study shows that the lost revenues amount to UGX 5.9 million per annum per 120 bed facility that can be saved as a result of TAT. If scaled up to the entire private hospital sector in Uganda, financial impact would be huge. Laboratory TAT indicators should be embedded in the national Health Sector Development Plan as one of the key indicators of financial risk protection and quality of care for the policy makers.

5.5 Limitations and Areas for Future Research

The final sample for the study was $n=217$, which, though principled was below the minimum of $n=342$ as recommended by Yamane, resulting in an effective margin of error of $\sim 6.6\%$. This needs to be taken into account when interpreting the regression coefficients and any results should be replicated with a larger sample.

Cross sectional design and causality – the study makes statistically significant associations, but does not make causal claims.

This cross-sectional and retrospective design approach employed does not allow for the exclusion of reverse causation (e.g., the more laboratory tests that were performed during a longer LOS, the sicker the patients were and not the other way around; the longer a TAT, the more likely a patient suffers and thus end up having longer LOS).

Self-report and recall bias:

Data from perceptual Likert scale questionnaires completed by staff may be subject to social desirability, acquiescence and recall bias. These perceptual findings support but cannot replace objective clinical audit information necessary for health facility quality management resolutions.

Qualified qualitative depth is a notable limitation. The qualitative part (open-ended survey questions) focused on themes of explanation rather than a deep qualitative investigation. There were no formal interviews, focus groups or ethnographic observations conducted, resulting in a limited understanding of the socio-organizational factors that influence TAT delays.

External validity:

Results from one hospital in Kampala a tertiary, fee-for-service hospital cannot be extrapolated to public facilities, rural hospitals or lower tier private hospitals.

Patient satisfaction:

Patient satisfaction was originally part of the conceptual framework but was not appropriated and measured in this study. Future studies should thoroughly examine patient-reported experience measures with regard to laboratory TAT.

5.5.1 Recommendations for Future Research

From this study findings and limitations registered future research should include longitudinal or quasi-experimental design (before-and-after measurements of hospital performance after TAT improvements or after LIS upgrades) to confirm causal links between TAT improvement and hospital performance outcomes.

Further future studies involving multi-site comparative investigations across different facility tiers (public, private-not-for-profit, private-for-profit) in Uganda and other states would help establish whether the identified constraints are general or context-specific.

Cost-effectiveness analyses need to be performed with rigorous CEA calculating the Return on Investment (ROI) of laboratory upgrades: the return on capital expenditure to purchase new analyzer equipment and be compared to the return from increased facility bed turnover vi-viz reduced patient hospital stay.

The novel finding on the order-to-payment delay should be explored using ethnographic or in-depth interviewing methods to garner insights into financial clearance and institutional, financial and social dynamics that might contribute to this priority.

Antimicrobial resistance audit is necessary in future research. A systematic audit of antimicrobial prescribing patterns, further quantifying the AMR risk specifically related to diagnostic delays done at Nakasero Hospital.

Patient satisfaction and financial impact studies also necessitates future research. Studies are needed to explore patient-reported experience measures and household financial impact (catastrophic expenditure) of the impact of efficient laboratory TAT on UHC financial protection outcomes.

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APPENDICES

Appendix I: Strathmore Introduction Letter

Ole Sangale Rd, Medunika Estate
P.O. Box 58857 - 00258, Nairobi, Kenya
Cell: +254 703 094 414/6/7
Twitter/Facebook: @StrathmoreKenya
Facebook/LinkedIn: Strathmore University Business School
Email: absinfo@strathmore.edu or visit www.abs.strathmore.edu



Thursday, October 16, 2025.

To Whom It May Concern,

RE: FACILITATION OF RESEARCH – ASIAH BAKARI

This is to introduce Asiah Bakari, a Master of Business Management in Healthcare Management (MBA-HCM) student at Strathmore University Business School, admission number MBAHCM/188470/24.

As part of our MBA-HCM program, Asiah is expected to do applied research and undertake a project. This partially fulfills the requirements of the MBA-HCM course; to this effect, she would like to request appropriate data from your organization.

Asiah is undertaking a research paper on *"Examining the Effect of Turnaround Time on Laboratory Performance: A Case Study of the Nakasero Hospital in Uganda"*. The information obtained shall be treated confidentially and used for academic purposes only.

Our MBA-HCM program seeks to establish links with industry, and one of these ways is by directing our research to areas that would be of direct use to the industry. We would be glad to share our findings with you after the research, and we trust that you will find them of great interest and practical value to your organization.

We appreciate your support and will be willing to provide further information if required. Yours sincerely,

Alois Njenga

A handwritten signature in black ink, appearing to be "Alois Njenga".

Manager – Graduate Programs

Strathmore University Business School (UK) Fraud member of:

Association of African
Business Schools



AACSB

Appendix II: Ethical Approvals

A. Letter of Exemption from Ethical Clearance



Strathmore University
Office of Graduate Studies

14th May 2026

Asiah Odongo Bakari

Student Number: 188470

asiah.bakari@strathmore.edu

MBA Healthcare Management

Dear Asiah,

RE: Examining the Effect of Turnaround Time on Laboratory Performance: A Case Study of the Nakasero Hospital in Uganda

This is to inform you that the Office of Graduate Studies received your request for exemption from ethical clearance. This is based on the fact that your study was/is based in Uganda, and you have already received ethical clearance from:

1. The Uganda National Council for Science and Technology (UNCST) - for the period of 25/03/2026 to 25/03/2027. The registration number with the UNCST is HS7283ES.
2. Kawempe National Hospital REC (KNRH-REC-2025-005)
3. Nakasero Hospital PSEC Approval

The office notes that: On the grounds of having obtained the Research approvals and clearance from Uganda. This is a letter for you to proceed with the next steps of your academic requirements.

Disclaimer: 1) This is not in any way an ethical approval letter.

Yours Sincerely,



Prof. Bernard Shibwabo Kasamani (PhD),
Director of Graduate Studies,
Strathmore University,
Email: bshibwabo@strathmore.edu

Appendix B: Institutional Ethics Review Committee (ISERC) Approval Letter for the Study



4th June 2026

Ms Bakari Asiah,
asiahbakari@gmail.com

Dear Ms Bakari,

RE: Examining the Effect of Turnaround Time on Laboratory Performance: A Case Study of Nakasero Hospital in Uganda.

This is to inform you that SU-ISERC has reviewed and approved your above SU-masters research proposal. Your application reference number is SU-ISERC3332/26. The approval period is from 4th June 2026 to 3rd June 2027.

This approval is subject to compliance with the following requirements:

- i. Only approved documents including (informed consents, study instruments, and MTA) will be used
- ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by SU-ISERC.
- iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to SU-ISERC within 72 hours of notification
- iv. Any changes, anticipated or otherwise, that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to SU-ISERC within 72 hours
- v. Clearance for the export of biological specimens must be obtained from relevant institutions.
- vi. Submission of a request for renewal of approval at least 60 days prior to the expiry of the approval period. Attach a comprehensive progress report to support the renewal.
- vii. Submission of an executive summary report within 90 days of completion of the study to SU-ISERC.

Before commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology, and Innovation (NACOSTI) <https://research-portal.nacosti.go.ke/> and obtain other clearances needed.

Yours sincerely,

Mr Ambrose Rachier,
Chairperson; SU-ISERC

Appendix III: Nakasero Hospital /PSEC Letter



Nakasero

Hospital

Date: 16th March, 2026

To: Ms. Asiah Odongo Bakari

From: Professionals Standards and Ethics Committee (PSEC) Chairman

RESEARCH APPLICATION FEEDBACK

Based on the review of the research application study document submitted, I am pleased to inform you that your application to carry out research at Nakasero Hospital has been approved by the Professional, Standards and Ethics Committee (PSEC).

We request you to acknowledge Nakasero Hospital in your Research and avail us with your final copy.

We sincerely wish you the best in your research study,

Susan Layado Opira

PSEC Secretary

Kind

regards,



03125314001



P.O.EOX 16595



Plot 144 Akii Bua Road www.nokoserohospital.com

0322346159



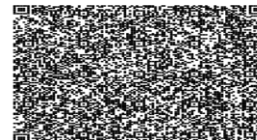
Appendix IV: UNCST Permit



Uganda National Council for Science and Technology
(Established by Act of Parliament of the Republic of Uganda)

25 March 2026
Our Ref: HS7283ES

Asiah Bakari
Nakasero Hospital Limited
Kampala



Re: Research Approval: Examining the Effect of Turnaround Time on Laboratory Performance: A Case Study of the Nakasero Hospital in Uganda

I am pleased to inform you that on **25/03/2026**, the Uganda National Council for Science and Technology (UNCST) approved the above referenced research project. The Approval of the research project is for the period of **25/03/2026** to **25/03/2027**.

Your research registration number with the UNCST is **HS7283ES**. Please, cite this number in all your future correspondences with UNCST in respect of the above research project. As the Principal Investigator of the research project, you are responsible for fulfilling the following requirements of approval:

1. Keeping all co-investigators informed of the status of the research.
2. Submitting all changes, amendments, and addenda to the research protocol or the consent form (where applicable) to the designated Research Ethics Committee (REC) or Lead Agency for re-review and approval **prior** to the activation of the changes. UNCST must be notified of the approved changes within five working days.
3. For clinical trials, all serious adverse events must be reported promptly to the designated local REC for review with copies to the National Drug Authority and a notification to the UNCST.

4. Unanticipated problems involving risks to research participants or other must be reported promptly to the UNCST. New information that becomes available which could change the risk/benefit ratio must be submitted promptly for UNCST notification after review by the REC.
5. Only approved study procedures are to be implemented. The UNCST may conduct impromptu audits of all study records.
6. An annual progress report and approval letter of continuation from the REC must be submitted electronically to UNCST. Failure to do so may result in termination of the research project.

Please note that this approval includes all study related tools submitted as part of the application as shown below:

No.	Document Title	Language	Version Number	Version Date
1	Consent Form	English	1.0	12 December 2025
2	Project Proposal	English	VERSION 1.0 (REC CORRECTED VERSION)	
3	Approval Letter	English		
4	Administrative Clearance	English		

Yours sincerely,



Hellen Opolot

For: Executive Secretary

LOCATION/CORRESPONDENCE

Plot 6 Kimera Road, Ntinda
P.O. Box 6884
KAMPALA, UGANDA

COMMUNICATION

TEL: (256) 414 705500
FAX: (256) 414-234579
EMAIL: info@uncst.go.ug
WEBSITE: <http://www.uncst.go.ug>

UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY Powered by
TCPDF (www.tcpdf.org)

Appendix V: Kawempe National Referral REC

Tele : 0414 672552
Email : kawemperefhosp18@gmail.com

FOR ANY CORRESPONDENCE ON THIS
SUBJECT PLEASE QUOTE NO: KNRH/REC:008



Office of the Executive Director
Kawempe National Referral Hospital
Plot 1035/3883 Kawempe, Bombo Road
P. o. Box 3253 Kampala, Uganda

THE REPUBLIC OF UGANDA

KAWEMPE NATIONAL REFERRAL HOSPITAL RESEARCH ETHICS COMMITTEE

22nd December 2025

To: Asiah Bakari

Type: Initial Review

Re: KNRH-REC-2025-005: EXAMINING THE EFFECT OF TURNAROUND TIME ON LABORATORY PERFORMANCE: A CASE STUDY OF THE NAKASERO HOSPITAL IN UGANDA

I am pleased to inform you that the Kawempe National Referral hospital REC (KNRH-REC), through its review held on **19th /12/2025** voted to approve the above referenced study. Approval of the research is for the period of **22nd /12/2025** to **21st/12/2026**.

As Principal Investigator of the research, you are responsible for fulfilling the following requirements of approval:

1. All co-investigators must be kept informed of the status of the research.
2. Changes, amendments, and addenda to the protocol or the consent form must be submitted to the REC for re- review and approval **prior**: to the activation of the changes.
3. Reports of unanticipated problems involving risks to participants or any new information which could change the risk benefit: ratio must be submitted to the REC.
4. Only approved consent forms are to be used in the enrollment of participants. All consent forms signed by participants and/or witnesses should be retained on file. The REC may conduct audits of all study records, and consent documentation may be part of such audits.
5. Continuing review application must be submitted to the REC **six weeks** prior to the expiration date of **21st/12/2026** in order to continue the study beyond the approved period. Failure to submit a continuing review application in a timely fashion may result in suspension or termination of the study.
6. The REC application number assigned to the research should be cited in any correspondence with the REC of record.



Appendix VI: Consent Form for Participation in Research Study

Study Title: Examining the Effect of Turnaround Time on Laboratory Performance: A Case Study of Nakasero Hospital in Uganda

Principal Investigator:

Asiah Odongo Bakari

+256 706 346 183

Purpose of the Study:

You are being invited to participate in a research study that aims to understand how the time taken for laboratory test results affects hospital performance, including treatment adherence, cost of care, hospital efficiency and patient satisfaction.

Procedures:

If you agree to participate, you will be asked to answer some questions about your experience with laboratory services during your hospital stay. Your hospital records related to laboratory tests may also be reviewed to gather information on laboratory turnaround times.

Voluntary Participation:

Your participation is completely voluntary. You may choose not to participate or withdraw at any time without affecting your care at this hospital.

Confidentiality:

All information collected will be kept confidential. Your identity will not be revealed in any reports or publications resulting from this study.

Risks and Benefits:

There are no known risks from participating in this study. While there may be no direct benefit to you, your participation will help improve laboratory services and hospital care for future patients.

Contact Information:

If you have any questions or concerns about the study, please contact:

Asiah Odongo Bakari +256 706 346 183

Consent Statement:

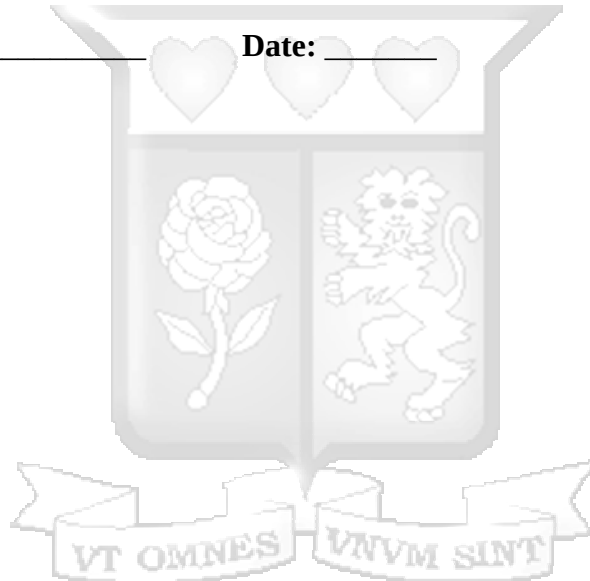
I have read and understood the information provided above. I have had the chance to ask questions, and all my questions have been answered to my satisfaction. I voluntarily agree to participate in this study.

Participant Name: _____

Signature: _____ **Date:** _____

Researcher Name: _____

Signature: _____ **Date:** _____



Appendix VII: Questionnaire

Instructions for Use:

- Sections A and B are for patients discharged from ICU and Medical-Surgical Ward.
- Sections C and D are for clinical staff (doctors, nurses, lab technologists).
- Questionnaire to be administered during the six-month study period.
- Responses will be anonymized to encourage honesty and confidentiality.

SECTION A: DEMOGRAPHIC INFORMATION (For Patients/Inpatients)

Instructions: Please tick (✓) the appropriate response.

1. **Age:**

☐ Under 18 ☐ 18–35 ☐ 36–50 ☐ 51–65 ☐ Over 65

2. **Gender:**

☐ Male ☐ Female ☐ Other

3. **Highest Level of Education:**

☐ None ☐ Primary ☐ Secondary ☐ Tertiary

4. **Department/Ward of Admission:**

☐ ICU ☐ Medical Ward ☐ Surgical Ward ☐ Other (Specify): _____

5. **Length of Hospital Stay:**

☐ <2 days ☐ 2–5 days ☐ 6–10 days ☐ >10 days

6. **Type of Health Financing:**

☐ Public ☐ Private ☐ Out-of-pocket

SECTION B: CLINICIAN / NON-LAB STAFF QUESTIONNAIRE

(Objectives ii, iii, iv)

Staff Demographics

1. **Profession:**

☐ Doctor ☐ Nurse ☐ Clinical Officer ☐ Other: _____

2. **Department:**

☐ ICU ☐ Medical Ward ☐ Surgical Ward ☐ Outpatient ☐ Other: _____

3. **Years of Clinical Experience:**

☐ <5 years ☐ 5–10 years ☐ >10 years

Subsection B1: Clinical Decision-Making

(Objective iii)

Scale: 1 = Never 2 = Rarely 3 = Sometimes 4 = Often 5 = Always 6 = N/A

Statement	1	2	3	4	5	N/A
-----------	---	---	---	---	---	-----

1. Treatment initiated based on confirmed laboratory results. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

2. Delays in lab results lead to delayed clinical decisions. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

3. Empirical treatment is often used due to delayed lab results. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

4. Timely results improve accuracy and appropriateness of treatment. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Subsection B2: Hospital Service Efficiency

(Objective ii)

Scale: 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree 6 = N/A

Statement	1	2	3	4	5	N/A
-----------	---	---	---	---	---	-----

1. Delays in lab results increase patient waiting time. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
2. Slow lab turnaround contributes to longer hospital stays. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
3. Efficient lab reporting improves patient throughput. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
4. Timely laboratory results enhance overall hospital workflow and service efficiency. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Subsection B3: Cost Implications of Laboratory TAT

(Objective iv)

Scale: 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree 6 = N/A

Statement	1	2	3	4	5	N/A
-----------	---	---	---	---	---	-----

1. Delayed lab results increase the cost of patient care. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
2. Repeated tests are ordered due to missing or delayed lab results. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
3. Delayed lab results lead to increased use of hospital resources. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
4. Timely lab reporting reduces unnecessary healthcare expenditures. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

SECTION C: LABORATORY STAFF QUESTIONNAIRE

(Objective i - Operational, Technological, and Human Resource Factors)

Laboratory Staff Demographics

1. Role:

☐ Lab Technologist ☐ Lab Technician ☐ Lab Assistant ☐ Other: _____

2. Years of Experience:

☐ <5 years ☐ 5–10 years ☐ >10 years

3. Shift Worked:

☐ Day ☐ Night ☐ Rotational

Subsection C1: Laboratory Turnaround Time (TAT)

Scale: 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree 6 = N/A

Indicator	1	2	3	4	5	N/A
-----------	---	---	---	---	---	-----

1. Average TAT is within the hospital's defined target time. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

2. Delays frequently occur during sample processing. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

3. Automation and technology reduce laboratory TAT. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

4. Results are consistently released promptly to clinicians. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Subsection C2: Operational, Technological, and Human Resource Factors

Scale: 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree 6 = N/A

Statement	1	2	3	4	5	N/A
1. Sample collection and transport processes are efficient.	☐	☐	☐	☐	☐	☐
2. Laboratory workflow processes are well organized.	☐	☐	☐	☐	☐	☐
3. Equipment availability and technology improve TAT.	☐	☐	☐	☐	☐	☐
4. Staff skills, training, and experience positively influence TAT.	☐	☐	☐	☐	☐	☐
5. Staffing levels are sufficient to maintain timely lab services.	☐	☐	☐	☐	☐	☐

SECTION D: TAT DATA COLLECTION TOOL (Objective i – Objective Measurement of Laboratory Turnaround Time)

Instructions for Data Collectors

- Use hospital clocks or synchronized watches.
- Record timestamps as accurately as possible.
- If a step is skipped, mark “N/A” and explain in Remarks.
- Use **one form per patient per test**.

A. General Information

Variable	Entry
Department	☐ ICU ☐ Medical Ward ☐ Surgical Ward Date: _____
Patient ID (Code)	_____
Test Type	_____
Test Requested By	_____

Variable	Entry
Data Collector Name	_____

B. Pre-Analytical Phase (Optional – Not part of intra-laboratory TAT)

Step	Activity	Time (HH:MM)	Remarks
1	Test ordered by physician	_____	-
2	Payment made	_____	-

C. Intra-Laboratory Phase (Start of TAT Measurement)

Step No.	Step Description	Time (HH:MM)	Remarks
3	Patient received at lab waiting room	_____	Start of intra-lab TAT
4	Sample collected	_____	-
5	Sample assembled (logged + batched)	_____	-
6	Sample transported to bench	_____	-
7	Sample received & sorted	_____	-
8	Sample prepared (e.g., centrifugation)	_____	-
9	Sample analyzed	_____	-
10	Results completed	_____	-
11	Biological validation	_____	-
12	Results released to clinician	_____	End of intra-lab TAT

D. TAT Calculation

Intra-lab

TAT

(Minutes):

[Time at Step 12] – [Time at Step 3] = _____ minutes

E. Observations

Observation Category	Notes
Any delay or bottleneck observed?	_____
Was the test urgent?	☐ Yes ☐ No
Staff available at time of test?	☐ Yes ☐ No
Equipment functioning normally?	☐ Yes ☐ No
Any repeat test required?	☐ Yes ☐ No — Reason: _____



Appendix VIII: TURNITIN REPORT

Asiah Odongo Bakari 188470 FINAL THESIS 22.06.2026.docx

 Strathmore University (Main Account)

Document Details

Submission ID

trn:oid::2945:394822544

Submission Date

Jun 23, 2026, 10:05 AM GMT+3

Download Date

Jun 23, 2026, 11:05 AM GMT+3

File Name

Asiah Odongo Bakari 188470 FINAL THESIS 22.06.2026.docx

File Size

3.4 MB

102 Pages

21,919 Words

137,027 Characters



Page 2 of 117 - Integrity Overview

Submission ID trn:oid::2945:394822544

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