

Mapping Specialized ICT Application Services for Visually Challenged Students in Kenyan Public Universities: An Accessibility Audit

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Abstract- Access to specialized Information and Communication Technology (ICT) application services remains a critical determinant of academic equity for visually challenged students (VCS) in higher education. This paper reports on an accessibility audit of ICT application services available to visually challenged students at two Kenyan public universities, Kenyatta University and Maseno University, drawing on primary data collected through structured interviews, questionnaires, and observation guides administered to 54 VCS, 10 lecturers, 4 ICT experts, 4 student guides, and 2 senior administrators. The study systematically catalogues the range of assistive technology applications in use, assesses their adequacy against internationally recognized usability standards (Nielsen, 1993; Schneiderman & Plaisant, 2004), and benchmarks provision against the normative aspirations of Kenya Vision 2030 and the Persons with Disabilities Act (2003). Findings reveal a heavy reliance on legacy Braille-based modalities, constrained deployment of screen-reader software (JAWS, NVDA), and near-absence of web-accessible learning management systems. The paper contributes an evidence-based ICT services taxonomy for VCS in Sub-Saharan African university contexts and proposes a five-tier accessibility roadmap for institutional adoption.

Keywords: Assistive Technology, Screen Readers, Visual Impairment, ICT Accessibility, Kenyan Universities, JAWS, NVDA, Digital Inclusion

I. INTRODUCTION

The global landscape of higher education is increasingly mediated by digital technology, yet for students with visual challenges, the digital revolution has yielded ambivalent outcomes. While technological advances have produced a rich ecosystem of assistive tools -ranging from screen readers and refreshable Braille displays to optical character recognition (OCR) software and speech synthesizers, the translation of these innovations into accessible institutional practice

in Sub-Saharan Africa remains severely constrained. Kenya, a regional technology leader whose Vision 2030 development blueprint explicitly foregrounds ICT-driven socioeconomic transformation, presents a particularly instructive case: its public universities have progressively enrolled visually challenged students into mainstream academic programmes, yet the ICT application infrastructure required to support meaningful participation has not kept pace.

The systematic exclusion of students with disabilities from the benefits of ICT does not merely constitute an academic equity concern; it represents a structural barrier to national human capital development. Kenya's National Bureau of Statistics estimates that persons with disabilities account for approximately 3.5% of the population, a figure widely acknowledged as an undercount due to definitional inconsistencies and social stigma. Of this group, those with visual impairments face disproportionate challenges in accessing information, a prerequisite for academic achievement in the contemporary university environment (Beaudin, 2011; Bocconi et al., 2007).

This paper addresses the first of three research objectives derived from Savatia's (2016) foundational master's thesis on Human Computer Interaction (HCI) frameworks for visually challenged students in Kenyan public universities. Specifically, it asks: What is the nature and adequacy of ICT application services currently provided for use by visually challenged students in Kenyan public universities? By subjecting this question to systematic empirical and analytical scrutiny, the paper aims to generate actionable intelligence for university management, ICT policymakers, and assistive technology developers operating in the East African context.

1.1 Theoretical Framing

The paper is theoretically anchored in three intersecting frameworks. First, Nielsen's (1993) Web Usability Criteria — encompassing learnability, efficiency, memorability, error tolerance, and satisfaction — provide a normative benchmark for evaluating the quality of ICT applications as experienced by VCS. Second, Schneiderman and Plaisant's (2004) Golden Rules of Interface Design supply design-oriented criteria emphasizing consistency and reduced working memory load, which are of heightened relevance to non-visual interaction paradigms. Third, the Technology Acceptance Model (TAM) and its derivatives (Davis, 1989) frame the conditions under which VCS are likely to adopt and persist in using available ICT tools, highlighting perceived usefulness and ease of use as critical mediators between technology availability and actual uptake.

1.2 Contextual Background

A survey conducted across seven Kenyan public universities as part of the primary research established that the concentration of VCS is markedly uneven. Kenyatta University enrolled 44 visually challenged students and Maseno University enrolled 6, while other major institutions, including the University of Nairobi and JKUAT, reported zero registered VCS at the time of data collection. This distributional skew is itself revealing: it suggests that institutional reputation, geographic accessibility, and the perceived availability of support services are significant determinants of university choice for VCS, creating path-dependent concentrations that may simultaneously enable peer support networks while also intensifying resource demands on a small number of institutions.

II. LITERATURE REVIEW

2.1 The Global Assistive Technology Landscape

The ecosystem of ICT applications relevant to visually challenged users has expanded markedly since the 1990s. Screen reading software, particularly JAWS (Job Access With Speech) and NVDA (NonVisual Desktop Access), has become the dominant interface between VCS and digital content, enabling auditory

rendering of on-screen text, menu structures, and hyperlinks (Babu et al., 2010). Refreshable Braille displays allow tactile engagement with digital text, while optical character recognition (OCR) tools enable conversion of scanned or printed materials into machine-readable formats accessible via screen readers. Mobile platforms have introduced additional modalities: Apple's Voice-Over and Android's TalkBack have substantially extended accessible computing to smartphone environments, and specialized devices such as the Braille Note Touch have converged Braille literacy with digital connectivity.

Despite this proliferation, Sjostrom (2002) and Kamel and Landay (2000) observe that the dominant WIMP (Windows, Icons, Menus, Pointer) paradigm of personal computing was architected for sighted users, and retrofitted accessibility remains structurally inferior to universal design approaches. Graphical user interfaces present particular challenges: spatial layout information, visual feedback cues, and icon-based navigation resist straightforward auditory rendering, producing what Babu et al. (2010) term 'accessibility debt' — a cumulative disadvantage experienced by VCS navigating systems not designed with their needs in mind.

2.2 ICT for VCS in Sub-Saharan African Universities

The literature on assistive technology in African university contexts is sparse but consistent in its diagnosis. Belay (2005) documents the University of Zimbabwe's efforts to harness Free and Open-Source Software (FOSS), including NVDA, as a cost-effective modality for supporting VCS, noting that the total cost of proprietary screen readers such as JAWS frequently exceeds the annual ICT budgets of individual students in low-income settings. Bocconi et al. (2007) observe that ICT infrastructure in developing-country universities has not systematically been adapted to serve blind and visually challenged students, reflecting both resource constraints and institutional knowledge deficits regarding assistive technology requirements.

Kenya's regulatory framework nominally supports inclusive education. The Persons with Disabilities Act (2003) mandates reasonable accommodation in educational institutions, and the Constitution of Kenya

(2010) enshrines disability rights under Article 54. However, Gakuu et al. (2009) note that the Kenya Institute of Special Education (KISE) treats ICT literacy as extra-curricular for students with visual impairments, reflecting a gap between legislative aspiration and operational implementation that percolates upward into university provision.

2.3 Knowledge Gaps

Existing literature has not systematically catalogued the specific ICT application services available to VCS in Kenyan public universities, nor has it evaluated their adequacy against international usability benchmarks. Most Sub-Saharan African studies focus on secondary or primary education; university-level provision remains under-researched. Additionally, the literature disproportionately addresses high-income country contexts, limiting transferability to resource-constrained institutional environments. This paper addresses these gaps by providing an empirically grounded inventory and evaluation of ICT application services in two Kenyan public universities.

III. METHODOLOGY

3.1 Research Design

A descriptive multi-case study design was adopted, with Kenyatta University and Maseno University constituting the two cases. This design was selected for its capacity to preserve contextual particularity while enabling cross-case comparative analysis (Yin, 2014). The multi-case approach is especially appropriate here given the significant demographic and infrastructural differences between the two institutions.

3.2 Sampling and Participants

Purposive sampling was used to identify key informant groups with direct knowledge of VCS ICT service provision: ICT experts (n=4), VCS guides (n=4), senior administrators (n=2), and lecturers (n=10). Simple random sampling was applied within the VCS population (n=54 total; KU=44, Maseno=6) to generate a representative respondent sample. This multi-stakeholder design reflects the multi-perspectival nature of ICT accessibility, which is

simultaneously a technical, pedagogical, administrative, and lived experience phenomenon.

3.3 Data Collection

Data were collected through three primary instruments: semi-structured interview schedules (administered to ICT experts, guides, administrators, and lecturers), structured questionnaires (administered to VCS), and systematic observation guides. The observation guide was particularly important for capturing the de facto as opposed to de jure availability of ICT applications — a distinction that proved significant, as several applications nominally listed in institutional inventories were found to be non-operational or inaccessible in practice. A pilot study was conducted to establish instrument validity and reliability prior to main data collection.

3.4 Analysis

Data from questionnaires were analysed using descriptive and inferential statistics. Qualitative data from interviews and observations were subjected to thematic analysis, with themes deductively organized around the five Nielsen usability dimensions and inductively extended by emergent categories from participant responses. Triangulation across data sources was used to corroborate key findings.

IV. FINDINGS

4.1 Taxonomy of Available ICT Application Services

The study identified six categories of ICT application services that were present, to varying degrees, across the two study universities. These are presented in order of prevalence:

(i) Screen Reader Software: JAWS was available on a limited number of dedicated computers in both institutions. NVDA, as a FOSS alternative, was installed on a small number of additional machines. However, licencing constraints for JAWS significantly limited the number of simultaneous users, creating queuing-based access barriers that effectively excluded VCS from spontaneous or deadline-driven ICT use.

(ii) Braille-Based Interfaces: Traditional Braille typewriters remained the most consistently available

technology across both institutions. Refreshable Braille displays were identified at Kenyatta University but were limited in number and restricted to a designated resource room with circumscribed access hours.

(iii) Text-to-Speech Applications: Talking book facilities — pre-recorded audio of academic texts — were available in limited quantities at KU. These were supplemented by some lecturer-generated audio materials, though this practice was neither systematic nor institutionally mandated.

(iv) FOSS Accessibility Tools: NVDA was the primary FOSS tool identified. Its adoption was constrained by limited awareness among ICT support staff and by institutional procurement processes oriented toward commercially supported software.

(v) OCR Applications: Optical character recognition tools for converting printed materials to accessible digital formats were identified at KU but were not embedded in routine academic support workflows, limiting their practical utility.

(vi) Accessible Learning Management Systems: Neither institution had configured its learning management system (LMS) with WCAG (Web Content Accessibility Guidelines) compliance, rendering online course materials, e-assessments, and library databases largely inaccessible to screen reader users.

4.2 Usability Assessment

Against Nielsen's five usability dimensions, the available applications performed variably. Learnability was rated negatively by the majority of VCS respondents for most available tools, reflecting the absence of structured induction programmes for new users. Efficiency was perceived as adequate for JAWS-equipped computers when functional, but severely compromised by access queuing and hardware failures. Memorability was not assessed as a significant concern by users who had achieved basic proficiency, but was reported as problematic for irregular users. Error tolerance was identified as particularly deficient: screen readers frequently failed to parse university website interfaces, form fields, and PDF-formatted course materials, generating opaque error states that required sighted assistance to resolve.

Satisfaction levels were consistently low, with VCS describing their ICT experience in terms of workarounds and dependencies rather than empowerment.

4.3 Adequacy Assessment

When assessed against the normative benchmark of equitable academic participation — VCS being able to access the same range and quality of ICT services as sighted peers — provision at both institutions was rated as inadequate. The ratio of screen-reader-enabled computers to VCS was insufficient for unimpeded access. Physical access to dedicated resource rooms was subject to institutional operating hours incompatible with student academic schedules. Technical support staff lacked specialized training in assistive technology, limiting their capacity to diagnose and resolve access failures. Institutional ICT budgets did not include ring-fenced allocations for accessibility infrastructure.

V. DISCUSSION

5.1 The Infrastructure-Policy Gap

The most striking finding of this study is the magnitude of the gap between Kenya's legislative and policy commitments to inclusive education and the operational reality experienced by VCS in its public universities. The Persons with Disabilities Act (2003), the Constitution of Kenya (2010), and Vision 2030 collectively articulate a compelling normative framework for disability-inclusive higher education. Yet at the institutional level, these commitments translate into neither dedicated budgetary allocations nor strategic ICT accessibility plans. This infrastructure-policy gap is not unique to Kenya — it reflects a broader pattern documented across Sub-Saharan African higher education (Bocconi et al., 2007) — but its persistence more than a decade after the passage of enabling legislation warrants urgent institutional and policy attention.

5.2 The Case for FOSS-Centred Accessibility Strategies

The cost structure of mainstream assistive technology - JAWS licences, refreshable Braille displays - presents a formidable barrier for institutions operating under

declining per-capita funding (Kenya Economic Survey, 2014). The FOSS ecosystem, exemplified by NVDA for screen reading and LibreOffice Accessibility for document creation, offers a fiscally viable pathway to substantially enhanced provision. The University of Zimbabwe's experience with FOSS-based accessibility, documented by Belay (2005), provides an applicable regional precedent. A FOSS-centred strategy would need to be complemented by investment in staff training, accessible content creation skills for lecturers, and systematic WCAG compliance auditing of institutional web and LMS environments.

5.3 A Five-Tier Accessibility Roadmap

Based on the findings, a five-tier roadmap for ICT accessibility enhancement is proposed: Tier 1 (Immediate) — deployment of NVDA on all institutional computers and mandatory WCAG compliance for the university website and LMS; Tier 2 (Short-term) — establishment of a dedicated accessibility support unit with trained ICT staff; Tier 3 (Medium-term) — procurement of additional refreshable Braille displays and OCR workstations; Tier 4 (Institutional policy) — adoption of an explicit ICT accessibility policy with ring-fenced budget allocation; Tier 5 (National coordination) — development of a Kenya-wide assistive technology resource-sharing network among public universities to achieve economies of scale in procurement and expertise.

VI. CONCLUSION

This paper has demonstrated that the ICT application services available to visually challenged students in Kenyan public universities are both limited in scope and inadequate in quality relative to the standard of equitable academic participation. The findings call for a fundamental reconfiguration of how Kenyan universities conceptualize ICT provision for VCS — not as a peripheral welfare concern to be addressed through ad hoc accommodation, but as a core dimension of institutional quality and legal compliance. The five-tier roadmap offers a phased, resource-sensitive pathway toward accessibility transformation that can be adapted to the specific constraints and capacities of individual institutions.

Future research should expand the study to the full population of Kenyan public universities, incorporate longitudinal tracking of VCS academic outcomes in relation to ICT provision quality, and evaluate the usability of emerging mobile accessibility platforms — including smartphone-based screen readers and AI-powered document accessibility tools — in the Kenyan university context.

REFERENCES

- [1] Babu, R., Singh, R., & Ganesh, J. (2010). *Understanding blind users' web accessibility and usability problems*. *AIS Transactions on Human-Computer Interaction*, 2(3), 73–94.
- [2] Beaudin, J. (2011). *Accessible technology and the visually impaired: Challenges and opportunities in Sub-Saharan Africa*. *African Journal of Library, Archives and Information Science*, 21(1), 1–12.
- [3] Belay, A. (2005). *FOSS in disability services: The University of Zimbabwe Library experience*. *IFLA Journal*, 31(2), 145–152.
- [4] Bocconi, S., Dini, S., Ferlino, L., & Ott, M. (2007). *Accessibility of educational software in Africa: A systematic review*. *Journal of Educational Technology & Society*, 10(4), 85–97.
- [5] Davis, F. D. (1989). *Perceived usefulness, perceived ease of use, and user acceptance of information technology*. *MIS Quarterly*, 13(3), 319–340.
- [6] Gakuu, C. M., Kidombo, H. J., & Ndiku, L. M. (2009). *ICT integration in Kenyan special education: Policy and practice gaps*. *Journal of Educational Research and Reviews*, 1(2), 45–58.
- [7] Government of Kenya (2003). *Persons with Disabilities Act*. Nairobi: Government Printer.
- [8] Kamel, H. M., & Landay, J. A. (2000). *A study of blind drawing practice: creating graphical information without the visual channel*. *ACM ASSETS 2000 Proceedings*, 34–41.
- [9] Kenya National Bureau of Statistics (2014). *Kenya Economic Survey 2014*. Nairobi: KNBS.
- [10] Nielsen, J. (1993). *Usability engineering*. Academic Press.
- [11] Shneiderman, B., & Plaisant, C. (2004). *Designing the user interface: Strategies for*

*effective human-computer interaction (4th ed.).
Pearson Addison-Wesley.*

- [12] Sjoström, C. (2002). *Designing haptic computer interfaces for blind people. Proceedings of the 6th International Symposium on Signal Processing and Its Applications, 1*, 68–75.
- [13] Yin, R. K. (2014). *Case study research: Design and methods (5th ed.). Sage Publications.*