

Digital Entrepreneurial Ecosystems and Women-Led Tourism Enterprises in the Himalayan Region

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Abstract: Purpose: This study examines digital platform adoption, revenue outcomes and structural barriers among women-led tourism enterprises in Ladakh's emerging platform economy. Design/methodology/approach: Using survey data from 346 women entrepreneurs across Leh, Nubra, Zaskar and Kargil collected between March and May 2025, the study employs descriptive statistics, regression analysis, ANOVA and structural equation modelling. Findings: Instagram and WhatsApp Business emerged as the dominant digital business platforms, significantly improving visibility and customer engagement. However, connectivity limitations, digital skill gaps and language barriers continue to constrain entrepreneurial growth, particularly in remote areas such as Zaskar. Research limitations/implications: The cross-sectional design and self-reported revenue data restrict causal inference and findings apply to a single Union Territory. Practical implications: Connectivity investment should precede digital skills training, curricula should be multi-platform and Hindi and Ladakhi portal interfaces are priority interventions. Originality/value: The study provides the quantitative analysis of women-led digital entrepreneurship in a peripheral Himalayan tourism economy and contributes evidence for platform localisation, digital literacy and connectivity-focused policy interventions. It further contributes to digital entrepreneurship literature by conceptualising digital platforms as infrastructural substitutes enabling entrepreneurial participation within geographically peripheral tourism economies.

Keywords: Digital entrepreneurship, Women entrepreneurs, Platform economy, Himalayan tourism, Social commerce, Digital inclusion

1. Introduction

The intersection of digital technology and women's entrepreneurship has emerged as one of the most consequential research frontiers in development economics. In mountain economies such as Ladakh, where geographic isolation, seasonal economic cycles and structural gender disadvantage have historically circumscribed women's economic participation, digital platforms represent a qualitatively new form of market access. An Instagram post from a shawl-weaving cooperative in Nubra Valley can reach a buyer in Berlin; a WhatsApp Business catalogue of trekking packages compiled by a women-owned agency in Leh is transmitted instantaneously to a client in Mumbai. Multiplied across hundreds of small enterprises, these transactional episodes constitute a structural shift in how the Ladakhi tourism economy is organised, who participates in it and on what terms.

The empirical literature on this transformation remains sparse, particularly in quantitative terms. Most existing scholarship on women's entrepreneurship in Himalayan tourism is qualitative in design and limited in geographic scope (Bhasin, 2007; Movono and Dahles, 2017; Sinha and Mathur, 2020), leaving key questions about adoption rates, revenue attribution and barrier hierarchies without systematic numerical answers. Three macro-level developments give this research particular urgency. First, Ladakh recorded approximately 525,000 tourist arrivals in 2023, of which some 489,000 were domestic (Ladakh Tourism Department, 2023), creating substantial demand for tourism services



that small women-owned enterprises are theoretically positioned to serve. Second, post-COVID traveller behaviour has shifted decisively toward online research, social-media discovery and portal-based reservations, advantaging businesses with an established digital presence over those relying on walk-in or word-of-mouth traffic. Third, the Government of India's Digital India initiative and the Union Territory (UT) administration's entrepreneurship support programmes have created, for the first time, an institutional framework within which digital upskilling interventions for women could be funded and delivered at scale, if the evidence base for their design existed. Existing studies have largely focused on urban digital markets and metropolitan platform adoption, leaving peripheral tourism economies comparatively underexplored. This study addresses that gap through the largest quantitative sample of this population to date: 346 women entrepreneurs drawn from four administrative sub-divisions of the Union Territory of Ladakh.

1.1 Research Objectives

1. To determine the platform adoption rates and active business-use frequencies of women entrepreneurs across digital marketing channels in Ladakh.
2. To quantify the revenue contribution attributed to each digital platform and identify the predictors of digital revenue variation.
3. To assess women entrepreneurs' attitudes toward and self-reported capability in digital marketing across geographic sub-groups.
4. To identify and rank the structural barriers limiting digital entrepreneurial participation and examine their differential impact across demographic groups.

1.2 Research Hypotheses

Eight hypotheses were tested, stated here in alternative form: **H1:** Digital skill level significantly predicts platform adoption. **H2:** Platform adoption significantly predicts digital revenue. **H3:** Internet access quality significantly predicts platform adoption. **H4:** Social support (family/community) significantly predicts platform adoption. **H5:** Education level significantly predicts digital revenue. **H6:** Barrier index score negatively predicts platform adoption. **H7:** Barrier index score negatively predicts digital revenue. **H8:** Platform adoption significantly predicts business visibility.

1.3 Contribution of the Study

The study contributes in four ways. First, it provides the quantitative assessment of women's digital entrepreneurship in Ladakh's tourism economy, based on a stratified sample of 346 women entrepreneurs across Leh, Nubra, Zaskar and Kargil. Second, it contributes methodologically through the combined application of hierarchical regression, structural equation modelling and barrier severity indexing in a remote mountain-economy context where such approaches remain limited. Third, it advances the conceptual understanding of platform-based entrepreneurship in peripheral regions by demonstrating that digital platforms operate not merely as promotional tools but as functional substitutes for missing market infrastructure, highlighting a dual-platform architecture in which Instagram supports customer discovery and visibility while WhatsApp Business facilitates conversion and transaction completion. Finally, it contributes policy-relevant evidence for digital literacy programmes, platform localisation strategies and connectivity-focused infrastructure investment for women-owned tourism enterprises in geographically isolated regions.

2. LITERATURE REVIEW

2.1 Digital Entrepreneurship and Platform Ecosystems

Digital entrepreneurship was initially conceptualised by Hull et al. (2007) and refined by Nambisan (2017) as the creation of new ventures or the transformation of existing businesses through digital technologies. Recent scholarship emphasises its multidimensional, ecosystem-based nature: Fernandes et al. (2024) argue that digital

entrepreneurship extends beyond technology adoption to the restructuring of entrepreneurial processes, value creation mechanisms and market interactions within digitally mediated ecosystems, while Kraus et al. (2022) stress its particular significance where traditional market infrastructures are weak or geographically constrained. Parker et al.'s (2016) platform ecosystem framework provides an especially relevant lens: digital platforms restructure market interactions by reducing transaction costs, bypassing traditional intermediaries and enabling direct producer-to-consumer connectivity through network effects.

Digital entrepreneurship in peripheral and mountain economies differs structurally from platform adoption in urban markets. In regions characterised by infrastructural deficits, seasonal accessibility constraints and limited intermediary networks, digital platforms frequently operate as substitutes for absent market infrastructure rather than supplementary marketing channels. The present study conceptualises this phenomenon as platform-as-infrastructure entrepreneurship, wherein digital platforms partially replace absent market intermediaries, weak institutional support systems and geographically constrained entrepreneurial networks. Milwood and Maxwell (2020) similarly conceptualise tourism entrepreneurial ecosystems as dynamic interaction spaces where physical and virtual elements continuously interact and recent evidence indicates that digital entrepreneurial ecosystems significantly influence women's entrepreneurial participation through the combined effects of digital infrastructure, institutional support and socio-cultural conditions (Huang et al., 2025). In tourism contexts specifically, women entrepreneurs contribute not only to economic activity but also to cultural preservation and community-based destination development, particularly in peripheral regions (Altinay et al., 2026; Stylianou et al., 2025). Ladakhi women-led tourism enterprises therefore operate within hybrid entrepreneurial ecosystems shaped simultaneously by geographic isolation, digital platforms and community-based tourism networks.

2.2 Women's Digital Entrepreneurship in Developing and Peripheral Economies

Early gender-focused entrepreneurship frameworks identified structural constraints relating to markets, finance, management capability, social expectations and institutional environments (Brush et al., 2009). Subsequent studies suggest that digital platforms partially reduce several of these barriers by improving market access, customer visibility and entrepreneurial flexibility (Ghouse et al., 2019). Recent Indian research indicates that digital platforms, artificial intelligence and mobile-based technologies enable women entrepreneurs to overcome barriers of market access, information asymmetry and business visibility, particularly within small-scale enterprises (Dominic et al., 2024), while mobile internet access increasingly contributes to women's financial inclusion across developing economies (Jeffrie et al., 2023). Research on geographically peripheral economies remains comparatively limited but consistently reports compound digital barriers involving connectivity limitations, language constraints and restricted access to formal networks: Pandit et al. (2024) document the infrastructural and market-access constraints facing pastoral communities in Changthang, Ladakh; Barge (2025) shows that digitally networked communication systems enhance participation and economic coordination among women-led community enterprises; and Movono and Dahles (2017) found that platform adoption positively influenced revenue among Pacific Island women entrepreneurs, although benefits remained unevenly distributed across education and formalisation levels. Digital technologies and accessible communication infrastructures are also increasingly central to equitable participation and accessibility within tourism systems (Domínguez Vila et al., 2025). Collectively, these studies indicate that the benefits of digital entrepreneurship remain uneven and strongly conditioned by infrastructural quality, institutional support and socio-economic context. Importantly, few studies have applied advanced quantitative approaches such as hierarchical regression or structural equation modelling within Himalayan tourism economies.

2.3 Tourism Marketing Through Social Media

The tourism marketing literature recognises social media as a central mechanism shaping destination discovery, travel evaluation and decision-making. Early research established that user-generated content significantly influences tourists' destination perceptions and planning behaviour (Xiang and Gretzel, 2010) and more recent scholarship shows that visually oriented platforms such as Instagram and TikTok have transformed tourism marketing through visual storytelling, influencer engagement and digitally mediated destination branding (Kilipiri et al., 2023; Fernández-

Blanco et al., 2026). Contemporary studies emphasise that these platforms function as interactive ecosystems through which destinations, businesses and travellers co-create destination images (Ogotu and Othieno, 2025) and social media adoption significantly improves customer engagement and business visibility while reducing dependence on traditional intermediaries (Palaniswamy, 2021). In peripheral tourism economies digital visibility frequently compensates for geographic isolation, although platform dependence also creates new challenges relating to algorithmic visibility, review management and platform commissions, dynamics that are highly relevant to the Ladakhi context.

2.4 Barriers to Digital Participation: Gender and Geography

Digital participation in developing and peripheral economies remains strongly shaped by intersecting inequalities of gender, geography, infrastructure and digital capability. Inadequate infrastructure, unreliable connectivity and limited digital literacy continue to function as major barriers to rural digital inclusion (Chatterjee et al, 2020 and Sindakis and Showkat, 2024), often compounded by socio-economic inequality and weak institutional support. Gender-specific barriers extend beyond technology: women entrepreneurs in rural regions frequently encounter time poverty, mobility restrictions, socio-cultural expectations and unequal access to networks and training (Nursanti and Nurhayati, 2024) and women tourism entrepreneurs face additional challenges relating to digital competencies, safety concerns and work-life balance (Khoo et al., 2024). The literature therefore suggests that barriers to digital entrepreneurship operate as interconnected socio-technical constraints rather than isolated technological limitations.

2.5 Research Gap

Three gaps remain. First, very limited quantitative research has examined women's digital entrepreneurship within Himalayan and geographically peripheral tourism economies where digital platforms function as alternative market infrastructures. Second, existing platform-based tourism entrepreneurship studies have rarely investigated the platform-specific economic effects of Instagram, WhatsApp Business and online travel portals on women-led micro-enterprises. Third, most studies of women entrepreneurs in peripheral regions rely on qualitative or small-sample approaches, limiting multivariate analysis and explanatory modelling. The present study addresses these gaps through a large-scale quantitative investigation (N = 346) integrating platform-specific revenue analysis, structured barrier severity measurement and multivariate statistical modelling within a Himalayan tourism context.

3. METHODOLOGY

3.1 Research Design

The study adopts a cross-sectional quantitative survey design, consistent with a post-positivist epistemological position that assumes platform adoption, revenue generation and attitudinal orientation can be meaningfully measured and subjected to statistical inference. The design is appropriate for the study's descriptive and predictive objectives while acknowledging its limitation with respect to causal directionality, which is addressed in part through the theoretical specification of the structural equation model.

3.2 Population and Sampling

The target population comprised all women aged 18 years and above who owned or jointly operated tourism-related enterprises in the Union Territory of Ladakh, India, including homestays, guesthouses, handicraft retail units, trekking services, food and catering businesses, cultural performance groups and transport services. A sampling frame of approximately 1,200 enterprises was constructed by combining registered enterprise lists from the Ladakh Autonomous Hill Development Council (LAHDC), the Jammu and Kashmir Bank self-help group loan database (accessed with permissions), membership registers of four women's self-help federations and a purposive snowball extension identifying unregistered micro-enterprises during field visits. A stratified random sampling design was employed on the basis of administrative sub-division (Leh, Nubra, Zaskar and Kargil) and enterprise type. At the time of fieldwork Ladakh comprised two revenue districts, Leh and Kargil, Nubra, Zaskar, Sham, Changthang and

Drass were notified as separate districts only in April 2026. The terms sub-division and stratum are therefore used here in preference to district. The final sample of 346 respondents provides an estimated margin of error of $\pm 5.2\%$ at the 95% confidence level under simple random sampling assumptions; applying a finite population correction for the sampling frame of approximately 1,200 enterprises reduces this to approximately $\pm 4.4\%$. The study was conducted across four major tourism regions of the Union Territory of Ladakh: Leh, Nubra, Zaskar and Kargil, which constituted the sampling strata for this research. These districts differ in tourism intensity, accessibility and digital infrastructure, making them an appropriate setting for examining variations in digital entrepreneurship among women-led tourism enterprises. Figure 1 illustrates the spatial distribution of the study area and the sampled districts.

Figure 1. Location of the study area in Ladakh, India, showing the four sampling strata (N = 346)

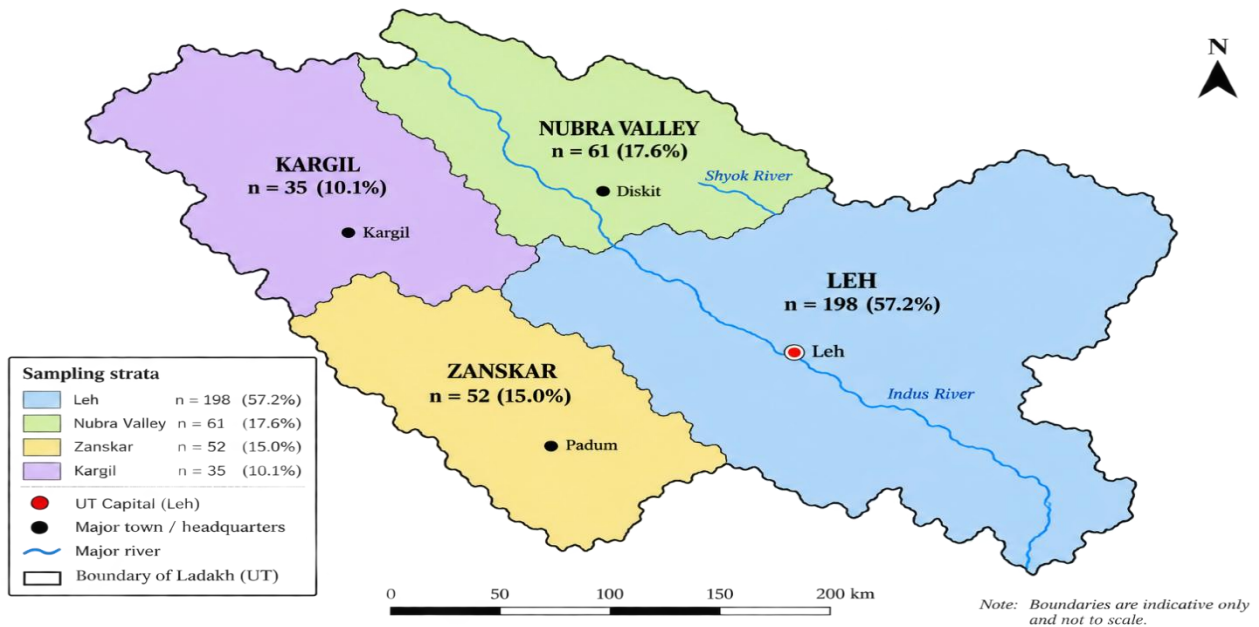


Figure 1: Location of the study area in the Union Territory of Ladakh, India, showing the four sampling strata (N = 346)

3.3 Instrument Development

The questionnaire was developed in three stages: (1) review of established instruments, including items adapted from Davis's (1989) Technology Acceptance Model, Fishbein and Ajzen's (1975) Theory of Reasoned Action and the Women's Digital Entrepreneurship Scale validated by Datta and Bhardwaj (2019); (2) content validation by a panel of five domain experts, resulting in three item revisions and two deletions; and (3) pilot administration to 30 women entrepreneurs in Leh town, producing Cronbach's alpha of 0.84 for the attitude-and-capability scale and 0.79 for the barrier scale, both exceeding the 0.70 threshold. The final instrument comprised four sections: demographic profile (12 items), platform adoption and use frequency (28 items), digital marketing attitudes and self-efficacy (28 Likert items, 1-5 scale) and barrier ranking and severity assessment (9 barriers). All items were translated into Hindi and Ladakhi (Bodhi), with back-translation to verify semantic equivalence.

3.4 Data Collection and Ethics

Data were collected between March and May 2025 by four trained female enumerators who conducted face-to-face interviews in the participant's preferred language. Face-to-face administration ensured the inclusion of participants with limited digital literacy, precisely the population whose experiences are most policy-relevant. Responses were double-entered into SPSS within 48 hours, with discrepancies resolved against original forms. The response rate was 94.1% (346 completed surveys from 368 approached). All respondents participated voluntarily after

informed consent; no personally identifiable information was recorded, all responses were anonymised and field access permissions were obtained through relevant local administrative and community channels.

3.5 Analytical Approach and Data Screening

Data were analysed using IBM SPSS Statistics 27 and Amos 27. Descriptive statistics were computed for all variables. One-way ANOVA with Tukey HSD post hoc testing assessed group differences in revenue and platform use by district and education, Pearson correlations examined bivariate relationships, hierarchical multiple regression (four blocks: demographic controls, infrastructure, platform adoption variables and digital marketing investment) identified independent predictors of annual digital revenue (log-transformed to correct right skew) and structural equation modelling (maximum likelihood) tested the hypothesised structural relationships among Digital Skill, Internet Access, Social Support, Platform Adoption, Barrier Index, Digital Revenue and Business Visibility, with fit assessed via χ^2/df , CFI, RMSEA and SRMR. Missing data (<2%) were addressed through mean substitution where appropriate, no observation exceeded ± 3.5 standard deviations and all cases were retained. VIF values below 2.5 indicated no problematic multicollinearity and residual plots confirmed acceptable homoscedasticity and linearity. Harman's single-factor test indicated that common method bias was unlikely to substantially affect the findings (first unrotated factor <50% of variance). Statistical significance was set at $\alpha = .05$.

4. RESULTS

4.1 Demographic Profile of Respondents

Table 1 presents the demographic characteristics of the 346 respondents. The sample is concentrated in the 26-35 age band (32.4%), consistent with the age profile of economically active women in Ladakh's tourism economy. Graduate-level education predominates (43.1%), a markedly higher share than in the general adult female population of the region, reflecting the entrepreneurial sub-population's self-selection toward higher education. Leh urban accounts for 57.2% of the sample, with Nubra (17.6%), Zaskar (15.0%) and Kargil (10.1%) representing progressively more remote sub-populations. Because sub-division and enterprise type served as stratification variables, these distributions are a product of the sampling design and should not be read as population estimates or as evidence of representativeness; the test statistics reported in Table 1 are correspondingly descriptive rather than confirmatory.

Table 1. Demographic Profile of Respondents (N = 346)

Characteristic	N	% of Sample	Cumulative %	χ^2/F
Age Group				
18-25 years	74	21.4	21.4	
26-35 years	112	32.4	53.8	F(3,342)
36-45 years	89	25.7	79.5	= 4.71*
46+ years	71	20.5	100.0	
Education Level				
Below Matriculation	38	11.0	11.0	
Matriculate / Higher Secondary	97	28.0	39.0	$\chi^2(3)$
Graduate	149	43.1	82.1	= 18.43***
Postgraduate and above	62	17.9	100.0	

District of Residence				
Leh (urban)	198	57.2	57.2	
Nubra Valley	61	17.6	74.9	$\chi^2(3)$
Zaskar	52	15.0	89.9	= 11.27**
Kargil / other	35	10.1	100.0	
Marital Status				
Single	128	37.0	37.0	
Married	186	53.8	90.8	
Widowed / Divorced	32	9.2	100.0	
Monthly Household Income (INR)				
< ₹10,000	48	13.9	13.9	
₹10,001-₹25,000	103	29.8	43.6	F(3,342)
₹25,001-₹50,000	121	35.0	78.6	= 9.14***
> ₹50,000	74	21.4	100.0	
Total	346	100.0	-	

Note: * $p < .05$, ** $p < .01$, *** $p < .001$. Chi-square values test distributional uniformity within categories; F-statistics test between-group mean differences on continuous outcomes. Income categories are self-reported monthly household figures.

4.2 Platform Adoption and Business Use

Table 2 presents adoption and active business-use rates across ten digital platforms. WhatsApp Business emerges as the most operationally embedded platform, recording the highest revenue linkage (61.8%) and the highest mean use frequency (6.1 days per week), although its active business-use rate (72.3%) sits marginally below Instagram's. This pattern reflects its integration into existing social communication infrastructure and low entry barriers. Instagram records the highest active business-use rate (73.7%) and the second-highest mean weekly frequency (5.2 days), together with a substantially higher revenue linkage (58.4%) than Facebook (44.2%); this difference is statistically significant (McNemar's test for paired proportions, $\chi^2(1) = 14.23$, $p < .001$) and corroborates the visual-tourism-marketing literature's emphasis on Instagram's superior commercial effectiveness for experiential product categories.

Table 2. Digital Platform Awareness, Registration, Active Use and Revenue Linkage

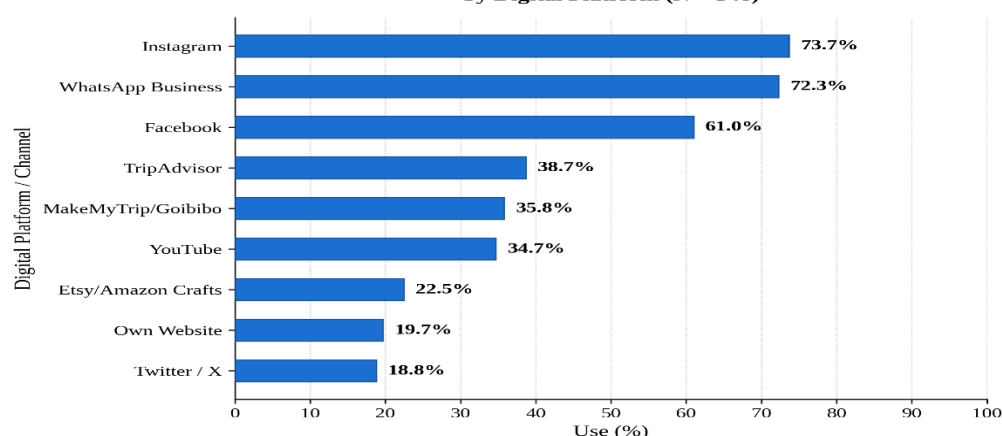
(N = 346)

Platform	Aware (%)	Registered (%)	Active User (%)	Business Use (%)	Revenue-Linked (%)	Mean Freq. (days/wk)
Instagram	97.4	89.3	81.8	73.7	58.4	5.2
Facebook	95.1	86.4	74.3	61.0	44.2	4.7

WhatsApp Business	91.6	84.1	79.5	72.3	61.8	6.1
YouTube	86.7	61.8	49.4	34.7	22.6	2.9
TripAdvisor	74.0	52.6	41.3	38.7	31.5	2.1
MakeMyTrip / Goibibo	71.4	49.1	38.4	35.8	29.4	1.8
Twitter / X	61.3	38.7	29.2	18.8	9.7	1.4
Etsy / Amazon Handicrafts	54.6	31.5	24.3	22.5	18.9	1.1
Own Website / Blog	43.9	27.5	21.7	19.7	14.7	1.3
Snapchat / Pinterest	38.4	24.0	18.2	10.1	5.5	0.9

Note: Active User = uses the platform at least once per week. Business Use = uses the platform specifically for marketing/sales. Revenue-Linked = directly attributes at least one completed sale to the platform in the past 12 months. Mean Freq. = self-reported mean days per week of active use among registered users.

Figure 2. Percentage of Women Entrepreneurs Reporting Active Business Use by Digital Platform (N = 346)



Note: Bars represent the percentage of the full sample (N = 346) reporting active business use of each platform. Values derived from Table 2.

Figure 2. Active business use of digital platforms among women entrepreneurs (N = 346)

Figure 2 makes visually clear the bifurcated platform landscape: Instagram and WhatsApp Business constitute a dominant tier of digital business activity, Facebook a secondary tier and travel portals, e-commerce channels and owned websites a substantially smaller but economically meaningful third tier. Twitter/X's low business-use rate (18.8%) and very low revenue linkage (9.7%) suggest that a text-primary public discourse medium is poorly suited to the visual, relational and local marketing needs of Ladakhi micro-tourism enterprises.

4.3 Revenue and Business Metrics

Table 3. Revenue and Business Performance Descriptive Statistics

Variable	N	Mean	SD	Min-Max	Skew
Annual Revenue (INR '000) - all	346	₹182.4	₹134.7	12-890	1.42

Annual Revenue - digital-primary	187	₹241.6	₹148.2	35-890	1.18
Annual Revenue - offline-primary	159	₹114.3	₹89.4	12-480	1.67
Revenue from Instagram (%)	254	38.7	17.4	5-85	0.61
Revenue from WhatsApp Business (%)	275	27.4	14.2	3-72	0.48
Revenue from Travel Portals (%)	168	19.3	11.8	2-61	0.72
Revenue from Facebook (%)	211	14.6	9.9	2-55	0.83
No. of digital platforms actively used	346	3.2	1.6	0-8	0.37
Business Age (years)	346	4.7	3.1	0.5-18	1.21
Monthly Digital Marketing Spend (INR)	346	₹2,847	₹2,204	0-18,000	1.89

Note: Revenue figures are self-reported and subject to recall and social desirability bias; interpret as indicative. Digital-primary = $\geq 50\%$ of revenue attributed to digital channels. Platform revenue components sum to more than total digital revenue due to multi-touch attribution. INR '000 = Indian Rupees in thousands.

Table 3 reveals a pronounced revenue premium for digitally primary businesses (mean ₹241,600 per annum) relative to offline-primary equivalents (mean ₹114,300), a premium of approximately 111% that remained significant after controlling for business age (partial $r = .41$, $p < .001$). Among platforms, Instagram generated the largest average revenue share (38.7% of digital revenue among active users), followed by WhatsApp Business (27.4%) and travel portals (19.3%). The high standard deviation in digital marketing expenditure ($SD = ₹2,204$ against a mean of ₹2,847) indicates substantial heterogeneity in promotional investment: a small minority invest heavily in paid Instagram promotion while most rely on organic content.

4.4 Attitudes and Capability (Likert Results)

Table 4. Digital Marketing Attitudes and Capability by Sub-Division (Selected Items; Mean Scores, Scale 1-5)

Statement (1 = Strongly Disagree ... 5 = Strongly Agree)	Leh (M)	Nubra (M)	Zaskar (M)	Kargil (M)	Overall M (SD)
Instagram helps me reach customers beyond Ladakh	4.61	4.48	4.12	4.22	4.41 (0.71)
Digital marketing has increased my revenue	4.38	4.21	3.84	3.97	4.18 (0.82)

I feel confident managing my social media accounts	3.74	3.48	3.02	3.19	3.47 (0.94)
Travel portal listings generate bookings for me	3.92	3.76	3.31	3.44	3.67 (0.87)
WhatsApp Business is my primary sales channel	4.02	4.17	4.29	4.11	4.12 (0.79)
Language barriers limit my digital engagement	3.18	3.44	3.88	3.72	3.48 (1.02)
Internet connectivity is a reliable resource for me	2.87	2.61	2.14	2.43	2.59 (1.11)
I invest time in learning digital skills regularly	3.22	2.98	2.71	2.84	2.99 (0.96)
E-commerce platforms suit my product/service type	3.66	3.51	3.08	3.29	3.44 (0.89)
My family supports my digital business activities	3.88	3.74	3.42	3.61	3.68 (0.91)

Note: One-way ANOVA indicated statistically significant sub-division differences on all items ($p < .001$). n by district: Leh = 198, Nubra = 61, Zaskar = 52, Kargil = 35.

Three findings warrant discussion. First, 'Instagram helps me reach customers beyond Ladakh' yields the highest grand mean (4.41), confirming that even women with limited digital confidence value the geographic reach extension Instagram provides, consistent with the platform-as-infrastructure framing. Second, the starkest district divergence appears in the connectivity item (Leh 2.87 vs. Zaskar 2.14), confirming that the digital infrastructure gap is an acutely localised reality within Ladakh itself. Third, 'I invest time in learning digital skills regularly' produces the second-lowest grand mean (2.99), suggesting that systematic skill development is not routine even among active platform users, likely reflecting the time constraints registered in the barrier analysis. Notably, 'WhatsApp Business is my primary sales channel' scores highly (4.12), including in Zaskar and Kargil: unlike Instagram, which facilitates visibility and promotional outreach, WhatsApp Business functions as a low-bandwidth coordination platform suited to intermittent connectivity and relationship-based transactions. The results also reveal an asymmetry between perceived platform usefulness and digital self-confidence (confidence $M = 3.47$), suggesting that practical adoption is outpacing deeper capability development, particularly where formal training and stable infrastructure remain limited.

4.5 Correlation and Regression Analysis

Bivariate analysis confirmed that platform adoption variables show the strongest relationships with (log-transformed) annual revenue: Instagram use ($r = .54$, $p < .01$) and number of platforms used ($r = .51$, $p < .01$) were the top bivariate predictors, followed by WhatsApp Business use ($r = .49$), travel portal use ($r = .43$) and Facebook use ($r = .37$, all $p < .01$). Moderate positive inter-correlations among platform-use variables ($r = .31$ to $.58$) indicate co-adoption patterns: digital business engagement is a generalisable orientation rather than a single-platform phenomenon. Education ($r = .32$) and business age ($r = .28$) correlate positively but more weakly with revenue, indicating that these structural factors are relevant but secondary to digital platform engagement.

Table 5 presents the hierarchical multiple regression examining predictors of annual digital revenue.

Table 5. Hierarchical Multiple Regression: Predictors of Annual Digital Revenue (Log-Transformed, $N = 346$)

Predictor Variable	B	SE	T	P	VIF
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(Constant)	-	18.42	-	<.001	-
Instagram Active Use (binary)	0.312	0.041	7.61	<.001	1.84
WhatsApp Business Use (binary)	0.287	0.038	7.55	<.001	1.76
Travel Portal Registration (binary)	0.198	0.044	4.50	<.001	1.54
No. of Platforms Used (count)	0.174	0.029	6.00	<.001	2.12
Education Level (ordinal 1-4)	0.143	0.033	4.33	<.001	1.38
Business Age (years)	0.128	0.021	6.10	<.001	1.29
Digital Marketing Spend (log ₁₀ INR)	0.119	0.047	2.53	.012	1.65
Urban Location (Leh = 1)	0.098	0.039	2.51	.013	1.47
Access to Smartphone (binary)	0.087	0.052	1.67	.096	1.22
Monthly Internet Hours	0.081	0.018	4.50	<.001	1.93
R² = 0.584, Adj. R² = 0.572, F(10,335) = 47.08, p < .001					

Note: Dependent variable: log₁₀(Annual Revenue, INR). B = unstandardized regression coefficient; SE = standard error; VIF = Variance Inflation Factor (all VIF values < 2.5). Variables were entered sequentially in four blocks: (1) demographic controls, (2) infrastructure, (3) platform adoption, and (4) digital marketing investment. Block 3 produced the largest incremental contribution to explained variance ($\Delta R^2 = .241$, $p < .001$). Instagram active use ($B = 0.312$) and WhatsApp Business use ($B = 0.287$) were the strongest positive predictors in the final model. Travel portal registration ($B = 0.198$) and the number of platforms used ($B = 0.174$) were also positively associated with annual digital revenue. Education level, business age, digital marketing expenditure, Leh location, and monthly internet use showed smaller positive associations with revenue, whereas access to a smartphone was not statistically significant ($p = .096$). The final model explained 58.4% of the variance in log-transformed annual revenue (Adjusted $R^2 = .572$). Given the cross-sectional design, these findings should be interpreted as associations rather than causal effects.

4.6 Barriers to Digital Entrepreneurship

Table 6. Barriers to Digital Marketing Participation: Frequency Ranking and Severity Index (N = 346)

Barrier	Ranked #1 (%)	Ranked #2 (%)	Ranked #3 (%)	Severity Index (1-5)
Inconsistent internet connectivity	44.2	18.7	9.4	4.31
Lack of digital skill / training	28.6	24.9	16.2	4.07
Language barriers (English content)	18.8	21.4	19.7	3.84
Financial cost of digital marketing	13.6	19.3	17.8	3.62
Household and family time constraints	11.2	17.6	21.4	3.55
Lack of trust in online payments	9.7	14.8	18.3	3.41
Social/cultural norms limiting visibility	8.4	12.1	15.6	3.28
Competition from established operators	7.8	10.4	12.9	3.14
Poor product photography / content skills	6.9	11.8	14.1	3.09

Note: Severity Index = weighted mean on a 5-point scale (1 = Not a barrier, 5 = Severe barrier) across all respondents. Ranking columns reflect the percentage nominating each barrier as their #1, #2 or #3 obstacle; multiple barriers could be nominated.

The barrier analysis produces a clear hierarchy. Inconsistent internet connectivity ranks first both as the most frequently nominated primary barrier (44.2%) and on the severity index (4.31), a result consistent across districts but most acute in Zaskar, where the connectivity Likert mean of 2.14 (Table 4) indicates widespread dissatisfaction. Digital skill gaps rank second (severity 4.07), with notably higher severity among Zaskar respondents (district-specific severity 4.48). Language barriers, primarily the English-language interfaces of international travel portals and e-commerce platforms, rank third (severity 3.84), consistent with wider evidence identifying language interfaces as a 'last-mile' barrier to digital commerce in the Himalaya. Social and cultural norm constraints rank only seventh of nine (severity 3.28), suggesting that the primary bottleneck to women's digital entrepreneurship in Ladakh is currently more structural than normative, a finding with direct implications for intervention prioritisation.

4.7 Education × Platform Intensity and Revenue

One-way ANOVA across six education-by-platform-intensity groups revealed a consistent and statistically significant joint effect on annual revenue ($F(5,340) = 22.41, p < .001$): revenue increases monotonically with both education level and platform use intensity (Low = 0-1, Moderate = 2-3, High = 4+ active platforms). The highest-revenue cell, postgraduate women with high platform use (mean ₹312,400), achieves nearly four times the revenue of the lowest cell, below-matriculation women with low platform use (₹84,200), with Tukey HSD tests confirming that the two high-platform-use groups differ significantly from all lower combinations ($p < .01$). Importantly, the effect of platform intensity is visible within each education level: among graduate women, moving from moderate to high platform use is associated with a ₹58,400 mean revenue increase (₹176,300 to ₹234,700), an effect larger than the

graduate-to-postgraduate education upgrade at the same platform intensity (₹248,900 against ₹234,700 at high platform use, a difference of ₹14,200). For women who are already educated, intensive digital engagement generates returns comparable to an additional educational qualification, a significant finding for policy prioritisation.

4.8 Structural Equation Model Results

Prior to estimation of the structural model, the measurement model was evaluated for reliability and validity: Cronbach's alpha and composite reliability values for all latent constructs exceeded 0.70, Average Variance Extracted exceeded 0.50 (confirming convergent validity), standardised factor loadings ranged from 0.67 to 0.88 and discriminant validity was satisfied under the Fornell-Larcker criterion. Table 7 presents the structural model results.

Table 7. Structural Equation Model: Standardised Path Coefficients (N = 346)

Construct Relationship	Path Coeff. (β)	SE	p-value	Hypothesis
Digital Skill → Platform Adoption	0.441	0.052	<.001	H1: Supported
Platform Adoption → Digital Revenue	0.512	0.048	<.001	H2: Supported
Internet Access → Platform Adoption	0.387	0.061	<.001	H3: Supported
Social Support → Platform Adoption	0.219	0.057	.001	H4: Supported
Education Level → Digital Revenue	0.198	0.043	<.001	H5: Supported
Barrier Index → Platform Adoption	-0.334	0.054	<.001	H6: Supported
Barrier Index → Digital Revenue	-0.278	0.049	<.001	H7: Supported
Platform Adoption → Business Visibility	0.583	0.041	<.001	H8: Supported
Indirect: Skill → Revenue (via Adoption)	0.226	0.039	<.001	Mediation confirmed

Note: Maximum likelihood estimation. Model fit: $\chi^2(42) = 77.28$, $\chi^2/df = 1.84$, CFI = 0.961, TLI = 0.949, RMSEA = 0.049 [90% CI: 0.032-0.064], SRMR = 0.062; all indices meet conventional benchmarks. Bootstrap mediation (2,000 samples) confirms the indirect effect of Digital Skill on Revenue via Platform Adoption ($\beta = 0.226$, 95% CI [0.161, 0.295]).

All eight hypotheses were supported. Digital skill and internet access are associated with revenue indirectly, through Platform Adoption; because direct paths from these two constructs to revenue were not specified in the model, the evidence is consistent with mediation but does not establish that mediation is complete. Platform Adoption's strong path to Business Visibility ($\beta = 0.583$) underscores that digital platforms substantially expand the reach and recognition of women-owned enterprises even before revenue is directly generated. The indirect path from Digital Skill to Revenue via Platform Adoption ($\beta = 0.226$) confirms mediation: skill generates revenue by enabling more extensive and effective platform engagement. The negative effects of the Barrier Index on both adoption ($\beta = -0.334$) and revenue ($\beta = -0.278$) confirm that barrier reduction, particularly connectivity and skill interventions, would release multiple downstream economic benefits simultaneously.

5. DISCUSSION

5.1 The Instagram-WhatsApp Business Duality

The study's most consistent finding is the paired dominance of Instagram and WhatsApp Business, a duality with a functional logic that existing literature captures only partially. Instagram's visual architecture is ideally suited to a destination whose commercial proposition is fundamentally experiential: mountain landscapes, Buddhist festivals and artisanal textiles. Its story and reel features allow authentic, low-cost content that communicates 'experience goods' (Nelson, 1970) more convincingly than text-based descriptions. WhatsApp Business, by contrast, addresses the conversion gap: it transforms browsing interest into direct customer relationships conducted in the user's preferred language, at no transaction cost, with instant payment confirmation through India's Unified Payments Interface (UPI). The two platforms thus operate as discovery (Instagram) and conversion (WhatsApp Business) stages of a funnel, a customer-journey architecture emerging spontaneously from women entrepreneurs' experimentation rather than structured training. Training programmes that focus on one platform in isolation therefore miss the complementary architecture that drives the highest-revenue outcomes; the regression coefficient for number of platforms used ($\beta = 0.174$) further supports a multi-platform emphasis. More broadly, the findings indicate that platforms function not only as marketing channels but as alternative business support systems, helping women overcome limitations in market access, customer connectivity and weak business networks in geographically remote regions.

5.2 The Connectivity-Skill Barrier Compound

The finding that connectivity barriers (Severity Index 4.31) marginally outrank skill barriers (4.07) has immediate policy relevance: skill interventions, however well designed, will produce sub-optimal returns until connectivity infrastructure meets a minimum reliability threshold. This sequencing aligns with Ramírez and Richardson's (2005) infrastructure-first principle and argues for coordinated rather than parallel investment. The connectivity deficit is not uniform: Zanskar's mean connectivity satisfaction of 2.14 against Leh's 2.87 indicates that sub-district variation within Ladakh is as significant as the overall UT-national gap, so targeted satellite internet deployment or dedicated tourism-corridor broadband would have differential impact depending on geographic prioritisation.

5.3 Revenue Stratification and the Education-Platform Interaction

The finding that platform intensity generates revenue returns comparable to additional educational qualifications has significant implications for development policy: formal education is a multi-year investment with substantial opportunity costs, whereas intensive platform training can be delivered on a much shorter timescale. The ₹58,400 mean revenue increment associated with moving from moderate to high platform use among graduate women is approximately 33% of mean annual revenue at moderate platform intensity, a return that would satisfy most development-finance impact thresholds. The literature on digital skill interventions in comparable populations (Datta and Bhardwaj, 2019; GSMA, 2020) suggests that sustained peer-facilitated training can raise adoption intensity, although the training dosage required to achieve increases of the magnitude observed here has not been established for this population.

5.4 Travel Portals: Underutilised Potential

The relatively low active business use of travel portals (TripAdvisor 38.7%, MakeMyTrip/Goibibo 35.8%) despite respectable revenue-linkage rates among active users (31.5% and 29.4%) suggests that portals are a structurally underutilised channel blocked by language barriers (English-language interfaces) and cost concerns rather than absence of demand. The regression coefficient for portal registration ($\beta = 0.198$, $p < .001$) confirms an independent revenue contribution; if portal adoption could be expanded from approximately 37% to 55% of the sample through Hindi-language interface support and commission-subsidy schemes, the revenue implications would be substantial. Portal operators, MakeMyTrip in particular, have both the commercial incentive and technical capacity to implement such localisation and the present data provide a quantified market-size rationale for that investment.

6. POLICY RECOMMENDATIONS

6.1 Digital Literacy Programme Design

Given the evidence that platform intensity predicts revenue more strongly than single-platform proficiency, the LAHDC's women entrepreneurship cell should commission a multi-platform immersion curriculum of approximately 48 hours, an indicative dosage that should itself be tested during piloting, delivered over eight weeks in blended format, structured as three modules: (1) Instagram content creation and analytics for Himalayan tourism products, (2) WhatsApp Business catalogue, broadcast-list and UPI payment integration and (3) travel portal listing optimisation. Delivery in Ladakhi and Hindi is essential given the language barrier severity score of 3.84. The programme should be piloted in Leh ($n = 50$) before sequential expansion to Nubra and Zaskar, where in-person sessions should be accompanied by mobile hotspot provision.

6.2 Infrastructure Investment Prioritisation

The connectivity Severity Index of 4.31, the highest in the barrier battery, indicates that broadband and mobile internet reliability should be treated as a precondition for digital entrepreneurship investment. The UT administration should formally request priority inclusion of Zaskar and remote Nubra sub-districts in the Universal Service Obligation Fund's 4G saturation programme and evaluate low-earth-orbit satellite internet pilots, for example through the Starlink distribution agreements concluded with Reliance Jio and Bharti Airtel in March 2025 and subject to the outcome of pending licensing and security clearances, for enterprises reporting zero or minimal connectivity. A threshold of at least 10 Mbps sustained download speed should be established as the minimum viable condition for deploying digital marketing training.

6.3 Platform Localisation and Policy Advocacy

The UT administration, particularly the tourism and commerce departments of the LAHDC, should establish formal engagement with MakeMyTrip, Goibibo and TripAdvisor to advocate for Ladakhi- and Hindi-oriented listing interfaces, Hindi-language review moderation and reduced commission rates, with a preferential commission band for LAHDC-certified women-owned micro-enterprises, the level to be established through negotiation and cost analysis. Collaboration with Meta platforms should focus on improving Devanagari-script autocomplete and introducing a Ladakhi language option within the WhatsApp Business interface. These low-cost adaptations could substantially improve digital accessibility and encourage wider adoption.

6.4 Women's Digital Enterprise Network

The social support Likert result ($M = 3.68$) and the SEM's positive social support $\rightarrow$ platform adoption path ($\beta = 0.219$) suggest that peer networks are a meaningful adoption enabler. The LAHDC and LLPS should jointly sponsor a Ladakhi Women Digital Enterprise Network, a WhatsApp super-group of 200+ verified women entrepreneurs facilitated by trained community moderators to share platform tips, aggregate bulk discounts on design-tool subscriptions and provide peer review of Instagram content. Analogous peer-network models in Uttarakhand (Sinha and Mathur, 2020) and Pacific Island tourism economies (Movono and Dahles, 2017) have demonstrated measurable effects on adoption quality and business sustainability.

7. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

Three limitations warrant acknowledgement. First, the cross-sectional design cannot establish temporal sequence or rule out reverse causality in the revenue-platform relationship: higher-revenue businesses may be better positioned to invest in digital marketing. Longitudinal designs tracking a panel of entrepreneurs over two to three tourism seasons would provide stronger causal evidence. Second, self-reported revenue data are subject to recall bias and social desirability inflation; future studies should explore triangulation against LAHDC enterprise registration or Goods and Services Tax (GST) filing records. Third, the study's geographic coverage excludes the easternmost areas of Ladakh (Changthang and the Demchok corridor) because of access constraints, leaving the most geographically isolated women unrepresented. Future research should include: (a) experimental evaluation of the multi-platform training programme using randomised assignment with 18-month revenue tracking, (b) qualitative depth interviews

with high-revenue Instagram users documenting content strategy and platform management, (c) a cross-Himalayan comparative study extending the methodology to Spiti Valley, Sikkim and Nepal's Khumbu region to test whether the Instagram-WhatsApp duality is Ladakh-specific or pan-Himalayan and (d) matched-sample analysis of gendered differences in platform adoption and revenue outcomes.

8. CONCLUSION

This study provides a quantitative characterisation of digital marketing platform adoption and its revenue associations among women entrepreneurs in Ladakh's tourism sector, based on a stratified random sample of 346 participants across four sub-divisions. The findings indicate that digital platforms Instagram and WhatsApp Business in particular are associated with measurable and substantial differences in revenue outcomes: digital-primary businesses report mean annual revenues more than double those of offline-primary equivalents and the regression model accounts for 57.2% of the variance in revenue (adjusted R^2) through platform adoption, education and business-age variables. The SEM analysis indicates that digital skill and internet access are associated with revenue indirectly through their enabling role in platform adoption, consistent with the hypothesised structural relationships and with clear intervention implications. Beyond its immediate policy relevance, the study contributes to scholarship on digital entrepreneurship in geographically peripheral economies by demonstrating that platform ecosystems function not merely as communication technologies but as alternative infrastructures enabling market participation, customer acquisition and business visibility for historically marginalised entrepreneurial groups.

Against this positive evidence, the barrier data document persistent constraints, namely unreliable internet connectivity, skill deficits and language barriers, that prevent the majority of women from achieving the platform adoption intensity associated with the highest revenue outcomes. Resolving this compound infrastructure problem requires coordinated investment by the UT administration, central government infrastructure programmes and, critically, the platform companies themselves, whose Hindi and Ladakhi-language localisation investments remain far below what the market data justify. The compound finding that digital platform engagement generates large revenue returns while adoption is severely constrained by avoidable structural barriers constitutes both a diagnosis and an investment case: targeted, well-sequenced digital entrepreneurship support for Ladakhi women represents a potentially high-impact development intervention in the Himalayan tourism economy.

Ethics Statement

The studies involving human participants were reviewed and approved by the Research Ethics Committee, University of Ladakh, Leh, India. Written informed consent was obtained from all participants prior to their participation in the study.

Informed Consent

All respondents voluntarily participated in the study and provided informed consent.

AI Declaration

The author used a large language model (ChatGPT) for minor language editing, structural feedback during the revision phase and formatting purposes. No AI tools were used for data collection, statistical analysis or substantive interpretation of results.

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