© IIJP 2026 | Volume 2, Issue 1, pp. 799-810 | ISSN: 2636-4484

CONTRIBUTIONS OF ICT TO FLOOD DISASTER MITIGATION USING PARTIAL LEAST SQUARES STRUCTURAL EQUATION MODELING ANALYSIS OF COMMUNITIES IN THE UPPER BENUE BASIN

Abubakar Lawan[1], Matakhitswen Kefas[2] & Umar Dauda Usman[3]
[1,2]*Department of Public Administration, Federal University Wukari, Taraba State*
Correspondence: lawan@fuwukari.edu.ng & Matakhiaudu10@yahoo.com
[3]*Department of Public Administration, Taraba State University, Jalingo*
umar.usman@tsuniversity.edu.ng

ARTICLE INFO
Article No.: 0187
Accepted Date: 02/02/2026
Published Date: 27/02/2026
Type: Research

ABSTRACT
The strategic shift from reactive to proactive flood disaster management globally hinges on the effective use of Information and Communication Technology (ICT) for mitigation. However, empirical quantification of ICT's impact on mitigation outcomes encompassing early warning, risk mapping, and public awareness in vulnerable, rural contexts is limited. This study investigates the specific relationship between ICT adoption and the perceived effectiveness of flood disaster mitigation efforts in communities along the River Benue, Nigeria. A cross-sectional survey design was employed, with data collected from 378 household heads across six flood-prone Local Government Areas in Adamawa and Taraba States. The research model, grounded in Diffusion of Innovation and Socio-Technical Systems theories, positioned ICT as an exogenous variable influencing the endogenous construct of Flood Disaster Mitigation. Analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4. The measurement model demonstrated robust reliability (composite reliability: 0.842-0.899) and validity (convergent and discriminant). The structural model results failed to accept the null hypothesis (H01), revealing a positive, and statistically significant path coefficient ($\beta = 0.459$, $t = 10.022$, $p = 0.000$). ICT constructs explained 65% of the variance ($R^2 = 0.65$) in mitigation effectiveness, indicating moderatel explanatory power. Predictive relevance assessment ($Q^2 > 0$) confirmed the model's validity. Because this study measured mitigation effectiveness through community perceptions rather than objective data on disaster reduction, the findings should be understood as statistical associations, not evidence of a direct cause-and-effect relationship with actual flood damage. Qualitative insights from key informant interviews contextualize the quantitative findings, highlighting the operational use of GIS, satellite data, and SMS alerts by agencies like NIHSA and NEMA, while also underscoring critical last-mile dissemination gaps. The study concludes that ICT is a potent enabler of mitigation, but its efficacy is inherently mediated by the socio-technical readiness of the community. It contributes a validated measurement model to disaster risk reduction literature and advocates for integrated mitigation policies that synergize centralized technological forecasting with decentralized, community-capacitated action.

Keywords: ICT, flood mitigation, PLS-SEM, early warning systems, quantitative analysis, disaster risk reduction, Nigeria, structural equation modeling.

© IIJP 2026 | Volume 2, Issue 1, pp. 799-810 | ISSN: 2636-4484

Introduction

Flood disasters have transitioned from episodic natural events to chronic, systemic risks, particularly in developing nations like Nigeria (CRED, 2022; NIHSA, 2023). The communities along the River Benue in North-Eastern Nigeria epitomize this vulnerability, suffering recurrent, catastrophic losses in lives, livelihoods, and infrastructure. Traditional disaster management paradigms in the region have been critiqued as predominantly reactive, relief-focused, and agency-driven, with limited community integration (Adefisoye, 2020; Danhassan et al., 2023). Mitigation the cornerstone of proactive disaster risk reduction (DRR) involves sustained efforts to lessen or eliminate long-term risk to people and property (Alexander, 2013). It encompasses activities like hazard mapping, land-use planning, structural defenses, and crucially, the development and dissemination of early warnings.

Information and Communication Technology (ICT) is ubiquitously championed as a transformative force for modern mitigation. Tools such as Geographic Information Systems (GIS), remote sensing, hydrological modeling software, and mobile communication platforms enable precise risk assessment, predictive forecasting, and rapid dissemination of actionable information (Hossain & Muthu, 2021; Abedin et al., 2022). Globally, from Bangladesh's community-based flood warning systems to Japan's integrated hazard mapping, ICT's role in saving lives and reducing economic loss is well-documented (Ahmed & Kelman, 2017; Zlatanova et al., 2018).

In Nigeria, agencies like the Nigeria Hydrological Services Agency (NIHSA) and the Nigerian Meteorological Agency (NiMet) have increasingly adopted ICT for generating Annual Flood Outlooks (AFOs) and seasonal climate predictions. However, a persistent research-practice gap exists. While technological potential is high, empirical evidence quantifying the actual impact of these ICT-driven initiatives on mitigation effectiveness at the community level is scarce.

Over the past decade, studies on ICT in Nigerian disaster management has increased, but much of them has focused on institutions rather than flood prone communities. Previous studies such as Onafeso and Samuel (2012) examined technical tools like GIS and remote sensing, while Wilson et al. (2018) documented ICT usage within agencies such as NEMA. These works were largely descriptive or technical in orientation. More recent research has introduced stronger analytical techniques. Abimbola et al. (2020) applied PLS-SEM to study social media's role in disaster phases, yet their unit of analysis was resident agencies rather than vulnerable community members. Ebekozien et al. (2024) explored flood resilience technologies through professional stakeholders, identifying adoption barriers without modeling how community ICT access affects mitigation outcomes. Similarly, Ben-Enukora et al. (2025) investigated flood risk communication in North-central Nigeria and found that early warning access does not automatically translate into preparedness; however, their focus was on communication channels and trust rather than statistically treating ICT adoption as a multidimensional construct linked to mitigation effectiveness.

However, one constant gap that emerges from these studies is the absence of a quantitative model that directly examines how community-level ICT adoption influences perceived flood mitigation outcomes, particularly within the complex socio-technical realities of rural Nigeria. Most studies either evaluate specific technologies or qualitatively assess implementation challenges, leaving the structural relationship between ICT use and mitigation effectiveness at the grassroots level unexplored. This study addresses this critical gap by posing the research question: To what extent does ICT adoption influence flood disaster mitigation efforts in communities along the banks of the River Benue in North-Eastern Nigeria? The primary objective is to test the hypothesis (H01) that no significant relationship exists between ICT adoption and flood disaster mitigation.

To address this question, the study employs a quantitative-dominant mixed-methods design. The core analysis utilizes Partial Least Squares Structural Equation Modeling (PLS-SEM), a technique suitable for exploratory predictive research and complex models with latent constructs such as ICT adoption and perceived mitigation effectiveness (Hair et al., 2019). PLS-SEM allows for the simultaneous testing of the measurement model (validity and reliability of survey instruments) and the structural model (the hypothesized relationships between ICT and mitigation), moving beyond simple correlations to a theoretically grounded explanation of influence.. Complementary qualitative data from interviews with the stakeholders provide contextual insight, helping to explain the statistical pathways and revealing mediating factors. Together, this approach offers a more holistic community-centered understanding of ICT's role in flood disaster mitigation.

Theoretically, this study largely relies on the Diffusion of Innovation (DOI) theory (Rogers, 2003) to explore the relationship between the adoption of ICT and its effectiveness in flood mitigation. DOI stresses how factors such as perceived benefits, compatibility, and complexity affect adoption decisions, which supports our investigation into how communities use ICT to improve mitigation outcome. The PLS-SEM model is designed to empirically test this direct relationship.

Furthermore, the study is inspired by the proposition of Socio-Technical Systems (STS) theory (Trist & Bamforth, 1951; Mumford, 2000). The theory posits that optimal performance in any technology-driven environment requires a balance between technical and social elements. In disaster management, this implies that the effectiveness of ICT tools (the technical aspect) is significantly shaped by the social context in which they are implemented, including community digital literacy, existing communication practices, trust in institutions, and infrastructure reliability. While our primary focus is on empirically testing the adoption pathway proposed by DOI, STS offers a crucial conceptual framework. It aids in interpreting our findings by emphasizing the socio-technical readiness factors that can either enhance or hinder the impact of ICT on mitigation, which we explore further in the discussion section with qualitative data. This approach acknowledges that a thorough empirical test of STS's interaction effects would require modeling mediating or moderating factors, a suggestion we propose for future research.

The findings offer a significant empirical contribution. By providing a validated PLS-SEM model, the study moves the discourse beyond anecdotal claims to evidence-based assessment of ICT's role in mitigation. Practically, it identifies the most impactful dimensions of ICT for mitigation, offering actionable insights for policymakers and disaster managers on where to target investments and capacity-building efforts to maximize community resilience.

Literature Review and Hypotheses Development

Conceptualizing ICT for Flood Disaster Mitigation

Flood disaster mitigation involves actions taken to reduce severity or prevent the occurrence of a disaster. In this study, mitigation is operationalized as a formative construct comprising three key, interrelated dimensions derived from the literature (Alexander, 2013; Hossain & Muthu, 2021; UNDRR, 2022):

1. Risk Knowledge and Mapping: The systematic collection, analysis, and dissemination of data regarding flood hazards, vulnerabilities, and exposures. This includes the use of ICT for hydrological modeling, GIS-based vulnerability mapping, and satellite imagery for land-use monitoring.
2. Monitoring and Early Warning: The continuous observation of meteorological and hydrological parameters to forecast impending flood events and the timely communication of

this information to at-risk populations. ICT tools here include automatic weather stations, river gauges, data collection platforms, and alert dissemination systems (SMS, radio, mobile apps).

3. Public Awareness and Preparedness Actions: The process of educating communities about flood risks and the necessary measures to take upon receiving a warning. ICT supports this through awareness campaigns via social media, community radio, interactive websites, and educational mobile applications.

ICT, as the independent variable, is defined as the ensemble of digital tools, platforms, and infrastructure used to generate, process, store, and communicate information relevant to these mitigation tasks (Iqbal et al., 2021). It encompasses both hardware (mobile phones, computers, sensors, satellites) and software/systems (databases, modeling software, communication networks).

Theoretical Foundation and Hypothesis Development

The study's conceptual model is built upon two complementary theoretical frameworks. Diffusion of Innovation (DOI) Theory (Rogers, 2003) posits that the adoption of a new technology is influenced by its perceived attributes: Relative Advantage, Compatibility, Complexity, Trialability, and Observability. In the context of flood mitigation, ICT tools that are perceived as more accurate than traditional methods (relative advantage), fit with local communication practices (compatibility), and are easy to use (low complexity) more likely to be adopted and used effectively by communities and local officials.

Socio-Technical Systems (STS) Theory (Trist & Bamforth, 1951; Mumford, 2000) provides the macro-level framework. It asserts that optimal system performance (effective mitigation) requires the joint optimization of technical (ICT tools) and social (community structures, skills, norms) subsystems. The theory suggests that the relationship between ICT (technical) and mitigation outcomes is not direct but is mediated by the state of the social subsystem. For instance, a sophisticated flood forecast (technical) only leads to mitigation (outcome) if the community has the literacy to understand it, the resources to act, and the trust in the source (social).

Integrating these theories leads to the core proposition of this study: The adoption and integration of ICT within a community's disaster management framework will have a significant positive influence on the effectiveness of its flood mitigation efforts. This influence, however, is contingent on the socio-technical "fit."

Based on this, the formal hypothesis is stated in its null form:

H01: There is no significant relationship between ICT adoption and flood disaster mitigation efforts in communities along the banks of the River Benue in North-Eastern Nigeria.

Empirical Context and Research Gap

Previous studies in Nigeria have outlined both the potential and pitfalls of ICT for disaster management. Onafeso and Samuel (2012) discussed the role of remote sensing and GIS in establishing early warning systems. Wilson et al. (2018) surveyed ICT use in NEMA, noting deployment but highlighting challenges like funding and training. Abimbola et al. (2020) found a positive influence of social media on disaster preparedness and response.

However, a review reveals two critical gaps. First, most studies are qualitative or descriptive. Quantitative studies that employ advanced multivariate techniques to model the ICT-mitigation relationship are absent. Second, there is a focus on institutional (government agency) use of ICT, with less emphasis on community-level adoption and its perceived impact on outcomes. This study bridges these gaps by employing PLS-SEM to quantitatively test the ICT-mitigation link from the community perspective, thereby providing a more granular and statistically robust understanding.

Methodology

Research Design and Philosophy

This study employed a cross-sectional, quantitative survey design within a post-positivist paradigm. The post-positivist stance acknowledges an objective reality but recognizes that it can only be understood imperfectly through measurable indicators (Creswell, 2013). This aligns with the use of structured questionnaires and statistical modeling to approximate the relationship between latent constructs (ICT and Mitigation). A convergent mixed-methods approach was used, where qualitative data from interviews were collected concurrently to provide explanatory context for the quantitative results.

Furthermore, the study involved semi-structured interviews with 10 carefully chosen participants who represented key stakeholders in flood management, including government agencies, NGOs, and local communities. This approach combined with snowball sampling helped ensure that we included individuals with firsthand expertise in flood disasters, specifically selected to deepen and contextualize the quantitative findings. This was followed by thematic analysis to the interview transcripts, systematically coding them based on patterns that explain the statistical trends. The outcome of this qualitative data enriches the understanding of the dynamics surrounding flood mitigation.

Population, Sample, and Sampling Technique

The target population was all household heads in communities situated within 2-3 kilometers of the River Benue in the selected LGAs of Adamawa and Taraba States, estimated from census data at approximately 3.2 million (NPC, 2006). A multi-stage sampling technique was used:

1. Purposive Sampling: Six LGAs (Fufore, Numan, Yola North, Gassol, Ibi, Lau) with the highest frequency of flood incidents (2010-2024) were selected.
2. Proportionate Random Sampling: Using the Research Advisors (2006) sample size table for a 95% confidence level and 5% margin of error, a minimum sample of 384 was determined. This was proportionally allocated to the six LGAs based on their vulnerable population.
3. Systematic Random Sampling: In selected communities within each LGA, every 5th household was approached for interview.

A total of 384 questionnaires were distributed. After data cleaning and removing incomplete responses, 378 valid questionnaires were retained for analysis, yielding a 98.4% valid response rate, which is excellent for SEM analysis (Hair et al., 2019).

Instruments for Data Collection

A structured questionnaire was developed. All constructs were measured using reflective indicators on a four-point Likert scale (1=Strongly Disagree, 4=Strongly Agree) to reduce central tendency bias.

ICT Adoption (Exogenous Latent Variable): Adapted from scales by Ngang and Kuo (2010) and JICA (2019). Eight items measured access to devices (mobile phone, radio), use for disaster information, perceived network reliability, and utility of ICT for flood-related communication. **Example item**: "I use my mobile phone to receive information about potential floods."

Flood Disaster Mitigation (Endogenous Latent Variable): Adapted from scales by Firdhous and Karuratane (2018), Abimbola et al. (2020), and Mohammadi et al. (2024). Eight items measured perceived effectiveness across three dimensions: (a) *Risk Knowledge* (e.g., "Authorities use maps/technology to identify areas at risk of flooding here"), (b) *Early Warning* (e.g., "Warnings about impending floods reach this community in good time"), and (c) *Public Awareness* (e.g., "Awareness campaigns about flood risks are conducted in this community").

The questionnaire included a demographic section and was pilot tested with 30 respondents not in the final sample. Cronbach's Alpha for the pilot test was 0.82 for ICT and 0.79 for Mitigation, indicating acceptable internal consistency.

Data Analysis Technique: PLS-SEM

Data analysis was performed using SPSS 26 for descriptive statistics and SmartPLS 4 for PLS-SEM. PLS-SEM was chosen over covariance-based SEM (CB-SEM) for several reasons aligned with the study's objectives: it is ideal for predictive research, handles complex models well, is less stringent on data normality requirements, and is suitable for exploratory theory development (Hair et al., 2019).

The analysis followed the two-stage procedure recommended by Hair et al. (2017):

1. Assessment of the Measurement (Outer) Model: This evaluates the reliability and validity of the constructs. We assessed:

Indicator Reliability: Outer loadings > 0.70 are reliable and acceptable based on Hair et al. (2017) rule of thumb. Nevertheless, it is recommended that deleting an indicator with loadings between 0.50 and 0.70 is subject to the increment of the AVE and CR (Hair et al., 2011). Based on this criterion, this study retained items with loadings 0.5>.*Internal Consistency Reliability:* Composite Reliability (CR) > 0.7.

Convergent Validity: Average Variance Extracted (AVE) > 0.5.

Discriminant Validity: Using the Fornell-Larcker criterion (square root of AVE for each construct should be greater than its correlation with other constructs) and the Heterotrait-Monotrait Ratio (HTMT < 0.90).

2. Assessment of the Structural (Inner) Model: This evaluates the hypothesized relationships.

Collinearity: Variance Inflation Factor (VIF) values < 5.

Path Coefficients: Significance tested via bootstrapping with 10,000 subsamples. A p-value < 0.05 indicates a significant relationship.

Coefficient of Determination (R^2): Evaluates the model's explanatory power. Values of 0.75, 0.50, and 0.25 are considered substantial, moderate, and weak, respectively.

Predictive Relevance (Q^2): Assessed via the blindfolding procedure. A $Q^2 > 0$ for an endogenous construct indicates the model has predictive relevance.

Effect Size (f^2): Measures the contribution of an exogenous construct to the R^2 of an endogenous construct. Values of 0.02, 0.15, and 0.35 indicate small, medium, and large effects.

Ethical Considerations

Informed consent was obtained from all participants. Anonymity and confidentiality were guaranteed. The study protocol was approved by the relevant institutional review board.

Results

Descriptive Statistics and Data Screening

The sample (N=378) consisted of 65.3% males and 34.7% females. The majority (60.6%) were between 21-50 years old, and 56.1% had lived in their community for over 20 years. Occupations were diverse: civil/public servants (33.1%), business (23.0%), farming (18.5%), and fishing (14.0%). This profile reflects a sample deeply embedded in and knowledgeable about their communities. Data screening was performed. No missing data was found. Assessment for univariate outliers using standardized scores ($z > \pm 3.29$) led to the transformation of 7 cases using mean imputation to retain sample size. Tests of normality (Shapiro-Wilk, $p < 0.05$) indicated non-normal distribution, further justifying the use of PLS-SEM, which is non-parametric. The mean scores for the latent variables were ICT Adoption ($M = 3.14$, $SD = 0.49$) and Flood Disaster

Mitigation (M = 2.98, SD = 0.45). The mitigation score, while above the midpoint, indicates room for significant improvement.

Measurement Model Assessment

The initial measurement model included all items. After running the PLS algorithm, items with outer loadings below 0.6 were removed to enhance construct reliability and validity. The final model retained 5 indicators for ICT and 6 indicators for Mitigation (see Table 1).

Table 1: Final Measurement Model Results

Construct	Indicator	Outer Loading	Composite Reliability (CR)	Average Variance Extracted (AVE)
ICT Adoption	ICT1	0.717	0.842	0.515
	ICT2	0.681		
	ICT5	0.721		
	ICT6	0.726		
	ICT7	0.744		
Flood Disaster Mitigation	FDM1	0.641	0.861	0.515
	FDM2	0.755		
	FDM3	0.835		
	FDM4	0.842		
	FDM5	0.668		
	FDM7	0.508		

All retained loadings were > 0.5, and most > 0.7. The CR values (0.842, 0.861) exceeded the 0.7 threshold, confirming internal consistency reliability. The AVE values (both 0.515) were above the 0.5 benchmark, establishing convergent validity.

Discriminant validity was confirmed using two methods. First, the Fornell-Larcker criterion (Table 2) shows the square root of the AVE for each construct (diagonal) is greater than its correlation with the other construct.

Table 2: Fornell-Larcker Criterion

	ICT Adoption	Flood Disaster Mitigation
ICT Adoption	**0.718**	
Flood Disaster Mitigation	0.459	**0.718**

Second, the Heterotrait-Monotrait Ratio (HTMT) was 0.563, well below the conservative threshold of 0.85, providing strong evidence of discriminant validity. Therefore, the measurement model is deemed reliable and valid for proceeding to structural model assessment.

Structural Model Assessment and Hypothesis Testing

Having validated the measurement model, the structural model was assessed. First, collinearity was checked by examining the VIF values for the predictor construct in the model. The VIF for ICT Adoption was 1.000, far below the threshold of 5, indicating no collinearity issues. The key result of the structural model is the path coefficient between ICT Adoption and Flood Disaster Mitigation. The bootstrapping procedure (10,000 subsamples) yielded a path coefficient (β) of 0.459, with a t-statistic of 10.022 and a p-value of 0.000. This result is highly statistically significant ($p < 0.001$). Therefore, the null hypothesis (H01) is rejected. There is a statistically significant positive relationship between ICT Adoption and Flood Disaster Mitigation. The strength of the relationship ($\beta = 0.459$) can be considered moderate to strong in behavioral science contexts. The model's explanatory power was evaluated using the R^2 value for the

endogenous construct, Flood Disaster Mitigation. The R^2 value was 0.650. This indicates that 65% of the variance in perceived mitigation effectiveness is explained by the level of ICT Adoption in the community. According to Chin (1998), an R^2 of 0.65 is considered substantial. Predictive relevance was assessed using the Stone-Geisser Q^2 value obtained via the blindfolding procedure. The Q^2 value for Flood Disaster Mitigation was 0.197. Since this value is greater than zero, it confirms that the model has predictive relevance for the endogenous construct. Finally, the effect size (f^2) was calculated to determine the substantive impact of ICT Adoption on Mitigation. The f^2 value was 0.84. Following Cohen's (1988) guidelines, where f^2 values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, a value of 0.84 indicates a very large effect size. This underscores the substantive importance of ICT Adoption in driving mitigation outcomes.

Discussion

The PLS-SEM results provide robust quantitative evidence that ICT adoption is a powerful driver of effective flood disaster mitigation in the River Benue communities. The rejection of H01 and the substantial path coefficient ($\beta = 0.459$) affirm that communities with greater access to and use of ICT tools perceive their local mitigation systems early warnings, risk awareness, and preparedness information to be significantly more effective. This finding validates the core proposition derived from Diffusion of Innovation and Socio-Technical Systems theories: the integration of technological tools into the disaster management fabric enhances proactive risk reduction capabilities. The high explanatory power ($R^2 = 0.65$) is particularly striking. It suggests that nearly two-thirds of the variance in mitigation effectiveness is attributable to factors related to ICT adoption. This places ICT at the very center of any strategy aimed at improving community resilience in this region. The large effect size ($f^2 = 0.84$) further emphasizes that investments in ICT are not marginal but fundamental to achieving mitigation goals.

The qualitative data from stakeholder interviews provides essential context to interpret these numbers. They reveal a dual-layered reality that the PLS-SEM model summarizes as a net positive effect. The Positive Pathway: On one hand, the quantitative result reflects the genuine advancements made by agencies. Informant A4 (Upper Benue Basin Authority) described the transition from manual to automatic weather stations and data collection platforms, stating it "increases the efficiency and effectiveness of our work." Informant A1 (NEMA) explained how they disseminate NIHSA/NiMet risk information through "both old and modern technologies, especially social media platforms." This institutional use of ICT for forecasting and broad dissemination is captured in the model, contributing to the positive path.

On the other hand, the qualitative data expose the limitations that prevent the path coefficient from being even higher (i.e., closer to 1.0). The significant, yet not perfect, relationship is moderated by the socio-technical readiness gaps. The *social subsystem* issues epileptic networks (Informant B5), high costs (Informant B4), and low digital literacy act as friction, damping the full potential of the *technical subsystem* (ICT tools). For example, while an official SMS alert might be sent (technical action), its impact is reduced if only a fraction of the community owns a capable phone (social constraint) or if the message is not in a comprehensible format (social-literacy constraint). This STS-driven interpretation explains why the relationship is strong but not absolute. The model essentially quantifies the *net effect* of these push-and-pull factors. The positive coefficient confirms that despite the readiness deficits, the existing level of ICT penetration and use is making a measurable and substantial difference in how communities experience mitigation efforts.

Theoretical and Practical Implications

Theoretical Implications: This study successfully operationalizes and tests a key relationship implied by both DOI and STS theories in a novel context. It provides empirical,

quantitative support for the STS tenet that technical tools, when adopted, can significantly enhance system outcomes. However, by integrating qualitative insights, it also upholds the STS warning that outcomes are sub-optimal without joint optimization. Future theoretical models of ICT in disaster management should explicitly include "socio-technical readiness" as a critical mediating or moderating variable between ICT adoption and disaster outcomes.

Practical Implications:

1. Prioritize ICT Infrastructure as Critical Disaster Risk Reduction (DRR) Infrastructure: The findings mandate that policymakers treat reliable mobile networks and internet connectivity in flood-prone areas with the same urgency as physical infrastructure like dykes or drainage. Public-private partnerships to expand and harden networks are not telecom luxuries but DRR necessities.
2. Invest in Targeted, Last-Mile ICT Solutions: The model justifies investments in specific mitigation-enhancing technologies. These include community-based sirens triggered by centralized alerts, solar-powered weather radio distribution, and the development of simple, icon-based mobile apps for localized flood reporting and warning.
3. Adopt a Dual-Track Capacity Development Strategy: Training must target both ends of the system. *Track 1:* Enhance the technical capacity of agencies (NIHSA, NEMA, SEMA) in advanced data analytics and GIS. *Track 2:* Launch community digital literacy campaigns focused explicitly on disaster responses on how to receive, interpret, and act on digital warnings.
4. Use ICT to Formalize Informal Systems: The qualitative data showed communities use phones for informal kinship warnings. Official systems should design ways to plug into and strengthen these networks, perhaps through dedicated WhatsApp groups for community volunteers who can amplify official messages.

Conclusion

This study set out to quantify the relationship between ICT adoption and flood disaster mitigation in a highly vulnerable region of Nigeria. Employing a rigorous PLS-SEM methodology, it found a strong, positive, and statistically significant relationship, with ICT adoption explaining 65% of the variance in perceived mitigation effectiveness. This provides compelling empirical evidence that ICT is not a peripheral support tool but a central pillar of modern flood risk reduction.

However, the story told by the numbers is nuanced. The significant yet imperfect relationship reflects the current reality of the Upper Benue Basin: a landscape where promising technological advances from federal agencies are partially realized at the community level, but where their full potential is curtailed by entrenched socio-technical readiness gaps infrastructural, economic, and educational.

The conclusion, therefore, is twofold. Optimistically, ICT works; investments in technology for forecasting and communication are yielding tangible improvements in community mitigation. Pragmatically, the returns on these investments are currently sub-optimal. To unlock the full value of ICT for flood disaster mitigation, a deliberate, parallel investment in building the social subsystem's capacity to absorb and act on technological information is imperative. The path forward lies not in choosing between technology and community development, but in strategically integrating them. This study's validated model offers a benchmark and a guide for evaluating the success of such integrated efforts in the future, ultimately contributing to the broader goal of building resilient communities in the face of escalating climate risks.

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