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Effects of Training on Service Delivery in Selected Medical Laboratories in Kenya

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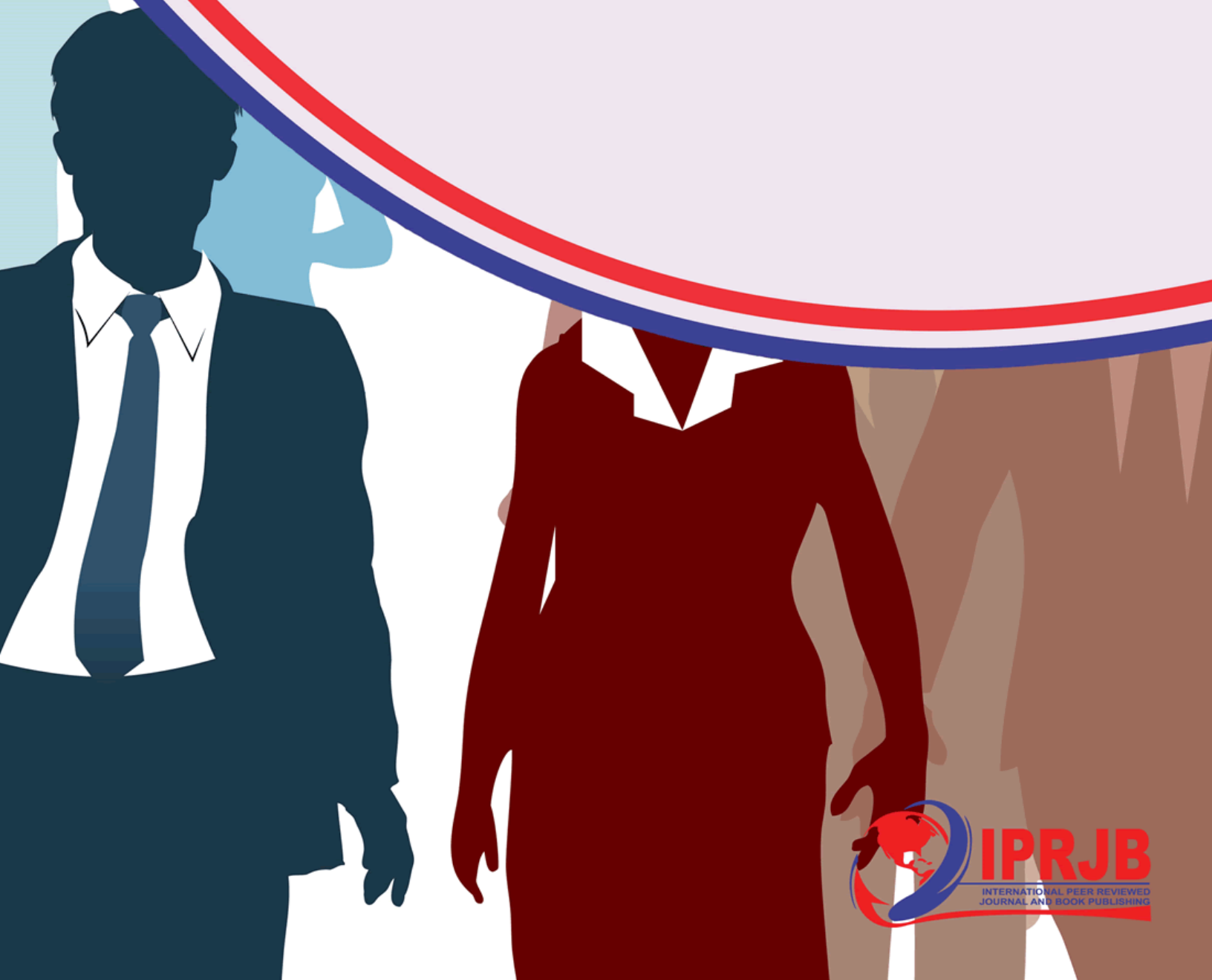

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Abstract

Purpose: Medical laboratories play an essential role in disease diagnosis and treatment, yet their efficiency is often compromised by gaps in staff competencies. This study examined the effects of technical, soft skills, digital, and cognitive skills training on service delivery in selected medical laboratories in Kenya.

Methodology: Guided by the Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), and Social Learning Theory, the study adopted a descriptive cross-sectional design targeting 4,053 practitioners across 18 accredited laboratories in Nairobi County. Data were collected through semi-structured questionnaires and analyzed using descriptive statistics, correlation, and multiple regression.

Findings: Results revealed that technical, soft, digital, and cognitive skills training significantly influenced service delivery, with technical training contributing the highest effect (B=0.364), followed by digital skills (B=0.310), soft skills (B=0.247), and cognitive skills (B=0.145), all at p=0.000. The study concludes that holistic training programs are essential for strengthening diagnostic accuracy, efficiency, and patient satisfaction in Kenyan medical laboratories.

Unique Contribution to Theory, Practice and Policy: Recommendations include establishing structured, continuous training frameworks prioritizing technical and digital competencies while reinforcing soft and cognitive skills.

Keywords: *Training, Service Delivery, Medical Laboratories, Skills Development*

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INTRODUCTION

Service delivery in medical laboratories is a critical pillar of healthcare systems worldwide, as laboratory results inform nearly 70% of all clinical decisions, including diagnosis, treatment planning, and disease monitoring (WHO, 2023). The effectiveness of laboratory service delivery is largely determined by the competence of personnel, the accuracy of diagnostic processes, and the efficiency of operational workflows. Central to this competence is training across multiple skill domains. Technical skills refer to the specialized procedural and analytical competencies required for specimen handling, equipment operation, quality control, and adherence to standard operating procedures. Soft skills encompass interpersonal and behavioral competencies such as communication, teamwork, integrity, and professionalism that facilitate effective collaboration and patient interaction. Digital skills involve the ability to use information technologies, including Laboratory Information Management Systems (LIMS), electronic health records, and automated diagnostic platforms. Cognitive skills relate to higher-order mental processes such as analytical reasoning, decision-making, critical thinking, and problem-solving that support accurate interpretation of laboratory results.

Globally, concerns persist regarding gaps in these skill domains, which directly affect diagnostic precision, turnaround time, and the reliability of laboratory outputs (APHL, 2022; Rajapakshe et al., 2022). Inadequate technical expertise increases analytical and pre-analytical errors, weak soft skills impair coordination between clinicians and laboratory staff, limited digital competence constrains effective system utilization, and underdeveloped cognitive skills compromise diagnostic judgment. Collectively, these deficiencies contribute to fragmented service delivery, reduced quality assurance, and heightened operational inefficiencies within laboratory environments.

In resource-limited settings, particularly across many regions in Africa, these challenges are more pronounced. Limited access to Continuing Professional Development (CPD), constrained infrastructure, and weak implementation of quality management systems hinder laboratory personnel from attaining and sustaining optimal competence levels (Gebregzabher et al., 2023; Odhiambo et al., 2023). Evidence shows that only about 36% of National Tuberculosis Reference Laboratories in the African region have undergone full quality audits, largely due to insufficient training resources and the absence of structured professional development frameworks (Odhiambo et al., 2023). These systemic constraints underscore the critical role of sustained, multidimensional training in strengthening diagnostic reliability.

In Kenya, medical laboratories face similar and, in some cases, intensified challenges. National reports highlight persistent shortages of adequately trained laboratory personnel, limited opportunities for career-long training, and technological constraints that undermine diagnostic efficiency (MOH, 2021; MOH, 2022). Diagnostic errors across pre-analytical, analytical, and post-analytical phases remain a major concern, with pre-analytical errors accounting for up to 42.8% of reported laboratory mistakes (Arthy et al., 2021). These errors lead to delayed results, repeat testing, misdiagnosis, increased patient visits, and prolonged treatment pathways, ultimately eroding public confidence in laboratory services (Allen, 2023).

Kenyan empirical studies have examined aspects of laboratory performance, including staff shortages, technical competence, quality management systems, and the adoption of digital health technologies such as LIMS and electronic health records (Muinga et al., 2020; MOH, 2022). Other studies have explored the influence of staff training on service delivery within healthcare institutions more broadly. However, these studies have largely treated training as a unidimensional construct or focused on isolated skill areas most commonly technical competence without systematically examining how multiple training dimensions (technical, soft, digital, and cognitive skills) interact to influence laboratory service delivery outcomes.

This limitation represents a significant analytical gap. Theoretically, models such as the Theory of Reasoned Action, Technology Acceptance Model, and Social Learning Theory suggest that behavior, technology use, and performance outcomes are shaped by a combination of skills, attitudes, and learning mechanisms rather than by single competencies in isolation. Practically, the absence of evidence on the relative and combined effects of different training dimensions constrains policymakers and laboratory managers from designing targeted, cost-effective training programs that address the full spectrum of performance determinants.

This study therefore sought to address this gap by empirically examining the effect of technical, soft skills, digital skills, and cognitive skills training on service delivery in selected medical laboratories in Kenya. By isolating and comparing the contribution of each training dimension within a single analytical framework, the study provides evidence to inform more holistic training strategies aimed at improving diagnostic accuracy, operational efficiency, and patient safety within Kenya's healthcare system.

Statement of the Problem

Medical laboratories are central to accurate diagnosis and effective patient care; however, service delivery in Kenyan laboratories remains suboptimal due to persistent training-related deficiencies. Empirical evidence indicates continued occurrence of pre-analytical, analytical, and post-analytical errors, which are associated with gaps in laboratory personnel competencies (Arthy et al., 2021; MOH, 2022). While existing Kenyan studies have documented the prevalence of diagnostic errors, staff shortages, and general training inadequacies, they have predominantly examined training as a broad or isolated factor, with a primary emphasis on technical competence.

The unresolved empirical problem lies in the absence of evidence on how distinct training dimensions; technical, soft, digital, and cognitive skills independently and collectively influence service delivery outcomes in medical laboratories. Current studies have not isolated the relative contribution of these training domains, nor have they assessed their combined effects within a single analytical framework. Consequently, policymakers and laboratory managers lack empirical guidance on which skill areas yield the greatest impact on service delivery and how training resources should be optimally allocated. This study addresses this gap by systematically examining the effects of technical, soft skills, digital skills, and cognitive skills training on service delivery in selected medical laboratories in Kenya.

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Theoretical Review

Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA), developed by Ajzen and Fishbein (1980), posits that an individual's behavior is driven by their intention to perform that behavior, which is shaped by their attitudes and perceived social norms. In the context of this study, TRA explains how laboratory personnel's intentions to engage in training activities are influenced by their beliefs about the usefulness of training and the expectations of colleagues and supervisors. When staff perceive training as beneficial and supported by their organization, they are more likely to participate, leading to improved service delivery outcomes.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), proposed by Davis (1986, 1989), explains technology adoption through perceived usefulness and perceived ease of use, making it relevant for understanding how digital skills training influences the adoption of systems such as Laboratory Information Management Systems in medical laboratories. When laboratory personnel perceive digital technologies as beneficial and easy to use, they are more likely to integrate them into routine operations, thereby improving service delivery. However, in low-resource contexts such as many Kenyan laboratories, TAM's explanatory power is limited because technology adoption is also shaped by infrastructural constraints, inadequate technical support, and weak leadership commitment. As a result, positive user perceptions alone may not guarantee effective technology utilization, underscoring the need to consider organizational and resource-related factors alongside individual acceptance.

Social Learning Theory (SLT)

Social Learning Theory, proposed by Bandura (1971), posits that individuals acquire new behaviors and skills through observation, imitation, and interaction within their social environment. In medical laboratory settings, SLT explains how laboratory personnel develop technical, soft, and cognitive skills not only through formal training programs but also through mentorship, peer learning, and observational learning. In this study context, mentorship and peer learning can be measured through indicators such as the presence of structured mentorship arrangements, frequency of on-the-job coaching, peer support during diagnostic procedures, and opportunities for knowledge sharing among colleagues. Observational learning may be assessed through staff exposure to experienced personnel, participation in team-based tasks, and learning through demonstration of standard operating procedures. Through these mechanisms, laboratory personnel adopt best practices that enhance diagnostic accuracy, communication, and decision-making, thereby improving overall service delivery.

Synthesis of Theoretical Frameworks

The Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), and Social Learning Theory (SLT) jointly provide a comprehensive theoretical foundation for this study by explaining how training influences service delivery through behavioral, technological, and social learning mechanisms. TRA explains how laboratory personnel's attitudes and perceived social expectations shape their intention to participate in training and apply acquired skills in practice.

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TAM complements this by explaining how digital skills training influences the acceptance and effective use of laboratory technologies based on perceived usefulness and ease of use. SLT extends this understanding by highlighting how skills are reinforced and sustained through mentorship, peer interaction, and observation within the workplace. Together, these theories support the study's assumption that improvements in service delivery arise not only from individual skill acquisition but also from positive behavioral intentions, effective technology adoption, and continuous social learning within laboratory environments.

Conceptual Framework

Independent Variable **Dependent Variable**

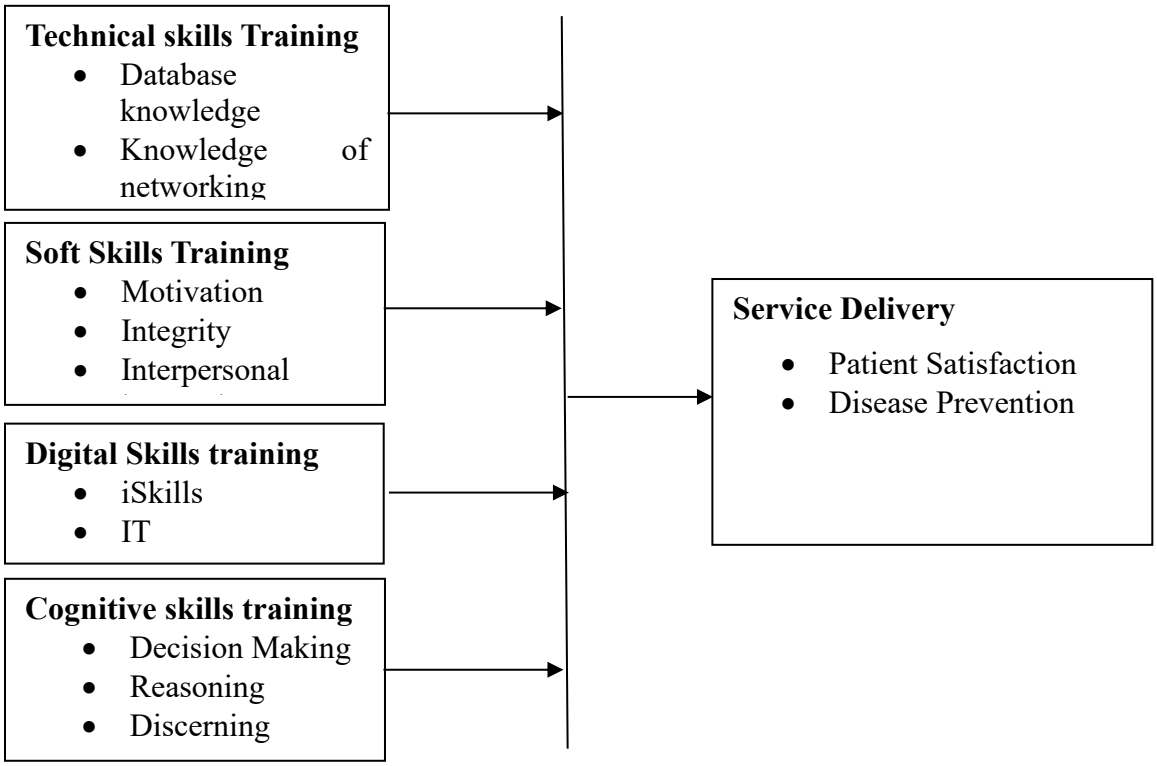

Figure 1: Conceptual Framework

METHODOLOGY

A descriptive cross-sectional design was employed to examine the relationship between training and service delivery. The target population comprised 4,053 laboratory practitioners from 18 accredited medical laboratories in Nairobi County, using simple random and convenience sampling. Data were collected using self-administered questionnaires, validated through pilot testing, and analyzed using SPSS v22. Descriptive statistics, correlation analysis, and multiple regression were used to address each objective. Diagnostic tests assessed normality, linearity, homoscedasticity, autocorrelation, and multicollinearity. Ethical approval was granted by NACOSTI.

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RESULTS AND DISCUSSION

Correlation Analysis

Table 1: Correlation Results

		Technical skills training	Soft skills training	Digital skills training	Cognitive skills training	Service Delivery
Technical skills training	Pearson Correlation	1	.618**	.781**	.395**	.775**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	315	315	315	315	315
Soft skills training	Pearson Correlation	.618**	1	.640**	.421**	.704**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	315	315	315	315	315
Digital skills training	Pearson Correlation	.781**	.640**	1	.454**	.781**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	315	315	315	315	315
Cognitive skills training	Pearson Correlation	.395**	.421**	.454**	1	.513**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	315	315	315	315	315
Service Delivery	Pearson Correlation	.775**	.704**	.781**	.513**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	315	315	315	315	315

The correlation analysis results in Table 1 indicate significant positive relationships between all training variables and service delivery in the selected medical laboratories. Technical skills training demonstrated a strong positive correlation with service delivery ($r = .775$, $p < .001$), suggesting that improved technical competence is closely associated with enhanced diagnostic accuracy and operational efficiency. Digital skills training also showed a similarly strong relationship with service delivery ($r = .781$, $p < .001$), reflecting the critical role of digital literacy in improving turnaround times, reducing documentation errors, and supporting efficient use of laboratory information systems. Soft skills training exhibited a moderately strong positive correlation with service delivery ($r = .704$, $p < .001$), indicating that effective communication, teamwork, and professionalism significantly contribute to improved workflow coordination and patient interactions. Cognitive skills training showed a moderate correlation with service delivery ($r = .513$, $p < .001$), highlighting the importance of analytical reasoning, decision-making, and problem-solving in reducing errors and enhancing the quality of diagnostic decisions. All correlations were statistically significant at the 0.01 level, demonstrating that improvements across all four training dimensions are meaningfully associated with higher service delivery outcomes

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Regression Analysis

Effect of Technical Skills Training on Service Delivery

The descriptive findings revealed that respondents strongly agreed that technical skills training contributed substantially to improvements in diagnostic processes within medical laboratories. Participants indicated that enhanced technical competencies resulted in greater accuracy of results, reduction of analytical and pre-analytical errors, and improved specimen handling procedures. Furthermore, respondents noted that staff who underwent continuous professional development in technical domains demonstrated improved capability in equipment handling, reagent preparation, and adherence to standard operating procedures (SOPs). These improvements collectively strengthened the reliability and credibility of laboratory outputs.

Table 2: **Regression Coefficients for Technical Skills Training**

Variable	B	Std. Error	Beta	p-value
Technical Skills Training	0.364			0.000

The regression analysis confirmed that technical skills training had a statistically significant positive effect on service delivery, with a coefficient of B = 0.364, p = 0.000. This indicates that a one-unit increase in technical training leads to a 0.364-unit improvement in service delivery outcomes, holding other variables constant. Among all the predictor variables, technical training emerged as the strongest determinant of enhanced service delivery. The implication is that strengthening technical competencies directly improves diagnostic accuracy, minimizes human error, accelerates turnaround time, and ensures higher adherence to quality assurance protocols across laboratory operations.

Effect of Soft Skills Training on Service Delivery

Descriptive results showed strong consensus that soft skills training—particularly in communication, teamwork, customer interaction, emotional intelligence, and professionalism—positively influenced the quality of laboratory services. Respondents highlighted that improved communication skills reduced misunderstandings between laboratory personnel and clinicians, leading to more accurate request processing and reduced sample rejection rates. Teamwork training enhanced collaboration across laboratory departments, while professionalism and interpersonal skills fostered a more patient-friendly environment. This contributed to better patient satisfaction and strengthened trust in laboratory services.

Table 3: Regression Coefficients for Soft Skills Training

Variable	B	Std. Error	Beta	p-value
Soft Skills Training	0.247			0.000

Regression analysis revealed that soft skills training had a significant positive effect on service delivery (B = 0.247, p = 0.000). Although its predictive strength was lower than that of technical and digital skills, the results demonstrate that soft skills meaningfully enhance operational efficiency. Improved communication; both internally among staff and externally with clinicians and patients, enhances workflow clarity and reduces service delays. Likewise, strengthened teamwork capabilities contribute to smooth coordination in sample handling, reporting, and

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problem resolution. Overall, the findings confirm that soft skills are integral to achieving patient-centered and responsive laboratory services.

Effect of Digital Skills Training on Service Delivery

Descriptive findings indicated that respondents highly valued digital skills training as essential for modern laboratory operations. Competence in using digital tools such as Laboratory Information Management Systems (LIMS), electronic test ordering platforms, automated reporting systems, and digital analyzers was reported to significantly improve workflow efficiency. Respondents noted that digital proficiency reduced manual entry errors, enhanced the speed of result retrieval, and enabled more seamless communication between laboratories and clinicians. The increasing presence of digitized diagnostic tools also makes digital literacy indispensable for maintaining accuracy and efficiency.

Table 4: Regression Coefficients for Digital Skills Training

Variable	B	Std. Error	Beta	p-value
Digital Skills Training	0.310			0.000

The regression results indicated a strong and statistically significant positive relationship between digital skills training and service delivery, with B = 0.310, p = 0.000. This suggests that digital competence is a major driver of improved laboratory performance. Staff who received digital skills training demonstrated enhanced accuracy in data entry, better turnaround times, improved traceability of samples, and faster report generation. Digital literacy also supports compliance with quality management systems, which increasingly rely on electronic documentation. Although technical skills had the strongest effect overall, digital skills training ranked second in its predictive power, highlighting its growing importance in contemporary laboratory workflows.

Effect of Cognitive Skills Training on Service Delivery

Descriptive results showed that respondents recognized cognitive skills training such as analytical reasoning, decision-making, problem-solving, and critical thinking as important for improving diagnostic processes. Cognitive skills play a particularly critical role in cases requiring interpretation of complex results, troubleshooting instrument failures, evaluating the validity of test outcomes, and making rapid decisions in urgent diagnostic situations. Respondents noted that personnel with strong cognitive skills were better able to identify anomalies, prevent errors, and resolve operational challenges efficiently.

Table 5: Regression Coefficients for Cognitive Skills Training

Variable	B	Std. Error	Beta	p-value
Cognitive Skills Training	0.145			0.000

Regression analysis showed that cognitive skills training had a significant but comparatively lower effect on service delivery (B = 0.145, p = 0.000). Although it was the weakest predictor among the four training variables, its influence remained both positive and statistically meaningful. Cognitive skills enable personnel to evaluate the accuracy of analytical procedures, detect inconsistencies in specimen results, and make informed decisions that impact patient care. The findings therefore demonstrate that cognitive capacity enhances overall laboratory reliability by reducing analytical

and post-analytical errors. Even though its contribution is smaller relative to technical and digital skills, cognitive skills training remains essential for maintaining high-quality diagnostic services

Discussion

The study's findings demonstrate that all four training dimensions; technical, soft, digital, and cognitive skills significantly enhance service delivery in medical laboratories, reinforcing global and regional evidence that continuous professional development is essential for diagnostic efficiency. Technical skills training exhibited the strongest influence on service delivery, aligning with Habon et al. (2019) and Tanui & Kwasira (2019), who established that technical proficiency directly improves operational accuracy, reduces errors, and enhances productivity in clinical environments. This is further supported by regional reports indicating that inadequate technical competence contributes heavily to diagnostic errors and delayed results in sub-Saharan Africa (Odhiambo et al., 2023).

Digital skills training emerged as the second strongest predictor, highlighting the increasing integration of digital technologies within Kenya's healthcare system. Similar to Mittal (2020), who emphasized digital capability as a driver of service modernization, this study shows that digital literacy improves data accuracy, accelerates turnaround times, and supports efficient use of Laboratory Information Management Systems (LIMS). Kenya's gradual adoption of electronic health systems (Muinga et al., 2020) further underscores the importance of digital upskilling.

Soft skills training also significantly influenced service delivery, echoing findings by Ibrahim et al. (2017) and Deshpande & Munshi (2022), who reported that communication, teamwork, and professionalism enhance coordination and customer satisfaction. In laboratory settings, these skills reduce workflow conflicts and improve clinician–laboratory interactions.

Cognitive skills training, though the weakest predictor remains crucial for analytical reasoning, troubleshooting, and decision-making. This corresponds with Turi et al. (2019), who emphasized the role of cognitive learning in sustaining organizational performance. Overall, the findings affirm that holistic training enhances diagnostic quality and advances Kenya's healthcare goals

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The study found that all four training dimensions; technical, soft, digital, and cognitive skills significantly improved service delivery in selected medical laboratories in Kenya. Technical training demonstrated the strongest influence, enhancing diagnostic accuracy, reducing laboratory errors, and improving adherence to standard operating procedures. Digital skills training ranked second, reflecting its role in improving data accuracy, turnaround times, and effective use of Laboratory Information Management Systems (LIMS). Soft skills training also positively affected service delivery by strengthening communication, professionalism, and teamwork, thereby supporting patient-centered care. Cognitive skills training, though the weakest predictor, contributed meaningfully to improved problem-solving, analytical reasoning, and decision-making, which are essential in complex diagnostic environments.

The study concludes that comprehensive, multidimensional training programs are essential for improving service delivery in medical laboratories. Technical and digital skills emerged as the most influential factors, demonstrating that diagnostic competence and technological proficiency

are central to laboratory efficiency. Soft and cognitive skills complement these competencies by enhancing communication, decision-making, and professional interaction. Together, these training components contribute to improved diagnostic accuracy, reduced turnaround time, strengthened quality assurance, and enhanced patient satisfaction. The findings affirm that investment in continuous professional development is critical to advancing the performance, reliability, and overall effectiveness of Kenya's medical laboratory services.

Based on the findings, the study recommends that laboratory management prioritize structured and continuous technical and digital skills training to strengthen diagnostic capacity and support digital transformation. Soft skills and cognitive skills training should be integrated into routine professional development to enhance teamwork, communication, and analytical competence. Policymakers should institutionalize national training guidelines and allocate adequate resources to ensure consistent, high-quality capacity development across all laboratories. Additionally, partnerships with training institutions and professional bodies should be strengthened to align laboratory training with emerging technological, operational, and patient-care requirements.

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