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Innovativeness, Technostress, Trust, and Perceived Risk in Digital Banking Adoption: An Extended TAM Study in a Chinese Ethnic Minority Region

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Abstract. Digital financial inclusion in ethnic minority regions of China depends not only on physical access to digital infrastructure but also on a second layer of barriers tied to user skills, trust, and the cognitive and affective costs of interacting with digital service systems. This study examines the antecedents of digital banking adoption intention among residents of Ganzi Tibetan Autonomous Prefecture, an under-served ethnic minority area where infrastructure expansion has outpaced uptake, by extending the Technology Acceptance Model (TAM) with Technostress, Perceived Risk, Innovativeness, and Trust. Survey data from 394 residents, collected through multi-stage sampling and enumerator-assisted administration in Mandarin and Tibetan, were analyzed using partial least squares structural equation modeling (PLS-SEM). Perceived Usefulness mediated the effects of Innovativeness, Technostress, and Perceived Ease of Use on Intention to Use Digital Banking; Perceived Risk negatively moderated the Perceived Usefulness–Intention relationship; and Trust emerged as one of the strongest direct predictors. The study offers *context-specific empirical insights* rather than a universal model, suggesting that in financially excluded, culturally distinct settings adoption is shaped as much by community-mediated trust, affective responses to interface design, and culturally embedded risk perception as by rational utility evaluation. The findings carry direct implications for the design and operation of digital banking service systems—including transaction-flow simplification, trust-leveraging onboarding, language-localized customer support, and community-mediated service-delivery channels—for institutions serving ethnic minority populations.

Keywords: digital banking adoption, second-order digital divide, technology acceptance, technostress, trust, perceived risk, ethnic minority communities, digital service systems

1. Introduction

Digital banking has emerged as a pivotal instrument for financial inclusion globally and a central concern for service-system design in emerging markets (Arner et al., 2020; Demirgüç-Kunt et al., 2022). In China, more than a decade of state-led policy—from the 13th Five-Year Plan for National Informatization through the FinTech Development Plan (2022–2025) (People's Bank of China, 2022)—has expanded mobile network coverage and physical banking infrastructure to remote western regions. Yet adoption among ethnic minority residents of western autonomous prefectures has lagged the pace of access expansion, generating an implementation gap in which first-order access barriers are being actively closed while behavioral uptake continues to trail policy investment. This gap is not adequately explained by dominant technology acceptance frameworks, which assume that users bring stable cognitive, linguistic, and material resources to their evaluation of novel digital systems.

Ganzi Tibetan Autonomous Prefecture in Sichuan Province is a theoretically significant case of this implementation gap. Located on the southeastern edge of the Qinghai–Tibet Plateau at an average elevation above 3,500 meters, Ganzi is home to approximately 1.2 million residents, of whom Tibetans account for 82.3% (Ganzi Bureau of Statistics, 2023). Banking outlet density in the prefecture is well below the national average, and network coverage in high-altitude pastoral zones remains uneven. The Sichuan Rural Commercial Bank (SCRB) mobile application—the primary digital banking platform serving this region—faces a persistent adoption gap despite substantial institutional investment, constrained by limited digital literacy, culturally embedded risk perceptions, and acute technostress arising from interface complexity and infrastructural fragility.

Dominant technology adoption frameworks, notably Davis's (1989) Technology Acceptance Model (TAM) and Venkatesh et al.'s (2003) Unified Theory of Acceptance and Use of Technology (UTAUT), have yielded robust explanatory power in economically advanced, digitally literate populations. The communities most urgently targeted by digital financial inclusion policy—ethnic minorities in remote regions who lack prior banking experience, face linguistic barriers in financial interfaces, and navigate compounding material constraints—are precisely those for whom these frameworks produce the least reliable predictions (Alalwan et al., 2017). Previous research has examined first-order access barriers in detail, but few studies analyze how second-order factors—trust, technostress, and perceived risk—interact to influence adoption intention in ethnic minority regions, and fewer still position these factors in relation to the service-system processes (onboarding, transaction flows, customer support, information flows) through which digital banking is actually delivered.

Three specific research gaps follow from this overall absence. First, the psychological and affective dimensions of adoption in digitally underserved ethnic minority communities—particularly the inhibiting role of technostress arising from interface complexity, linguistic mismatch, and infrastructural fragility—have received limited empirical attention within the IT adoption literature (Tarafdar et al., 2019). Second, Perceived Risk has typically been treated as a direct predictor of intention, yet its moderating function on the utility–intention relationship has rarely been examined as a boundary condition in rural, resource-constrained adoption contexts (Featherman & Pavlou, 2003). Third, the role of community-mediated institutional trust in adoption—where confidence in a digital system derives not from direct system experience but from collective social validation through kinship and religious networks—has not been theorized or tested in ethnic minority digital inclusion contexts. The convergence of these three gaps in a single underserved community context makes Ganzi a site of theoretical leverage for extending technology acceptance research in directions relevant to digital banking service-system design.

This study addresses these gaps by extending TAM as a measurement instrument, with Innovativeness, Technostress, Perceived Ease of Use, and Trust as antecedents, Perceived Usefulness as a mediating mechanism, and Perceived Risk as both a direct deterrent and a contextual moderator of Intention to Use Digital Banking. The model is estimated using PLS-SEM with data from 394 residents

of Ganzi Tibetan Autonomous Prefecture. Three specific empirical contributions follow: (i) the first quantitative examination of technostress within an extended TAM applied to digital banking in a Chinese ethnic minority context; (ii) the reconceptualization of Perceived Risk as a moderating boundary condition on the Perceived Usefulness–Intention link; and (iii) the demonstration that Trust functions as one of the strongest direct predictors of adoption intention in this context. These contributions are positioned as context-specific empirical findings with conceptual implications for service-system design, rather than as general extensions of the underlying theory.

2. Theoretical Background and Hypotheses Development

This study integrates two complementary theoretical perspectives. The Technology Acceptance Model (TAM; Davis, 1989) provides the core explanatory architecture, proposing that Perceived Ease of Use and Perceived Usefulness jointly determine behavioral intention to use a technology, with Perceived Ease of Use also shaping Perceived Usefulness through a usability heuristic. TAM's parsimony and adaptability make it the most widely applied framework in technology acceptance research, and its central proposition—that cognitive evaluations of effort and value mediate the translation of system characteristics into behavioral intention—remains empirically robust across diverse domains (Venkatesh & Davis, 2000). However, standard TAM does not accommodate dispositional antecedents, negative affective states, or contextual risk factors, all of which are necessary to explain adoption in Ganzi's distinctive setting.

Diffusion of Innovations Theory (DOI; Rogers, 2003) supplements TAM by situating individual Innovativeness within a broader socio-technical adoption process. DOI conceptualizes innovators as individuals who actively seek information about novel technologies, tolerate uncertainty, and adopt ahead of social validation—characteristics that may differentially predict early digital banking adoption in communities where digital financial services are nascent and peer experience is limited. By incorporating Innovativeness as a dispositional antecedent that shapes both direct adoption intentions and perceptions of utility, the present framework bridges individual psychology and the cognitive evaluations central to TAM (Agarwal & Prasad, 1998; Goldsmith & Hofacker, 1991).

These perspectives generate a unified analytical proposition: digital banking adoption in ethnically distinct, resource-constrained communities is a psychologically layered process in which dispositional facilitators (Innovativeness), cognitive facilitators (Perceived Ease of Use), institutional anchors (Trust), and negative psychological states (Technostress) jointly shape Perceived Usefulness as a mediating mechanism, while Perceived Risk functions as a contextual boundary condition that modulates whether perceived utility translates into behavioral intention. The framework yields ten testable hypotheses, depicted in Figure 1 at the end of this section.

2.1. Innovativeness and Digital Banking Adoption

Innovativeness refers to an individual's dispositional tendency to adopt new technologies voluntarily and at an early stage relative to peers, without being primarily driven by external social pressure (Goldsmith & Hofacker, 1991). In digital banking contexts, Innovativeness operates through two pathways. Highly innovative users derive intrinsic value from engaging with novel technological features, generating a direct positive influence on adoption intention independent of utility assessments. Simultaneously, innovative dispositions shape cognitive evaluations of new technologies: users predisposed toward novelty are more likely to perceive a digital banking application as useful because they approach new systems with curiosity and forward orientation rather than anxiety (Agarwal & Prasad, 1998). In Ganzi, where the SCRB application represents a genuinely novel financial instrument for many residents, Innovativeness may determine whether residents perceive digital banking as an opportunity for economic inclusion or as an unwelcome intrusion into habitual financial practices.

H1: Innovativeness positively influences Intention to Use Digital Banking.

H4: Perceived Usefulness mediates the relationship between Innovativeness and Intention to Use Digital Banking.

2.2. Technostress and Digital Banking Adoption

Technostress is defined as the negative psychological state arising when the demands of using a specific technology surpass an individual's perceived coping resources (Tarafdar et al., 2019). In the context of the SCRB application in Ganzi, Technostress is manifested through interface complexity, fear of irreversible transaction errors, cognitive overload from learning new digital security protocols, and anxiety induced by unstable network connectivity. From a human-centered design perspective, each of these stressors reflects a failure of alignment between the system's assumptions about its user and the actual cognitive, linguistic, and material conditions of Ganzi residents—a manifestation of what Norman (2013) terms the gulf of execution. Technostress is thus the affective signature of a design–reality gap (Heeks, 2002) operationalized through that gulf: the application's embedded assumptions about literacy, language, device familiarity, and network stability diverge systematically from the conditions in which Ganzi residents actually encounter it. Technostress operates through two pathways: it directly suppresses adoption intention through an avoidance mechanism, and it indirectly diminishes intention by impairing the cognitive capacity needed to evaluate technological benefits, thereby eroding Perceived Usefulness (Ragu-Nathan et al., 2008).

H2: Technostress negatively influences Intention to Use Digital Banking.

H5: Perceived Usefulness mediates the relationship between Technostress and Intention to Use Digital Banking.

2.3. Perceived Ease of Use and Digital Banking Adoption

Perceived Ease of Use is defined as the degree to which an individual believes that using a particular system will be free of effort (Davis, 1989). In digital banking, Perceived Ease of Use reduces cognitive load, lowers entry barriers, and fosters user confidence, particularly among populations with limited digital literacy. Its influence operates through two channels: a direct path, wherein effortless systems are intrinsically preferred, and an indirect path through Perceived Usefulness via the ease-of-use heuristic, wherein users infer utility from perceived usability (Venkatesh & Davis, 2000). This dual-pathway dynamic is especially pertinent in Ganzi, where Tibetan–Mandarin interface mismatches and limited prior smartphone exposure may amplify perceptions of complexity. Recent JLISS work on digital banking in developing-market contexts has likewise identified ease of use as a robust direct predictor of adoption intention (Kurniawan et al., 2024).

H3: Perceived Ease of Use positively influences Intention to Use Digital Banking.

H6: Perceived Usefulness mediates the relationship between Perceived Ease of Use and Intention to Use Digital Banking.

2.4. Perceived Usefulness and Intention to Use

Perceived Usefulness represents the degree to which an individual believes that using a system will enhance their performance (Davis, 1989) and serves as the primary cognitive mediator in the extended TAM framework. Perceived Usefulness aggregates the inputs of dispositional, usability, and affective antecedents into a unified belief about functional value, which then directly drives behavioral intention. Even when antecedent conditions are favorable, adoption is unlikely if residents do not perceive the SCRB application as genuinely useful for their specific financial activities, such as transferring money to family members in distant counties, paying for livestock supplies, or accessing government pension disbursements. The direct effect of Perceived Usefulness on Intention to Use is one of the most consistently replicated findings in TAM research across diverse cultural and technological contexts (Venkatesh & Davis, 2000; Kurniawan et al., 2024).

H7: Perceived Usefulness positively influences Intention to Use Digital Banking.

2.5. Trust and Digital Banking Adoption

Trust in digital banking refers to the user's subjective belief that the digital banking platform and its underlying institution are reliable, benevolent, and capable of protecting financial interests and personal information (McKnight et al., 2002). In Ganzi, Trust operates as a hybrid construct blending institution-based confidence in SCRB's regulatory compliance with community-mediated trust rooted in kinship networks and local social institutions. Consistent with trust-transfer logic, the deep-seated trust that Ganzi residents hold for physical SCRB branches is expected to serve as a heuristic for evaluating the digital platform (McKnight et al., 2002). When Trust is established, it provides the psychological safety necessary for users in high-uncertainty environments to commit to the platform, overriding the caution characteristic of Tibetan communities' approach to novel financial instruments.

H8: Trust positively influences Intention to Use Digital Banking.

2.6. Perceived Risk as Direct Deterrent and Moderator

Perceived Risk encompasses concerns about financial loss, privacy violation, performance failure, and psychological discomfort associated with digital banking use (Featherman & Pavlou, 2003). In Ganzi, where digital fraud rumors can propagate rapidly through tightly knit community networks and where the irreversibility of digital errors is acutely feared, Perceived Risk is expected to function dually. As a direct antecedent, high Perceived Risk independently vetoes adoption by activating loss-aversion heuristics that override utility assessments. As a moderator, elevated Perceived Risk attenuates the translation of Perceived Usefulness into behavioral intention: users who acknowledge the functional benefits of the SCRB application but simultaneously fear financial loss or data exposure may find that risk perceptions suppress the positive effect of usefulness beliefs. This moderation mechanism is consistent with the privacy calculus framework, wherein benefits must disproportionately outweigh risks before high-risk-perceiving individuals commit to adoption (Featherman & Pavlou, 2003).

H9: Perceived Risk negatively moderates the relationship between Perceived Usefulness and Intention to Use Digital Banking, such that the positive effect of Perceived Usefulness weakens as Perceived Risk increases.

H10: Perceived Risk negatively influences Intention to Use Digital Banking.

Figure 1 summarizes the proposed conceptual framework. The four antecedents (Innovativeness, Technostress, Perceived Ease of Use, and Trust) exert both direct effects on Intention to Use Digital Banking and indirect effects through Perceived Usefulness, which serves as the central cognitive mediator. Perceived Risk operates as both a direct deterrent and a negative moderator of the Perceived Usefulness–Intention relationship, with the dashed arrow representing the moderation pathway.

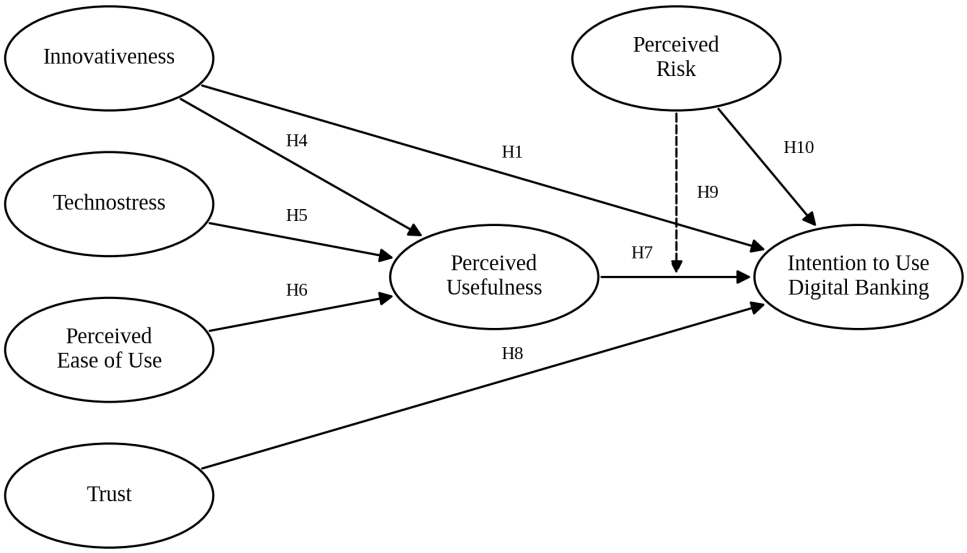

Fig. 1: Conceptual Framework

3. Method

3.1. Participants and Sampling

A multi-stage sampling strategy was employed to ensure proportional representation across Ganzi's eighteen counties, with stages defined by county population size and digital infrastructure tier. The target population comprised permanent residents aged 18 and above who owned smartphones—the prerequisite hardware for SCRB application use—with particular attention to farmers, herders, small business owners, and middle-aged and elderly individuals aged 45 and above, who constitute the primary underserved population for digital financial inclusion in the prefecture. Because smartphone ownership was a screening prerequisite, the sample is likely to underrepresent the most digitally excluded residents, and the reported effects of Technostress and limited digital literacy therefore represent conservative estimates of the barriers operating in the broader Ganzi population.

A total of 500 questionnaires were distributed as an online survey via the Wenjuanxing platform (Changsha Ranxing Information Technology Co., Ltd., Hunan, China) between March and June 2025. The survey was available in both Mandarin and Tibetan; respondents selected their preferred language at the start of the questionnaire and self-completed on their own smartphones. Eligibility screening questions—covering residency in Ganzi, age (18+), and smartphone ownership—were embedded at the beginning of the survey, and respondents failing any screen were automatically routed out. Of the 421 returned questionnaires (84.2% return rate), 27 were excluded due to excessive missing data (n = 11), straight-lining (n = 9), or failure to meet eligibility criteria (n = 7), yielding 394 usable responses (78.8% effective response rate). Nonresponse bias was assessed by comparing early respondents (first quartile, n = 98) with late respondents (last quartile, n = 98) on key demographic and study variables; no statistically significant differences were found on age (t = 0.92, p = .359), digital literacy self-rating (t = 1.07, p = .286), or any primary construct (all p > .20).

Table 1 presents the demographic profile of the 394 respondents. The sample is dominated by farmers and herders, which directly addresses the policy-targeted underserved population. Tibetan speakers form a plurality, consistent with the prefecture's ethnic composition.

Table 1. Respondent Demographics (N = 394)

Sample Characteristics	*n*	%
Gender		
Male	201	51.0
Female	193	49.0
Age		
18–29	82	20.8
30–44	121	30.7
45–59	129	32.7
60 and above	62	15.7
Occupation		
Farmer / herder	145	36.8
Small business owner	88	22.3
Student	57	14.5
Retiree	50	12.7
Government / institutional employee	54	13.7
Primary language		
Tibetan	163	41.4
Mandarin	152	38.6
Bilingual (Tibetan and Mandarin)	79	20.0
Education		
No formal schooling	39	9.9
Primary	94	23.9
Junior secondary	118	29.9
Senior secondary / vocational	95	24.1
Tertiary	48	12.2
Prior digital banking use		
Used at least once in past month	136	34.5
Used less frequently or never	258	65.5

Note. Self-reported primary language refers to the language used for most everyday communication.

3.2. Measures

All constructs were measured using multi-item reflective scales on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Innovativeness (6 items) was adapted from Goldsmith and Hofacker (1991) and Agarwal and Prasad (1998); Technostress (8 items) from Tarafdar et al. (2019) and Ragu-Nathan et al. (2008); Perceived Ease of Use (6 items) and Perceived Usefulness (6 items) from Davis (1989), localized to reflect digital banking activities relevant to Ganzi residents (mobile transfers, bill payment, government subsidy collection); Perceived Risk (5 items) from Featherman and Pavlou (2003) to encompass financial, privacy, performance, and psychological risk dimensions; Trust (6 items) from McKnight et al. (2002) to incorporate both institutional confidence and community-mediated trust dimensions; and Intention to Use Digital Banking (5 items) from Ajzen (1991).

Because all primary scales were originally developed in Western industrial contexts, a four-step cultural adaptation procedure was implemented prior to administration. First, the English versions were translated into Mandarin by a bilingual research team member with subject-matter expertise. Second, an independent Mandarin–English back-translation was performed by a second bilingual reviewer, and discrepancies were resolved by consensus discussion. Third, Mandarin items were translated into Tibetan by a Tibetan-language professional translator familiar with rural Ganzi vocabulary, and a Tibetan–Mandarin back-translation was again performed to confirm equivalence. Fourth, a comprehension pilot was conducted with 32 SCRB branch staff and local residents (cognitive interview protocol): respondents were asked to paraphrase each item in their own words, and items that yielded

ambiguous interpretations or showed culturally inappropriate framing were revised before the main survey was deployed. Cronbach's alpha across all constructs in the pilot ranged from .81 to .90. Content validity was further established through review by a panel of five experts in technology acceptance, rural digital finance, and Tibetan cultural studies; the scale-level content validity index (S-CVI/Ave) ranged from .86 to .93, meeting the .80 threshold recommended by Polit and Beck (2006).

Several procedural measures were implemented to reduce common method bias (Podsakoff et al., 2012): construct blocks were presented in randomized order across respondents, demographic items used categorical response formats distinct from the Likert-scale items, and respondents were assured of anonymity and encouraged to respond honestly. Ethics approval was obtained from the Suan Sunandha Rajabhat University Institutional Review Board; fieldwork in Ganzi was conducted with the consent of local community gatekeepers and in accordance with Chinese regulations governing social survey research, and all participants provided informed consent prior to participation.

3.3. Data Analysis

Data analysis was conducted using PLS-SEM implemented in SmartPLS 4. PLS-SEM was selected over covariance-based SEM (CB-SEM) for four reasons that align with the methodological guidance of Hair et al. (2022). First, the study has a predictive orientation rather than a strict confirmatory one, and PLS-SEM is the appropriate algorithm when the goal is prediction and explanation of variance in key endogenous constructs. Second, the structural model incorporates mediation and moderation pathways simultaneously, including a product-indicator interaction term for the Perceived Risk × Perceived Usefulness moderation, which PLS-SEM accommodates without compromising convergence. Third, several construct distributions exhibited modest skewness in a rural ethnic minority sample, and PLS-SEM is robust to non-normality, whereas CB-SEM with maximum-likelihood estimation assumes multivariate normality. Fourth, the context is exploratory in that the integration of second-order digital divide factors with TAM in an ethnic minority adoption setting has not been previously tested, and PLS-SEM is the preferred choice for theory development in such contexts.

The sample size of 394 exceeds the minimum of 200 recommended for structural equation modeling (Kline, 2023) and satisfies the a priori power analysis minimum of 76 computed using G*Power 3.1 for multiple regression with $f^2 = .15$, $\alpha = .05$, power = .80, and six predictors (Faul et al., 2009). The analysis followed a two-stage approach: (i) measurement model assessment—covering indicator reliability, internal consistency, convergent validity, and discriminant validity via both the Fornell–Larcker criterion and the Heterotrait–Monotrait (HTMT) ratio—followed by (ii) structural model assessment covering collinearity diagnostics, direct path coefficients, mediation via bootstrapping with 5,000 subsamples and bias-corrected confidence intervals, moderation via product-indicator interaction terms, coefficient of determination, and predictive relevance through Q^2 and PLSpredict (Shmueli et al., 2019). Perceived Risk × Perceived Usefulness interaction terms were constructed using the orthogonalized product-indicator approach recommended by Hair et al. (2022) to minimize multicollinearity.

4. Results

4.1. Preliminary Analysis

Little's MCAR test confirmed that missing data were missing completely at random ($\chi^2 = 287.41$, $df = 276$, $p = .312$). The proportion of missing values was 1.09%, and missing data were imputed using the expectation–maximization algorithm. Common method bias was assessed through Harman's single-factor test and the full collinearity VIF approach (Kock, 2015): the first unrotated factor accounted for 28.63% of total variance, well below the 50% threshold, and full collinearity VIF values ranged from 1.18 to 2.84, all below the conservative 3.3 threshold, suggesting that common method bias does not pose a serious threat. Only 34.5% of respondents reported using their smartphone for any financial activity in the past month, underscoring the low baseline adoption that motivates this study (Table 1).

4.2. Measurement Model

The measurement model demonstrated satisfactory psychometric properties (Table 2). All outer loadings exceeded the .708 threshold, composite reliability (CR) values ranged from .898 to .924 (all exceeding the .70 threshold), and average variance extracted (AVE) values ranged from .548 to .596 (all exceeding .50), confirming indicator reliability, internal consistency, and convergent validity (Hair et al., 2022). All skewness and kurtosis values fell within the ±2 acceptable range for PLS-SEM estimation.

Table 2. Descriptive Statistics, Reliability, and Convergent Validity

Construct	Items	*M*	*SD*	λ range	CR	AVE
INN	6	3.47	0.74	.72–.86	.91	.58
TS	8	3.21	0.79	.72–.86	.92	.56
PEOU	6	3.38	0.77	.73–.87	.91	.57
PU	6	3.55	0.71	.74–.87	.91	.58
PR	5	3.64	0.68	.73–.85	.90	.55
Trust	6	3.29	0.82	.73–.87	.92	.59
ITU	5	3.43	0.76	.75–.88	.92	.60

Note. INN = Innovativeness; TS = Technostress; PEOU = Perceived Ease of Use; PU = Perceived Usefulness; PR = Perceived Risk; ITU = Intention to Use Digital Banking; λ = outer loading range; CR = composite reliability; AVE = average variance extracted. Thresholds: CR ≥ .70; AVE ≥ .50; λ ≥ .708.

Discriminant validity was assessed through two complementary procedures, both reported in Table 3. Below the diagonal, the Fornell–Larcker criterion compares the square root of each construct's AVE (on the diagonal) with the inter-construct correlations: all diagonal values exceed their corresponding off-diagonal correlations, confirming construct-level discriminant validity. Above the diagonal, the Heterotrait–Monotrait (HTMT) ratios fall below the conservative .85 threshold recommended by Henseler et al. (2015), with the highest ratio being .741 between Trust and Intention to Use, jointly confirming that the seven constructs are empirically distinct.

Table 3. Discriminant Validity: Fornell–Larcker Criterion and Heterotrait–Monotrait Ratios

	1	2	3	4	5	6	7
1. INN	.76	.49	.55	.61	.46	.51	.56
2. TS	−.41	.75	.45	.52	.54	.41	.49
3. PEOU	.48	−.39	.76	.60	.44	.54	.51
4. PU	.53	−.44	.51	.76	.57	.57	.67
5. PR	−.40	.46	−.37	−.49	.74	.49	.60
6. Trust	.44	−.35	.47	.49	−.42	.77	.74
7. ITU	.49	−.42	.44	.57	−.51	.53	.77

Note. Diagonal values are the square root of AVE. Below-diagonal values are inter-construct correlations (Fornell–Larcker criterion). Above-diagonal values are Heterotrait–Monotrait (HTMT) ratios from 5,000-subsample bootstrapping. All HTMT values are below .85 (Henseler et al., 2015), and all square roots of AVE on the diagonal exceed their corresponding off-diagonal correlations.

4.3. Structural Model and Hypothesis Testing

All inner-model VIF values ranged from 1.00 to 2.84, below the 5.0 threshold, confirming the absence of multicollinearity in the structural model. Table 4 presents the direct path coefficients estimated with 5,000-subsample bootstrapping. Perceived Usefulness exerted the strongest direct effect on Intention to Use Digital Banking (H7: β = .32; $p < .001$; $f^2 = .11$), followed by Trust (H8: β = .24; $p < .001$; $f^2 = .07$). Innovativeness (H1: β = .18; $p < .001$), Perceived Ease of Use (H3: β = .17; $p = .001$), Technostress (H2: β = −.16; $p < .001$), and Perceived Risk (H10: β = −.20; $p < .001$) all exerted significant direct effects in the hypothesized directions. For the upstream paths to Perceived Usefulness, Perceived Ease of Use demonstrated the strongest positive influence (β = .31; $p < .001$; $f^2 = .11$), followed by Innovativeness (β = .27; $p < .001$; $f^2 = .08$) and Technostress (β = −.21; $p < .001$; $f^2 = .06$).

Table 4. Structural Path Coefficients, Effect Sizes, and Hypothesis Testing

Path	β	*SE*	*t*	*p*	95% CI	f^2
INN → PU	.27	.05	5.24	< .001	[.17; .37]	.08
TS → PU	−.21	.05	3.96	< .001	[−.32; −.11]	.06
PEOU → PU	.31	.05	6.00	< .001	[.21; .41]	.11
INN → ITU (H1)	.18	.05	3.89	< .001	[.09; .28]	.04
TS → ITU (H2)	−.16	.05	3.31	< .001	[−.26; −.07]	.03
PEOU → ITU (H3)	.17	.05	3.35	.001	[.07; .27]	.03
PU → ITU (H7)	.32	.05	6.00	< .001	[.21; .42]	.11
Trust → ITU (H8)	.24	.05	5.02	< .001	[.15; .34]	.07
PR → ITU (H10)	−.20	.05	4.30	< .001	[−.29; −.11]	.05
PR × PU → ITU (H9, interaction)	−.15	.04	3.50	< .001	[−.23; −.07]	.03

Note. β = standardized path coefficient; *SE* = standard error; CI = bias-corrected confidence interval from 5,000-subsample bootstrapping. f^2 benchmarks: .02 = small, .15 = medium, .35 = large (Cohen, 1988).

Simple-slope analysis confirmed the moderation pattern: the Perceived Usefulness → Intention to Use slope was significantly positive at low Perceived Risk (one *SD* below the mean: β = .43; $p < .001$) but substantially attenuated at high Perceived Risk (one *SD* above the mean: β = .21; $p = .003$), though it remained statistically significant. This partial moderation pattern indicates that Perceived Usefulness retains predictive value even under elevated risk perceptions, but its effectiveness is meaningfully constrained, consistent with the privacy calculus framework (Featherman & Pavlou, 2003).

Table 5 presents the mediation results. All three indirect effects through Perceived Usefulness are statistically significant, with none of the 95% bias-corrected confidence intervals containing zero, supporting H4, H5, and H6. Because both the direct and the indirect effects are statistically significant in all three pathways, each relationship exhibits partial (rather than full) mediation, indicating that Perceived Usefulness serves as a substantial but not exclusive mechanism through which antecedent variables influence adoption intention. Variance accounted for (VAF) ranges from 29.6% to 36.7%.

Table 5.Mediation Analysis: Indirect Effects via Perceived Usefulness

Hypothesis / Path	β (indirect)	*SE*	*t*	*p*	95% CI	VAF	Type
H4: INN → PU → ITU	.09	.02	3.70	< .001	[.04; .13]	31.7%	Partial
H5: TS → PU → ITU	−.07	.02	3.09	.002	[−.11; −.03]	29.6%	Partial
H6: PEOU → PU → ITU	.10	.03	3.81	< .001	[.05; .15]	36.7%	Partial

Note. VAF = Variance Accounted For (indirect effect / total effect). CI = bias-corrected bootstrap confidence interval. All three mediation effects are classified as partial because both the direct and the indirect paths are statistically significant.

4.4. Model Evaluation

The structural model explained substantial variance in both endogenous constructs (Table 6): Perceived Usefulness ($R^2 = .41$) and Intention to Use Digital Banking ($R^2 = .59$). All Q^2 values were positive (.22 for Perceived Usefulness; .32 for Intention to Use), confirming predictive relevance beyond the mean (Hair et al., 2022). Overall model fit was acceptable with SRMR = .06 (below the .08 threshold) and NFI = .91.

Table 6. Model Explanatory Power and Predictive Relevance

Construct	R^2	R^2 adj.	Q^2	SRMR
Perceived Usefulness	.41	.41	.22	—
Intention to Use Digital Banking	.59	.58	.32	—
Overall model	—	—	—	.06

Note. R^2 interpretation: .25 = weak, .50 = moderate, .75 = substantial (Hair et al., 2022). $Q^2 > 0$ indicates predictive relevance. SRMR < .08 indicates acceptable fit.

Out-of-sample predictive relevance was further assessed using the PLSpredict procedure (Shmueli et al., 2019). As Table 7 shows, all RMSE values from PLS-SEM are smaller than those from the linear-model (LM) benchmark, indicating that PLSpredict outperforms the LM benchmark at every endogenous indicator, consistent with high predictive power for both Perceived Usefulness and Intention to Use Digital Banking (Hair et al., 2022; Shmueli et al., 2019).

Table 7. PLSpredict Analysis Results

Indicator	Q^2 predict	RMSE (PLS-SEM)	RMSE (LM)	Difference
PU1	.21	.69	.75	−.07
PU2	.22	.69	.76	−.07
PU3	.22	.67	.74	−.07
PU4	.23	.70	.77	−.07
PU5	.21	.68	.75	−.07
PU6	.22	.69	.76	−.07
ITU1	.32	.65	.74	−.09
ITU2	.33	.64	.73	−.09
ITU3	.33	.64	.73	−.09
ITU4	.32	.66	.75	−.09
ITU5	.32	.66	.75	−.09

Note. LM = linear model benchmark; RMSE = root mean square error. All RMSE (PLS-SEM) values are lower than RMSE (LM), confirming predictive superiority of the proposed model at the indicator level.

5. Discussion

The model supported a dual-pathway architecture in which Perceived Usefulness partially mediated the effects of Innovativeness, Technostress, and Perceived Ease of Use on adoption intention, while Perceived Risk both directly deterred adoption and moderated the utility–intention link. Four principal insights emerge: Trust is among the strongest direct predictors of adoption intention; Technostress constitutes a significant adoption barrier operating through dual pathways; Perceived Risk functions as a critical moderating boundary condition that attenuates the utility–intention relationship; and Perceived Usefulness mediates the effects of all three cognitive and dispositional antecedents on intention, with partial mediation indicating that direct pathways also carry independent explanatory weight. These findings are discussed below as context-specific empirical insights from the Ganzi setting, with cautious extrapolation to comparable contexts. Theoretical and service-system implications are presented in Sections 5.5 and 5.6 respectively, and practical implications in 5.7.

5.1. Trust as a Dominant Predictor

The finding that Trust exerts a strong direct effect on Intention to Use Digital Banking (H8: $\beta = .24$; $f^2 = .07$) is theoretically and practically significant. This result aligns with McKnight et al.'s (2002) institutional trust framework. In the Ganzi context, Trust appears to operate as a hybrid construct blending regulatory confidence in SCRB with community-mediated social validation. The prominence of Trust relative to other cognitive antecedents suggests that in communities where physical cash carries not only economic but also symbolic and social legitimacy, the affective assurance of safety that Trust provides may be a necessary precondition for adoption, one that cognitive utility assessments alone cannot substitute. This interpretation should be read as context-specific: the strong Trust effect could also partly reflect acquiescence bias among respondents who associate SCRB with state institutional authority, an alternative we address in the limitations.

5.2. Technostress as a Dual-Pathway Barrier

The significant direct effect of Technostress on Intention to Use (H2: $\beta = -.16$) and its significant indirect effect through Perceived Usefulness (H5: indirect $\beta = -.07$; VAF = 29.6%) confirm that

Technostress operates as a dual-pathway adoption barrier in the Ganzi context. The direct path reflects an avoidance mechanism: when the cognitive and emotional demands of navigating the SCRB application exceed users' perceived coping resources, the desire to avoid the source of anxiety translates directly into reduced adoption intention. The indirect path through Perceived Usefulness indicates that Technostress additionally impairs the cognitive capacity required to evaluate technological benefits, consistent with Tarafdar et al.'s (2019) theoretical proposition that Technostress narrows attentional focus and elevates risk aversion. From a service-system perspective, this dual-channel effect implies that usability redesign delivers compound returns: it raises Perceived Usefulness while simultaneously lowering the affective cost of engagement.

5.3. Perceived Risk as a Moderating Boundary Condition

The moderation finding (H9: $\beta = -.15$ for the Perceived Risk × Perceived Usefulness interaction) provides empirical support for conceptualizing Perceived Risk as a contextual boundary condition rather than merely an additive predictor. Simple-slope analysis revealed that the Perceived Usefulness–Intention relationship remains significant even at high Perceived Risk levels ($\beta = .21$; $p = .003$), but its effectiveness is substantially attenuated. This partial-moderation pattern is consistent with the privacy calculus framework (Featherman & Pavlou, 2003), in which users with high risk perceptions require a disproportionately strong utility signal before committing to adoption. The strong direct effect of Perceived Risk on Intention (H10: $\beta = -.20$) further reinforces this interpretation in the Ganzi context, where digital fraud rumors propagate through tight community networks and the irreversibility of digital errors is acutely feared.

5.4. Perceived Usefulness as the Central Mediating Mechanism

The consistent pattern of partial mediation through Perceived Usefulness (VAF range: 29.6%–36.7%) confirms TAM's central proposition while extending it. Perceived Ease of Use generates the largest indirect effect through Perceived Usefulness (H6: indirect $\beta = .10$; VAF = 36.7%), replicating the ease-of-use heuristic documented by Venkatesh and Davis (2000): users who experience the SCRB application as effortless to navigate are substantially more likely to perceive it as functionally valuable for their specific financial activities. The mediation of Innovativeness through Perceived Usefulness (H4: indirect $\beta = .09$; VAF = 31.7%) indicates that dispositional openness shapes cognitive evaluations of utility as well as directly motivating adoption. Partial rather than full mediation across all three pathways indicates that each antecedent contributes to adoption intention through both a cognitive-evaluative channel (via Perceived Usefulness) and a direct channel that operates independently of utility assessment.

5.5. Theoretical Contributions

This study makes four context-specific contributions to the digital banking adoption literature. First, it provides empirical evidence that, in a Tibetan ethnic minority context, second-order divide factors—trust, technostress, and culturally embedded risk perception—operate as the primary determinants of adoption once first-order access has been secured. The pattern is consistent with second-order digital divide scholarship (van Dijk, 2006; Warschauer, 2004) and offers a context-specific extension rather than a universal generalization. Second, the study contributes to the ICT4D literature on design–reality gaps (Heeks, 2002) by providing empirical evidence that technostress is the affective signature of a design–reality mismatch in an ethnic minority digital financial inclusion setting; where technostress is elevated, the appropriate intervention may be system redesign rather than user training. Third, the study contributes to trust theory by demonstrating that institutional and community-mediated trust operates as a dominant direct predictor in this context, challenging the universalist assumptions of standard TAM and UTAUT frameworks. Fourth, the study makes a methodological contribution by reconceptualizing Perceived Risk from a direct predictor to a moderating boundary condition on the Perceived Usefulness–Intention link (Featherman & Pavlou, 2003); treating Perceived Risk as a moderator reveals

boundary conditions of TAM's utility–intention relationship that have been obscured by earlier additive modeling approaches.

5.6. Implications for Digital Banking Service Systems

Beyond consumer-behavior implications, the findings carry direct implications for the design and operation of digital banking service systems, the core thematic concern of JLISS. Three implications follow.

First, transaction-flow and information-flow design. The dual-pathway effect of Technostress indicates that interface friction and the perceived irreversibility of transactions are not merely usability nuisances but operational barriers that depress adoption through both cognitive and affective channels. For digital banking service systems serving low-literacy minority users, this implies that transaction workflows should be simplified to the minimum number of steps necessary, frequently used functions should be one-tap accessible, and real-time error-recovery features (cancel-and-undo windows, transaction previews, and confirmation feedback) should be built into the information flow to mitigate the fear of irreversible mistakes. The implication for operational management is that these design features are not peripheral but central determinants of the conversion rate from infrastructure access to active use.

Second, trust-leveraging onboarding and service-coordination. Because Trust functions as a dominant direct predictor, the onboarding process should be redesigned as a trust-transfer mechanism rather than a feature tour. Concrete service-system interventions include in-branch onboarding sessions led by familiar branch staff, dual-channel customer support that preserves the physical-branch relationship during the digital transition, and integration of community intermediaries—such as village grid workers and local SCRB account managers—into the service-delivery chain so that institutional trust accumulated through physical service points can flow into the digital service system rather than be lost in the transition.

Third, language-localized customer support and community engagement as service-delivery channels. The Perceived Risk moderation finding implies that utility-focused communication campaigns will be systematically less effective among high-risk-perceiving residents unless accompanied by credible, culturally sensitive risk-mitigation messaging delivered through trusted community channels. Operationally, this means providing Tibetan-language voice navigation, telephone customer support staffed by Tibetan speakers, and structured community-engagement programs (village-level digital-literacy campaigns, demonstration events) that function as alternative service-delivery channels rather than supplementary marketing.

5.7. Practical Implications

For SCRB and comparable institutions serving ethnic minority regions, the findings translate into specific operational priorities: (i) deploy Tibetan-language interface localization co-designed with members of the target community, rather than translated post hoc; (ii) implement a phased rollout that front-loads usability and frequently used functions, introducing more advanced features only as users build competence; (iii) leverage existing branch-level trust as a bridge to the digital platform through assisted-onboarding programs at the physical branch; (iv) provide ongoing customer support through both digital and human channels in the local language; and (v) build a community-engagement strategy anchored in village governance structures so that adoption decisions are made within trusted social networks rather than individually under conditions of uncertainty.

For digital inclusion policy more broadly, the findings imply that monitoring frameworks tracking only penetration rates and transaction volumes will misread progress in minority regions, missing the psychological and cultural barriers that determine whether access translates into meaningful use. Effective monitoring frameworks for ethnic minority digital inclusion should incorporate attitudinal and trust-related measures alongside behavioral indicators (Kleine, 2013).

6. Limitations and Future Directions

Several limitations warrant acknowledgment, and each suggests a specific direction for future research. First, the cross-sectional design precludes causal inference; longitudinal research tracking adoption intentions and actual behaviors over multiple time points is needed to establish temporal dynamics and potential feedback loops between Trust development and Perceived Risk reduction.

Second, the geographic focus on Ganzi limits generalizability to other ethnic minority regions in China and to comparable contexts internationally. The findings should be read as context-specific rather than as a general account of ethnic minority digital banking adoption; comparative studies across the ethnic minority autonomous prefectures of Yunnan, Xinjiang, and Inner Mongolia would illuminate the boundary conditions of the proposed model.

Third, all constructs were measured through self-report at a single time point, introducing potential response bias. Specifically, the online self-administration mode—chosen for scalable reach across Ganzi's eighteen counties—likely produced a self-selection effect favouring residents with higher digital literacy and stable mobile-network access, leaving the most digitally excluded households underrepresented. The reported effects of Technostress and limited digital literacy should therefore be read as conservative estimates of the barriers operating in the broader Ganzi population. Online self-completion may also have introduced acquiescence bias, particularly with respect to Trust, where respondents associating SCRB with state institutional authority may have been reluctant to express distrust even in an anonymous survey. Future research should incorporate behavioral indicators such as SCRB application usage logs and transaction-frequency data, and consider implicit-association or behavioral-observation techniques to triangulate self-reported Trust.

Fourth, Technostress was treated as a unidimensional composite, whereas Tarafdar et al.'s (2019) multidimensional conceptualization identifies distinct sub-dimensions—techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. Future research should decompose Technostress into its constituent dimensions to identify which forms of digital strain are most consequential in ethnic minority digital banking contexts.

Fifth, while the survey instrument was carefully back-translated and pilot-tested as described in Section 3.2, the underlying constructs were originally developed in Western industrial contexts. Some constructs (e.g., Innovativeness, Technostress) may not fully capture culturally specific manifestations in a Tibetan pastoral context. Future research should consider indigenous-development approaches—particularly cognitive interviewing and emic concept elicitation—to identify whether additional culturally specific constructs should be incorporated.

Sixth, the moderation finding was established using perceptual measures of risk; future research should incorporate objective risk proxies such as reported fraud victimization, insurance coverage, and network reliability indices to triangulate the moderation effect. Finally, although the sample size of 394 is adequate for PLS-SEM, it is modest relative to the diversity of the Ganzi population across eighteen counties; larger samples would permit multi-group analyses across counties, occupational categories, and language groups.

A note on reflexivity is warranted. The research team included members with prior familiarity with Sichuan rural financial services and access to local enumeration networks in Ganzi, which enabled the culturally sensitive administration of the survey instrument. We acknowledge that the study interprets Tibetan respondents' adoption decisions through predominantly Western theoretical frameworks (TAM, DOI, trust theory), which have analytic utility for comparison with the broader adoption literature but necessarily abstract away from culturally specific meanings that an ethnographic approach could recover. The quantitative findings should therefore be read as a complement to, rather than a substitute for, interpretive work on digital financial practices in Tibetan communities.

7. Conclusion

This study provides empirical evidence that digital banking adoption in Ganzi Tibetan Autonomous Prefecture is a psychologically and culturally layered process that standard TAM frameworks are not fully equipped to capture. Three context-specific conclusions follow. First, Trust rather than functional utility alone is a dominant driver of adoption intention in this Tibetan community context, reflecting the role of institutional and community-mediated trust mechanisms in settings where formal digital financial services are nascent. Second, Technostress constitutes a dual-pathway barrier that suppresses adoption intention both directly through avoidance and indirectly by impairing cognitive evaluation of technological utility, underscoring that the adoption challenge is partly a service-design problem rather than a pure access problem. Third, Perceived Risk functions as a moderating boundary condition that systematically attenuates the utility–intention relationship, implying that utility-focused adoption strategies will be ineffective for high-risk-perceiving residents unless complemented by credible, culturally sensitive risk-mitigation communication.

These findings contribute context-specific empirical insights to digital banking adoption research, second-order digital divide scholarship, and service-system design for institutions serving under-served populations. Future research extending this model to other ethnic minority communities in China and comparable contexts internationally would help establish whether these findings reflect the particular circumstances of Ganzi or identify a broader pattern of adoption dynamics in digitally underserved minority populations.

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