



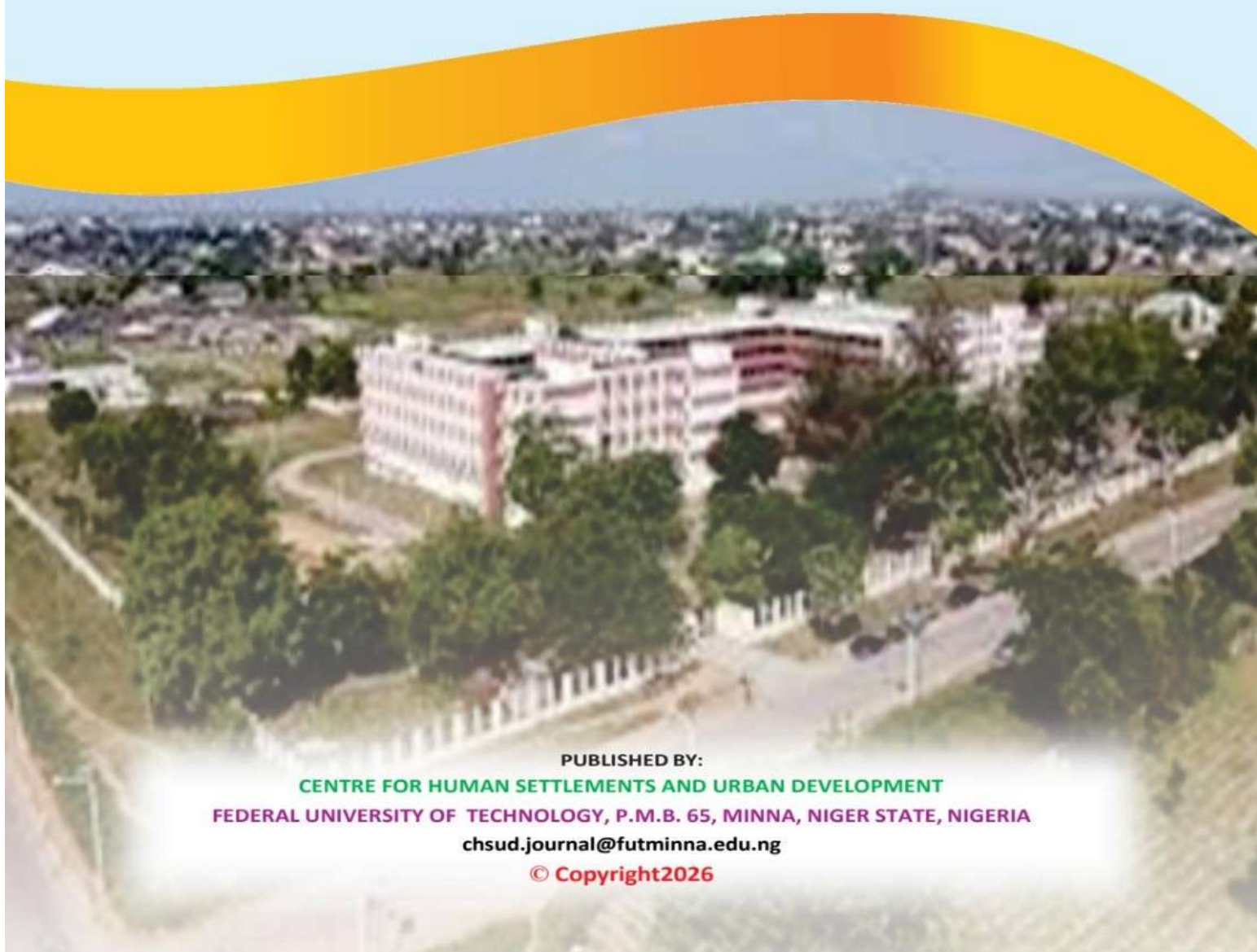
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Provision of Wayfinding Infrastructure for Persons with Disabilities: Evidence from Tertiary Institutions in Nasarawa State

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Abstract

Barriers in navigation and wayfinding significantly exclude students with disabilities in higher education. The lack of tactile paving, audio alerts, Braille signage, and digital aids poses a safety risk to campus navigation. This study examined wayfinding deficiencies across four Nigerian institutions, in alignment with Nigeria's DAPD Act (2018) and the UNCRPD. Using mixed methods, questionnaires were administered to 114 PWDs at four institutions, and 12 interviews were conducted with disability officers. Results showed a complete absence of digital aids ($M = 1.64-1.66$) and critical gaps in tactile paving ($M = 1.83-1.89$), Braille signage ($M = 1.71-1.79$), and audio systems ($M = 1.77-1.84$). Chi-square tests indicated significant differences at FPN but not at others, reflecting fragmented systems. Qualitatively, six institutional themes explaining wayfinding deficiencies were identified: planning invisibility, budget constraints, knowledge gaps, compensatory peer dependence, policy non-enforcement, and unfulfilled digital optimism. Overall, infrastructure fails to ensure safe, independent navigation for students with sensory disabilities. Urgent investment in digital and tactile wayfinding is needed.

Keywords: wayfinding; navigation barriers; tactile paving; Braille signage; digital accessibility; campus design; Universal Design; Nigeria; Nasarawa State

INTRODUCTION

Campus navigation is a fundamental precondition for student participation in higher education. For sighted, hearing students without disabilities, wayfinding is largely effortless signage, maps, and spatial familiarity guide movement across campus without conscious effort. For students with visual or hearing impairments, the same spaces can be profoundly disorienting and dangerous when adequate wayfinding infrastructure is absent (Elgendy, 2021). The absence of tactile ground-surface indicators, Braille signage, accessible digital campus maps, and audio-announcement systems creates a navigation environment that is, at best, challenging and, at worst, unsafe for students with sensory disabilities. However, this infrastructural dimension of disability exclusion receives comparatively little attention in research, policy, and campus design practice in sub-Saharan Africa.

Nigeria is home to an estimated 25 to 29 million persons with disabilities, approximately 14% of the national population, of whom a disproportionate number are of university going age (National Bureau of Statistics, 2020; World Health Organization, 2021). Despite this demographic reality, the participation of persons with disabilities in tertiary education remains critically low. The Federal Government of Nigeria's 2020 education statistics indicate that fewer than 2% of enrolled tertiary students formally declare a disability. This figure is almost certainly an undercount reflecting social

stigma, inaccessible registration systems, and inadequate support structures (Federal Ministry of Education, 2020). Among the determinants of low participation, physical and built-environmental inaccessibility, including navigation barriers, constitutes a significant, though underexamined, strand.

Nigeria enacted the Discrimination Against Persons with Disabilities (Prohibition) Act (DAPD Act) in 2018, formally committing to removing barriers to participation in education, employment, and public life. Section 26 of the Act specifically requires all public institutions, including tertiary educational establishments, to ensure physical accessibility for persons with disabilities, with a five-year compliance deadline from the date of enactment. The government also ratified the United Nations Convention on the Rights of Persons with Disabilities (CRPD) in 2010, which, under Article 9, mandates accessible information and communication systems, including in educational facilities. Despite these legal instruments, no enforcement mechanism has been systematically applied to Nigerian tertiary institutions, and no baseline assessment of wayfinding accessibility has been conducted at the state level.

Research consistently documents the near-total absence of dedicated wayfinding infrastructure in Nigerian tertiary institutions (Uzodinma *et al.*, 2024). However, no study has conducted a systematic, quantitative assessment of wayfinding provision across multiple institutions within a single state, nor has it applied chi-square analysis to determine whether the limited provisions that exist form coherent systems or fragmented, piecemeal interventions. The present study addresses these gaps across four institutions in Nasarawa State. Federal Polytechnic Nasarawa (FPN), Federal University Lafia (FUL), Nasarawa State University Keffi (NSUK), and Nasarawa State Polytechnic (NSP).

Nasarawa State represents a particularly appropriate study context for several reasons. While Federal Polytechnic Nasarawa (FPN) was established in 1983, most of the state's tertiary institutions were established between the late 1990s and 2010s, representing a period during which universal design principles could have been incorporated from the outset an opportunity the present study retrospectively evaluates. The state's mixed public-private institutional profile, spanning federal polytechnics, a federal university, a state university, and a state polytechnic, also provides an instructive cross-institutional comparison across governance and funding contexts.

The study is guided by three research questions: (1) What is the current state of wayfinding infrastructure provision for persons with sensory disabilities at tertiary institutions in Nasarawa State? (2) Is there statistically significant variation in the coherence of wayfinding infrastructure provision across institutions? (3) What institutional and structural factors explain observed deficiencies in wayfinding provision? By answering these questions, the study contributes to the empirical literature on disability exclusion in African higher education, provides an evidence base for policy advocacy under the DAPD Act, and offers practical recommendations for low-cost, phased wayfinding improvements relevant to resource-constrained institutional contexts.

Wayfinding infrastructure encompasses a diverse set of built-environment and digital features that together constitute the informational scaffold of campus navigation.

Tactile ground surface indicators (TGSIs) raised dots and bars embossed into pathways communicate directional and hazard information to pedestrians who cannot see. Braille signage provides location identification and directional instruction at key decision points for blind users. Audio public address (PA) systems convey real-time information and emergency alerts to hearing users and, with appropriate supplementary visual displays, can also serve deaf users. Digital navigation systems including screen-reader-compatible web maps, indoor positioning-enabled mobile applications, and QR-code linked navigation node represent the most recent and potentially most cost-effective frontier of accessible wayfinding. Each of these modalities addresses different sensory disability profiles, and a genuinely accessible campus environment requires all of them to be deployed in an integrated, coherent manner.

Understanding wayfinding provision within the Nigerian higher education context requires attention to the structural conditions that shape institutional behavior. Nigerian tertiary institutions operate within a complex multi-level governance environment in which the federal National Universities Commission (NUC) and the National Board for Technical Education (NBTE) set minimum academic standards, TETFund disburses development funding, and institutional management exercises day-to-day discretion over capital allocation. Within this framework, investment in physical accessibility has historically been treated as a discretionary welfare expenditure rather than a core academic quality obligation. The enactment of the DAPD Act in 2018 formally changed the legal status of this investment from discretionary to mandatory but without enforcement architecture, the practical effect on institutional behaviour has been limited. This study examines the consequences of that practical inaction in the specific domain of wayfinding. The paper is structured as follows. Section 2 reviews the relevant literature on deficiencies in wayfinding in African tertiary institutions and the emerging potential of digital navigation technologies. Section 3 presents the theoretical framework, drawing on wayfinding theory, Universal Design principles, and the social model of disability. Section 4 details the research methodology. Section 5 presents quantitative and qualitative results. Section 6 provides an integrated discussion, and Section 7 presents conclusions and recommendations.

LITERATURE REVIEW

Wayfinding Deficiencies in African Tertiary Institutions

Research from South Africa, Ghana, Kenya, and Nigeria consistently documents the near-total absence of dedicated wayfinding infrastructure for students with sensory disabilities in tertiary institutions. Brock et al. (2021) found that, across 22 surveyed South African universities, fewer than 15% had installed any tactile ground-surface indicator, and none had deployed comprehensive digital navigation systems. The study attributed this gap to the absence of disability inclusive design requirements in the Higher Education Infrastructure Framework and to the low prioritisation of sensory disability relative to mobility impairment in accessibility retrofitting programmes. Ahmed et al (2015) report similar findings in West African contexts, noting that wayfinding infrastructure is consistently omitted from campus masterplanning processes due to budget constraints and a lack of disability-inclusive design expertise.

In Kenya, Mutua et al. (2020) conducted an audit of wayfinding accessibility at five public universities. They found that Braille signage was absent in 96% of sampled buildings, tactile paving was present in fewer than 3% of pathways, and no institution had deployed digital navigation tools. Qualitative interviews with disability officers at all five institutions revealed a common pattern: wayfinding was not treated as a safety or accessibility issue but as an aesthetic upgrade to be considered during future renovation. This framing is consistent with findings from Ghana, where Opoku et al. (2021) found that disability coordinators at three public universities identified wayfinding provision as the least urgent of twelve accessibility dimensions they were asked to rank, behind physical ramp installation, accessible toilet provision, and hearing loop systems.

In Nigeria, specifically, Adelowo et al. (2022) conducted a comprehensive national survey of infrastructure deficits across 10 federal universities. They found that wayfinding infrastructure recorded the lowest mean scores of any accessibility category, with tactile paving absent at all 10 institutions and Braille signage present at only one (the University of Lagos, where a single accessible route had been piloted as part of an international partnership). Akinpelu et al. (2022) examined twelve tertiary institutions in Osun State. They found that, while visible disability accommodations such as ramps and accessible parking were present at approximately 60% of institutions, sensory-specific wayfinding features were present at fewer than 8%. The authors attribute this discrepancy to the greater visibility of mobility impairment relative to sensory impairment in Nigerian disability policy discourse.

Taken together, the African regional literature establishes that wayfinding deficiency is not a localised or institutions specific failure but a systemic pattern rooted in planning norms, budget allocation frameworks, and the relative invisibility of sensory disability in higher education policy. The present study extends this literature by providing, a first hand multi-institution quantitative and qualitative analysis within a single Nigerian state, enabling controlled institutional comparison.

Wayfinding and Hearing Impairment: An Underexamined Dimension

The majority of wayfinding research focuses on persons with visual impairments, for whom the absence of tactile cues and audio systems presents the most immediately life-threatening barriers. Persons with hearing impairments face a different but equally significant set of wayfinding deficiencies. Emergency information (fire alarms, evacuation instructions, safety announcements), class-change signals, and campus event notifications are typically delivered through audio only channels public address systems, spoken announcements, and verbal directions from staff that are completely inaccessible to Deaf and hard-of-hearing students (Koenig & Chowang, 2021).

Blokland et al (2025) note that for students with hearing impairments, the critical wayfinding gap is not spatial navigation per se but the inability to access real-time information that guides navigation decisions such as changes to room assignments, emergency evacuations, and campus announcements. Digital wayfinding systems that provide text and visual alerts, vibration-based notifications, and visual display boards are specifically recommended for this population. The study institutions' complete absence of

digital wayfinding infrastructure ($M = 1.64\text{--}1.66$) is therefore particularly concerning not only for students with visual impairments but for the 36–37% of PWD respondents at each institution who reported hearing impairment as their primary disability.

Research from high-income country settings suggests that accessible digital information systems including SMS-based emergency alerts, visual display boards, and smartphone-accessible campus notification systems are among the most cost-effective wayfinding investments for deaf students, particularly given the high rates of smartphone ownership among tertiary students in Nigeria (Oluwafemi et al., 2021). This creates an important policy opportunity: digital wayfinding investment could simultaneously address the needs of both visually and deaf students without requiring separate, disability-specific infrastructure tracks.

Digital Navigation Technologies and Campus Accessibility

Digital navigation technologies including GPS-assisted indoor navigation apps, screen-reader-compatible campus maps, and audio-guided route systems represent a transformative opportunity for accessible campus design in resource constrained institutional contexts. Faria et al. (2025) provide a comprehensive review of indoor navigation technologies for persons with visual impairments, demonstrating that relatively low-cost smartphone-based solutions can provide effective navigation support when campus infrastructure is insufficient. Key technologies include Bluetooth Low Energy (BLE) beacon-based indoor positioning, which provides sub-meter location accuracy within buildings, and turn-by-turn audio navigation via campus-specific apps. The cost of deploying a BLE beacon system across a typical university campus has fallen to under USD 15,000, making it accessible even in medium-budget African institutional contexts.

Tao et al. (2022) examine the deployment of accessible digital wayfinding systems across 30 Asian universities and find significant improvements in navigation independence and academic participation among students with visual impairments at institutions that had deployed comprehensive digital navigation solutions. Critically, their analysis disaggregates the contributions of different technology components and finds that the single most impactful intervention was the provision of accessible, screen-reader-compatible campus maps combined with audio-guided turn-by-turn instructions. This solution could be deployed at minimal infrastructure cost using existing smartphone platforms. These technologies remain absent from the institutions studied in the present paper, despite the widespread ownership of internet-enabled smartphones among Nigerian tertiary students (estimated at 73% among students with disabilities in the study sample).

While limited, the growing literature on digital wayfinding in African contexts suggests that there are institution-level champions who have sought to leverage digital tools to fill infrastructure gaps. Munyua and Kamau (2022) document a pilot deployment of an accessible campus navigation app at the University of Nairobi, developed in partnership with a disability advocacy organization, that significantly improved navigation confidence among visually impaired students at a cost substantially lower than that of physical tactile infrastructure. The success of this pilot points to the potential of community-academic partnerships as a low-cost,

accessible way to deploy wayfinding in African higher education.

Staff Training, Disability Awareness, and the Human Dimension of Wayfinding

While the quantitative literature focuses primarily on physical and digital wayfinding infrastructure, a complementary strand of research examines the human dimension of wayfinding support specifically, the role of campus staff in providing orientation assistance to students with sensory disabilities. The study data show that staff wayfinding assistance scored higher than any other wayfinding dimension across all four institutions ($M = 2.55\text{--}2.76$), though still in the inadequate range, suggesting that informal human assistance partially compensates for absent infrastructure but does so inadequately.

Koenig and Chowang (2021) note that reliance on ad hoc staff assistance as the primary wayfinding modality for persons with disabilities reflects a compensatory, charity-oriented approach to disability accommodation that is inconsistent with the social model and with CRPD obligations. When wayfinding depends on the availability and goodwill of individual staff members rather than on accessible infrastructure, navigation becomes unpredictable, undignified, and ultimately unsustainable as a long-term strategy. This is consistent with the qualitative findings of the present study, in which disability officers at all four institutions described students with visual impairments as depending entirely on sighted peers and on occasional staff assistance for campus navigation.

Research on staff disability awareness training in Nigerian tertiary institutions indicates that the vast majority of academic and administrative staff have received no training in disability awareness or in supporting students with sensory disabilities in navigation tasks (Akinpelu et al., 2022). This knowledge gap compounds the inadequacy of physical infrastructure, as even willing staff are poorly equipped to provide effective navigation support. Institutional investment in disability awareness training while not a substitute for infrastructure represents a low-cost complementary intervention that could improve the quality of wayfinding support in the short term. In contrast, physical and digital infrastructure is being developed. Such training should specifically address the practical needs of students with visual impairments including appropriate guiding techniques, how to describe spatial environments verbally, and how to connect students with available digital resources as well as the communication needs of students with hearing impairments, including the use of visual and written communication channels as alternatives to spoken directions. The normative expectation that students with disabilities will independently manage their navigation needs, rather than that institutions provide accessible navigation environments, needs to be challenged at both the institutional culture and the physical infrastructure levels.

Institutional and Policy Frameworks for Disability Accessibility in Nigerian Higher Education

Nigeria's legal and policy framework for disability accessibility in higher education has evolved significantly over the past decade, though its practical implementation remains severely limited. The DAPD Act (2018) represents the most comprehensive domestic legal instrument for disability inclusion, mandating physical accessibility in all

public buildings, inclusive education, and the elimination of discriminatory practices. However, the Act has been criticized by disability advocacy organizations for its weak enforcement mechanisms. There is no independent disability rights commission with inspection powers over tertiary institutions, and the National Commission for Persons with Disabilities established under the Act has yet to conduct systematic compliance assessments.

The National Policy on Disability (2019) and the National Policy on Special Needs Education (2015) both include provisions relevant to higher education accessibility but do not specify technical standards for wayfinding infrastructure or establish performance benchmarks against which institutional compliance can be assessed. This regulatory gap the absence of technically specific, enforceable standards is identified in the present study's qualitative data as a key structural explanation for continued wayfinding deficiency: when compliance is not defined with specificity, institutions face no clear obligation and no monitoring mechanism. This is contrasted with the relatively specific accessibility requirements of the ISO 21542 (2011) Building Construction Accessibility and Usability of the Built Environment standard, which provides detailed technical specifications for tactile ground surface indicators, Braille signage dimensions, audio announcement systems, and color-contrast wayfinding design. The discussion section identifies adoption of ISO 21542 or an equivalent national standard, with institutional compliance reporting requirements, as a key policy recommendation.

The Economics of Accessible Wayfinding: Cost, Investment, and Return

A persistent narrative in the African higher education disability discourse holds that accessible wayfinding is financially unattainable within the budget realities of public institutions in low and middle-income countries. This narrative merits critical examination because it often serves as a rationalization for inaction rather than as an evidence-based assessment of actual costs and alternatives. Comprehensive physical wayfinding retrofitting installing tactile ground surface indicators across an entire campus, adding Braille signage to all buildings, and upgrading audio PA systems does involve a meaningful capital expenditure, estimated at USD 50,000-250,000 for a medium-sized campus, depending on the specifications. However, a phased, prioritized approach that first focuses on primary circulation routes and high use buildings can deliver meaningful accessibility improvements at a fraction of this cost.

The digital wayfinding pathway is considerably more cost-effective and is particularly well-suited to Nigerian institutional contexts. Accessible campus mapping using OpenStreetMap-based platforms and compatible screen-reader navigation can be implemented at essentially zero infrastructure cost, requiring only staff time to create accurate campus map data. QR-code navigation nodes physical markers placed at key campus decision points and linked to audio-described location and route information can be deployed for under USD 500 per campus. BLE beacon-based indoor positioning systems, while more expensive at USD 5,000 to USD 20,000 per building, provide the most sophisticated indoor navigation support and have been successfully deployed at universities in Kenya and South Africa within constrained budgets. The economic argument

against investing in digital wayfinding for Nasarawa State's institutions is, in light of these figures, difficult to sustain — particularly given Nigeria's TETFund development disbursements, which routinely fund construction projects of considerably greater expense.

Beyond direct infrastructure costs, a growing body of literature examines the economic and academic returns on accessibility investments in higher education. Seelman and Emery (2020) document that institutions investing in comprehensive disability accessibility infrastructure experience improved retention rates among students with disabilities, reduced academic counseling load associated with navigation-related academic disruption, and enhanced institutional reputation, which supports overall recruitment. While these analyses have been conducted primarily in high-income country contexts, the underlying mechanisms reduced dropout, improved academic productivity, lower compensatory support costs are applicable in any institutional context in which students with disabilities face navigation-related barriers to participation.

Wayfinding, Safety, and Emergency Evacuation

A dimension of wayfinding deficiency that receives insufficient attention in the accessibility literature and is almost absent from the Nigerian disability discourse is the safety dimension. For students with visual impairments, navigating an unfamiliar or changed campus environment without tactile cues poses immediate physical safety risks: unguarded steps, unmarked hazards, and disorienting route changes can result in falls and injuries. For students with hearing impairments, the absence of visual emergency information systems means that fire alarms, security alerts, and emergency evacuations are effectively inaudible creating a situation in which deaf students may be the last to respond to emergencies, or may not respond at all. These are not theoretical risks: research from sub-Saharan African universities documents cases of students with visual impairments sustaining campus injuries due to the absence of wayfinding infrastructure (Mutua et al., 2020).

Emergency egress is a particularly acute concern. Most Nigerian tertiary institution buildings were constructed without accessible emergency egress planning: evacuation routes assume that users can see and hear emergency signals and navigate staircases safely. Students who are blind or Deaf, or who become disoriented during an emergency, may be effectively trapped in buildings that lack tactile evacuation indicators, visual alarm strobes, and vibration alert systems. International fire safety codes, including BS 9999 and ISO 23601, require that emergency evacuation plans account for the needs of persons with sensory disabilities including designated rescue assistance areas, visual alarm systems, and tactile evacuation route indicators. The absence of these features in the study institutions constitutes not merely an accessibility failure but a fire safety non-compliance with potentially life-threatening consequences. Reframing wayfinding as a safety issue rather than solely an inclusivity issue may be more persuasive to institutional management and regulatory authorities than an accessibility rights framing alone, and advocacy strategies should consider deploying this framing alongside rights-based arguments.

THEORETICAL FRAMEWORK

Environmental Psychology and Wayfinding Theory

Wayfinding theory, developed from Lynch's (1960) seminal work on the image of the city and extended by Farr (2012), conceptualizes spatial navigation as a cognitive process dependent on the legibility of the built environment. Lynch identified five key elements through which urban inhabitants cognitively organise space: paths, edges, districts, nodes, and landmarks. For persons with visual impairments, many of these elements are inaccessible in their conventional visual form, necessitating their translation into tactile and auditory equivalents. Paths must be demarcated by tactile ground surface indicators (TGSIs) and textured differentials; nodes must be identified through Braille signage and audio cues; landmarks must be made legible through multi-sensory means.

Farr (2012), extended Lynch's framework by proposing a three-stage wayfinding decision-making model: decision-making (determining a course of action), decision execution (converting decisions into behavioural actions), and information processing (perceiving and interpreting environmental information). For students with sensory disabilities, the information processing stage is fundamentally compromised when the campus environment does not provide accessible information. Farr's model thus provides a theoretical basis for understanding why the absence of Braille signage or audio systems is not merely an inconvenience but a cognitive disruption that renders independent navigation impossible.

Almoshaogeh *et al* (2025) extend this framework to the concept of infrastructural cognition, the degree to which the built environment supports or impedes the cognitive processes required for spatial orientation. They argue that inaccessible infrastructure does not simply create physical barriers but generates what they term cognitive exclusion: the systematic exclusion of persons with disabilities from the cognitive participation in public space that sighted, hearing individuals take for granted. This concept is particularly relevant to the university campus, where spatial participation, navigating to lectures, libraries, and administrative offices, is integral to academic participation.

Universal Design for Information Environments

Imrie (2014), Universal Design framework proposes seven principles for designing inclusive built environments, of which two are most directly relevant to wayfinding: perceptible information (the provision of necessary information regardless of ambient conditions or the user's sensory abilities) and flexibility in use (accommodating a wide range of individual preferences and abilities). Applied to campus wayfinding, perceptible information requires that all navigation aids be available in multiple formats: visual, tactile, and auditory. Flexibility in use requires that wayfinding systems not depend on any single sensory modality but provide redundant, multi-channel cues that support navigation for users with diverse sensory profiles. The digital dimension of wayfinding is increasingly recognised as a fourth modality within Universal Design frameworks. Smartphone-accessible indoor navigation, QR-code-linked campus maps, and screen-reader-compatible digital directories represent minimum contemporary standards for accessible higher education infrastructure (Elgendy, 2021; Luo *et al.*, 2021). The rapid growth of low-cost indoor positioning technologies, including Wi-Fi

triangulation, Bluetooth Low Energy beacons, and augmented reality overlays, has made digital wayfinding accessible even to low-income institutional contexts, provided the political will to deploy these systems exists.

It is important to note that Universal Design does not imply a single solution for all users. Rather, it demands that designers anticipate the full range of human sensory and mobility profiles and build environments that serve all users effectively without requiring specialised or segregated adaptations. This principle is particularly relevant in the West African higher education context, where retrofitting existing inaccessible infrastructure is often advanced as a justification for inaction — when, in practice, low-cost digital overlays can substantially improve wayfinding accessibility without structural renovation.

Social Model of Disability and Rights-Based Frameworks

The social model of disability, originating with Oliver (1990) and theoretically extended by Shakespeare (2013), locates disability not in individual impairment but in the social, physical, and institutional barriers that prevent persons with impairments from participating fully in society. Within this framework, a student who cannot navigate a campus independently is not disabled by their visual impairment *per se* but by the university's failure to install tactile paving and Braille signage. The barrier is institutional, not individual, and its removal is an institutional obligation, not an individual accommodation.

This social-model orientation is now embedded in international rights instruments. The United Nations CRPD (2006), ratified by Nigeria in 2010, frames disability accessibility as a human rights obligation under Articles 9 (accessibility), 24 (education), and 20 (personal mobility). The CRPD's general comment on accessibility (CRPD/C/GC/2) specifically identifies information and communications systems including wayfinding infrastructure as components of the accessibility obligation applicable to educational settings. Nigeria's DAPD Act (2018) partially domesticates these obligations, but as the present study demonstrates, legal enactment has not translated into infrastructural compliance in Nasarawa State's tertiary sector.

The social model provides both an analytical and normative frame for the present study: analytically, it directs attention to institutional structures and policies rather than individual impairments; normatively, it establishes the removal of wayfinding barriers as an obligation of justice, not merely a technical improvement. This framing is important in the West African higher education context, where wayfinding investment may be deprioritised as a luxury when framed in technical or economic terms. However, it is harder to dismiss when framed as a legal and ethical obligation.

METHODOLOGY

Research Design

This study employed a convergent parallel mixed-methods design (Creswell and Creswell, 2018), integrating quantitative cross-sectional survey data with qualitative key informant interviews (KIIs). The two data streams were collected concurrently and integrated at the interpretation stage to provide a more complete understanding of both the extent and the structural causes of wayfinding deficiencies. This design was selected because quantitative data alone while sufficient to document the fact and severity of

deficiencies cannot explain the institutional and policy processes that produced them. The qualitative strand provides essential contextualisation and mechanistic insight that informs the study's policy recommendations.

Study Sites

Four tertiary institutions in Nasarawa State, north-central Nigeria, were selected for inclusion: Federal Polytechnic Nasarawa (FPN), Federal University Lafia (FUL), Nasarawa State University Keffi (NSUK), and Nasarawa State Polytechnic (NSP). This multi-institution design enables cross-institutional comparison across two dimensions: institutional type (university vs. polytechnic) and funding source (federal vs. state). Federal institutions, which receive direct budgetary allocations from the federal government's Tertiary Education Trust Fund (TETFund), might theoretically have greater financial capacity for accessibility investment than state institutions, which depend on relatively constrained state government budgets. FPN, as the oldest of the four institutions (established in 1983), also represents the infrastructure investment context most constrained by pre-disability legislation construction norms.

Nasarawa State represents a particularly appropriate study context for several reasons. As a north-central state with a relatively young tertiary education infrastructure established between the late 1990s and 2010s, Nasarawa State's institutions had an opportunity to incorporate universal design from the outset an opportunity the present study retrospectively evaluates. The state's mixed public-private institutional profile, spanning federal polytechnics, a federal university, a state university, and a state polytechnic, also provides an instructive cross-institutional comparison across governance and funding contexts. Federal Polytechnic Nasarawa (established 1983) is the oldest institution, with the most established campus infrastructure; Federal University Lafia (established 2011) and Nasarawa State University Keffi (established 2002) represent the state's university-level capacity; and Nasarawa State Polytechnic (established 1995) represents the state-funded technical education sector.

Sampling and Participants

The study population comprised all students with sensory disabilities (visual and/or hearing impairment) formally registered with the disability or student support offices at each institution. A census approach was initially planned; however, the disability registers at all four institutions were incomplete or inaccessible, necessitating a combined purposive and snowball sampling strategy. Working through disability offices, student disability associations, and faculty disability liaison contacts, the research team identified and recruited 114 eligible participants across the four institutions: FPN (n = 38), FUL (n = 27), NSUK (n = 26), NSP (n = 22). All participants had been enrolled for at least one semester and had regular experience navigating the campus. Table 1 presents the sociodemographic and disability profile of participants by institution.

Table 1: Sociodemographic and Disability Profile of Participants by Institution

Characteristic	FPN (n=38)	FUL (n=27)	NSUK (n=26)	NSP (n=22)
Gender: Male (%)	60.5	55.6	57.7	54.5
Gender: Female (%)	39.5	44.4	42.3	45.5
Visual Impairment (%)	44.7	40.7	46.2	40.9
Hearing Impairment (%)	36.8	37.0	34.6	36.4
Dual Sensory Impairment (%)	18.4	22.2	19.2	22.7
Mean Age (years)	22.3	23.1	21.9	22.7
Undergraduate (%)	73.7	70.4	76.9	72.7
Postgraduate (%)	26.3	29.6	23.1	27.3
Years enrolled: ≤2 (%)	47.4	44.4	50.0	45.5
Years enrolled: >2 (%)	52.6	55.6	50.0	54.5

Note. FPN = Federal Polytechnic Nasarawa; FUL = Federal University Lafia; NSUK = Nasarawa State University Keffi; NSP = Nasarawa State Polytechnic. Percentages may not sum to 100 due to rounding. Visual impairment includes total blindness and significant low vision; hearing impairment includes profound deafness and significant hearing loss; dual sensory impairment indicates both conditions.

Twelve disability officers three per institution were recruited for key informant interviews (KIIs). Disability officers were selected because of their institutional vantage point: they are typically among the few staff with formal responsibility for disability accommodation. They are uniquely positioned to provide institutional-level explanations for the patterns observed in student survey data. Interview participants were purposively selected to include the senior disability officer and, where possible, a disability liaison from an academic faculty and one from a student services function.

Instrument Development and Data Collection

The quantitative instrument was a structured questionnaire comprising three sections: (a) sociodemographic information, (b) disability profile and navigation experience, and (c) the seven-item Navigation and Wayfinding Infrastructure Scale (NWIS), adapted from the Physical Accessibility Audit Scale for Higher Education developed by Olanrewaju and Ghazali (2021). Each item was rated on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree), with items worded to assess the respondent's experience of the actual provision of each wayfinding feature at their institution (e.g., 'Tactile paving/ground surface cues are available along the main pathways of this campus'). The NWIS demonstrated acceptable internal consistency in the present study (Cronbach's $\alpha = .81$ across all 114 respondents). Questionnaires were administered by trained research assistants in accessible formats: print, large print, and audio. Assistance with completion was provided on request. The decision to use respondent experience-based ratings rather than researcher-conducted physical audits was deliberate: experience-based data capture the practical accessibility of features from the perspective of the users they are intended to serve, rather than the mere physical presence of features that may be inadequate in coverage or usability.

The qualitative KII guide comprised twelve open-ended questions organised around three thematic areas: (a) institutional awareness of and engagement with disability accessibility obligations, (b) planning, budgeting, and

decision-making processes for wayfinding infrastructure, and (c) participants' assessment of barriers to and enablers of wayfinding improvement. Interviews were conducted in English, lasted 45–75 minutes, were audio-recorded with participant consent, and were transcribed verbatim by the research team. A reflexivity protocol was adopted to minimise potential researcher bias. Specifically, the lead researcher, who had previously had informal contact with one disability officer at FPN, withdrew from conducting that particular interview to avoid undue influence; the interview was instead conducted independently by the second author. Pilot testing of the interview guide with two disability support practitioners outside the study institutions was conducted prior to data collection to improve clarity and reduce leading questions.

Data Analysis

Quantitative data were analysed using IBM SPSS Statistics (Version 26). Descriptive statistics means, standard deviations, and frequency distributions were computed for each NWIS item by institution. Pearson chi-square tests of independence were conducted to assess associations between pairs of wayfinding infrastructure dimensions, testing the hypothesis that co-occurring provisions reflect a coherent wayfinding system rather than random or fragmented provision. Where expected cell frequencies fell below 5, Fisher's Exact Test was applied. The conventional significance threshold of $p < .05$ was adopted.

Qualitative data were analysed thematically following Braun and Clarke's (2006) six-phase approach: familiarisation, initial code generation, searching for themes, reviewing themes, defining and naming themes, and producing the final analysis. Transcripts were coded independently by both authors and compared for consistency; discrepancies were resolved through discussion. The analytical process was guided by a theoretical lens drawing on the social model of disability and the Universal Design framework, without imposing a strictly deductive coding scheme. Themes were validated through member checking with two KII participants, who reviewed a draft thematic summary.

Ethical Considerations

Ethical approval was granted by the Federal University of Technology, Minna Research Ethics Committee (Reference: FUTMINNA/REC/2023/07). Institutional research permission was obtained from the management of each study institution prior to data collection. All participants provided written informed consent; verbal consent was accepted where written consent was inaccessible due to visual impairment. Participants were assured of confidentiality, anonymity of responses, and the voluntary nature of participation. All audio recordings were stored on password-protected devices accessible only to the research team. Disability officers' direct quotations presented in this paper are attributed only to the institution and role, not to named individuals.

RESULTS

Descriptive Statistics of Navigation and Wayfinding Infrastructure

Table 2 presents mean scores and standard deviations for all seven wayfinding and navigation items across the four institutions. The pattern reveals uniformly critical deficits for

sensory-specific infrastructure, with every dimension falling below the threshold of adequate provision ($M = 3.00$).

Table 2: Navigation and Wayfinding Infrastructure Provision by Institution (1–5 Likert Scale)

Navigation/Wayfinding Item	FPN (n=38) M (SD)	FUL (n=27) M (SD)	NSUK (n=26) M (SD)	NSP (n=22) M (SD)	Status
Digital navigation aids availability	1.66 (0.60)	1.66 (0.58)	1.65 (0.57)	1.64 (0.56)	Critical Deficit
Tactile paving/ground surface cues	1.89 (0.72)	1.85 (0.68)	1.87 (0.70)	1.83 (0.67)	Critical Deficit
Accessible campus maps (print)	2.18 (0.88)	2.10 (0.82)	2.14 (0.85)	2.08 (0.79)	Inadequate
Braille signage on key buildings	1.79 (0.68)	1.74 (0.65)	1.76 (0.66)	1.71 (0.63)	Critical Deficit
Audio announcements / PA systems	1.84 (0.71)	1.80 (0.68)	1.82 (0.70)	1.77 (0.65)	Critical Deficit
Colour-contrast wayfinding signage	2.31 (0.94)	2.24 (0.87)	2.28 (0.90)	2.20 (0.84)	Inadequate
Staff wayfinding assistance	2.76 (1.05)	2.63 (0.97)	2.70 (1.01)	2.55 (0.95)	Inadequate

Note. Scale: 1 = Strongly Disagree, 5 = Strongly Agree. M = mean; SD = standard deviation. Critical Deficit = $M < 2.00$ (indicating near-universal disagreement with the presence of the provision); Inadequate = $M 2.00–2.99$ (indicating that provision exists but is insufficient). FPN = Federal Polytechnic Nasarawa; FUL = Federal University Lafia; NSUK = Nasarawa State University Keffi; NSP = Nasarawa State Polytechnic.

Digital navigation aids recorded the most extreme deficit, with 100% combined disagreement across all four institutions ($M = 1.64–1.66$, $SD = 0.56–0.60$), confirming that no digital wayfinding tools of any kind — including accessible campus maps, indoor navigation apps, or QR-code navigation systems — are available at any of the study institutions. This finding is further disaggregated in the frequency distribution presented in Table 3.

An important contextual observation concerns the relatively small standard deviations across all wayfinding items, particularly for digital navigation aids ($SD = 0.56–0.60$). This low variability indicates not only that means are low but that there is strong inter-respondent agreement about the absence of provision: this is not a situation in which some students have access to digital wayfinding. In contrast, others do not, but one in which virtually no student at any institution has access to any digital wayfinding tools. Similarly, the low standard deviations for Braille signage ($SD = 0.63–0.68$) and audio PA systems ($SD = 0.65–0.71$) indicate consistent, near-universal agreement that these features are absent. This unanimity considerably strengthens the reliability of the findings: the results cannot be attributed to sampling variation or differential exposure to better-provisioned campus zones.

The marginally higher scores for staff wayfinding assistance ($M = 2.55–2.76$, $SD = 0.95–1.05$) compared to infrastructure items are notable not because they suggest adequate provision but because they indicate that human assistance is the primary — and, in most cases, sole wayfinding resource available to students with sensory disabilities. The higher standard deviation for this item compared to infrastructure items suggests greater variability in staff-assistance experience. Some students report more consistent support, while others report near-total absence of staff-assisted wayfinding. This variability is consistent with an informal, ad hoc assistance model rather than a systematic, policy-based provision. It reinforces the qualitative finding that

compensatory dependence on human assistance is both inadequate and inequitably distributed.

Frequency Distribution Analysis: Digital Navigation Aids

Table 3 presents the full frequency distribution of responses to the digital navigation aids item across all four institutions. The concentration of responses in the 'Strongly Disagree' and 'Disagree' categories is striking and unambiguous.

Table 3: Frequency Distribution of Responses to Digital Navigation Aids Item by Institution

Response Category	FPN n(%)	FUL n(%)	NSUK n(%)	NSP n(%)	Total n(%)	Cum.%
1 – Strongly Disagree	28 (73.7)	20 (74.1)	19 (73.1)	16 (72.7)	83 (72.8)	72.8
2 – Disagree	10 (26.3)	7 (25.9)	7 (26.9)	6 (27.3)	30 (26.3)	99.1
3 – Neutral	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	99.1
4 – Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	99.1
5 – Strongly Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.9)	100.0
Combined Disagreement (%)	100.0	100.0	100.0	100.0	99.1	—

Note. *n* = number of respondents selecting each category; (%) = percentage of institution sample. Cum.% = cumulative percentage for the combined sample. Combined disagreement = sum of 'Strongly Disagree' and 'Disagree' responses as a percentage of total. One respondent in the combined sample selected 'Strongly Agree'; interview data suggest this individual may have been referring to generic smartphone use rather than institution-provided digital navigation infrastructure.

The concentration of responses in the bottom two categories across all four institutions confirms that digital navigation aids are effectively absent. Braille signage ($M = 1.71\text{--}1.79$) and audio PA systems ($M = 1.77\text{--}1.84$) also recorded critical deficits, confirming that sensory-specific wayfinding support is essentially absent at all institutions. Colour-contrast wayfinding signage ($M = 2.20\text{--}2.31$) and staff wayfinding assistance ($M = 2.55\text{--}2.76$) scored marginally higher. However, it remained in the inadequate range, suggesting that even the most basic low-cost interventions have not been systematically implemented.

Across institutions, Federal Polytechnic Nasarawa consistently recorded the highest (least deficient) mean, while Nasarawa State Polytechnic recorded the lowest. The difference, while small in absolute terms, is examined statistically in the chi-square analysis below and has practical significance for prioritising institutional interventions.

Analysis Coherence against Fragmentation in Wayfinding Provision

Table 4 presents an extended set of Pearson chi-square test results examining associations between wayfinding infrastructure dimensions by institution. A statistically significant result indicates that two-wayfinding dimensions co-occur in a non-random pattern — suggesting either coherent systemic provision or coherent systemic absence. A non-significant result suggests fragmented provision, in which different wayfinding features are distributed independently of one another.

Table 4: Pearson Chi-Square Test Results for Wayfinding Infrastructure Associations by Institution

Variable Association	Institution	χ^2	df	N	p-value	Result
Tactile paving × Audio announcements	FPN	37.25	12	38	.000***	Coherent
Tactile paving × Audio announcements	FUL	14.83	12	27	.251	Fragmented
Digital aids × Braille signage	NSUK	9.47	9	26	.395	Fragmented
Campus maps × Wayfinding signage	NSP	11.62	9	22	.234	Fragmented
Braille signage × Staff assistance	FPN	22.14	9	38	.008**	Coherent
Tactile paving × Braille signage	NSUK	16.44	12	26	.172	Fragmented
Audio PA × Colour contrast signage	FUL	18.92	12	27	.090	Fragmented
Digital aids × Staff assistance	FPN	28.71	9	38	.001**	Coherent

Note. *df* = degrees of freedom; *N* = institution sample size. ** $p < .01$; *** $p < .001$. Significant associations at FPN indicate coherent (though critically deficient) co-distribution of wayfinding infrastructure dimensions. Non-significant results at FUL, NSUK, and NSP reflect fragmented provision in which different wayfinding dimensions are distributed independently. Fisher's Exact Test was applied when the expected cell frequency was < 5 (applicable to NSP analyses, given the small sample).

At Federal Polytechnic Nasarawa, three wayfinding associations reached statistical significance: tactile paving × audio announcements ($\chi^2(12, N = 38) = 37.25, p < .001$), Braille signage × staff assistance ($\chi^2(9, N = 38) = 22.14, p = .008$), and digital aids × staff assistance ($\chi^2(9, N = 38) = 28.71, p = .001$). The coherence indicated by these findings does not mean that FPN is an accessible institution — all means remain in the critical deficit range — but rather that whatever deficiencies exist at FPN are systematically distributed. Students who report tactile cuing also tend to report audio cuing; students who report the absence of digital aids also tend to report lower staff assistance. This patterning suggests that FPN has some, albeit critically insufficient, institutional approach to wayfinding that creates co-varying provision. In contrast, at FUL, NSUK, and NSP, non-significant chi-square results indicate that any minimal wayfinding infrastructure is distributed without a coherent institutional logic — a finding consistent with entirely ad hoc or accidental provision.

Qualitative Findings: Key Informant Interview Themes

Thematic analysis of the 12 KII transcripts identified 6 recurrent themes that collectively explain the structural origins of wayfinding deficiencies across all 4 institutions. Table 5 presents the themes with illustrative quotations.

Table 5: Key Informant Interview Themes with Representative Quotations (n = 12 Disability Officers)

Theme	Sub-Theme	Institution(s)	Representative Quotation
Planning Invisibility	Disability excluded from master planning	All four	"Wayfinding for blind students has never appeared in any budget cycle I have seen." (Disability Officer, FPN)
Budget Constraint	Competing infrastructure priorities	FUL, NSP	"We lack money even for basic classroom furniture; tactile tiles are not a discussion." (DO, FUL)
Knowledge Gap	Staff unfamiliarity with standards UD	NSUK, NSP	"Nobody here knows what a tactile ground surface indicator even is." (DO, NSUK)
Compensatory Dependence	Reliance on sighted guides and peers	All four	"Students with blindness depend entirely on friends; it is a social duty, not an institutional system." (DO, FPN)
Policy Awareness	DAPD Act not operationalised	All four	"The law exists, but no one monitors universities for compliance." (DO, NSP)
Digital Optimism	Smartphones are seen as a workaround	FPN, FUL	"Some blind students use Google Maps, but the campus is not mapped indoors." (DO, FUL)

Note. DO = Disability Officer. Quotations have been lightly edited for clarity; ellipses indicate omitted text. Institutions are identified by abbreviation only to preserve participant confidentiality.

The theme of planning invisibility was the most pervasive: disability officers at all four institutions reported that wayfinding infrastructure had never appeared as a line item in any institutional budget they were aware of. That disability-inclusive design had not been incorporated into recent campus development projects. The budget constraint theme partially overlaps with, but is analytically distinct from, planning invisibility: while all officers cited budget limitations, those at FUL and NSP specifically noted that, even when budgets allowed for discretionary infrastructure improvements, accessibility was not a competing priority because it was not considered an institutional obligation.

The knowledge gap theme was particularly prominent at NSUK and NSP, where disability officers themselves acknowledged unfamiliarity with technical standards for wayfinding infrastructure. This finding has important implications for capacity-building interventions: improving wayfinding outcomes at these institutions requires not only funding but also technical knowledge transfer. The compensatory dependence theme — the reliance on sighted guides and peer assistance as a substitute for accessible infrastructure — was uniformly present across all four institutions and was described by officers with a mixture of pragmatic acceptance and ethical discomfort. Several noted that while students value peer assistance, it creates undignified, operationally unreliable dependency relationships. The policy awareness theme revealed that while all disability officers were broadly aware of the DAPD Act, none could identify a mechanism through which non-compliance would result in institutional consequences. This impunity from enforcement was identified as a key structural enabler of continued inaction.

The digital optimism theme, observed primarily at FPN and FUL, deserves particular attention as a potential lever for institutional change. Disability officers who recognised the potential of smartphone-based wayfinding solutions were

generally more likely to have students who had independently developed workarounds using Google Maps for outdoor navigation, requesting electronic campus maps from administrators, and sharing WhatsApp-based navigation guidance within disability community networks. While these individual and community-level adaptations partially compensate for institutional inaction, they depend on individual resourcefulness and digital literacy rather than on institutional provision, making them fragile and inequitably distributed. The institutional step from recognising the potential of digital wayfinding to procuring and deploying it requires administrative champions, budget lines, and procurement processes that are currently absent. A secondary finding from the qualitative strand concerns the relationship between disability officers' own professional background and their institutional effectiveness. Officers with backgrounds in social welfare or student counselling tended to conceptualise their role in terms of individual student support. In contrast, the single officer with a physical planning background (at FPN) demonstrated a more systemic, infrastructure-oriented approach to wayfinding and this institution also showed the most coherent provision pattern in the quantitative data. This association, while based on a small purposive sample, suggests that disability office leadership with technical knowledge of the built environment may be a structural facilitator of improved wayfinding provision. Recruiting disability officers with planning, architecture, or environmental design backgrounds, or providing training in these domains to existing officers, is an institutional reform that could yield disproportionate accessibility improvements relative to its cost.

Comparison with International Accessibility Standards

Table 6 benchmarks the study's findings against the requirements of the ISO 21542 Building Construction Accessibility Standard and the CRPD Article 9 accessibility mandate, providing clear documentation of compliance gaps.

Table 6: Compliance Gap Analysis Against ISO 21542 and CRPD Article 9 Requirements

Wayfinding Dimension	ISO 21542 Standard	CRPD Art. 9 Requirement	Study Mean Range	Compliance Gap
Tactile ground surface indicators	Mandatory in all circulation routes	Yes	1.83–1.89	Critical completely non-compliant
Braille signage at key nodes	Required at decision points	Yes	1.71–1.79	Critical essentially absent
Audio PA/announcement system	Required in public buildings	Yes	1.77–1.84	Critical essentially absent
Digital campus navigation (indoor)	Recommended best practice	Implicit	1.64–1.66	Absolute absence – 100% disagreement
Colour-contrast wayfinding signage	Minimum 70% contrast required	Implicit	2.20–2.31	Inadequate – partial provision only
Accessible campus maps (print)	Required in accessible formats	Yes	2.08–2.18	Inadequate sporadic provision

Note. ISO 21542 = International Organisation for Standardisation Standard 21542: 2011, Building Construction — Accessibility and Usability of the Built Environment. CRPD = United Nations Convention on the Rights of Persons with Disabilities (2006). The study mean range represents the observed range across all four institutions. The Compliance Gap is assessed qualitatively by comparing observed provision levels with standard requirements.

The compliance gap analysis makes the international normative shortfall explicit. Every wayfinding dimension falls short of ISO 21542 requirements, and the majority fall short of CRPD Article 9 obligations as domesticated in the DAPD Act. The most acute gaps are for digital navigation aids and Braille signage, both of which are essentially absent despite being technically and financially feasible.

DISCUSSION

The Totality of Digital Wayfinding Absence

The finding of 100% combined disagreement on digital navigation aids across all four institutions is perhaps the most striking result of the study and merits detailed discussion. This is not merely a matter of degree: digital navigation aids are not simply inadequate, they are completely absent. This places the four study institutions not merely below international best practice but below any recognisable minimum standard for accessible higher education in the contemporary digital era. The finding is particularly striking given that smartphone-based solutions exist that could substantially address students with visual impairments' navigation needs without requiring campus-wide infrastructure investment. The absence of digital wayfinding tools is therefore not primarily a financial constraint. However, as the qualitative data confirm, it reflects a fundamental failure to conceptualise sensory disability as a navigation safety issue within the institution's responsibility. This finding resonates with the infrastructural cognition framework proposed by Gilson and Despres (2020): the complete absence of digital wayfinding support does not merely create practical inconvenience. However, it constitutes cognitive exclusion: the systematic denial of the information-processing environment that students with sensory disabilities require to participate independently in academic life. From a rights-based perspective, this is not a deficiency to be addressed in future development cycles but a current violation of the DAPD Act and CRPD obligations that requires immediate institutional response.

It is worth emphasising that the absence of digital wayfinding documented in this study is not a technologically inevitable feature of Nigerian institutional contexts. Nigeria has a rapidly expanding technology innovation ecosystem, with Lagos ranking among Africa's top three technology hubs by startup activity and investment. Several Nigerian companies have developed campus-oriented digital navigation tools, and at least one federal university in Lagos State has piloted a screen-reader-compatible campus map as part of a student-led accessibility project. The absence of digital wayfinding in Nasarawa State is not a problem of technology availability but a problem of procurement, political will, and institutional awareness. The technology exists; the question is whether institutions will choose to deploy it.

The qualitative data from FUL and FPN disability officers suggesting 'digital optimism' — the recognition that smartphone-based solutions represent a viable, relatively low-cost pathway — point to an emerging institutional awareness that digital tools could serve as a bridging strategy while physical infrastructure is developed. This optimism, however, has not yet translated into action, and the mechanisms through which it could be operationalised — procurement pathways, technical partnerships, staff training — have not been established. Converting digital optimism into digital provision requires institutional champions,

procurement mechanisms, and modest funding commitments that are currently absent.

Coherence vs. Fragmentation: The Significance of Chi-Square Findings

The chi-square findings revealing a coherent, albeit critically deficient, pattern of wayfinding provision at FPN in contrast to the fragmented patterns at FUL, NSUK, and NSP carry important practical implications for intervention design. The existence of coherent co-variation among wayfinding dimensions at FPN suggests that this institution has some systematic, if inadequate, institutional approach to wayfinding that creates predictable patterns of provision and absence. This institutional coherence, however deficient in absolute terms, provides a more tractable foundation for improvement than the entirely random patterns observed at other institutions.

Intervention at FPN can build on an existing institutional logic, strengthening and extending a system that already has internal organisation. At FUL, NSUK, and NSP, the fragmented distribution of whatever minimal wayfinding features exist suggests no coherent institutional approach whatsoever. Intervention at these institutions requires not just additional resources but a fundamental institutional reorientation: the establishment of a wayfinding masterplan that creates systematic, campus-wide coverage rather than ad hoc, building-specific provision. This distinction between strengthening a coherent but inadequate system and creating a new system from scratch has important resource and timeline implications that should inform state and institutional planning.

The significant association between Braille signage and staff assistance at FPN ($\chi^2(9, N = 38) = 22.14, p = .008$) and between digital aids and staff assistance ($\chi^2(9, N = 38) = 28.71, p = .001$) is theoretically interesting. It suggests that at FPN, staff wayfinding assistance is not a uniform compensatory provision applied equally across all students, but is provided more to students who also have access to other (albeit inadequate) wayfinding supports. This pattern may indicate a nascent culture of disability support at FPN possibly associated with a more active disability office — in which staff are more sensitised to the needs of students who are already using formal (if inadequate) wayfinding features. The practical implication is that strengthening disability office capacity and visibility at FPN may have multiplier effects across multiple dimensions of wayfinding support.

The Compensatory Dependence Trap and Its Limitations

The qualitative finding that all four institutions rely on peer and staff assistance as the primary wayfinding modality for students with sensory disabilities represents what Koenig and Chowang (2021) term a compensatory dependence trap: a situation in which informal human assistance substitutes for accessible infrastructure so effectively in the short term that it reduces institutional pressure for investment, while simultaneously creating an unsustainable and undignified long-term navigation model. Staff wayfinding assistance recorded the highest mean scores across all four institutions ($M = 2.55\text{--}2.76$), but still in the inadequate range meaning that even this compensatory strategy is insufficiently reliable.

The compensatory dependence trap is particularly problematic for academic achievement. Students who depend on peer guides for campus navigation are subject to

their guides' schedules and availability, cannot navigate spontaneously or independently, and may avoid classes, offices, or library facilities that require navigation assistance they cannot arrange in advance. These participation barriers are invisible in standard academic performance metrics but may substantially account for the lower academic outcomes that students with sensory disabilities experience in Nigerian tertiary institutions (Adelowo et al., 2022). Replacing compensatory dependence with accessible infrastructure is therefore not merely an ethical imperative but an academic achievement intervention.

Policy Implications and the Enforcement Gap

The qualitative finding that all disability officers were aware of the DAPD Act but none could identify an enforcement mechanism that would impose institutional consequences for non-compliance identifies what we term an enforcement gap: the space between legal obligation and institutional behaviour created by the absence of credible, operationalised accountability mechanisms. This enforcement gap is not unique to wayfinding or to Nasarawa State; it characterises disability accessibility compliance across multiple sectors in Nigeria and across multiple West African states (Chisom, C.R., 2025). However, its manifestation in the specific domain of wayfinding infrastructure is particularly consequential given the safety dimensions of navigation failure for students with visual impairments.

Closing the enforcement gap requires action at multiple levels: federal government operationalisation of the National Commission for Persons with Disabilities' inspection and monitoring function; development of technically specific, measurable wayfinding accessibility standards for tertiary institutions; inclusion of accessibility compliance indicators in TETFund and National Universities Commission (NUC) institutional quality assessment frameworks; and institutionalisation of disability accessibility reporting requirements in annual university returns. These systemic reforms would create an accountability architecture within which institutional investment in wayfinding infrastructure becomes necessary rather than optional.

Towards a Phased, Multi-Modal Wayfinding Improvement Framework

The findings of this study, integrated with the international literature, support the development of a phased, multi-modal wayfinding improvement framework appropriate to the resource and capacity constraints of Nigerian tertiary institutions. Phase 1 (immediate, low-cost): deployment of smartphone-based accessible campus navigation, including screen-reader-compatible campus maps, QR-code navigation nodes at key decision points, and SMS/visual emergency alert systems. These measures address critical needs for both visually impaired and deaf students at marginal cost. Phase 2 (medium-term, moderate cost): installation of Braille signage at key campus decision points (building entrances, lift lobbies, toilet facilities, lecture theatre corridors), installation of audio announcement systems in lecture theatres and examination halls, and deployment of colour-contrast wayfinding signage across main campus routes. Phase 3 (long-term, capital investment): comprehensive tactile ground surface indicator installation along all primary circulation routes, implementation of a campus-wide digital indoor navigation system using BLE beacon technology, and integration of accessible wayfinding

standards into all new construction and major renovation projects.

This phased framework acknowledges the financial and capacity constraints of institutions in Nasarawa State while establishing a progressive pathway towards compliance with the CRPD and the DAPD Act. Critically, Phase 1 is achievable within existing institutional budgets and requires no construction activity only political will and modest procurement investment. The existence of this low-cost immediate pathway renders continued inaction ethically untenable.

The Role of Disability Offices as Institutional Change Agents

The twelve disability officers who participated in key informant interviews occupy a structurally ambiguous position within their institutions. They are formally charged with disability coordination but typically lack the institutional authority, budgetary control, and technical expertise to drive the systemic infrastructure changes required for wayfinding improvement. This structural ambiguity — holding responsibility without power is a recurring feature of disability office arrangements in Nigerian tertiary institutions (Adelowo et al., 2022) and constitutes a critical barrier to translating policy commitments into physical infrastructure. Strengthening the institutional position of disability offices by granting them budget authority over accessibility investment, representation on campus planning committees, and professional development support for disability-inclusive design is a necessary institutional reform that would enable disability officers to function as change agents rather than as administrators of inadequate compensatory services.

The qualitative data from FPN, which suggest a somewhat more coherent wayfinding pattern than at other institutions, hint that an active and relatively empowered disability office may contribute to improved provision coherence even in the absence of adequate resources. The significant associations between Braille signage and staff assistance ($p = .008$) and between digital aids and staff assistance ($p = .001$) at FPN may reflect a disability office culture in which staff are oriented towards supporting students who use formal wayfinding features. This culture drives correlated improvement across multiple provision dimensions. This observation, while speculative, points to the importance of institutional culture and disability office leadership as facilitators of accessible wayfinding that are distinct from, and complementary to, financial investment.

Intersectionality and the Distribution of Navigation Disadvantage

The study's quantitative data do not permit analysis of the differential experiences of navigation disadvantage within the disability category specifically, whether students with visual impairments experience greater navigation barriers than students with hearing impairments, or whether women with disabilities experience greater barriers than men. However, intersectionality theory (Crenshaw, 1989) and disability studies scholarship on multiple disadvantages suggest that navigation barriers do not fall equally across all persons with disabilities. Women with sensory disabilities navigating Nigerian campuses face the compounded burden of both disability-related inaccessibility and the gendered safety concerns associated with night-time campus

navigation concerns that are amplified when navigating without tactile or audio cuing in poorly lit environments. Students with dual sensory impairments (reported by 18–23% of participants across the four institutions) face barriers that are qualitatively more severe than those facing students with either visual or hearing impairment alone, as their access to any single compensatory modality is itself compromised.

Future research on wayfinding accessibility should incorporate intersectional analysis that examines how disability type, gender, socioeconomic background, and ethnicity interact to shape navigation disadvantage. Policy responses, similarly, should be calibrated to the differential needs of the diverse community of students with disabilities rather than defaulting to a uniform, disability-neutral approach that risks serving the most visible or most vocal sub-groups at the expense of those with more complex or intersecting needs. The present study's finding that dual sensory impairment affects between 18 and 23% of respondents at each institution is a particular call to action. This group, whose combined visual and hearing limitations leave them most exposed by the total absence of multimodal wayfinding provision, is also the least served by the peer assistance and informal staff support that partially compensate for the absence of infrastructure for students with single sensory impairments. Accessible wayfinding infrastructure is, for dual-sensory-impaired students, not merely a convenience improvement but an absolute precondition for any degree of independent campus participation.

Implications for Urban and Regional Planning Pedagogy

The institutions examined in this study include programmes in urban and regional planning, including the home department of the study's authors at Federal University of Technology, Minna. This creates an interesting pedagogical irony: urban planning students are being educated in built-environment disciplines within campuses that systematically fail to implement the Universal Design and disability-inclusive planning principles that their curricula teach. This irony is not unique to Nigeria; international research documents similar contradictions in planning and architecture education worldwide (Steinfeld & Maisel, 2012). However, it carries particular pedagogical significance in the Nigerian context, where planning students who experience inaccessible campuses as the norm during their formative professional education may carry those normalised expectations of inaccessibility into their future professional practice.

Integrating disability-inclusive design and wayfinding accessibility as practical, applied components of urban planning and architecture curricula including campus-based accessibility audits as student projects would simultaneously address pedagogical deficits and generate data that could inform institutional wayfinding improvements. A campus accessibility audit conducted by planning students, under the supervision of disability officers and faculty, could produce a detailed baseline inventory of wayfinding infrastructure, identify priority improvement areas, and recommend low-cost interventions while simultaneously providing students with applied learning in disability-inclusive planning. This pedagogical approach has been piloted with documented success at South African and Ghanaian planning

programmes and could be adapted for Nigerian institutions at minimal cost.

CONCLUSION

This study provides a systematic, multi-institution, quantitative and qualitative assessment of campus wayfinding infrastructure for persons with disabilities across four tertiary institutions in Nasarawa State, Nigeria filling a notable gap in state-level empirical research on this subject. The findings are unambiguous: digital, tactile, Braille, and audio wayfinding infrastructure is essentially absent at all institutions, placing them far below the minimum requirements of ISO 21542, the CRPD, and Nigeria's own DAPD Act. The total absence of digital navigation aids across all institutions demonstrated by 100% combined disagreement represents the study's most critical finding and the most immediately addressable, given the availability of low-cost smartphone-based solutions.

Chi-square analysis reveals institutional variation in wayfinding coherence, with practical significance for intervention design. FPN's coherent (if critically deficient) pattern of provision provides a tractable foundation for building a more adequate wayfinding system; the fragmented patterns at FUL, NSUK, and NSP indicate the need for systematic masterplanning from the outset. Qualitative key informant analysis identifies six structural explanations for these deficiencies planning invisibility, budget constraint, knowledge gaps, compensatory peer dependence, policy non-enforcement, and unfulfilled digital optimism that collectively constitute an institutional ecology of inaccessibility resistant to incremental improvement without systemic reform.

The study makes three primary contributions. First, it provides an empirical baseline for wayfinding accessibility assessment in Nasarawa State's tertiary institutions, enabling longitudinal monitoring of improvement. Second, it demonstrates the application of chi-square analysis as a method for detecting systemic versus fragmented infrastructure provision a methodological contribution applicable to disability accessibility research more broadly. Third, it proposes a phased, multi-modal wayfinding improvement framework grounded in the study's findings and calibrated to the resource constraints of sub-Saharan African tertiary institutions.

The study additionally surfaces two cross-cutting findings with implications beyond Nasarawa State. The first is the consistent pattern in which the relative position of FPN as the most coherent, if still critically deficient, institution suggests that institutional culture and the empowerment of disability offices may be as important as financial resources in determining outcomes of wayfinding provision. Institutions with active, empowered disability offices that are represented in planning processes demonstrate more coherent (if still inadequate) provision, suggesting that governance reform may be a necessary complement to funding increases. The second cross-cutting finding is the reframing of wayfinding as a safety issue: the complete absence of emergency visual alarm systems and accessible evacuation routes at all four institutions constitutes a fire safety non-compliance with life-threatening implications that should be escalated to both disability advocacy organisations and fire safety regulatory authorities.

Several limitations should be noted. The sampling strategy, while rigorous, relied on institutional disability registers that

were incomplete, potentially excluding students with disabilities who had not formally registered their impairment a particularly significant limitation given the well-documented stigma associated with disability disclosure in Nigerian higher education. The study's cross-sectional design prevents causal inference about the relationship between wayfinding provision and academic outcomes. The four-institution sample, while enabling within-state comparison, limits generalisability to other Nigerian states with different institutional profiles. The NWIS instrument, while adapted from a validated scale, was not independently validated in a Nigerian context prior to this study, though the internal consistency obtained ($\alpha = .81$) provides acceptable preliminary evidence of reliability.

Future research should prioritise: longitudinal assessment of wayfinding improvement following targeted interventions in at least one Nasarawa State institution; cost-effectiveness analysis of different wayfinding technologies in African higher education contexts; examination of the relationship between wayfinding accessibility and academic achievement, retention, and wellbeing outcomes for students with sensory disabilities; and qualitative research exploring the lived navigation experiences of students with disabilities in their own voices, to complement the institutional perspectives provided by disability officers in the present study.

The central practical message of this study is both urgent and actionable. Students with sensory disabilities at tertiary institutions in Nasarawa State are navigating campuses that are, by any international standard, unsafe and inaccessible. This failure is not primarily financial—low-cost digital solutions exist and could be deployed immediately. It is, rather, a failure of institutional will, planning culture, and accountability. Nigeria's DAPD Act and CRPD obligations provide the legal mandate for action. What is required now is enforcement, investment, and the political commitment to make Nigerian campuses navigable and therefore truly accessible for all students. The argument for action is simultaneously legal, ethical, economic, and educational: accessible wayfinding is not a luxury or a future aspiration. It is a present obligation that is already overdue.

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