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A Comprehensive Review of the Unified Payments Interface (UPI) in India

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Abstract

Since its introduction in 2016, the Unified Payments Interface (UPI) has become the backbone of India's shift from cash-based to digital payments. Research on UPI has grown quickly, but it is scattered across adoption, security, performance and policy questions. This review traces how that research has developed and identifies what remains unresolved. Structured searches of Google Scholar and other databases, using UPI-specific key phrases, identified English-language journal articles, conference papers, technical reports and reviews published between 2016 and early 2026. The 53 sources retained were read in full, assigned to eight thematic pillars and interpreted in chronological order. SWOC and ABCD analyses consolidate the evidence. UPI scholarship has moved through three phases: descriptive work on architecture and benefits (2017–2019); theory-driven studies of adoption, satisfaction, security and pandemic-era scalability (2020–2022); and, from 2023, machine-learning fraud detection, segment-specific adoption research and analyses of global expansion. Convenience, trust, perceived risk and digital literacy recur as determinants of use, whereas technical failures, fraud and uneven infrastructure persist as constraints. Technological development has outpaced empirical evidence, and most studies examine a single aspect of UPI. The review extends earlier systematic work on digital payments and UPI by placing eight thematic pillars on one timeline and converting them into a research agenda. The findings are relevant to policymakers, payment service providers and scholars working to consolidate UPI's role in building a less-cash society.

Keywords

Unified Payments Interface; UPI; Digital Payments; Financial Inclusion; Adoption Models; Cyber-security; Fraud Detection; Scalability; Cashless Economy

1. Introduction

India's demonetization of November 2016 acted as an unexpected catalyst for the country's digital payments landscape [1]. Although the measure was a government policy decision, it exposed a growing consumer need for alternative payment methods, and public authorities and private organizations moved quickly to meet it [8]. In the preceding years, information and communication technology (ICT) had already been reshaping banks and businesses and lowering their operating costs [2]. Settlement and payment functions, in particular, migrated to electronic channels, which gradually weakened the role of banknotes and pushed the country towards a cashless environment [6].

The notion of cashless payment was never meant to remove currency from circulation. Mahapatra and Patra (2018) [4] describe it as a complement to, rather than a replacement for, traditional modes of

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exchange. Even so, affordable smartphones, wider broadband coverage and a favourable regulatory environment led to the adoption of digital wallets faster than expected [16]. Among competing options such as mobile wallets, online banking and card systems, UPI stands out as the most innovative, because it offers round-the-clock inter-bank transactions without exposing sensitive account information [3,5].

Technically, UPI is a real-time, API-driven payment network managed by the National Payments Corporation of India (NPCI) [6]. It links multiple bank accounts to a single mobile payment application and assigns each user a Virtual Payment Address (VPA), which conceals the underlying account number [5]. The framework supports person-to-person (P2P) and person-to-merchant (P2M) transactions and protects every transaction with two-factor, PIN-based authentication [3,12]. By simplifying inter-bank transfers and operating continuously, UPI has, according to empirical studies, advanced financial inclusion and the digitalization of the Indian economy [14,22].

A decade after its launch, the literature on UPI is substantial but dispersed. Most studies examine one aspect of the platform, such as its architecture, user acceptance, security, scale or social impact, and technological development in real-time payments has moved considerably faster than the empirical evidence available to assess it. An earlier systematic review linked digital payments, UPI and digital financial inclusion [28]; to the authors' knowledge, however, no review has yet arranged the evidence on UPI along a single timeline and across its principal dimensions.

This review therefore examines UPI research published between 2016 and early 2026 through eight thematic pillars. It pursues nine objectives: (O1) to understand the system architecture and technological foundations of UPI; (O2) to evaluate the factors behind adoption, drawing on user perceptions and established behavioural theories; (O3) to assess satisfaction, usability and overall user experience; (O4) to investigate growth patterns, performance and scalability; (O5) to analyze security threats, protocols, vulnerabilities and fraud-detection systems; (O6) to examine UPI's contribution to financial inclusion and to a "less-cash" society; (O7) to identify the obstacles that continue to hinder adoption and the policy questions that remain open; (O8) to explore opportunities for international adoption and interoperability; and (O9) to identify research gaps and set out a forward-looking agenda. Objectives O1–O8 correspond to the eight thematic pillars, and O9 is addressed through the cross-theme synthesis.

The remainder of the paper is organized as follows. Section 2 summarizes the technical foundations of UPI, and Section 3 describes the review methodology. Section 4 traces the chronological evolution of UPI scholarship, and Section 5 synthesizes the evidence thematically. Section 6 discusses the findings through SWOC and ABCD analyses, sets out research gaps and draws implications. Section 7 presents the limitations, and Section 8 concludes.

2. Technical Foundations of UPI

Table 1 lists the features that make UPI technically distinctive; this section explains how they fit together. UPI is a payment infrastructure designed for continuous, real-time use [6]. Its core is an API-based middleware that connects participating banks through the NPCI switch [5]. Because every bank interacts with the same switch, funds move instantly and at any hour, irrespective of the two accounts involved [6], and the design provides a high degree of interoperability between heterogeneous banking systems [3].

Identity and security are handled differently from earlier channels. Each user holds a VPA, so no one needs to divulge personal banking information [12], and every transaction must pass through multi-factor authentication in which a user-specific PIN is used for verification [35]. The platform accommodates both P2P and P2M transfers [3]. In general, UPI transactions are cheaper than cash

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payments, which encourages cashless transactions [22]. Taken together, these attributes make UPI an enabler of financial inclusion and an engine of economic digitalization [14,28].

Table 1. Key technical features of UPI and the sources that describe them

S. No	Feature	Description	Source
1	Real-time operation	Payment infrastructure designed for continuous, real-time use	[6]
2	API-based middleware	Participating banks are connected through the NPCI switch	[5]
3	Instant, round-the-clock transfers	Funds move immediately at any hour, regardless of the banks involved	[6]
4	Virtual Payment Address	Users need not disclose personal banking information	[5,12]
5	P2P and P2M support	Both person-to-person and person-to-merchant transactions are handled	[3]
6	Interoperability	High interoperability between heterogeneous banking systems	[3]
7	Multi-factor authentication	A user PIN is required to verify each transaction	[35]
8	Lower transaction cost	Cheaper than cash payments, which encourages cashless use	[22]
9	Developmental role	Enabler of financial inclusion and economic digitalization	[14,28]

3. Review Methodology

3.1 Review Design and Search Strategy

This study follows a systematic literature review approach, consistent in large part with the precedent set by Mahesh and Ganesh Bhat (2022) [28]. Relevant literature was gathered through structured searches on Google Scholar and other databases, using key phrases such as “Unified Payments Interface,” “UPI adoption,” “UPI security,” “UPI fraud detection” and “UPI financial inclusion.”

3.2 Selection Criteria

A source was retained if it met all three of the following criteria:

- Timeline: publications from 2016 through early 2026.
- Document types: peer-reviewed journal articles, conference proceedings, technical reports and review papers.
- Language: English-language publications only.

3.3 Coding and Synthesis

Each retrieved article was read in full, from abstract to conclusion, and assigned to one or more thematic categories for cross-referenced synthesis. The categories form eight pillars: (i) system architecture and technical design; (ii) adoption, user perception and behavioural models; (iii)

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customer satisfaction, usability and user experience; (iv) growth, performance and scalability; (v) cybersecurity, vulnerabilities and fraud detection; (vi) financial inclusion and the cashless economy; (vii) challenges, barriers and policy issues; and (viii) global expansion and future perspectives. Within each pillar, studies are discussed in order of publication so that changes in focus, method and evidence can be followed over time.

The resulting corpus comprises 53 sources. The earliest dates from 2017, and Table 2 shows that output rose from two sources in 2017 to nine in 2024, with seven each in 2020 and 2022. The five sources dated 2026 reflect the early-2026 cut-off of the search.

Table 2. Distribution of reviewed sources by year of publication

Year	Number of sources
2017	2
2018	4
2019	5
2020	7
2021	5
2022	7
2023	5
2024	9
2025	4
2026	5
Total	53

4. Chronological Evolution of UPI Scholarship

Read in order of publication, the sources reveal three overlapping phases. Early studies explained what UPI is and why it mattered. Mid-period studies tested why people adopt it, how satisfied they are and how secure it is. Recent studies apply data-driven methods, examine particular user segments and look outward to other countries.

4.1 Phase I: Foundations and Context (2017–2019)

The earliest studies place UPI in the aftermath of demonetization [1,8]. Gochhwal (2017) [2] argued that UPI's main contribution is to simplify transactions, which moves India towards an economy driven by digital intermediation. Sharma (2018) [6] described the underlying architecture, an API-based network that links banks through a central NPCI switch, while Neema and Neema (2018) [5] compared the technology with conventional payment methods and concluded that adoption depends on user awareness, security, competing methods and infrastructure. Boke and Harkare (2018) [3] stressed the gains in retail-payment efficiency but also recorded early problems with server failure, transaction errors and low digital proficiency among users, and Mahapatra and Patra (2018) [4] framed electronic payments as a complement to traditional modes of exchange.

By 2019 the focus had turned towards growth and users. IJIRT (2019) [9] and ask et al. (2019) [7] documented rapid diffusion and efficiency gains, Philip (2019) [10] linked customer satisfaction to

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convenience, speed and reliability, and Vinay (2019) [11] applied the Technology Acceptance Model (TAM) to UPI adoption in Mysuru city.

4.2 Phase II: Theory-Driven Inquiry and Stress-Testing (2020–2022)

From 2020 the field became more theoretical and more critical. Adoption research drew on TAM and the Unified Theory of Acceptance and Use of Technology (UTAUT). Singh and Srivastava (2020) [18] found perceived usefulness and ease of use significant for the intention to adopt mobile banking, Patil and Varma (2020) [17] developed an extended UTAUT model for mobile-payment adoption, and Khanra et al. (2020) [13] identified perceived risk, lack of trust and dispositional resistance to change as barriers. Kumar and Kavya (2020) [16] linked perceptions of digital-banking quality to continued UPI engagement, and Shahid (2022) [30] applied diffusion of innovation theory, identifying ease of use as one of the strongest predictors of adoption.

Security came under scrutiny at the same time. Kumar et al. (2020) [15] found authentication vulnerabilities in UPI 1.0 that were only partly addressed in later releases, Dam and Deshpande (2021) [19] showed how users are exposed to social-engineering attacks, and Priya and Saradha (2021) [21] demonstrated that supervised machine-learning classifiers could detect fraudulent transactions. Abraham (2020) [12] examined PIN-based authentication within the wider debate on sovereign digital payment systems. The COVID-19 lockdowns then served as a stress test: Mahesh and Bhat (2021) [20] reported that the infrastructure coped with a surge in contactless payments but showed latency and system failures, and Das and Das (2022) [25] described an exponential growth trend involving billions of real-time transactions.

Evidence on outcomes also accumulated. Rastogi et al. (2021) [22] reported significant correlations between UPI use and financial literacy, inclusion indices and regional development, in line with the view that UPI promotes inclusion and digitalization [14]. Satisfaction studies multiplied, with contributions from Sukanya and Subbulakshmi (2021) [23], AARF Journal (2022) [24], Goyal and Monga (2022) [27], Sai Kumar (2022) [29] and Deshmukh and Phule (2022) [26], and Mahesh and Ganesh Bhat (2022) [28] consolidated the field in a systematic review that connected digital payments, UPI and financial inclusion.

4.3 Phase III: Data-Driven Methods, Segmentation and Global Outlook (2023–2026)

Since 2023, three developments stand out. First, security research has become data-driven. Charan et al. (2023) [31] addressed phishing-link and QR-code fraud, Mothukuri et al. (2023) [35] placed UPI within the broader landscape of e-banking security, Raju et al. (2024) [39] applied LSTM networks, and Jagadeesan et al. (2024) [37] and Nagaraju et al. (2024) [38] tested ensemble and convolutional models.

Second, adoption research became more refined. Linge et al. (2023) [34] used structural equation modelling to show that trust mediates long-term use, and Chaudhari and Singh (2023) [32] showed that TAM predicts actual usage as well as intention. Extended UTAUT models followed for specific contexts and segments: Goswami et al. (2023) [33] added security, privacy and proficiency, Razi-ur-Rahim et al. (2024) [40] studied urban users, Sharma and Chauhan (2024) [42] examined Generation Z, Kiran and Vedala (2025) [45] examined new users, and Solanki et al. (2025) [48] examined Generation X.

Third, the unit of analysis broadened from the payment method to the infrastructure and its international reach. Cornelli et al. (2024) [36], Verma et al. (2024) [44], Vadera and Khobar (2024) [43], Sahoo et al. (2024) [41], Rayarao et al. (2025) [46] and Sarkar and Rabha (2025) [47] examined UPI as digital infrastructure, as a driver of fintech growth and as a subject of policy. The most recent

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studies ask whether the model can travel: Emini et al. (2026) [50], Jadhav et al. (2026) [51], Rudransh and Menaka (2026) [52], Andia et al. (2026) [49] and Y. Sharma (2026) [53] consider trust, perceived technical sophistication, value and risk, welfare effects and the digital-public-infrastructure case for other markets. Section 5 follows each of these threads in turn.

5. Thematic Synthesis of the Literature

Each subsection below examines one thematic pillar and presents its studies in order of publication. A summary table closes each subsection.

5.1 UPI System Architecture, Features and Technical Design

Architectural scholarship begins with Sharma (2018) [6], who showed that calls to standardized APIs route payments through the central NPCI switch, so that funds can be transferred instantly regardless of the sending or receiving bank. Neema and Neema (2018) [5] extended this account by comparing UPI with other payment technologies and by noting that the use of VPAs in place of bank account numbers brings ease of use and reduces the risk of credential exposure. The ability to process both P2P and P2M transactions, together with cross-bank interoperability, widens the range of use cases the platform supports [3]. On the security side, every UPI transaction requires PIN-based authentication, which Abraham (2020) [12] placed in perspective through the discussion of sovereign digital payment systems.

Later studies concentrated on scale. Mahesh and Bhat (2021) [20] presented a case study of UPI's design, features and scalability during COVID-19 and concluded that the system is highly scalable, although infrastructure load, security and network reliability must be addressed. Das and Das (2022) [25] reported that UPI handles billions of real-time transactions efficiently but requires continuous improvement in infrastructure and reliability. Cornelli et al. (2024) [36] described UPI as a scalable, interoperable and inclusive model for real-time payments, and Rayarao et al. (2025) [46] concluded that UPI has transformed India's payment landscape while still needing improvements in security and scalability.

The architecture explains why the system can absorb such loads. The API layer distributes traffic across participating banks through the NPCI switch, and round-the-clock availability together with cross-bank interoperability means that no single institution's back end becomes a bottleneck [5,6]. Even so, although the technology has made digital payment easier and reduced reliance on cash, its long-term sustainability depends on continuous improvement in authentication, infrastructure and reliability [25,46].

Table 3. Studies on UPI system architecture and technical design (in chronological order)

S. No	Area and focus of the research	Outcome of the research	Reference
1	UPI as a modern, API-based digital payment system	UPI integrates multiple bank accounts into one platform for seamless real-time transactions and supports a cashless economy [6]	Sharma (2018)
2	Architecture, working process, technologies and comparison with other methods	UPI is an efficient and innovative payment system, but adoption depends on user awareness, security, competing methods and infrastructure [5]	Neema and Neema (2018)

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S. No	Area and focus of the research	Outcome of the research	Reference
3	Case study of UPI system design, features and scalability during COVID-19	UPI is highly scalable; infrastructure load, security and network reliability must be addressed [20]	Mahesh and Bhat (2021)
4	UPI as large-scale digital payment infrastructure	UPI handles billions of real-time transactions efficiently; continuous improvement in infrastructure and reliability is required [25]	Das and Das (2022)
5	UPI as a global fast-payment system: architecture and interoperability	UPI is a scalable, interoperable and inclusive model for real-time payments globally [36]	Cornelli et al. (2024)
6	Comprehensive analysis of UPI architecture, growth and future scope	UPI has transformed India's payment landscape; future improvements in security and scalability are required [46]	Rayarao et al. (2025)

5.2 Adoption, User Perception and Behavioural Models (TAM/UTAUT)

What motivates or deters users from embracing UPI has attracted considerable scholarly attention, much of it grounded in TAM and UTAUT. Across studies, perceived usefulness, ease of use, trust and security recur as the constructs with the greatest explanatory power over both intention and actual usage [17,18].

The evidence falls into three clusters. The first, adoption and impact, emphasizes macro-level consequences. Gochhwal (2017) [2] argued that UPI reduces transaction complexity and so eases the transition to a digital economy, and Shahid (2022) [30], drawing on diffusion of innovation theory, found ease of use and efficiency to be powerful drivers of adoption. The second cluster tests behavioural models. Vinay (2019) [11] showed that perceived usefulness and ease of use shape attitude and intention among UPI users in Mysuru, and Singh and Srivastava (2020) [18] confirmed the strong relationship between usefulness and behavioural intention for mobile banking. Khanra et al. (2020) [13] offered a counterweight, identifying perceived risk, distrust and resistance to change as effective obstacles, and Kumar and Kavya (2020) [16] observed that perceptions of digital-banking quality influence continued UPI engagement.

The third cluster treats trust as a variable in its own right. Linge et al. (2023) [34] used structural equation modelling to show that trust mediates long-term use, and Chaudhari and Singh (2023) [32] extended TAM to assess both behavioural intention and actual use. More recent work adapts UTAUT to particular contexts. Goswami et al. (2023) [33] found that security, privacy and technology proficiency significantly influence adoption. Razi-ur-Rahim et al. (2024) [40] reported that performance expectancy, effort expectancy, social influence and attitude explain a high share of variance among urban users, while Sharma and Chauhan (2024) [42] found performance expectancy, effort expectancy, hedonic motivation and habit to drive adoption among Generation Z. Kiran and Vedala (2025) [45] identified social influence and trust as important determinants of adoption by new users, and Solanki et al. (2025) [48] found that social influence, trust and habit shape adoption among Generation X.

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From the technological side, cross-bank interoperability, 24/7 service and PIN-based authentication lower the barriers that might otherwise deter first-time digital payment users [5].

Table 4. Studies on adoption and behavioural models (in chronological order)

S. No	Area and focus of the research	Outcome of the research	Reference
1	User adoption factors (ease of use, convenience)	UPI adoption is driven by ease of use, convenience and efficiency [2]	Gochhwal (2017)
2	TAM application in Mysuru city	Perceived usefulness and ease of use significantly influence attitude and intention [11]	Vinay (2019)
3	TAM model for mobile banking (UPI context)	Perceived usefulness and ease of use strongly influence behavioural intention [18]	Singh and Srivastava (2020)
4	Barriers to UPI adoption (UTAUT model)	Perceived risk, lack of trust and resistance to change are major barriers [13]	Khanra et al. (2020)
5	Determinants of UPI adoption (diffusion of innovation theory)	Ease of use is among the strongest predictors of adoption [30]	Shahid (2022)
6	Use behaviour towards mobile payment apps (SEM approach)	Trust mediates long-term use [34]	Linge et al. (2023)
7	TAM for predicting actual usage of mobile payment apps	TAM predicts both intention and actual usage [32]	Chaudhari and Singh (2023)
8	Extended UTAUT2 with security, privacy and proficiency	Security, privacy and technology proficiency significantly influence adoption [33]	Goswami et al. (2023)
9	Extended meta-UTAUT model among urban users	Performance expectancy, effort expectancy, social influence and attitude explain high variance [40]	Razi-ur-Rahim et al. (2024)
10	UTAUT2 among Generation Z	Performance expectancy, effort expectancy, hedonic motivation and habit drive adoption [42]	Sharma and Chauhan (2024)
11	Extended UTAUT with trust and promotional benefits	Trust, social influence and promotional benefits significantly influence adoption [45]	Kiran and Vedala (2025)
12	UTAUT among Generation X	Social influence, trust and habit significantly affect adoption among Generation X [48]	Solanki et al. (2025)

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5.3 Customer Satisfaction, Usability and User Experience

Alongside adoption, researchers have asked how users experience UPI once they use it. Surveys indicate that ease of use and speed are among the most appreciated features, although occasional technical errors and security concerns persist [29]. Boke and Harkare (2018) [3] listed the design features behind the service, namely instant settlement, VPA-based identity protection, P2P and P2M transfers and cross-bank compatibility, which aim to reduce transaction costs, and later studies examine how users respond to them.

Philip (2019) [10] identified convenience, efficiency and perceived reliability as the main components of customer satisfaction. Sukanya and Subbulakshmi (2021) [23], studying Chennai, found that perceived simplicity is a key driver of positive assessments, and AARF Journal (2022) [24] and Sai Kumar (2022) [29] indicate that these design features strengthen customers' trust over time, provided the system remains reliable. Goyal and Monga (2022) [27] reported that urban users show higher adoption and that awareness and trust are key. Deshmukh and Phule (2022) [26] then broke satisfaction down into its components and found that ease of use, interface clarity and security assurance sustain high satisfaction scores.

Reliability emerges as the weak point. Das and Das (2022) [25] note that even a slight increase in transaction failure rates or server downtime can damage the goodwill that UPI has built up.

Table 5. Studies on customer satisfaction and usability (in chronological order)

S. No	Area and focus of the research	Outcome of the research	Reference
1	Impact of UPI on customer satisfaction	UPI improves satisfaction through convenience, speed and reliability [10]	Philip (2019)
2	Customer perception of UPI in Chennai city	Perceived simplicity is a key driver of positive assessments [23]	Sukanya and Subbulakshmi (2021)
3	Customer satisfaction with UPI services	Design features strengthen trust over time, depending on system reliability [24]	AARF Journal (2022)
4	Consumer perception and attitude towards UPI	Urban users show higher adoption; awareness and trust are key [27]	Goyal and Monga (2022)
5	Customer satisfaction with UPI apps and transactions	High convenience, but technical errors and security concerns affect the experience [29]	Sai Kumar (2022)
6	Customer satisfaction towards UPI services	Ease of use, interface clarity and security assurance drive high satisfaction [26]	Deshmukh and Phule (2022)

5.4 Growth, Performance, Efficiency and Scalability

Few payment platforms anywhere have matched UPI's rate of growth. Launched in 2016, the system now handles billions of real-time transactions, a finding on which several studies converge [25,43]. A quantitative analysis by IJIRT (2019) [9] revealed a compression of the diffusion curve for digital payment technology once UPI reached critical mass, and Ask et al. (2019) [7] added evidence of greater transaction efficiency, lower cost per transaction and improvements across the wider digital ecosystem.

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The COVID-19 crisis acted as a stress test. Mahesh and Bhat (2021) [20] observed that UPI infrastructure managed the increased volume of contactless payments but suffered from latency and system failures. Das and Das (2022) [25] similarly concluded that UPI shows signs of sustainable growth, although continuous scaling creates problems of its own. More recently, Vadera and Khobar (2024) [43] discussed UPI's catalytic role in India's fintech innovation, noting the fast onboarding of merchants in response to a growing consumer base. Perhaps the most comprehensive study to date is that of Rayarao et al. (2025) [46], which traces the history of UPI and sets out the steps still needed to secure its security and scalability. The architectural reasons for UPI's capacity to absorb load are discussed in Section 5.1.

Table 6. Studies on growth, performance and scalability (in chronological order)

S. No	Area and focus of the research	Outcome of the research	Reference
1	Growth and expansion of UPI in retail payments	UPI significantly increased retail transactions and accessibility [9]	IJIRT (2019)
2	Productivity and efficiency of UPI	UPI improves transaction speed, reduces cost and strengthens the digital ecosystem [7]	Ask et al. (2019)
3	UPI growth during COVID-19 and infrastructure challenges	UPI demonstrated high scalability during the pandemic, with latency and system failures [20]	Mahesh and Bhat (2021)
4	UPI as large-scale digital infrastructure	UPI handles billions of real-time transactions efficiently; continuous improvement is required [25]	Das and Das (2022)
5	UPI and the growth of the fintech sector	UPI catalysed fintech innovation, with rapid onboarding of merchants [43]	Vadera and Khobar (2024)
6	Growth, impact and future scope of UPI	Security and scalability must be strengthened as UPI grows [46]	Rayarao et al. (2025)

5.5 Cybersecurity, Vulnerabilities and Fraud Detection (ML/DL)

Security has attracted attention from both academics and practitioners. The first protocol-level investigation exposed problems with authentication [15], and later studies showed that social engineering undermines the protections built into UPI [19]. PIN-based identification is the protocol-level safeguard against illicit access [6], but it was not sufficient in the first implementation. A detailed security evaluation published at USENIX Security by Kumar et al. (2020) [15] found authentication vulnerabilities in UPI 1.0, which were partly addressed in later releases. Beyond protocol weaknesses, Dam and Deshpande (2021) [19] pointed to user-side threat vectors such as phishing, vishing and QR-code attacks, and Mothukuri et al. (2023) [35] widened the scope by placing UPI's vulnerabilities within the broader picture of e-banking security, noting that multi-layered defence strategies remain the exception rather than the norm.

On the detection side, a discernible shift from rule-based heuristics towards data-driven models is under way. Priya and Saradha (2021) [21] were among the first to demonstrate that supervised machine-learning classifiers, including Random Forest, XGBoost and logistic regression, can detect

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fraudulent UPI transactions with high accuracy and scalability. Charan et al. (2023) [31] narrowed the focus to phishing-link and QR-code fraud and achieved positive results in detecting such cases accurately. A further development is temporal modelling: Raju et al. (2024) [39] reported that LSTM networks identify fraudulent transactions more effectively through sequences, producing fewer false positives than static classifiers. Ensemble and convolutional networks have also been explored, and both Jagadeesan et al. (2024) [37] and Nagaraju et al. (2024) [38] independently report improved outcomes compared with traditional methods [37,38]. Taken together, these studies show a literature moving from diagnosing weaknesses to building defenses, even as the threat landscape continues to evolve.

Table 7. Studies on cybersecurity and fraud detection (in chronological order)

S. No	Area and focus of the research	Outcome of the research	Reference
1	Security analysis of the UPI protocol	UPI 1.0 had serious authentication flaws; later updates addressed many issues [15]	Kumar et al. (2020)
2	UPI platform as a tool for social engineering attacks	Users are vulnerable to phishing, vishing and QR scams; awareness is essential [19]	Dam and Deshpande (2021)
3	Machine learning for fraud detection	ML algorithms provide accurate and scalable fraud detection [21]	Priya and Saradha (2021)
4	ML-based detection of phishing links and QR fraud	High accuracy in real-time detection of phishing and QR scams [31]	Charan et al. (2023)
5	Security features in e-banking	UPI's vulnerabilities sit within the broader e-banking security picture; multi-layered defenses remain the exception [35]	Mothukuri et al. (2023)
6	LSTM-based deep learning for fraud detection	LSTM captures temporal patterns and reduces false positives [39]	Raju et al. (2024)
7	Ensemble ML and CNN for UPI fraud detection	Ensemble and CNN models outperform traditional methods [37,38]	Jagadeesan et al. (2024); Nagaraju et al. (2024)

5.6 Impact on Financial Inclusion and the Cashless Economy

One of the most frequently cited consequences of UPI is wider access to finance for segments long ignored by mainstream banking. Sharma (2018) [6] characterized UPI at an early stage as a tool that reduces dependence on cash and traditional banking methods, and later empirical work has supported this view. Kumar and Kavya (2020) [16] found that digital banking services with UPI are significantly related to first-time users' perceived service quality, and Rastogi et al. (2021) [22] reported statistically significant correlations between UPI penetration and improvements in financial literacy, inclusion indices and regional economic-development metrics. Mahesh and Ganesh Bhat (2022) [28] were, to their knowledge, the first to establish an analytical link between digital payment, UPI and digital financial inclusion within a single systematic review.

More recent contributions extend these findings. Verma et al. (2024) [44] argue that UPI's seamless, round-the-clock payments further reduce the need for cash in routine transactions, thereby

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supporting the less-cash economy thesis. Sahoo et al. (2024) [41] describe UPI as a gateway technology, because it enables digital transactions even through a basic mobile phone and so lowers the barrier that had kept underserved groups out of the financial network. Sarkar and Rabha (2025) [47] single out interoperability and real-time processing as the architectural features that give UPI its competitive advantage in India's fast-changing fintech landscape. At the macro level, Rayarao et al. (2025) [46] highlight the transformation UPI has brought to India's payment landscape and caution that its inclusive advantage would stall unless scalability and security keep pace with the user base. Kiran and Vedala (2025) [45] add a behavioural dimension, finding that social influence and trust are important determinants of adoption by new users, a reminder that inclusion depends on confidence as well as access.

Table 8. Studies on financial inclusion and the cashless economy (in chronological order)

S. No	Area and focus of the research	Outcome of the research	Reference
1	UPI impact on financial inclusion and economic development	UPI significantly improves financial literacy, inclusion and economic development [22]	Rastogi et al. (2021)
2	Systematic review and research agenda on digital payments with reference to UPI	Links digital payment, UPI and digital financial inclusion in a single systematic review [28]	Mahesh and Ganesh Bhat (2022)
3	UPI growth, development and financial inclusion	UPI enables seamless transactions and reduces cash dependency [44]	Verma et al. (2024)
4	Adoption of UPI: a literature review	UPI works as a gateway technology, enabling digital transactions through a basic mobile phone [41]	Sahoo et al. (2024)
5	Success of UPI in India's fintech ecosystem	Interoperability and real-time processing make UPI highly successful [47]	Sarkar and Rabha (2025)

5.7 Challenges, Barriers and Policy Issues

Despite its effectiveness, UPI still faces structural and perceptual problems. The literature points to limited technical reliability, security concerns, weak digital literacy and uneven infrastructure coverage, particularly outside metropolitan areas [41,48]. Some of these problems were visible early: Boke and Harkare (2018) [3] cited server failure, transaction errors and low user proficiency as brakes on adoption. Khanra et al. (2020) [13] later used UTAUT to describe the cognitive barriers of risk perception, trust deficit and dispositional resistance. Practical constraints compound them, since entering a PIN presupposes a degree of digital competence and using UPI at all requires a smartphone and internet access [3,16].

Recent evidence suggests that these obstacles remain. In a survey of the available research, Sahoo et al. (2024) [41] found digital-literacy disparities, lack of trust and infrastructure shortcomings to be the three factors most often cited as hindrances to universal acceptance. Solanki et al. (2025) [48] examined Generation X and found that reliance on social norms and interpersonal trust appears to outweigh utilitarian considerations. On the policy side, Sarkar and Rabha (2025) [47] argue that although interoperability explains much of UPI's success in India, narrowing the digital divide will need more than platform design.

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Table 9. Studies on challenges, barriers and policy issues (in chronological order)

S. No	Area and focus of the research	Outcome of the research	Reference
1	Review of UPI advancement and challenges	Technical issues, security concerns and low digital literacy affect adoption [3]	Boke and Harkare (2018)
2	Barriers to UPI adoption (psychological and technological)	Perceived risk, lack of trust and resistance to change hinder adoption [13]	Khanra et al. (2020)
3	Literature review on UPI adoption challenges	Digital literacy, trust issues and technical barriers remain [41]	Sahoo et al. (2024)
4	UPI adoption among Generation X	Social norms and interpersonal trust appear to outweigh utilitarian considerations [48]	Solanki et al. (2025)
5	UPI's success and its policy implications	Closing the digital divide needs more than platform design [47]	Sarkar and Rabha (2025)

5.8 Global Expansion and Future Perspectives

UPI began as a domestic experiment in real-time payments, but it is slowly attracting attention abroad. Several of its design principles, namely open APIs, built-in interoperability and a low cost per transaction, correspond closely to what other jurisdictions look for when designing fast-payment systems, which supports the view that the approach is worth replicating [5,50]. Cornelli et al. (2024) [36], writing for the Bank for International Settlements, analyze UPI's architecture in detail and draw lessons for other developing countries. Y. Sharma (2026) [53] presents UPI as a digital public infrastructure solution whose low cost, real-time capability and interoperability make it competitive in cross-border transactions. Andia et al. (2026) [49] study digital wallets in Peru, drawing a parallel with UPI-type deployments, and argue that well-implemented payment innovations can generate welfare gains in developing economies.

Other contemporary studies shed light on the conditions for successful internationalization. Emini et al. (2026) [50] examine consumer trust in digital payment systems in emerging markets and conclude that two-factor authentication and regulatory transparency offer useful lessons. Jadhav et al. (2026) [51] focus on the mediating role of perceived technical sophistication in consumer acceptance, which matters most when foreign users evaluate an unfamiliar payment system. Rudransh and Menaka (2026) [52] study the tension between perceived value and perceived risk, which becomes especially salient when UPI enters markets with different regulations and consumer expectations. Rayarao et al. (2025) [46] predict that UPI's global success will require security to be strengthened and infrastructure to be expanded at the same time, while Verma et al. (2024) [44] argue that UPI's progression from a pilot project to a full digital payment system demonstrates its inherent adaptability.

Table 10. Studies on global expansion and future perspectives (in chronological order)

S. No	Area and focus of the research	Outcome of the research	Reference
1	Lessons from UPI: global analysis	UPI is a scalable global model for real-time payments with cross-border linkages [36]	Cornelli et al. (2024)

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S. No	Area and focus of the research	Outcome of the research	Reference
2	Adoption and welfare effects of payment innovations (digital wallets in Peru)	Well-implemented payment innovations can raise welfare in developing economies [49]	Andia et al. (2026)
3	Consumer trust in digital payment systems in emerging markets	Two-factor authentication and regulatory transparency offer useful lessons [50]	Emini et al. (2026)
4	Technical advancement in digital payment acceptance	Perceived technical sophistication mediates acceptance, notably among foreign users [51]	Jadhav et al. (2026)
5	Perceived value and risk in UPI adoption	The value–risk trade-off becomes salient when UPI enters markets with different regulations [52]	Rudransh and Menaka (2026)
6	UPI from a digital public infrastructure perspective	Strong potential for global expansion owing to a low-cost, real-time and interoperable design [53]	Y. Sharma (2026)

6. Discussion

6.1 Cross-Cutting Findings

Three themes connect the eight pillars. The first is trust. Adoption models identify trust, perceived risk and security as decisive constructs [13,33,34,48], security studies show that the vulnerabilities behind those perceptions are real [15,19,35], and detection research is building the technical response [21,31,37–39]. Trust therefore operates simultaneously as a behavioural variable, a technical outcome and a regulatory concern, and the same constructs reappear when researchers consider foreign markets [50,51].

The second theme is reliability. Satisfaction depends on UPI working smoothly [25,29], yet the stress that growth places on infrastructure produced latency and system failures during the pandemic [20], and early studies had already recorded server failures and transaction errors [3]. Growth, satisfaction and scalability are thus linked through the same operational constraint.

The third theme is design. Interoperability, real-time processing and low cost, which are the features described in the architectural literature [3,5], are the same features that later studies credit for financial inclusion [41,47] and for UPI's portability to other markets [36,53]. Finally, across the whole timeline, technological development has run ahead of empirical evidence: architectural and scaling claims are plentiful, while outcome studies remain comparatively few and often examine a single dimension in isolation.

6.2 SWOC Analysis

Table 11 consolidates the evidence from the reviewed studies into strengths, weaknesses, opportunities and challenges.

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Table 11. SWOC analysis of UPI based on the reviewed literature

Dimension	Evidence from the reviewed studies
Strengths	Real-time, round-the-clock, interoperable inter-bank transfers [3,5,6]; account details protected by VPAs [5,12]; PIN-based authentication [6,35]; efficiency gains and lower costs [7,22]; demonstrated scalability to billions of transactions [20,25].
Weaknesses	Latency and system failures under peak load [20]; transaction failures and server downtime that erode goodwill [25]; early server failures and transaction errors [3]; authentication flaws in UPI 1.0 [15]; dependence on a smartphone, internet access and PIN competence [3,16].
Opportunities	Gateway to finance for underserved groups through even a basic mobile phone [41]; fintech growth and merchant onboarding [43]; data-driven fraud detection [21,31,37–39]; replication abroad as digital public infrastructure [36,53]; engagement with segment-specific users [42,48].
Challenges	Social-engineering attacks such as phishing, vishing and QR scams [19]; digital-literacy disparities and trust deficits [41]; infrastructure shortcomings outside metropolitan areas [41,48]; a digital divide that platform design alone cannot close [47]; unfamiliar regulatory contexts abroad [52]; keeping security and infrastructure in step with scale [46].

6.3 ABCD Analysis

Table 12 organizes the same evidence by advantages, benefits, constraints and disadvantages. Advantages describe the inherent properties of the system, benefits the outcomes users and society obtain, constraints the conditions that limit use, and disadvantages the negative consequences observed.

Table 12. ABCD analysis of UPI based on the reviewed literature

Dimension	Evidence from the reviewed studies
Advantages	Open, API-based middleware connected through the NPCI switch [5,6]; cross-bank interoperability [3]; VPA-based identity protection [5]; 24/7 availability [6].
Benefits	Convenience, speed and satisfaction [10,26]; greater efficiency and lower cost per transaction [7]; improved financial literacy and inclusion [22]; reduced dependence on cash [44].
Constraints	Digital-literacy gaps, limited infrastructure and the need for a smartphone and internet access [3,16,41]; perceived risk and resistance to change [13].
Disadvantages	Exposure to fraud and social-engineering attacks [19,35]; transaction failures, downtime and latency [20,25].

6.4 Research Gaps and Future Agenda

The synthesis points to six gaps that together address objective O9.

First, the literature is fragmented. Adoption models, security studies, performance analyses and inclusion studies are largely conducted separately, and future work should develop integrated

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frameworks that connect adoption, security, reliability and inclusion outcomes. Second, empirical evidence lags behind technological change. Studies that use large-scale transaction data and longitudinal designs would help to test the claims about scalability, efficiency and inclusion that currently rest on case studies and perception surveys.

Third, coverage of user segments and geographies is uneven. Several studies concentrate on urban users [27,40] or on particular generations [42,48], while infrastructure and literacy shortfalls are reported to be most acute outside metropolitan areas [41,48]. Research on rural and low-literacy users is therefore a priority. Fourth, security and behaviour are rarely studied together. Fraud-detection research reports on detection performance [21,31,37–39], whereas adoption models treat security as a perception [33]; studies that connect actual fraud exposure to trust and continued use [34] are needed.

Fifth, operational reliability deserves direct measurement. Latency, system failures and downtime are reported as problems [20,25], but their frequency and effect on user trust are seldom quantified. Sixth, cross-border evidence is thin. Studies of UPI's international prospects are concentrated in 2026 [49–53], and comparative empirical work in markets that adopt similar systems is still needed.

6.5 Implications

For policymakers, the evidence supports sustained investment in digital literacy and in infrastructure outside metropolitan areas [41,48], together with attention to the digital divide that platform design alone cannot close [47]. Regulatory transparency also emerges as a factor in consumer trust, including in foreign markets [50]. For payment service providers, the priorities are reliability at scale [20,25], a simple user interface [23,26] and the adoption of data-driven fraud-detection methods [37,39]. For scholars, the agenda outlined above offers a route from isolated studies towards cumulative, comparable evidence.

7. Limitations

Several limitations should be noted. The searches relied on Google Scholar and other databases, and the restriction to English-language publications may have excluded relevant studies. The corpus includes technical reports, working papers and preprints alongside peer-reviewed articles, which differ in the rigour of their review. The synthesis is narrative and thematic and does not attempt a quantitative meta-analysis. Finally, the field is evolving rapidly, and the search closed in early 2026.

8. Conclusion

This review has traced UPI research from 2017 to early 2026 through a chronological lens and eight thematic pillars. Early work explained the architecture and benefits of a system born in the wake of demonetization. Mid-period work tested adoption, satisfaction, security and scale, notably during the COVID-19 lockdowns. Recent work applies machine-learning methods to fraud, refines adoption models for specific segments and considers whether the UPI model can be exported.

Across this timeline, convenience, trust, perceived risk and digital literacy recur as determinants of use, while technical failures, fraud and uneven infrastructure recur as constraints. The central finding is that the technology has advanced faster than the evidence on its outcomes, and that most studies examine one dimension of UPI in isolation. Integrated, longitudinal and geographically broader research, together with direct measurement of reliability and of the security–trust link, would give policymakers, payment service providers and scholars a firmer basis for consolidating UPI's role in building a less-cash society.

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References

1. S. Bhardwaj and M. Kaushik, "Unified Payment Interface—A way ahead for demonetization in India," in Smart Computing and Informatics. Springer, 2017. https://doi.org/10.1007/978-981-10-5547-8_29

2. R. Gochhwal, "Unified Payment Interface—An advancement in payment systems," American Journal of Industrial and Business Management, 2017. https://doi.org/10.4236/ajibm.2017.710084

3. S. Boke and O. Harkare, "Review on unified payment interface advancement towards digitalization and challenges faced," Episteme Journal, 2018. https://episteme.net.in/content/73/3820/attachments/6-UPI.pdf

4. D. M. Mahapatra and S. K. Patra, "Electronic payment adoption in India: Development and policy issues," Aweshkar Research Journal, vol. 24, no. 1, pp. 49–59, 2018.

5. K. Neema and A. Neema, "UPI (Unified Payments Interface) – A new technique of digital payment: An explorative study," International Journal of Creative Research in Management (IJCRM), 2018. http://www.ijcrm.com/publish_article/edition-28/18IJCRM31010.pdf

6. A. Sharma, "Unified Payments Interface: The Recent Indian Financial Innovation Demystified," Apeejay Journal of Management & Technology, 2018.

7. R. Ask et al., "The study of productivity and efficiency of unified payment interface," International Journal of Research in Social Sciences (IJRSS), Jun. 2019. https://www.ijmra.us/project%20doc/2019/IJRSS_JUNE2019/IJRSSJune19RajeshAsk.pdf

8. K. Chavali, C. Prasad, and K. S. S. Rao, "Demonetization and its impact on digitization in India," Management Dynamics, 2019. https://doi.org/10.57198/2583-4932.1026

9. IJIRT, "E-payment: A case study of unified payment interface," International Journal of Innovative Research in Technology (IJIRT), vol. 5, no. 11, 2019. https://ijirt.org/publishedpaper/IJIRT169239_PAPER.pdf

10. B. Philip, "Unified payment interface – Impact of UPI in customer satisfaction," ResearchGate, 2019. https://www.researchgate.net/profile/Bijin-Philip/publication/342361407

11. S. Vinay, "Application of technology acceptance model of unified payment interface services adoption in Mysuru city: An exploratory study," ResearchGate, 2019. https://www.researchgate.net/publication/374144402

12. S. Abraham, "Unified payment interface: Towards greater cyber sovereignty," 2020. https://sunilabraham.in/publications/files/unified-payment-interface-towards-greater-cyber-sovereignty.pdf

13. S. Khanra, R. P. Joseph, A. Dhir, and P. Kaur, "Antecedents of the barriers toward the adoption of unified payment interface," in Re-imagining Diffusion and Adoption of Information Technology and Systems. Springer, 2020. https://doi.org/10.1007/978-3-030-64861-9_53

14. D. M. Kolte and V. R. Humbe, "Study of UPI/BHIM payment system in India," International Journal of Science and Research (IJSR), vol. 9, no. 12, 2020. https://www.ijsr.net/archive/v9i12/SR201202182305.pdf

15. R. Kumar, S. Kishore, H. Lu, and A. Prakash, "Security analysis of unified payments interface and payment apps in India," in 29th USENIX Security Symposium (USENIX Security 20), 2020. https://www.usenix.org/conference/usenixsecurity20/presentation/kumar

16. S. V. S. Kumar and C. Kavya, "Role of unified payment interface in digital banking services – An empirical study on user perceptions," Mukt Shabd Journal, vol. 9, no. 4, 2020.

17. A. Patil and G. K. Varma, "Developing a general extended UTAUT model for Mpayment adoption," Technology in Society, vol. 62, 2020. https://doi.org/10.1016/j.techsoc.2020.101293

18. S. Singh and R. K. Srivastava, "Understanding the intention to use mobile banking by existing online banking customers: An empirical study," Journal of Financial Services Marketing, vol. 25, no. 3–4, pp. 86–96, 2020. https://doi.org/10.1057/s41264-020-00074-w

19. L. B. Dam and K. Deshpande, "Unified payment interface (UPI) platform: Conniving tool for social engineering attack," Pacific Business Review International, 2021. https://www.researchgate.net/publication/357837725

20. A. Mahesh and G. Bhat, "Digital payment service in India – A case study of unified payment interface," International Journal of Case Studies in Business, IT, and Education, 2021. https://www.researchgate.net/publication/353217166

21. G. J. Priya and S. Saradha, "Fraud detection and prevention using machine learning algorithms: A review," IEEE, 2021. https://ieeexplore.ieee.org/document/9383631

22. S. Rastogi, C. Panse, A. Sharma, and V. M. Bhimavarapu, "Unified payment interface (UPI): A digital innovation and its impact on financial inclusion and economic development," Universal Journal of Accounting and Finance, vol. 9, no. 3, pp. 518 – 530, 2021. https://doi.org/10.13189/ujaf.2021.090326

23. N. Sukanya and S. Subbulakshmi, "Unified payment interface application: A study of customer perception with special reference to Chennai city," Sv¯adhya¯ya – International Journal of Transdisciplinary Research and Development, vol. 1, no. 1, pp. 25–29, 2021. https://www.sdnbvc.edu.in/wp-content/uploads/2022/02/Paperid04.pdf

24. AARF Journal, "Customer satisfaction with UPI services," AARF Journal, 2022. https://aarf.asia/current/2022/Mar/p0zN7pWpWmj1pBQ.pdf

25. A. Das and A. Das, "Unified payments interface – A giant in the digital payments space," IIT Bombay Technical Report, 2022. https://www.math.iitb.ac.in/~ashish/workshop/UPI-AmoghDas-2022.pdf

26. S. S. Deshmukh and K. Phule, "Customer satisfaction towards unified payment interface (UPI) services," International Research Journal of Human Resource and Social Sciences, vol. 9, no. 3, pp. 141–147, 2022.

27. M. K. Goyal and N. Monga, "An empirical study on perception and attitude of consumers towards unified payment interface (UPI)," Journal of Positive School Psychology, 2022. https://www.researchgate.net/publication/366426620

28. A. Mahesh and S. Ganesh Bhat, "A Systematic Review and Research Agenda of Digital Payment System with reference to Unified Payment Interface," International Journal of Management,

Technology, and Social Sciences (IJMTS), vol. 7, no. 2, pp. 679–709, 2022. https://doi.org/10.5281/zenodo.7504169

29. Sai Kumar, "Study of customer satisfaction of using UPI apps and transactions (Project report)," Sathyabama Institute of Science and Technology, 2022. https://sist.sathyabama.ac.in/sist_naac/documents/1.3.4/39280023%20SAI%20KUMAR.pdf

30. M. Shahid, "Exploring the determinants of adoption of unified payment interface (UPI) in India: A study based on diffusion of innovation theory," Digital Business, 2022. https://doi.org/10.1016/j.digbus.2022.100040

31. G. R. Charan, K. D. Thilak, et al., "Detection of phishing link and QR code of UPI transaction using machine learning," IEEE Conference, 2023. https://ieeexplore.ieee.org/document/10426613/

32. T. Chaudhari and M. Singh, "Empirical evaluation of technology acceptance model for predicting actual usage of mobile payment apps," Zenodo, 2023. https://zenodo.org/records/7951826

33. A. Goswami et al., "An empirical study on the customer acceptance of unified payment interface," IEEE, 2023. https://ieeexplore.ieee.org/document/10392139/

A. A. Linge et al., "Analysis of factors affecting use behavior towards mobile payment apps: A SEM approach," Wiley Open Access, 2023. https://onlinelibrary.wiley.com/doi/pdf/10.1155/2023/3327994

34. N. P. H. K. Mothukuri, A. Rakesh, et al., "A comprehensive study of different security features in e-banking," IEEE Conference, 2023. https://ieeexplore.ieee.org/document/10073735/

35. G. Cornelli, J. Frost, L. Gambacorta, S. Sinha, and R. M. Townsend, "Lessons from the unified payments interface (UPI)," BIS Papers No. 152, 2024. https://www.bis.org/publ/bppdf/bispap152_e_rh.pdf

36. S. Jagadeesan, K. S. Arjun, G. Dhanika, G. Karthikeyan, and K. Deepika, "UPI fraud detection using machine learning," ResearchGate, 2024. https://www.researchgate.net/publication/385968094

37. M. Nagaraju et al., "UPI fraud detection using convolutional neural networks (CNN)," ResearchGate, 2024. https://www.researchgate.net/publication/378963932

38. M. N. Raju et al., "Detection of fraudulent activities in unified payments interface using machine learning – LSTM networks," IEEE Conference, 2024. https://ieeexplore.ieee.org/document/10672890/

39. M. Razi-ur-Rahim, M. R. Rabbani, F. Uddin, and Z. H. Shaikh, "Adoption of UPI among Indian users: Using extended meta-UTAUT model," Digital Business, 2024. https://www.researchgate.net/publication/385148923

40. D. K. Sahoo, B. C. M. Patnaik, and I. Satpathy, "Adoption of unified payment interface (UPI): A literature review," Journal of the Oriental Institute, 2024. https://www.researchgate.net/publication/387265340

41. S. Sharma and N. S. Chauhan, "Exploring UPI adoption and usage among Generation Z," XIME Journal, 2024.

https://xime.org/uploads/manuscripts/ARTICLE%209%20UNLOCKING%20THE%20UNIFIED1786465740132700851.pdf

42. S. Vadera and A. Khobar, "A study on unified payment system and its role in the growth of fintech sector in India," ProQuest, 2024. https://www.proquest.com/openview/c205f8718e68ac855d23d3465a58bf54/1

B. Verma, M. Purohit, and J. Vidani, "A study on the rise and recent development in unified payments interface (UPI)," SSRN, 2024. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4849785

43. K. P. Kiran and N. S. Vedala, "Assessing unified payments interface (UPI) adoption and usage through the interplay of UTAUT factors," Humanities and Social Sciences Communications, 2025. https://www.nature.com/articles/s41599-025-05313-w

44. S. R. Rayarao et al., "Unified payments interface (UPI): A comprehensive analysis of growth, impact, and future scope," Authorea, 2025. https://www.authorea.com/doi/full/10.22541/au.175803379.95084591

45. K. Sarkar and M. J. Rabha, "The success of unified payments interface (UPI) system in India's fintech ecosystem—What's unique?" Springer, 2025. https://doi.org/10.1007/978-981-96-3452-1_7

46. V. Solanki et al., "Sustainable digital payments: Examining unified payment interfaces (UPI) adoption among Generation X," ResearchGate, 2025. https://www.researchgate.net/publication/392540365

47. A. Andia, J. Aurazo, and M. Paliza, "Adoption and welfare effects of payment innovations: The case of digital wallets in Peru," BIS Working Papers No. 1329, 2026. https://www.bis.org/publ/work1329.pdf

A. Emini, H. Budić, and H. Volarević, "Consumer trust and adoption of digital payment systems in emerging markets," Business Systems Research Journal, 2026. https://reference-global.com/download/article/10.2478/bsrj-2026-0001.pdf

48. S. Jadhav, P. Bakhshi, and S. Das, "The mediating role of technical advancement in digital payment acceptance," ResearchSquare, 2026. https://www.researchsquare.com/article/rs-8609420/latest.pdf

49. K. Rudransh and B. Menaka, "Analyzing the impact of perceived value and risk on UPI adoption," Research Publish Journals, 2026. https://www.researchpublish.com/upload/book/Analyzing%20the%20Impact%20of%20Perceived%20Value-02032026-2.pdf

50. Y. Sharma, "Unified payments interface (UPI): Digital public infrastructure perspective," Edward Elgar Publishing, 2026. https://www.elgaronline.com/edcollchap/book/9781035321421/chapter5.xml