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National Institute of Bank Management, Pune (An Autonomous Apex Institute Established by RBI & Banks)

## Digitalisation and Financial Inclusion for the Next 100 Million

February 2025

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## **List of Acronyms**

ACH	Automated Clearing House
AePS	Aadhaar-enabled Payment Systems
AI	Artificial Intelligence
BCB	Brazilian Central Bank
CBDC	Central Bank Digital Currency
CBIRC	China Banking and Insurance Regulatory Commission
CFPB	Consumer Financial Protection Bureau
CFPB	Consumer Financial Protection Bureau
CPCA	China Payment and Clearing Association
DBT	Direct Benefit Transfers
DeFi	Decentralised Finance
DPDPA	Digital Personal Data Protection Act
DPI	Digital Public Infrastructure
EBSI	European Blockchain Services Infrastructure
FCA	Financial Conduct Authority
GDPR	General Data Protection Regulation
IMF	International Monetary Fund
IMPS	Immediate Payment Service
JAM	Jan Dhan-Aadhaar-Mobile
КҮС	Know Your Customer
MFI	Microfinance Institution
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
ML	Machine Learning
NPCI	National Payments Corporation of India
NEFT	National Electronic Funds Transfer
PET	Privacy-Enhancing Technologies
PMJDY	Pradhan Mantri Jan Dhan Yojana
PM-KISAN	Pradhan Mantri Kisan Samman Nidhi
RBI	Reserve Bank of India
Regtech	Regulatory Technology
RTGS	Real-Time Gross Settlement
SMFI	Small Financial Institutions
SRO	Self-Regulatory Organisation
UIDAI	Unique Identification Authority of India
UKDBEIS	UK Department for Business, Energy & Industrial Strategy
UKPSR	UK Payments Systems Regulator
UPI	Unified Payments Interface
USFR	US Federal Reserve
USSD	Unstructured Supplementary Service Data
WBGF	World Bank Global Findex

## **Executive Summary**

This report, prepared under the aegis of the National Institute of Bank Management (NIBM) and the Merchants Payments Alliance of India (MPAI), presents an analysis of India's digital financial inclusion journey. It highlights key milestones achieved through policy and regulatory initiatives, identifies persistent barriers to greater adoption and offers policy recommendations to foster a more inclusive and equitable financial ecosystem.

Global benchmarking is a key component of this report. The report evaluates India's progress in financial inclusion by comparing it with both developed (US, UK) and developing (China, Brazil) economies across multiple dimensions. These include access to banking services, digital payments adoption, credit and microfinance availability and insurance penetration. The analysis examines how financial infrastructure models and public-private collaborations have influenced financial access in these countries, offering insights that can inform India's strategy for bridging existing gaps.

Unlike existing literature, which primarily tracks digital financial inclusion trends, this report takes a novel approach by examining the role of emerging technologies in bridging systemic financial gaps. It explores technologies such as artificial intelligence (AI) and blockchain to enhance accessibility, security and scalability within digital financial ecosystems.

Additionally, insights from a high-level consultation workshop hosted by MPAI on November 27, 2024, in Mumbai inform the findings of this report. The event brought together regulators (RBI and NIBM), representatives from major banks (SBI and HDFC), fintech startups and global digital finance firms (Mastercard and Visa). The discussions focused on last-mile challenges in digital payments, Al-driven risk mitigation and regulatory alignment for inclusive finance. A dedicated working group session explored solutions for digital lending, improving financial literacy and expanding access to underserved populations. The inputs from this multi-stakeholder dialogue have helped refine the report's recommendations.

A key focus is on the next 100 million financially excluded individuals—predominantly rural, lowincome and digitally illiterate populations—who represent among the most complex challenges in financial inclusion. Addressing their needs requires coordinated efforts from both policymakers and industry stakeholders. The report underscores the importance of a dual strategy, combining policydriven interventions with private-sector innovations, to effectively integrate these underserved groups into the formal financial system.

The report also highlights significant achievements in digital financial inclusion through flagship initiatives such as the Unified Payments Interface (UPI), Aadhaar-enabled Direct Benefit Transfers (DBT) and the Pradhan Mantri Jan Dhan Yojana (PMJDY). Together, these programmes have processed over ₹15 trillion in monthly UPI transactions as of 2023, onboarded 490 million previously unbanked individuals and reduced welfare disbursement leakages by 40 percent. These accomplishments showcase India's leadership in leveraging digital public infrastructure (DPI) to drive financial inclusion.

Despite these advancements, several critical gaps remain. The digital divide between rural and urban populations persists, with only 38 percent of rural residents engaging with digital financial systems compared to 85 percent in urban areas. Women's participation remains limited, smaller financial

systems compared to 85 percent in urban areas. Women's participation remains limited, smaller financial institutions face capacity constraints and rising fraud incidents continue to erode trust in digital ecosystems. Additionally, privacy and data security concerns further exacerbate these challenges, underscoring the urgent need for robust governance and targeted policy interventions.

#### To address these barriers, the report provides the following policy recommendations:

- **Privacy and Security by Design in DPIs:** Implement privacy-enhancing technologies such as differential privacy and secure multiparty computation. Establish data protection standards aligned with global frameworks.
- Enhancing Regulatory Supervision Through Al in Regtech: Leverage Al to proactively detect fraud and automate compliance processes. Develop capacity-building programs for regulators to strengthen oversight.
- **Fraud Reduction Through Information Sharing:** Foster inter-institutional data-sharing partnerships to detect fraud patterns and implement real-time grievance redressal systems.
- Inclusion of Non-Financial Market Participants: Extend access to microfinance and digital tools for non-banking stakeholders, including informal sector participants and promote gender-focused financial inclusion initiatives.
- Al Guidance for Fintech Based on First Principles: Mandate transparency in Al models to eliminate biases in credit scoring and underwriting. Establish ethics frameworks for Al deployment in financial systems.
- **Expanding and Capacitating Self-Regulatory Organisations (SROs):** Enable SROs to monitor digital lending practices and ensure fair play in emerging technologies.
- **Personalised Digital Financial Literacy:** Launch targeted literacy programmes for rural and marginalised populations and develop user-centric tools to simplify onboarding and engagement.
- **Building Offline Payment Use Cases:** Invest in offline-capable payment systems like UPI 123 to reach connectivity-deprived regions. Integrate payment solutions with welfare schemes to drive adoption.
- **Scaled Integration of Neo-Banking:** Promote interoperability between neo-banks and traditional financial systems while supporting smaller financial institutions in adopting digital banking practices.
- **Data Classification:** Establish common classification frameworks to enhance AI transparency, interoperability and inclusivity. Encourage global data-sharing collaborations.
- Shared Responsibility Models and Liability Regimes: Define clear liability standards for stakeholders in the digital financial ecosystem. Promote partnerships between private entities and regulators to share compliance responsibilities.

## CHAPTER 2 Introduction

India stands at the forefront of the digital revolution, demonstrating the potential of technology to drive financial inclusion and bridge socio-economic divides. By leveraging innovations such as the Aadhaar-enabled Payment System (AePS), the Unified Payments Interface (UPI) and Direct Benefit Transfers (DBTs), the country has achieved unprecedented strides in enhancing accessibility, efficiency and equity in financial services. This report examines the scope and drivers of the country's digital financial inclusion journey, along with opportunities linked to the use of emerging technology.

Initiatives such as the Pradhan Mantri Jan Dhan Yojana (PMJDY), which brought over 490 million individuals into the formal financial system and UPI, which processes over ₹15 trillion in monthly transactions, underscore the scalability of India's digital financial solutions (National Payments Corporation of India [NPCI], 2023). However, barriers such as low rural adoption rates (38 percent compared to 70 percent in urban areas), gender disparities and infrastructural deficits persist (Ministry of Finance, 2023). Similarly, early milestones such as the Real-Time Gross Settlement (RTGS) and National Electronic Funds Transfer (NEFT) systems laid the foundation for the development of a robust digital infrastructure. Subsequent breakthroughs, including Aadhaar-enabled authentication and UPI, have redefined access to financial services. For example, Aadhaar has been instrumental in linking welfare schemes with direct transfers, reducing inefficiencies and ensuring timely disbursements, leading to reduced welfare leakages by 40 percent (Ministry of Finance, 2023). Despite these successes, systemic challenges remain, particularly for rural and marginalised populations who face barriers such as limited digital literacy and connectivity. For instance, only 38 percent of households are digitally literate in India and the figure is just 25 percent for rural households (Dattopant Thengadi National Board, 2023). Understanding such challenges and policies that can address them are critical for building resilient financial systems that promote equity.

Unlike previous literature, which primarily provides updates on digital financial inclusion trends, this report takes a distinct approach by examining the role of emerging technologies in bridging systemic financial gaps. It focuses on emerging technologies such as AI and blockchain, to enhance accessibility, security and scalability in digital financial ecosystems. Additionally, this report places emphasis on the next 100 million financially excluded individuals—predominantly rural, low-income and digitally illiterate populations. It highlights the need for coordinated action from both policymakers and market players. A dual approach—policy-driven initiatives complemented by private-sector innovations—is essential to effectively serve this population.

Our research findings underscore progress in digital financial inclusion, particularly among urban populations and younger demographics. However, persistent disparities in rural and gendered access remain critical barriers. Comparative lessons from Brazil's Pix and China's Alipay demonstrate the importance of user-centric design and public-private partnerships in scaling digital financial ecosystems. Initiatives such as India's UPI 123 and AePS illustrate adaptive approaches to bridging connectivity and accessibility gaps, particularly in underserved regions.

By examining these dimensions, this report aims to provide actionable insights for policymakers, financial institutions and technology providers. The recommendations focus on embedding privacy and security by design in digital infrastructures to improve public trust, leveraging emerging

technologies for regtech and supervisory tech, expanding offline payment solutions and promoting personalised digital literacy. Together, these strategies could help address systemic gaps and create a resilient, inclusive financial ecosystem.

The remainder of the report is structured as follows: Section 2 examines the state of digitalisation and inclusion in India, identifying key barriers and achievements. Section 3 traces the historical evolution of India's digital financial journey, highlighting transformative milestones. Section 4 explores the role of emerging technologies in advancing inclusion. Section 5 discusses critical challenges, including the digital divide and regulatory gaps. Finally, Section 6 presents actionable policy recommendations to maximise the potential of digital financial inclusion in India.

### CHAPTER 2 The State of Digitalisation and Financial Inclusion

This section provides an overview of India's digitalisation journey and its implications for financial inclusion. It examines the country's progress across key dimensions, including banking access, digital payment adoption, credit availability, integration of social security systems and insurance penetration. Notable initiatives such as the PMJDY, UPI and Aadhaar-enabled DBTs are highlighted for their transformative impact on enhancing financial access and empowering marginalised groups, particularly women and rural populations.

By benchmarking these advancements against global examples, the section identifies persistent challenges. These include infrastructural deficits, digital literacy gaps and trust issues in digital systems, which continue to impede equitable access.

#### 2.1 Banking Access and Usage

Banking access and usage are fundamental to financial inclusion. Over the past decade, India has made rapid progress, driven by large-scale initiatives like the PMJDY. Launched in 2014, PMJDY has successfully brought 490 million previously unbanked individuals into the formal banking ecosystem by 2023. As a result, as seen in Table 1, the country has achieved a bank account ownership rate of 77 percent, with 56 percent of these accounts held by women—a significant milestone in addressing gender disparities in financial access (Ministry of Finance, 2023; World Bank, 2023).

Despite these gains, India lags behind global leaders such as the US and UK, where bank account ownership rates exceed 95 percent. In the US, financial literacy campaigns and employer-sponsored savings schemes have driven high banking participation, while in the UK, advanced digital ecosystems and behavioural nudges have nearly achieved universal banking access (US Federal Reserve [USFR], 2023; UK Payments Systems Regulator [UKPSR], 2023). China's mobile-integrated financial platforms, like Alipay, have facilitated seamless access to banking services, contributing to an account ownership rate of 80 percent (World Bank Global Findex [WBGF], 2021). Similarly, Brazil's 88 percent ownership rate reflects robust government-backed programmes like Bolsa Família (Brazilian Central Bank [BCB], 2023).

Metric	India	US	UK	China	Brazil
Bank account ownership (% of adults, 2021)	77	95	96	80	88
Women account ownership (%, 2021)	56	93	94	78	84
Active account usage (% of total accounts, 2021)		90	92	85	78
Total banking deposits (₹ trillion, 2023)		410	108	960	130
Mobile banking users (% of adults, 2023)		78	82	75	60
Internet banking users (% of adults, 2023)		85	88	70	50
Rural adoption rate (%, 2023)		70	75	60	40

#### Table 1: Banking Access and Usage

Notes: 1 USD = ₹83. Sources: WBGF (2021), RBI (2023), NPCI (2023), USFR (2023), UKPSR (2023), BCB (2023).

India's banking deposit base reached ₹20 trillion in 2023, showing growth fuelled by digital initiatives like UPI. However, this is modest compared to ₹410 trillion in the US and ₹960 trillion in China, underscoring untapped potential in formal savings mobilisation (Reserve Bank of India [RBI], 2023). While active account usage in India (65 percent) shows improvement, it still falls short of the 90 percent benchmark achieved in the US and the UK. Factors such as financial literacy and automation have contributed to consistent engagement in these countries (World Bank, 2023).

The disparity in rural adoption rates remains a pressing concern. With only 25 percent rural engagement in formal banking, India is significantly behind the US (70 percent) and China (60 percent). This gap is often attributed to barriers like unreliable internet connectivity, low digital literacy and socio-cultural constraints disproportionately affecting women (World Bank, 2021). There is also regional disparity with southern states having experienced significantly higher financial inclusion, driven by more robust banking networks, higher literacy rates and targeted microfinance initiatives. Targeted interventions in mobile and internet banking can help in bridging this divide. India's mobile banking user rate of 45 percent and internet banking rate of 35 percent are substantially lower than the US (78 percent and 85 percent, respectively) and the UK (82 percent and 88 percent) (NPCI, 2023).

Integrating successful strategies from global counterparts, such as China's mobile payment platforms and the UK's savings-focused behavioural nudges, could enhance engagement (Huang et al., 2021). Investments in infrastructure, innovative outreach and holistic digital ecosystems will be essential to achieving equitable financial inclusion in India (RBI, 2023).

#### 2.2 Microfinance and Credit Access

Microfinance plays a pivotal role in enhancing financial inclusion in economies with substantial informal sectors and India's achievements in this domain are notable. By 2023, Indian Microfinance Institutions (MFIs) disbursed ₹3 trillion in loans to over 60 million borrowers, with women constituting 75 percent of these recipients (Table 2). Programmes like the PMMY have further bolstered credit access by sanctioning ₹23 trillion to 133 million small businesses.

Metric I		US	UK	China	Brazil
Microfinance loans (₹ trillion, 2023)		10	2	8	5
Borrowers (millions, 2023)		20	5	45	25
Women Borrowers (% of total, 2023)		55	50	60	65
Default Rate (%, 2023)		2	1.5	3	4
SME lending penetration (% of GDP, 2023)		18	15	20	13

#### **Table 2: Microfinance and Credit Access**

Notes: 1 USD = ₹83. Sources: Sa-Dhan (2023), Ministry of Finance (2023), USFR (2023), China Microfinance Network ([CMN] 2023), BCB (2023).

India's microfinance model, which provides small-ticket, collateral-free loans, has empowered women and rural entrepreneurs, fostering significant social and economic benefits. However, the default rate of five-seven percent is higher than that of the peers in Table 2, highlighting gaps in financial literacy and credit assessment mechanisms. Regional disparities also persist, with southern states like Tamil Nadu and Karnataka receiving the majority of microfinance disbursements, while northern and northeastern states lag due to weaker institutional networks (Sa-Dhan, 2023). Additionally, the design of financial products significantly influences accessibility for underserved populations. Systematic Investment Plans (SIPs) have simplified mutual fund investments, enabling low-income individuals to enter the financial market with small, recurring contributions (Ministry of Finance, 2023). However, similar innovations remain limited for other financial products, particularly formal credit.

The global landscape offers valuable lessons. The US and UK, despite lower microfinance penetration, utilise alternative credit models for SMEs. In the US, fintech platforms have enhanced SME lending, increasing loan accessibility by 35 percent compared to traditional banks (Consumer Financial Protection Bureau [CFPB], 2022). Meanwhile, the UK's government-backed lending schemes have addressed financing gaps for underserved enterprises (UK Department for Business, Energy & Industrial Strategy [UKDBEIS], 2022). China's integration of microfinance into digital platforms like Alipay and WeChat Pay demonstrates the power of technology, facilitating ₹8 trillion in loans with a three percent default rate (China Banking and Insurance Regulatory Commission [CBIRC], 2022). Brazil's Pix platform showcases government-led digital ecosystems' potential in driving microfinance adoption, with ₹5 trillion disbursed (BCB, 2023).

To sustain its progress, India must address existing access disparities through robust credit assessment frameworks, enhanced financial literacy and digital integration. UPI can play a critical role in reducing transaction costs and improving accessibility in rural areas. Adopting strategies from global counterparts, such as integrating microfinance with digital platforms and leveraging public-private partnerships, could further enhance India's microfinance ecosystem.

#### 2.3 Digital Payments

Digital payments have become a cornerstone of financial inclusion, facilitating seamless transactions and reducing dependency on cash. India's digital payment ecosystem, led by innovations such as UPI, has witnessed exponential growth (Table 3). By 2023, UPI accounted for 75 percent of India's retail digital payments. This growth reflects the government's commitment to fostering a cashless economy, under the aegis of the Digital India programme (NCPI, 2023).

Metric	India	US	UK	China	Brazil
Monthly transactions volume (billion, 2023)		1.2	0.8	18	1
Monthly transaction value (₹trillion, 2023)		5	3	18	7
Digital payment adoption (% of adults, 2023)		89	88	90	76
Rural Penetration (%, 2023)		78	80	65	50
Women Users (% of adults, 2023)		75	73	60	45

#### **Table 3: Digital Payments**

Notes: 1 USD = ₹83. Sources: NPCI (2023), WBGF (2021), BCB (2023), CPCA (2023), UKPSR (2023), USFR (2023).

Despite significant urban penetration, rural adoption of digital payments in India remains a challenge, with only 38 percent of rural users engaging in digital transactions. This figure contrasts sharply with the success of Brazil's Pix, which achieved a 50 percent rural penetration rate within three years. China, too, achieved a 65 percent rural penetration, driven by platforms like Alipay and WeChat Pay, which integrate payments with credit and insurance services (China Payment and Clearing Association [CPCA], 2023). The expansion of digital payments in rural China is a relevant case in hand. This expansion was driven primarily via public-private partnerships. Initiatives like Rural Taobao—backed by Alibaba in collaboration with local governments—led to the establishment of numerous service centres in rural areas. These centres functioned as logistical and educational hubs, helping villagers

navigate digital purchases and making e-commerce significantly more accessible to rural populations (Khanna et al., 2019).

Women's participation in digital payments also reveals stark disparities. While women account for 30 percent of UPI users in India, developed economies like the US and UK report participation rates of 75 percent and 73 percent, respectively, due partly to targeted financial education and user-friendly tools (UKPSR, 2023; USFR, 2023). Addressing extant gaps requires customised digital literacy campaigns and infrastructure improvements.

India's AePS and innovations like UPI 123 have shown promise in bridging connectivity gaps by enabling offline digital transactions. However, several challenges hinder the widespread adoption of UPI 123 (Merchant Payments Alliance of India [MPAI], 2024). Users have reported functional and operational bugs, slow transaction processing, transaction failures and a cumbersome interface. Additionally, language barriers, particularly variations in accents, further complicate user experience.

Extending offline payment solutions and further enhancing AePS integration into welfare schemes such as Pradhan Mantri Kisan Samman Nidhi (PM-KISAN)—will be crucial for driving financial inclusion (Ministry of Agriculture and Farmers Welfare, 2023). Trust also remains a significant barrier to digital payments adoption, particularly in rural and semi-urban regions. A report by RBI (2023) suggests that fraud-related concerns deter as many as 25 percent of potential rural users from adopting digital payment systems, underscoring the critical link between trust and inclusion (RBI, 2023). First-time users often struggle with grievance redressal mechanisms, many unaware of available fraud resolution processes. Establishing robust grievance redressal mechanisms can help build trust and encourage greater adoption of digital payment systems.

#### 2.4 Digital Payments Acceptance Infrastructure

A well-developed digital payments acceptance infrastructure is critical for fostering financial inclusion, enabling merchants to seamlessly process transactions through Point-of-Sale (PoS) terminals, QR codes and sound boxes. While India has made significant strides in expanding this infrastructure, major gaps remain, particularly in rural and underserved regions.

Historically, non-cash payments in offline retail settings were primarily conducted through PoS machines. However, their high cost (ranging from ₹5,000 to ₹12,000) and dependency on reliable internet connectivity limited their adoption, restricting access primarily to large retail chains and highvalue merchants (MeitY, 2024). As of December 2016, India had only 1.7 million PoS machines serving over a billion people. While this number has since grown at a compound annual growth rate (CAGR) of 25 percent, reaching 8.3 million by 2023, adoption remains concentrated in urban and semi-urban areas (MeitY, 2024). In fact, India's digital payments acceptance infrastructure remains underdeveloped compared to global benchmarks. Table 4 highlights the disparity in PoS density across countries, illustrating the need for accelerated efforts to expand financial touchpoints.

Table 4: Cross-Country Comparison of Financial Touchpoint
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Country	India	China	UK	Brazil
PoS per Million Adult Population	54.5	352.9	698.1	758.3

Source: NPCI (n.d.)

To address these limitations, India has transitioned towards lower-cost, more accessible alternatives such as UPI-based QR codes. QR codes, in particular, have transformed merchant payments by eliminating upfront deployment costs and enabling digital transactions for small and micro-merchants. As of October 2023, over 306 million QR codes had been deployed across merchant outlets, supported by zero deployment costs, zero Merchant Discount Rates (MDR) and a growing digital user base exceeding 300 million (MeitY, 2024; NPCI, 2023).

Mobile Point-of-Sale (mPoS) solutions are also contributing to the expansion of card-based digital payments by converting smartphones and tablets into PoS terminals. Unlike traditional PoS machines, mPoS devices are more affordable as well as portable. They also do not require dedicated hardware, making them viable even for small businesses and merchants in rural areas.

However, while QR codes and mPoS have substantially improved accessibility, they do not fully address all merchant needs. India has over 63 million micromerchants, 96 percent of whom are served by traditional financial institutions and banks (MeitY, 2024). Moreover, approximately 77 percent of merchants remain outside the digital payments ecosystem, despite the deployment of 8.3 million PoS machines, 1.4 million Bharat PoS (BAP) terminals and over 5 million Bharat QR codes (MeitY, 2024).

Several challenges contribute to this gap (NPCI, n.d.): (a) low transaction volumes make digital payments less viable for micromerchants; (b) recurring charges and lack of incentives prompt merchants from transitioning away from cash; and (c) limited digital literacy among small retailers restricts their ability to navigate digital payment systems effectively. Bridging the last-mile acceptance infrastructure gap is essential to ensuring widespread financial inclusion.

#### 2.5 Social Security and Direct Benefit Transfers

Social security systems and DBT have deepened financial inclusion in India. Anchored in the Jan Dhan-Aadhaar-Mobile (JAM) trinity, DBT has enhanced the efficiency, transparency and accessibility of welfare delivery (Ministry of Finance, 2023). For example, by directly crediting subsidies and benefits into beneficiaries' bank accounts, DBT has reduced leakages, streamlined targeting and empowered vulnerable populations. As of 2023, over ₹21 trillion has been disbursed through DBT, benefiting more than 800 million individuals, including 400 million women (Table 5).

Metric		US	UK	China	Brazil
Beneficiaries (millions, 2023)		100	65	960	150
Annual disbursements (₹ trillion, 2023)		29	13	28	7
Women beneficiaries (% of total)		60	55	45	56
Administrative cost savings (%)		15	12	25	18

#### **Table 5: Social Security and Direct Benefit Transfers**

**Notes:** 1 USD = ₹83. Sources: Ministry of Finance (2023), US Census Bureau (2023), UK Office for National Statistics (2023), China National Bureau of Statistics (2023), Brazilian Ministry of Social Development (2023).

India's DBT system is among the most extensive globally, encompassing programmes such as LPG subsidies, pensions, maternity benefits and wages under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). These initiatives have addressed systemic inefficiencies, such as leakages accounting for 30–40 percent of allocated funds in traditional welfare mechanisms (Government of India, 2023). By linking beneficiary accounts to Aadhaar, India's biometric

identification system, DBT has also curtailed fraud and duplication, helping ensure that resources reach their intended recipients.

Comparatively, social security systems in the US and UK, while narrower in reach, exhibit higher per capita disbursements due to focused welfare structures. For example, America's Supplemental Nutrition Assistance Program (US-SNAP) and unemployment benefits serve approximately 100 million beneficiaries with ₹29 trillion in annual disbursements. Similarly, the UK's Universal Credit system integrates multiple benefits into a single mechanism, reaching 65 million individuals annually.

China and Brazil offer compelling insights. China's rural subsidy programmes and digital integration via platforms like Alipay reach 960 million beneficiaries with ₹28 trillion in annual disbursements, illustrating the transformative potential of mobile-linked welfare systems. Brazil's Bolsa Família, now expanded under Auxílio Brasil, combines conditional cash transfers with education and healthcare outcomes, benefiting 150 million individuals and disbursing ₹7 trillion annually.

India's DBT system has generated a substantial administrative cost savings of 20 percent by digitising payment channels and removing intermediaries. However, challenges remain. Last-mile delivery is hindered by connectivity gaps, delays in Aadhaar-linked account updates and limited digital literacy in rural and tribal areas (National Institute of Public Finance and Policy [NIPFP], 2023). Addressing these barriers requires infrastructure expansion, targeted literacy programmes and outcome-based conditional cash transfers similar to Brazil's model.

Gender disparities also persist. Women beneficiaries in India account for 50 percent of DBT recipients but face limited engagement with digital systems, restricting their financial autonomy (International Monetary Fund [IMF], 2022). By contrast, Brazil's women beneficiaries, representing 56 percent of Bolsa Família participants, actively manage household funds due to tailored financial literacy initiatives. India must prioritise culturally appropriate literacy interventions to enhance women's participation and control over financial resources.

#### 2.6 Micro and Rural Insurance

Microinsurance and rural insurance play a critical role in enhancing financial resilience among lowincome and underserved communities by offering protection against economic shocks. These insurance products, designed to be affordable and accessible, mitigate risks associated with health crises, agricultural losses, accidents and mortality, which disproportionately affect rural populations.

Historically, insurance penetration in India has been low, particularly among rural and informal sector workers. Recognising this gap, India introduced dedicated microinsurance regulations in 2005 under the Insurance Regulatory and Development Authority of India (IRDAI) to facilitate last-mile delivery through NGOs, self-help groups and microfinance institutions (IRDAI, n.d.). These efforts were further strengthened by targeted government-backed insurance schemes, which have played a crucial role in expanding coverage.

Over the years, India has launched several government-backed insurance schemes to expand financial protection for underserved populations. The Rashtriya Swasthya Bima Yojana (RSBY), introduced in 2008, was one of the earliest efforts to provide health insurance to low-income families, offering coverage of ₹30,000 per family per year for secondary and tertiary hospitalization. The scheme leveraged smart card technology for paperless transactions, covering over 27 million households across 24 states before being subsumed into Ayushman Bharat – Pradhan Mantri Jan Arogya Yojana

(PMSBY) to increase life and accident insurance penetration. PMJJBY provides life insurance coverage of ₹2 lakh for an annual premium of ₹436, while PMSBY offers accident insurance of ₹2 lakh for ₹20 per year. These schemes have seen significant uptake, with 64 million and 220 million enrolments, respectively, as of 2022 (PIB, 2022).

The Pradhan Mantri Fasal Bima Yojana (PMFBY) was launched in 2016 to protect farmers against yield losses due to natural calamities. The scheme leverages satellite imagery, drones and weather data for risk assessment and has consistently covered about 30 percent of the Gross Cropped Area (GCA) each year (Ministry of Agriculture and Farmers Welfare, 2023). Additionally, regulatory measures have also played a crucial role in expanding rural insurance. The Obligations of Insurers to Rural and Social Sectors Regulations, first introduced in 2015 and further amended in 2024, require insurers to allocate a minimum percentage of policies to rural populations. The latest amendment introduced gram panchayat-level coverage targets and linked compliance with social security schemes like PMSBY and PMJJBY (IRDAI, 2024). These initiatives collectively underscore the government's commitment to improving insurance accessibility, though challenges remain in awareness, last-mile delivery and claim settlement processes.

Despite these initiatives, India's insurance penetration and density remain below global standards (Table 6), highlighting the need for further expansion. As of 2023, India's total insurance penetration (premium-to-GDP ratio) stands at 3.7 percent, which is comparable to Brazil (3.9 percent) and China (3.9 percent) but significantly lower than the UK (9.7 percent) and the US (11.9 percent). While life insurance penetration (2.8 percent) is near the global average (2.9 percent), non-life insurance penetration (1.0 percent) remains one of the lowest globally, indicating gaps in health, motor and property insurance uptake (Swiss Re Sigma, 2024).

Metric	India	US	UK	Brazil	China
Penetration (%)					
Total	3.7	11.9	9.7	3.9	3.9
Life	2.8	2.6	7.1	2.1	2.1
Non-life	1.0	9.3	2.6	1.8	1.8
Density (\$)					
Total	95	9,640	4,759	390	508
Life	70	2,136	3,466	207	274
Non-life	25	7,504	1,294	183	234

#### **Table 6: Insurance Penetration and Density**

**Source**: Swiss Re Sigma World Insurance Report, 2024

In terms of insurance density (per capita premium expenditure), India lags behind significantly, with total density at \$95 per capita compared to \$9,640 in the US, \$4,759 in the UK, \$508 in China and \$390 in Brazil. The disparity highlights India's limited per capita spending on risk protection, particularly in rural areas where insurance remains a low-priority financial product. While government-backed schemes have increased basic coverage, a vast proportion of India's population remains underinsured. The existing insurance market is still largely driven by savings-linked life insurance products, rather than pure protection plans, further limiting overall penetration.

Several challenges hinder the expansion of micro and rural insurance in India, limiting its reach and effectiveness. Low awareness and financial literacy remain critical barriers, as many rural households

are either unaware of existing insurance schemes or lack the understanding necessary to assess their benefits. This is particularly evident in the case of crop insurance, where farmers often view premiums as an unnecessary expense rather than a risk mitigation tool (Economic Survey, 2022-23).

Another major challenge is India's high protection gap, estimated at 90 percent, meaning that the majority of the population remains underinsured (PwC, 2024). Insurance in India is often a push product, meaning it is sold rather than actively sought by consumers. Many individuals purchase policies not out of necessity, but due to sales pressure or incentives provided by intermediaries. Furthermore, commission-driven sales practices lead to policyholders purchasing inappropriate or excessive coverage, often without understanding the terms and conditions.

The last-mile delivery of insurance services is also hindered by infrastructure limitations in rural areas. The lack of access to insurance agents, digital enrolment systems and claim processing centers creates bottlenecks that discourage participation. Even when insurance is available, delays in claim settlements and cumbersome bureaucratic processes erode trust in the system. Farmers under PMFBY, for example, frequently report long waiting periods for compensation, reducing their willingness to enrol in subsequent years (Ministry of Agriculture and Farmers Welfare, 2023). Additionally, high operational costs for insurers in rural areas, driven by low policy volumes and high distribution costs, make microinsurance less attractive to private-sector players.

Finally, digital literacy and technological adoption barriers contribute to the exclusion of large segments of the population from insurance services. While Aadhaar-based e-KYC and digital payment systems have streamlined certain processes, many rural users still lack the skills or confidence to navigate digital insurance platforms. The absence of standardized, user-friendly grievance redressal mechanisms further discourages policyholders from engaging with insurance providers.

Addressing these gaps requires a combination of financial literacy initiatives, innovative productmarket fit design and strategies, better grievance mechanisms and digital infrastructure enhancements to make insurance more affordable, accessible and relevant for India's diverse population.

#### 2.7 Barriers to Digital Financial Inclusion

Despite having made strides, India's journey toward digital financial inclusion of the next 100 million users is constrained by multiple barriers. These challenges span multiple areas, affect access, trust and usability and impact rural, low-income and marginalised groups the most.

#### **Infrastructure Barriers**

**Internet connectivity in rural areas:** The disparity in internet infrastructure between rural and urban areas restricts access to digital financial services. Rural adoption of mobile and internet banking is only 25 percent, compared to 70 percent in urban areas. This gap limits the reach of mobile-first solutions like UPI and Aadhaar-enabled services, which rely heavily on reliable connectivity. Moreover, the limited integration of feature phone-compatible systems, such as UPI 123, further exacerbates accessibility challenges in areas with poor internet infrastructure. (World Bank, 2021; NPCI, 2023; Ministry of Finance, 2023)

**Last mile infrastructure for digital payments and insurance:** 77 percent of merchants remain outside the digital payment ecosystem due to infrastructure constraints.: (MeitY, 2024). Similarly, inadequate physical and digital infrastructure hampers the delivery of microinsurance and rural insurance services, limiting financial safety nets for vulnerable populations (PwC, 2024).

#### **Digital Literacy and Awareness**

**Low digital and financial literacy**: As of 2023, digital literacy in the country stands at only 38 percent, while this statistic is just 25 percent in rural areas. Among rural occupational groups, casual workers in agriculture exhibit the lowest digital literacy rates at only 13 percent (Dattopant Thengadi National Board, 2023).

Financial literacy is another significant barrier, with only 27 percent of India's population being financially literate (Business Standard, 2023). Financially illiterate individuals are more likely to make poor financial decisions, fall prey to scams, or engage in predatory practices. These challenges disproportionately affect vulnerable groups, such as women and non-numerate populations.

**Awareness deficits in insurance products**: Limited awareness about insurance schemes like the Pradhan Mantri Fasal Bima Yojana (PMFBY) and the Rashtriya Swasthya Bima Yojana (RSBY) discourages adoption. This problem is compounded by the misselling of policies and a consumer preference for savings-linked products, which often fail to provide adequate risk protection (Economic Survey, 2022-23; Ministry of Agriculture and Farmers Welfare, 2023).

#### Trust Deficit

**Fraud and data security concerns**: NPCI (2023) indicates a 40 percent surge in complaints regarding fraudulent UPI transactions in 2022, disproportionately affecting first-time users and rural populations (NPCI, 2023). Fraud-related concerns deter 25 percent of potential rural users from adopting digital payment systems, underscoring the critical link between trust and inclusion (RBI, 2023). The lack of robust grievance redress mechanisms further exacerbates this issue, discouraging users from adopting digital services (NPCI, 2023; RBI, 2023; Suri & Jack, 2016).

**Misaligned financial product**: Financial offerings often do not align with underserved populations' needs. While innovations like SIPs have increased accessibility in mutual funds, similar advancements are lacking in insurance and credit.

#### **Regulatory and Policy Challenges**

**Regional disparities**: Access to financial services remains highly uneven across India, with northern and northeastern states lagging behind southern regions in banking and digital payment adoption. (Sa-Dhan, 2023)

**Lack of access to quality data**: Many rural and semi-urban populations lack formal credit histories or comprehensive financial records, making it difficult for institutions to design tailored products. This raises service costs and leaves large sections financially excluded (Sa-Dhan, 2023).

Overall, the discussions in this section suggests that the state of digitalisation and financial inclusion in India reflects both substantial progress and persistent barriers. While initiatives such as PMJDY, UPI and Aadhaar-enabled DBTs have revolutionised financial access, infrastructural limitations and socioeconomic disparities continue to impede equitable participation. To understand these dynamics fully, it is essential to contextualise India's current achievements within its historical trajectory of digital financial inclusion.

The following section provides a chronological analysis of India's journey, from foundational banking

reforms to the integration of advanced digital technologies. By examining milestones and the policy frameworks that enabled them, this perspective offers insights into the interplay between innovation and inclusivity, laying the groundwork for addressing structural challenges by leveraging technology, policy and market-related opportunities.

## CHAPTER 3 A Brief History of Digital Financial Inclusion in India

This section traces the historical evolution of digital financial inclusion in India, charting its journey from foundational banking reforms to the integration of advanced digital payment systems. Key milestones, including the introduction of Real-Time Gross Settlement (RTGS) and National Electronic Funds Transfer (NEFT) in the early 2000s, the launch of Aadhaar in 2009 and the rapid proliferation of the UPI post-2016, are examined in detail. These developments underscore the interplay between technological advancements, market conditions and policy frameworks in creating a robust ecosystem for financial inclusion.

#### 3.1 Timeline of Digital Financial Inclusion

The evolution of digital financial inclusion in India highlights a journey from foundational reforms to cutting-edge innovations. This timeline, juxtaposed against global developments, underscores milestones in India's progression from traditional banking to digital financial systems.

The introduction of the RTGS in 2004 and the NEFT in 2005 marked India's initial transition to electronic transactions (Table 7). These systems enhanced the speed and security of interbank and consumer transfers, enabling scalability for large transaction volumes. Comparatively, the US implemented the Automated Clearing House (ACH) system in the 1970s, while the UK launched Faster Payments in 2008, establishing real-time transaction capabilities.

Year	Milestone	Impact
2004	RTGS launch	Enabled large-value, real-time fund transfers for interbank settlements.
2005	NEFT launch	Facilitated electronic consumer and interbank transactions.
2008	NPCI set-up	Established to manage and innovate digital payments systems.
2009	Aadhaar launch	Introduced biometric authentication for financial and social services.
2010	IMPS launch	Allowed instant fund transfers for consumers, enhancing retail payment systems.
2014	PMJDY launch	Provided financial access to 490 million unbanked individuals.
2016	UPI launch	Revolutionised payments with interoperability and mobile-first design.
2022	AePS and UPI 123 adoption	Addressed rural and offline transaction challenges.
2023	UPI transactions exceed ₹15 trillion	Highlighted the scale and efficiency of India's digital payment systems.

Notes: Sources: RBI (2023), NPCI (2023), Ministry of Finance (2023).

In 2010, the Immediate Payment Service (IMPS) was introduced, enabling real-time retail transactions in India. IMPS reduced transaction times by 70 percent, setting the stage for consumer-centric payment solutions (NPCI, 2023). Around the same period, China's Alipay integrated similar real-time features into its digital payment ecosystem, reflecting a global shift towards efficiency and convenience (Ant Group, 2023).

The establishment of the NPCI in 2008 was pivotal, as it laid the groundwork for the UPI, launched in 2016. UPI revolutionised digital payments in India by integrating multiple banks and offering seamless interoperability. By 2023, UPI processed over ₹15 trillion in monthly transactions, underscoring its centrality in India's digital payment ecosystem.

Aadhaar, launched in 2009, introduced biometric-linked authentication, further enhancing the scope of digital financial inclusion. This innovation supported the DBT implementation, reducing leakages in welfare disbursement. By 2022, AePS and offline technologies like UPI 123 gained traction, addressing connectivity challenges in rural areas.

The timeline of digital financial inclusion initiatives in India reflects the significant interplay between policy and technology. While UPI serves as a global benchmark, systems like AePS exemplify targeted solutions for underserved populations. This journey underscores the importance of an adaptive and inclusive framework to sustain momentum in digital financial ecosystems.

#### 3.2 Speed of Digital Financial Inclusion

The speed at which digital financial instruments are adopted is a determinant of their impact on financial inclusion. India's digital finance ecosystem has expanded rapidly, driven by large-scale adoption of innovations such as the UPI and the PMJDY. However, a comparative analysis with global leaders such as China, Brazil, the US and the UK reveals areas for improvement.

Instrument	Time to scale adoption	Adoption rate (%)	Rural penetration rate (%)
UPI (India)	7 years (2016–2023)	85 (Urban)	38
Alipay/WeChat Pay (China)	5 years (2010–2015)	90 (Urban)	65
Pix (Brazil)	3 years (2020–2023)	76	50
ACH/Faster Payments (US/UK)	Decades (1960s–2000s)	85 (UK), 78 (US)	~70
AePS (India)	10 years (2012–2022)	45	45

Table 8: S	peed of Ado	ption of Digital	Financial	Instruments

Sources: NPCI (2023), BCB (2023), Huang et al. (2021), RBI (2023), Ministry of Finance (2023).

The UPI became the cornerstone of India's digital payment ecosystem within seven years, processing over ₹15 trillion in monthly transactions by 2023 (Table 8). Its adoption was facilitated by user-friendly design, interoperability and strong government support through initiatives like Digital India. Similarly, PMJDY enabled the opening of over 200 million bank accounts within two years of its launch in 2014, providing a significant boost to financial inclusion efforts. AePS, another noteworthy initiative, scaled rapidly to process over 2.5 billion transactions annually by 2022, particularly in rural areas.

Comparatively, China's Alipay and WeChat Pay achieved a 90 percent urban and 65 percent rural adoption rate within five years, facilitated by seamless integration with e-commerce and social media platforms. Similarly, Brazil's Pix platform attained a 50 percent rural penetration rate within three

years of its launch in 2020, supported by government incentives and a user-friendly interface. In contrast, ACH in the US and Faster Payments in the UK took decades to achieve widespread adoption, though they now exhibit high usage rates with a robust focus on credit and insurance-linked digital platforms.

India's adoption trajectory varies significantly across instruments and demographics. For example, UPI adoption among urban users reached 85 percent, while rural penetration remained at 38 percent. This contrasts with Brazil's and China's rural adoption rates of 50 percent and 65 percent, respectively, highlighting the effectiveness of integrating digital systems with everyday consumer services and incentives. In the US and UK, higher initial infrastructure levels contributed to a more incremental yet comprehensive adoption process, particularly in credit and insurance-linked financial ecosystems.

Several factors influence the speed of adoption across countries. In India, government programmes such as Digital India, PMJDY and DBT accelerated adoption among underserved populations (Ministry of Finance, 2023). Comparatively, China's rapid adoption was propelled by private sector innovations seamlessly integrated into consumers' daily experiences (Ant Group, 2023). Brazil's Pix exemplifies the effectiveness of government-led incentives for rural users (BCB, 2023). Meanwhile, higher smartphone penetration and consistent internet access in the US and China facilitated faster adoption of digital platforms than in India, where infrastructural gaps and trust deficits remain significant barriers (World Bank, 2021). These comparatives point to the need for India to make targeted efforts towards expanding rural digital infrastructure, enhancing digital literacy and establishing robust trust-building mechanisms.

The subsequent section delves into the role of emerging technologies in addressing these complexities and advancing financial inclusion. By exploring innovations such as AI, blockchain and digital currencies, this discussion highlights how emerging tech can help overcome existing barriers, foster equitable access and redefine the scope of financial inclusion in the digital age.

## CHAPTER 4 Emerging Tech and Financial Inclusion

This section explores the potential of emerging technologies in advancing financial inclusion in India. It examines cutting-edge technologies such as AI, machine learning (ML), blockchain and Central Bank Digital Currencies (CBDCs) and their applications in addressing challenges like customer onboarding, credit access, fraud prevention and regulatory compliance. These challenges can be traced back to barriers identified earlier (Section 2.7). For instance, customer onboarding in underserved regions is often hindered by last-mile infrastructure gaps, such as unreliable connectivity and limited point-of-service networks, as well as low digital literacy levels. Similarly, credit access is constrained by a lack of quality data to assess creditworthiness, especially for first-time borrowers. The rising cases of fraudulent activities further deepen trust deficits.

These technologies promise to enhance efficiency, scalability and equity in the financial ecosystem while addressing the unique needs of underserved populations.

By drawing on global case studies and India-specific examples, the section acknowledges the associated risks, such as data privacy concerns, algorithmic biases and the complexities of regulatory oversight. The discussion highlights the opportunities and challenges presented by emerging technologies in order to optimise their deployment and maximise their impact on financial inclusion.

#### 4.1 Customer Onboarding

Customer onboarding has historically been a significant bottleneck in achieving financial inclusion, particularly in regions with underdeveloped infrastructure and low digital literacy. While onboarding costs in India are among the lowest, challenges persist in ensuring authenticity and avoiding duplication in financial databases. This duplication can result in several downstream challenges, including fraudulent activity, data integrity issues and operational inefficiencies stemming from the time and resources required to resolve redundancies. Additionally, it can erode customer trust, as duplication-related discrepancies may lead to delayed or denied services, further discouraging engagement with financial institutions.

Consultation with industry experts also reveals that authentication continues to be a significant barrier during onboarding (MPAI, 2024). Biometric methods like fingerprint scanning often fail for specific populations, such as farmers and kitchen workers, due to eroded fingerprints. Iris scanning is being explored as an alternative, offering higher reliability. However, myths around its safety (e.g., fears of cancer) and higher costs, coupled with integration delays into banking systems, have slowed adoption.

Another issue is the hesitance of banks in converting Jan Dhan accounts to regular accounts. Jan Dhan accounts have been a cornerstone of financial inclusion, enabling millions to access basic banking services. However, transitioning these accounts into regular ones with more facilities poses challenges. Banks often resist conversions due to a focus on maintaining high Jan Dhan account numbers for reputational purposes.

Many rural customers also face a documentation overload. Extensive documentation requirements

for KYC, re-KYC, Aadhaar linkage and other processes create significant barriers for them. The repetitive nature of these requirements not only prolongs the onboarding process but also discourages participation among first-time users. Customers often perceive these measures as intrusive, further deterring them from engaging with formal financial institutions.

Emerging technologies can be leveraged to address several of these obstacles. For instance, multimodal authentication systems, combining biometric options like facial recognition and iris scanning can address these gaps. Al-powered tools can enhance biometric accuracy and ensure faster onboarding, even in rural settings. Facial recognition technology is being employed to register beneficiaries for the Ayushman Bharat Pradhan Mantri Jan Arogya Yojana, verify beneficiaries in the PM Kisan Scheme and allow pensioners to generate digital life certificates from home (Press Information Bureau, 2023).

The traditional Know Your Customer (KYC) process, which involves repeated submissions of identity verification documents across institutions, is both labour-intensive and cost-inefficient. This burden discourages many individuals from engaging with formal financial services, especially those with limited literacy or access to documentation. Blockchain technology offers a solution to this issue. As highlighted by Malhotra et al. (2021), blockchain's decentralized and tamper-proof architecture can streamline KYC processes. By enabling customers to store verified identity data securely, blockchain allows for seamless sharing of this data across multiple institutions, eliminating the need for repeated onboarding efforts. This reduces onboarding time and also minimizes risks and operational costs, making the process more efficient and accessible. Blockchain technology eliminates the need for repeated documentation submissions, allowing customers to reuse verified information across financial institutions and could thus address the issue of duplication as well.

However, successful adoption of blockchain -based solutions in the Indian context will depend on ensuring that such solutions have an intuitive and accessible user interface. Additionally, cost of deployment must be low to facilitate underserved communities.

#### 4.2 Credit Scoring and Underwriting

Credit scoring and underwriting are core components of financial inclusion, particularly in regions where formal credit histories are scarce. Emerging technologies such as AI, ML and big data analytics have revolutionised these processes by enabling financial institutions to assess creditworthiness using alternative data sources. India has made strides in leveraging these technologies to enhance credit access for underserved populations, but challenges related to biases, data quality and infrastructural constraints persist.

Country	Technology	Impact	Key Challenges
India	Al-driven alternative	25% increase in SME loan approvals;	Data fidelity and biases in
	credit scoring	expanded rural credit access	underserved groups
China	Sesame Credit (Ant	40% higher loan disbursements in Al-	Concerns over data
	Financial)	enabled groups	monopolisation and bias
Brazil	Pix-integrated credit models	18% higher approval rates for rural borrowers	Limited rural digital literacy
US	Al in consumer	Enhanced credit access for thin-file	Regulatory concerns over
	lending	borrowers	racial biases

#### **Table 9: Comparative Metrics in Credit Scoring Innovations**

**Sources:** BCB (2023), Huang et al. (2021), CFPB (2023), Singh et al. (2022).

India's adoption of alternative credit scoring models has expanded access to credit for individuals and small businesses lacking traditional credit histories. Platforms such as Cred and Bajaj Finserv utilise AI and ML algorithms to analyse non-traditional data sources, including utility bill payments, mobile usage patterns, transaction histories and GST filings. A study by Singh et al. (2022) found that AI-driven credit scoring increased loan approval rates for small and medium enterprises (SMEs) by 25 percent, significantly boosting entrepreneurship and economic growth (Table 9). Similarly, fintech startups such as KreditBee and MoneyTap have used these technologies to extend microloans to first-time borrowers, addressing longstanding credit gaps in rural and semi-urban areas.

India is also enhancing its credit ecosystem with two new initiatives: the National Financial Information Registry (NFIR) and the Unified Lending Interface (ULI). The NFIR consolidates essential credit-related data, including borrower credit histories, repayment patterns and financial transactions, into a unified registry. By centralizing this information, NFIR reduces information asymmetry between borrowers and lenders (Financial Express, 2024). It ensures that even individuals with limited or informal credit histories, such as first-time borrowers in rural areas, are represented in the financial ecosystem. Complementing this, the ULI facilitates the seamless and standardized exchange of credit data across lenders and credit institutions in real-time. Acting as a digital infrastructure, the ULI enables lenders to access NFIR's data efficiently, reducing redundancies and delays in loan approvals (Reserve Bank Innovation Hub [RBIH], n.d.).

Moreover, in a significant move to strengthen credit reporting frameworks, RBI issued a master direction on credit information reporting on January 6, 2025. The MD eliminates the need for user consents in data sharing between credit institutions and bureaus, as these exchanges are now mandated by law. This can help ensure seamless data flows and reduce operational bottlenecks in credit reporting. Additionally, the new rule consolidates earlier directives, providing a standardised framework that mandates credit bureaus to actively review data reporting practices by banks and financial institutions. These changes are expected to enhance data quality, improve grievance redressal mechanisms and foster greater accountability in the credit ecosystem.

Globally, alternative credit scoring has demonstrated efficacy in expanding financial inclusion. In China, Ant Financial's Sesame Credit evaluates borrower creditworthiness based on online behaviour and e-commerce transactions, resulting in a 40 percent increase in loan disbursements in treatment groups using Al-enabled credit scoring compared to control groups relying on traditional models (Huang et al., 2021). Brazil has also adopted Al in credit underwriting, integrating data from Pix transactions to offer customised credit products for rural farmers, achieving an 18 percent higher loan approval rate compared to standard underwriting methods (BCB, 2023).

Despite these advancements in use of AI for underwriting, significant challenges remain in addressing algorithmic biases and data fidelity. Studies show that women and rural borrowers are more likely to be incorrectly classified as high-risk due to their underrepresentation in training datasets (Gupta & Sharma, 2022). Globally, similar concerns have emerged; for instance, the Consumer Financial Protection Bureau (CFPB) in the US identified racial biases in AI-based lending models, leading to tighter regulatory oversight (CFPB, 2023).

#### 4.3 Regulatory Compliance

Regulatory compliance is foundational to the stability and reliability of financial systems. Emerging technologies, particularly regtech, have revolutionised compliance processes by automating complex tasks, reducing costs, and improving accuracy. While compliance mandates ensure transparency and reduce systemic risks, they also impose significant operational costs, particularly for smaller financial

institutions (SMFIs). The discussion below examines how regtech innovations have reshaped regulatory frameworks in India and draws lessons from global experiences.

In India, the Aadhaar-based Account Aggregator (AA) framework has emerged as a transformative regtech tool, designed to enhance data accessibility and financial transparency. The fundamental principle behind the AA ecosystem is that citizens have the autonomy to select any RBI-licensed AA to act as their 'consent manager', facilitating the transfer of their financial data from a Financial Information Provider (FIP) to a Financial Information User (FIU). This user-centric approach empowers individuals with greater control over their personal financial information while ensuring seamless and secure data sharing within the financial sector (RBI, 2024).

Notably, AAs are not obligated or expected to perform KYC for individuals utilising their services. One potential implication of this directive is that the due diligence performed on FIUs as "clients" may not be directly leveraged by AAs when establishing contractual agreements with the same FIUs. This distinction helps maintain regulatory boundaries while ensuring the integrity of the data-sharing framework (Sahamati, n.d.).

All AAs and FIPs interact through a standard, non-customisable protocol, ensuring interoperability across the ecosystem. This means that once an FIP integrates with one AA, the same technical infrastructure can be leveraged to connect with other AAs, eliminating redundancy and reducing compliance costs by 30 percent while improving the efficiency of credit assessments (Table 10). However, its adoption remains uneven, with larger institutions more likely to integrate such regtech solutions effectively than their smaller counterparts (RBI, 2023).

Moreover, the cost of regulatory compliance in financial services is rising sharply, driven by stricter mandates on data protection, cybersecurity and financial traceability. Over the past five years, compliance costs for Indian financial firms have increased by 25-30 percent, largely due to regulations like the Digital Personal Data Protection Act (DPDPA) 2023 and enhanced cybersecurity norms from the Reserve Bank of India (RBI) and CERT-In (PwC, 2024). Large banks now allocate eight to twelve percent of their IT budgets to cybersecurity compliance, while fintech firms spend five to seven percent of their revenue on meeting regulatory standards for Know Your Customer (KYC) and Anti-Money Laundering (AML) (EY, 2023).

The regulatory landscape is tightening further with stricter SEBI disclosure norms, Foreign Account Tax Compliance Act (FATCA) requirements and G20 cross-border transaction reporting. Banks and payment service providers face 15-20 percent annual increases in compliance costs due to mandatory data retention, financial auditability and blockchain-based traceability measures (KPMG, 2023).

As regulatory expectations intensify, financial institutions must strike a delicate balance between compliance and cost efficiency, leveraging regtech solutions, AI-driven compliance automation and shared regulatory infrastructures to manage escalating expenditures effectively. Global cases underscore the impact of regtech on financial ecosystems. In the UK, the Financial Conduct Authority (FCA) has collaborated with technology providers to implement AI-powered compliance platforms that automate anti-money laundering (AML) and counter-terrorism financing (CTF) checks. These platforms have reduced compliance costs by 25 percent for UK financial institutions, demonstrating the scalability of regtech solutions in resource-constrained environments (FCA, 2023). Similarly, in Brazil, regtech applications integrated into the Pix payment system have enhanced transaction transparency and reduced systemic risks, fostering trust among users and regulators (BCB, 2023).

Country	<b>Regtech Application</b>	Impact	Key Challenges
India	Aadhaar-based Account Aggregator	30% reduction in compliance costs; enhanced data-sharing efficiency	Limited adoption by SMFIs
υк	Al-powered AML and CTF checks	25% cost reduction for financial institutions	High initial implementation costs
Brazil	Regtech in Pix	Improved transaction transparency and reduced systemic risks	Digital literacy gaps in rural areas
EU	Blockchain-based AML systems	Enhanced fraud detection and trust in compliance processes	Scalability for smaller institutions

Table 10:	Comparative	Impact of	Regtech	Innovations

Sources: RBI (2023), FCA (2023), BCB (2023), European Commission (2023).

These comparatives suggest that ensuring even adoption of regtech requires a multi-pronged approach. Policymakers must provide financial incentives and capacity-building programmes to empower SMFIs. Establishing partnerships between regulators and private technology firms can drive innovation and ensure accessibility.

#### 4.4 Digital Literacy, Customer Support and AI Agents

Digital literacy is a cornerstone of financial inclusion, enabling individuals to effectively use digital financial systems. However, its absence remains a significant barrier, particularly for marginalised communities, rural populations and women in India. Rural digital payment adoption lags significantly at 38 percent, compared to 85 percent in urban areas, with gender disparities further compounding the issue; only 30 percent of women actively use digital financial platforms (NPCI, 2023; Ministry of Finance, 2023).

Emerging technologies, particularly AI and ML, are playing a key role in bridging these gaps by providing accessible and personalised customer support. Innovations such as AI-driven chatbots and virtual assistants have enhanced the adoption of digital financial services, particularly among first-time users. A study by Goel and Madan (2022) revealed a 20 percent increase in successful first-time digital transactions among rural users who utilised AI-powered virtual assistants. Similar applications in Kenya's M-Pesa ecosystem have shown that AI agents significantly enhance trust and user confidence (Suri & Jack, 2016).

Globally, AI agents have demonstrated their potential to improve customer support in digital financial systems. In the US and the UK, AI-powered systems provide real-time fraud alerts and personalised transaction guidance, significantly enhancing user trust (World Bank, 2023). In India, platforms like Paytm and PhonePe have incorporated chatbots to guide users until through complex financial processes, such as applying for loans or setting up recurring payments. Stock market apps too have transformed retail investing by integrating AI-powered tools that enhance decision-making, provide personalised insights, and improve trade execution. Platforms like Robinhood and eToro in the US and UK, and Zerodha, Groww, and Upstox in India, use AI for portfolio analysis, algorithmic trading recommendations, and chatbot-assisted investing (World Bank, 2023). These innovations make investing more accessible while improving regulatory compliance and fraud detection.

Country	Application	Impact	Key Challenges
India	Al chatbots in UPI platforms	20% increase in first-time transaction success rates	Limited regional language support
Kenya	Al agents in M-Pesa	Enhanced trust and adoption among rural users	Connectivity challenges in remote areas
US	Al-powered fraud alerts	Real-time fraud detection and enhanced user confidence	Privacy concerns regarding data usage
UK	Virtual assistants in banking	24/7 customer support, reducing in-person interactions	High implementation costs

Table 11: Comparative Applications of AI Agents in Customer Support

Sources: NPCI (2023), Goel & Madan (2022), Suri & Jack (2016), World Bank (2023).

Despite these promises, these technologies face challenges, including limited regional language support, inadequate internet access in rural areas and privacy concerns related to data usage. Overcoming these barriers requires targeted investments in digital infrastructure, robust data protection and public awareness campaigns to build trust in AI technologies.

#### 4.5 Personalised Learning Platforms and Voice-based Education Tools

Digital literacy is pivotal in enhancing financial inclusion and bridging the digital divide, especially in underserved and rural areas. However, as discussed earlier in this report, challenges such as limited access to financial education, low technological familiarity, and language barriers persist.

To address these challenges, Al-driven personalised learning platforms and voice-based financial education tools have emerged as potential solutions. Al-powered learning platforms such as FinBox and Coursera utilise adaptive learning models that tailor financial literacy courses based on user behaviour, knowledge levels, and goals (Table 12). This personalised approach has led to a 25 percent improvement in financial literacy scores among low-income users in global pilot projects (IMF, 2024).

Country	Application	Impact	Key Challenges
India	Al-powered learning platforms (FinBox, Coursera)	25% improvement in financial literacy scores for low-income users	Limited regional language support
India	Voice-based financial education (YONO Krishi, Google Assistant)	18% increase in financial participation among first-time rural users	Internet connectivity issues in remote areas
US	Adaptive Al learning platforms (Khan Academy)	Improved financial literacy for low- income groups	Digital divide between urban and rural areas
υк	Al-driven financial education chatbots	Increased engagement with digital finance tools	Data privacy concerns

Table 12 <sup>.</sup> Com	narative An	onlications	of AI Agents	s in Customer	Support
	ραι ατίνε πρ	plications	VI AI Agenta		Support

Sources: MeitY (2023), NPCI (2023), Goel & Madan (2022), Araujo (2023).

Similarly, voice-based financial education tools, such as Google Assistant's financial literacy integration and SBI's YONO Krishi, enable users to access financial guidance in regional languages through voice commands, improving financial participation by 18 percent among first-time rural users (IMF, 2024).

These emerging technologies are reshaping financial literacy and customer support by making information more accessible, interactive and tailored to user needs. However, investment in infrastructure, language inclusivity and digital trust frameworks will be essential to ensure widespread and equitable adoption.

#### 4.6 CBDCs and Programmable Money

Central Bank Digital Currencies (CBDCs) represent an innovation in global financial ecosystems, offering unprecedented opportunities for enhancing efficiency, transparency and financial inclusion. CBDCs are issued directly by central banks, ensuring stability and reducing reliance on intermediaries. A critical feature of CBDCs, programmable money, has the potential to revolutionise the delivery of public welfare programmes by ensuring that funds are utilised solely for their intended purposes.

India's pilot launch of its CBDC, the digital rupee (e₹), is a relevant milestone. Designed to complement existing digital payment systems like the UPI, the digital rupee addresses challenges such as settlement delays and currency management costs. Studies estimate that programmable money in welfare schemes like PM-KISAN and MGNREGA could reduce subsidy leakages by up to 40 percent, vastly improving the efficiency of public welfare delivery (RBI, 2023; NPCI, 2023).

Globally, countries such as China and Brazil offer valuable lessons (Table 13). China's digital yuan, integrated with government subsidies, has demonstrated its efficacy in enhancing transaction transparency and ensuring funds reach intended beneficiaries. Impact evaluations show a 25 percent improvement in subsidy utilisation efficiency in pilot regions (Huang et al., 2021). Similarly, Brazil's Pix platform incorporates programmable money features to facilitate targeted payments for welfare schemes like Auxílio Brasil, achieving higher transparency and accountability (BCB, 2023).

Country	CBDC Application	Impact	Key Challenges
India	Digital rupee for welfare schemes	Potential 40% reduction in subsidy leakages	Infrastructure deficits; privacy concerns
China	Digital yuan in public subsidies	25% improvement in subsidy utilisation efficiency	Limited rural reach in initial phases
Brazil	Pix for conditional cash transfers	Enhanced transparency and accountability in welfare disbursement	Digital literacy gaps among rural beneficiaries
EU	CBDC prototypes for targeted payments	Improved cross-border payment efficiency and fraud reduction	High implementation costs

#### Table 13: Comparative Applications of CBDCs and Programmable Money

**Sources:** RBI (2023), NPCI (2023), Huang et al. (2021), BCB (2023).

With UPI processing over ₹15 trillion in monthly transactions, seamless interoperability between the digital rupee and UPI could facilitate mass adoption while enhancing the reach of programmable money. Integrating CBDCs with Aadhaar-linked accounts and the Account Aggregator framework could further strengthen welfare delivery mechanisms, ensuring precision and transparency in fund allocation.

Despite these potentials, significant challenges persist. Infrastructure deficits in rural regions and privacy concerns regarding programmable money could hinder its adoption. Moreover, India already has a well-established digital payments ecosystem, driven by UPI which offers convenience and

efficiency. This reduces the immediate incentive for users to shift to CBDCs. Building trust and familiarity is another hurdle, as is evident from declining transaction volumes in India's CBDC pilots indicating a lack of organic demand (Economic Times, 2024). Privacy concerns also remain, and international experiences underscore the importance of robust data protection frameworks and user consent mechanisms to foster trust in CBDCs.

## CHAPTER 5 Key Challenges in the Use of Tech for Financial Inclusion

This section examines the critical challenges impeding the effective use of technology for advancing financial inclusion in India. These challenges include public trust deficits in digital platforms, disparities in digital literacy, the institutional digital divide and regulatory capacity limitations. Furthermore, it addresses emerging concerns such as the explainability of AI systems, privacy and data protection and the commodification of technology, which introduce new complexities to financial ecosystems. By analysing these obstacles, the section provides an assessment of their implications for financial inclusion.

#### 5.1 Public Trust in Technology

Public trust is a cornerstone of technology adoption, particularly in the realm of financial inclusion. However, among the next 100 million users in India—comprising rural, semi-urban, and underserved populations—trust in digital financial systems remains low. This deficit is exacerbated by rising incidents of fraud, scams, and data breaches, posing a barrier to deepening adoption. Addressing these issues requires a multifaceted strategy that integrates technological, policy, and market interventions.

Country	Key Challenges	Intervention	Impact
India	Rising UPI fraud incidents; Iow rural trust	Al-powered fraud alerts; digital literacy campaigns	Potential 40% reduction in fraud incidents
Brazil	Trust deficits in Pix adoption	User-centric fraud detection; awareness campaigns	35% reduction in fraud incidents
υк	Fraud risks in Faster Payments	Real-time fraud alerts; regulatory oversight	Reduced financial losses significantly
Kenya	Low adoption in rural areas	Simplified UI in M-Pesa; real-time assistance	30% increase in rural adoption rates

#### Table 14: Comparative Insights on Public Trust Interventions

Sources: NPCI (2023), BCB (2023), FCA (2023), Suri & Jack (2016).

The increasing prevalence of digital fraud in India's UPI ecosystem highlights the scale of the challenge (Table 14). Reports indicate a 40 percent surge in complaints regarding fraudulent UPI transactions in 2022, disproportionately affecting first-time users and rural populations (NPCI, 2023). Studies have shown that fraud-related concerns deter 25 percent of potential rural users from adopting digital payment systems, underscoring the critical link between trust and inclusion (RBI, 2023). Globally, similar trends have emerged. For instance, during the initial rollout of Pix, Brazil faced significant trust deficits, prompting the BCB to implement robust fraud detection protocols and nationwide awareness campaigns. These measures reduced fraud incidents by 35 percent within two years, restoring user confidence (BCB, 2023).

Simplified user interfaces, intuitive transaction previews and real-time fraud alerts can reduce errors and foster user confidence. Evidence from Kenya's M-Pesa ecosystem demonstrates that user-friendly

designs (e.g. utilising SMS technology, menu-driven interface, etc.) increased rural adoption rates by 30 percent, while India's AI-powered virtual assistants, incorporated into UPI platforms, have shown potential in addressing real-time user concerns (Suri & Jack, 2016; NCPI, 2023).

Moreover, transparency initiatives, such as detailed transaction summaries and fraud detection notifications, have proven effective in the UK's Faster Payments system, significantly reducing financial losses (FCA, 2023). These initiatives are AI-powered, leveraging real-time data analysis and machine learning algorithms to detect irregular transaction patterns and mitigate fraud risks. India's policymakers and markets can draw from these global best practices to develop tailored strategies, such as enhancing digital literacy programmes, building intuitive platform designs and strengthening regulatory frameworks to mitigate frauds and scams.

#### 5.2 Digital Divide Among Users

The digital divide remains a significant barrier to universal financial inclusion in India. While urban digital payment adoption stands at 85 percent, rural adoption lags behind at 38 percent, largely due to limited internet access, low smartphone penetration, and digital literacy challenges (NPCI, 2023). Women are disproportionately affected, with only 30 percent actively participating in digital transactions, despite holding 56 percent of PMJDY accounts (Ministry of Finance, 2023). Similarly, marginalised communities, such as tribal populations and the elderly, face documentation barriers, lack of financial awareness, and heightened vulnerability to fraud, further restricting their financial inclusion (RBI, 2023).

Al-driven solutions are being implemented to address these disparities. Al-powered voice assistants and interactive chatbots, integrated into UPI platforms and banking apps, provide real-time guidance to first-time users, helping them navigate digital transactions with greater ease (RBIH, n.d.). These tools analyse user queries and offer tailored assistance, reducing the digital literacy barrier and improving confidence in digital platforms (MeitY, 2024). Evidence from China's Alipay ecosystem suggests that Al-based financial education modules have improved rural adoption rates by 65 percent (Table 15), demonstrating how Al can facilitate personalised learning and greater digital financial participation (Huang, Li, and Zhang, 2021).

While discussions on digital inclusion often focus on Direct Benefit Transfers (DBT) and digital payments, the digital divide in financial market participation remains even wider. In India, rural and lower-income populations have limited access to capital markets, mutual funds and credit-based investments, primarily due to financial illiteracy and a lack of accessible platforms (World Bank, 2023). In contrast, robo-advisors and AI-powered financial planning tools in countries such as the United Kingdom and the United States have expanded retail participation in stock markets, particularly among younger and lower-income investors (FCA, 2023). AI-driven financial advisory systems in India could similarly improve retail investment participation, making financial markets more accessible to first-time and low-income investors (PwC India, 2023).

A comparison of interventions across different countries highlights the varying effectiveness of digital inclusion strategies. In India, initiatives such as UPI 123 and community literacy campaigns have contributed to some improvement, yet rural UPI adoption remains at 38 percent, with women's usage at 30 percent (NPCI, 2023). In Kenya, the success of USSD-enabled payments via M-Pesa has led to near-universal rural adoption, bypassing the need for internet connectivity (Suri & Jack, 2016). Brazil's Bolsa Família programme, combined with women-focused literacy campaigns, has significantly increased women's engagement with digital finance (Brazilian Ministry of Social Development, 2023).

China's strategy of integrating digital training via Alipay has resulted in rural adoption reaching 65 percent, while the UK and US, with their comprehensive digital ecosystems and government subsidies, have achieved high rural penetration rates exceeding 70 percent (World Bank, 2023).

Country	Key Challenges	Interventions	Impact
India	Low rural and women's participation	UPI 123; community literacy campaigns	Rural UPI adoption at 38%; women's usage at 30%
Kenya	Limited rural internet connectivity	USSD-enabled payments via M-Pesa	Near-universal rural adoption
Brazil	Gender disparities in financial access	Women-focused literacy campaigns; Bolsa Família	Women's engagement significantly increased
China	Limited rural infrastructure	Integrated digital training via Alipay	Rural adoption at 65%
UK/US	Generalised urban-rural disparities	Comprehensive digital ecosystems and subsidies	High rural penetration rates (70%+)

Table 15: Comparative Insights on Digital Divide Interventions

Sources: NPCI (2023), Ministry of Finance (2023), Suri & Jack (2016), Huang et al. (2021), BCB (2023).

Despite the progress made, scaling these solutions in India presents ongoing challenges. While UPI 123 and digital literacy programmes have been introduced to bridge the adoption gap, their impact remains limited in scope. Unlike Kenya's M-Pesa, which ensures financial access through USSD technology without requiring internet connectivity, UPI 123 depends on IVR-based interactions, which many users find inefficient and difficult to navigate (RBI, 2023). The integration of voice-based AI solutions could significantly improve usability and encourage wider adoption, particularly among low-tech rural users (NPCI, 2023).

A crucial factor in ensuring the success of these initiatives is accounting for socio-cultural dynamics. Countries such as Brazil and Kenya have effectively embedded financial literacy within local community structures, leading to greater trust and adoption (Brazilian Central Bank, 2023). Brazil's Bolsa Família scheme prioritised women as financial decisionmakers, ensuring higher adoption rates, while Kenya's community-led financial education programmes played a key role in fostering trust in M-Pesa (Suri & Jack, 2016). India too has similar community-led developmental initiatives in place. For instance, India has long relied on women-led Self-Help Groups (SHGs) to empower women, particularly in the microfinance sector. As of 2024, there were more than 90 lakh SHGs in India with over 10 crore participating women (Ministry of Rural Development, 2024). Large-scale government efforts like JEEViKA have further contributed to rural women's financial participation. In FY 2023-24, 52,863 SHGs opened new savings accounts. In the same year, 339,861 SHGs were also successfully linked to credit facilities, demonstrating the potential of the community-driven financial inclusion model (Bihar Rural Livelihoods Promotion Society, 2024). By integrating Al-driven solutions such as multilingual AI chatbots, voice-assisted financial training, and community-led AI workshops within these existing networks could help to improve trust, participation, and financial inclusivity (World Bank, 2023).

#### 5.3 Institutional Digital Divide

The institutional digital divide presents a significant barrier to achieving equitable financial inclusion in India. While larger financial institutions (LFIs) have rapidly adopted advanced technologies, smaller financial institutions (SMFIs), such as regional rural banks (RRBs) and small non-banking financial institutions (SMFIs), such as regional rural banks (RRBs) and small non-banking financial companies (NBFCs), continue to face systemic constraints. These disparities undermine the inclusive potential of India's digital financial ecosystem and amplify inequalities within the broader financial landscape.

SMFIs often operate with limited resources, constrained budgets and insufficient technical expertise, making it difficult for them to adopt and integrate advanced technologies such as AI, blockchain, or regtech. For example, during the early adoption of the UPI, larger banks accounted for the majority of transaction volumes, while SMFIs lagged due to high implementation costs and infrastructural deficiencies (RBI, 2023). The disparity is further evident in the adoption of Aadhaar-enabled systems, where integration by smaller institutions remains inconsistent.

Comparatively, countries like Brazil and the UK have implemented targeted interventions to bridge institutional divides (Table 16). Brazil's Pix payment system demonstrates the effectiveness of government-led initiatives in equipping smaller banks with the technical tools and training needed to participate effectively. Within three years of Pix's rollout, the share of smaller institutions in the digital payment ecosystem increased by 20 percent (BCB, 2023). Similarly, the UK's open banking framework mandates data interoperability through standardised APIs, allowing financial institutions to seamlessly exchange customer financial data in a secure and regulated manner. This enables smaller institutions to access the same real-time transaction data, credit history, and account information as larger banks, fostering competition and innovation (FCA, 2023). Additionally, the framework promotes cloud-based services, particularly in data storage, fraud detection, and Al-driven financial analytics. Smaller institutions leverage cloud computing to reduce infrastructure costs, enhance cybersecurity through scalable solutions, and deploy Al-powered customer insights without needing extensive in-house resources (FCA, 2023). In the US, fintech collaboration with small banks has increased access to credit for underserved communities by 35 percent, while China's integration of microfinance with Alipay platforms has expanded digital access for rural enterprises (Huang et al., 2021; USFR, 2023).

Country	Challenge	Intervention	Impact
India	High integration costs for SMFIs	Account Aggregator framework	Limited but growing adoption among SMFIs
Brazil	Limited resources for smaller banks	Technical training and government incentives	20% increase in small bank participation
UK	Disparities in IT infrastructure	Open banking with shared APIs	Enhanced competitiveness of smaller players
US	Low fintech collaboration	Public-private co-innovation hubs	35% increase in credit access for small banks
China	Uneven adoption in rural banks	Integration with Alipay and WeChat Pay	Expanded rural enterprise access

Table 16: Com	narative Insights (	on Bridging the	Institutional D	igital Divide
	purative morgines .		moticational D	ISICAL DIVIAC

Sources: RBI (2023), BCB (2023), FCA (2023), Huang et al. (2021), USFR (2023).

Efforts to address India's institutional digital divide must prioritise scalable, cost-effective solutions. Initiatives such as the Account Aggregator framework can facilitate secure and efficient data sharing, enabling SMFIs to offer competitive services. Lessons from the UK's shared infrastructure models underscore the importance of government-led training and technical support in empowering smaller institutions. These strategies, coupled with regulatory measures to ensure equitable access to emerging technologies, will be essential for fostering a more inclusive financial ecosystem.

#### 5.4 Challenges in Auditing Emerging Technologies

The rapid adoption of artificial intelligence (AI), machine learning (ML) and blockchain has significantly reshaped financial systems worldwide, introducing unprecedented efficiency and innovation. However, these advancements have also complicated auditing and accountability processes, making it challenging to ensure transparency, fairness and regulatory compliance. One of the most pressing concerns in India's financial ecosystem is the increasing reliance on automated credit scoring systems, which often suffer from algorithmic biases. Studies indicate that 30 percent of AI-based lending decisions in India exhibit bias, disproportionately affecting women and rural borrowers (Gupta and Sharma, 2022).

International regulatory responses provide useful models for addressing these challenges (Table 17). The European Union (EU) has enacted an EU AI Act, which mandates explainability for high-risk AI applications. This legislation requires financial institutions to disclose their decision-making processes and conduct regular audits of AI systems to ensure fairness and compliance (European Commission, 2023). Similarly, the UK has implemented advanced AI auditing tools, such as SHAP (SHapley Additive exPlanations) and LIME (Local Interpretable Model-Agnostic Explanations), which enhance the transparency of AI models by making their decision-making processes more interpretable and justifiable (FCA, 2023).

Country	Key Challenges	Intervention	Impact
India	Algorithmic biases in Al; blockchain complexity	Diversity in training datasets; blockchain auditing tools	Improved fairness in credit access; reduced fraud
EU	Lack of explainability in Al algorithms	Mandatory algorithm audits (Al Act)	Enhanced transparency and reduced biases
Brazil	Complexity in blockchain- based payments	Integrated blockchain analytics	Improved transaction traceability
UK	Opaqueness in Al-based lending	SHAP and LIME for Al explainability	Enhanced user trust and regulatory compliance

Table 17: Comparative Insights on Auditing Emerging Technologies

Sources: FCA (2023), European Commission (2023), BCB (2023), Gupta & Sharma (2022), Huang et al. (2021).

Despite these international efforts, challenges persist in scaling AI auditing frameworks due to gaps in testing infrastructure, regulatory expertise and standard-setting capabilities. Unlike traditional financial audits, which rely on historical records and reconciliations, auditing AI systems requires continuous monitoring of live algorithms, ensuring that they do not develop discriminatory patterns over time.

Al auditing should be adapted to local needs, focusing on improving data diversity, enhancing fairness in credit allocation and addressing socio-economic disparities. One of the first steps in this process is to conduct a comprehensive net assessment of India's Al audit capabilities, identifying key regulatory gaps and investment priorities.

#### 5.5 Commodification of Technology

The commodification of technology in financial services has accelerated innovation and accessibility while also creating systemic risks, particularly when the competencies of developers and deployers diverge. This divergence has implications for the stability and inclusivity of the digital financial ecosystem.

The rapid integration of technologies such as AI, decentralised finance (DeFi) and blockchain has exposed gaps in the technical readiness of SMFIs due to limited technical expertise and scalability (RBI, 2023). Similarly, the adoption of AI-driven credit scoring in India has been constrained among SMFIs, despite its potential to enhance credit accessibility.

The risks associated with emerging technologies are further compounded by their complexity. DeFi platforms, for instance, decentralise traditional financial services but lack the regulatory oversight that mitigates systemic risks in conventional banking. India has seen a rise in DeFi activity, yet concerns about security vulnerabilities and operational misalignment persist (Gupta & Sharma, 2022). Similarly, AI systems in financial services have raised concerns about algorithmic biases and opaque decision-making, particularly when deployed without sufficient governance structures.

The UK's open banking framework provides a model for overcoming such disparities (Table 18). By mandating data interoperability and shared infrastructure, smaller institutions have been able to compete more effectively with established players (FCA, 2023). In the US, regulatory sandboxes have fostered collaboration between technology developers and financial institutions, mitigating risks associated with the rapid commodification of emerging technologies (FCA, 2023; USFR, 2023). Evidence from Brazil indicates that capacity-building programmes reduced institutional disparities in the adoption of Pix by smaller banks within three years of its launch (BCB, 2023).

Country	Key Challenges	Intervention	Impact
India	Divergence in technical readiness between LFIs and SMFIs	Capacity-building programmes for SMFIs	Improved UPI integration among smaller banks
Brazil	Institutional disparities during Pix adoption	Government-led technical support initiatives	Reduced disparity within three years
UK	Limited collaboration between fintech and traditional banks	Open banking and shared infrastructure	Enhanced competitiveness for smaller institutions
US	Challenges in DeFi regulation and adoption	Regulatory sandboxes for emerging technologies	Improved alignment between developers and deployers

Table 18: Comparative Insights on Interventions in Technology Commodification

Sources: RBI (2023), BCB (2023), FCA (2023), Gupta & Sharma (2022), USFR (2023).

Leveraging these approaches to address the commodification challenge in India requires a multipronged approach that includes fostering partnerships between developers and deployers (as in the case of the UK), enhancing regulatory frameworks (as in the case of the US), and investing in capacitybuilding for smaller institutions (as in the case of Brazil).

#### 5.6 Regulatory Capacity Gaps

As digital platforms increasingly integrate decentralised finance (DeFi), Al-driven credit assessments, and blockchain applications, regulators are struggling to keep pace with emerging risks due to limited expertise and inadequate resources. This regulatory gap threatens financial stability, potentially eroding public trust and financial inclusion efforts (RBI, 2023).

India's regulatory frameworks, primarily designed for traditional financial institutions, are often misaligned with new intermediaries operating in digital finance (Table 19). Although self-regulatory organisations (SROs) have been introduced in digital lending, their effectiveness in governing complex

Al and blockchain-driven platforms remains limited (RBI, 2023). By contrast, the UK's FCA has established regulatory sandboxes, facilitating real-time collaboration between regulators and technology developers to test and refine oversight mechanisms (FCA, 2023). This proactive engagement has mitigated systemic risks in the UK's fintech ecosystem and serves as a model for India.

A significant challenge arises from the decentralised nature of emerging financial platforms. DeFi networks facilitate peer-to-peer transactions outside traditional regulatory frameworks, making oversight particularly difficult. In the United States, the Federal Reserve (USFR) has recognised this issue and is currently exploring automated monitoring systems to track DeFi activities (USFR, 2023). Similarly, Brazil has incorporated regtech solutions to oversee its Pix payment system, promoting transparency, compliance and innovation (BCB, 2023).

Country	Key Challenges	Intervention	Impact
India	Limited oversight of DeFi; SRO inefficacy	Capacity-building initiatives for regulators	Improved compliance in digital lending
υк	Complexity of emerging tech (Al, blockchain)	Regulatory sandboxes enabling collaboration	Reduced systemic risks in fintech adoption
Brazil	Limited initial capacity for Pix oversight	Regtech tools integrated into payment systems	Enhanced transparency and compliance
US	Decentralised nature of DeFi platforms	Automated monitoring systems	Improved risk identification in peer-to- peer systems

Sources: RBI (2023), FCA (2023), Brazilian Central Bank (2023) and US Federal Reserve (2023).

The Reserve Bank of India (RBI) has taken steps to address these gaps through institutional capacitybuilding efforts such as its College of Supervisors, which focuses on training regulators in AI governance, blockchain oversight and fintech risk management (RBI, 2023). However, there remains an urgent need to expand regulatory expertise, particularly within future SROs, to ensure effective oversight of digital financial ecosystems. Establishing interdisciplinary regulatory teams, composed of technologists and financial experts, will significantly improve oversight capabilities.

#### 5.7 User Privacy and Data Protection

User privacy and data protection are pivotal to sustaining trust and participation in digital financial systems, particularly as the scope and sophistication of such systems continue to expand. India, with its extensive reliance on Digital Public Infrastructures (DPIs) like Aadhaar, UPI and Account Aggregators, faces significant challenges in ensuring robust privacy and security frameworks. These concerns are magnified by the exponential growth in personal and financial data usage, which heightens the risks of breaches, misuse and regulatory lapses.

India's regulatory framework has made progress with the Digital Personal Data Protection Act (DPDPA), 2023, aimed at standardising data collection, storage and sharing protocols. However, the absence of comprehensive implementation mechanisms and enforcement capabilities limits its effectiveness. Recent reports indicate that over 30 percent of Aadhaar-linked financial accounts remain vulnerable to unauthorised access due to lax security protocols (Gupta and Singh, 2023). Furthermore, a lack of user awareness exacerbates privacy risks, with only 40 percent of surveyed users confident in the safety of their digital financial data (World Bank, 2022).

Global experiences offer valuable insights (Table 20). In Brazil, the Pix platform has incorporated advanced encryption and data anonymisation protocols, enhancing user trust and adoption rates (BCB, 2023). Similarly, the UK's emphasis on integrating homomorphic encryption in fintech applications has demonstrated its potential to safeguard sensitive financial transactions without compromising functionality (FCA, 2023).

Country	Key Challenges	Intervention	Impact
India	Aadhaar-linked data breaches; user mistrust	Encryption protocols; data protection bill	Improved trust but limited enforcement capacity
Brazil	Payment data exposure in Pix	Advanced encryption and anonymisation	Increased adoption and reduced data misuse
UK	Data privacy in fintech	Homomorphic encryption	Secure processing without revealing sensitive data

**Table 20: Comparative Insights on Privacy and Data Protection Strategies** 

Sources: Brazilian Central Bank (2023), European Commission (2023), FCA (2023), Gupta & Singh (2023), World Bank (2022).

A proactive adoption of international best practices, enhanced user awareness campaigns and stringent enforcement of privacy regulations can create a resilient framework in India that balances innovation with security. Privacy-enhancing technologies (PETs) also provide a viable solution. Differential privacy, which introduces statistical noise to prevent individual identification and secure multi-party computation, which allows data analysis without exposing raw data, have shown promise in addressing similar challenges globally (Huang et al., 2021). Leveraging these technologies, combined with stronger regulatory oversight, can significantly reduce vulnerabilities.

## CHAPTER 6 Regulatory and Policy Recommendations

This section outlines a regulatory and policy framework designed to enhance financial inclusion by leveraging technology and market dynamics. Key areas of focus include utilising AI for regulatory compliance, expanding the role of self-regulatory organisations (SROs), promoting offline payment solutions and eliminating barriers to personalised financial literacy.

#### 6.1 Privacy and Security by Design in DPIs

Privacy and security are critical pillars of trust and usability in Digital Public Infrastructures (DPIs), particularly in Aadhaar and the Unified Payments Interface (UPI), which process vast volumes of sensitive personal and financial data. While India's DPIs have played a transformative role in driving financial inclusion, they remain vulnerable to breaches and misuse, underscoring the urgent need for privacy-by-design principles. Implementing Privacy-Enhancing Technologies (PETs) such as encryption, anonymisation and differential privacy can strengthen data protection while maintaining system functionality (European Commission, 2023). These safeguards are particularly crucial for first-time users and rural populations, who often exhibit apprehension toward digital financial risks and require greater assurances of security and transparency.

Evidence suggests that proactive security frameworks significantly enhance data protection and user confidence. The adoption of PETs, including homomorphic encryption, trusted execution environments and secure multi-party computation, provides innovative solutions to modern privacy challenges (Information Commissioner's Office, 2024). While quantitative reductions in data breaches due to PET adoption remain underexplored, these technologies are widely recognised for minimising data exposure risks and improving compliance with stringent security regulations.

#### 6.2 Enhancing Regulatory Supervision Through AI in Regtech

The integration of AI into regtech enhances supervisory capabilities by automating complex processes, enabling real-time fraud detection and improving compliance monitoring. Al-driven tools, such as predictive analytics and NLP, facilitate efficient detection of non-compliance and streamline legal document analysis, reducing regulatory burdens (Huang et al., 2021). This is particularly critical in India's expanding financial ecosystem, where rapid digitalisation has heightened the complexity of regulatory oversight. However, ensuring fairness, data security and explainability remains paramount to sustain public trust and regulatory confidence (Gupta and Sharma, 2022).

Globally, AI has demonstrated transformative potential in financial services, particularly in enhancing fraud detection and compliance efficiency. The UK's Financial Conduct Authority (FCA) has leveraged AI to improve supervisory oversight, deploying AI tools for firm segmentation, portfolio monitoring and risk assessment, significantly enhancing fraud detection capabilities (FCA, 2023). Similarly, Brazil's Pix system has integrated AI-driven compliance tools, ensuring transaction transparency and regulatory efficiency. Pix transactions are fully traceable, allowing authorities to identify suspicious accounts and mitigate fraudulent activity, strengthening security and compliance enforcement (Checkout.com, 2023).

#### 6.3 Fraud Reduction Through Information and Signal Sharing

Fraud remains a critical threat to the integrity of financial systems, disproportionately impacting vulnerable populations and impeding financial inclusion. The establishment of centralised fraud databases and real-time alert mechanisms is essential for financial institutions to collectively combat fraudulent activities. Evidence suggests that information-sharing frameworks can significantly reduce fraud-related financial losses among participating entities by enhancing early detection, risk assessment and coordinated response mechanisms (Basel Committee on Banking Supervision, 2024).

India's fragmented approach to fraud detection underscores the urgent need for coordinated platforms integrating advanced technologies like blockchain and AI. The Central Payments Fraud Information Registry (CPFIR), established in March 2020, marks a step toward centralised fraud data reporting. Under the RBI's Payments Vision 2025, CPFIR operationalised a negative database of fraudulent beneficiaries, using suspect information reported by financial institutions. This registry is intended to be shared with supervised entities to enhance risk management checks. However, legal and procedural concerns remain, as highlighted by a Supreme Court ruling, which questioned the classification of accounts as fraudulent without providing an opportunity for borrowers to be heard. While the CPFIR represents a commendable initiative, a more legally robust and integrated fraud detection framework is necessary for effective financial crime prevention (Standing Committee on Finance, 2024-25).

India's approach requires greater technological sophistication, with blockchain offering secure, immutable records of fraudulent transactions, while AI enables real-time pattern detection across institutions (Gupta and Sharma, 2022). Global benchmarks reinforce this strategy. In the US, financial institutions leverage AI-driven transaction monitoring and compliance analytics to enhance oversight under the Bank Secrecy Act (BSA), improving fraud detection and regulatory compliance efficiency (Financial Brand, 2023). India's NPCI has also implemented an AI-powered Real-time Fraud Risk Monitoring and Management (FRM) solution, which enables real-time and near-real-time fraud detection across digital payment systems (NPCI, n.d.). However, a collaborative framework, engaging all relevant regulators and ministries to develop proactive fraud mitigation strategies, remains in the pipeline.

#### 6.4 Inclusion of Non-Financial Digital Market Participants

Integrating non-financial digital market participants, such as telecom providers, app developers, and ecommerce platforms, is essential for fostering a resilient and inclusive digital financial ecosystem. These stakeholders often serve as intermediaries for users accessing digital financial services, offering valuable data and innovative capabilities. Their formal inclusion in operational frameworks and regulatory consultations enhances fraud prevention, service delivery, and data-sharing protocols. For example, the UK's open banking initiative has demonstrated how collaboration with non-financial entities strengthens data interoperability and fraud detection (FCA, 2023).

In recognition of the need for such multisectoral cooperation, the RBI has proposed establishing the Digital India Trust Agency (DIGITA) to combat the proliferation of illegal lending applications. DIGITA will verify digital lending apps and maintain a public register of authorised platforms and ensure that only vetted applications are accessible to consumers (Business Standard, 2024). Similar collaborative platforms are needed for all financial products.

#### 6.5 AI Guidance for Fintech Based on First Principles

Al is pivotal to fintech advancements, driving innovations in credit scoring, fraud detection and customer service. However, unchecked Al deployment risks perpetuating systemic biases, fostering opacity in decision-making and eroding public trust. Adopting Al guidance rooted in first principles—fairness, accountability and transparency—is essential for fostering ethical and effective applications in fintech. Strategies such as human-in-the-loop systems and clearly delineated roles for developers and deployers ensure ethical oversight and operational clarity (Huang et al., 2021).

Evidence from Al-driven lending shows that accounting for and auditing bias not only improves fairness and inclusivity but also enhances accuracy and profitability, reinforcing the need for structured bias mitigation in fintech (Hu et al., 2023). Similarly, explainable AI (XAI) tools like SHAP and LIME enhance decision transparency, bolstering user trust (FCA, 2023).

#### 6.6 Expanding and Capacitating SROs

Self-Regulatory Organisations (SROs) play a crucial role in dynamic sectors like fintech where rapid technological advancements often outpace traditional regulatory frameworks. Strengthening and expanding SROs can help bridge governance gaps, reduce regulatory burdens, and enhance compliance with evolving standards. To maximise their effectiveness, resource allocation, skill development, and well-defined mandates are essential (RBI, 2023). Recognising the importance of industry-led governance, the RBI has granted recognition to the Fintech Association for Consumer Empowerment (FACE) as an SRO in the fintech sector, underscoring a broader push towards self-regulation.

Global examples reinforce the benefits of robust SROs in fintech regulation. In Singapore, SROs have played a key role in streamlining compliance for payment systems, balancing regulatory oversight with financial innovation (Monetary Authority of Singapore, 2023). Similarly, in Brazil, SROs managing the Pix payment system have ensured interoperability, fraud prevention, and financial stability, supporting its rapid adoption and success (BRB, 2023). These cases highlight the importance of structured, industry-driven governance in regulating fast-evolving digital financial ecosystems.

Complementing these regulatory advancements, the RBI has constituted the Framework for Responsible and Ethical Enablement of Artificial Intelligence (FREE-AI) Committee to develop ethical AI standards for the financial sector. This initiative reflects India's commitment to responsible innovation, while aligning with ongoing efforts to enhance self-regulation in digital finance (Economic Times, 2024). By integrating SRO-led governance, AI-driven compliance frameworks and global regulatory best practices, India can build a future-ready fintech ecosystem that balances innovation with financial security.

#### 6.7 Personalised Digital Financial Literacy

Personalised digital financial literacy is essential for bridging the digital divide and empowering underserved populations, particularly in rural and semi-urban areas. Tailored programmes can address linguistic, regional and demographic nuances, enabling users to interact confidently with financial systems. For example, Kenya's M-Pesa ecosystem demonstrated that literacy initiatives tailored to local contexts increased adoption rates by 30 percent, particularly among rural women (Suri and Jack, 2016).

In India, where digital literacy remains low in rural regions and is exacerbated by cultural factors, personalisation through AI-driven tools such as chatbots and multilingual interfaces can significantly

enhance user engagement. These tools can cater to specific needs by overcoming barriers like language differences and limited digital familiarity (Gupta and Sharma, 2022). Additionally, integrating financial literacy modules into onboarding processes for platforms like AePS and UPI can improve trust and system usability.

#### 6.8 Building Offline Payment Use Cases

Expanding offline payment solutions is crucial for financial inclusion, particularly in regions with limited or intermittent connectivity. Systems like UPI 123 and USSD-based platforms provide viable alternatives for rural populations, where basic mobile devices remain the primary mode of digital transactions. Global benchmarks, such as Ghana's offline mobile money system, highlight that adoption rates can increase by 25 percent when payment systems effectively address connectivity constraints (World Bank, 2023).

India's AePS and UPI 123 have shown potential in bridging digital accessibility gaps by enabling offline transactions. However, several barriers hinder UPI 123's widespread adoption (MPAI, 2024). Users have reported operational challenges, including functional bugs, slow transaction processing and a cumbersome interface. Additionally, language barriers—especially variations in accents—complicate user interactions, limiting adoption among non-English and non-Hindi-speaking users.

While AePS has facilitated financial access, its reliance on a stable internet connection restricts its usability in areas with poor connectivity. Enhancing AePS with offline transaction capabilities, similar to UPI 123, would expand its reach and improve last-mile financial service delivery. Integrating offline AePS with key welfare programs, such as Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) and Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), can ensure seamless disbursement of social benefits, even in network-constrained regions (Ministry of Agriculture and Farmers Welfare, 2023).

#### 6.9 Scaled Integration of Neo-Banking

Neobanking, defined by fully digital and branchless banking services, offers significant potential for enhancing financial inclusion in India. Currently, Indian neobanks such as Fi and Jupiter operate in partnership with traditional banks due to the absence of a dedicated regulatory framework for standalone digital banks. This contrasts with the United Kingdom, where a well-established regulatory environment has facilitated the emergence of fully licensed neobanks like Monzo and Starling Bank. The UK's Financial Conduct Authority (FCA) and Prudential Regulation Authority (PRA) have implemented a New Bank Startup Unit to support entities aiming to establish new banks, thereby promoting innovation and competition in the financial sector (Bank of England, 2023).

In Brazil, Nubank has successfully onboarded millions of first-time bank users, demonstrating the scalability of neo-banking in emerging economies with similar socio-economic conditions (Nubank, 2024). India's neo-banking potential lies in eliminating barriers associated with traditional banking, such as high costs, extensive documentation requirements and limited physical accessibility. By integrating with Digital Public Infrastructures (DPIs) like Aadhaar and UPI, neo-banks can streamline onboarding processes and facilitate seamless transactions. However, regulatory clarity on licensing models, consumer protection and capital adequacy norms remains critical to their expansion.

The Monetary Authority of Singapore's regulatory sandbox provides a tested model for iterative policy development, allowing regulators to evaluate risk, stability and compliance requirements before full-scale adoption (Monetary Authority of Singapore, 2023). Establishing collaborative frameworks

involving government, fintech companies and academic institutions is essential for developing a structured, scalable and inclusive neo-banking ecosystem that meets India's diverse financial needs.

#### 6.10 Data Classification in Financial Sector

Effective data classification—as public, internal-only, confidential and restricted—is essential for ensuring security, regulatory compliance and operational efficiency in financial services. However, India's financial ecosystem lacks a structured framework for data classification, resulting in inconsistent security implementations across financial institutions.

Proper classification allows financial institutions and government agencies to implement appropriate security measures based on the sensitivity and risk profile of the data. A structured classification approach—like models adopted by the National Institute of Standards and Technology (NIST) in the US —can provide clarity by defining tiered categories based on sensitivity and operational impact. Establishing a standardised three-tier system with clear naming conventions for each category, along with corresponding security and deployment requirements, can improve data management across financial institutions.

#### 6.11 Shared Responsibility Models and Liability Regimes

In complex financial ecosystems, particularly those integrating AI, shared responsibility models are crucial for ensuring accountability and mitigating systemic risks. Establishing clear legal frameworks that delineate liabilities among key stakeholders—regulators, technology providers and financial institutions—is essential for maintaining trust and stability.

A primary concern in Al-driven financial services is determining who bears responsibility for potential harms caused by AI technologies. This raises critical legal questions, including whether a strict liability approach (holding developers accountable by default) or a fault-based liability model (requiring proof of negligence) is more suitable. For example, in automated credit scoring, if an AI model wrongly denies a loan due to bias in training data, should the developer, financial institution, or data provider be liable? In algorithmic trading, if an AI-driven decision results in market manipulation or financial losses, should the investment firm or the AI provider bear the responsibility?

A 2024 report by Esya Centre highlights that AI liability is highly contextual due to the heterogeneous nature of AI systems. Effective liability frameworks must consider the specific context of AI deployment and the degree of control various stakeholders have over these systems.

Park's (2024) Al taxonomy, which categorizes Al systems based on their training models and intended functions, illustrates how different Al applications pose distinct risks that should be addressed uniquely under the law. This approach is already being applied in the European Union's Al Act, where high-risk Al systems—such as biometric identification and financial decision-making algorithms—are subject to stricter regulations. Singapore's Payment Services Act (Monetary Authority of Singapore, 2023) serves as a model, demonstrating how well-structured liability frameworks can mitigate risks associated with digital payments. This approach has allowed Singapore to set clear compliance requirements for e-wallet providers and payment aggregators, reducing disputes and enhancing consumer protection.

A similar taxonomy-based approach can be applied in India, enabling a context-specific regulatory framework that aligns with sectoral regulations and standards. For example, in digital lending,

differentiating between AI-powered risk assessment models versus automated loan approval systems can help define specific liability structures. Similarly, in fraud detection, the legal framework should distinguish between false positives that inconvenience users and false negatives that enable fraud, ensuring fair accountability for AI providers and financial firms. By enhancing contractual obligations between financial institutions and third-party service providers, liability disputes can be managed more effectively, fostering greater trust and stability in digital finance.

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