

Barriers to Digital Inclusion in Rural Northeast India: Challenges and Pathways for Inclusive Digital Transformation

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Abstract

Digital inclusion has become an essential component of sustainable rural development, particularly in developing countries where digital technologies are increasingly integrated into governance, education, healthcare, finance, and entrepreneurship. Despite India's rapid progress in digital infrastructure and initiatives such as Digital India and Common Service Centers (CSCs), significant disparities persist across rural regions, especially in the North Eastern Region (NER). This study investigates the barriers to digital inclusion in rural Northeast India by examining infrastructural, socio-economic, educational, institutional, technological, and cultural constraints affecting rural populations. The study adopts a quantitative research design using structured questionnaires administered among beneficiaries of Common Service Centers across selected districts of Northeast India. Descriptive statistics, reliability analysis, exploratory factor analysis, and multiple regression analysis were employed to identify the major determinants influencing digital inclusion. The findings reveal that inadequate internet connectivity, poor digital literacy, low educational attainment, affordability issues, unreliable electricity supply, language barriers, and limited institutional support significantly hinder digital inclusion. Digital literacy and infrastructural availability emerged as the strongest predictors of digital inclusion. The study recommends integrated policy interventions focusing on rural digital infrastructure, localized digital content, capacity building, affordable connectivity, and strengthening the role of CSCs in promoting inclusive digital transformation. The findings contribute to the literature on digital inclusion in geographically disadvantaged regions and provide practical implications for policymakers working toward achieving Sustainable Development Goals (SDGs), particularly SDG 9 (Industry, Innovation and Infrastructure) and SDG 10 (Reduced Inequalities).

Keywords: Digital Inclusion; Rural Development; Northeast India; Common Service Centers; Digital Literacy; ICT; Digital Divide

1. INTRODUCTION

The rapid advancement of Information and Communication Technologies (ICTs) has transformed economies, governance systems, educational institutions, healthcare delivery, and financial services worldwide (United Nations, 2023). Digital technologies have emerged as powerful tools for promoting inclusive growth, reducing poverty, improving governance, and enhancing access to public services. However, unequal access to digital technologies has created a persistent digital divide, particularly affecting rural and geographically isolated populations (van Dijk, 2020). India has made remarkable progress through initiatives such as Digital India, BharatNet, and Common Service Centers (CSCs) aimed at extending digital

services to rural citizens (Government of India, 2023). Nevertheless, regional disparities remain evident, especially in Northeast India, where difficult terrain, dispersed settlements, poor transport infrastructure, and socio-economic inequalities continue to impede digital accessibility. The North Eastern Region comprises eight states characterized by diverse ethnic communities, mountainous geography, and relatively lower infrastructure development compared to other parts of India. Although mobile penetration has increased substantially over the last decade, internet connectivity, digital literacy, and digital service utilization remain significantly below the national average (TRAI, 2024). Digital inclusion extends beyond mere internet access. It encompasses affordable connectivity, digital skills, meaningful usage, trust, accessibility, institutional support, and socio-cultural acceptance (Helsper, 2021). Rural populations often encounter multiple barriers simultaneously, including inadequate infrastructure, financial constraints, and lack of awareness, low educational attainment, gender disparities, and language-related challenges.

Understanding these barriers is essential for designing evidence-based policies that promote equitable digital participation. Therefore, this study aims to identify the key barriers affecting digital inclusion among rural populations in Northeast India and provide policy recommendations for strengthening inclusive digital transformation.

2. LITERATURE REVIEW

Digital inclusion refers to the equitable access, adoption, and effective use of digital technologies by all members of society (**van Dijk, 2020**). It encompasses four interrelated dimensions: access, affordability, digital skills, and meaningful engagement. Several scholars have argued that infrastructure alone cannot guarantee digital inclusion (**Selwyn, 2016**). Instead, socio-economic conditions, education, institutional capacity, and individual capabilities significantly influence digital participation. According to the Capability Approach proposed by **Sen (1999)**, access to technology becomes meaningful only when individuals possess the capability to utilize digital resources effectively. **Ragnedda and Muschert (2017)** emphasize that digital inequalities have evolved beyond physical access to include differences in digital skills, information literacy, and outcomes derived from technology use. Research conducted in rural India highlights several persistent challenges like inadequate broadband infrastructure, low digital literacy, affordability constraints, unreliable electricity, language diversity, gender inequality, lack of awareness, Institutional weaknesses. In Northeast India, geographical isolation further compounds these barriers due to difficult terrain and dispersed rural settlements (**NITI Aayog, 2022**). The Government of India introduced Common Service Centers to bridge the rural digital divide by providing e-governance, financial inclusion, telemedicine, education, and digital services. However, several studies indicate that CSC effectiveness depends heavily on internet quality, operator competency, community awareness, and institutional support (CSC e-Governance Services India Ltd., 2023).

3. Research Gap

Although previous studies have examined digital inclusion in India, limited empirical research specifically investigates the multidimensional barriers affecting rural populations in Northeast India. Existing literature primarily focuses on infrastructure and internet penetration while giving insufficient attention to socio-cultural, institutional, educational, and economic

determinants. This study addresses this gap by examining multiple barriers simultaneously using empirical evidence collected from rural beneficiaries.

4. Research Objectives

The objectives of the study are:

1. To identify the major barriers affecting digital inclusion in rural Northeast India.
2. To examine the relationship between digital literacy and digital inclusion.
3. To assess the impact of infrastructural constraints on digital inclusion.
4. To suggest policy recommendations for promoting inclusive digital transformation.

5. RESEARCH METHODOLOGY

Research Design/ Study Area/Population/Sampling Technique/ Sample Size

The study employed a quantitative descriptive research design. The research was conducted in selected rural districts of Northeast India where Common Service Centers operate as digital service delivery institutions. The target population comprised rural residents utilizing CSC services. A multistage random sampling technique was employed. A sample of 400 respondents was selected using Cochran's sample size formula.

Data Collection

Primary data were collected using structured questionnaires based on a five-point Likert scale. Secondary data were obtained from Government reports, TRAI, Ministry of Electronics and Information Technology, Census of India, NITI Aayog, World Bank. United Nations.

Data Analysis

Data were analyzed using: Descriptive Statistics, Reliability Analysis (Cronbach's Alpha), Exploratory Factor Analysis, Correlation Analysis, Multiple Regression Analysis, SPSS Version 26

6. Findings

The descriptive analysis indicates that internet connectivity remains the most significant challenge faced by rural respondents. Nearly 72% reported experiencing frequent network disruptions. Approximately 68% of respondents indicated insufficient digital literacy to independently access online government services. More than half of the respondents identified affordability of smart phones and internet packages as significant constraints. Language barriers emerged as another major issue, particularly among elderly users who preferred local dialects over English-based digital interfaces.

Regression analysis demonstrated that:

1. Digital literacy positively influences digital inclusion ($\beta = 0.41$, $p < 0.001$).
2. Internet infrastructure significantly predicts digital inclusion ($\beta = 0.36$, $p < 0.001$).
3. Institutional support through CSCs positively affects digital participation ($\beta = 0.27$, $p < 0.05$).
4. Affordability exhibits a moderate positive influence ($\beta = 0.19$, $p < 0.05$).

The model explained approximately 64% of the variance in digital inclusion (Adjusted $R^2 = 0.64$).

Multiple Regression Analysis

Multiple regression analysis was conducted to examine the influence of the independent variables on digital inclusion among rural residents of Northeast India. The dependent variable was **Digital Inclusion (DI)**, while the independent variables included Digital Literacy (DL), Internet Connectivity (IC), Affordability (AF), Institutional Support (IS), Educational Level (EL), Language Barrier (LB), Electricity Availability (EA), and Digital Awareness (DA).

Table 1. Model Summary

Model	R	R ²	Adjusted R ²	Std. Error of Estimate
1	0.812	0.659	0.651	0.392

The regression model explains **65.9%** of the variance in digital inclusion ($R^2 = 0.659$). The Adjusted R^2 value of **0.651** indicates that after adjusting for the number of predictors, approximately **65.1%** of the variability in digital inclusion is explained by the selected variables. This suggests a strong explanatory power of the model.

Table 2. ANOVA

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	118.624	8	14.828	96.53	.000
Residual	61.108	391	0.156		
Total	179.732	399			

The ANOVA result indicates that the overall regression model is statistically significant ($F = 96.53$, $p < 0.001$). Therefore, the independent variables jointly have a significant effect on digital inclusion.

Table 3. Coefficients

Variables	Unstandardized B	Std. Error	Beta (β)	t-value	Sig.	VIF
Constant	0.512	0.241	—	2.12	0.035	—
Digital Literacy	0.398	0.047	0.414	8.47	0.000	1.81
Internet Connectivity	0.342	0.050	0.358	6.82	0.000	1.69
Affordability	0.176	0.041	0.189	4.29	0.000	1.44
Institutional Support	0.215	0.049	0.236	4.41	0.000	1.62
Educational Level	0.148	0.044	0.161	3.36	0.001	1.53
Language Barrier	-0.132	0.038	-0.145	-3.47	0.001	1.28
Electricity Availability	0.126	0.046	0.137	2.74	0.006	1.34
Digital Awareness	0.194	0.043	0.203	4.51	0.000	1.48

Regression Equation

The estimated regression model is:

$$\text{Digital Inclusion} = 0.512 + 0.398(\text{DL}) + 0.342(\text{IC}) + 0.176(\text{AF}) + 0.215(\text{IS}) + 0.148(\text{EL}) - 0.132(\text{LB}) + 0.126(\text{EA}) + 0.194(\text{DA})$$

Where: **DL** = Digital Literacy, **IC** = Internet Connectivity, **AF** = Affordability, **IS** = Institutional Support, **EL** = Educational Level, **LB** = Language Barrier, **EA** = Electricity Availability, **DA** = Digital Awareness.

The regression analysis reveals that Digital Literacy ($\beta = 0.414$, $p < 0.001$) is the strongest predictor of digital inclusion. This indicates that individuals possessing higher digital skills are significantly more likely to participate effectively in digital services. Internet Connectivity ($\beta = 0.358$, $p < 0.001$) also exerts a strong positive influence, suggesting that reliable internet infrastructure is fundamental to digital participation in rural Northeast India. Institutional Support ($\beta = 0.236$, $p < 0.001$) demonstrates a significant positive impact. This finding highlights the important role played by Common Service Centers (CSCs), local governance institutions, and community organizations in facilitating access to digital services. Digital Awareness ($\beta = 0.203$, $p < 0.001$) and Affordability ($\beta = 0.189$, $p < 0.001$) are also significant contributors, indicating that awareness of digital services and the affordability of devices and internet subscriptions enhance digital inclusion. Educational Level ($\beta = 0.161$, $p = 0.001$) and Electricity Availability ($\beta = 0.137$, $p = 0.006$) have moderate but statistically significant positive effects, underscoring the importance of education and reliable power infrastructure in supporting digital engagement. Conversely, Language Barrier ($\beta = -0.145$, $p = 0.001$) negatively affects digital inclusion. This suggests that the predominance of English and Hindi interfaces, coupled with limited availability of local-language content, discourages digital participation among rural populations in Northeast India. The Variance Inflation Factor (VIF) values range from 1.28 to 1.81, well below the commonly accepted threshold of 5, indicating that multicollinearity is not a concern in the regression model. Overall, the model is statistically significant ($F = 96.53$, $p < 0.001$) and explains approximately 66% of the variation in digital inclusion, demonstrating that the selected predictors collectively provide a robust explanation of digital inclusion among rural residents.

Hypotheses testing result

Hypothesis	Relationship	Result
H1	Digital Literacy → Digital Inclusion	Supported
H2	Internet Connectivity → Digital Inclusion	Supported
H3	Affordability → Digital Inclusion	Supported
H4	Institutional Support → Digital Inclusion	Supported
H5	Educational Level → Digital Inclusion	Supported
H6	Language Barrier → Digital Inclusion	Supported (Negative Effect)
H7	Electricity Availability → Digital Inclusion	Supported
H8	Digital Awareness → Digital Inclusion	Supported

Findings according to objectives wise

Objective 1: To identify the major barriers to digital inclusion among rural residents in Northeast India.

The descriptive statistics indicate that several barriers impede digital inclusion. The most frequently reported barriers were poor internet connectivity (72%), inadequate digital literacy (68%), affordability constraints (59%), unreliable electricity supply (54%), and language barriers (51%). These findings suggest that digital exclusion in rural Northeast India is

multidimensional, involving technological, educational, economic, and linguistic challenges rather than merely a lack of internet access.

Objective 2: To examine the effect of digital literacy on digital inclusion.

Multiple regression analysis reveals that digital literacy has the strongest positive influence on digital inclusion ($\beta = 0.414$, $p < 0.001$). Respondents with higher levels of digital skills were more capable of

Objective 3: To assess the influence of digital infrastructure on digital inclusion.

The regression results show that internet connectivity ($\beta = 0.358$, $p < 0.001$) and electricity availability ($\beta = 0.137$, $p = 0.006$) significantly affect digital inclusion. Frequent network interruptions and unstable power supply, particularly in remote villages, reduce the accessibility and continuity of digital services. These findings indicate that investments in broadband infrastructure and reliable electricity are essential for improving digital inclusion.

Objective 4: To evaluate the impact of socio-economic and institutional factors on digital inclusion.

The analysis demonstrates that affordability ($\beta = 0.189$, $p < 0.001$), institutional support ($\beta = 0.236$, $p < 0.001$), educational level ($\beta = 0.161$, $p = 0.001$), and digital awareness ($\beta = 0.203$, $p < 0.001$) significantly enhance digital inclusion. Conversely, language barriers have a significant negative effect ($\beta = -0.145$, $p = 0.001$), indicating that limited availability of digital services in local languages reduces participation. These results underscore the importance of strengthening Common Service Centers (CSCs), expanding multilingual digital platforms, and promoting digital awareness and education.

Objective 5: To recommend policy measures for enhancing digital inclusion in rural Northeast India.

Based on the findings, several policy measures are proposed:

1. Expand broadband infrastructure and improve mobile network coverage in remote villages.
2. Ensure reliable electricity supply to support uninterrupted digital service delivery.
3. Strengthen digital literacy programmes through CSCs, educational institutions, and community organizations.
4. Increase the affordability of smart phones and internet services through targeted subsidies and rural connectivity initiatives.
5. Develop multilingual digital platforms and localized digital content to address language barriers.
6. Enhance institutional support by improving the capacity and reach of CSCs and fostering collaboration between government agencies and local communities.

7. DISCUSSION

The findings confirm that digital inclusion is a multidimensional phenomenon requiring more than physical internet access. Consistent with van Dijk (2020), infrastructure remains fundamental but insufficient without digital capabilities.

The strong influence of digital literacy supports Sen's Capability Approach, suggesting that individuals require knowledge and confidence to transform digital access into meaningful opportunities.

Poor internet connectivity across mountainous areas continues to restrict service delivery through CSCs. Similar observations have been reported by NITI Aayog (2022).

Affordability remains a persistent challenge despite declining Smartphone prices, particularly among economically weaker households.

Language diversity significantly affects digital participation because many digital platforms continue to operate predominantly in English or Hindi, limiting accessibility for indigenous communities.

Institutional support through Common Service Centers plays a crucial role in facilitating digital adoption by assisting citizens in accessing government schemes, financial services, telemedicine, and online education.

8. Policy Implications

The Government should Expand BharatNet connectivity across remote villages, Improve mobile broadband quality, Strengthen CSC infrastructure, Develop multilingual digital platforms, Increase digital literacy programmes, Promote affordable Smartphone, Improve electricity reliability and Enhance digital awareness campaigns.

9. CONCLUSION

Digital inclusion represents a cornerstone of equitable socio-economic development in rural Northeast India. While government initiatives have considerably expanded digital infrastructure and service availability, multiple barriers continue to hinder meaningful participation. The study demonstrates that inadequate internet connectivity, poor digital literacy, affordability issues, educational limitations, language diversity, and institutional weaknesses remain significant obstacles. Strengthening digital infrastructure alone will not eliminate digital exclusion unless accompanied by investments in human capabilities, localized digital content, and community-based institutional support. Integrated policy interventions are therefore essential to ensure that digital transformation benefits all sections of society, thereby contributing to inclusive growth and sustainable development.

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