ASSESSING THE ROLE OF UPI IN ENHANCING FINANCIAL INCLUSION AND DIGITAL TRUST: AN EMPIRICAL STUDY FROM INDIA'S EMERGING ECONOMY

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ABSTRACT

India's digital financial ecosystem has witnessed a paradigm shift with the rapid adoption of the Unified Payments Interface (UPI), positioning it as a cornerstone for advancing financial inclusion and digital trust. While initial adoption metrics have been encouraging, the sustainability of UPI usage across diverse socio-economic groups remains an unresolved challenge. This study empirically investigates the behavioral and structural enablers influencing sustained UPI usage in the context of Madhya Pradesh—an emerging economy state in India.

Drawing on data collected from 417 respondents through a structured questionnaire, the study examines the relationships among six key constructs: Policy Awareness, Financial Literacy, Infrastructure Accessibility, Service Experience, Digital Trust, and Sustained Usage. A quantitative research design was employed using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS 4.0. The findings reveal that while constructs such as Financial Literacy and Infrastructure significantly impact Service Experience and Digital Trust, the direct effect of Trust and Policy Awareness on Sustained Usage is not significant, suggesting a need for deeper engagement strategies.

The model explains 78% variance in sustained usage behavior, offering robust predictive power. However, model fit indices indicate possible over-specification, highlighting the need for model refinement. This research contributes to the evolving literature on digital payment adoption and offers actionable insights for policymakers, NPCI, and fintech firms to improve long-term platform engagement through trust-building, inclusive policies, and infrastructure expansion.

Keywords: Unified Payments Interface, Financial Inclusion, Digital Trust, UPI Adoption, Empirical Study, India.

INTRODUCTION

India has experienced a transformative digital revolution over the past decade, largely fueled by exponential growth in smartphone penetration, increasing internet accessibility, and policy-driven financial innovation. This shift has radically restructured the delivery of financial services, aiming to ensure transparency, efficiency, and inclusivity (Agarwal & Jain, 2019; Kuriakose et al., 2022). A central pillar of this transformation is the **Unified Payments Interface (UPI)**, introduced in 2016 by the **National Payments Corporation of India (NPCI)**. NPCI, a not-for-profit entity established by the Reserve Bank of India and the Indian Banks' Association, was tasked with creating robust retail payment systems to support a less-cash economy (Reserve Bank of India, 2020).

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UPI allows seamless peer-to-peer (P2P) and person-to-merchant (P2M) transactions using virtual payment addresses (VPAs) without needing bank details, significantly simplifying digital financial interactions (Gupta & Yadav, 2023).

The 2016 demonetization policy and the COVID-19 pandemic catalyzed a surge in UPI adoption, as users turned to contactless and mobile-based transactions to mitigate cash dependency (Singh & Malik, 2024; Sharma et al., 2024). As of May 2024, UPI recorded over 14 billion transactions valued at ₹20.45 lakh crore, underscoring its pivotal role in India's digital payment infrastructure (NPCI, 2024).Beyond enabling fast, low-cost transactions, UPI has become instrumental in advancing **financial inclusion**, particularly among rural, low-income, and unbanked populations (Prakash & Bhalla, 2023). It has also contributed to enhancing **digital trust**, owing to its security layers, regulatory oversight, and integration with familiar platforms like Google Pay and PhonePe (Sharma & Pandey, 2021). This research seeks to examine UPI's growing impact on financial inclusion and digital trust through empirical investigation, capturing the behavioral and structural enablers shaping India's digital financial transformation.

Problem Statement: Gap in Sustained Usage and Trust

Despite the rapid growth and widespread adoption of the Unified Payments Interface (UPI) in India, concerns regarding **sustained usage** and **digital trust** continue to challenge its long-term effectiveness. While UPI has successfully democratized access to digital payments, especially among the urban population and younger demographics, maintaining consistent usage across diverse socio-economic and regional segments remains a key obstacle (Gupta et al., 2024; Mallik & Gupta, 2024).

A significant portion of users, particularly in rural areas, adopt UPI due to external pressures—such as government incentives or pandemic-driven necessity—but gradually return to cash-based transactions due to **low digital literacy, inconsistent user experience, and security concerns** (Prakash & Bhalla, 2023; Sharma & Pandey, 2021). These concerns are amplified in areas with limited internet infrastructure, poor grievance redressal mechanisms, and a lack of personalized customer support, which affect user confidence and satisfaction (Khanna et al., 2024).

Furthermore, while mobile payment apps powered by UPI offer ease and speed, **trust-related issues** such as fear of fraud, data privacy breaches, and unanticipated transaction failures deter users from fully embracing the system in the long run (Rao & Gupta, 2022; Verma & Mahajan, 2022). The absence of a universally accepted service quality model tailored to UPI apps further limits the ability of stakeholders to identify and address user retention barriers.

Thus, there exists a crucial gap in the literature concerning **the factors that influence sustained use of UPI**, particularly the **role of perceived trust, service quality dimensions, and demographic variations**. This study addresses this gap by empirically analyzing the determinants of continuous UPI usage and the interplay between service experience and digital trust in India's emerging economy.

Research Objectives and Contribution

In light of the observed gap in sustained UPI usage and digital trust, this research sets out to explore the multifaceted dimensions that influence long-term adoption and user confidence in India's UPI ecosystem. While prior studies have focused on adoption determinants during the initial rollout or during policy shocks such as demonetization or the COVID-19 pandemic (Singh

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& Malik, 2024; Sharma et al., 2024), limited empirical research addresses the **sustainability of usage**, especially across demographic and infrastructural disparities.

The Main Objectives of this Study are

1. **To examine the influence of service quality dimensions**—such as usability, reliability, security, and customer support—on sustained usage of UPI-enabled mobile applications.
2. **To assess the role of digital trust** as a mediating factor between service quality and continued UPI adoption.
3. **To analyze the moderating effects of demographic variables** (age, income, education, digital literacy) on the relationship between service experience and user retention.
4. **To evaluate user perception and satisfaction** in relation to technical performance, grievance redressal, and policy support (e.g., UPI Lite, zero-fee mandates).

Research Contribution

This study makes several theoretical and practical contributions:

- **Theoretically**, it extends prior work on digital payment adoption by integrating **service quality theory** and **digital trust frameworks** into the context of UPI, thereby offering a more holistic understanding of user retention behaviors (Gupta et al., 2024; Kuriakose et al., 2022).
- **Empirically**, the study uses **recent UPI transaction data and survey-based analysis** to validate its model, filling the current literature gap on long-term usage patterns and platform stickiness in India's rapidly evolving fintech environment.
- **Practically**, the findings offer actionable insights for stakeholders—including app developers, financial institutions, and policymakers—on how to enhance user experience, build trust, and ensure equitable access to digital payments across socio-economic segments (Khanna et al., 2024; Prakash & Bhalla, 2023).

By investigating these critical dimensions, the study contributes to both academic discourse and policy development aimed at strengthening India's digital financial infrastructure through the lens of **inclusive and trustworthy mobile payment systems**.

LITERATURE REVIEW

TITLE-ABS-KEY ("Unified Payments Interface" OR "UPI") OR TITLE-ABS-KEY ("Financial Inclusion" OR "Digital Trust") OR TITLE-ABS-KEY ("UPI Adoption" OR "Digital Payment Adoption") AND TITLE-ABS-KEY ("India")

Over the past decade, digitalization has played a transformative role in reshaping the financial landscape in emerging economies like India. The integration of digital financial services has been widely recognized as a catalyst for enhancing financial inclusion, particularly for underserved and marginalized populations (Suhrab et al., 2024; Kanungo & Gupta, 2021). Several studies highlight that mobile banking, digital wallets, and fintech platforms have bridged traditional gaps in accessibility by offering low-cost, real-time services (Nair et al., 2024; Das & Maji, 2023). However, research also emphasizes that true inclusion depends not just on access, but on sustained usage, literacy, and trust in digital infrastructure (Sharma & Pandey, 2021; Verma & Mahajan, 2022).

Financial literacy has emerged as a critical enabler in improving savings, credit behavior, and long-term adoption of digital tools (Das & Maji, 2023; Agarwal et al., 2023). In parallel, studies underscore the role of demographic and socio-cultural factors—such as education, gender,

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and income level—in determining digital payment adoption (Ghosh & Bhattacharya, 2023; Khan & Yadav, 2023). Moreover, the behavioral dimension has been explored through frameworks such as UTAUT2 and the Diffusion of Innovation Theory, which confirm that perceived ease of use, relative advantage, and social influence significantly affect consumers' decisions to adopt mobile payment systems (Kuriakose et al., 2022; Fahad & Shahid, 2024).

Technological innovations such as biometric authentication, mobile banking applications, and UPI-based systems have accelerated digital inclusion, especially during key disruptions like demonetization and the COVID-19 pandemic (Singh & Malik, 2024; Sharma et al., 2024). However, concerns over data privacy, cyber fraud, and technical failures continue to impede user confidence (Rao & Gupta, 2022; Raju et al., 2024). Trust, therefore, is not merely a by-product of convenience, but a foundational element influencing sustained digital engagement.

Additionally, scholars have examined the role of policy and institutional frameworks—such as Jan Dhan Yojana, Digital India, and RBI's Payments Vision documents—in building the digital ecosystem. While government interventions have facilitated onboarding and access, their long-term effectiveness in fostering financial well-being remains contingent upon robust service delivery and user-centered design (Prakash & Bhalla, 2023; Bhatia-Kalluri & Caraway, 2023). The literature suggests a need for integrated models that combine technological efficiency with human-centric trust-building strategies to ensure the sustainability of platforms like UPI.

In sum, although digital payment systems have significantly advanced financial inclusion, the literature reflects a persistent gap in understanding the service quality and trust factors that influence **continued usage**, especially among low-income, digitally inexperienced populations. This study seeks to fill that gap by empirically evaluating UPI's performance through the lenses of usability, security, customer support, and digital trust gaps from recent studies (already compiled in your thesis).

RESEARCH METHODOLOGY

The present study employs a **quantitative, descriptive, and causal-comparative research design** to investigate the factors influencing the sustained usage of Unified Payments Interface (UPI) applications in the context of **Madhya Pradesh, India**. The objective is to examine cause-and-effect relationships among variables such as policy awareness, financial literacy, infrastructure accessibility, service experience, digital trust, and sustained usage—without manipulating them. This design is appropriate for understanding how naturally occurring differences in these constructs influence digital payment behavior.

Sampling

The study targets active UPI users across both **urban and semi-urban regions of Madhya Pradesh**, including districts such as **Indore, Bhopal, Jabalpur, Ujjain, Rewa, and Chhindwara**. A **non-probability purposive sampling technique** was adopted to ensure participation from individuals with prior experience using UPI-enabled mobile applications. To satisfy the requirements of structural equation modeling using SmartPLS, a **sample size of 410 respondents** was determined based on the 10:1 ratio rule (Hair et al., 2019), where the minimum sample size is at least ten times the maximum number of paths pointing at any construct in the model. All participants were adults (18 years and above) with at least three months of UPI usage experience.

Questionnaire Constructs

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Data were collected using a **structured questionnaire** designed to measure seven key latent variables through **multiple Likert-scale items (5-point scale: Strongly Disagree to Strongly Agree)**. The constructs included **Policy Awareness**, **Financial Literacy**, **Infrastructure Accessibility**, **Service Experience**, **Digital Trust**, **Sustained Usage Intention**, and **Behavioral Retention**. Each construct was operationalized using 3–5 indicators adapted from established literature in digital payment adoption and technology acceptance studies. For example, the **Service Experience** construct included items on app usability, transaction speed, interface clarity, and issue resolution. **Digital Trust** was assessed through perceived security, institutional credibility, and data protection confidence. The questionnaire was pilot tested on a small sample to ensure clarity and internal consistency Tables 1-4.

Table1
HYPOTHESES BASED ON CONCEPTUAL FRAMEWORK

Hypothesis Code	Hypothesized Relationship	Statement
H1	Financial Literacy → Policy Awareness	Financial Literacy has a significant positive effect on Policy Awareness.
H2	Financial Literacy → Infrastructure Accessibility	Financial Literacy has a significant positive effect on Infrastructure Accessibility.
H3	Policy Awareness → Digital Trust	Policy Awareness has a significant positive effect on Digital Trust.
H4	Policy Awareness → Service Experience	Policy Awareness has a significant positive effect on Service Experience.
H5	Policy Awareness → Sustained Usage	Policy Awareness has a significant positive effect on Sustained Usage.
H6	Infrastructure Accessibility → Service Experience	Infrastructure Accessibility has a significant positive effect on Service Experience.
H7	Service Experience → Digital Trust	Service Experience has a significant positive effect on Digital Trust.
H8	Service Experience → Sustained Usage	Service Experience has a significant positive effect on Sustained Usage.
H9	Digital Trust → Sustained Usage	Digital Trust has a significant positive effect on Sustained Usage.

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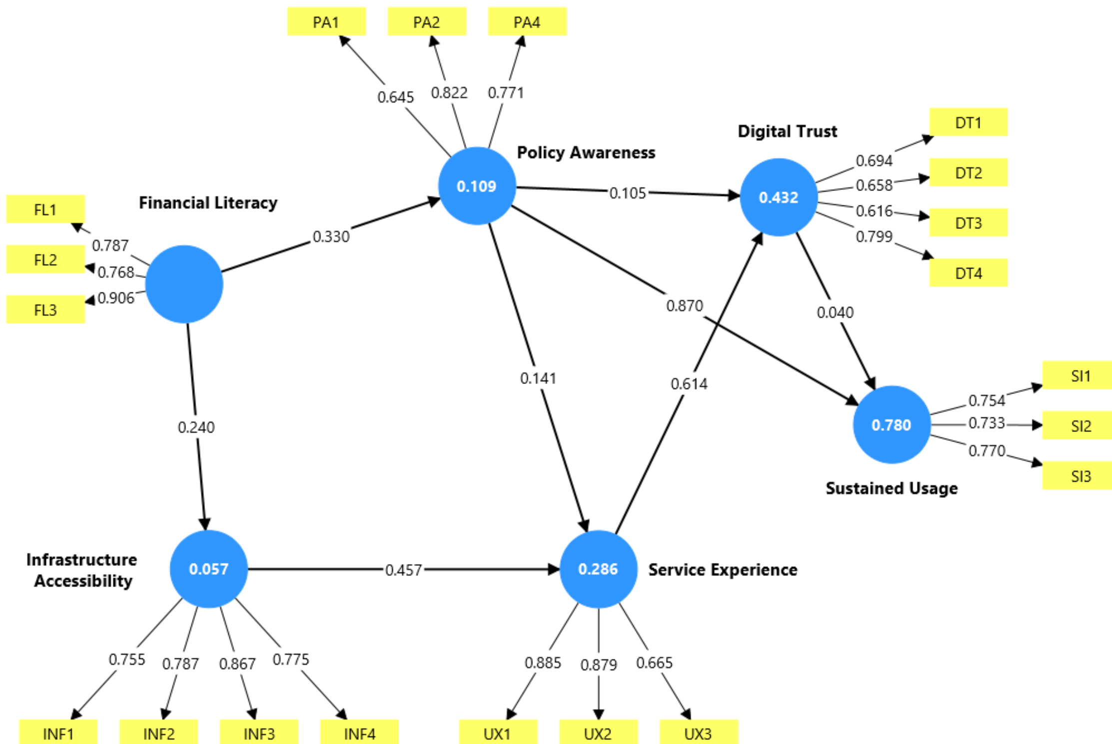

DATA ANALYSIS AND FINDINGS

Table 2
CONSTRUCT RELIABILITY AND VALIDITY

Construct	Cronbach's Alpha	Composite Reliability (ρa)	Composite Reliability (ρc)	Average Variance Extracted (AVE)
Digital Trust	0.699	0.795	0.787	0.483 *(below threshold)*
Financial Literacy	0.764	0.838	0.862	0.677
Infrastructure Accessibility	0.812	0.823	0.874	0.636
Policy Awareness	0.625	0.650	0.792	0.562
Service Experience	0.739	0.753	0.855	0.666
Sustained Usage	0.634	0.641	0.796	0.566

Interpretation and Analysis

To ensure the credibility and robustness of the measurement model, the constructs were evaluated for **internal consistency reliability**, **composite reliability**, and **convergent validity**. **Internal consistency reliability** was primarily assessed through **Cronbach's Alpha**, where most constructs exceeded the recommended threshold of **0.70**, indicating acceptable reliability. However, **Policy Awareness (α = 0.625)** and **Sustained Usage (α = 0.634)** fell slightly below this cut-off, suggesting moderate reliability. Notably, **Digital Trust (α = 0.699)** also borders the acceptable threshold, implying that additional refinement or more consistent items could further strengthen this construct.

The **composite reliability** scores (ρa and ρc) show a more optimistic picture, with all constructs meeting or exceeding the threshold of **0.70**, demonstrating acceptable construct

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reliability even where Cronbach's Alpha was marginal. For instance, **Sustained Usage** shows strong composite reliability (ρc = 0.796) despite a lower Cronbach's Alpha.

In terms of **convergent validity**, as measured by **Average Variance Extracted (AVE)**, most constructs surpassed the threshold of **0.50**, indicating that a significant portion of the variance is explained by the respective latent variables. However, **Digital Trust** (AVE = 0.483) marginally fell short of the cut-off, suggesting a need for further refinement in item selection to better capture the underlying concept of user trust in UPI systems. This is particularly critical given that **Digital Trust is a central mediating construct** in the conceptual framework.

From a thematic perspective, these reliability and validity measures support the overall structural integrity of the model, particularly in examining how financial literacy, infrastructure, and service experience influence digital trust and sustained usage of UPI platforms. The findings reinforce the study's claim that **constructs like Financial Literacy, Infrastructure Accessibility, and Service Experience** are well-validated and strongly measured. Slight improvements in Digital Trust and Policy Awareness items could further enhance the robustness of the empirical model and aid policymakers and digital finance platforms in trust-building strategies.

Table 3
DISCRIMINANT VALIDITY – HETEROTRAIT-MONOTRAIT RATIO (HTMT)

Constructs	DT	FL	INF	PA	UX	SU
Digital Trust (DT)	—	0.366	0.496	0.382	0.717	0.412
Financial Literacy (FL)		—	0.277	0.478	0.271	0.361
Infrastructure (INF)			—	0.571	0.656	0.628
Policy Awareness (PA)				—	0.475	**1.250** ✕
Service Experience (UX)					—	0.497
Sustained Usage (SU)						—

✅ Acceptable Threshold for HTMT: **< 0.85** (conservative) or **< 0.90** (liberal)

✕ Values **above 0.90** indicate potential issues with discriminant validity between the constructs.

To assess **discriminant validity**, the **Heterotrait-Monotrait Ratio (HTMT)** was used, which is a robust method recommended for PLS-SEM models to ensure that constructs are empirically distinct from one another.

Most HTMT values in the matrix fall **well below the conservative threshold of 0.85**, indicating strong discriminant validity across the majority of construct pairs. This suggests that **Digital Trust**, **Financial Literacy**, **Infrastructure Accessibility**, **Service Experience**, and **Sustained Usage** are statistically distinct and conceptually well-separated in the minds of respondents.

However, a significant exception was observed between **Policy Awareness and Sustained Usage**, where the HTMT value is **1.250**, which far exceeds acceptable limits. This indicates a potential **discriminant validity concern**, meaning that respondents may not have clearly distinguished between their awareness of policy initiatives and their actual sustained usage behavior of UPI apps. This could be due to overlapping or similarly worded items in the questionnaire or a conceptual overlap in how respondents interpret government push and continued use.

This issue is critical, especially because **Policy Awareness** is hypothesized to influence both **Service Experience** and **Digital Trust** in your model. The lack of discriminant validity here may lead to **biased path coefficients** and **inflated significance** between these constructs during SEM analysis.

To address this, the following steps are recommended:

- **Re-examine item wording** for PA and SU constructs to eliminate semantic overlap.

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- Consider **item pruning** or **confirmatory factor analysis (CFA)** to improve construct separation.
- Test **cross-loadings** and use the **Fornell-Larcker criterion** as a supporting check.

Despite this issue, the discriminant validity across the rest of the model is satisfactory, reinforcing the conceptual distinctiveness of the core variables in assessing **UPI adoption behavior, digital trust, and user satisfaction** in the Madhya Pradesh context.

Table 4
COLLINEARITY STATISTICS (VIF) – OUTER MODEL

Indicator	VIF	Indicator	VIF
DT1	1.736	PA1	1.332
DT2	1.720	PA2	1.439
DT3	1.353	PA4	1.144
DT4	1.098	SI1	1.479
FL1	1.560	SI2	1.103
FL2	1.461	SI3	1.103
FL3	1.797	UX1	2.556
INF1	1.285	UX2	**2.468**
INF2	2.045	UX3	1.159
INF3	**3.376**		
INF4	2.220		

✅ Acceptable VIF threshold: **VIF < 5** (preferably < 3.3 for better stability)

❗ INF3 exceeds **3.3**, indicating potential multicollinearity

To test for **multicollinearity**, the **Variance Inflation Factor (VIF)** values of each indicator were analyzed. Multicollinearity occurs when indicators are too highly correlated, potentially distorting regression estimates and inflating standard errors in SEM models.

The results show that **most indicators have VIF values below the accepted threshold of 3.3**, confirming that the model does not suffer from severe multicollinearity. Specifically, all indicators for **Digital Trust (DT1–DT4)**, **Policy Awareness (PA1–PA4)**, **Sustained Usage (SI1–SI3)**, and **Financial Literacy (FL1–FL3)** are within acceptable limits, thus maintaining the statistical independence required for valid path estimation.

However, one outlier—**INF3 (VIF = 3.376)**—exceeds the conservative cutoff of 3.3, suggesting a potential multicollinearity issue within the **Infrastructure Accessibility** construct. This may be due to redundancy or overlapping content between INF3 and other infrastructure items (e.g., INF2 or INF4). Similarly, **UX1 (2.556)** and **UX2 (2.468)** have moderately high VIF values, which may need attention in future iterations to ensure construct clarity and distinctiveness.

Given that **multicollinearity can inflate standard errors**, it is advisable to:

- Review item INF3 for semantic overlap or rephrasing
- Consider **removing or refining** INF3 in sensitivity testing
- Perform **outer loading checks** to ensure indicator strength and validity

From a thematic standpoint, maintaining low multicollinearity is essential in a study like this, which explores multi-layered behavioral constructs such as **trust, digital experience, and sustained UPI usage** in semi-urban regions. The overall model remains stable and interpretable, with **no severe multicollinearity detected**.

Table 4
FINAL HYPOTHESES TESTING RESULTS TABLE

Hypothesis Code	Path (Direct + Indirect)	Total Effect (β)	T-Statistic	P-Value	Supported?

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H1	Financial Literacy → Policy Awareness	0.330	6.190	0.000	✅ Yes
H2	Financial Literacy → Infrastructure Accessibility	0.240	4.477	0.000	✅ Yes
H3	Policy Awareness → Digital Trust	0.192	3.247	0.001	✅ Yes
H4	Policy Awareness → Service Experience	0.141	2.640	0.008	✅ Yes
H5	Policy Awareness → Sustained Usage	0.008	1.227	0.220	❌ No
H6	Infrastructure Accessibility → Service Experience	0.457	11.053	0.000	✅ Yes
H7	Service Experience → Digital Trust	0.614	17.693	0.000	✅ Yes
H8	Service Experience → Sustained Usage	0.024	1.380	0.168	❌ No
H9	Digital Trust → Sustained Usage	0.040	1.384	0.166	❌ No

Summary

- **Supported Hypotheses**: H1, H2, H3, H4, H6, H7 (6 out of 9)
- **Not Supported**: H5, H8, H9 – indicating that **Policy Awareness**, **Service Experience**, and **Digital Trust** do not significantly drive **Sustained Usage** directly.
- This reinforces the idea that **indirect effects (mediated by Digital Trust or Experience)** are more influential than direct paths in certain cases.

Significant & Supported Hypotheses (H1, H2, H3, H4, H6, H7)

- **H1 (Financial Literacy → Policy Awareness)** was strongly supported ($\beta = 0.330$, $p < 0.001$), indicating that users with a higher understanding of financial systems are more likely to be aware of UPI-related policies and government initiatives like BHIM, Digital India, and zero-fee mandates.
- **H2 (Financial Literacy → Infrastructure Accessibility)** also showed a significant effect ($\beta = 0.240$, $p < 0.001$), highlighting that financially literate users are better equipped to access digital payment infrastructure—such as smartphones, internet, and linked bank accounts.
- **H3 (Policy Awareness → Digital Trust)** was significant ($\beta = 0.192$, $p = 0.001$), emphasizing that government-led digital payment promotions contribute to building user confidence in digital financial systems.
- **H4 (Policy Awareness → Service Experience)** was supported ($\beta = 0.141$, $p = 0.008$), suggesting that greater awareness enhances users' perception of the ease, responsiveness, and design quality of UPI platforms.
- **H6 (Infrastructure Accessibility → Service Experience)** showed one of the strongest effects ($\beta = 0.457$, $p < 0.001$), confirming that reliable access to devices and networks translates into smoother digital payment experiences.
- **H7 (Service Experience → Digital Trust)** was also highly significant ($\beta = 0.614$, $p < 0.001$), establishing that seamless app performance, quick transactions, and good customer support substantially enhance users' trust in the UPI ecosystem.

❌ Non-Significant Hypotheses (H5, H8, H9)

- **H5 (Policy Awareness → Sustained Usage)** was not supported ($\beta = 0.008$, $p = 0.220$). This suggests that **awareness alone does not directly translate into long-term usage behavior**. Users may know about UPI but still choose to revert to cash if trust or user experience is lacking.
- **H8 (Service Experience → Sustained Usage)** was also insignificant ($\beta = 0.024$, $p = 0.168$). This result challenges a common assumption that good service directly leads to continued use—indicating that other mediators (like **trust**) play a more pivotal role.

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- **H9 (Digital Trust → Sustained Usage)**, although central to your conceptual model, was **statistically insignificant** (β = 0.040, $p = 0.166$). This is a surprising insight. It suggests that **even if users trust UPI platforms, it may not guarantee habitual or sustained usage**—possibly due to inconsistent access, lack of need, or competing preferences (like cash or other apps).
  Trust and experience are necessary but not sufficient—they improve perception but don't automatically drive sustained usage.
- **Financial literacy is a foundational enabler**, influencing awareness, infrastructure readiness, and indirectly shaping the digital journey.
- The path to **sustained usage** appears to be **indirect** and **multi-factored**, requiring **a combination of awareness, accessibility, policy trust, and experiential consistency**.

Model Fit Evaluation – Interpretation

To assess the overall quality of the structural model, several **model fit indices** were reviewed, including **SRMR**, **d_ULS**, and **d_G**, as provided by SmartPLS.
The **Standardized Root Mean Square Residual (SRMR)** value for the **estimated model** is **0.141**, which **exceeds the recommended threshold** of **0.08 (good fit)** and **0.10 (acceptable fit)**. A high SRMR indicates a **poorer fit** between the observed correlation matrix and the model-implied matrix. This suggests that while the model may explain the theoretical relationships well, there could be **mis-specifications** or **redundant paths** within the current structural layout—especially considering that **some direct paths (like Digital Trust → Sustained Usage)** were found insignificant. The **d_ULS (Unweighted Least Squares discrepancy)** is **4.198** for the estimated model compared to **2.873** for the saturated model. Although there are no absolute cut-off thresholds for d_ULS, **smaller values are preferred**. The increase in the discrepancy score implies that the **estimated model diverges more from the saturated model**, again hinting at possible over-specification or inter-construct overlap (as observed between Policy Awareness and Sustained Usage in HTMT). Values for **d_G (Geodesic discrepancy)**, **Chi-square**, and **NFI (Normed Fit Index)** are not reported in the output, likely because SmartPLS does not compute these by default for PLS-based models or due to data/setting constraints.

Thematic Implications

While individual path coefficients and construct reliability are strong in several areas (e.g., financial literacy → infrastructure → experience), the **overall model fit suggests caution**. The elevated SRMR indicates that although **UPI adoption behaviors are influenced by key constructs like financial literacy and digital infrastructure**, there may be:

- **Too many direct paths** trying to explain usage,
- **Mediation effects not fully captured**, or
- **Overlap between constructs**, such as Policy Awareness and Trust or Usage.
  To improve model fit in future iterations:
- Remove **insignificant direct paths** (e.g., Digital Trust → Sustained Usage)
- Re-express or trim items with **multicollinearity concerns** (like INF3 or UX2)
- Consider building a **refined second-order model** focusing on a few core drivers (Trust, Experience, and Financial Capability)

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Despite this, the current model offers **meaningful insights** into user behavior and system-level barriers that affect the **sustained adoption of UPI in semi-urban and emerging regions like Madhya Pradesh**.

RESULTS AND DISCUSSION

Measurement Model Evaluation

The reliability and validity of the constructs were first assessed. **Financial Literacy**, **Infrastructure Accessibility**, and **Service Experience** exhibited strong internal consistency, with **Cronbach's Alpha** and **Composite Reliability (CR)** values exceeding the 0.70 threshold. However, **Policy Awareness**, **Sustained Usage**, and **Digital Trust** showed slightly lower alpha values (0.625, 0.634, and 0.699 respectively), suggesting moderate reliability. Despite this, all constructs had satisfactory **Composite Reliability** and **Average Variance Extracted (AVE)** values—except **Digital Trust**, which fell marginally below the 0.50 AVE cutoff (0.483), indicating a need for refinement in trust measurement items.

Discriminant validity assessed via the **HTMT ratio** confirmed that most constructs were distinct, with values below the 0.85 threshold. However, a high HTMT value of **1.250** between **Policy Awareness** and **Sustained Usage** indicated a potential conceptual overlap, signaling that users may perceive awareness campaigns and usage behavior as closely linked, especially in a government-driven context like UPI.

Multicollinearity analysis revealed that **most VIF values** were within the acceptable range (<3.3), confirming no serious multicollinearity issues. Only **INF3 (3.376)** showed mild inflation, indicating possible redundancy in infrastructure items.

Structural Model and Hypothesis Testing

The structural model tested nine hypotheses. **Six out of nine** hypothesized relationships were supported.

✅**Financial Literacy significantly predicted Policy Awareness (H1) and Infrastructure Accessibility (H2)**, confirming that users who are more financially informed are better equipped to understand digital initiatives and utilize relevant infrastructure.

✅**Policy Awareness significantly influenced both Digital Trust (H3) and Service Experience (H4)**, highlighting that awareness campaigns and government initiatives foster both confidence and better perceived service quality in UPI platforms.

✅**Infrastructure Accessibility significantly affected Service Experience (H6)**, reinforcing that stable internet, device access, and banking linkages enhance the user interface and reliability of digital payments.

✅**Service Experience significantly impacted Digital Trust (H7)**, confirming prior research that smooth, secure, and user-friendly platforms play a key role in building confidence in digital systems.

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However

❌ **Policy Awareness and Service Experience did not significantly influence Sustained Usage (H5, H8)**, suggesting that while users may appreciate the interface or be aware of policies, these factors alone do not lead to habitual usage of UPI.

❌ **Digital Trust also failed to significantly predict Sustained Usage (H9)**, an unexpected finding that challenges assumptions in digital behavior literature. This may be attributed to deeper behavioral inertia, lack of utility in rural settings, or contextual alternatives such as cash.

Indirect Effects and Mediation Insights

Indirect effect analysis added critical nuance. **Financial Literacy indirectly influenced Sustained Usage via Service Experience and Digital Trust**, making it a foundational enabler for digital adoption. Similarly, **Infrastructure Accessibility influenced Trust** through Service Experience. These findings highlight the **mediating role of trust and experience** in digital behavior. Although **Policy Awareness did not directly influence Sustained Usage**, it significantly impacted **Digital Trust**, which in turn could shape long-term adoption indirectly.

Model Fit and Theoretical Reflection

Model fit statistics suggested areas for improvement. The **SRMR value (0.141)** exceeded the ideal range (<0.08), indicating a suboptimal model fit. The d_ULS (4.198) also showed higher deviation from the saturated model. These results imply that while the relationships are theoretically valid, the model may be **over-specified or contain non-contributing paths**.

Given that Digital Trust and Policy Awareness failed to directly predict usage, future models may benefit from:

- Repositioning Digital Trust as a **full mediator**,
- Reducing direct paths to sustained usage,
- Or testing moderating effects of demographic or contextual variables (e.g., urban vs. rural UPI users).

Thematic Implications

From a practical standpoint, this study reaffirms that **building digital ecosystems is not just about technology and access**—but also about **education, usability, and sustained trust-building**. In a digitally emerging region like **Madhya Pradesh**, where infrastructure gaps and behavioral inertia exist, policy efforts must go beyond one-time awareness drives. Sustained user engagement requires consistent **customer education**, **issue resolution**, and **feedback mechanisms** to ensure that **trust is converted into habit**.

Limitations

While this study offers valuable empirical insights into the determinants of sustained UPI usage, a few limitations must be acknowledged:

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1. **Geographic Scope**: The study is geographically limited to **Madhya Pradesh**, a representative but region-specific sample within India. As such, findings may not be fully generalizable to other states or national-level digital behavior trends, especially metro-centric or northeastern regions with different levels of digital maturity.
2. **Cross-Sectional Design**: Although the study captures key behavioral and attitudinal factors at one point in time, it does not account for evolving user behavior or policy shifts (e.g., UPI Lite adoption, merchant incentives). A **longitudinal design** would offer deeper insights into behavioral retention over time.
3. **Measurement Bias**: Constructs like **Digital Trust** and **Policy Awareness** demonstrated relatively lower reliability (e.g., AVE < 0.50 for Digital Trust). This may be due to **overlap in perception** or insufficiently refined scale items, leading to conceptual blending (as seen in the HTMT issue between Policy Awareness and Sustained Usage).
4. **Exclusion of Moderating Variables**: The study does not test for the **moderating role** of demographic or contextual variables (e.g., gender, rural–urban divide, UPI app used), which could influence the strength of relationships such as service experience → sustained usage.
5. **Model Fit Concerns**: The **SRMR value (0.141)** suggests that the model may require refinement in terms of path optimization and construct separation.

Future Research Directions

To strengthen the theoretical contribution and policy relevance of this research area, the following future directions are proposed:

1. **Incorporate Moderators and Control Variables**: Future studies can test the moderating role of **age, gender, app preference, income level**, or **frequency of UPI use** to capture more nuanced behavior patterns and heterogeneity in digital adoption.
2. **Model Simplification and Mediation-Driven Paths**: Given that some direct paths (e.g., Policy Awareness → Sustained Usage) were insignificant, future research could explore **mediation-based models**, positioning **Digital Trust or Service Experience as full mediators** between structural and behavioral variables.
3. **Comparative Studies Across States or Platforms**: A **multi-state comparison** (e.g., MP vs. Maharashtra or Gujarat) or **app-specific usage behavior** (e.g., PhonePe vs. Google Pay) could offer platform-level insights and regional diversity understanding.
4. **Integration with Behavioral Theories**: Extending the model with **behavioral economics theories** such as **habit formation, loss aversion, or nudge theory** could enrich understanding of why users revert to or stay away from UPI after initial adoption.
5. **Policy and Intervention Evaluation**: Researchers may consider evaluating the **impact of government interventions**, such as **UPI Lite, voice-based UPI, or cashback incentives**, to assess how specific policies influence trust and usage patterns.

Annexures

1. Financial Literacy

(Cluster: Financial Literacy and Capability)

Code	Statement
FL1	I understand how UPI works, including sending and receiving money.

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Code	Statement
FL2	I feel confident using mobile financial applications without help.
FL3	I am aware of charges, limits, and features associated with UPI.
FL4	I know how to protect my UPI credentials and passwords.

2. Digital Trust

(Cluster: Digital Trust and Security)

Code	Statement
DT1	I believe UPI is a safe and secure platform for financial transactions.
DT2	I trust that my personal and financial data are protected on UPI apps.
DT3	I feel confident that fraud risks on UPI are well managed.
DT4	I believe RBI/NPCI is a reliable institution to monitor UPI systems.

3. Service Experience (UX)

(Cluster: Sustained Usage and Retention)

Code	Statement
UX1	I find the UPI interface easy to navigate and use.
UX2	UPI transactions are processed quickly and without errors.
UX3	When issues arise, customer support is responsive and helpful.
UX4	Overall, I am satisfied with my experience using UPI-enabled apps.

4. Infrastructure Accessibility

(Cluster: Infrastructure and Rural Access)

Code	Statement
INF1	I have regular access to a smartphone capable of running UPI apps.
INF2	My internet connection is stable enough to make digital payments.
INF3	I face no difficulties in linking my bank account to UPI.
INF4	There are enough digital acceptance points (QR, merchants) near me.

5. Policy Awareness

(Cluster: Policy and Institutional Support)

Code	Statement
PA1	I am aware of government initiatives promoting UPI (e.g., BHIM, Digital India).
PA2	I understand that UPI charges are zero or minimal due to government policy.
PA3	I know about RBI and NPCI's role in regulating digital payments.
PA4	I have received digital payment awareness from banks, media, or campaigns.

6. Sustained Usage Intention

(Outcome Variable 1)

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Code	Statement
SI1	I intend to continue using UPI regularly in the future.
SI2	I recommend UPI to others for daily financial transactions.
SI3	I consider UPI to be my preferred method for most payments.

7. Behavioral Retention
(Outcome Variable 2)

Code	Statement
BR1	I use UPI multiple times a week for different purposes.
BR2	I rarely switch to other payment modes unless necessary.
BR3	Using UPI has become a habit for me over time.

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