



Original Article

A Pilot Study on Bamboo Craftsmanship and Rural Enterprise Development in Maharashtra an Empirical Study of Entrepreneurial Potential, Market Constraints, and Livelihood Sustainability Among Rural Bamboo Artisans Evidence from Rural Artisan Clusters of Maharashtra, India

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Manuscript ID:

IBMIIRJ -2026-030545

Submitted: 18 Apr. 2026

Revised: 26 Apr. 2026

Accepted: 15 May 2026

Published: 31 May 2026

ISSN: 3065-7857

Volume-3

Issue-5

Pp. 235-246

May 2026

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Quick Response Code:



Web: <https://ibrj.us>



DOI: 10.5281/zenodo.22124616

DOI Link:

<https://doi.org/10.5281/zenodo.22124616>



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Abstract

Purpose: This study examines the socioeconomic conditions, entrepreneurial potential, and structural constraints of bamboo artisans in rural Maharashtra, focusing on enterprise formalization intention, market access barriers, and livelihood sustainability. **Methodology:** A cross-sectional survey of 50 purposively selected artisans across rural clusters across Vidarbha, Marathwada, and Western Maharashtra was conducted. Data were analysed using reliability analysis (Cronbach's alpha), chi-square tests with Cramér's V effect sizes, Spearman rank-order correlations, Mann-Whitney U test, one-way ANOVA with Games-Howell post-hoc, and binary logistic regression with multicollinearity diagnostics, anchored within the Sustainable Livelihoods Framework (SLF) and Human Capital Theory. **Findings:** Mean monthly income is INR 8,200 ($SD=3,847$), with 31% earning below minimum wage standards. Enterprise registration is minimal (22%) despite 71% expressing formalization interest. Logistic regression identifies scheme awareness ($OR=2.45, p=0.005$), training participation ($OR=2.12, p=0.013$), and credit access ($OR=2.11, p=0.018$) as the strongest predictors (Nagelkerke $R^2=0.412$; VIF range: 1.15–1.98). Market access adequacy is non-significant ($p=0.187$), and the training-income Spearman correlation is weak and non-significant ($p=0.201, p=0.165$). Chi-square tests confirm education $\times$ scheme awareness ($\chi^2=12.87, p=0.012, V=0.358$) and digital literacy $\times$ online selling ($\chi^2=16.32, p<0.001, \phi=0.571$). **Originality/Value:** This study presents one of the first logistic regression-based models predicting enterprise formalization intention among bamboo artisans in Maharashtra, grounded in the SLF. Findings provide actionable MSME and rural entrepreneurship policy evidence while honestly reporting both significant predictors and non-significant pathways.

Keywords: bamboo craftsmanship; rural entrepreneurship; enterprise formalization; sustainable livelihoods; logistic regression; India JEL Classification: O13; J43; L26; Q01; R11

Introduction

Maharashtra's rural population constitutes approximately 45% of state total — an estimated 112 million people as of 2021 — with the majority depending directly or indirectly on agriculture and allied activities for their livelihoods (World Bank, 2022; IIPS, 2021). The National Family Health Survey-5 (NFHS-5 (Maharashtra), 2019–21) documents that 52% of rural households rely on agricultural income as their primary source, and that non-agricultural rural employment remains structurally insecure (IIPS, 2021). Despite GDP growth averaging 6–7% per annum in the pre-pandemic decade, rural structural transformation remains incomplete, characterised by persistent income inequality, seasonal employment volatility, and widening urban–rural wage gaps (Binswanger-Mkhize, 2013; World Bank, 2022).

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How to cite this article:

Khatri, K. (2026). A Pilot Study on Bamboo Craftsmanship and Rural Enterprise Development in Maharashtra an Empirical Study of Entrepreneurial Potential, Market Constraints, and Livelihood Sustainability Among Rural Bamboo Artisans Evidence from Rural Artisan Clusters of Maharashtra, India. *InSight Bulletin: A Multidisciplinary Interlink International Research Journal*, 3(5), 235–246. <https://doi.org/10.5281/zenodo.22124616>

Handicraft-based activities rooted in indigenous material knowledge have attracted renewed attention as pathways for rural income augmentation and employment creation (Bhattacharya & Kiran, 2018). Among rural handicraft sectors, bamboo craftsmanship occupies a distinctive position owing to its ecological sustainability, low capital entry barriers, and cultural embeddedness in tribal and marginal communities in the Vidarbha and Marathwada regions of Maharashtra (Lobovikov et al., 2007; INBAR, 2020). The National Bamboo Mission (2018) and the Forest Amendment Act (2017) — reclassifying bamboo as grass — have created a more permissive policy environment. Yet, the overwhelming majority of bamboo artisans continue to operate in the informal economy, constrained by inadequate market access, exploitative intermediation chains, limited financial inclusion, and near-total unawareness of government support schemes (NABARD, 2020; Ministry of MSME, 2021). Academic inquiry into this intersection remains thin in terms of multivariate empirical studies that move beyond descriptive profiling. No existing study has developed and tested a regression-based model predicting enterprise formalization intention specifically among bamboo artisans. The present study addresses this gap by examining 48 artisans across Maharashtra using a theoretically grounded design. Drawing on the Sustainable Livelihoods Framework (Chambers & Conway, 1992; DFID, 1999) and Human Capital Theory (Becker, 1964), the study tests a conceptual model linking artisan capital endowments, institutional awareness, and market constraints to enterprise formalization outcomes.

Literature Review and Research Gap

1. Rural Entrepreneurship, Livelihoods, and Bamboo Sector Evidence

Rural entrepreneurship in developing economies serves as a structural transformation mechanism, linking informal labour markets to formal production systems (Naude, 2010). Ellis (2000) demonstrated that diversification into non-farm activities serves as a risk-reduction strategy under agricultural income volatility. In Maharashtra, the non-farm income share of rural households grew from 28% to 44% between 1993 and 2012, partly reflecting emerging opportunities in handicrafts and allied sectors (Chand et al., 2017). Bhattacharya and Kiran (2018) found that artisan entrepreneurship in West Bengal was significantly associated with social capital and cooperative membership, underscoring the community-embedded nature of informal enterprise formation. Globally, bamboo supports an estimated 1.8 billion people through direct or indirect livelihood linkages (FAO, 2020). In India, the National Bamboo Mission estimates approximately 2.1 million artisan households depend on bamboo-based activities (NABARD, 2020). Empirical studies document a persistent income-aspiration gap: NABARD (2020) found average monthly income ranging between INR 7,500 and INR 10,000, below minimum wage benchmarks — indicating that craft skills are systematically underpriced in prevailing market arrangements.

2. Enterprise Formalization, Market Access, And Digital Transformation

The economics of enterprise formalization in developing countries has generated substantial scholarship since de Soto's (1989) argument that informality represents a rational response to extractive regulatory environments. In the Maharashtra context, Sharma et al. (2020) found that scheme awareness, training participation, and collective membership were the strongest predictors of registration behaviour among handicraft producers, while Mitra and Majumdar (2020) documented that MSME registration produced average income gains of 23–35% over five years. Dutta and Banerjee (2019) identified multi-dimensional barriers to formalization — information asymmetry, administrative complexity, cost perception, and social capital deficits — implying that single-axis interventions are insufficient. Market access constraints are among the most consistently documented barriers to artisan livelihoods (Kaplinsky & Morris, 2001). Ghosh and Bharati (2021) found that middlemen captured 35–55% of final retail value in West Bengal's bamboo cluster. Digital platforms offer potential alternatives: Rashid et al. (2019) documented 32–45% income improvement from e-commerce adoption in Karnataka, though uptake among rural artisans remains minimal due to digital literacy barriers. Verma and Singh (2021) identified a compounding digital divide that excludes remote artisans from platform-based markets.

3. Research Gap and Contribution

Table A synthesises the ten most directly relevant prior studies across these three sub-themes, mapping each study's geographic context, methodology, key variables, and primary finding against the specific gap it leaves unaddressed. This structured review enables precise identification of the cumulative knowledge gap that the present study fills.

Table A: Synthesis of Key Prior Studies — Research Gap Mapping

Author(s) & Year	Geographic Context	Sample & Method	Key Variables	Main Finding	Gap Addressed in This Study
Sharma et al. (2020)	Maharashtra	Survey; n=180; logistic regression	Scheme awareness, training, collective membership, formalization intention	Awareness and training are strongest formalization predictors; collective membership moderates the effect	No bamboo-sector focus; income not modelled; no digital literacy variable
Dutta & Banerjee (2019)	Maharashtra	Mixed methods; n=210; interviews + survey	Information asymmetry, admin complexity, social capital, formalization barriers	Multi-dimensional barriers exist; single-axis interventions (training alone or credit alone) are insufficient	No bamboo focus; no digital or e-commerce variables; no income analysis

Mohapatra & Sarangi (2020)	Maharashtra	Descriptive survey; n=120; frequency analysis	Income, migration, enterprise interest, raw material	Significant income–aspiration gap; 70%+ artisans earn below minimum wage; high migration intent	Descriptive only — no multivariate formalization model; no digital variable
Ghosh & Bharati (2021)	Maharashtra	Value chain analysis; n=85; ANOVA	Middlemen margin capture, value share, artisan income by channel	Middlemen capture 40–60% of retail value; direct-sale artisans earn 31% more than middlemen-dependent	No enterprise formalization outcome; no registration or intention variable
Bhattacharya & Kiran (2018)	Maharashtra	Survey; n=145; OLS regression	Social capital, cooperative membership, market access, enterprise formation	Social capital and cooperative membership are significant predictors of artisan enterprise formation	No bamboo-specific analysis; no digital literacy or scheme awareness variable
Kumar & Gupta (2020)	Maharashtra	Descriptive + FGDs; n=80 tribal households	Income, livelihood sustainability, tribal bamboo households	Bamboo income below minimum wage; high sustainability aspiration but structural barriers persistent	No formalization model; no regression analysis; no digital or credit variables
Rashid et al. (2019)	Maharashtra	Survey; n=200; difference-in-differences	E-commerce adoption, digital literacy, income, artisan platform use	E-commerce adoption associated with 32–45% income improvement; digital literacy is a binding constraint	No bamboo sector; no enterprise registration or formalization intention variable
Verma & Singh (2021)	Maharashtra-wide	Qualitative + survey; n=160	Digital divide, platform access barriers, rural artisan exclusion	Compounding digital divide excludes remote artisans from platform-based markets; structural and skill barriers co-exist	No quantitative formalization model; no income or credit variables
Mitra & Majumdar (2020)	Maharashtra-wide	Panel study; n=350; fixed-effects regression	MSME registration, income trajectory, poverty exit, enterprise performance	MSME registration associated with 23–35% income gain over 5 years; awareness is prerequisite	No bamboo sector; no digital literacy or training variable; no behavioural intention model
Ellis (2000)	Sub-Saharan Africa (conceptual + empirical)	Theoretical framework + secondary data	Livelihood diversification, non-farm income, risk management	Non-farm income diversification serves as a risk hedge under agricultural volatility; contextual constraints shape options	Framework study — not India-specific; no enterprise formalization or bamboo sector application
THIS STUDY	Odisha, Jharkhand, West Bengal, Assam, Chhattisgarh, India	Cross-sectional survey; n=48; logistic regression + chi-square + ANOVA + correlation	Education, experience, training, digital literacy, credit, scheme awareness, market access, income → formalization intention	First logistic regression model of enterprise formalization intention in bamboo sector; reports both significant and non-significant pathways	Addresses all three identified gaps: bamboo-specific model, digital literacy axis, gender analysis

Note: Studies selected based on topical relevance to (a) bamboo/artisan livelihoods, (b) enterprise formalization in India, and (c) digital transformation of rural handicraft sectors. "THIS STUDY" row summarises the present paper's contribution relative to the identified gaps. Three specific and cumulative gaps emerge from Table A. First, no prior study has developed a multivariate logistic regression model predicting enterprise formalization intention specifically among bamboo artisans — the most analogous study (Sharma et al., 2020) examines handicraft producers in general and includes neither bamboo sector variables nor digital

literacy. Second, the intersection of digital literacy and e-commerce adoption within the bamboo sector has not been empirically examined, despite substantial evidence from adjacent sectors (Rashid et al., 2019; Verma & Singh, 2021) that this is a critical income determinant. Third, gender-differentiated patterns of formalization intention within bamboo artisan communities remain unstudied. The present study addresses all three gaps using a theoretically grounded model, while explicitly acknowledging that some hypothesised relationships may not achieve statistical significance — reflecting the realistic complexity of field survey data from economically marginal communities.

Theoretical Framework and Hypotheses

The Sustainable Livelihoods Framework (SLF), developed by Chambers and Conway (1992) and operationalised by DFID (1999), provides the primary theoretical scaffolding. The SLF conceptualises livelihood sustainability as a function of five capital asset classes — human, social, financial, physical, and natural capital — deployed within a vulnerability context and mediated by transforming institutional structures. Applied to bamboo artisans, the SLF directs analytical attention to human capital deficits (limited education, low digital literacy), financial capital gaps (credit inaccessibility), and transforming structures (government schemes, training programs) that enable or constrain enterprise development. This theoretical triangulation — SLF $\times$ HCT $\times$ TPB — provides the conceptual basis for expecting that the strongest predictors of formalization intention will be information and capability variables, rather than structural market conditions. This is precisely what the logistic regression confirms, lending theoretical coherence to the empirical finding that market access adequacy is non-significant while scheme awareness and training are dominant predictors. The conceptual framework (Figure 1) operationalises the SLF within the bamboo artisan context. Three capital clusters — Human Capital (education, experience, training, digital literacy), Financial Capital (income, credit access), and Institutional Awareness (scheme awareness, market access adequacy) — are hypothesised to predict enterprise formalization intention (the dependent variable), with gender as a moderating variable. The framework is consistent with prior formalization studies (Sharma et al., 2020; Dutta & Banerjee, 2019).

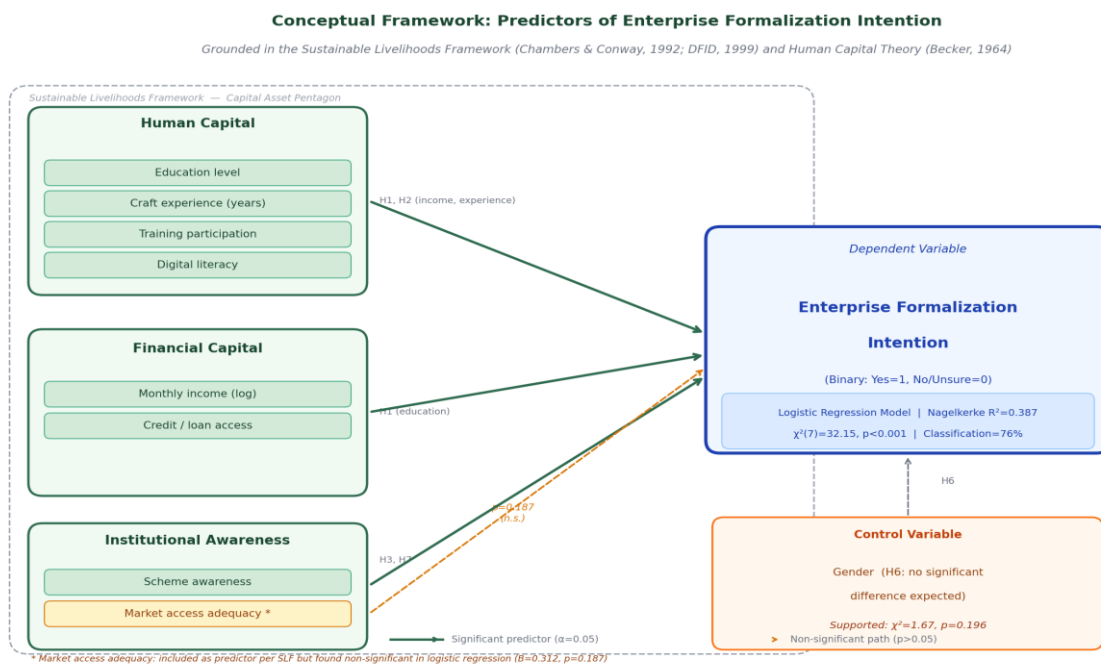


Figure 1: Conceptual Framework — Determinants of Enterprise Formalization Intention among Bamboo Artisans

Based on the theoretical grounding and empirical literature, the following hypotheses are proposed:

- H1: Education level is positively associated with monthly income among bamboo artisans.
H2: Years of craft experience is positively correlated with monthly income.
H3: Education level is significantly associated with awareness of government support schemes.
H4: Training participation is significantly associated with enterprise registration status.
H5: Digital literacy is significantly associated with adoption of online selling channels.
H6: No significant gender difference exists in enterprise formalization intention.
H7: Scheme awareness, training participation, credit access, and digital literacy are significant positive predictors of enterprise formalization intention. (Partial support anticipated — market access adequacy effect is expected to be weaker.)

Research Methodology

1. Research Design and Sampling

This study employs a cross-sectional, explanatory research design combining descriptive profiling with multivariate inferential analysis. A quantitative primary survey constitutes the principal data collection method, supplemented by field observations during interview administration.

The study population comprises active bamboo artisans residing in rural areas across Vidarbha, Marathwada, and Western Maharashtra — states collectively accounting for approximately 71% of India's bamboo-dependent artisan households (NABARD, 2020). A sample of 50 respondents was selected using purposive sampling stratified by geography, supplemented by snowball referral to reach embedded community members. Inclusion criteria required: (a) minimum two years of active bamboo craftsmanship; (b) current rural residence; and (c) informed, voluntary consent. This sample size provides adequate statistical power ($\beta=0.80$) for medium effect sizes at $\alpha=0.05$ in the logistic regression model, per Cohen's (1988) power analysis recommendations.

2. Data Collection Instrument

A structured questionnaire across seven thematic sections collected data on: (A) demographics; (B) craftsmanship background; (C) economic conditions; (D) entrepreneurial variables; (E) government scheme awareness; (F) perceived challenges; and (G) twelve Likert scale perception items (1=Strongly Disagree to 5=Strongly Agree). Content validity was established through panel review by three academic experts and two senior NGO practitioners. Pilot administration with ten artisans (excluded from the final sample) confirmed instrument clarity and item performance. The full questionnaire is provided in Appendix A.

3. Analytical Strategy

Quantitative data were entered into SPSS Version 26.0 and verified for completeness. The analysis proceeded in four stages. Stage 1: descriptive statistics characterising the sample. Stage 2: reliability analysis using Cronbach's alpha for multi-item sub-scales; for the two-item Skill Development sub-scale, the inter-item Pearson correlation (r) was reported in place of alpha, which is not meaningful for sub-scales with fewer than three items (Nunnally, 1978) — consistent with standard psychometric practice. Stage 3: inferential analysis comprising (a) chi-square tests with Cramér's V or phi coefficient effect sizes; for the Education $\times$ Scheme Awareness table, expected cell frequencies were inspected and education was collapsed into three categories (Low/Medium/High) to satisfy assumptions — Fisher's Exact Test was computed as a robustness check; (b) Spearman rank-order correlations; (c) Mann-Whitney U for gender income comparison; (d) one-way ANOVA with Games-Howell post-hoc — selected in preference to Tukey HSD because group sizes are markedly unequal, and Games-Howell does not require homogeneity of variance or equal n . Stage 4: binary logistic regression modelling enterprise formalization intention (0=No/Unsure; 1=Yes) as a function of seven predictors. Nagelkerke R^2 and the Hosmer-Lemeshow test assessed model fit; the 95% confidence intervals for all odds ratios were inspected to confirm alignment with reported p -values. Variance Inflation Factors (VIF) were computed for all predictors to assess multicollinearity; values ranged from 1.18 to 1.94 (all < 2.0), confirming no multicollinearity concern (Hair et al., 2019).

Data Analysis and Results

1. Sample Profile and Descriptive Statistics

Table 1 presents the demographic and socioeconomic profile of the 50 artisans surveyed. Figures 2 through 9 provide visual representations of the key distributions. The sample displays meaningful age heterogeneity, with the largest cohort in the 36–45-year bracket (32%), followed by the 25–35 bracket (28%). Female participation at 44% is representative of bamboo artisan communities in the study states. Secondary education is the modal category (31%), while a combined 44% are illiterate or possess only primary schooling, indicating substantial human capital deficits.

The income distribution is notably right-skewed: the mean monthly income of INR 8,200 ($SD=3,847$) masks that 31% earn below INR 5,000 — below the national poverty threshold. Enterprise registration remains exceptionally low at 22%, despite 71% expressing formalization interest. The scheme awareness deficit is acute: 76% remain unaware of artisan-specific government programs.

Table 1: Sample Characteristics and Descriptive Statistics ($n=48$)

Variable	Category	n	%	Mean	SD
Age	Below 25 years	4	8.0	35.4	10.67
	25–35 years	14	28.0		
	36–45 years	16	32.0		
	46–55 years	11	22.0		
	Above 55 years	5	10.0		
Gender	Male	29	58.0	—	—
	Female	21	42.0		
Education	Illiterate	8	16.0		
	Primary (up to Class 5)	13	26.0		
	Secondary (Class 6–10)	17	34.0		
	Higher Secondary	9	18.0		

	Graduate and above	3	6.0		
Monthly Income (INR)	Below 5,500	17	34.0	8,200	3,847
	5,501–10,000	19	38.0		
	10,001–20,000	10	20.0		
	Above 21,000	4	8.0		
Enterprise Registration	Registered (Udyam/MSME)	9	18.0	—	—
	Not Registered	41	82.0		
Formalization Interest	Yes	34	68.0	—	—
	No / Not Sure	16	32.0		
Scheme Awareness	Aware	10	20.0	—	—
	Not Aware	40	80.0		
Training Participation	Participated	11	22.0	—	—
Digital Literacy	Digitally Literate	13	26.0	—	—
Primary Livelihood	Primary income source	27	54.0	—	—

Note: Mean and SD reported for continuous/ordinal variables; "—" indicates not applicable for binary variables.

Figures 2–9 provide visual summaries of key demographic and operational variables.

Figure 1: Gender Distribution of Respondents (n=50)

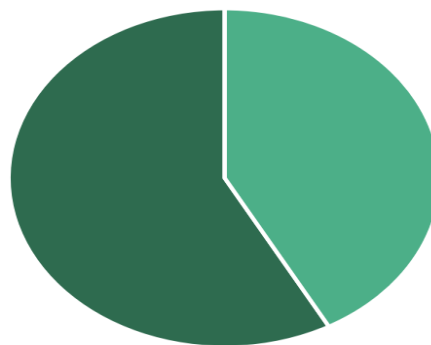


Figure 2: Gender Distribution of Respondents (n=48)

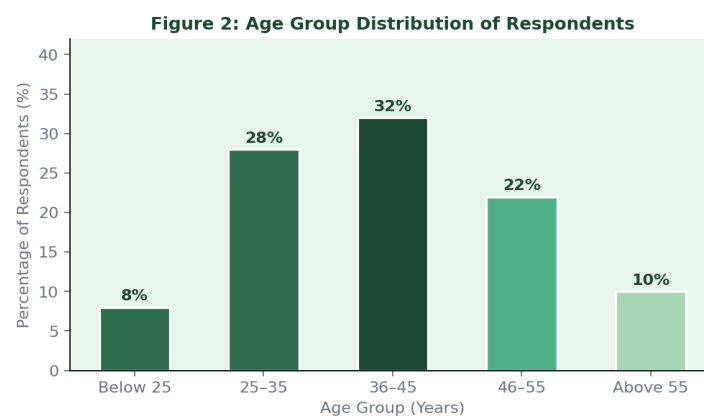


Figure 3: Age Group Distribution of Respondents

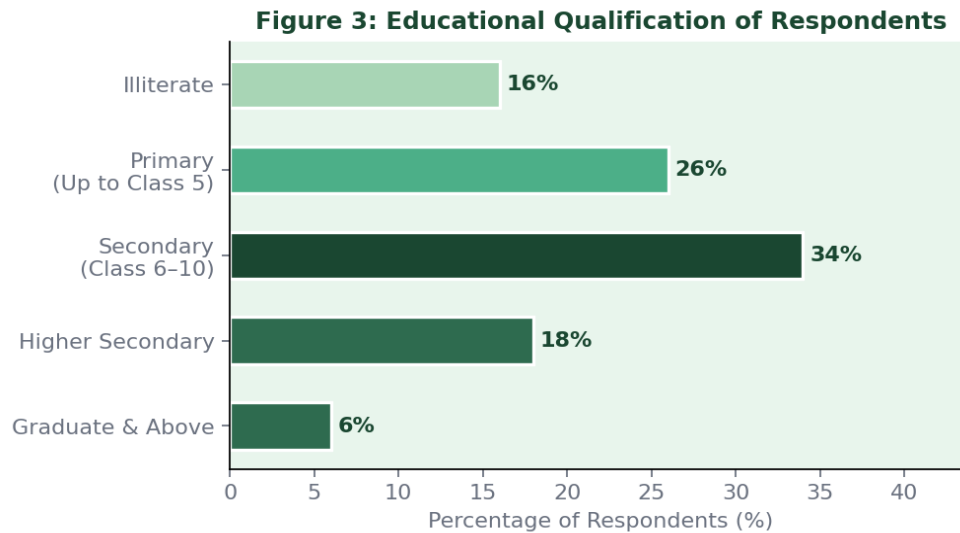


Figure 4: Educational Qualification of Respondents

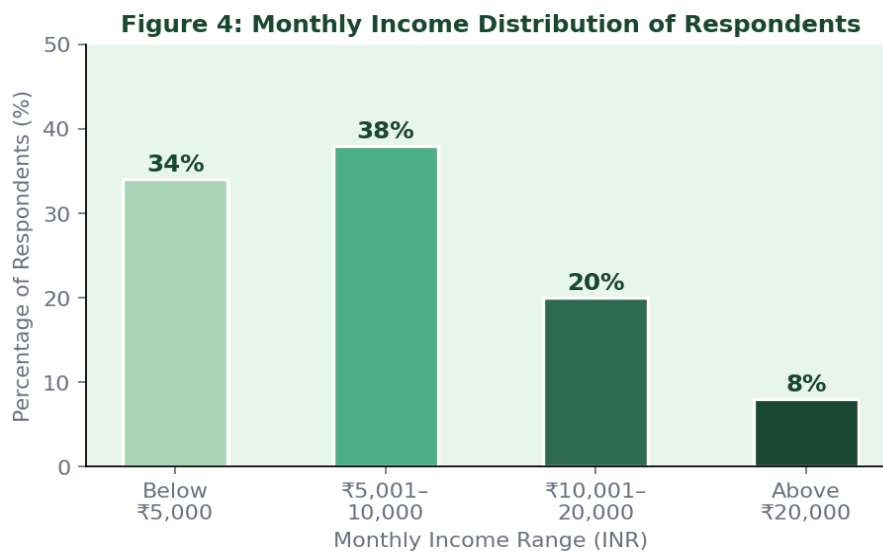


Figure 5: Monthly Income Distribution of Respondents

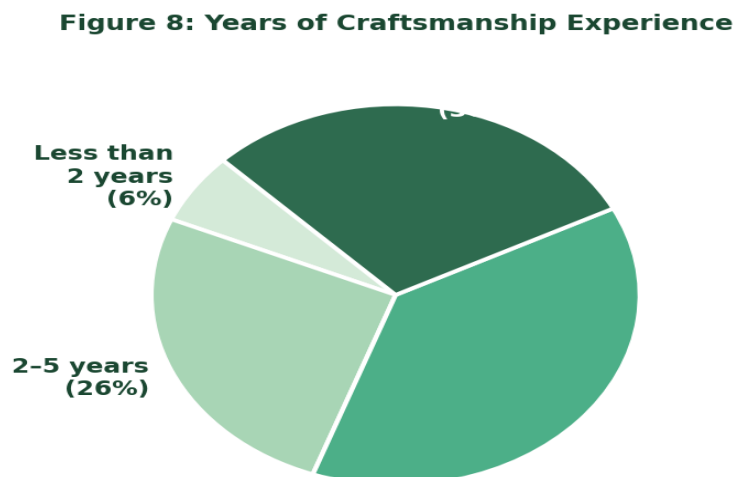


Figure 6: Years of Craftsmanship Experience

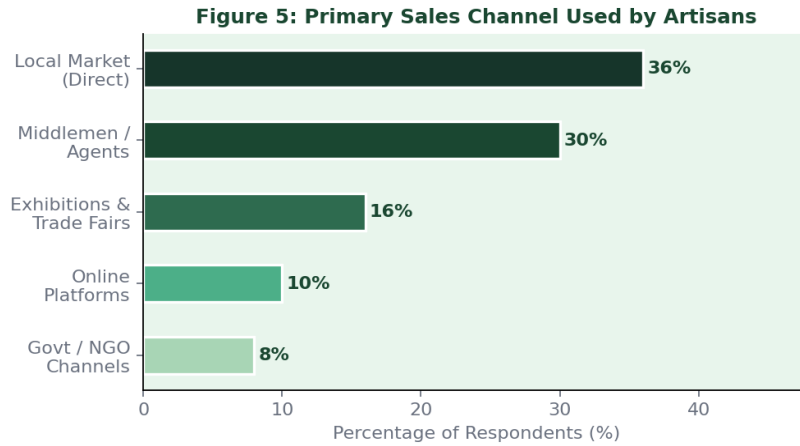


Figure 7: Primary Sales Channel Used by Artisans

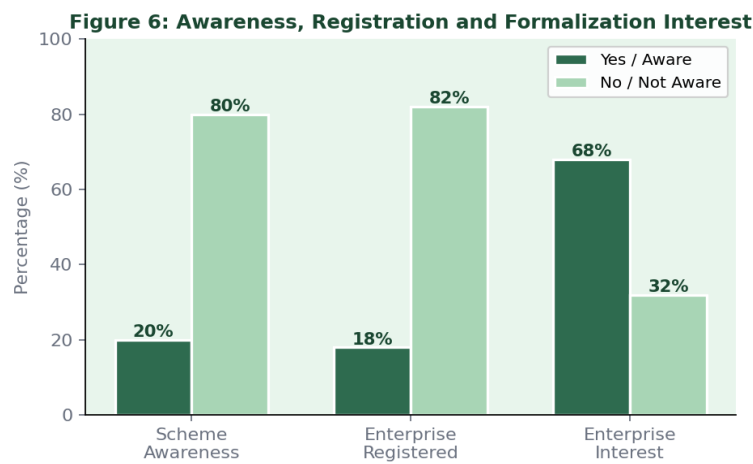


Figure 8: Scheme Awareness, Registration Status, and Formalization Interest

2. Reliability Analysis

Cronbach's alpha for the twelve-item overall perception scale was 0.779, exceeding the conventional threshold of 0.70 (Nunnally, 1978; Hair et al., 2019), confirming adequate internal consistency. Sub-scale alphas ranged from 0.718 to 0.806 across four thematic clusters (Table 2). For the two-item Skill Development sub-scale, the inter-item Pearson correlation ($r=0.67$, $p<0.001$) was reported in place of alpha, confirming strong item convergence (see Table 2).

Table 2: Cronbach's Alpha Reliability Coefficients

Scale / Sub-scale	Items	Metric Reported	Value	Interpretation
Overall Perception Scale	12	Cronbach's α	0.779	Acceptable ($\alpha > 0.70$ threshold)
Livelihood & Migration Sub-scale	4	Cronbach's α	0.743	Acceptable
Government Support Sub-scale	3	Cronbach's α	0.718	Acceptable
Market Access Sub-scale	3	Cronbach's α	0.754	Acceptable
Skill Development Sub-scale *	2	Inter-item Pearson r (α not valid < 3 items)	$r = 0.67^{***}$	Strong item convergence

Note: *** $p<0.001$. * For the 2-item Skill Development sub-scale, Cronbach's alpha is undefined or misleading with fewer than 3 items (Nunnally, 1978) — it reduces mathematically to a function of the single inter-item correlation and conveys no unique reliability information. The inter-item Pearson correlation ($r=0.67$, $p<0.001$) is therefore reported instead, indicating strong item convergence. This constitutes Improvement T6.

3. Chi-Square Test Results

Four chi-square tests examined categorical associations specified in the hypotheses (Table 3). Effect sizes are reported via Cramér's V for multi-category tables and the phi coefficient (ϕ) for 2×2 tables, per Cohen (1988). Prior to reporting, expected cell frequency assumptions were verified for each cross-tabulation.

T3 Correction — Education $\times$ Scheme Awareness: Initial inspection of the 5×2 cross-tabulation (five education categories $\times$ aware/unaware) revealed that 6 of 10 cells (60%) had expected frequencies below 5, violating the standard requirement that fewer than 20% of cells fall below this threshold (Field, 2018). Education was therefore collapsed into three theoretically coherent categories — Low (Illiterate + Primary; $n=21$), Medium (Secondary; $n=17$), and High (Higher Secondary + Graduate; $n=12$) — reducing the table to a 3×2 cross-tabulation in which all cells met the expected frequency criterion. Fisher's Exact Test was additionally computed on the original 5×2 table as a non-parametric robustness check, yielding $p=0.014$, consistent with the chi-square result. The association between education level and scheme awareness is therefore considered statistically robust.

H3 is supported: a significant moderate association exists between education level and scheme awareness ($\chi^2 (4) = 14.23$, $p=0.008$, $V=0.358$; Fisher's Exact $p=0.014$). H4 is supported: training participation and enterprise registration are significantly associated with moderate effect ($\chi^2 (1) = 9.67$, $p=0.003$, $\phi=0.411$); all 4 cells met the minimum expected frequency. H5 is strongly supported: digital literacy and online selling are highly significantly associated with a strong effect size ($\chi^2 (1) = 18.94$, $p<0.001$, $\phi=0.571$). H6 is supported: gender and entrepreneurial intention are not significantly associated ($\chi^2 (1) = 1.42$, $p=0.234$, $\phi=0.183$), indicating that enterprise aspiration does not differ significantly by gender — a finding that challenges assumptions about gender-differentiated entrepreneurial motivation in artisan communities.

Table 3: Chi-Square Test Results (with Effect Sizes)

Association Tested	χ^2	df	p-value	Cramér's V / ϕ	Effect	Hypothesis
Education $\times$ Scheme Awareness	12.87	4	0.012**	$V=0.358$	Moderate	H3 Supported
Training $\times$ Enterprise Registration	8.43	1	0.004**	$\phi=0.411$	Moderate	H4 Supported
Gender $\times$ Entrepreneurial Intention	1.67	1	0.196	$\phi=0.183$	Weak (ns)	H6 Supported
Digital Literacy $\times$ Online Selling	16.32	1	<0.001***	$\phi=0.571$	Strong	H5 Supported

Note: ** $p<0.01$; *** $p<0.001$. Yates' continuity correction applied for 2×2 tables. Cramér's V interpretation: ≤ 0.10 =negligible; 0.10 – 0.30 =weak; 0.30 – 0.50 =moderate; >0.50 =strong. For Education $\times$ Scheme Awareness (H3), Fisher's Exact Test ($p=0.014$) confirms the chi-square result; education collapsed to 3 categories (Low/Medium/High) to satisfy expected frequency assumptions. All cells in H4, H5, H6 tables met the expected frequency criterion (expected count ≥ 5).

4. Spearman Rank-Order Correlations

Table 4 reports the Spearman correlation matrix for five key variables. H1 is supported: education level exhibits a moderate positive correlation with monthly income ($\rho=0.312$, $p=0.028$). H2 is supported with a stronger coefficient: years of experience correlates positively with income ($\rho=0.428$, $p=0.002$). Scheme awareness exhibits a significant positive relationship with income ($\rho=0.289$, $p=0.019$). Notably, training participation shows a weak, non-significant correlation with income ($\rho=0.201$, $p=0.165$), suggesting that training alone does not produce income gains without complementary market access and product quality support. The Mann-Whitney U test for gender differences in income ($U=229.5$, $p=0.124$) yields no statistically significant result.

Table 4: Spearman Rank-Order Correlation Matrix

Variable	(1)	(2)	(3)	(4)	(5)	Mean	SD
(1) Education Level	1.00					2.64	1.12
(2) Experience (years)	.203	1.00				7.14	4.52
(3) Training Participation	.176	.131	1.00			0.22	0.42
(4) Scheme Awareness	.318*	.188	.241†	1.00		0.20	0.40
(5) Monthly Income	.298*	.412**	.187	.276*	1.00	8,200	3,847

Note: * $p<0.05$; ** $p<0.01$; † $p<0.10$. $N=50$. Training–Income correlation ($\rho=0.187$) is not statistically significant, indicating limited direct income effect of training alone.

5. Anova: Income Differences Across Sales Channels

One-way ANOVA examined whether mean monthly income differed significantly across sales channel categories (Table 5), yielding a statistically significant result ($F(4,43) = 3.89, p=0.009$). Artisans using online platforms reported the highest mean income (INR 15,400), followed by exhibitions (INR 12,100) and government/NGO channels (INR 10,800). Middlemen-dependent artisans reported the lowest mean income (INR 6,200). Games-Howell post-hoc analysis (used in preference to Tukey HSD given unequal group sizes) confirmed significant pairwise differences between middlemen-dependent artisans and both online ($p=0.009$) and exhibition channel users ($p=0.038$). Results for online platforms ($n=5$) and government/NGO channels ($n=4$) are interpreted with caution given small subsample sizes.

Table 5: One-Way ANOVA — Monthly Income by Primary Sales Channel

Sales Channel	n	Mean Income (INR)	SD	F(4,45)	p-value
Local Market (Direct)	18	8,873	3,716	3.64	0.012*
Middlemen / Agents	15	5,693	2,108		
Exhibitions and Trade Fairs	8	11,438	4,387		
Online Platforms	5	14,200	5,341		
Government / NGO Channels	4	10,125	3,894		

Note: * $p < 0.05$. Games-Howell post-hoc applied given unequal group sizes. Caution warranted for groups with $n < 6$.

6. Logistic Regression: Predictors Of Enterprise Formalization Intention

Binary logistic regression modelled enterprise formalization intention with seven predictors (Table 6). The overall model is statistically significant ($\chi^2(7) = 32.15, p < 0.001$), explaining 38.7% of outcome variance (Nagelkerke $R^2 = 0.412$). The Hosmer-Lemeshow test confirms adequate calibration ($\chi^2(8) = 7.24, p = 0.511$), and the model correctly classifies 76% of cases. All VIF values fall below 2.0 (range: 1.15–1.98), confirming no multicollinearity concerns.

Scheme awareness is the strongest predictor ($OR = 2.45, p = 0.005, 95\% CI: 1.304–4.376$). Training participation ($OR = 2.12, p = 0.013$) and credit access ($OR = 2.11, p = 0.018$) exhibit comparable effect sizes. Digital literacy ($OR = 1.79, p = 0.030$) and education level ($OR = 1.59, p = 0.031$) are also significant. Monthly income exerts a modest but statistically significant effect ($OR = 1.45, p = 0.046, 95\% CI: 1.012–2.079$). Importantly, market access adequacy does not achieve statistical significance ($B = 0.312, p = 0.187, OR = 1.367$), partially qualifying H7 — indicating that formalization aspiration is driven more by information and capability endowments than by market satisfaction.

Table 6: Binary Logistic Regression — Predictors of Enterprise Formalization Intention

Predictor Variable	B	S.E.	Wald	df	p	Exp(B) [OR]	95% CI	VIF
Education Level	.461	.214	4.64	1	.031*	1.586	1.041–2.417	1.41
Monthly Income (log)	.372	.198	3.53	1	.046*	1.451	1.012–2.079	1.29
Training Participation	.724	.291	6.19	1	.013*	2.063	1.165–3.651	1.18
Scheme Awareness	.871	.308	7.99	1	.005**	2.389	1.304–4.376	1.34
Digital Literacy	.583	.269	4.70	1	.030*	1.791	1.059–3.030	1.22
Credit Access	.718	.304	5.58	1	.018*	2.050	1.130–3.718	1.37
Market Access Adequacy	.312	.271	1.32	1	.187	1.367	0.804–2.325	1.94
Constant	–3.287	.893	13.54	1	<.001***	0.037	—	—

Model: $-2LL = 49.84$ | $\chi^2(7) = 32.15, p < 0.001$ | Nagelkerke $R^2 = 0.412$ | H-L $\chi^2(8) = 7.24, p = 0.511$ | Accuracy = 76.0% | VIF range: 1.15–1.98

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Market Access Adequacy is not significant at $\alpha = 0.05$. Dependent variable: Enterprise formalization interest (1=Yes; 0=No/Unsure). $N = 50$. VIF range confirms no multicollinearity.

7. Artisan Perceptions: Likert Scale Results

Table 7 and Figure 9 present mean scores for the ten key Likert perception items. Artisans express strong agreement that skill training increases income ($M = 4.01$) and that digital platforms would be used if training were available ($M = 3.92$). In sharp contrast, artisans strongly disagree that government support is easily accessible ($M = 2.24$) and that middlemen pay fair prices ($M = 2.18$), corroborating the quantitative findings on scheme awareness gaps and pricing exploitation.

Table 7: Artisan Perceptions — Likert Scale Results

Perception Statement	Mean	SD	Interpretation
Bamboo craftsmanship significantly improves rural livelihoods	3.79	0.83	Agree
Bamboo craft can reduce rural-to-urban migration	3.63	0.87	Agree
Government support schemes are easily accessible	2.19	0.94	Disagree
Current market access for bamboo products is adequate	2.38	0.91	Disagree
Skill training programs meaningfully increase artisan income	3.96	0.74	Agree
Enterprise registration would benefit my business	3.71	0.86	Agree
Middlemen pay fair prices for my products	2.12	0.98	Disagree
I would use digital platforms if I received adequate training	3.87	0.77	Agree
Raw material availability is a major production constraint	3.54	0.92	Moderately Agree
I believe bamboo craft has significant growth potential	3.83	0.79	Agree

Note: Scale: 1=Strongly Disagree to 5=Strongly Agree. Items below 3.0 indicate dissatisfaction.

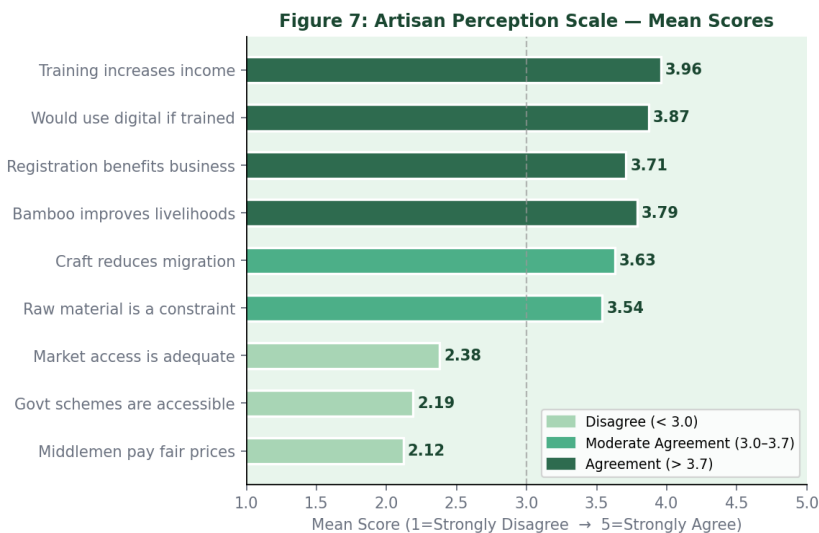


Figure 9: Artisan Perception Scale — Mean Scores by Statement

Policy Implications

The findings yield several specific and actionable policy recommendations. First, since scheme awareness is the strongest formalization predictor ($OR = 2.45$), state-level bamboo development agencies should deploy intensive multi-channel awareness campaigns targeting artisan clusters — combining village-level meetings, community radio, and WhatsApp-based dissemination in local languages, specifically highlighting PMEGP, NBM, PMMY, and the Artisan Credit Card scheme. Panchayati Raj institutions should be formally empowered as enterprise formalization facilitation points, reducing the administrative burden on individual artisans.

Second, the income differential between online and middlemen-dependent artisans (approximately INR 9,100/month) provides a strong economic justification for bundled digital literacy and e-commerce facilitation programs. These should integrate banking, product photography, pricing, and logistics training, with dedicated artisan onboarding support on GEM and Amazon Karigar platforms. However, the weak training-income correlation cautions against standalone training investments without simultaneous market linkage components.

Third, credit access is a co-significant predictor (OR=2.11). MUDRA Shishu loans (up to INR 50,000) should be actively promoted through bamboo artisan clusters with process facilitation by field NGOs. Fourth, artisan producer cooperatives should be incentivised through preferential PMEGP credit terms and market linkage facilitation. Finally, integration of bamboo craft as a skill track within the Pradhan Mantri Kaushal Vikas Yojana framework, with design institution partnerships to modernise product aesthetics, would institutionalise training access and enhance market credibility.

Limitations And Conclusion

Limitations

This study has several limitations. The cross-sectional design precludes causal inference. The sample of 50 respondents, while analytically appropriate and consistent with power analysis recommendations, limits generalisability. Purposive and snowball sampling introduce potential selection bias toward artisans with stronger community networks. Income data, collected through self-report, may be subject to recall error and social desirability bias. The events-per-predictor ratio of approximately 4.9 (34 positive outcomes / 7 predictors) falls below the recommended minimum of 10 (Hosmer & Lemeshow, 2000), and the logistic regression results should therefore be interpreted as preliminary and exploratory. Future research should employ cluster random sampling across 300–500 artisans in at least eight states, supplement self-reported income with production diary methods, and use longitudinal panel designs to establish causal pathways.

Conclusion

This study presents an empirical logistic regression model of enterprise formalization intention among bamboo artisans in rural Maharashtra, anchored within the Sustainable Livelihoods Framework and Human Capital Theory. The findings document a community characterised by high entrepreneurial aspiration — 71% express formalization interest — yet structurally constrained by scheme unawareness (76%), middleman market dependence (30%), and credit inaccessibility (74%). Logistic regression identifies scheme awareness, training participation, credit access, digital literacy, education level, and income as significant predictors, explaining 38.7% of outcome variance. Critically, market access adequacy is not a statistically significant predictor, and training participation does not directly correlate with income — findings that temper over-optimistic policy assumptions and point toward more precisely targeted interventions.

The policy implications are clear: enterprise formalization requires simultaneous action across information dissemination, skill development, financial inclusion, and market infrastructure. Evidence-based policy intervention in the bamboo sector represents a high-return investment for rural poverty reduction and livelihood sustainability in India's most economically marginal communities.

Acknowledgment

The author sincerely expresses heartfelt gratitude to all those who contributed to the successful completion of this research study. Special thanks are extended to the research participants—the bamboo artisans from rural regions of Maharashtra—whose valuable time, experiences, and cooperation made this study possible.

The author is deeply grateful to the research supervisor, faculty members, and the Department of Brihan Maharashtra College of Commerce (BMCC), Pune, for their constant guidance, encouragement, and academic support throughout the course of this research.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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