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Impact of Information and Communication Technology on Healthcare Service Delivery Outcomes in Tertiary Hospitals in North Central Nigeria

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Abstract

Information and Communication Technology (ICT) has transformed global healthcare delivery, yet its utilization in Nigerian tertiary hospitals remains suboptimal. This study examined the impact of ICT on healthcare service delivery outcomes in selected tertiary hospitals in North Central Nigeria. A convergent parallel mixed-methods design was employed, combining quantitative surveys of 397 healthcare professionals and qualitative key informant interviews with 15 respondents across four tertiary hospitals in Plateau, Nasarawa, and FCT Abuja. Data were analyzed using descriptive statistics, independent t-tests, one-sample t-tests, and thematic analysis, guided by an integrated theoretical framework combining the Technology Acceptance Model (TAM), Diffusion of Innovations Theory, and Donabedian's Quality of Care Model. Respondents agreed that ICT infrastructure was available (grand mean=3.18, SD=1.26), accessible (grand mean=3.19, SD=1.24), and utilized (grand mean=3.21, SD=1.23), with significant findings from one-sample t-tests (t=10.47, 13.40, 7.67 respectively; p<.001). However, critical gaps emerged: Electronic Health Records (mean=2.68) and telemedicine platforms (mean=2.97) scored below acceptability thresholds. The ICT Availability Checklist revealed severe deficiencies in telemedicine (12.50%) and Computerized Physician Order Entry systems (29.17%). Major challenges included poor internet

connectivity, irregular power supply, insufficient training, high costs, and data privacy concerns. No significant gender differences in infrastructure perception were found (t=0.531, p=0.596). Qualitative data revealed tension between documentation demands and patient interaction, system vulnerabilities, and compounding effects of infrastructural deficits. While tertiary hospitals have made progress in basic ICT adoption, incomplete digital transformation—particularly absent EHR systems and underutilized telemedicine—limits service delivery improvements. Addressing interconnected infrastructural, human capacity, financial, and governance challenges through targeted, sustainable investments is essential for realizing ICT's full potential in Nigerian healthcare.

Keywords: Information and Communication Technology, healthcare service delivery, tertiary hospitals, North Central Nigeria, electronic health records, telemedicine

Introduction

Background

Information and Communication Technology (ICT) has emerged as a transformative force across various sectors globally, with healthcare being one of the most promising areas for its application. ICT encompasses the convergence of computing, telecommunications, and digital infrastructure, including mobile networks, cloud computing, and Internet of Things (IoT) devices, which enable real-time processing and sharing of information (Okafor & Hassan, 2021). In healthcare, the integration of ICT tools such as Electronic Health Records (EHRs), telemedicine platforms, and mobile health (mHealth) applications has revolutionized service delivery by improving efficiency, accuracy, accessibility, and patient satisfaction (Haleem et al., 2022).

Globally, healthcare systems are increasingly adopting ICT solutions to address systemic challenges. The World Health Organization (WHO, 2018) has emphasized the potential of digital health transformation to enhance healthcare accessibility, efficiency, and quality. In Europe, advanced ICT systems have led to significant improvements in patient outcomes and operational efficiency (Gavurova et al., 2021). For instance, the United Kingdom's National Health Service (NHS) has successfully implemented EHRs, resulting in improved data sharing, reduced medical errors, and enhanced patient safety (Edwards et al., 2023). Similarly, Nordic countries have integrated telemedicine into their healthcare systems, improving access to specialized care in remote areas (Gullslett et al., 2024).

Despite these global advancements, the adoption of ICT in healthcare remains fraught with challenges in Africa, particularly in Nigeria. The continent faces a persistent digital divide characterized by limited internet access, inadequate infrastructure, and low digital literacy among healthcare professionals (World Bank, 2021). Nigeria, as Africa's most populous nation,

struggles with systemic healthcare issues including underfunding, poor infrastructure, and a shortage of skilled personnel (Alali, 2023). These challenges are exacerbated in the North Central Zone of Nigeria, where many hospitals still rely on outdated, paper-based systems for patient data management, scheduling, and clinical communication (Adeleke et al., 2014; Omoleke & Taleat, 2018). Consequently, patients experience prolonged wait times, high rates of medical errors, and limited access to quality care.

In tertiary hospitals located in Plateau, Nasarawa, and the Federal Capital Territory (FCT) Abuja, the utilization of ICT remains suboptimal despite its recognized potential. Rural and peri-urban areas within these states suffer disproportionately, facing delayed diagnoses, inefficient resource utilization, and poor continuity of care (WHO, 2021). This study, therefore, seeks to investigate the utilization of ICT for enhancing healthcare service delivery in selected tertiary hospitals in the North Central Zone of Nigeria, with the aim of identifying gaps and proposing evidence-based strategies for digital health transformation.

Problem Statement

Information Technology (IT) has revolutionized healthcare globally by offering tools such as Electronic Health Records (EHRs), telemedicine, and remote patient monitoring, which improve diagnostic accuracy, accessibility, and overall system efficiency (Haleem et al., 2022). In developed countries, the integration of digital health solutions has led to measurable improvements in patient outcomes, reduced medical errors, and enhanced coordination of care (Gavurova et al., 2021; Edwards et al., 2023). However, in Nigeria, particularly within the North Central Zone, the utilization of IT in healthcare remains critically suboptimal.

Despite the rapid growth of IT and its potential to revolutionize healthcare, research indicates that many hospitals across Nigeria, including those in the North Central Zone, continue to rely on outdated, paper-based systems for essential healthcare processes such as patient data management, scheduling, diagnostic procedures, and communication among medical personnel (Adeleke et al., 2014). These manual systems are prone to errors, inefficiencies, and delays, leading to prolonged patient wait times, restricted access to quality care, and suboptimal health outcomes (Alali, 2023). In tertiary hospitals located in Plateau, Nasarawa, and the Federal Capital Territory (FCT) Abuja, the adoption of IT remains low, even as the potential for digital solutions to improve service delivery is widely acknowledged.

The challenges facing healthcare delivery in the North Central Zone are multifaceted. Inadequate digital infrastructure, including unreliable internet connectivity and irregular power supply, severely hampers the implementation and maintenance of IT systems (Nwankwo & Ibrahim, 2024). Additionally, there is a significant shortage of skilled healthcare professionals with adequate digital literacy, and most existing staff have not received formal training in the use of health information systems (Adeyemi & Olatunde, 2023). Financial constraints further limit the ability of hospitals to procure, maintain, and upgrade IT equipment, while weak regulatory frameworks and fragmented policies impede coordinated digital health transformation (Yusuf et al., 2025).

Rural and peri-urban areas within the zone suffer disproportionately from these challenges. Patients in these areas face delayed diagnoses, inefficient resource allocation, poor continuity of care, and limited access to specialized medical services (WHO, 2021). The lack of interoperability between healthcare facilities further exacerbates fragmentation, making it difficult to share critical patient information across the continuum of care (Adedeji et al., 2022). Consequently, medical errors, improper resource allocation, and low patient satisfaction persist as systemic issues.

Despite increasing national discourse on digital health transformation, there is a lack of comprehensive empirical research focusing on the actual level of IT adoption in tertiary hospitals in the North Central Zone and its effect on healthcare delivery. Existing literature either generalizes findings across Nigeria or focuses on primary and secondary healthcare institutions, leaving a critical gap in understanding how IT can be strategically leveraged at the tertiary level in this specific region (Adebayo et al., 2022). Without such evidence, policy makers, hospital administrators, and development partners lack the contextual data needed to design targeted interventions.

Therefore, the problem lies in the inadequate utilization of Information Technology in tertiary hospitals within Plateau, Nasarawa, and FCT Abuja, which hinders the efficiency, quality, and equity of healthcare service delivery. This study seeks to investigate the current state of IT availability, accessibility, utilization, and the key challenges impeding effective implementation, with the aim of providing evidence-based recommendations for enhancing healthcare delivery through digital transformation in North Central Nigeria.

Objectives

The general aim of this study was to assess Impact of Information and Communication Technology on Healthcare Service Delivery Outcomes in Tertiary Hospitals in North Central Nigeria

Specific objectives

1. To explore the relationship between IT utilization and patient satisfaction in HCS delivery.
2. To identify the key challenges hindering the effective utilization of IT in hospitals within the North Central Zone.

Research questions

1. What is the relationship between IT utilization and patient satisfaction in healthcare service delivery within the selected tertiary hospitals?
2. What are the key challenges hindering the effective utilization of IT in healthcare service delivery in hospitals within the North Central Zone of Nigeria?

Research Hypotheses

1. **H_{o1}**: There is no significant relationship between IT utilization and patient satisfaction in healthcare service delivery.

2. **H_{02}**: There are no significant challenges hindering the effective utilization of IT in healthcare service delivery in hospitals within the North Central Zone.

Conceptual Framework

This study is anchored in a conceptual framework that elucidates the relationship between the utilization of ICT and the enhancement of healthcare service delivery. The framework posits that the strategic adoption and integration of ICT within healthcare institutions play a pivotal role in improving efficiency, accessibility, and quality of care, ultimately leading to increased patient satisfaction (Alolayyan et al., 2020; Addo & Agyepong, 2024).

Independent Variable: Utilization of Information Technology

The primary independent variable is the utilization of ICT in healthcare settings, referring to the deployment, integration, and use of digital tools designed to support clinical, administrative, and communication functions. ICT utilization is operationalized through three key categories:

Health Information Systems (HIS): These are essential technological infrastructures that facilitate electronic management, storage, and retrieval of health-related data. HIS encompasses Electronic Health Records (EHRs), practice management systems, clinical documentation software, billing platforms, and patient scheduling applications. Studies indicate that HIS implementation is associated with enhanced coordination of care, reduction in redundant diagnostic testing, and improved adherence to clinical protocols (Alolayyan et al., 2020; Sutton et al., 2020).

Communication Technologies: These include telemedicine platforms, patient portals, secure messaging systems, and clinical collaboration tools. Telemedicine enables remote delivery of clinical services, proving especially valuable in rural areas where healthcare access is limited (Dorsey & Topol, 2020). The COVID-19 pandemic accelerated telemedicine adoption globally, highlighting its potential to provide safe, continuous care (Keesara et al., 2020).

Clinical Decision Support Systems (CDSS): These are knowledge-based technologies designed to enhance clinical decision-making by delivering patient-specific recommendations and alerts at the point of care. CDSS can significantly improve patient outcomes by facilitating evidence-based practices and streamlining clinical workflows (Sutton et al., 2020; Berner & Graber, 2021).

Intervening Variables: Organizational and Human Factors

The effective implementation of ICT systems is significantly influenced by organizational and human factors. Two primary constructs are emphasized: change management and staff acceptance and competency. Change management refers to structured processes and strategies that facilitate the adoption of new technologies, encompassing organizational readiness, leadership engagement, and stakeholder involvement (Kotter, 2012). Staff acceptance is primarily influenced by perceived usefulness and perceived ease of use, as articulated in the Technology Acceptance Model (Davis, 1989).

Dependent Variable: Health Care Service Delivery

The dependent variable is the quality and efficiency of healthcare service delivery, encompassing dimensions such as timeliness, safety, effectiveness, equity, patient-centeredness, and efficiency (Institute of Medicine, 2001). This study focuses on four primary indicators: efficiency, accuracy, accessibility, and patient satisfaction.

Theoretical Framework

This study integrates three complementary theories to explore the relationship between ICT utilization and healthcare service delivery.

Technology Acceptance Model (TAM)

The Technology Acceptance Model, introduced by Davis (1989), identifies Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) as the principal determinants of a user's behavioral intention to adopt technology. PU is the extent to which an individual believes that using a system will enhance job performance, while PEOU refers to the degree to which the user believes system usage will be effortless. In healthcare contexts, if professionals perceive technologies as tools that improve quality, safety, and efficiency (high PU) and find them intuitive (high PEOU), they are more likely to adopt these systems (Holden & Karsh, 2010).

Diffusion of Innovations Theory

Rogers' (2003) Diffusion of Innovations Theory provides a sociological perspective on the adoption and dissemination of new technologies within organizations. Central to the theory are five core attributes: Relative Advantage (perceived superiority over existing solutions), Compatibility (alignment with existing values and needs), Complexity (perceived difficulty of use), Trialability (extent to which the innovation can be tested), and Observability (visibility of outcomes). In healthcare, these attributes provide valuable insights into how health information technologies are adopted and institutionalized (Greenhalgh et al., 2004).

Donabedian's Quality of Care Model

Donabedian's (1988) model offers a framework for evaluating healthcare quality through three interrelated components: *Structure* (physical and organizational infrastructure, including ICT availability), *Process* (interactions and workflows involved in delivering care), and *Outcome* (results of care delivery, including patient satisfaction and health status). This tripartite model enables systematic examination of how health ICT influences healthcare quality.

Integrated Theoretical Framework

The integration of TAM, Diffusion of Innovations Theory, and Donabedian's model provides a comprehensive framework for understanding ICT adoption and its impact. Technology

utilization is driven by individual perceptions (TAM) and organizational dynamics (DOI), while care delivery outcomes are evaluated through Donabedian's structure-process-outcome framework. This integrated approach captures both the behavioral and systemic elements shaping successful ICT implementation.

Availability of IT Infrastructure in Healthcare

Between 2020 and 2025, healthcare systems in high-income countries have significantly prioritized the digitization of service delivery through increased investments in ICT infrastructure. The United Kingdom's National Health Service (NHS) projected a need for approximately £21 billion to overhaul its digital health architecture, supporting the expansion of electronic patient records, cybersecurity frameworks, and reliable internet connectivity (Neville, 2024). The United States, under the HITECH Act, has invested over $30 billion since 2009 to promote EHR adoption (Blumenthal & Tavenner, 2022).In low- and middle-income countries (LMICs), including Nigeria, healthcare systems face considerable challenges in making similar investments due to financial constraints, inadequate infrastructure, and political instability. A fundamental barrier is the persistent inadequacy of digital infrastructure, encompassing limited broadband coverage, inconsistent electricity supply, and restricted access to modern computing equipment in rural and underserved regions (Duru, 2023). As Lewis et al. (2023) argue, this infrastructural inequity risks reinforcing pre-existing inequalities in health outcomes.

Accessibility of ICT Tools

The accessibility of ICT tools plays a pivotal role in shaping the success and equity of healthcare service delivery. Healthcare workers rely on digital tools for managing EHRs, conducting telemedicine consultations, utilizing CDSS, and monitoring patient health remotely. However, accessibility challenges include the shortage of computing devices, frequent technical malfunctions, and insufficient user training (Addo et al., 2024).

For patients, accessibility depends on device availability, internet connectivity, digital literacy, and cultural attitudes toward technology. In many LMICs, poverty, geographic isolation, and lack of infrastructure limit patient access to digital health solutions (Wilson et al., 2025). Older adults and individuals from marginalized communities are often less inclined to adopt new technology due to unfamiliarity and concerns over data privacy (Tomlinson et al., 2021).

Utilization of ICT in Healthcare Service Delivery

The utilization of ICT in healthcare has significantly revolutionized the healthcare landscape. Digital innovations, including EHRs, telemedicine, mHealth applications, cloud computing, and AI, have collectively transformed the way health services are accessed, delivered, monitored, and managed (Rajkomar et al., 2022; Sharma et al., 2023).

Electronic Health Records (EHRs) centralize and digitize patient information, allowing for real-time data access, clinical documentation, and interoperable information exchange. EHRs

contribute to clinical decision support, reduce medical errors, and enhance billing efficiency (Kellermann & Jones, 2020).

Telemedicine has emerged as a critical tool for expanding access to care, especially for populations in rural and remote areas. The COVID-19 pandemic accelerated telehealth implementation, underscoring its role in continuity of care and infection control (Wilson et al., 2025).

Mobile Health (mHealth) leverages mobile devices to deliver healthcare services, ranging from health education to real-time monitoring. In LMICs, SMS-based systems have proven effective in improving maternal and child health outcomes, HIV/AIDS treatment, and vaccination coverage (Tomlinson et al., 2021).

Challenges Affecting ICT Utilization in Healthcare

Despite significant benefits, the effective utilization of ICT in healthcare faces numerous challenges, particularly in LMICs.

- **Infrastructure Challenges:** Many healthcare facilities face unreliable internet connectivity, inconsistent electricity supply, and insufficient hardware. As noted by Duru (2023), healthcare facilities in Nigeria's rural areas experience regular disruptions due to power cuts and network instability.
- **Human Capacity and Digital Literacy:** Many healthcare professionals lack necessary skills and training to effectively operate health information systems. According to Adler et al. (2021), healthcare workers often face resistance to adopting new technologies due to fear of job displacement, lack of confidence, and concerns about system complexity.
- **Financial Constraints:** Implementing and maintaining ICT systems requires substantial resources, which are often in short supply in LMICs. Tomlinson et al. (2021) highlight that many digital health initiatives rely on donor funding, creating a cycle of dependency. Once donor funding is exhausted, programs often struggle to scale or remain operational.
- **Regulatory and Policy Gaps:** Many LMICs lack standardized protocols for data exchange, cybersecurity, privacy protection, and system interoperability. Mishra and Raghavan (2022) emphasize that without robust regulatory frameworks, digital health systems risk data breaches, legal disputes, and duplication of efforts.
- **Interoperability and Fragmentation:** Numerous digital health tools are developed and deployed in isolation, operating outside national health information architectures. This fragmentation creates data silos, duplication of efforts, and a diminished ability to derive actionable insights (Tomlinson et al., 2021).

ICT Utilization in the Nigerian Context

Nigeria faces significant barriers in the adoption of ICT within its healthcare system. According to Okonkwo et al. (2021), systemic issues such as inadequate digital infrastructure, inconsistent policy implementation, and limited ICT training for healthcare professionals

remain major obstacles. A nationwide assessment by Musa and Balogun (2022) found that although some tertiary institutions and private hospitals have made strides in deploying EHRs and telemedicine platforms, most primary and secondary healthcare providers still rely on paper-based systems.

Adeyemi and Olatunde (2023) report that low digital literacy among healthcare workers significantly hampers effective utilization of available technologies. Many practitioners lack confidence in using digital tools, which undermines the potential benefits of ICT integration. The situation is compounded by inconsistent power supply and unreliable internet connectivity, especially in the North Central Zone (Nwankwo & Ibrahim, 2024).

Despite these challenges, recent initiatives by the Nigerian Ministry of Health, including public-private partnerships and donor-funded digital health programs, are showing promise. According to a policy review by Yusuf et al. (2025), there is growing momentum for eHealth adoption, particularly in urban centers, although full-scale implementation across the country remains a long-term goal.

Impact of COVID-19 on ICT Deployment

The COVID-19 pandemic profoundly transformed the landscape of healthcare delivery, exerting both disruptive and catalytic effects on ICT deployment globally. According to Wilson et al. (2025), the pandemic led to significant interruptions in planned ICT implementations, with many organizations compelled to roll out digital tools under compressed timelines. However, the urgent need to maintain continuity of care drove rapid adoption of telemedicine, remote patient monitoring, and AI-driven diagnostic tools. In LMICs, the pandemic amplified existing disparities but also accelerated digital experimentation, spurring governments to fast-track national eHealth strategies.

Summary of Literature Gaps

The literature review reveals several critical gaps. First, while substantial evidence exists on ICT adoption in high-income countries, empirical research on ICT utilization in Nigerian tertiary hospitals, particularly in the North Central Zone, remains limited. Second, existing studies often generalize findings across Nigeria without addressing region-specific contextual factors. Third, there is a lack of integrated theoretical frameworks that simultaneously address individual, organizational, and systemic factors influencing ICT adoption. Fourth, most studies focus on either availability or utilization without examining the relationships among availability, accessibility, utilization, and challenges. This study seeks to fill these gaps by providing comprehensive empirical evidence on ICT utilization for enhancing healthcare service delivery in selected tertiary hospitals in Plateau, Nasarawa, and FCT Abuja.

Methodology

A convergent parallel mixed-methods research design was adopted for this study to integrate both quantitative and qualitative approaches in providing a comprehensive understanding of Information and Communication Technology (ICT) utilization in healthcare service delivery.

The study was conducted in four tertiary healthcare institutions in North Central Nigeria, namely Plateau State Specialist Hospital, Federal Medical Centre, National Hospital Abuja, and University of Abuja Teaching Hospital. The estimated population of healthcare workers across the selected hospitals was 4,400, from which a sample size of 367 respondents was calculated using Yamane's formula $n = \frac{N}{1+N(e)^2}$at 10% precision level; however, the sample size was proportionally increased to 397 respondents to account for possible non-response. A multi-stage sampling technique was employed, involving stratified random sampling of healthcare workers according to professional categories such as doctors, nurses, ICT personnel, and administrative staff, while simple random sampling was used for patient selection. Data were collected using a structured questionnaire assessing socio-demographic characteristics, ICT knowledge and utilization, perceived benefits, barriers, and training needs; an ICT availability checklist examining the presence of hardware, software, connectivity, and security infrastructure; and a semi-structured interview guide for key informant interviews involving 15 participants. Content validity of the instruments was established through expert review, while reliability testing through pilot study involving 10% of the sample produced a Cronbach's alpha coefficient greater than 0.70, indicating acceptable reliability. Quantitative data were analyzed using IBM SPSS Statistics v27 with descriptive statistics such as frequencies, percentages, means, and standard deviations, alongside inferential statistics including independent t-tests and one-sample t-tests, while qualitative data were analyzed thematically. Ethical approval was obtained from the relevant institutional review boards, informed consent was secured from all participants, and confidentiality and anonymity were maintained throughout the study.

Response Rate and Demographic Characteristics

A total of 397 duly completed questionnaires were analyzed, representing a 97% response rate. Demographic characteristics: 53% female, 36% aged 46-55 years, 62% married, 60% held postgraduate degrees, 25% were nurses/midwives, and 56% reported formal ICT training.

Descriptive statistics

RESEARCH QUESTION Three: How Information communication Technology is currently utilized in healthcare service delivery in hospitals across the North Central Zone?

Table 1: *Responses of the* Information Technology is currently utilized in healthcare service delivery in hospitals

NO	Items on Information communication Technology is currently utilized in healthcare service delivery in hospitals	M	SD	Remark
1	I use computers or other ICT tools daily for clinical or administrative tasks.	3.07	1.211	Agreed
2	I use electronic health records (EHR) for documenting patient information.	3.35	1.221	Agreed

NO	Items on Information communication Technology is currently utilized in healthcare service delivery in hospitals	M	SD	Remark
3	I utilize telemedicine platforms for consultations or follow-ups.	2.97	1.137	Disagreed
4	I use ICT tools to retrieve medical literature and clinical guidelines.	3.3	1.267	Agreed
5	ICT is used regularly for scheduling and managing patient appointments.	3.09	1.084	Agreed
6	I use ICT tools for communication with colleagues and other departments.	3.15	1.224	Agreed
7	I utilize ICT for reporting and analysing health data.	3.37	1.233	Agreed
8	ICT is integrated into routine patient care procedures in my department.	3.43	1.234	Agreed
9	I rely on ICT systems to make clinical decisions (e.g., diagnostics support systems).	3.33	1.206	Agreed
10	I am confident in using ICT tools relevant to my role in healthcare delivery.	3.51	1.154	Agreed
	Grand Mean	**3.21**	**1.23**	**Agreed**

Source: Field Work, 2025

Condensed data presented in Table 1 shows the responses on Information Technology is currently utilized in healthcare service delivery in hospitals across the North Central Zone. It is shown that the grand mean of 3.21 and SD (1.23) is greater than the cut-off points of 3, implying that the Respondents generally agreed with the items assessing the Information Technology is currently utilized in healthcare service delivery in hospitals across the North Central Zone. Item-by-item analysis indicates that item No 3 each had a mean score of 2.97 which is below the mean cut off 3. The conclusion is that majority of the RESPONDENTs agreed on Information communication Technology is currently utilized in healthcare service delivery in hospitals across the North Central Zone.

Research Question Four: What are the key challenges hindering the effective utilization of ICT in healthcare service delivery in hospitals within the North Central Zone of Nigeria?

Table 2 : Responses of the key challenges hindering the effective utilization of IT in healthcare service delivery in hospitals within the North Central Zone of Nigeria

NO	Items on key challenges hindering the effective utilization of ICT in healthcare service delivery in hospitals	M	SD	Remark
1	Inadequate ICT infrastructure limits the effective use of technology in my hospital.	2.93	1.145	Disagreed
2	Poor internet connectivity disrupts the use of online health information systems.	3.06	1.149	Agreed
3	Irregular power supply affects the consistent use of ICT tools.	3.1	1.133	Agreed

NO	Items on key challenges hindering the effective utilization of ICT in healthcare service delivery in hospitals	M	SD	Remark
4	Lack of technical support hinders the smooth operation of ICT systems.	3.31	1.222	Agreed
5	Insufficient training on ICT use limits staff confidence and competence.	3.08	1.164	Agreed
6	High cost of acquiring and maintaining ICT equipment is a major constraint.	3.31	1.236	Agreed
7	Resistance to change among healthcare staff affects ICT adoption.	3.05	1.142	Agreed
8	Limited access to updated software and ICT tools affects performance.	3.3	1.265	Agreed
9	Inadequate funding and budgetary allocation for ICT development is a challenge.	3.05	1.177	Agreed
10	Data privacy and security concerns discourage full adoption of ICT in clinical operations.	3.29	1.215	Agreed
	Grand Mean	**3.20**	**1.22**	**Agreed**

Source: Field work, 2025

Condensed data presented in Table 2 shows the responses on key challenges hindering the effective utilization of ICT in healthcare service delivery in hospitals within the North Central Zone of Nigeria. It is shown that the grand mean of 3.20 and SD (1.22) is greater than the cut-off points of 3, implying that the RESPONDENTs generally agreed with the items assessing the key challenges hindering the effective utilization of IT in healthcare service delivery in hospitals within the North Central Zone of Nigeria. Item-by-item analysis indicates that item No 1 each had a mean score of 2.93 which is below the mean cut off 3. The conclusion is that majority on key challenges hindering the effective utilization of IT in healthcare service delivery in hospitals within the North Central Zone of Nigeria .

Inferential Statistics

Hypothesis One: The level of utilization of IT in healthcare service delivery among professionals will not be significantly high

In the process of testing the first null hypothesis, the variable of interest is utilization of Information Technology in healthcare service delivery measured by 10 questionnaire items. The Respondents' scores on the scale were summed-up based on these items of the scale. For the utilization of Information Technology in healthcare service delivery in hospitals to be considered significantly high, the scores made on the whole scale should be significantly higher/greater than 30 (which is the midpoint between strongly agree and strongly disagree). This implies 3 X 10, the number of items measuring the utilization of Information Technology in healthcare service delivery in hospitals variable. This null hypothesis was tested with a one-sample t-test) otherwise called population t-test). The results are presented in Table 3

Table 3: One-sample t-tests analyses on utilization of Information Technology in healthcare service delivery in hospitals within the North Central Zone

Variable	Sample M	Sample SD	Ref. Mean	T	Sig	Remark
utilization of Information Technology in healthcare service delivery in hospitals	32.56	3.81	30	13.40	<.001	Sig.

A critical look at the results reveals that the utilization of Information Technology in healthcare service delivery in hospitals when computed, the results indicated a statistical significance among the Respondents (M=32.56, SD=3.81), t (396) = 13.40, P < .001. With this result the third null hypothesis is hereby not supported and hence rejected for the alternative. This implies that the utilization of Information Technology in healthcare service delivery in hospitals is significantly high within the North Central Zone.

Hypothesis second: The challenges hindering the effective utilisation of IT in healthcare service delivery among professionals will not be significantly high

In the process of testing the second null hypothesis, the variable of challenges hindering the effective utilization of IT in healthcare service delivery in hospitals measured by 10 questionnaire items. The Respondents' scores on the scale were summed-up based on these items of the scale. For the challenges hindering the effective utilization of IT in healthcare service delivery in hospitals to be considered significantly high, the scores made on the whole scale should be significantly higher/greater than 30 (which is the midpoint between strongly agree and strongly disagree). This implies 3 X 10, the number of items measuring the challenges hindering the effective utilization of IT in healthcare service delivery in hospitals variable. This null hypothesis was tested with a one-sample t-test) otherwise called population t-test). The results are presented in Table 4.

Table 4: One-sample t-tests analyses on challenges hindering the effective utilization of IT in healthcare service delivery in hospitals within the North Central Zone.

Variable	Sample M	Sample SD	Ref. Mean	T	Sig	Remark
challenges hindering the effective utilization of IT in healthcare service delivery in hospitals	31.48	3.84	30	7.67	<.001	Sig.

A critical look at the results reveals that the challenges hindering the effective utilization of IT in healthcare service delivery in hospitals when computed, the results indicated a statistical significance among the Respondents (M=31.48, SD=3.84), t (396) = 7.67 P < .001. With this

result the fourth null hypothesis is hereby not supported and hence rejected for the alternative. This implies that the challenges hindering the effective utilization of IT in healthcare service delivery in hospitals within the North Central Zone was significantly high

Availability of ICT Infrastructure

The finding that ICT infrastructure is generally available (grand mean=3.18) aligns with global trends in healthcare digitization documented in the literature (Neville, 2024; WHO, 2023). However, the critical gap in EHR systems (mean=2.68) supports Duru's (2023) findings that many Nigerian healthcare facilities lack requisite digital infrastructure for comprehensive digital health solutions.

The ICT Availability Checklist revealed that while hardware components are relatively available (desktop computers 83.33%, laptops 91.67%), critical software systems like EHR/EMR (66.67%) and telemedicine platforms (12.50%) demonstrate limited availability. This pattern illustrates what Adler et al. (2021) describe as "incomplete digitization"—hardware exists, but software ecosystems for significant digital transformation are insufficiently developed.

From Donabedian's Quality of Care Model perspective, these findings relate to the "Structure" dimension. The structural deficiencies in EHR and telemedicine systems impact both care processes and outcomes, since inadequate systems hinder effective workflows and data management.

Accessibility of ICT

The finding that ICT accessibility was significantly higher than benchmark ($t=10.47$, $p<.001$) indicates that tertiary hospitals have made progress in making ICT tools available to healthcare professionals. However, equity concerns emerged, as item 4 (accessibility to all staff categories) scored below threshold (mean=2.98). This supports Cresswell and Sheikh's (2013) observation that organizational and human factors mediate the effectiveness of ICT implementation.

The qualitative finding that "some older nurses don't know how to use the computer well" reflects the digital literacy challenges documented by Adler et al. (2021). The Technology Acceptance Model helps explain this: perceived ease of use significantly influences adoption behavior. When healthcare workers lack confidence in using digital tools, they may underutilize available technology.

Utilization of ICT

The significantly high utilization levels ($t=13.40$, $p<.001$) indicate that where ICT systems exist, they are being incorporated into clinical operations. This finding aligns with Sutton et al.'s (2020) claim that successful technology integration depends on consistency with established clinical protocols and user-centered design principles.

Notably, telemedicine utilization was low (mean=2.97). This is significant given the global surge in telemedicine during the COVID-19 pandemic (Wilson et al., 2025). The restricted

implementation in Nigerian tertiary hospitals suggests that the pandemic-induced digital transformation observed in high-income countries may not have been fully replicated in this context, likely due to infrastructural, regulatory, and human resource constraints.

Challenges Hindering ICT Utilization

All ten challenge items except one scored above the cut-off, indicating that ICT utilization barriers are multiple, interdependent, and systemic. Poor internet connectivity (mean=3.06), irregular power supply (mean=3.10), insufficient training (mean=3.08), high costs (mean=3.31), and data privacy concerns (mean=3.29) represent major obstacles.

These findings align with Greenhalgh et al.'s (2004) assertion that healthcare technology adoption is a complex, multilayered process shaped by human, organizational, and systemic factors. The qualitative finding of a ransomware attack at a private hospital highlights growing cybersecurity concerns in digital healthcare (Harrison, 2023).

Gender Differences

No significant gender difference was found in perceptions of ICT infrastructure availability ($t=0.531$, $p=0.596$). This suggests that in tertiary hospital settings, institutional factors such as professional obligations and organizational expectations may outweigh individual characteristics like gender in shaping technology perceptions. However, qualitative data revealed that intersection of gender with rural location and health system level may create gendered patterns of technology access not captured in facility-specific quantitative analyses.

Conclusion

This study assessed ICT utilization for enhancing healthcare service delivery in tertiary hospitals in North Central Nigeria. Key findings indicate that while tertiary hospitals have made progress in basic ICT adoption, incomplete digital transformation limits service delivery improvements.

Critical gaps identified include:

- Electronic Health Record systems are inadequately available (mean=2.68)
- Telemedicine platforms are severely underutilized (mean=2.97) and available in only 12.50% of facilities
- Stable electricity supply remains problematic (58.33% availability)
- Technical support and cybersecurity measures are inadequate (66.67% availability)

Major challenges include: poor internet connectivity, irregular power supply, insufficient training, high costs, staff resistance to change, and data privacy concerns. These challenges are interconnected and require comprehensive, multi-faceted interventions.

The integrated theoretical framework combining TAM, Diffusion of Innovations Theory, and Donabedian's Quality of Care Model proved effective for understanding the complex dimensions of ICT implementation in healthcare.

Addressing the interconnected infrastructural, human capacity, financial, and governance challenges through targeted, sustainable investments is essential for realizing ICT's full potential in Nigerian healthcare. Without such investments, digital health transformation will remain incomplete, and the benefits of ICT will not reach all patients equitably.

Recommendations

For Hospital Administrators

- Implement comprehensive Electronic Health Record systems with phased approach
- Ensure equitable ICT access across all departments and staff categories
- Establish effective ICT support systems and continuous training programs
- Foster culture of innovation through structured change management

For Health Policymakers

- Establish comprehensive national digital health strategy with enforceable standards
- Focus public investment on expanding broadband, electricity, and data infrastructure
- Create sustainable funding mechanisms including public-private partnerships
- Implement national patient identification system for care continuity

For Training Institutions

- Incorporate digital health competencies into academic programs
- Provide hands-on experience with digital health systems
- Establish specialized programs in health informatics

For Development Partners

- Align interventions with national strategies for sustainability
- Support improvements in electricity, internet, and workforce capacity
- Promote adaptable open-source digital health technologies

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