Digital Payment Barriers and Exclusion among Tribal Households in Bargarh, Odisha

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Received:Oct 02, 2026 Accepted:Oct 30, 2026 Published:Oct 30, 2026

Abstract

The use of digital payments expands access to financial services, but living individuals may not be able to cross the divide from access to use. This study examines potential patterns of digital payment access, use, and exclusion in the context of tribal households in Bargarh, Odisha. This study uses a simulation based exploratory approach rather than primary field data. A synthetic dataset of three hundred household records was generated for the analysis. A simulation seed created 42 variables used to construct households and their characteristics. After constructing the simulated households, digital payment and barrier related variables were generated for analysis. Descriptive data, hypothesis tests, and regression analysis were performed. Logistic regression was used to identify barriers to digital payment transactions for households. Within the simulated dataset, 87% of households had bank accounts, 63% had independent access to smartphones, 73% made a digital payment within the 90-day time period, and 25% were excluded from transactions because of barriers. Barriers depended on having an independent smartphone. The language interface was more difficult to use, and households were more likely to be excluded as a result. The simulations used implies that the results are specific to the Bargarh area and need to be verified.

Keywords: digital payments; financial inclusion; tribal households; digital literacy; Odisha

1. Introduction and Literature Context

India's payment systems have developed quickly due to interoperable frameworks, improved digital public facilities, banking systems, and regulations. The Reserve Bank of India (2024) indicated that its Digital Payments Index reached 445.5 in March 2024 and identified UPI, payment infrastructure, consumer awareness, and digitally enabled districts as key components

of the national transition. The National Payments Corporation of India (2024) noted the large scale and continuing product diversification of UPI in 2023-24. Expanding digital payments, however, does not guarantee households can use digital payment services independently.

The use of digital payments also must be distinguished from the ownership of accounts. The Global Findex 2021 noted that 78% of Indian adults had an account, whereas digital payment use was still low and rural usage was less than urban usage, and was also significantly low (Demirguc-Kunt et al., 2022). The Reserve Bank of India (2020) also demonstrated that the priority of India's financial inclusion policy is also on account access, usage, literacy, affordability, and consumer protection. Trust along with available resources, technology, digital adoption, and ease of use are some of the main challenges to digital inclusion (Asif et al., 2023; Nandru et al. 2024; Parvathy & Kumar, 2022; Vyas & Jain, 2021). Furthermore, digital inclusion should be concerned with both service capability and design (Malladi et al., 2021).

For socially and geographically marginalized populations, the digital divide can include devices, Internet access, language, education, support, and confidence. Infrastructure and social inequities can join to further worsen digital inequity. This is evident in the research done with tribal youth in rural Jharkhand (Nayak & Alam, 2022). Similar research done with the financially excluded, migrant workers, emphasizes the need for accessible, trustworthy, and secure design, along with supporting interfaces for vulnerable users (Ravishankar et al., 2023). Government planning documents discuss the Scheduled Tribe development and include context specific to Bargarh tribal regions (Ministry of Tribal Affairs, 2025; Government of Odisha, Department of Water Resources, 2022).

As a result, this paper differentiates between many of those components like bank-account ownership, access to a smartphone and other devices, the ability to pay, use of payment systems, barriers to payment system use, and how certain individuals and groups are systematically disenfranchised and prevented from using payment systems. The use of cash or the absence of using digital systems is not considered absolute exclusion. The research questions are: What types of use and barriers do we see in the simulated dataset? What different types of exclusion do we see across the households? What factors do we see associated with exclusion after adjustments? The approach for addressing these research questions is the generating of audit-worthy mechanisms to analyze exclusion.

2. Methodology

The analysis is based on 300 simulated household records. Field interviews and observations were not done. Household records were created with NumPy and random seed 42. Assumptions were made to capture diversity and did not aim to fit the demographics of Bargarh. Household records were restricted to have adult informants and no household member could have more than 16 years of education. The household records also had right-skewed monthly income. Bank ownership and smartphone access were generated probabilistically. Network reliability was measured on a 5-point Likert scale. The other two measures were also evaluated on a similar scale, although one measured the challenge of language interfaces and the other measured the trust of digital payments.

Digital literacy was composed of five capability items: app navigation, PIN management, QR payment, resolution of errors in transactions, and identifying cues of fraud. Each item was scored as 0Unable, 1Able with help, or 2 Able independently. The sum of these items yielded a score of 0 to 10 and had a Cronbach's alpha of 0.903. Independent payment ability required an account, smartphone access, and digital payment literacy. Digital payment use was defined as at least one successful payment in the preceding 90 days. Payment frequency was measured separately as the number of successful payments in the preceding 30 days.

The absence of one or more successful payments needed to conduct digitally the activities of daily living defined barrier-related exclusions. It was generated from the preset predictors and a random variation. It should not be equated with payment use. A household could make payments but still be barred from conducting one or more needed transactions. There were eight multiple response indicators: device access, unreliable network, limited ability, difficulty in language, authentication, transaction costs, lack of help, and fraud.

Counts, percentages, and means (or standard deviations for approximately symmetric distributions, and medians with interquartile ranges for skewed and ordinal measures) were used to describe the data. Chi-square tests were conducted where the expected counts were sufficient. Mann-Whitney tests were conducted to compare the measures with bounded or skewed distributions. These effects were expressed as phi or rank-biserial correlations. A pre-specified binary logistic regression was conducted to analyze the impact of independent smartphone access, digital literacy, the reliability of networks, the difficulty caused by language-interfaces, education, and distance to banking support. Adjusted odds ratios, 95%

confidence intervals, and p values were obtained. Collinearity and separation were not problems, and the model converged. Parameters refer to the simulations only.

3. Results and Statistical Analysis

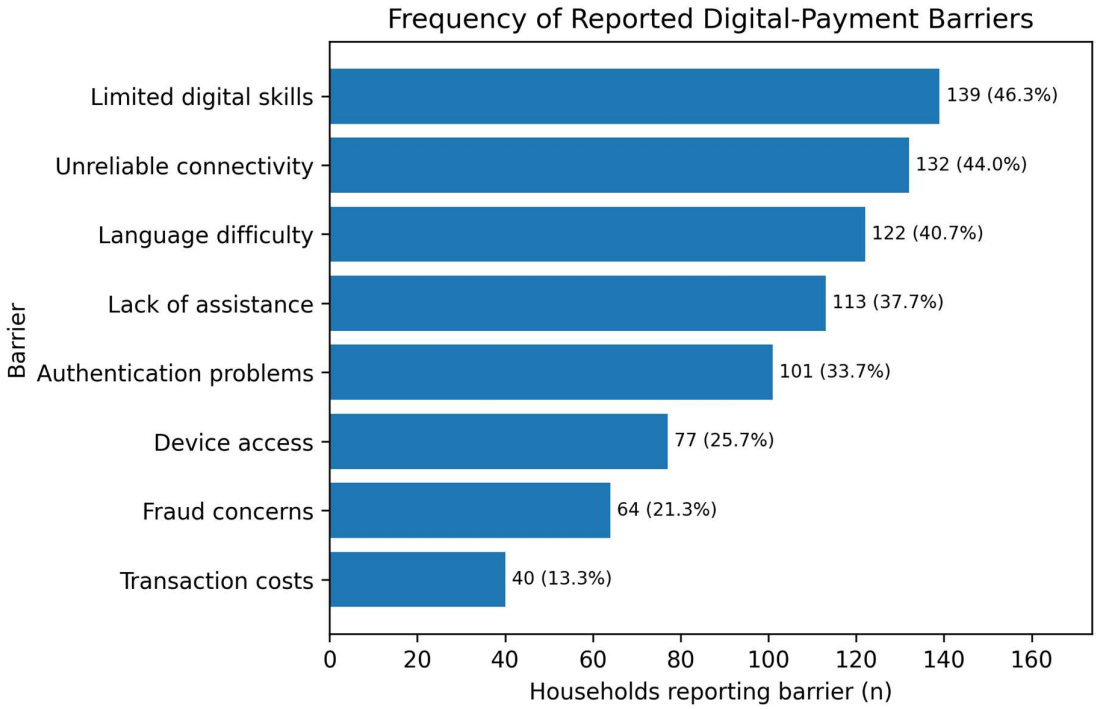
Table 1. Characteristics of the Simulated Household Dataset

Characteristic	Simulated result
Age, years	39.5 mean; SD 11.8
Gender	Woman 145 (48.3%); Man 155 (51.7%)
Education, years	Median 7; IQR 4-9
Monthly household income, INR	Median 15,750; IQR 10,975-21,550
Bank-account ownership	261 (87.0%)
Independent smartphone access	188 (62.7%)
Independent digital-payment ability	130 (43.3%)
Network reliability, 1-5	Median 3; IQR 2-4
Digital literacy, 0-10	6.44 mean; SD 3.37
Language-interface difficulty, 1-5	Median 2; IQR 1-3
Distance to banking support, km	Median 3.9; IQR 2.2-5.8
Digital-payment trust, 1-5	Median 4; IQR 3-5
Prior suspected fraud experience	42 (14.0%)
Digital-payment use, preceding 90 days	220 (73.3%)
Payment frequency, preceding 30 days	Median 5; IQR 0-9
Barrier-related exclusion	74 (24.7%)

Source: Author-generated simulated dataset; calculations from the accompanying analysis code.

Table 1 separates financial access from practical capability. Within the simulated sample, 261 (87%) households held accounts, but only 188 (62.7%) households had autonomous smartphone access, and only 130 (43.3%) households met the standard of independent digital-payment capability. This indicates that having a bank account did not necessarily translate into the ability to make digital payments independently. Some households that did not meet the criteria for independent payment capability could still make payments with assistance, as permitted by the simulation framework. Of the sample households, the median payment transaction frequency was 5, including transactions of zero frequency, and 74 households were classified as excluded from at least one transaction.These figures are based on simulated data and predefined assumptions and should not be interpreted as observed or representative measures for households in Bargarh district.

Figure 1. Frequency of Reported Digital-Payment Barriers



Source: Author-generated simulated dataset; calculations from the accompanying analysis code. Multiple responses were allowed; denominator N=300.

Figure 1 shows that limited digital skills was the most frequent simulated barrier, reported by 139 households, followed by unreliable connectivity at 132, language difficulty at 122, and lack of assistance at 113. Authentication problems affected 101 records, device access 77, fraud concerns 64, and transaction costs 40. Multiple responses allow barriers to overlap rather than forcing one category.

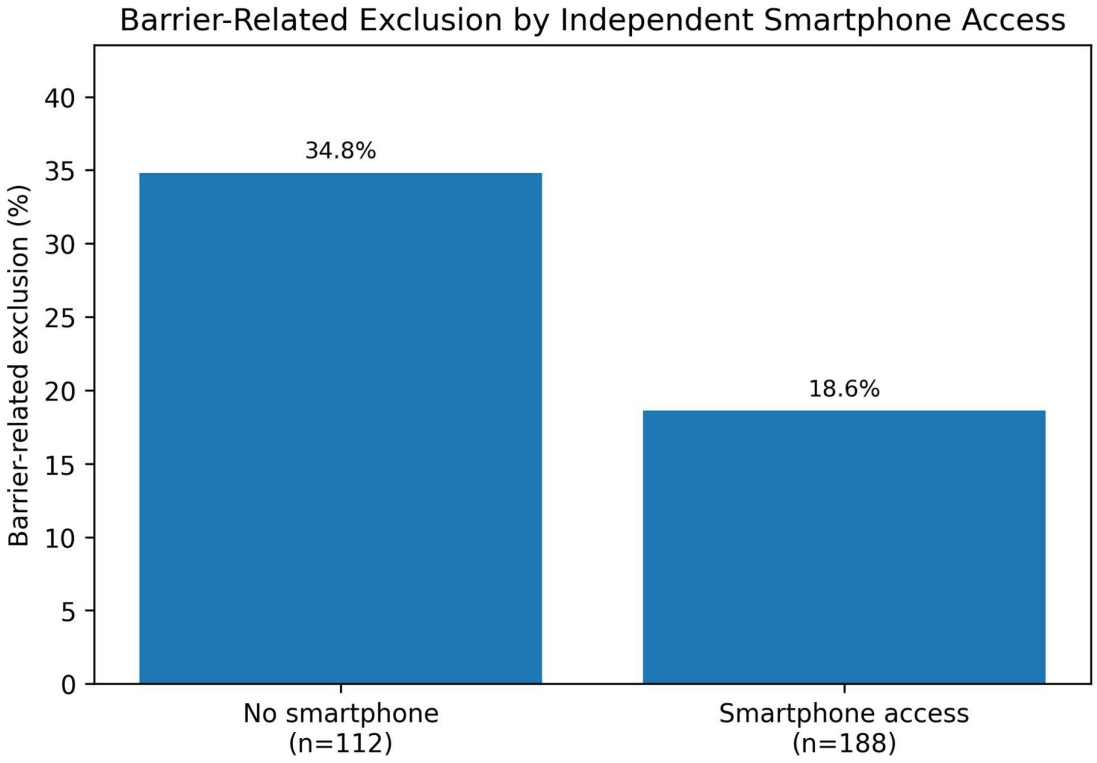
Table 2. Digital-Payment Participation, Exclusion, and Selected Group Comparisons

Comparison	Group results	Test	Effect size
Payment use by smartphone access	No 57/112 (50.9%); Yes 163/188 (86.7%)	chi-square 44.21; p<.001	phi 0.384
Exclusion by smartphone access	No 39/112 (34.8%); Yes 35/188 (18.6%)	chi-square 9.07; p=.003	phi 0.174
Digital literacy by exclusion	Excluded mean 5.11; not excluded 6.87	Mann-Whitney U=5894; p<.001	rank-biserial 0.295
Language difficulty by exclusion	Excluded median 3; not excluded 2	Mann-Whitney U=10662.5; p<.001	rank-biserial 0.275
Network reliability by exclusion	Excluded median 2.5; not excluded 3	Mann-Whitney U=6723.5; p=.009	rank-biserial 0.196

Source: Author-generated simulated dataset; calculations from the accompanying analysis code.

Table 2 indicates substantial separation between access and outcomes. Successful payment use was 86.7% among records with independent smartphone access compared with 50.9% among those without access; the association was strong within this simulation. Barrier-related exclusion was 18.6% with smartphone access and 34.8% without it. Excluded records also had lower digital-literacy scores, greater language difficulty, and lower network reliability. These bivariate differences do not establish causation.

Figure 2. Barrier-Related Exclusion by Independent Smartphone Access



Source: Author-generated simulated dataset; calculations from the accompanying analysis code.

Figure 2 Compares exclusion rates based on access to a smartphone. Includes a sample group size for each. This example shows how it is important to separate the device ownership and measuring instruments. 35 households with independent smartphone access were still classified as excluded, showing that having a device does not eliminate challenges related to language, network, authentication, assistance, skills or trust.

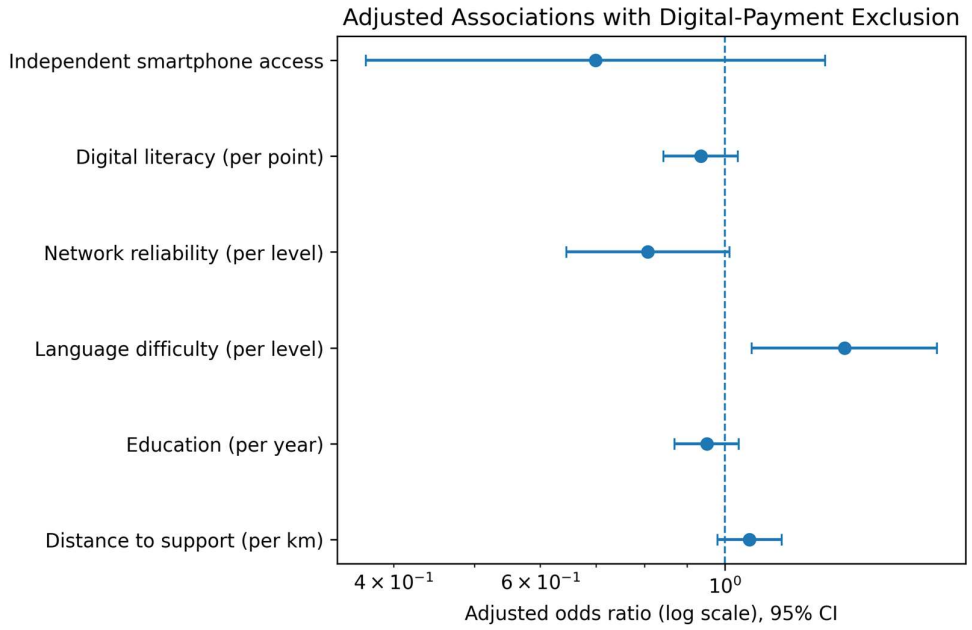
Table 3. Logistic Regression Results for Barrier-Related Digital-Payment Exclusion

Predictor	Adjusted OR	95% CI	p
Independent smartphone access	0.70	0.37-1.32	.268
Digital literacy, per point	0.93	0.84-1.04	.199
Network reliability, per level	0.81	0.64-1.01	.063
Language difficulty, per level	1.39	1.08-1.80	.012
Education, per year	0.95	0.87-1.04	.262
Distance to support, per km	1.07	0.98-1.17	.136

Source: Author-generated simulated dataset; calculations from the accompanying analysis code.

After adjusting variables, the difficulty of user interactions with the language retains a positive association with exclusion. With each level of increase, we may expect an adjusted odds ratio of 1.39 (95% CI 1.08-1.80, p=.012). Of the other variables, network reliability showed a protective, but unclear, direction, with an adjusted odds ratio of 0.81 (CI including one).Smartphone access, digital literacy, education, and distance to support showed associations in the estimated direction, but the confidence intervals included one and the evidence was uncertain. The model's pseudo-R-squared was 0.102 and indicated a simplified exploratory specification.

Figure 3. Adjusted Associations with Digital-Payment Exclusion



Source: Author-generated simulated dataset; calculations from the accompanying analysis code.

Figure 3 presents adjusted odds ratios on a logarithmic scale with 95% confidence intervals and a reference line at one. Only language-interface difficulty had an interval wholly above one. Statistical significance was not used to alter the generated dataset, and nonsignificant associations were retained because all six predictors were prespecified before model estimation.

4. Discussion

This simulation demonstrates how rapid growth in national payments should not justify pervasive functional inclusion. RBI policies combine access, use, quality, literacy, consumer protection and payment systems, and infrastructures. The RBI's 2024-25 Annual Report noted the expansion of digitally enabled districts and financial literacy infrastructure. In addition, the RBI Payment Index for September 2024 showed further growth, with the digital infrastructure continuing to be deployed (Reserve Bank of India, 2025a, 2025b). The Findex and Indian studies show that socio-economic status and the availability of technology impact usage. The simulation has defined the operationalized differences.

The most adjusted pattern in the dataset is the complexity of the language-interface. This indicator should not be interpreted as evidence about the actual Bargarh population, but rather as a potential mechanism that requires validation through field research. Indian studies on the adoption of technology focus more on Behavioral Acceptance and usability (Asif et al., 2023; Vyas & Jain, 2021), while studies on the digital divide of tribal communities focus more on the conjunction of inequalities (Nayak & Alam, 2022). Assisted transactions, Use-Case Interfaces, and multimodal systems require more study.

In both practice and theory, connectivity and capability have similar levels of importance. As indicated in Figure 1, most of the barriers were attributed to unreliable connectivity and user digital skills. As indicated in Table 2, the recordings that were excluded were of low reliability and literacy. Digital infrastructure policy is composed of digitally-enabled buildings, acceptance infrastructures, and innovative offline solutions (Reserve Bank of India, 2024). Similar to other authors, Parvathy and Kumar (2022) additionally assert that the technology-centered financial ecosystem creates an inclusion problem due to poor access. For the other authors, Malladi et al. (2021), inclusion in a digital space will depend more on developing solutions to close the divide in digital capability, as opposed to digital availability.

Taking a technology-oriented solution and the adoption of digital systems will include user exposure to automated authenticators, resolver systems, and disputes, as well as fraud. A secure

and inclusive payment system is a sustainability goal that NPCI (National Payments Corporation of India, 2024) fulfills, and Ravishankar et al. (2023) describe a System of Assistance for vulnerable users that fulfills a trust need. User-centered interventions, such as fraud-awareness training, local assistants, practice provision, and grievance pathways, can be tested in the field.

There are many limitations. For one, the dataset was constructed and assumed random relationships, whereas buyer acceptance, sampling, observation, interviews, administrative data were neglected. Additionally, regression analysis was done without considering disability, household headship, merchant acceptance, electricity, logic behind the transactions, and the preference for communicating in a specific language. The cross sections do not express causal relationships and the literacy scale was assesses within the simulated dataset and should not be viewed as validated measure based on responses from the users. The next phase of the work should include preregistering the measures of the constructs of interest and more legitimate ways to select respondents. Also, an integration of published quantitative studies and qualitative transaction accounts should be prioritized.

5. Conclusion

This study presents an innovative methodology to distinguish formal access from substantive participation in digital payments. The analysis of 300 simulated records shows that bank account ownership does not necessarily translate into independent smartphone access and digital payment capability in the presence of barriers. Regressions and group comparisons focused on access to devices, networks, issues with literacy and language, distance and education. The simulated data do not provide evidence of discrimination against tribal households in Bargarh, as the dataset does not represent actual observed households. The validation process should include assisted transactions, authentication failures, acceptability of merchants, support availability, and preferred language of the interface. Formulation of evidence-based policy should incorporate a combination of actions, first hand field data, and evidence gained through careful and ethically informed sampling, along with flexibility to accommodate adoption to local languages.

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