Empowering Financial Inclusion: A Data-Driven Approach to Affordable Credit in UPI

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This research uses a analytics-driven approach towards increasing lending rates for Unified Payment Interface network clients with particular emphasis on sellers. Utilizing advanced clustering techniques and vector error correction modeling this study will attempt to construct a transparent credit approval mechanism. A proposal model is presented to ascertain creditworthiness about the selected set of customers and simultaneously it alters the prime lending rate quoted on advances without succumbing to prime lending rates set by Reserve Bank of India. With the help of data from 910 rural loan borrowers.

Keywords: UPI, Data Driven Approach, Cluster Analysis

1. Introduction

The UPI credit line feature is experiencing significant growth, leveraging the familiar UPI infrastructure for easy access. Users can activate the credit line through apps like PhonePe by linking it to their registered phone number, after which it appears as a payment option. This expansion aligns with an overall surge in UPI transactions, which grew 3.95% month-on-month to 14.44 billion in July 2023, with a year-on-year rise of 49%. PhonePe, leading the UPI ecosystem, recorded 6.98 billion transactions (INR 10.28 lakh crore), capturing a 48.3% market share and reflecting the platform's momentum in digital payments. NPCI said the total transaction amount increased 47 per cent year-on-year.

The Reserve Bank of India's introduction of a pre-sanctioned credit line on UPI marks a critical advancement in digital lending, with significant potential to reshape India's credit ecosystem. By enabling digital, short-term borrowing and allowing repayment through UPI, this initiative leverages an established infrastructure to expand credit accessibility. Given the sharp rise in demand for personal loans (with banks disbursing INR 40 lakh crore in FY23, a 20% year-on-year increase), this credit line may reach a larger consumer base, especially among underbanked segments. The product's seamless integration with UPI ensures that existing UPI users will experience minimal disruption in payment flows, which enhances user experience and drives higher adoption rates. Furthermore, interest rates on UPI credit lines are anticipated to be competitive, potentially lower than the typical 36% charged on credit cards, making it an appealing alternative to both credit cards and Buy Now, Pay Later (BNPL) services.

Operationally, banks are likely to pilot the UPI credit line with Existing-To-Bank (ETB) customers to mitigate risk and optimize underwriting processes before opening to New-To-Bank (NTB) customers. The process will involve banks evaluating creditworthiness based on transaction history, credit scores, and other eligibility metrics. Such selective rollout ensures initial stability, allowing for refinement based on early user behaviour and repayment patterns. This gradual approach aligns well with current market realities, where transaction volume on UPI has reached over 10 billion monthly transactions, underscoring a high-growth opportunity.

Notably, UPI credit lines could considerably impact the B2B segment, particularly for MSMEs that contribute nearly 30% to India's GDP but are underserved in terms of credit access. UPI credit lines could address these gaps by offering businesses instant, digital, and flexible funding options that traditional credit cards or bank loans cannot meet. As adoption grows, UPI credit line innovations, like revolving credit and overdraft facilities, could further support the financing needs of MSMEs, adding significant value to the sector.

For banks and PSPs, the UPI credit line offers avenues for revenue generation through transaction fees and lower-cost credit disbursement. Looking forward, the inclusion of NBFCs and fintechs in the UPI credit ecosystem could foster co-lending models, enhancing interoperability and creating innovative service offerings. By streamlining credit access, reducing costs, and catering to both retail and MSME needs, the UPI credit line initiative stands as a transformative force in India's digital finance landscape, promoting financial inclusion and economic growth.

2. Objectives

This research aims to investigate the optimal utilization of the Unified Payments Interface (UPI) by financial institutions (FIs) for extending credit lines. The specific objectives are as follows.

To Identify Key Drivers of UPI Credit Line Adoption. – The research focuses on uncovering the primary factors that motivate FIs to offer credit lines through the UPI platform. This might include aspects like transaction data analysis, enhanced efficiency, and financial inclusion.

To understand the High-Frequency User Behavior. This objective delves into identifying factors that significantly influence credit line usage among frequent UPI users. This could involve analyzing frequency and volume of transactions, merchant category analysis, and demographic and psychographic profiling.

To Characterize High-Value UPI Credit Customers. This objective seeks to isolate specific traits that distinguish users with high credit line pre-approvals. The research will explore financial health indicators, creditworthiness models, and risk-profiling techniques.

To Prioritize the Credit Assessment Factors. This objective aims to identify the core factors that banks prioritize when assessing creditworthiness and allocating credit lines within the UPI ecosystem. The research will examine transaction risk analysis, creditworthiness models, and regulatory compliance.

By addressing these objectives, this research will contribute valuable insights into the effective utilization of UPI for credit line disbursement. The findings can inform FIs and regulatory bodies in developing strategies that promote financial inclusion, improve risk management, and optimize credit offerings through UPI.

3. Review of Literature

Past research on digital financial systems (UPI), particularly the transition from cash to cashless economies, highlights important trends, challenges, and implications. Aggarwal et al. (2021) explored India's push toward a cashless economy, emphasizing the role of digital finance in achieving a "Digital India" and the factors influencing this shift, such as accessibility and infrastructure. Almuhammadi (2020) provided an overview of mobile payments, fintech, and digital wallets in Saudi Arabia, identifying the essential technologies and regulatory frameworks that support mobile financial services and enhance user adoption. Similarly, Bagla and Sancheti (2018) examined gaps in customer satisfaction with digital wallets in India, identifying key challenges to sustaining user engagement and trust. Baker (2021) focused on India's micro-entrepreneurs, particularly in paratransit services, analyzing how digital financial inclusion impacts their daily operations and addresses socio-economic barriers. In their study on India's demonetization, Chakrabarty, Jha, and Ray (2021) assessed perceptions and realities of digital payments, revealing both the initial acceptance of cashless alternatives and long-term challenges to consistent usage. Chandrasekhar and Ghosh (2018) critically analyzed India's push for demonetization and ceaselessness, discussing potential risks of financial exclusion and the unintended consequences of rapid digital adoption on vulnerable populations. Chawla and Joshi (2019) conducted an empirical study on consumer attitudes and adoption intentions regarding mobile wallets in India, identifying convenience, ease of use, and security as key drivers for adoption. Together, these studies provide a comprehensive view of the opportunities and challenges in transitioning to digital finance across different user groups and geographic regions, highlighting areas for policy focus and technological improvement to ensure inclusive financial systems.

Research on digital payment adoption and user engagement has shed light on consumer awareness, satisfaction, and the dynamics influencing digital transactions. Chawla and Joshi (2021) examined the level of consumer awareness and the factors driving mobile wallet adoption, emphasizing the importance of digital media in increasing awareness. Goel et al. (2019) investigated consumer perceptions of digital transactions in the context of a cashless economy, identifying both opportunities and challenges associated with shifting from cash to digital payments. Similarly, Grover and Kar (2020) explored how mobile payment providers can enhance user engagement by leveraging social media, proposing a model for effective engagement strategies. Gupta and Xia (2018) provided insights into Asia's fintech evolution, highlighting the rapid changes in the banking sector as digital financial services gain prominence. Gupta, Kapoor, and Yadav (2020) focused on user acceptance of digital payments and emphasized the need for improvements in the cashless payment ecosystem to ensure broad adoption.

In addition, Gupta, Kiran, and Sharma (2022) validated the role of digital payment options as significant drivers of online shopping, using an adapted UTAUT2 model to analyze consumer behavior in India. In a related study, Gupta, Mittal, and Mittal (2019) applied a PLS-SEM approach to model the factors influencing users' intentions to adopt UPI (Unified Payments Interface), uncovering motivations specific to digital payments in India. Jakhiya, Mittal Bishnoi, and Purohit (2020) analyzed the growth and impact of mobile money in India, identifying the critical role of mobile payments in modernizing the financial landscape. Finally, Joseph et al. (2018) conducted an empirical study on mobile payment adoption in India, providing insights into customer preferences and barriers to adoption. Together, these studies offer a comprehensive perspective on digital payment adoption, underscoring the importance of awareness, technological ease, ecosystem development, and strategic engagement to drive digital transactions forward.

Kameswaran and Muralidhar (2019) examined accessibility challenges in adopting digital payments across diverse demographics in India, underscoring the need for inclusive financial solutions. Kandpal and Mehrotra (2019) discussed the transformative role of fintech and digital services in advancing financial inclusion, positioning technology as a bridge to underserved populations. Kar (2021) modeled user satisfaction in mobile payments, identifying critical factors that influence long-term engagement, such as transaction ease and customer support. Khan and Akhtar (2020) explored how electronic payments enhance financial satisfaction by facilitating efficient and transparent transactions. Khanra et al. (2020) identified barriers to UPI adoption, suggesting improvements in user experience and security to boost adoption rates. Lakshmi et al. (2019) analyzed UPI mobile banking security, proposing enhancements to safeguard user data and foster trust.

Kumar et al. (2021) examined platform-based mobile payments across emerging and developed nations, emphasizing the influence of country-specific factors and network effects on adoption. Ligon et al. (2019) investigated low adoption rates among

small-scale merchants in Jaipur, revealing that digital literacy and transaction costs impact usage decisions. Lohana and Roy (2023) studied demographic factors in digital payment adoption, suggesting targeted approaches to increase uptake across varied user segments. Lupo-Pasini (2021) reviewed the global shift towards cashless transactions, noting legal and social implications for financial inclusion. Madhava Priya et al. (2019) assessed how digital technologies support small merchants, finding digital payments essential for business sustainability in evolving markets. Maindola et al. (2018) conducted sentiment analysis on digital wallets post-demonetization, revealing mixed user sentiments around the transition.

Manickam et al. (2022) focused on the growing preference for mobile wallets like Google Pay and PayTM in Bengaluru, highlighting convenience as a primary motivator. Manrai et al. (2021) investigated digital payment adoption among semi-rural women, showing that perceived credibility and ease of use are pivotal in driving engagement. Meher et al. (2021) explored digital banking's impact on MSMEs, linking access to digital financial services with business growth. Menon and Ramakrishnan (2019) analyzed e-wallet adoption among Indian millennials, identifying ease of use and perceived value as key motivators. Mishra et al. (2022) examined mobile payment adoption among unorganized retailers, identifying factors that facilitate adoption in emerging economies. Mukul et al. (2023) discussed challenges for fintech and BigTech integration in banking, noting the importance of addressing multimedia and cybersecurity challenges in digital finance. Together, these studies provide a comprehensive view of India's digital payment ecosystem, highlighting factors that influence adoption, satisfaction, and sustained usage across varied user groups.

Raghavendra and Veeresha (2023) utilized a predator-prey model to analyze the digital payments market, revealing complex interactions between various stakeholders that shape market dynamics. Raman and Aashish (2021) conducted a structural analysis of mobile payment systems, identifying key antecedents influencing consumers' decisions to continue using these services. Ravikumar (2019) highlighted the role of fintech in promoting digital financial inclusion, emphasizing the significant benefits arising from the rise of digital finance in India. In a subsequent study, Ravikumar and Prakash (2022) focused on the determinants of digital payment adoption among small retail stores in Bangalore, pinpointing critical factors that drive usage in this sector. They also assessed the broader economic implications, with Ravikumar et al. (2019) demonstrating a positive correlation between digital payments and economic growth.

Sam et al. (2021) provided insights into India's cashless vision, examining the policies and practices facilitating this shift. Savitha et al. (2022) explored continuance intentions for FinTech peer-to-peer payment apps, emphasizing user experience and satisfaction as pivotal for sustained engagement. Seethamraju and Diatha (2018) discussed the specific challenges small retail stores face in adopting digital payments, while Singh et al. (2019) identified critical success factors essential for developing robust digital payment infrastructures in emerging economies. Singh et al. (2019) also analyzed digital payment adoption through Twitter analytics, showcasing social media's role in shaping public perception. Sinha et al. (2018) addressed the demand-side challenges of financial inclusion within the fintech landscape, while Sivathanu (2019) provided empirical evidence of digital payment adoption trends following India's demonetization policy. Thirupathi et al. (2019) and Tiwari et al. (2019) both examined various aspects of digital payment methods, contributing to a comprehensive understanding of the factors influencing their adoption and usage in the Indian context. Collectively, these studies present a nuanced view of the digital payment ecosystem, highlighting the interplay of technological, economic, and social factors driving transformation in India's financial landscape.

4. Methodology

The research project employs a quantitative, descriptive design to explore the feasibility of financial institutions, including banks and NBFCs, extending credit lines through the Unified Payments Interface (UPI). This structured approach, suited to the large volume of collected data, enables systematic analysis of factors affecting UPI-based credit usage and relies on statistical tools to interpret these influences. Primary data was collected from UPI users who had borrowed from the State Bank of India, ensuring respondents' familiarity with credit policies and UPI transactions. To achieve statistically significant findings, the sample size was initially set at 840 users, based on the confidence interval approach, which supports high reliability in interpretations. Consequently, a questionnaire was distributed to 2,500 users, garnering 1,834 responses (a 73.36% response rate). After applying rigorous reliability testing via Cronbach's alpha, 1,014 responses were deemed consistent, while further content and construct validity tests narrowed this to 910 validated responses, with 328 users disclosing their credit scores. These validated responses provide a robust data foundation, improving generalizability and enabling insights into the larger UPI user population.

The research methodology is structured into distinct stages following an Input-Process-Output (IPO) model to align with each research objective. In the first stage, factor analysis is applied to identify primary factors driving credit-line extension on UPI, simplifying data by isolating underlying factors influencing credit adoption. Factor analysis enables the better understand factors that increase UPI-based credit usage, allowing for more targeted strategic initiatives. In the second stage, Receiver Operating Characteristic (ROC) analysis identifies sensitive factors that are particularly influential among high-frequency UPI credit line users. ROC analysis quantifies sensitivity and specificity in the model, pinpointing which factors most impact high-frequency users, thus enabling banks to refine their credit products to cater more effectively to this user segment. The third stage employs discriminant analysis to isolate discriminating characteristics among high-value, pre-approved UPI credit users. Discriminant analysis is useful here as it highlights unique attributes that set high-value users apart, allowing institutions to develop tailored services for this valuable customer group. The final stage uses Analysis of Variance (ANOVA) to determine which core factors banks prioritize when assessing creditworthiness and credit line allocation on UPI platforms. By assessing

differences in credit scores and other factors across various groups, ANOVA reveals which variables most impact credit allocation decisions, thus improving banks' UPI-based credit assessments.

Data collection was achieved via a structured electronic questionnaire sent to selected UPI users who had prior loan experience with the bank. This data collection method ensured a targeted response pool with a high level of understanding of UPI credit services. To ensure the reliability of the gathered data, Cronbach's alpha was used to test internal consistency across variables, yielding 1,014 responses deemed reliable. Further validity checks—both content and construct—were applied, ensuring the data accurately represented the study's constructs, leaving 910 responses that were both reliable and valid for final analysis. These rigorous reliability and validity assessments ensure that the data and subsequent findings are credible, supporting grounded insights for UPI-based credit line extension in financial institutions. Through this structured, multi-stage methodology, the study's findings can help inform financial institutions about the key factors in UPI credit extension, enabling data-driven decisions for product development in digital credit offerings.

5. Modus Operandi of Credit Line

In India, the Unified Payments Interface (UPI) ecosystem has grown rapidly, powered by a diverse array of apps that cater to specific user preferences and banking needs. UPI providers fall into several types, each featuring unique functionalities that enhance digital transactions:

Digital Wallet Platforms with UPI: -Apps like PhonePe, Paytm, and Freecharge combine e-wallet services with UPI, offering users the flexibility to store funds, earn cashback, and transfer money through UPI. For example, PhonePe allows linking e-wallets like Jio Money and Airtel Money, supports QR-based transfers, and offers bill payment facilities. Paytm expands this with Paytm Payment Bank services and supports offline payments via QR codes. Such platforms often integrate KYC to facilitate wallet-based transactions alongside UPI.

Bank-Driven UPI Apps - Many banks provide UPI-enabled apps, such as ICICI's iMobile and Axis Pay, allowing users to conduct UPI transactions directly from their bank accounts. Bank-driven apps support fund transfers through VPA (Virtual Payment Address) and QR codes, ensuring secure transactions with added security layers like PIN and biometrics. For instance, ICICI's iMobile integrates traditional banking services with UPI and enables account holders to access advanced financial products, like loans and investments.

Standalone UPI Apps - Apps like BHIM UPI—endorsed by the National Payments Corporation of India—serve as dedicated UPI platforms. They offer streamlined payment processing with minimal features beyond fund transfer and bill payments. BHIM is known for its broad language support and low transaction fees, appealing to users seeking simple, secure transactions without needing additional services like e-wallets.

Shopping and Financial Services Apps with UPI Integration- E-commerce and lifestyle platforms, such as Amazon Pay and CRED, integrate UPI to facilitate in-app purchases and provide rewards. Amazon Pay simplifies UPI transactions within its shopping ecosystem and offers cashback, while CRED offers bill payment and credit score services along with transaction-based rewards. Each type of UPI provider caters to a segment of the market, driving seamless digital transactions, promoting financial inclusivity, and boosting the adoption of cashless payments across India. To access a credit line through UPI, users must first initiate a formal application with their bank. This process begins by contacting the bank, either through its digital banking portal or in person, to apply for a UPI-linked credit line. The application typically requires documentation, such as identity proof, address verification, income statements, and additional financial records. Once submitted, the bank assesses the applicant's financial profile, including credit score, income, and repayment history, to determine eligibility. Upon successful review, the bank either approves or denies the credit line; if approved, the applicant is notified of the credit limit and terms, which resemble a credit card limit, allowing for flexible fund usage within the established limit. The user then links this approved credit line to their UPI account, enabling access across multiple UPI apps. This interoperability means that, at the time of transaction, users can select the credit line instead of their savings account, with the UPI app recording the debit against the loan account rather than impacting their savings. Banks offer varied tenure options, ranging from short-term to longer-term repayment plans, allowing borrowers to align repayment periods with their financial goals. Interest rates for UPI credit lines, generally lower than those of credit cards, may be fixed or floating depending on the bank's terms and the borrower's creditworthiness. At the point of transaction, users can convert their dues into Equated Monthly Instalments (EMIs), providing additional flexibility in managing payments. Additionally, some banks may offer rewards, though these may be modest compared to those provided on credit cards, due to the absence of a merchant discount rate (MDR). This facility can especially benefit new-to-credit customers, as responsible use of a UPI-linked credit line can gradually help build a positive credit history. However, users should manage their credit prudently to avoid overextension, which can lead to debt accumulation. Banks encourage responsible use by reminding borrowers of the importance of repayment schedules and financial discipline. The UPI credit line offers a structured, accessible solution for those who seek the flexibility of credit without needing a physical credit card, bridging convenience with the rigor of structured repayment options to support sound financial planning.

6. Analysis

Stage I – Credit Line Factors

The selection of 19 variables in this research provides a comprehensive framework for understanding the dynamics of the UPI credit line from the perspective of customer behaviour and risk management. UPI Credit Balance reflects the current credit available to the customer, a direct indicator of credit line utilization and potential customer satisfaction. User Trust Rating is a

critical variable as it gauges customer trust, which directly influences creditworthiness and the likelihood of continued engagement with the UPI service. UPI Quick Payments measures the efficiency and speed of transactions, a key feature that can enhance user experience and impact customer loyalty. UPI User Referrals indicates customer advocacy, revealing the influence of user satisfaction on the likelihood of referrals, which can drive organic growth. UPI Multi Loan Accounts assesses the extent to which customers utilize multiple credit lines, which can be an indicator of credit dependency and financial behaviour. UPI Available Funds provides insight into liquidity, important for understanding a customer's financial stability. UPI Payment Aging tracks overdue payments and is essential for assessing credit risk, as delayed payments can signal financial stress.

UPI Transaction History offers a record of the customer's transactional behaviour, which helps in evaluating credit patterns and risk. UPI Late Payment Charges are penalties for delayed payments, which reflect both the customer's repayment behaviour and the system's financial enforcement mechanisms. UPI Transaction Fees and UPI Factoring Fees represent the costs associated with using the service, affecting user experience and adoption. UPI Delayed Payment identifies instances of payment delays, which can affect both credit risk and the provider's cash flow. UPI Non-Performing Loans captures loans that have defaulted, serving as a critical measure of credit risk. UPI Credit Limit Freeze indicates instances where the credit line is restricted, often due to risk-related triggers, affecting the user's access to funds. UPI Debt Repayment reflects the customer's ability to pay down debt, a primary factor in creditworthiness. UPI Repayment Period shows the duration of repayment obligations, which can influence affordability and financial planning. UPI Loan Foreclosure, UPI Loan Restructuring, and UPI Loan Forfeiture are variables associated with high-risk situations where standard repayment is compromised. These variables collectively capture multiple facets of customer behaviour, financial health, and risk, providing a robust basis for assessing the performance and sustainability of UPI credit line services.

The dataset used for this factor analysis was collected to understand various factors related to customer perceptions and behaviours regarding UPI (Unified Payments Interface) credit line services. The data includes variables that capture different aspects of customer experiences, such as fees, credit limits, loan repayment, and trust.

The validity of factor analysis was assessed using the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The KMO score for this dataset is 0.696. Since KMO value is greater than 0.6, data is ideal for factor analysis. Bartlett's Test of Sphericity yielded a Chi-Square value of 283.198 with 171 degrees of freedom, with a significance level of $p < 0.001$. This indicates that the correlations among variables are statistically significant, suggesting that factor analysis is appropriate for this dataset despite the low KMO value. Based on the significant Bartlett's Test of Sphericity, factor analysis was deemed feasible, though the marginal KMO score indicates that the results should be interpreted with care. Principal Component Analysis (PCA) was chosen as the extraction method to identify underlying patterns in the data by transforming the original variables into a set of uncorrelated components. Factors were selected based on their eigenvalues, with only those factors having eigenvalues greater than 1 retained. This threshold, often referred to as the Kaiser criterion, is a common rule of thumb in factor analysis. According to the initial eigenvalues, a total of 9 factors were selected, each with an eigenvalue greater than 1. These factors collectively explain a significant portion of the variance in the dataset, with each factor capturing different aspects of customer perceptions related to UPI credit services. The total variance explained by the 9 retained factors is approximately 64.7%, as shown in the Rotation Sums of Squared Loadings section. This means that these factors collectively account for more than half of the variance in the original data, providing a reasonable level of data simplification while retaining meaningful information.

Table 1 *Factor Component Matrix of Credit line Variables*

Variables	Component								
	1	2	3	4	5	6	7	8	9
UPI Factoring Fees	.782	.030	.146	-.128	-.026	.036	.034	-.108	-.032
UPI Transaction Fees	.468	.011	-.197	.257	.125	.136	-.112	.202	.179
UPI Credit Limit Freeze	.045	.701	-.193	.020	.027	.174	.083	.022	-.045
UPI Non-Performing Loans	.014	-.565	-.230	.136	-.031	.180	.131	-.066	.053
UPI Loan Foreclosure	.113	-.029	.720	.106	-.065	.026	.036	.010	-.064
UPI Loan Restructuring	.321	-.140	-.494	.035	-.186	-.427	.052	.103	-.058
UPI Available Funds	-.218	-.064	-.077	.680	.191	-.165	.216	-.186	-.006
UPI Debt Repayment	.122	-.039	.168	.610	-.085	.133	-.148	.071	-.059
UPI Late Payment Charges	-.155	-.063	-.084	-.008	.726	.244	-.077	.005	-.050
UPI Transaction History	.220	.126	.087	.056	.650	-.288	.070	.015	.045
UPI Loan Forfeiture	.124	-.004	.040	.041	-.011	.772	.096	-.010	.018
User Trust Rating	.123	-.205	.071	.071	.117	.000	-.691	-.125	-.094
UPI Delayed Payment	.116	-.247	.121	.043	.113	.110	.665	.024	-.085
UPI Payment Aging	.067	.403	.123	.170	-.075	-.106	.122	-.564	.117
UPI User Referrals	-.004	.043	.318	.042	.059	-.196	.063	.542	.213
UPI Credit Balance	.040	.116	-.094	.005	-.038	.004	.171	.480	-.094
UPI Multi Loan Accounts	-.196	.262	.113	.300	-.252	.077	-.174	.334	.029
UPI Repayment Period	.204	.045	-.249	.130	.003	.111	-.012	.032	.707
UPI Quick Payments	-.172	-.139	.205	-.239	-.027	-.086	.025	-.100	.628

Source: *Based on the Primary Data*

These nine factors reflect various dimensions of customer perspectives on UPI credit, from concerns about fees and charges to trust, credit risk, repayment flexibility, and loyalty. This classification can guide UPI providers in tailoring services and addressing specific areas like enhancing trust, improving credit risk management, and offering flexible repayment options to meet diverse customer needs.

Table 2 *Identified Factors*

Factor	Variables	Interpretation
1	UPIFactoringFees, UPITransactionFees	Factor 1: Transactional Fees and Charges - Variables here relate to the different fees associated with UPI transactions. Customers likely perceive these fees as related or similar.
2	UPICreditLimitFreeze, UPINonPerformingLoans, UPIPaymentAging	Factor 2: Credit Risk and Limit Controls - These variables involve control measures for managing risk, such as credit freezes and non-performing loans, possibly reflecting credit risk concerns.
3	UPILoanForeclosure, UPIUserReferrals	Factor 3: Loan Default and Customer Loyalty - This factor may represent issues around loan defaults and the role of customer loyalty in maintaining good credit.
4	UPIAvailableFunds, UPIDebtRepayment	Factor 4: Financial Capacity and Repayment Ability - This factor combines availability of funds and ability to repay, indicating financial stability.
5	UPILatePaymentCharges, UPITransactionHistory	Factor 5: Payment Timeliness and History - Variables here reflect the importance of payment timeliness and transaction records.
6	UPILoanForfeiture	Factor 6: Loan Cancellation - Loan forfeiture stands alone in this factor, suggesting it is a unique concept perceived independently by customers.
7	UserTrustRating, UPIDelayedPayment	Factor 7: Trust and Payment Reliability - This factor highlights the relationship between trustworthiness and the reliability of payment behavior.
8	UPICreditBalance, UPIMultiLoanAccounts	Factor 8: Credit Balance Management and Account Multiplicity - Variables here involve managing multiple loan accounts and credit balances.
9	UPIRepaymentPeriod, UPIQuickPayments	Factor 9: Repayment Flexibility and Speed - This factor emphasizes flexible repayment periods and quick payment options, indicating preferences for flexible credit management.

The factor analysis identified key themes in customer perceptions. Transactional Fees and Charges involve fees associated with UPI transactions, viewed as interrelated by customers. Credit Risk and Limit Controls address risk management practices like credit freezes and non-performing loans, reflecting credit risk concerns. Loan Default and Customer Loyalty highlights the impact of defaults and loyalty on credit relationships. Financial Capacity and Repayment Ability underscores financial stability through fund availability and repayment capability. Payment Timeliness and History emphasizes the importance of timely payments and transaction records, while Loan Cancellation stands alone as a distinct concept related to loan forfeiture. Trust and Payment Reliability illustrates the link between trust and payment dependability, and Credit Balance Management and Account Multiplicity relates to handling multiple accounts and balances. Finally, Repayment Flexibility and Speed highlights preferences for adaptable repayment options. By aligning these objectives and decisions with customer needs, UPI providers can enhance user satisfaction, foster trust, and improve overall service efficiency, thereby gaining a competitive advantage in the digital finance market.

Stage II: Factors related to High frequency UPI credit customers.

The study employs Receiver Operating Characteristic (ROC) analysis to assess the sensitivity and specificity of various factors in distinguishing high-frequency UPI credit line users. The ROC analysis calculates the Area Under the Curve (AUC) for each factor to evaluate its discriminative ability. AUC values range from 0 to 1, where values closer to 1 indicate a stronger ability to discriminate between high-frequency and low-frequency users, while values near 0.5 suggest no discriminative power. The test variable includes factors potentially influencing UPI credit line use, and the state variable represents high-frequency UPI credit line users.

The ROC results highlight "Repayment Flexibility and Speed" (AUC = 0.696, $p < 0.05$) and "Credit Balance Management and Account Multiplicity" (AUC = 0.681, $p < 0.05$) as the strongest predictors of high-frequency UPI credit line usage, suggesting that these factors significantly influence users who frequently use the UPI credit system. "Trust and Payment Reliability" (AUC = 0.607, $p < 0.05$) and "Transactional Fees and Charges" (AUC = 0.611, $p < 0.05$) also show moderate discriminative power, indicating that they have a meaningful, albeit weaker, association with high-frequency usage. Variables such as "Payment Timeliness and History" (AUC = 0.519) and "Financial Capacity and Repayment Ability" (AUC = 0.521) have AUC values near 0.5, implying low predictive relevance.

These findings have practical implications for UPI providers in terms of optimizing user engagement strategies and credit line offerings. Providers could focus on enhancing flexibility and ease in repayment options, as these factors resonate with high-frequency users. Additionally, features supporting multiple account management could be beneficial in attracting and retaining active users. However, the moderate AUC values of the top predictors suggest that while these factors matter, they alone may not fully capture the profile of high-frequency users. UPI providers might need to integrate these factors with additional variables, like user demographics or spending patterns, to enhance predictive accuracy.

The ROC analysis reveals that "Repayment Flexibility and Speed", and "Credit Balance Management and Account Multiplicity" are the most significant factors influencing high-frequency UPI credit line usage, though their predictive power is moderate. Other factors, such as "Trust and Payment Reliability" and "Transactional Fees and Charges," also contribute to distinguishing high-frequency users, albeit less strongly. Consequently, UPI providers may benefit from focusing on these areas to improve engagement with high-frequency users.

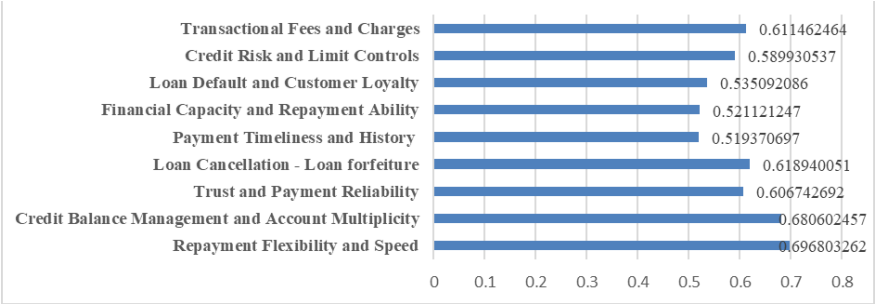

Figure 1 *Area Under ROC*

Stage III: Discriminant factor for the High value Credit Customers

The discriminant analysis was conducted to distinguish between high-value pre-approved loan borrowed customers based on various independent variables. The primary focus was on understanding how specific financial behaviours influence the categorization of customers into high-value segments. The analysis began with selecting three independent variables: Repayment Flexibility and Speed, Transactional Fees and Charges, and Credit Balance Management and Account Multiplicity. A structure matrix was then used to assess correlations between these variables and the discriminant functions, revealing the strength and direction of these relationships. Next, eigenvalues and canonical correlations were analysed to determine variance explained by each function: the first function accounted for 91.9% of the variance with a canonical correlation of 0.269, while the second explained 8.1% with a correlation of 0.082. Wilks' Lambda was used to evaluate the significance of the discriminant functions, where a value of 0.921 for the first two functions indicated they significantly differentiated between groups (chi-square = 10.66, p = 0.099). In contrast, the second function, with a high Wilks' Lambda of 0.993, contributed minimally to the differentiation.

Table 3 Discriminant Functions

Independent variables	First Function	Second Function
Repayment Flexibility and Speed	.883*	0.45
Transactional Fees and Charges	-0.323	.790*
Credit Balance Management and Account Multiplicity	-0.326	.478*

The strongest relationship was observed with "Repayment Flexibility and Speed," which had a high positive correlation (0.883) with the first discriminant function. This suggests that customers who exhibit greater repayment flexibility are likely to be classified as high-value customers. Conversely, "Transactional Fees and Charges" (-0.323) and "Credit Balance Management and Account Multiplicity" (-0.326) demonstrated negative correlations with the first function, suggesting that lower fees and effective balance management might detract from the classification as high-value customers. The first discriminant function (Eigenvalue = 0.078) explained most of the variance in the dataset, indicating that the characteristics captured by this function are crucial for distinguishing high-value customers.

The results suggest that financial institutions aiming to enhance their understanding of high-value customers should focus on facilitating repayment flexibility and minimizing transactional fees. By recognizing these characteristics, businesses can tailor their services to attract and retain high-value customers. Additionally, the lower correlation values of the other independent variables indicate potential areas for further investigation, such as the impact of transactional fees on customer loyalty and overall satisfaction.

Discriminant analysis effectively identified key characteristics that differentiate high-value customers. The primary finding emphasizes the importance of repayment flexibility and speed in categorizing customers, while transactional fees and credit management aspects appear to play a lesser role. Financial institutions can leverage these insights to optimize their customer relationship management strategies, ultimately fostering higher retention rates among high-value customers. Further research could explore additional factors influencing customer value and develop a more comprehensive model for segmentation.

Stage IV – Credit Score and UPI Credit line

Through interview schedule, we collected the annual income, outstanding deposit amount, asset holding value, investments value and collateral value of the customers. In the next stage, we wish to discover the primary loan approval process variables that coincide with the credit scores. We applied 'F' test to test the variation between and within the primary variables with the credit score. To testing the hypothesis, the variables are grouped. We establish the following hypotheses.

Null Hypothesis: There is no significant variation among the means of the primary loan approval factors and credit scores used in UPI credit lines.

Alternative Hypothesis: There is a significant variation among the means of the primary loan approval factors and credit scores used in UPI credit lines.

The independent variable is the credit score. We use one-way Analysis of Variance to test the null hypothesis. We interpret the result with the associate 'F' probability value of 0.00 and the level of significance of 0.05. Table III shows the results.

Table 4 *Loan Approval Constraints*

ANOVA						
Primary Loan approval process variables		Sum of Squares	df	Mean Square	F	Sig.
Credit Income	Between Groups	400.598	199	2.013	171.781	0.000
	Within Groups	1.500	128	.012		
	Total	402.098	327			
Credit Deposits	Between Groups	229.707	199	1.154	1.604	0.212
	Within Groups	92.119	128	0.720		
	Total	321.826	327			
Credit Assets	Between Groups	174.792	199	.878	1.140	0.211
	Within Groups	98.610	128	.770		
	Total	273.402	327			
Credit Investments	Between Groups	667.623	199	3.355	.769	0.951
	Within Groups	558.203	128	4.361		
	Total	1225.826	327			
Credit Collateral	Between Groups	48.379	199	.243	1.004	0.494
	Within Groups	30.984	128	.242		
	Total	79.363	327			

The ANOVA analysis conducted on primary loan approval factors in relation to credit scores within the Unified Payment (UPI) system highlights the variability across several determinants, focusing on the statistical significance of each factor's relationship with credit scores. The independent variable, credit score, was tested against loan approval constraints to determine if differences in credit score significantly impact these constraints. The null hypothesis, which assumes no significant difference in the loan approval variables based on credit score, was tested at a 0.05 significance level, and the F-value's associated probability was used for interpretation.

The ANOVA results indicate a highly significant effect of credit score on Credit Income with an F-value of 171.781 and a p-value of 0.000. This result strongly suggests that variations in credit income are associated with differences in credit scores, leading to the rejection of the null hypothesis for this variable. However, other variables such as Credit Deposits ($F = 1.604$, $p = 0.212$), Credit Assets ($F = 1.140$, $p = 0.211$), Credit Investments ($F = 0.769$, $p = 0.951$), and Credit Collateral ($F = 1.004$, $p = 0.494$) did not show statistically significant results, as their p-values exceeded the 0.05 threshold. These findings indicate that these aspects of the loan approval process are less likely to be influenced by differences in credit score, and we fail to reject the null hypothesis for these variables.

The implications of these findings are meaningful for credit institutions. Since Credit Income shows a significant relationship with credit score, credit officers may consider credit score a valuable predictor for assessing income-related factors in the loan approval process. This aligns with the general expectation that higher credit scores correlate with stronger income profiles, potentially reflecting better financial stability and lower risk for lenders. However, for the other variables—Credit Deposits, Credit Assets, Credit Investments, and Credit Collateral—credit score appears to have minimal influence. This suggests that these factors may not provide additional insights when evaluated solely based on credit score and may require separate criteria for assessment.

The ANOVA results reveal that among the primary loan approval factors analysed, Credit_Income is the only variable showing a statistically significant relationship with credit scores within the UPI system. This finding underline income's pivotal role in determining creditworthiness, as it reflects a borrower's immediate capacity for debt servicing. Conversely, other factors such as Credit Deposits, Credit Assets, Credit Investments, and Credit Collateral did not demonstrate significant variance in relation to credit scores, indicating that they may be less critical in the credit evaluation process used by the UPI system.

These insights suggest that UPI's credit scoring model could benefit from focusing on income-related factors, while perhaps re-evaluating the weight given to deposits, assets, investments, and collateral. By homing in on metrics directly tied to a borrower's income, the UPI platform can enhance its ability to assess credit risk effectively, ensuring a more precise and reliable loan approval process. This analysis offers a basis for refining the UPI credit model, supporting more targeted lending decisions and a streamlined approach to assessing user creditworthiness in the digital payments ecosystem.

7. Findings and Implications

The research findings highlight several actionable steps for improving financial services through a focus on fee transparency, credit risk management, customer loyalty, flexible repayment options, multi-loan management, and tailored credit products. First, revising the fee structure is crucial; ensuring transparency and competitiveness in fees can significantly enhance customer

satisfaction and trust, making services more appealing. By clearly communicating fees and aligning them with market standards, customers may feel more confident in their transactions and associated costs.

In the area of credit limit and risk management, adjusting policies around credit limits and tracking non-performing loans can create a balance between protecting the institution's financial health and meeting customer needs. Offering flexibility in credit freezes or structuring limits more sensitively can help institutions manage risk without alienating customers, especially those with fluctuating credit requirements.

Enhancing trust-building and loyalty is another critical focus, where loyalty programs can incentivize positive payment behaviours. By rewarding consistent repayments or offering benefits to high-trust customers, institutions can deepen customer loyalty and reduce churn, fostering long-term relationships that add value to both parties.

The introduction of flexible repayment plans will cater to diverse customer preferences, potentially offering options like varying repayment periods or bonuses for early payment completion. These tailored repayment options will make credit products more attractive to a broader range of customers, allowing individuals to choose plans that best suit their financial circumstances and repayment capabilities.

Addressing multi-loan management, developing product features for credit balance and loan tracking can streamline user experiences, especially for customers managing multiple accounts. Implementing tools that aggregate accounts or allow easy tracking of credit balances would empower users with a clear view of their financial obligations, simplifying credit management.

Lastly, by offering targeted credit products tailored to varying financial capacities, institutions can better serve diverse customer segments. For instance, higher credit limits could be allocated to financially stable customers, while those with limited capacity might receive more controlled credit offers. This segmentation would support customer retention and ensure that credit offerings align with user needs and financial abilities.

Together, these steps provide a roadmap for improving customer satisfaction, loyalty, and overall service experience. Re-evaluating fee structures, enhancing credit risk policies, and focusing on flexible, tailored product options will position financial institutions to better meet market demands and foster lasting customer relationships.

8. Conclusion

This research provides valuable insights for financial institutions on utilizing UPI for extending credit lines, with implications that can strengthen customer engagement and optimize credit offerings. The findings indicate that customer perception of fees and risk management practices are pivotal in shaping credit line adoption on UPI, as customers respond to clear, manageable fees and thoughtful risk controls. Therefore, institutions should enhance transparency in fee structures and prioritize credit policies that balance protection with customer accessibility. By doing so, financial institutions can create an environment that fosters trust and meets the core needs identified, such as credit reliability, payment history, and repayment flexibility, ultimately attracting more users to adopt UPI-based credit lines.

In addressing high-frequency user behaviour, the findings reveal that factors like repayment flexibility, speed, and credit balance management most significantly drive engagement among frequent users. Financial institutions can leverage these insights by offering streamlined, flexible repayment options and tools to manage multiple credit balances, which would encourage regular use of UPI credit lines. By focusing on these preferences, institutions can create targeted engagement strategies, potentially increasing transaction volumes and building long-term relationships with high-frequency users. The moderate predictive power of these factors suggests that institutions should continually monitor additional elements influencing usage to refine user engagement strategies.

For high-value customers, discriminant analysis suggests that repayment flexibility and processing speed are key differentiators, with transactional fees and basic credit management playing a lesser role. This implies that for high-value customers, ease of repayment is a priority. Financial institutions can implement tailored credit lines that prioritize fast, flexible repayment options, ensuring that high-value customers experience minimal friction in managing their accounts. Recognizing this focus on efficiency over cost can help institutions develop premium offerings for this segment, reinforcing customer loyalty and increasing the institution's value perception.

Lastly, the significance of credit income in creditworthiness highlights income's role as a primary indicator of debt repayment ability within the UPI system. Since income significantly predicts creditworthiness, FIs should consider placing it at the centre of credit assessments. Conversely, factors such as deposits, assets, investments, and collateral may be deprioritized in the initial credit evaluation process for UPI credit lines, given their limited predictive power. Streamlining credit assessments around income could simplify decision-making and improve approval speed, benefiting both customers and institutions.

In conclusion, these findings suggest that by aligning credit policies with user behaviours and preferences, financial institutions can enhance the appeal and effectiveness of UPI credit lines. Prioritizing income-based assessments, repayment flexibility, and transparent fees will not only improve credit adoption but also foster loyalty and trust in the digital finance landscape, positioning FIs to gain a competitive advantage in the rapidly evolving UPI market.

9. References

1. Aggarwal, K., Malik, S., Mishra, D. K., & Paul, D. (2021). Moving from Cash to Cashless Economy: Toward Digital India. *Journal of Asian Finance, Economics and Business*, *8*(4). https://doi.org/10.13106/jafeb.2021.vol8.no4.0043

2. Almuhammadi, A. (2020). An overview of mobile payments, fintech, and digital wallet in Saudi Arabia. *Proceedings of the 7th International Conference on Computing for Sustainable Global Development, INDIACom 2020*. https://doi.org/10.23919/INDIACom49435.2020.9083726
3. Bagla, R. K., & Sancheti, V. (2018). Gaps in customer satisfaction with digital wallets: challenge for sustainability. *Journal of Management Development*, *37*(6). https://doi.org/10.1108/JMD-04-2017-0144
4. Baker, L. (2021). Everyday experiences of digital financial inclusion in India's 'micro-entrepreneur' paratransit services. *Environment and Planning A*, *53*(7). https://doi.org/10.1177/0308518X211026320
5. Chakrabarty, M., Jha, A., & Ray, P. (2021). Demonetization and digital payments in India: perception and reality. *Applied Economics Letters*, *28*(4). https://doi.org/10.1080/13504851.2020.1752895
6. Chandrasekhar, C. P., & Ghosh, J. (2018). The Financialization of Finance? Demonetization and the Dubious Push to Cashlessness in India. *Development and Change*, *49*(2). https://doi.org/10.1111/dech.12369
7. Chawla, D., & Joshi, H. (2019). Consumer attitude and intention to adopt mobile wallet in India – An empirical study. *International Journal of Bank Marketing*, *37*(7). https://doi.org/10.1108/IJBM-09-2018-0256
8. Chawla, D., & Joshi, H. (2021). Degree of Awareness and the Antecedents of the Digital Media Platform: The Case of Mobile Wallets. *FIIB Business Review*. https://doi.org/10.1177/23197145211023413
9. Goel, R., Sahai, S., Vinaik, A., & Garg, V. (2019). Moving from cash to cashless economy: - A study of consumer perception towards digital transactions. *International Journal of Recent Technology and Engineering*, *8*(1). https://doi.org/10.17492/pragati.v7i1.195425
10. Grover, P., & Kar, A. K. (2020). User engagement for mobile payment service providers – introducing the social media engagement model. *Journal of Retailing and Consumer Services*, *53*. https://doi.org/10.1016/j.jretconser.2018.12.002
11. Gupta, A., & Xia, C. (2018). A paradigm shift in banking: Unfolding asia's fintech adventures. In *International Symposia in Economic Theory and Econometrics* (Vol. 25). https://doi.org/10.1108/S1571-038620180000025010
12. Gupta, R., Kapoor, C., & Yadav, J. (2020). Acceptance towards digital payments and improvements in cashless payment ecosystem. *2020 International Conference for Emerging Technology, INCET 2020*. https://doi.org/10.1109/INCET49848.2020.9154024
13. Gupta, S., Kiran, R., & Sharma, R. K. (2022). Validating the role of digital payment mode as a new driver of online shopping: A modified UTAUT2 model. *Journal of Public Affairs*, *22*(2). https://doi.org/10.1002/pa.2434
14. Gupta, S., Mittal, R., & Mittal, A. (2019). Modelling the intentions to adopt UPIs: A PLS-SEM approach. *Proceedings of the 2019 6th International Conference on Computing for Sustainable Global Development, INDIACom 2019*.
15. Jakhiya, M., Mittal Bishnoi, M., & Purohit, H. (2020). Emergence and growth of mobile money in modern india: A study on the effect of mobile money. *2020 Advances in Science and Engineering Technology International Conferences, ASET 2020*. https://doi.org/10.1109/ASET48392.2020.9118375
16. Joseph, J., Sriram, K. V., Rodrigues, L. L. R., Mathew, A. O., & Gana, K. C. (2018). An empirical study on customer adoption of mobile payment application in India. *International Journal of Enterprise Network Management*, *9*(3–4). https://doi.org/10.1504/IJENM.2018.094675
17. Kameswaran, V., & Muralidhar, S. H. (2019). Cash, digital payments and accessibility - A case study from India. In *Proceedings of the ACM on Human-Computer Interaction* (Vol. 3, Issue CSCW). https://doi.org/10.1145/3359199
18. Kandpal, V., & Mehrotra, R. (2019). Financial inclusion: The role of fintech and digital financial services in India. *Indian Journal of Economics and Business*, *18*(1).
19. Kar, A. K. (2021). What Affects Usage Satisfaction in Mobile Payments? Modelling User Generated Content to Develop the "Digital Service Usage Satisfaction Model." *Information Systems Frontiers*, *23*(5). https://doi.org/10.1007/s10796-020-10045-0
20. Khan, K. A., & Akhtar, M. A. (2020). Electronic payment system use: A mediator and a predictor of financial satisfaction. In *Investment Management and Financial Innovations* (Vol. 17, Issue 3). https://doi.org/10.21511/imfi.17(3).2020.19
21. Khanra, S., Joseph, R. P., Dhir, A., & Kaur, P. (2020). Antecedents of the Barriers Toward the Adoption of Unified Payment Interface. *IFIP Advances in Information and Communication Technology*, *618*. https://doi.org/10.1007/978-3-030-64861-9_53
22. Krithiga Lakshmi, K., Gupta, H., & Ranjan, J. (2019). UPI Based Mobile Banking Applications - Security Analysis and Enhancements. *Proceedings - 2019 Amity International Conference on Artificial Intelligence, AICAI 2019*. https://doi.org/10.1109/AICAI.2019.8701396
23. Kumar, V., Nim, N., & Agarwal, A. (2021). Platform-based mobile payments adoption in emerging and developed countries: Role of country-level heterogeneity and network effects. *Journal of International Business Studies*, *52*(8). https://doi.org/10.1057/s41267-020-00346-6
24. Ligon, E., Malick, B., Sheth, K., & Trachtman, C. (2019). What explains low adoption of digital payment technologies? Evidence from small-scale merchants in Jaipur, India. *PLoS ONE*, *14*(7). https://doi.org/10.1371/journal.pone.0219450
25. Lohana, S., & Roy, D. (2023). Impact of Demographic Factors on Consumer's Usage of Digital Payments. *FIIB Business Review*, *12*(4). https://doi.org/10.1177/23197145211049586
26. Lupo-Pasini, F. (2021). Financial Inclusion And The "War For Cash." *Law and Contemporary Problems*, *84*(1).
27. Madhava Priya, D., Prashanth, J., & Indira, A. (2019). Sustainability of small merchants through digital technologies. *Prabandhan: Indian Journal of Management*, *12*(1). https://doi.org/10.17010/pijom/2019/v12i1/141424

28. Maindola, P., Singhal, N., & Dubey, A. D. (2018). Sentiment Analysis of Digital Wallets and UPI Systems in India Post Demonetization Using IBM Watson. *2018 International Conference on Computer Communication and Informatics, ICCCI 2018*. https://doi.org/10.1109/ICCCI.2018.8441441
29. Manickam, T., Vinayagamoorthi, G., Gopalakrishnan, S., Sudha, M., & Mathiraj, S. P. (2022). Customer Inclination on Mobile Wallets With Reference to Google-Pay and PayTM in Bengaluru City. *International Journal of E-Business Research*, *18*(1). https://doi.org/10.4018/IJEBR.293295
30. Manrai, R., Goel, U., & Yadav, P. D. (2021). Factors affecting adoption of digital payments by semi-rural Indian women: extension of UTAUT-2 with self-determination theory and perceived credibility. *Aslib Journal of Information Management*, *73*(6). https://doi.org/10.1108/AJIM-12-2020-0396
31. Meher, B. K., Hawaldar, I. T., Mohapatra, L., Spulbar, C., Birau, R., & Rebegea, C. (2021). The impact of digital banking on the growth of micro, small and medium enterprises (Msmes) in india: A case study. *Business: Theory and Practice*, *22*(1). https://doi.org/10.3846/btp.2021.12856
32. Menon, M. M., & Ramakrishnan, H. S. (2019). Revolution of E-wallets usage among Indian millennial. *International Journal of Recent Technology and Engineering*, *8*(3). https://doi.org/10.35940/ijrte.C6601.098319
33. Mishra, V., Walsh, I., & Srivastava, A. (2022). Merchants' adoption of mobile payment in emerging economies: the case of unorganised retailers in India. *European Journal of Information Systems*, *31*(1). https://doi.org/10.1080/0960085X.2021.1978338
34. Mukul, Taneja, S., Özen, E., Plaha, R., & Zammit, M. L. (2023). Banking, Fintech, BigTech: Emerging challenges for multimedia adoption. In *Intelligent Multimedia Technologies for Financial Risk Management: Trends, Tools and Applications*. https://doi.org/10.1049/pbpc060e_ch3
35. Nair, B. J., Baskar, B., Kallarakal, T. K., Poola, K., Uma, V. R., & Girish, S. (2024). Understanding the technological evolution in electronic payments system in India and the acceptance. *International Journal of Process Management and Benchmarking*, *16*(4). https://doi.org/10.1504/IJPMB.2024.137151
36. Padmaja, C. H., & Venkata Durga Rao, P. (2019). The rise and growth of digital payments in India. *International Journal of Innovative Technology and Exploring Engineering*, *8*(12). https://doi.org/10.35940/ijitee.L3263.1081219
37. Pal, A., Herath, T., De, R., & Raghav Rao, H. (2018). Factors facilitating adoption of mobile payment services over credit/debit cards: An investigation after the demonetization policy shock in India. *Proceedings of the 22nd Pacific Asia Conference on Information Systems - Opportunities and Challenges for the Digitized Society: Are We Ready?, PACIS 2018*.
38. Pal, A., Herath, T., De', R., & Raghav Rao, H. (2021). Why do people use mobile payment technologies and why would they continue? An examination and implications from India. *Research Policy*, *50*(6). https://doi.org/10.1016/j.respol.2021.104228
39. Pal, A., Herath, T., De', R., & Rao, H. R. (2020). Contextual facilitators and barriers influencing the continued use of mobile payment services in a developing country: insights from adopters in India. *Information Technology for Development*, *26*(2). https://doi.org/10.1080/02681102.2019.1701969
40. Pal, J., Chandra, P., Kameswaran, V., Parameshwar, A., Joshi, S., & Johri, A. (2018). Digital payment and its discontents: Street shops and the indian government's push for cashless transactions. *Conference on Human Factors in Computing Systems - Proceedings*, *2018-April*. https://doi.org/10.1145/3173574.3173803
41. Patil, P., Tamilmani, K., Rana, N. P., & Raghavan, V. (2020). Understanding consumer adoption of mobile payment in India: Extending Meta-UTAUT model with personal innovativeness, anxiety, trust, and grievance redressal. *International Journal of Information Management*, *54*. https://doi.org/10.1016/j.ijinfomgt.2020.102144
42. P.H, H. (2023). Mobile payment service adoption: understanding customers for an application of emerging financial technology. *Information and Computer Security*, *31*(2). https://doi.org/10.1108/ICS-04-2022-0058
43. Raghavendra, V., & Veeresha, P. (2023). Analysing the market for digital payments in India using the predator-prey model. *International Journal of Optimization and Control: Theories and Applications*, *13*(1). https://doi.org/10.11121/ijocta.2023.1306
44. Raman, P., & Aashish, K. (2021). To continue or not to continue: a structural analysis of antecedents of mobile payment systems in India. *International Journal of Bank Marketing*, *39*(2). https://doi.org/10.1108/IJBM-04-2020-0167
45. Ravikumar, T. (2019). Digital financial inclusion: A payoff of financial technology and digital finance uprising in India. *International Journal of Scientific and Technology Research*, *8*(11).
46. Ravikumar, T., & Prakash, N. (2022). Determinants of adoption of digital payment services among small fixed retail stores in Bangalore, India. *International Journal of Business Innovation and Research*, *28*(3). https://doi.org/10.1504/IJBIR.2022.124123
47. Ravikumar, T., Suresha, B., Sriram, M., & Rajesh, R. (2019). Impact of digital payments on economic growth: Evidence from India. *International Journal of Innovative Technology and Exploring Engineering*, *8*(12). https://doi.org/10.35940/ijitee.L3432.1081219
48. Sam, J. S., Chakraborty, A., & Srinivasan, J. (2021). Cashlessness in India: Vision, policy and practices. In *Telecommunications Policy* (Vol. 45, Issue 8). https://doi.org/10.1016/j.telpol.2021.102169
49. Savitha, B., Hawaldar, I. T., & Kumar K, N. (2022). Continuance intentions to use FinTech peer-to-peer payments apps in India. *Heliyon*, *8*(11). https://doi.org/10.1016/j.heliyon.2022.e11654

50. Seethamraju, R., & Diatha, K. S. (2018). Adoption of digital payments by small retail stores. *ACIS 2018 - 29th Australasian Conference on Information Systems*. https://doi.org/10.5130/acis2018.as
51. Singh, N. K., Sahu, G. P., Rana, N. P., Patil, P. P., & Gupta, B. (2019). Critical success factors of the digital payment infrastructure for developing economies. *IFIP Advances in Information and Communication Technology*, *533*. https://doi.org/10.1007/978-3-030-04315-5_9
52. Singh, P., Dwivedi, Y. K., Kahlon, K. S., Rana, N. P., Patil, P. P., & Sawhney, R. S. (2019). Digital Payment Adoption in India: Insights from Twitter Analytics. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *11701 LNCS*. https://doi.org/10.1007/978-3-030-29374-1_35
53. Sinha, S., Raj Pandey, K., & Madan, N. (2018). Fintech and the demand side challenge in financial inclusion. *Enterprise Development and Microfinance*, *29*(1). https://doi.org/10.3362/1755-1986.17-00016
54. Sivathanu, B. (2019). Adoption of digital payment systems in the era of demonetization in India: An empirical study. *Journal of Science and Technology Policy Management*, *10*(1). https://doi.org/10.1108/JSTPM-07-2017-0033
55. Thirupathi, M., Vinayagamoorthi, G., & Mathiraj, S. P. (2019). Effect of cashless payment methods: A case study perspective analysis. *International Journal of Scientific and Technology Research*, *8*(8).
56. Tiwari, T., Srivastava, A., & Kumar, S. (2019). Adoption of digital payment methods in India. In *International Journal of Electronic Finance* (Vol. 9, Issue 3). https://doi.org/10.1504/IJEF.2019.099058