

Unpacking the determinants of digital inclusion among women: An empirical evidence from West Bengal, India

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Abstract

Digital access and skills are central to inclusive development and to several Sustainable Development Goals, yet women in India continue to face barriers to digital participation, and evidence at the state level is limited. This study examines the extent and determinants of digital inclusion among women aged 15 to 45 in West Bengal, India, using unit level data from the Comprehensive Annual Modular Survey 2022 to 2023 (79th round of the National Sample Survey), covering 19,203 women. A composite digital inclusion score from 0 to 14 was built from 14 indicators covering high speed internet access, communication and banking use, office and technical skills, digital security, and information verification. Descriptive results show that basic use is far more common than advanced skills: 49.35 percent of women use the internet, 15.90 percent use email, 7.20 percent use digital banking, and 0.24 percent can write programming code, with rural women behind urban women on every indicator. Ordinary least squares estimates with district clustered standard errors show that access to 4G or faster mobile internet, individual and household education, and household expenditure are positively associated with digital inclusion, urban residence has a small positive association, and being married is negatively associated. Caste groups do not differ significantly once these factors are controlled for. These are cross sectional associations, and the index includes high speed internet access as one component. The findings point to infrastructure and education as priority areas for policy.

Keywords: Digital Inclusion, Gender Digital Divide, Determinants of Digital Inclusion, Women, West Bengal, India

JEL Classification: J26, O33, I24

1. Introduction

Development aspects in the twenty first century involve digital access and inclusion for all. Digital access and literacy are strongly acknowledged in the Sustainable Development Goals (SDGs). SDG-4 is about quality education and the promotion of ICT skills for employability and lifelong learning. Moreover, improving Internet access is central to achieving SDG 9 (Industry, Innovation and Infrastructure). These developments should be achieved by all regardless of gender, as outlined in SDG 5 (gender equality). However, women were found to be less likely than men to own a mobile phone in India (Dreze & Sen 2013; UNICEF 2024), and 18% less likely to use the internet (Ministry of Health and Family Welfare, Government of India, 2021). Existing studies on digital access often use the digital divide lens to explain differences in digital access and use between men and women. There is a wide range of frameworks that explain the digital gender divide, including Van Dijk and Hacker (2003), Warschauer (2004), Warnecke (2017), Nath and Barah (2017), and Duvendack et al. (2023), Santra et al. (2025). Van Dijk (2006) argued that digital inclusion is not simply a matter of access to devices but also of usage capabilities, socio-economic background, and institutional support. In the Indian context, the digital divide is both infrastructural and socio-cultural. The GSMA (2022) Mobile Gender Gap Report shows that women in South Asia are significantly less likely than men to own mobile phones or use mobile internet. A gap guided by affordability, literacy, safety concerns, and social norms. However, there is limited literature on the determinants of women's digital inclusion in India. There are a few context-specific studies in the Indian context. Potnis (2011) used Hofstede's cultural dimensions (power distance, masculinity–femininity, uncertainty avoidance, and individualism–collectivism) to study 245 women living in slums in urban and rural Maharashtra, India. They have found that long power distance and collectivism require women to share income and savings with their families for safety and social protection; gender roles require them to bear disproportionate financial responsibility for dependents; and uncertainty avoidance dissuades some from investing in phones despite recognising their benefits. Owing to the economic disadvantages stemming from the above cultural factors, it is challenging for women to earn enough to afford even the least expensive mobile phone handsets. Bala and Singhal (2018) explore the extent of the gender digital divide in Uttar Pradesh, India, focusing on the availability, access time, and use of the internet. The study used a stratified multistage sampling design across six districts (and twelve sub-districts) of Uttar Pradesh. A sample of 591 respondents (297 men, 294 women) was interviewed on ICT availability, time of access and use. The findings point to the persistence of the gender digital divide across almost all study areas, both in the first-order divide (unequal access to computers/internet) and in the second-order divide (unequal usage patterns), with the gap narrowing only in more urbanised areas and widening significantly in less developed rural sub-districts. They have found that patriarchal norms and household responsibilities restrict women from using mobile phones before marriage. Using Household Social Consumption data, Sharma and Banerjee (2022) investigate the first-level digital divide (ownership of a computer and access

to the internet) and the second-level digital divide (an individual's skill to use a computer and the internet) and argue that there exists a large first-level and second-level digital divide between the disadvantaged caste groups and unreserved/general groups in India. Bhallamudi (2022) studied adolescents across high- and low-income classes in Mumbai and found that the intersection of gender and class creates varying standards of 'respectable femininity' and class distinctions that enable or constrain girls' access to mobile phones. Islam and Manchanda (2023) used a face-to-face survey of 735 respondents (368 men, 367 women) aged 18–25 in Delhi (urban) and Uttar Pradesh and Bihar (rural), with the analysis primarily focusing on the intersection of gender and urban/rural location. Results show that, although digital access is widespread (89% use the internet, 63.7% own a smartphone), it is unevenly distributed and household-mediated: women are much less likely to own a smartphone, more likely to share a "household phone" with family members, and use it for fewer daily hours. Anand and Pandey (2025) sought to identify the major determinants of digital adoption among teenagers in a semi-urban district of India and to evaluate the gender gap in these factors. The researchers, using a mixed-methods design, identified three key factors underlying digital adoption: experience of digital training, basic ability to operate computers, and ease of online presence. Basic access to devices was not significantly different by gender, but girls consistently reported less support and skill across these factors, as well as lower phone ownership, less training exposure and greater family-imposed restrictions than boys.

However, a recent comprehensive macro-level study on the determinants of digital inclusion among women in a sub-national context is lacking. Filling this gap is the intended attempt of this paper. Through our study, we will focus on two issues: the nature of digital inclusion and its determinants in the context of West Bengal (a sub-national state of India). The study is motivated by the recognition that improving digital access is a multidimensional developmental imperative with implications for gender parity, innovation capacity, and inclusive economic growth.

2. Methodology

This study uses data from the Comprehensive Annual Modular Survey (CAMS) 2022–23, the 79th round of the National Sample Survey. The National Sample Survey Office conducted this survey from July 2022 to June 2023. CAMS (2022-23) used a two-stage stratified sampling design. The survey covered a total of 3,02,086 households (1,73,096 in rural areas and 1,28,990 in urban areas), and 12,99,988 individuals (7,85,246 in rural areas and 5,14,742 in urban areas) were enumerated. The main purpose of the survey was to estimate national-level indicators of telecom and ICT skills. CAMS includes self-reported information like usage of mobile phones in last 3 months, ownership of mobile phone, use of internet in last 3 months, executing ICT skills like sending messages with attachment, able to use internet, execution of skill of 'copy and paste tools to duplicate or move data, information, documents, etc, send or receive emails, performing online banking transactions in the age group 15–45 years. This age group represents relatively young adult women who have had access to better digital technology than the older population. So, we chose only women aged

15- 45 from West Bengal. The sample size is 19203. In constructing the digital inclusion index, we drew on ideas from the GSMA (2023) report on the digital gap. With the broad dimensions of usage, access, and digital skills in mind, we have created the digital inclusion variable. CAMS data provides self-reported information about digital access and ICT skills. The variables used to create the digital inclusion index are:

1. high-speed (5G/4G) internet availability, 2. able to use email, 3. able to use digital banking, 4. able to copy and paste, 5. able to send SMS, 6. able to use MS Excel 7. able to use a modem, 8. able to use software, 9. Able to create PowerPoint presentations, 10. able to transfer files, 11. able to protect the device via digital security, 12. able to change privacy settings, 13. Able to verify the reliability of information, 14. writing programming code. We derived a comprehensive digital inclusion (CDI) score by summing the parameter scores. The maximum score is 14, and the minimum is 0.

2.1 Nature of Digital Inclusion in West Bengal

The data presented in the table on digital access, usage and skills among women in West Bengal shows a clear and consistent gap between rural and urban populations across almost every measure, which is part of a wider pattern of the urban/rural digital divide that continues in the region's technology adoption. Women have a total Internet usage rate of 49.35 percent, but this number obscures a large rural-urban divide: 43.09 percent and 65.23 percent, respectively. Therefore, women in urban areas are much more likely to have access to the internet and participate in digital platforms than women in rural areas. The discrepancy is even more stark when considering more specific uses of digital technology. Email usage, for instance, is reported at a mere 15.90 percent overall, with rural women at 11.12 per cent, far behind urban women at 28.04 percent. Thus, while basic internet access may be proliferating, the uptake of communication-oriented electronic devices remains substantially more limited. Similarly, digital banking, an increasingly important aspect of financial inclusion, also has an overall adoption rate of only 7.20 percent, with rural women at 4.14 percent and urban women at 14.96 percent, indicating that despite national efforts toward financial digitisation, rural women continue to be largely excluded from formal digital financial services.

Table 1. Digital Access, Usage and Skills among Women aged 15-45 in West Bengal

	Overall (%)	Rural (%)	Urban (%)
Internet use	49.35	43.09	65.23
Email use	15.90	11.12	28.04
Digital Banking	7.20	4.14	14.96

Copy-paste skill	38.27	31.72	54.89
SMS	43.39	36.60	60.61
Excel use	7.10	3.93	15.14
Modem Use	8.10	5.75	14.08
Software use	11.87	9.40	18.16
Powerpoint presentation skill	3.91	1.84	9.16
Transfer files	9.90	7.30	16.50
Digital security	5.21	3.44	9.69
Privacy setting	4.57	3	8.57
Verify online information	4.28	2.64	8.42
Programming code writing skill	0.24	0.09	0.60

Authors' calculation using Comprehensive Annual Modular Survey (CAMS) 2022–23, the 79th round of the National Sample Survey

Basic online literacy skills like ability for cypaste (38.27 percent overall; 31.72 percent rural vs . 54.89 percent urban) and SMS usage (43.39 percent overall; 36.60 percent rural vs. 60.61 percent urban) are comparatively more widespread than advanced online literacy skills, but the rural /urban gap persists at a similar magnitude, indicating that the divide is not confined to complex digital tasks but extends even to elementary forms of digital engagement. More advanced or professional digital skills have even lower levels of penetration and wider relative disparity: Excel use is only 7.10 percent overall (3.93 percent of rural women vs. 15.14 percent of women in urban areas), modem use at 8.10 percent overall (5.75 percent of rural women vs. 14.08 percent of women in urban areas), general software use at 11.87 percent overall (9.40 percent of rural women vs. 18.16 percent of women in urban areas), and PowerPoint presentation skills at an alarmingly low 3.91 percent overall (1.84 percent of rural women vs. 9.16 percent of women in urban areas), collectively suggesting that access to and skills with tools linked to formal employment, education, or professional development remain severely limited, particularly for rural women, and may be a

significant barrier to their participation in the digital economy and knowledge-based jobs. Furthermore, indicators related to digital safety and critical digital literacy, namely digital security awareness, privacy setting management, and the ability to verify online information, are alarmingly low across both rural and urban categories, though rural women again fare considerably worse, raising concerns about their heightened vulnerability to online fraud, misinformation, and privacy breaches given their limited capacity to protect themselves in digital spaces. Finally, the ability to transfer files and, most notably, programming or code-writing skills represent the most advanced end of the digital skills spectrum and show near-negligible penetration among women in West Bengal as a whole, underscoring the near-total absence of technical or computational literacy necessary for participation in higher-skilled digital occupations. These figures illustrate that digital access and skill levels decline progressively as one moves from basic connectivity to more sophisticated applications, with rural women consistently disadvantaged relative to urban women across all indicators, thereby reinforcing existing socio-economic inequalities.

2.2 Determinants of Digital Inclusion

2.2.1 Model Specification

$$CDI_i = \beta_0 + \beta_1 mpce_i + \beta_2 Hh. head. edu_i + \beta_3 education\ level\ of\ the\ individual + \delta_1 location_i + \gamma_j \sum_{j=1}^n caste_{ij} + \alpha_k \sum_{k=1}^n religion_{ik} + \delta_2 Internet\ speed_i + \delta_3 Marital\ status_i + \mu_i \dots\dots\dots 1)$$

i= individual , μ_i = Stochastic error term

In our empirical specification, we treat comprehensive digital inclusion (CDI) as the dependent variable. γ_1 , γ_2 , and γ_3 are the coefficients of caste dummies. We consider the general/unreserved category as the base in the Caste dummy. α_1 , α_2 , and α_3 are the coefficients of religion dummies, and we took Hindu as our base category. δ_1 is the coefficient of the location dummy, and rural is the reference category. We have also included marital status as a dummy variable, with unmarried as the reference category. We have also considered internet speed, as a higher-speed internet connection could have some impact on inclusion. In our model, we create an internet speed dummy variable, with 3G connection treated as the base. As a proxy for income, we used monthly per capita expenditure (MPCE). Further, we incorporated education. We have also used clustered standard errors to adjust for district-level effects.

Table 2. Determinants of Digital Inclusion of the Women aged 15-45 in West Bengal

Dependent variable- CDI	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Religion:							
Ref- Hindu							
Islam	.002	.076	0.03	.979	-.156	.16	
Christian	.004	.112	0.04	.972	-.229	.237	
Other religion	-.444	.203	-2.19	.04	-.865	-.023	**
Caste:							
Ref- General							
ST	-.075	.095	-0.79	.435	-.271	.121	
SC	-.042	.082	-0.52	.61	-.212	.127	
OBC	-.076	.075	-1.01	.322	-.23	.079	
Marital status,							
Ref- Unmarried							
Married	-1.16	.1	-11.58	0	-1.368	-.952	***
Internet speed,							
Ref- 3G connection							
4G & above	2.438	.151	16.14	0	2.125	2.752	***
Location:							
Ref- Rural							
Urban	.131	.063	2.08	.049	0	.262	**
Mpce	0.00002	0	8.24	0	0	0	***

Education of the individual	.168	.016	10.82	0	.136	.201	***
Education level of the household	.041	.007	5.69	0	.026	.056	***
Constant	-.511	.126	-4.05	.001	-.773	-.249	***
Mean dependent var		2.238	SD dependent var			3.067	
R-squared		0.525	Number of obs			19203	
F-test		89.926	Prob > F			0.000	
Akaike crit. (AIC)		83268.648	Bayesian crit. (BIC)			83370.865	
*** $p < .01$, ** $p < .05$, * $p < .1$							

Authors' calculation using Comprehensive Annual Modular Survey (CAMS) 2022–23, the 79th round of the National Sample Survey

3. Result

The results of this study tell a clear story about what shapes digital inclusion. The single most important factor is the quality of internet connection available to a household: people with access to faster, more advanced mobile networks are far more digitally included than those relying on older, slower connections. This shows that having a strong network infrastructure is one of the key factors in bridging the digital divide. Education also plays a major role for both individuals and the household as a whole. More educated people, and those who live in more educated households, tend to be more digitally included, showing how learning and technology use go hand in hand. Where people live also matters, as those in cities tend to have slightly better digital access than those in rural areas, reflecting that cities generally have better infrastructure and services. Household income also matters, as families with more financial resources are somewhat more likely to be digitally included, though the effect is small. Interestingly, being married appears to reduce digital inclusion, possibly because married individuals have more household duties or different priorities that leave less room for technology use. Religion does not appear to have a strong effect on digital inclusion, except among people in other religious groups, who show slightly lower levels of inclusion. Perhaps the most notable finding is that caste does not appear to

matter once education, income, and access to good networks are taken into account. Our result indicates that in today's context, digital inclusion is shaped more by practical factors such as education, infrastructure, and money than by traditional social categories such as caste.

4. Conclusion

In this article, we have explored the nature of digital inclusion among women and its determinants. Using CAMS NSSO unit-level data for West Bengal (a sub-national state of India), we have found that basic digital skills and usage are widespread, but advanced technical skills remain underdeveloped. The data reveal an inverse relationship between application complexity and digital engagement among women. Urban cohorts consistently outperform rural cohorts across both infrastructural access and technical competence, reinforcing broader patterns of gendered and spatial marginalisation. Next, our regression analysis shows that Digital inclusion is primarily driven by practical factors, most notably access to high-speed mobile infrastructure and higher educational attainment, alongside minor urban and income advantages. Conversely, traditional social stratifications such as caste exert no significant effect once these structural and socioeconomic variables are controlled for.

Acknowledgement: The authors are recipient of Indian Council of Social Science sponsored collaborative research project. The article is largely an outcome of their research work sponsored by ICSSR. However, the responsibility for the facts stated, opinions expressed and the conclusions drawn is entirely that of the authors.

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