

Principals' Provision of Infrastructure: Predictor of Teachers' Integration of ICT in Secondary Schools in Nairobi City County, Kenya

Eunice Munyilu Kikuvu-Mbului,

Postgraduate student, University of Nairobi

Dr. Petronilla M. Kingi

Lecturer, Department of Educational Management, Policy and Curriculum Studies,
University of Nairobi

Jeremiah M. Kalai

Lecturer, Department of Educational Management, Policy and Curriculum Studies,
University of Nairobi

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Abstract

The integration of Information and Communication Technology (ICT) in secondary education remains a major challenge despite growing policy emphasis and increased availability of digital tools. This study examined the influence of principals' provision of ICT infrastructure on teachers' integration of ICT in secondary schools in Nairobi City County, Kenya. Grounded in the Diffusion of Innovations Theory (Rogers, 2003) and the Technology Acceptance Model (Davis, 1989), the study adopted a descriptive survey design targeting 142 principals, 17 sub-county officers, and 2,955 teachers, with a stratified sample of 296 teachers. Data were collected through questionnaires, interviews, and an observation checklist; construct validity was confirmed through factor loadings above 0.4 and Cronbach's alpha values exceeding 0.7. Pearson correlation analysis revealed a strong positive relationship between principals' ICT infrastructure provision and ICT integration ($r = 0.667$, $p = 0.000$). Regression analysis confirmed that infrastructure provision significantly predicts integration ($B = 0.242$, $p = 0.000$), meaning each unit improvement yields a 0.242 increase in integration levels. The effect ranked fourth among five leadership-related predictors, underscoring that infrastructure is necessary but not sufficient without complementary

teacher capacity building. The study concludes that inadequate hardware, software, connectivity, and maintenance systems limit ICT use, with connectivity deficits most severe. It recommends prioritizing reliable internet connectivity, developing strategic multi-year infrastructure plans, and institutionalising systematic maintenance cycles.

Keywords: Principals' ICT infrastructure development, integration of ICT, secondary schools Nairobi City County

1. Introduction

1.1 Background of the Study

Principals' managerial initiatives are central to the successful integration of technology in education, which is globally regarded as a transformative approach to enhancing educational quality and outcomes (Rahaman & Amadu, 2018). This technological integration represents a fundamental shift in how educational institutions operate and deliver instruction to students (Hashim & Tasir, 2019). The success of this integration can be significantly influenced by principals' managerial initiatives, as demonstrated by multiple researchers (Rahaman & Amadu, 2018; Hashim & Tasir, 2019; Martin, Budhrani & Wang, 2019; Yadav, Chaudhary, Patel, Shah, & Kantharia, 2016; Nwagwu, 2020; Rabah, 2015). These leadership initiatives play a crucial role in determining whether and how effectively technology becomes integrated into teaching and learning processes, affecting everything from resource allocation to teacher training and support (Martin, Budhrani & Wang, 2019).

Building on this global recognition, leadership has emerged as the most critical success factor driving ICT adoption across educational systems worldwide. Globally, the importance of ICT integration in education has been widely recognised, with more than 61 percent of schools in developed countries having successfully integrated ICT into their educational processes (Moreira, Rivero & Alonso, 2019). This success reflects strong policy frameworks, well-developed digital infrastructure, and consistent government investments in educational technology (Moreira, Rivero & Alonso, 2019). In Malaysia, Hu, AlSaqqaf and Swanto (2020) emphasised that ICT integration is critical for students to develop competencies to thrive in the digital age. Thannimalai, Raamani, and Raman Arumugam (2018) further revealed that technology leadership by principals, coupled with professional development opportunities, significantly influences technology incorporation in teaching. This global evidence confirms that principals' leadership initiatives are central to successful ICT integration (Martin, Budhrani & Wang, 2019; Hashim & Tasir, 2019).

Despite this global leadership success, African contexts reveal persistent barriers that distinguish the continent's ICT integration challenges from those experienced in developed nations. African schools continue to struggle due to resource constraints and policy gaps that limit the effectiveness of even well-intentioned leadership initiatives (Chimezie & Prince, 2016). Within the African context, countries such as Tunisia, Mauritius, and South Africa have made relatively better progress, with ICT integration rates of 31%, 29%, and 21%, respectively (Hiba, 2021; Ramkissoon, Belle & Bhurosy, 2020; Maré & Mutezo, 2021). However, these rates still lag significantly behind those of developed nations, revealing the magnitude of challenges facing African educational systems (Moreira, Rivero & Alonso, 2019).

Specific country-level evidence across Africa further illustrates how inadequate government support and infrastructure deficits consistently undermine ICT implementation in schools. Chimezie and Prince (2016) found that in Nigeria, insufficient funding, inadequate infrastructure, and limited teacher training opportunities constituted major obstacles. Similarly, in Ghana, Abdul, Ming, Rahaman, and Amadu (2018) observed that ICT initiatives

remain limited in scope due to inadequate resources and weak policy frameworks. In Cameroon, Arrey-Ndip, Carole, Njikam and Tamajong (2020) identified inadequate ICT infrastructure as a significant challenge, with unreliable electricity, insufficient hardware and software, and limited internet connectivity constituting major barriers. These African contextual factors demonstrate that resource and policy gaps create substantial obstacles that principals must navigate when attempting to drive ICT integration in their schools (Arrey-Ndip, Carole, Njikam & Tamajong, 2020; Chimezie & Prince, 2016).

Narrowing to the Kenyan context, government-led ICT initiatives have similarly failed to produce meaningful or consistent progress in secondary school integration. Despite government efforts to promote ICT integration, Kenya faces significant challenges, with less than ten percent of public secondary schools offering computer studies as a subject (Kibuku, Ochieng & Wausi, 2020). This low adoption rate is particularly concerning given the rapid penetration of ICT in sectors such as health and finance (Kibuku, Ochieng & Wausi, 2020). Despite the recognised potential of technology to enhance teaching and learning, the education sector has been slow to embrace this transformative tool (Nyang'ari, 2017; Tarus, Gichoya & Muumbo, 2015; Mutua & Ng'eno, 2016). This reluctance is further compounded by the underutilisation of available ICT tools by teachers, resulting in weak integration and limited usage (Musyoki, 2016).

These integration shortfalls are further reflected in Kenya's national statistics, which reveal a persistent gap between policy targets and actual classroom technology adoption. The percentage of schools that have integrated ICT in Kenya remains alarmingly low, with less than 13% of the country's schools having embraced this technology, far short of the Ministry of Education's 2015 target of 25% (Chege, Kiilu, Nyerere & Ogeta, 2018; Mutisya & Mwanja, 2018). While barriers to ICT integration have been documented (Kibuku, Ochieng & Wausi, 2020; Musyoki, 2016), there is limited empirical evidence on how principals' specific actions in mobilising resources, financing teacher development, providing supervision, developing infrastructure, and sensitising teachers influence actual integration outcomes in Kenyan secondary schools. This gap underscores the need for targeted leadership-focused investigation.

Within Kenya, Nairobi City County offers a particularly valuable context for examining how principals' initiatives can bridge the gap between low integration rates and desired educational outcomes. With its relatively higher ICT penetration (Ministry of Education, 2021), Nairobi is urban and resource-rich, with better access to technology infrastructure, more reliable electricity supply, broader internet connectivity, and greater availability of ICT hardware and software than rural regions. The county also hosts a diverse student population from varied socio-economic backgrounds, enabling examination of how principals' initiatives function across different resource contexts (Ministry of Education, 2021). Furthermore, Nairobi serves as Kenya's educational hub, where innovative practices are first implemented before scaling to other regions (Chege, Kiilu, Nyerere & Ogeta, 2018), making it an ideal setting for this study.

Infrastructure development, as a core dimension of principals' ICT initiatives, constitutes the foundational enabler upon which all other aspects of technology integration depend. Apostolou (2020) emphasises that the level of ICT integration in education correlates directly with the benefits students receive from technology use. According to Mwangi (2017), effective infrastructure development must encompass three key areas: strategic prioritisation of ICT equipment purchases, proper equipping of dedicated resource centres within schools, and planned expansion of these facilities to meet growing needs. This comprehensive approach to infrastructure development creates the technical foundation necessary for successful technology integration (Grace, Odhiambo & Amolo, 2020). Thus, the study examined the influence of principals' ICT infrastructure development on teachers' integration of ICT in secondary schools in Nairobi City County.

1.2. Statement of the Problem

Despite Kenya's strong regional standing in ICT readiness, ranked second in Sub-Saharan Africa in 2021, this position has not translated into meaningful classroom integration, as only 10.8% of secondary schools have adopted ICT in teaching and learning (World Bank, 2021; Ministry of Education, 2021). This level remains far below the Ministry's 2015 target of achieving at least 25% integration (Ministry of Education, 2015). Despite national initiatives such as the Digital Literacy Programme (Paul, Iravo & Yusef, 2020) and policy directives emphasising the enhancement of ICT infrastructure in schools (Ministry of Education, 2021), persistent deficits in hardware, software, connectivity, and maintenance continue to undermine integration efforts. Prior studies consistently attribute low ICT uptake to inadequate infrastructure, insufficient digital tools, unreliable internet access, and poor maintenance systems (Kibuku, Ochieng & Wausi, 2020; Nyambane & Nzuki, 2019; Mutisya & Mwanja, 2018).

Within this national context, Nairobi City County presents a distinctive yet equally problematic situation, where relatively higher ICT penetration coexists with significant disparities in infrastructural readiness across schools (Ministry of Education, 2021). Schools in affluent neighbourhoods possess adequate computer laboratories and stable internet connections, while those in informal settlements operate with minimal facilities and inconsistent connectivity (Chege, Kiilu, Nyerere & Ogeta, 2018). Differences also emerge across school types, with private schools generally better equipped than public institutions. Although the county is geographically advantaged by its proximity to corporate organisations, NGOs, and potential ICT partners, many schools fail to leverage these opportunities to strengthen their infrastructural base (Awuor, 2015). These disparities suggest structural challenges and inconsistent institutional prioritisation of ICT infrastructure development.

Empirical evidence from the current study reveals that principals' ICT infrastructure development is inadequately implemented, as reflected by low mean scores across key components, including hardware, software, facilities, and connectivity (mean = 2.09). Wi-Fi access shows the most severe deficit, with 86.8% of teachers reporting lack of connectivity, while 73.3% indicate the absence of regular maintenance and replacement systems. Statistical results further demonstrate that infrastructure development significantly influences ICT

integration ($r = 0.667$; $\beta = 0.242$; $p = 0.000$), confirming that technology adoption increases when schools possess adequate and reliable infrastructure. Yet, the effect ranks fourth among leadership-related determinants, showing that infrastructure provides necessary enabling conditions but remains insufficient on its own without complementary support mechanisms.

Despite these insights, existing research has not adequately examined how principals' infrastructural development efforts specifically shape teachers' ICT integration practices within Nairobi City County. Previous studies largely address general barriers, training issues, or policy gaps (Rahaman & Amadu, 2018; Martin, Budhrani & Wang, 2019), offering limited context-specific evidence on infrastructural determinants in urban secondary schools. This gap restricts policy formulation and limits the county's capacity to strengthen ICT integration outcomes. Therefore, this study focuses on addressing this gap by empirically examining how principals' ICT infrastructure development influences teachers' ICT integration in Nairobi's secondary schools, generating evidence that can inform leadership practice, infrastructure planning, and education sector policy across urban settings in Kenya and beyond.

1.3 Research Objective

To examine the influence of principals' provision of ICT infrastructure (mobilization of financial resources) on ICT integration by teachers in Secondary Schools in Nairobi City County

2. Literature Review

The literature review was done in sections.

2.1 Empirical Review

Effective ICT infrastructure provision strategies encompass deliberate mechanisms that modernise schools' technological foundations to support meaningful ICT integration (Powell & Barbour, 2018). Some strategies used to strengthen ICT integration include internet connectivity, mobile network coverage, and intranet connectivity (Parnwell, 2019). Institutions are required to develop strategies ensuring sufficient ICT infrastructure preparedness before implementing technology integration. Another study by Powell and Barbour (2018) indicated that school management plays a critical role in promoting e-learning readiness, with management mandated to cultivate strategies enabling schools to procure the best technology. The Digital Strategy for Schools 2015–2020 was designed to enhance teaching, learning, and assessment through ICT integration in Irish schools, focusing on four key themes: teaching and learning using ICT, teacher professional learning, leadership and research, and ICT infrastructure provision (Department of Education and Skills, 2015).

School leadership commitment to ICT infrastructure provision directly determines the quality of digital learning environments and the effectiveness of technology-enhanced instruction. The provision of ICT infrastructure in schools is crucial for enhancing digital learning and fostering an interactive educational environment (Maholwana-Sotashe, 2007). School principals play a pivotal role in ICT infrastructure provision by prioritising the purchase of

essential equipment such as desktops, laptops, and projectors, which facilitate digital instruction (Kisirkoi, 2015). When schools invest in modern technological tools, teachers can integrate digital resources into their pedagogical approaches, making learning more engaging for students (Mukhari, 2016). The effectiveness of these investments depends on the availability of financial resources and commitment of school leadership to ensure ICT tools are procured based on specific school needs (Tonui, Kerich & Koross, 2016). Without proper planning, schools face challenges such as underutilisation of ICT resources or lack of maintenance, hindering realisation of the full benefits of technology in education (Hodgkinson-Williams, Sieborger & Terzoli, 2017).

Evidence from Kenya's Competency-Based Curriculum implementation demonstrates that infrastructure adequacy and sustained professional development are equally critical determinants of successful ICT integration outcomes. Murithi and Yoo (2021) examined the role of ICT in implementing the Competency-Based Curriculum in Kenyan public primary schools, focusing on teachers' experiences, challenges, and opportunities. Despite government efforts to equip schools with digital resources, findings indicated that ICT use remained inconsistent due to inadequate infrastructure provision, limited teacher training, and unreliable internet connectivity. Many teachers lacked technical expertise to effectively incorporate digital tools into CBC teaching, relying instead on traditional instructional methods (Murithi & Yoo, 2021). Schools with well-provisioned ICT infrastructure and sustained professional development programmes demonstrated significantly better integration outcomes, where teachers actively leveraged e-learning platforms, multimedia content, and digital assessments to enhance student engagement and deepen learning experiences.

Further evidence from a Kenyan secondary school case study illustrates that where visionary leadership prioritises ICT infrastructure provision, measurable improvements in both integration quality and academic performance are achievable. Kisirkoi (2015) conducted a case study on ICT integration in curriculum delivery, where ICT was successfully incorporated into instruction, leading to improved learning outcomes. Findings indicated that both students and teachers were proficient in using computer applications for education, with a notable shift towards learner-centred instructional approaches emphasising interactivity and activities-based learning. The school's mean score in the Kenya Certificate of Secondary Education improved from 6.2 to 8.4 between 2007 and 2013, highlighting the positive effect of ICT on academic performance (Kisirkoi, 2015). Key enablers of ICT integration included high teacher motivation, a strong desire to enhance teaching effectiveness, and visionary, supportive school leadership committed to ICT infrastructure provision.

Adequate provision of ICT infrastructure is a fundamental prerequisite for successful technology integration in secondary schools. Schools that invest in robust digital infrastructure, including computer labs, reliable internet connectivity, and adequate hardware and software, create an enabling environment for effective ICT adoption by teachers (Powell & Barbour, 2018; Parnwell, 2019). However, research patterns consistently show that infrastructure provision alone proves insufficient without corresponding teacher capacity building, supportive leadership, and ongoing technical support structures (Maholwana, 2017; Masingila et al., 2019; Hodgkinson-Williams et al., 2017). The interdependence between ICT

infrastructure provision and other enabling factors suggests that principals must adopt comprehensive, multi-dimensional approaches addressing infrastructure, human capacity, and institutional leadership support simultaneously to achieve successful and sustainable ICT integration outcomes in secondary schools across diverse educational contexts (Kisirkoi, 2015; Murithi & Yoo, 2021). This article derives from a broader doctoral study examining five principal initiatives influencing teachers' ICT integration in Nairobi City County secondary schools. The present article independently analyses financial resource mobilization as a distinct variable and constitutes an original scholarly contribution separate from the doctoral thesis.

However, it is important to acknowledge that not all research supports the direct primacy of infrastructure provision in driving ICT integration. Several studies present contradictory or qualifying evidence that challenges a straightforward infrastructure-determines-integration conclusion. Gil-Flores, Rodriguez-Santero and Torres-Gordon (2017) found, using a multilevel logistic regression of the TALIS 2013 dataset from Spanish secondary schools, that teacher characteristics — particularly attitudes, beliefs, and self-efficacy — were more powerful predictors of ICT use than the availability of ICT infrastructure, suggesting that physical resources alone may be insufficient when individual teacher disposition is not addressed. Similarly, Momcilovic and Ninkovic (2024) demonstrated, in a study of 590 Serbian teachers, that ICT self-efficacy explained ICT integration to a greater extent than teachers' perception of available school infrastructure. Eickelmann and Vennemann (2017) further showed that strong affective teacher attitudes toward ICT were likely to override infrastructure constraints, indicating that internal factors can be more determinative than external provision. Apostolou (2020), whose work the present study cites in support of infrastructure's importance, paradoxically found in a comparison of limited versus high ICT infrastructure environments in Greek high schools that ICT integration outcomes were equally successful in both environments when effective pedagogical approaches were applied, directly questioning the value of investing in full device-to-student ratios. These contradictory findings collectively suggest that infrastructure is a necessary but not a uniquely sufficient predictor of ICT integration, and that teacher capacity, motivation, and pedagogical beliefs mediate the extent to which physical resources translate into actual classroom technology use. The present study's own finding that infrastructure ranked fourth among five leadership-related predictors — behind teacher capacity building, supervision, and sensitisation — is consistent with this body of contradictory evidence and underscores the need for a multi-dimensional approach to ICT integration that addresses both material and human dimensions simultaneously.

2.2 Theoretical Framework

Two theoretical frameworks guide this study's examination of how principals' ICT infrastructure provision influences teachers' technology integration in secondary schools. This study is primarily anchored on Rogers' (2003) Diffusion of Innovations Theory, which explains how, why, and at what rate new technologies are adopted within a social system. Applied to the school context, ICT integration by teachers constitutes the adoption of an innovation, while principals' provision of ICT infrastructure represents the critical enabling

condition determining whether adoption occurs (Rogers, 2003). The theory identifies five attributes influencing adoption: relative advantage, compatibility, complexity, trialability, and observability. When principals provide adequate hardware, software, reliable connectivity, and functional computer laboratories, they directly enhance the relative advantage and trialability of ICT, reducing complexity barriers that inhibit teacher adoption. Schools functioning as social systems demonstrate that leadership-driven infrastructure provision increases technology uptake likelihood by creating accessible digital environments where teachers can experiment with and observe the benefits of ICT-enhanced instruction (Rogers, 2003; Kisirkoi, 2015).

Complementing the Diffusion of Innovations framework, Davis's (1989) Technology Acceptance Model (TAM) explains how teachers' individual perceptions mediate the relationship between infrastructure provision and ICT integration. TAM posits that adoption is determined by two factors: perceived usefulness-the degree to which a teacher believes ICT enhances instructional performance-and perceived ease of use-the degree to which ICT is considered effort-free (Davis, 1989). Principals' provision of adequate, functional, and reliable ICT infrastructure directly shapes both perceptions. When computers are available, internet connectivity is stable, and software is properly installed, teachers are more likely to perceive ICT as useful and manageable. This two-theory framework-Diffusion of Innovations explaining system-level adoption and TAM explaining individual teacher acceptance-provides a comprehensive foundation for examining how principals' ICT infrastructure provision influences integration outcomes in Nairobi City County secondary schools.

3. Research Methodology

The study was grounded in positivist research paradigm, which assumes an objective reality measurable through quantitative methods. The study adopted a descriptive survey design to examine how principals' provision of ICT infrastructure influenced teachers' ICT integration in secondary schools in Nairobi City County. The target population comprised 142 principals, 17 Sub-County Directors of Education, and 2,955 teachers drawn from both public and private secondary schools. A stratified random sampling approach ensured proportional representation, resulting in a teacher sample of 296 respondents. Data were collected using structured questionnaires administered to teachers, interview guides for principals and education officers, and an observation checklist used to assess available ICT infrastructure and its level of utilization. Instrument pretesting in 14 schools confirmed construct validity through factor loadings above 0.4, while Cronbach's alpha values exceeding 0.7 confirmed internal reliability. Ethical approval was secured from NACOSTI and relevant educational authorities, with all participants providing informed consent under conditions of confidentiality and voluntary participation. Quantitative data were analyzed using SPSS to generate descriptive statistics and regression outputs, while qualitative responses underwent thematic analysis to complement the quantitative findings. Pearson correlation and regression analysis were conducted instead of cross-tabulation since the independent and dependent variables were both measured on continuous Likert scales (information communication technology infrastructure development mean=2.09 and ICT integration mean=2.07). This

methodological combination provided a comprehensive basis for determining the extent to which principals' ICT infrastructure development practices shaped teachers' capacity and willingness to integrate technology in classroom instruction in Nairobi City County.

4. Data Analysis, Presentation and Interpretations

The data analysis, presentation and interpretations were done in sections.

4.1 General and Demographic Information

The study achieved a strong participation rate that guaranteed data representativeness and credibility across all respondent categories. The study achieved a high response rate of 92.1%, with 281 teachers (94.9%), 126 principals (88.7%), and 12 sub-county officers (70.6%) completing and returning their research instruments. This response rate exceeded the 70% threshold recommended for social science studies (Kothari, 2004; Israel, 2013), ensuring data representativeness and reliability. The high response rate from teachers and principals indicated strong engagement with the research topic, reinforcing the credibility of the findings. The lower response rate among sub-county officers (70.6%) may have been due to their administrative workload, though it did not significantly affect the study's overall representativeness. The strong participation of school-based respondents minimized non-response bias and provided a solid foundation for analysing ICT integration in secondary schools in Nairobi City County. The demographic analysis showed that 58.7% of respondents were male, while 41.3% were female, indicating a moderate gender imbalance in the teaching profession. The majority of respondents (81.5%) were aged 36-55 years, highlighting an experienced workforce. Academic qualifications revealed that 80.4% held graduate degrees, while 14.9% had post-graduate qualifications, confirming a highly educated teaching staff. Regarding teaching experience, 44.8% had taught for 11-15 years, while 27.0% had 7-10 years of experience, demonstrating a workforce with extensive professional expertise. These findings suggest that the respondents had the qualifications, experience, and knowledge necessary to provide informed insights on ICT integration, reinforcing the credibility of the study's conclusions and recommendations for enhancing technology adoption in secondary education.

4.2 Information Communication Technology Infrastructure Development and Integration of ICT

The objective examined the influence of principals' ICT infrastructure development on teachers' ICT integration in secondary schools. Teachers responded to 15 items measuring infrastructure adequacy across hardware, software, connectivity, and facilities. Table 1 presents descriptive statistics.

Table 1. Principals' ICT Infrastructure Provision

	SD	D	N	A	S A	Mean	Std. Dev
The principal prioritizes purchasing computers.	27.80%	52.00%	4.60%	11.00%	4.60%	2.13	1.08
Good Wi-Fi connection.	51.60%	35.20%	3.20%	5.00%	5.00%	1.77	1.07
Electricity connectivity.	33.50%	46.30%	6.00%	6.80%	7.50%	2.09	1.16
Computer laboratory available.	16.00%	60.50%	4.30%	17.80%	1.40%	2.28	0.98
The school has enough computers/desktops.	33.80%	47.30%	1.80%	10.30%	6.80%	2.04	1.17
There are enough computers/desktops.	29.50%	53.40%	5.00%	6.00%	6.00%	2.06	1.06
Office Word software is available.	24.90%	62.30%	2.50%	8.50%	1.80%	2.00	0.88
Office Excel software is available.	34.20%	45.20%	3.90%	11.70%	5.00%	2.08	1.14
Office PowerPoint software is available.	27.40%	46.60%	8.50%	14.20%	3.20%	2.19	1.09
The school has QuickBooks software	37.40%	51.20%	3.90%	5.70%	1.80%	1.83	0.88
Microsoft Word, Excel, and PowerPoint.	40.60%	39.10%	5.70%	9.30%	5.30%	2.01	1.15
There is Broadband internet is installed.	29.20%	52.70%	3.60%	6.00%	8.50%	2.12	1.15
Old computers are regularly replaced.	32.70%	40.60%	8.20%	11.40%	7.10%	2.20	1.21
The laboratories are spacious.	30.20%	38.40%	4.60%	13.90%	12.80%	2.41	1.38
Average						2.09	1.10

Source: Teacher questionnaires, n=281

Quantitative analysis of Table 1 revealed that principals' ICT infrastructure provision is systematically inadequate across all measured dimensions, with the overall composite mean of 2.09 (SD=1.10) confirming critical deficits. Three severe infrastructure gaps emerged from the quantitative analysis. Hardware inadequacy proved most pronounced with 225 teachers (79.8%) disagreeing that management prioritises desktop and laptop purchases (mean=2.13, SD=1.08). Computer adequacy showed 228 teachers (81.1%) disagreement (mean=2.04, SD=1.17), while laptop availability demonstrated 233 teachers (82.9%) disagreement (mean=2.06, SD=1.06). Laboratory construction revealed 215 teachers (76.5%) disagreed (mean=2.28, SD=0.98), indicating that many schools lack dedicated ICT facilities entirely. Connectivity infrastructure demonstrated the weakest performance across all items. Wi-Fi installation showed 244 teachers (86.8%) disagreement (mean=1.77, SD=1.07)-the lowest mean across all infrastructure dimensions. Broadband internet in resource centres received 230 teachers (81.9%) disagreement, with a mean of 2.12 (SD=1.15). Electricity adequacy demonstrated 224 teachers (79.8%) disagreement (mean=2.09, SD=1.16). Uninterrupted power supply in laboratories showed similar deficits, with observations revealing frequent power disruptions constraining consistent technology use.

Software availability demonstrated substantial gaps. Office Word software showed 245 teachers (87.2%) disagreement (mean=2.00, SD=0.88), while QuickBooks demonstrated 249 teachers (88.6%) disagreement (mean=1.83, SD=0.88)-representing the second-lowest infrastructure mean. Excel software revealed 223 teachers (79.4%) disagreement (mean=2.08, SD=1.14), and PowerPoint showed 208 teachers (74.0%) disagreement (mean=2.19, SD=1.09). Complete Microsoft Office installation demonstrated 224 teachers (79.7%) disagreement (mean=2.01, SD=1.15). Maintenance and expansion capacity showed critical weaknesses. Regular computer replacement received 206 teachers (73.3%) disagreement (mean=2.20, SD=1.21), while laboratory space adequacy demonstrated 193 teachers (68.6%) disagreement (mean=2.41, SD=1.38)-the highest infrastructure mean, but still indicating substantial inadequacy.

Interview data from 126 principals and 12 sub-county officers revealed that infrastructure deficits reflect systemic under-prioritisation rather than isolated resource constraints (Source: Principal and sub-county officer interviews, 2023). Budget limitations emerged as the primary structural barrier, yet analysis revealed that inadequate funding stems from broader institutional failures in resource allocation and priority-setting. Principals emphasised that robust infrastructure creates foundational environments for ICT integration, yet multiple contextual factors prevent adequate development. A principal from a formal school in Embakasi South explained that strategic infrastructure planning requires multi-year sustained investments rather than sporadic purchases. The Sub-County Officer in Kamukunji noted that comprehensive internet connectivity enables access to online resources and cloud-based tools, but unreliable electricity and limited broadband create persistent obstacles. Respondents consistently identified competing institutional priorities forcing trade-offs between infrastructure investment and other urgent needs, relegating ICT development to secondary importance despite recognised value.

Principals highlighted that infrastructure inadequacies reflect deeper systemic issues in educational technology policy implementation. A principal from an informal school in Kasarani reported that despite government commitments to digital education, schools experience fundamental infrastructure deficits undermining integration efforts. The Sub-County Officer in Kibra noted that comprehensive ICT infrastructure transforms technological tools from peripheral resources to core educational strategies, yet achieving transformation requires investments exceeding current allocations. Analysis reveals that infrastructure inadequacy stems from multiple interconnected structural and contextual factors operating beyond simple resource scarcity. First, budget constraints reflect not just limited funding but misaligned priorities treating technology as discretionary enhancement rather than essential educational infrastructure. The 244 teachers (86.8%) disagreeing about Wi-Fi adequacy despite connectivity's recognised importance demonstrates how budgetary decisions consistently deprioritise digital infrastructure when competing against traditional educational expenses.

Second, procurement challenges extend beyond funding availability to include technical expertise deficits in specifying appropriate equipment, negotiating favourable terms, and ensuring quality standards. Many schools acquire inappropriate or incompatible hardware due to insufficient technical guidance during procurement processes. Third, maintenance infrastructure proves virtually absent, with 206 teachers (73.3%) disagreeing about regular computer replacement, indicating that schools lack systematic maintenance and upgrade cycles. Equipment degrades without repair capacity, rendering initial investments increasingly ineffective over time. Fourth, infrastructure planning remains reactive rather than strategic, with schools acquiring technology opportunistically when funding appears rather than following comprehensive development roadmaps aligned with pedagogical goals. This fragmented approach produces disconnected systems lacking interoperability and sustainability. Fifth, stakeholder engagement weaknesses limit infrastructure development, as schools struggle to articulate compelling technology visions attracting external support. The Sub-County Officer in Makadara explained that principals' investment in cybersecurity infrastructure builds teachers' confidence in digital tool usage, yet security considerations rarely receive budgetary attention.

These infrastructure challenges align with and extend findings from multiple prior studies, demonstrating both consistency with existing research and context-specific intensification in Nairobi schools. Powell and Barbour (2018) emphasised school management's critical role in developing strategies to procure and maintain ICT infrastructure, yet the current findings reveal that Nairobi principals lack systematic approaches to infrastructure development, with 225 teachers (79.8%) disagreeing about desktop/laptop prioritisation. Parnwell (2019) identified internet connectivity, mobile network coverage, and intranet connectivity as essential infrastructure components, yet the 244 teachers (86.8%) disagreeing about Wi-Fi adequacy demonstrates these elements remain severely underdeveloped. The particularly acute connectivity deficits (mean=1.77 for Wi-Fi) suggest infrastructure conditions in Nairobi schools may have deteriorated rather than improved despite policy commitments to digital education.

Masingila et al. (2019) found Kenyan secondary schools possess ICT infrastructure but primarily use technology for administrative rather than pedagogical purposes. The current study extends this finding by documenting that many Nairobi schools lack even basic infrastructure prerequisites for meaningful integration, with 249 teachers (88.6%) disagreeing about QuickBooks availability and 245 teachers (87.2%) about Office Word software. This suggests infrastructure deficits in Nairobi exceed those reported in previous national studies, indicating urban schools do not automatically possess superior infrastructure compared to rural institutions. Hodgkinson-Williams et al. (2017) demonstrated that well-equipped schools with sufficient hardware, software, and stable connectivity show higher pedagogical ICT integration levels. However, the current findings reveal that infrastructure's regression coefficient ($\beta=0.242$, $p=0.000$), while significant, shows moderate rather than dominant influence. This aligns with Maholwana's (2017) observation that hardware and software presence does not automatically translate to effective ICT use, requiring complementary teacher capacity building and supportive leadership.

The infrastructure challenges documented here reflect broader systemic issues in educational technology policy implementation that extend beyond Nairobi to national and regional contexts. Tonui et al. (2016) documented similar infrastructure limitations constraining Kenya's Free Laptops initiative implementation, while Murithi and Yoo (2021) found inconsistent ICT use in implementing the Competency-Based Curriculum due to inadequate infrastructure and unreliable connectivity. These consistent findings across multiple studies and contexts suggest that infrastructure deficits represent endemic rather than isolated challenges requiring comprehensive policy interventions beyond school-level initiatives. The study conducted Pearson correlation analysis, and results are presented in Table 2.

Table 2. Pearson Correlation Analysis between Principals' ICT Infrastructure provision and Integration of ICT

		Integration of ICT	Principals' ICT Infrastructure Development
Integration of ICT	Pearson Correlation	1.000	
	Sig. (2-tailed)		
Principals' ICT Infrastructure Development	Pearson Correlation	.667**	1.000
	Sig. (2-tailed)	0.000	

Source: Teacher questionnaires, $n=281$

Pearson correlation analysis revealed a strong positive relationship between principals' ICT infrastructure development and ICT integration ($r=0.667$, $p=0.000$). This significant correlation indicates that schools with better-developed infrastructure demonstrate

substantially higher technology adoption rates. However, the correlation strength ranks fourth among five principals' initiatives examined, suggesting infrastructure provides necessary but insufficient conditions for successful integration. The relationship between infrastructure and integration operates through multiple mechanisms requiring simultaneous attention to physical resources and human capacity. Adequate hardware enables regular teacher technology access rather than scheduling limited equipment use. Reliable connectivity facilitates consistent online resource access and digital collaboration tools. Sufficient software licenses eliminate barriers to exploring diverse ICT applications. However, interview data revealed infrastructure benefits materialize only when accompanied by teacher competency and supportive leadership, explaining why infrastructure's regression coefficient ($\beta=0.242$) shows moderate rather than dominant influence compared to capacity building ($\beta=0.461$).

The analysis reveals ICT infrastructure development as a critical but insufficient determinant of technology integration in secondary schools. The systematically inadequate infrastructure documented—with 244 teachers (86.8%) disagreeing about Wi-Fi adequacy, 249 teachers (88.6%) about QuickBooks software, and 245 teachers (87.2%) about office-word software—creates fundamental constraints preventing meaningful technology adoption regardless of teacher motivation or training quality. These deficits reflect structural under-prioritization and strategic failures rather than mere resource scarcity, requiring comprehensive interventions addressing budget allocation priorities, procurement expertise, maintenance systems, and strategic planning capacity. However, infrastructure's moderate correlation strength ($r=0.667$) and regression coefficient ($\beta=0.242$) compared to capacity building ($r=0.772$, $\beta=0.461$) demonstrate that physical resources alone cannot drive successful integration. Schools must simultaneously invest in teacher professional development, supervision systems, and sensitization efforts to convert infrastructure potential into actual pedagogical transformation. The findings suggest that principals should prioritize reliable connectivity over additional hardware when resources constrain comprehensive infrastructure development, as observations revealed existing equipment remains underutilized due to connectivity deficits.

These findings underscore the crucial role of school leadership in ensuring continuous investment in technological infrastructure to foster an enabling environment for ICT integration, ultimately enhancing digital learning experiences in secondary schools. The study results agree with existing literature, which emphasizes the importance of ICT infrastructure development in facilitating the integration of ICT in schools. Powell and Barbour (2018) highlight that school management plays a crucial role in ensuring e-learning readiness by developing strategies to procure and maintain ICT infrastructure. Similarly, Parnwell (2019) identifies key strategies such as internet connectivity, mobile network coverage, and intranet connectivity as essential for strengthening ICT integration. Additionally, the findings align with the study by Arrey-Ndip, Carole, Njikam, and Tamajong (2020), which identified inadequate ICT infrastructure as a major barrier to ICT adoption in schools.

In summary, ICT infrastructure development is a key determinant of successful technology integration in secondary schools. Schools with outdated or inadequate technology often

struggle with connectivity issues, insufficient devices, and lack of technical support, all of which contribute to reduced ICT adoption. Conversely, institutions that prioritize infrastructure development provide teachers with the foundation needed to incorporate digital tools into their teaching, enhancing the overall effectiveness of ICT integration. Schools that invest in robust digital infrastructure, including computer labs, internet connectivity, and adequate hardware and software, create an enabling environment for effective ICT adoption. Teachers in well-equipped schools are more likely to utilize technology in their lesson delivery, as they have the necessary resources to support digital learning. The findings suggest that without reliable infrastructure, ICT integration efforts may be severely hampered, as teachers cannot effectively implement digital strategies in classrooms.

4.3 Integration of ICT

The dependent variable examined teachers' actual ICT integration across multiple school functions including instruction, assessment, student personnel management, staff mobilization, facility management, and school-community relations. Teachers responded to 30 items measuring technology adoption breadth and depth. Table 3 presents descriptive statistics.

Table 3. Integration of ICT

	SD	D	N	A	SA	Mean	Std. Dev
Activities that show ICT integration by teachers							
Soft copy schemes of work	35.90%	42.00%	4.60%	8.90%	8.50%	2.12	1.23
PowerPoint lesson presentations	34.90%	46.30%	4.30%	8.90%	5.70%	2.04	1.12
Online content search by learners	42.30%	45.60%	4.30%	5.30%	2.50%	1.80	0.93
Online examination administration	38.10%	48.40%	1.80%	7.80%	3.90%	1.91	1.03
ICT-based examination processing	33.50%	52.30%	1.10%	5.00%	8.20%	2.02	1.13
ICT-based results reporting to parents	38.10%	29.20%	3.20%	20.60%	8.90%	2.33	1.39
Student personnel management							
Student admission records	36.70%	43.80%	3.90%	12.50%	3.20%	2.02	1.09
Student progression records	38.80%	36.30%	5.70%	10.30%	8.90%	2.14	1.28

Student health services	34.90%	44.80%	5.00%	7.10%	8.20%	2.09	1.19
Guidance and counselling services	34.50%	48.00%	2.10%	12.50%	2.80%	2.01	1.06
Talent identification and nurturing	39.50%	40.60%	3.20%	8.20%	8.50%	2.06	1.24
Recreation management	28.80%	47.30%	2.80%	7.50%	13.60%	2.30	1.32
Staff mobilisation							
Establishing problems	31.00%	52.30%	2.50%	10.30%	3.90%	2.04	1.05
Establishing student needs	51.20%	27.80%	4.30%	11.40%	5.30%	1.92	1.22
Building group morale	39.90%	41.30%	3.60%	6.80%	8.50%	2.03	1.22
Securing teacher teamwork	38.10%	44.10%	1.40%	8.50%	7.80%	2.04	1.20
Facilities maintained by use of ICTs							
Effective facility maintenance via ICT	27.80%	53.40%	5.70%	7.10%	6.00%	2.10	1.08
Facility condition monitoring via ICT	18.50%	49.10%	3.20%	20.60%	8.50%	2.52	1.25
Renovation needs identified via ICT	40.90%	38.80%	4.30%	7.50%	8.50%	2.04	1.23
Strategic facility planning via ICT	32.70%	44.80%	5.70%	9.60%	7.10%	2.14	1.18
Resource allocation via ICT	31.70%	50.90%	2.50%	12.50%	2.50%	2.03	1.03
School-community relations							
Community outreach via ICT	28.80%	46.30%	2.10%	16.00%	6.80%	2.26	1.22
ICT advancement monitoring committee	37.00%	47.00%	1.80%	8.50%	5.70%	1.99	1.12
ICT information sharing with community	44.10%	36.30%	3.20%	8.20%	8.20%	2.00	1.24
Community support for ICT equipment	45.20%	40.20%	3.60%	5.70%	5.30%	1.86	1.09
Financial management via ICT	39.10%	44.50%	4.30%	5.70%	6.40%	1.96	1.11
Fundraising events for ICT equipment	42.00%	42.70%	2.10%	7.50%	5.70%	1.92	1.12

Occasional ICT fundraising	21.40%	56.60%	5.70%	12.50%	3.90%	2.21	1.04
ICT integration needs satisfaction	31.70%	40.90%	4.30%	9.60%	13.50%	2.32	1.37
Average						2.07	1.16

Source: Teacher questionnaires, n=281

The findings reveal that teachers' ICT integration across all functional areas remains critically low, as reflected by the overall composite mean of 2.07 (SD=1.16), which revealed limited integration across all dimensions, with specific patterns emerging across functional areas. Instructional technology adoption showed systematically severe deficits across core teaching activities. Online content searching enablement demonstrated the lowest integration with 247 teachers (87.9%) disagreeing (mean=1.80, SD=0.93). Online examination administration received 243 teachers (86.5%) disagreement (mean=1.91, SD=1.03), while PowerPoint lesson presentations showed 228 teachers (81.2%) disagreement (mean=2.04, SD=1.12). Soft copy scheme preparation demonstrated 219 teachers (77.9%) disagreement (mean=2.12, SD=1.23), and lesson note documentation revealed 239 teachers (85.1%) disagreement (mean=1.98, SD=0.96). These patterns reveal fundamental instructional ICT integration gaps, with approximately 8 out of every 10 teachers maintaining traditional methods and using technology peripherally rather than centrally in teaching processes. The particularly acute deficit in enabling online content searches (247 teachers or 87.9% disagreement) suggests teachers neither possess skills nor perceive value in leveraging digital resources for student learning. This finding aligns with Msafiri, Kangwa and Cai's (2023) observation that despite ICT's potential to enhance student engagement and personalized learning through interactive approaches, many schools demonstrate minimal pedagogical technology adoption. The consistently high disagreement contradicts research demonstrating ICT's capacity to improve learning outcomes through digital literacy development and access to diverse educational resources (UNESCO IIEP, 2023).

The low instructional integration carries profound implications for educational quality and equity. When teachers fail to leverage technology for personalized learning, interactive instruction, and digital literacy development, students miss essential 21st-century skill acquisition opportunities. This gap proves particularly concerning in urban Nairobi schools theoretically possessing superior infrastructure compared to rural areas, suggesting that even relatively advantaged contexts fail to translate resource availability into pedagogical transformation. The instructional adoption deficit underscores urgent need for principals to prioritize instructional ICT applications over purely administrative uses, ensuring technology serves educational transformation rather than merely operational efficiency. Assessment technology demonstrated mixed adoption patterns revealing strategic selectivity. Examination processing showed 241 teachers (85.8%) disagreement (mean=2.02, SD=1.13), suggesting minimal digital assessment practices. However, results reporting to parents demonstrated relatively lower disagreement with 189 teachers (67.3%) disagreeing (mean=2.33, SD=1.39), indicating some schools utilize digital communication channels when direct operational

benefits appear evident. This variation suggests administrative efficiency motivations drive selective technology adoption where tangible benefits seem clearest.

Student personnel management technology integration remained predominantly inadequate across dimensions. Admission record management showed 226 teachers (80.5%) disagreement (mean=2.02, SD=1.09), while student progression tracking demonstrated 211 teachers (75.1%) disagreement (mean=2.14, SD=1.28). Health services coordination revealed 224 teachers (79.7%) disagreement (mean=2.09, SD=1.19), and guidance-counselling services showed 231 teachers (82.5%) disagreement (mean=2.01, SD=1.06). Talent identification demonstrated 226 teachers (80.1%) disagreement (mean=2.06, SD=1.24), while recreation management revealed 214 teachers (76.1%) disagreement (mean=2.30, SD=1.32). Staff mobilisation technology integration showed comparable deficits with problem identification, receiving 233 teachers (83.3%) disagreement (mean=2.04, SD=1.05). Student needs establishment demonstrated 222 teachers (79.0%) disagreement (mean=1.92, SD=1.22), group morale building showed 228 teachers (81.2%) disagreement (mean=2.03, SD=1.22), and teamwork facilitation revealed 231 teachers (82.2%) disagreement (mean=2.04, SD=1.20).

These patterns indicate systematic underutilization of technology for student support services and collaborative planning, representing missed opportunities for enhanced efficiency and effectiveness. The selective adoption in results reporting (189 teachers or 67.3% disagreement) compared to examination processing (241 teachers or 85.8% disagreement) suggests that when technology offers clear administrative convenience, adoption increases modestly. However, the overall inadequacy demonstrates that even pragmatic efficiency motivations prove insufficient to drive comprehensive integration without addressing capacity building and sensitisation deficits documented in previous sections. Facility management technology showed limited adoption across monitoring and planning functions. Effective maintenance technology received 228 teachers (81.2%) disagreement (mean=2.10, SD=1.08), while facility condition monitoring demonstrated 189 teachers (67.6%) disagreement (mean=2.52, SD=1.25)—the highest mean within this category. Renovation identification technology showed 224 teachers (79.7%) disagreement (mean=2.04, SD=1.23), strategic facility planning revealed 218 teachers (77.5%) disagreement (mean=2.14, SD=1.18), and resource allocation prioritization demonstrated 232 teachers (82.6%) disagreement (mean=2.03, SD=1.03).

School-community relations technology integration revealed the weakest overall adoption across functional areas. Community outreach technology showed 211 teachers (75.1%) disagreement (mean=2.26, SD=1.22), while ICT advancement monitoring committees received 236 teachers (84.0%) disagreement (mean=1.99, SD=1.12). Information exchange technology demonstrated 226 teachers (80.4%) disagreement (mean=2.00, SD=1.24), community equipment support showed 240 teachers (85.4%) disagreement (mean=1.86, SD=1.09), and financial management technology revealed 235 teachers (83.6%) disagreement (mean=1.96, SD=1.11). Fundraising technology integration showed 238 teachers (84.7%) disagreement (mean=1.92, SD=1.12), with occasional fundraising technology demonstrating 219 teachers (78.0%) disagreement (mean=2.21, SD=1.04).

Overall, ICT integration needs satisfaction revealed substantial dissatisfaction with 204 teachers (72.6%) disagreeing that school needs are satisfactorily accomplished (mean=2.32, SD=1.37). This perception reflects general recognition that current integration levels remain inadequate despite institutional requirements and expectations.

The thematic analysis across functional areas reveals selective rather than comprehensive ICT integration patterns, contradicting visions of holistic digital transformation in education. The moderate adoption in some administrative functions (results reporting showing 189 teachers or 67.3% disagreement) compared to minimal instructional integration (online content enablement showing 247 teachers or 87.9% disagreement) demonstrates that efficiency motivations dominate over pedagogical transformation goals. This finding extends Masingila et al.'s (2019) observation that Kenyan teachers primarily use ICT for administrative tasks rather than interactive learning, revealing that selective adoption reflects limited understanding of technology's pedagogical potential or insufficient capacity for implementing instructional applications.

In summary, schools that successfully integrate technology into instructional practices experience improvements in student engagement, access to learning materials, and overall academic performance. Teachers who effectively use digital tools in their lessons can create interactive and personalized learning experiences for students. This finding reinforces the broader impact of ICT integration beyond just the adoption process, as it contributes to improving the quality of education. Schools that fully embrace ICT often report better student outcomes due to increased interactivity and access to a wealth of online educational resources. ICT integration presents numerous benefits, it also comes with challenges that require proactive leadership intervention. Schools that lack adequate resources, infrastructure, or teacher training face significant barriers to technology adoption. However, schools where principals actively address these challenges through strategic financial planning, training programs, and supervision mechanisms achieve better ICT integration outcomes.

4.3.1 Cross-Tabulation of Principals' ICT Infrastructure Development and ICT Integration

To establish patterns between principals' ICT infrastructure development and teachers' ICT integration, composite mean scores for both variables were recoded into three ordinal categories: Low (1.00–2.33), Moderate (2.34–3.66), and High (3.67–5.00), consistent with the five-point Likert scale applied throughout the study. Table 4 presents the cross-tabulation results.

Table 4. Cross-Tabulation of Principals' ICT Infrastructure Development and ICT Integration

	ICT Integration: Low	ICT Integration: Moderate	ICT Integration: High	Total
Infrastructure: Low	195 (69.4%)	25 (8.9%)	5 (1.8%)	225 (80.1%)
Infrastructure: Moderate	25 (8.9%)	12 (4.3%)	5 (1.8%)	42 (14.9%)
Infrastructure: High	4 (1.4%)	5 (1.8%)	5 (1.8%)	14 (5.0%)
Total	224 (79.7%)	42 (14.9%)	15 (5.3%)	281 (100%)

Source: Teacher questionnaires, n=281

The cross-tabulation reveals that the majority of teachers fell within the Low infrastructure development and Low ICT integration cell (195 out of 281, or 69.4%), confirming that weak infrastructure provision directly corresponds with minimal technology adoption. Of teachers recording Moderate infrastructure development, the majority (25 out of 42, or 59.5%) remained at Low ICT integration, indicating that improved infrastructure alone is insufficient without complementary teacher capacity building and leadership support. Teachers in the High infrastructure category were negligible in number (14 out of 281, or 5.0%), reflecting the severely constrained infrastructure environment documented in Section 4.2. These patterns confirm that infrastructure development is a necessary but insufficient precondition for ICT integration, providing contextual grounding for the regression analysis that follows.

4.4 Regression Analysis

Regression analysis is a statistical method used to examine the relationship between independent and dependent variables. Its primary purpose is to model and analyse these relationships, enabling the prediction of the dependent variable based on the values of the independent variables. Additionally, regression analysis identifies the strength and nature of the relationships between variables. In this study, the regression analysis included regression coefficients. The results of the study's coefficients of regression are shown in Table 5.

Table 5. Regressions of Coefficients

	Unstandardized Coefficients	Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	0.180	0.062		2.883	0.004
Principals' ICT infrastructure development	0.242	0.063	0.185	3.853	0.000

Principals' ICT infrastructure development demonstrates positive significant relationship ($B=0.242$, $p=0.000$), revealing that each unit increase in infrastructure investment yields 0.242 unit increase in integration. This coefficient confirms that adequate hardware, software, and connectivity create essential enabling environments for technology adoption, though infrastructure alone proves insufficient without complementary teacher capacity and leadership support. The study results align with existing research literature. The significant relationship between financial resource mobilization and ICT integration supports findings by Mutisya and Mwanja (2018), Ngatia, Njoka and Ndegwa (2021), and Chimezie and Prince (2016), who demonstrated that schools' ability to acquire and maintain technological resources depends heavily on principals' capacity to secure sustainable funding. The study's finding that principals' financing of teacher capacity building has an impact on ICT integration reinforces research by Nyambane and Nzuki (2019) and Adiyarta, Napitupulu, Rahim, Abdullah and Setiawan (2018), highlighting how professional development investments significantly enhance teachers' effectiveness in utilising educational technology.

5. Conclusions

The study concludes that principals demonstrate systematically inadequate ICT infrastructure development across hardware, software, connectivity, and facilities, with Wi-Fi and broadband internet access showing the most severe deficits. Infrastructure development significantly influences teachers' ICT integration, confirming that adequate and reliable technology resources create the necessary enabling environments for meaningful technology adoption in secondary schools. However, infrastructure's moderate predictive strength relative to teacher capacity building demonstrates that physical resources provide necessary but insufficient conditions for successful integration. Infrastructure inadequacy reflects structural under-prioritisation rather than mere resource scarcity, stemming from budget constraints, competing institutional priorities, procurement challenges, absent maintenance and replacement systems, and reactive rather than strategic planning approaches. Connectivity infrastructure faces the most severe challenges across all dimensions, suggesting that principals should prioritise reliable internet access over additional hardware acquisition when resources constrain comprehensive infrastructure development, as existing equipment frequently remains underutilised in the absence of stable connectivity.

6.1 Recommendations of the Study

The study recommends that principals prioritise reliable internet connectivity-including Wi-Fi and broadband access-over additional hardware procurement, since existing equipment remains significantly underutilised due to connectivity deficits. Principals should develop comprehensive multi-year ICT resource provision plans aligned with clearly defined pedagogical goals, replacing opportunistic and reactive acquisitions with strategic, phased investment roadmaps. Systematic maintenance and replacement cycles should be institutionalised to prevent equipment degradation and sustain the value of initial investments. Schools are further encouraged to leverage bulk procurement arrangements and technology partnerships to reduce acquisition costs and extend infrastructure reach. At the policy level, the Ministry of Education and county authorities should establish dedicated ICT resource provision grants accompanied by technical assistance for appropriate equipment specification.

National licensing agreements for educational software should be negotiated to reduce per-school costs, and county-level technical support units should be established to assist schools with ongoing maintenance, troubleshooting, and infrastructure planning capacity.

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