BUILDING PLATFORMS AS DIGITAL PUBLIC INFRASTRUCTURE:

TRUST, ADOPTION & ECOSYSTEM VALUE USING INDIA'S UPI AS A CASE STUDY

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Acknowledgements

We are thrilled to release a compendium titled *'Platforms of the World*.' The comprehensive three-piece collection of research takes a journey from a broad global perspective to a more specialised focus on India, specifically delving into the intricacies of the Unified Payments Interface (UPI). We would like to take this opportunity to express gratitude to Prof Jagdish Sheth, Prof Raj Srivastava, Prof Siddhartha Singh, and Prof Abhishek Kathuria for their unwavering guidance and support. Their exceptional expertise and strategic direction have been pivotal in shaping the overarching vision of this compendium.

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As we release this compendium, we invite you to explore the rich insights within and join us in the ongoing conversation about the evolving landscape of digital platforms worldwide. We are delighted to present a comprehensive exploration of the nuances of digital payments within the Indian context. This three-part collection unfolds as a testament to our commitment to catalysing digital transformation on our nation's financial landscape. Grounded in a qualitative methodology, predominantly featuring insightful interviews, open data and NPCI data, this study unravels the evolving tapestry of the journey of emerging technology – from its global roots to the specialised focus on its role in India.

Within these pages, we aim to provide not just a glimpse but a profound understanding of UPI's significance, drawing from the experiences and expertise of those deeply entrenched in this digital revolution. From the macrocosm of global digital trends to the microcosm of UPI's impact on India, we trust that this exploration will not only inform but inspire conversations and innovations that shape the future of societal development in our country and form an inspiration to other nations.

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Abstract

Understanding trust in technology with digital public infrastructure, using India's Unified Payment Interface payments as a case study.

The world is fast changing, and with digitisation sweeping the world, all the major sectors and industries globally have been disrupted. This disruption has been aggravated and strengthened by the COVID-19 pandemic. India is the leading example that has leveraged the power of technology to make financial inclusion a reality. The foundation of financial literacy has been laid through the JAM trinity (Jan Dhan, Aadhar, and Mobile). Financial inclusion aims to empower the excluded and most vulnerable groups/communities by providing them with affordable access to public goods.

India has made accessible digital public infrastructure (DPIs), which has become a new factor of production in the Indian economy, fostered growth, and led to societal empowerment. Our research has contributed to building the UN definition of Digital Public Infrastructure, which is now defined as

> *"...a combination of (i) networked open technology standards built for public interest, (ii) enabling governance, and (iii) a community of innovative and competitive market players working to drive innovation, especially across public programs."*

These infrastructures help create and deliver various public and private goods. In today's era of rapid digitisation, a range of government to private services, activities, and goods are mediated through digital systems. With a global recognition for its significance and potential to drive economic growth, several countries have converged on three fundamentals of DPIs:
Identity
Payments
Data management

India was one of the first countries to develop the three foundational layers of Digital Public Infrastructure (DPI) and called it the 'India Stack.' The India stack is a collection of open Application Programming Interfaces (API) and DPGs designed to enable widespread access to these three fundamental layers of identity, data, and payment systems.

Some of the many key components of the India Stack are Aadhaar, Unified Payments Interface (UPI), eKYC, and DigiLocker.

The launch of the UPI was a step in the process of strengthening India's digital payments ecosystem. The UPI was launched in 2016, and over the years, it has become one of the most preferred modes of payment in India. The private sector and startups have leveraged the power of UPI in their platforms. UPI applications such as PhonePe, GPay and Paytm are the most used applications with PhonePe as the leader, followed by GPay and Paytm. It is imperative to understand the reasons for the preference of

UPI over other payment methods. The amalgamation and co-existence of different stakeholders such as banks, companies, retailers and consumers on the same platform is crucial for financial inclusion.

The growth of UPI must be understood from the perspective of usage that comes after adoption. There are various factors are responsible for the adoption of UPI, such as:
access to bank account, identification, mobile and internet
benefits such as immediate transfer to the bank account
adoption is low-cost
trust in the UPI ecosystem- the user trust in the UPI ecosystem comes from its government ownership and a very comprehensive and transparent grievance redressal system that safeguards the interest of users

This is a qualitative research to understand factors impacting user trust in the UPI ecosystem. It explores the discourses behind the higher adoption of UPI among different social classes in India. The study analyses usage data of retailers and consumers from disadvantaged socio-economic sections of society and adoption by the startup ecosystem.

The outcomes are essential for building new DPIs like ONDC within India and setting frameworks for other low and medium-income countries.

Digital Platforms of the World

Background

In the records of human history, there have been pivotal moments that altered the course of civilisation, and now we stand on the precipice of one such epochal transformation – the Fourth Industrial Revolution. This technological revolution is poised to transform every aspect of human life, work, and relationships on an unprecedented scale, blurring the boundaries between the physical, digital, and biological realms.[1] But it's not just the breathtaking convergence of cutting-edge technologies that sets this revolution apart; it's the exponential speed of progress, disrupting industries worldwide and challenging traditional norms. As we delve deeper into the heart of the Fourth Industrial Revolution, the fusion of artificial intelligence with quantum computing emerges as a beacon of transformative potential. This confluence not only accelerates computational capacities but also heralds a new era of problem-solving capabilities, from climate change mitigation to revolutionising medical diagnostics. As society stands on this technological brink, the imperative to ethically harness these advancements becomes paramount, ensuring that such progress serves as a cornerstone for global betterment."

Governments and regulators face a formidable challenge in keeping up with the rapidly evolving technology landscape while safeguarding consumer interests and fostering innovation. National and International Security, too, undergoes a redefinition in the face of these advancements, introducing new forms of conflict and vulnerabilities. Ethical questions surrounding privacy and the impact of technology on our humanity come to the forefront, demanding a collective response from individuals, policymakers, and society as a whole to ensure human values and well-being remain at the core of this revolution.

The Fourth Industrial Revolution represents a transformative era with immense potential for human progress. However, realising its benefits while addressing its challenges requires a comprehensive approach that combines social and technological innovation while integrating sustainability principles. By embracing a holistic perspective, society can navigate the disruptions of Industry 4.0 and forge a

[1] van Doorn, Menno and Duivestein, Sander. "The Fourth Industrial Revolution." Vint Research 3: Things, Sogeti, https://www.sogeti.com/explore/reports/vint-research-3-things---the-fourth-industrial-revolution/

prosperous and sustainable future.[2] Proactively shaping this revolution will ensure that it serves humanity's best interests and leads us to a better world where technology is harnessed to benefit all. As we stand at this crossroads of history, it is up to us to make the right choices and shape the future we want to create.

The Influence of Big Tech

In the age of digital transformation, a handful of tech giants stand tall, wielding unparalleled power and influence over the global economy and society. Big Tech platforms have become integral to modern life, reaching billions of users across the globe. These platforms have proven to be powerful vehicles for communication and coordination, even fueling revolutions. By harnessing this immense power, Big Tech could play a decisive role in meeting the SDGs, fostering mass inclusion, and facilitating a managed transition to a sustainable future. However, the path to becoming a force for good is not without obstacles. Big Tech companies have faced increasing criticism and calls for regulation, fair taxation, and concerns over data usage, privacy, censorship, misinformation, and fake news. To truly fulfil their potential as forces for good, these tech giants must address both perception and substance issues.

Digital platforms have significantly disrupted traditional markets, often leading to job displacement and market uncertainties. Sectors such as retail, transport, and hospitality face challenges adapting to new digital-led economic models. This disruption has raised concerns about the equitable distribution of digital dividends and the societal impact of rapid technological changes.

Several key observations highlight the current positioning of Big Tech:

- **Deep Consumer Access Creates Unprecedented Value:** The high valuations of Big Tech companies are a result of their access to vast user bases and valuable data insights, driving highly profitable business models.
- **Global Internet Reach:** Major tech platforms connect with over four billion social media users, representing over half of the world's population, granting them significant indirect power and influence.
- **Shift in Public Opinion:** Despite offering highly valued services, Big Tech companies have faced a negative shift in public perception due to concerns over privacy, misinformation, foreign interference, and monopolistic power. In a notable shift towards transparency and user

[2] Morrar, Rabeh and Husam, Arman, and Saeed, Mousa. "The fourth industrial revolution (Industry 4.0): A social innovation perspective." Technology innovation management review, Volume 7: Issue 11, Pages 12-20.

empowerment, several Big Tech entities have introduced groundbreaking initiatives aimed at safeguarding personal data and enhancing privacy controls. These measures, amidst growing public scrutiny over digital rights, signify a pivotal moment in the redefinition of user-platform dynamics. Moreover, the past year witnessed Big Tech's concerted efforts in combating misinformation, with the adoption of sophisticated AI tools designed to curtail the spread of falsehoods, thereby reaffirming their commitment to responsible content dissemination.

- **Corporate Climate Change Leaders:** Big Tech companies have taken the lead in addressing climate change, achieving carbon neutrality, and becoming significant purchasers of clean energy.
- **Untapped Potential for Broad Impact:** While some progress has been made in sustainability and corporate responsibility, Big Tech companies have yet to fully leverage the potential of their platforms for broad social impact.
- **High Bar for Private Sector Leadership:** The finance industry has been proactive in addressing sustainability and other global issues, setting a high bar for other private sector businesses to follow.

Private platforms often engage in rent-seeking behaviors, profiting from data and market control without proportionate contributions to society. This can exacerbate economic disparities and raise questions about the equitable distribution of digital dividends. Addressing these issues is crucial for ensuring that the benefits of digital transformation are broadly shared across all segments of society. Algorithms driving digital platforms can inadvertently perpetuate biases, leading to significant ethical and societal concerns. Examples include biased job advertisement delivery, search results, and content recommendations. Addressing these biases is essential to ensure that digital platforms promote fairness and equity.

With vast data collection, private platforms pose significant privacy risks, often lacking transparency in data usage. Instances of data breaches and unauthorized data sharing have raised serious concerns about user privacy and trust. Effective regulation and transparent data policies are necessary to mitigate these risks. Private platforms often gain significant market control, leading to reduced competition and monopolistic behaviors. This dominance can stifle innovation, limit consumer choices, and result in unfair pricing practices. Ensuring a competitive market is crucial for fostering innovation and providing better services to consumers.

Ultimately, the potential of Big Tech as a global force for good lies in its values. While technology itself is neutral, how it is used determines its impact. By prioritising initiatives that align with

the demands of stakeholders and customers, tech companies can maximise their impact on sustainability and inclusion. To succeed in its mission, Big Tech must proactively choose to align its values with global challenges and make a transformative impact on the world. By doing so, they can become true champions of positive change, driving us toward a brighter and more sustainable future for all.

Digital Platform Technology

The past decade has seen significant advancements in information, computing, communication, and connectivity, elevating digital technologies to influential emerging technologies with a profound impact on the business landscape. Ecosystems, including social networks and digital platforms, play an increasingly vital role in the digital age, fostering collaboration between participants and supporting innovation in business models, mainly enabled by digital technologies.

The business world is witnessing a significant transformation fueled by the emergence of platform-based business models, with tech giants like Apple, Google, Amazon, and Alibaba leading the way. These companies have experienced remarkable growth, surpassing traditional firms and gaining substantial market share. While being an early adopter is crucial in this platform revolution, established companies still have opportunities to thrive. They can create their own platforms, collaborate with others, or leverage existing platforms to their advantage.

In the last few decades, technology driven platform models have changed how businesses are conducted. Prior to this, the enterprises followed the pipeline business model, which is based on the flow of goods and services in a linear manner from producers to consumers[3]. The continuous and rapid digital innovation led to a shift from pipeline model to technology driven models[4].

Mckinsey defines Platform Technology as,

> "*...technologies that enable visibility into management of business or operations processes through native capabilities and seamless integration with other technologies to aggregate data and process control in a single place.*" [5]

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[3] Watts, Stephen. "What Is the Platform Economy?" ***BMC Blogs***, www.bmc.com/blogs/platform-economy.

[4] Id

[5] "Rise of the Platform Era: The Next Chapter in Construction Technology." ***McKinsey & Company***, Oct. 2020, www.mckinsey.com/industries/private-equity-and-principal-investors/our-insights/rise-of-the-platform-era-the-next-chapter-in-construction-technology.

They also believed platforms are attractive to customers due to their ability to enhance customer stickiness compared to point solutions. The better features and interface the platform has, the higher the chances for the customers to use the platform for its critical day-to-day operations. [6]

The term "digital platform" lacks a precise definition, but the focus is on how business models leverage platform economics. Developers make strategic choices regarding internalising demand externalities, exploiting direct or indirect network effects, revenue models, data usage, and vertical integration. Platforms often internalise demand externalities, leading to either direct or indirect network effects, making them attractive to users.

Platform technology has changed modern-day business by accelerating, scaling, and increasing the number of users. The 'enabler' feature of platform technology makes it a preferred space:

- The ability to build upon existing interfaces, adding new features and interfaces will enable the platform to be used critically by the customer in everyday business operations[7].
- It is an ever evolving industry as the consistency in platform growth implies large companies have to continue to scale to remain competitive, while smaller companies have to become a part of the ecosystem along with the core value proposition of their technology[8].

This structure enables companies to accelerate their business operations. Platforms operate in a similar manner with independent entities which brings together business, technology, and governance[9].

Platform Approach

Historically it can be seen that new inventions and developments in the various fields such as art, music, literature, technology, medicine, and sports; etc. have been built on existing models with modifications to serve the requirements of everyday life or to simply appeal to the aesthetics.

Similarly, earlier models of online businesses were developed based on innovations in the field of technology in the 19th century. The innovations and techniques have been used to build upon pre-

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[6] Id

[7] Id

[8] Id

[9] Bossert, Oliver, and Driek Desmet. "The Platform Play: How to Operate Like a Tech Company." *McKinsey & Company*, Feb. 2019, www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the-platform-play-how-to-operate-like-a-tech-company.

existing platforms to provide the users with simple solutions to their complex challenges. The advantages of this approach are[10]:

- **Increased business options:** With the establishment of a channel, the enterprises can now directly communicate with their prospective clients. The same benefit is accessible to clients as well, they can choose from a range of service
- **Cost effective:** The platform approach uses different techniques, such as data analytics, algorithm, AI, ML to streamline their target groups. Also, with the absence of agencies and traditional gatekeepers, the expenditure incurred to get access to clients/companies; given an advantage.
- **Trust building:** The platform enablers have developed structures to build the trust among consenting parties to come and do business/ transactions on mutually agreed business. The time saving, feasibility, and trust building have been developed by these services which traditionally would have been a dreadful task to do, i.e. door to door verification of every transaction at every level. For example, the Uber and Ola applications now use OTP and face verification for every ride to ensure the safety of passengers.

The enterprises can scale their business operations and carry on multiple transactions simultaneously in a quick span of time. The fast changing environment signals enterprises to innovate faster, for example; companies like Google and Amazon have scaled their businesses and now offer multiple products and services. Below mentioned are the points which focus on how the platform model provides a cutting edge[11]:

- **Simplifying Data Integration:** The IT experts face challenges with integrating new technologies with older ones. However, with Platform as a Service (PaaS), this integration has been made possible- cloud applications and services can be built into the platform using 'low-code' tools. These applications have the ability to share data that is generated and stored in the platform, thus making integration hassle free. Also, the companies do not have to write new code for every application, but instead, they can configure the solutions residing outside of the platform to PaaS setup.
- **Platforms blend control and freedom:** The PaaS system can be used to let non-tech users create and customize their applications, however, to ensure it does not get disrupted by wrong code, safety at the backend is not compromised;

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[10] Grumbach, Sascha. "Tech Platforms- Anatomy and Benefits | Blog - Argo Venture Studio." *Blog - Argo Venture Studio*, 12 Sept. 2019, www.blog.argo-venture-studio.com/tech-platforms-anatomy-and-benefits

[11] *5 Benefits of a Platform-as-a-Service*. www.appian.com/blog/2018/5-benefits-of-a-platform-as-a-service.html.

- The low-code interface has bundles of tested and proven code through which users can create and customize applications.
- The No-code framework is a software design system that empowers people without technical expertise to execute software without coding[12]. It uses a visual development interface to enable users to create applications by dragging and dropping these applications to develop the application.

➢ **Customisation:** Through PaaS solutions, the users can customize the services offered as per their requirements, which in earlier days was not possible. Some of these customisation services include personalising analytics dashboards based on the user's role and preferences and aligning tech functionality precisely with requirements to coordinate capabilities; etc.

Understanding Platforms & Digital Business Models

Digital business models fall into several categories, each determining the potential operationalization of network effects[13]:

1. **Resellers or Distributors:** They provide content or products to end-users without transactions between consumers and upstream suppliers, leading to no indirect network effects. (e.g., Netflix)
2. **Marketplaces:** They facilitate transactions between user groups, impacting a wide range of markets, with indirect network effects between suppliers and consumers. (e.g., Amazon Marketplace)
3. **Social Networks:** These enable social interaction among users, creating direct network effects, and may have indirect network effects based on their revenue model. (e.g., Facebook, WhatsApp)
4. **Platforms of Platforms:** These ecosystems host interconnected platforms, offering various services and functionalities to users. (e.g., Apple iOS, Facebook as an application platform)

Some business models may combine elements of multiple service types, demonstrating the versatility and complexity of the digital platform landscape. As the platform economy continues to evolve, policymakers must grapple with its implications for innovation, competition, and consumer welfare. Platform business models, driven by digitalization, have emerged as the prevailing configuration

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[12] Kissflow, Inc. "No-Code 101 : A Complete Guide to No Code Development for 2023." *Kissflow, Inc*, Sept. 2023, www.kissflow.com/low-code/no-code/no-code-overview.

[13] Nooren, Pieter and van Gorp, Nicolai and van Eijk, Nico and Fathaigh, Ronan O. "Should We Regulate Digital Platforms? A New Framework for Evaluating Policy Options." Policy & Internet, Volume 10: Issue 3, September 2018, Pages 241-367, doi: https://doi.org/10.1002/poi3.177

in the 21st century, disrupting and dominating various traditional industries. Companies like Uber, Amazon, and Microsoft exemplify this new type of platform business model, combining developments from previous decades with innovative features. These platforms, despite utilizing only a fraction of traditional assets, hold significant economic importance in the digital economy and shape the terms of the markets they enter.

Platforms function as both intermediaries and infrastructures, providing shared techniques and interfaces open to various users. They serve as online digital arrangements that organize economic and social interactions, enabling participants to interact and exchange information. These platform business models connect independent actors from both the demand and supply sides, facilitating commercial transactions and benefiting from network effects, where value grows as more participants join. The digital economy's shift towards network effects has replaced traditional economies of scale, with networking activities becoming central to value creation. Companies like Google, Facebook, and Amazon continually redefine industries through network effects.[14] The more participants on one side of the platform, the more attractive it becomes to participants on the other side, leading to a self-reinforcing cycle of growth.

Platform business models rely on user engagement and quality interactions to create value. As users participate more innovatively, valuable digital data and experiences are generated, enhancing the platform's value proposition. Trust and information symmetry improve as consumers gain access to a broader range of goods and services and benefit from user-based reviews and ratings. They grow rapidly by leveraging resources they do not own or control. These platforms enhance market transparency, reduce moral hazards, build trust, and improve information provision through incentive systems and advanced technologies. Data and algorithms play a critical role in platform operations, making them powerful intermediaries and market makers.

Their strategic use of digital data and innovative networking activities allows them to lead in an increasingly connected world. In today's digital landscape, major platforms like Google, Facebook, Amazon, and Apple are disrupting traditional businesses by reshaping value-creation processes and customer behaviour. This transformation is forcing established companies to reevaluate their business models while also presenting new opportunities for emerging players. As platform ecosystems gain momentum, companies are increasingly drawn towards participating in them to boost revenues and profits, benefiting from the inherent network effects that drive exponential growth.

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[14] Sorri, Krista and Seppanen, Marko and Stikk, Kaisa et al. “Business Model Innovation with Platform Canvas.” Journal of Business Models, Volume 7: Issue 2, 2019, Pages 1-13, link: https://cris.vtt.fi/en/publications/business-model-innovation-with-platform-canvas

The success of platforms lies in the sustainable and repeatable interactions that foster the emergence of ecosystems. Modularity and complementarities play a vital role in enabling ecosystem emergence, allowing distinct yet interdependent organizations to coordinate without complete hierarchical control. This ecosystem is characterized by a shared set of rules of operation and modular complementarities. It is essential to view the platform ecosystem from a business perspective rather than solely as a technical issue. The economic value of technology is realized when it is commercialized through a well-designed business model.

In an era increasingly defined by the metaverse and decentralized finance (DeFi), our understanding of digital business models is undergoing a profound transformation. These emergent arenas offer a glimpse into the future of commerce and social interaction, underpinned by blockchain technologies that promise to decentralize control and distribute value more equitably among users. As platforms pivot towards these innovative models, they challenge traditional monopolies and introduce a new paradigm of user agency and empowerment. This shift necessitates a reevaluation of regulatory frameworks to ensure they foster innovation while protecting users from potential risks associated with these nascent technologies.

Business model innovation[15] focuses on the business model itself, covering aspects like value creation, proposition, and capture. Platforms change traditional business rules and interactions among companies, facilitating multi-party exchanges that create novel value while allowing value capture. They act as matchmakers, bringing together members of different groups and providing more value to customers through integrated services. Digital platforms are software-based external platforms, provide a technical infrastructure for ecosystem participants to integrate with. They foster interactions among firms and individuals, creating a two-sided or multi-sided marketplace where value is created for all members of the network.

Digital platform ecosystems are reshaping how economic value is created and captured. These ecosystems consist of platform owners, users, and complementors, each playing a crucial role in driving innovation and economic growth. Platform owners provide the technical infrastructure that facilitates interactions among participants, users engage with the platform to consume and create value, and complementors add value by developing complementary products and services. In India, the development of platforms like UPI has demonstrated how digital ecosystems can drive financial inclusion and empower users by providing seamless and secure payment solutions. The value creation

[15] Gatautis, Rimantas. "The Rise of Platforms: Business Model Innovation Perspectives." Engineering Economics, 28(5), 2017, Pages 585-591, doi: http://dx.doi.org/10.5755/j01.ee.28.5.19579.

mechanism within these ecosystems varies, but the overall impact is a more connected and efficient digital economy.[16]

To succeed in the platform economy, companies must understand their roles within the platform ecosystem. Platforms offer the ability to create and scale value outside the organization, making participants interdependent in a business ecosystem. Recognizing their impact on the overall ecosystem, companies must link their capabilities with the actions of other participants for co-evolution. The platform's opportunity often arises when there are frictions in the market that hinder interactions between different user groups. The platform aims to reduce these barriers and enable sustainable interactions between producers and users, ensuring both quality and quantity of interactions. Platforms empower value co-creation with users, fostering innovation beyond in-house expertise.

The core interaction of the platform, where value exchange occurs, is vital and introduces the two sides of the platform: producers and users. Filtering mechanisms, such as matching algorithms, efficiently facilitate value exchange and attract participants to the platform. Governance rules ensure fairness and trust, while resilience enables the platform to adapt to a changing environment and maintain compatibility with future and past complements.

Platforms are transforming the economy, and their owners wield considerable power, rivaling that of factor owners in previous industrial revolutions.[17] They disrupt economic activities, lower barriers to market entry, and reshape the logic of value creation, capture, and transfer. Companies that wish to apply platform models need to innovate their business perspectives.[18] Platforms are no longer confined to specific industries but are visible across various sectors. They facilitate cooperation and value creation between companies, necessitating changes in business models to compete effectively in digital ecosystems. As platforms fundamentally affect value creation, companies must adapt their models to thrive in platform-based global value chains.

The impact of platforms on innovation and competition requires further exploration. Understanding platforms is essential, and businesses must adopt platform thinking to remain competitive in the future. Virtually any industry where information is essential is ripe for the platform

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[16] "The Rise of Platform Ecosystems: An Overview." McKinsey & Company, 2023. Accessed June 12, 2024. https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the-rise-of-platform-ecosystems.

[17] Gawer, Annabelle. "Bridging different perspectives on technological platforms: Toward an integrative framework." Research Policy, Volume 43, 2014, Pages 1239-1249, doi: http://creativecommons.org/licenses/by/3.0/.

[18] Zhao, Yang and von Delft, Stephan and Morgan-Thomas, Anna and Buck, Trevor. "The Evolution of Platform Business Models: Exploring Competitive Battles in the World of Platforms." Long Range Planning, Volume 53: Issue 4, 2020, 101892.

revolution. Developing a digital platform strategy[19] is essential for every organization, but the approach will vary depending on the company's unique circumstances. Companies must carefully assess the opportunities presented by platforms, as they bring significant market power. Decisions about relationships with platform owners and whether to innovate business models should be made thoughtfully to avoid failure. For every successful platform, there are many more that struggle or simply don't make it, dynamics that may eventually give rise to a winner-take-all outcome.

The digital platform revolution is an ongoing and transformative process that is changing the face of businesses and industries. As platforms continue to evolve and expand, it is crucial for companies to understand and adapt to the new dynamics of the digital economy. Embracing platform thinking and developing effective platform strategies will be essential for companies to remain competitive and thrive in this increasingly connected world.

The Emergence of E-Services in Different Scenarios

Companies such as Amazon Web Services (AWS), Stripe, Google, Flexport; etc. have changed the traditional model of trading and business. The traditional business models were heavily dependent on preparing ledgers, and documents and storing them, however, digitisation and cloud computing services have changed this sector. The convenience, lucrative discounts, easy user interface (UI), no visits to stores, long queues; etc. have enhanced user experience virtually; hence, the shift towards e-commerce happened. This shift is encouraging companies to innovate and sustain in the new market.

With the onset of the fourth one, the companies have been innovating and coming up with new technology exponentially, which is unprecedented. These innovations and the building of platform models have disrupted traditional business models; for example Airbnb, Ola, Uber; etc.

Prior to the introduction of Uber in the US, Europe, or India, customers would arrive at their destination and then struggle with transportation or booking through an agent. However, these companies who act as matchmakers have disrupted the traditional business operation model of Cabs and Autos. Uber has created application-based mobility as a service platform that connects users with the drivers[20]. The low-cost pricing models have been used to retain customers while rapidly scaling up and occupying a significant market share has put traditional taxi companies out of business.

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[19] P1: Mlcuchova, M. "A Review of Platform Business Models." MENDELU Working Papers in Business and Economics, Volume 80, 2022, http://ideas.repec.org/s/men/wpaper.html

[20] "Transforming Urban Mobility to Our Advantage." *BusinessLine*, 15 Jan. 2018, www.thehindubusinessline.com/opinion/uber-taxis-and-transformations/article9433187.ece.

The proliferation of AI-driven e-services marks a significant leap forward in the digital transformation journey, offering personalized and efficient solutions across various sectors, from healthcare to finance. The integration of AI algorithms in e-service platforms has not only enhanced user experience through customisation but also significantly improved accessibility, breaking down traditional barriers to service delivery. However, this surge in AI adoption brings to the fore critical ethical considerations, particularly regarding data privacy and algorithmic bias, urging stakeholders to forge a consensus on ethical AI use that respects individual rights and promotes fairness.

The Relationship Between the Government and Big Tech

The comprehensive penetration of the internet into almost every segment of a human's personal and professional life is leading to the emergence of big data, which is in turn transforming world trade and politics. [21] This data is rapidly intertwining itself with power. [22] Benefiting from relatively more financial and personnel resources, Big Tech have developed a monopoly in the technology market, establishing a dominance in no time. [23]

The government lags behind Big Tech when it comes to data gathering, algorithm R&D, talent reserve, capital investment, and technological application. [24] This is mostly because the government lacks surplus financial resources, specialized tasks, and clear objectives. [25] But due to the emerging concept of digital governance and the government's increasing dependency on big data, it begins relying on the Big Tech that controls this big data. Although the modern government still remains at the center of the power structure, the dominance and control that the Big Techs hold combined with the fluid and borderless nature of data, is leading towards the creation of a multi-center, decentralized power structure. [26]

When it comes to the information sector, the Big Tech with their advanced technological advantage, strongly dominate the digital markets. Elements like algorithms, data, computing power, etc

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[21] Gu, Hongfei. "Data, Big Tech, and the New Concept of Sovereignty." *Journal of Chinese Political Science*, Springer Science+Business Media, May 2023, https://doi.org/10.1007/s11366-023-09855-1.

[22] McCormick, Matthew J. Slaughter and David H. "Data Is Power: Washington Needs to Craft New Rules for the Digital Age." *Foreign Affairs*, 13 July 2023, www.foreignaffairs.com/articles/united-states/2021-04-16/data-power-new-rules-digital-age.

[23] Gu, Hongfei. "Data, Big Tech, and the New Concept of Sovereignty." *Journal of Chinese Political Science*, Springer Science+Business Media, May 2023, https://doi.org/10.1007/s11366-023-09855-1.

[24] Id

[25] Id

[26] Id

are pioneered and controlled by companies that are platform-based, labeling data as a critical strategic resource. [27] This way, they inevitably come to play a role in the international economies and politics. [28]

Big Tech has undoubtedly played a crucial role in catalyzing the construction of a digital ecology around the world. This technological revolution has changed the concept of governance, and has now become a prerequisite for a majority of decision-making processes. But the key challenge here is to balance the civil rights and public power, which were originally maintained by the legal order of the state. [29] This need is the result of an inorganic redistribution of power between the public and the private sector in this era of industrial and information economy.

With data as a crucial asset in today's world, and the unstoppable dominance of the Big Tech over it, especially in the realm of social media and such platforms, it becomes necessary to map out a sort of system that could recognise both the need to place sovereign states as the central actors, while allowing Big Techs to function within certain capacities and space.

Private digital platforms, despite their widespread use, present several challenges. Issues such as market dominance, reduced competition, data privacy risks, algorithmic bias, and economic disparities are prevalent. These platforms often engage in rent-seeking behaviors, profiting from data control without proportionate societal contributions. The dominance of a few tech giants can stifle innovation and limit consumer choices. Addressing these challenges requires regulatory oversight and the promotion of open, interoperable digital public infrastructure, as demonstrated by India's approach with UPI and other Digital Public Infrastructure (DPI) initiatives.

As the digital landscape matures, the symbiotic yet complex relationship between governments and Big Tech evolves to address the dual mandates of fostering innovation and ensuring digital sovereignty. Recent global initiatives towards digital taxation and antitrust regulations exemplify efforts to recalibrate this relationship, aiming to ensure equitable growth and curb monopolistic practices. Moreover, the collaborative endeavours in cybersecurity and infrastructure resilience underscore the mutual reliance between states and technology giants, paving the way for a cooperative governance model that leverages Big Tech's capabilities for societal benefits while safeguarding public interests and national security.

The integration of government and market apps within India's digital ecosystem exemplifies a balanced approach to innovation and regulation. Government apps focus on public service delivery and

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[27] Id

[28] Id

[29] Id

inclusivity, while market apps drive user engagement and technological advancements. By ensuring interoperability and fostering competition, India's DPI model encourages diverse solutions that cater to various user needs. This collaborative framework has been instrumental in the success of initiatives like UPI, which leverages both public oversight and private sector innovation.

The Emergence of U.S. in Big Tech

As of May 2023, the top 10 largest companies in the world, in the context of market capitalization, were U.S. based. These are, however, followed by more U.S. dominated companies. Rounding out the top few on the list were some of the most recognised U.S. brands, namely, Apple, Microsoft, Alphabet, Amazon, and NVIDIA.[30]

The development of American Big Tech can be attributed to it being '*private-led*', in the sense that these are primarily private-owned companies, with ownership dispersed amongst an array of shareholders. The government has not only helped construct an environment to foster a relatively open and competitive market, but has also provided institutional spaces for R&D in tech throughout the years. It is with the support of these acting as a solid backbone, that the tech giants today could achieve what they have.

Although the government's intervention today is limited to regulatory and oversight policies, the aim is to protect consumer rights, ensure fair competition, and address antitrust issues. Because these do not fall under the direct ambit of the companies, the government assumes responsibility to look after these concerns.

In the swiftly evolving terrain of global technology, the United States continues to solidify its status as a crucible of innovation, particularly in the realms of quantum computing and artificial intelligence. The year 2023 has been pivotal, with landmark initiatives aimed at bolstering the nation's cybersecurity infrastructure and fostering public-private partnerships to drive technological advancement. Amidst growing global competition, the U.S. tech sector has witnessed a resurgence in manufacturing and R&D investments, signifying a strategic pivot towards securing supply chains and nurturing domestic talent. This reinvigoration, underscored by policy reforms and federal incentives, is poised to sustain America's technological preeminence while addressing the imperative of ethical technology development and deployment.

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[30] "Biggest Companies in the World by Market Cap 2023 | Statista." *Statista*, 30 Aug. 2023, www.statista.com/statistics/263264/top-companies-in-the-world-by-market-capitalization.

The History of Technological Development

Technological growth in the U.S. has played a pivotal role in its economic growth since the 19th century. [31] The periodic transition between the 19th to the 20th century marked the beginning of the nation's shifting visions, symbolizing the advancement of technology and scientific creation. [32] This shift was complemented with the government's institutional and industrial investments, establishing new organizational structures in support of technological and scientific knowledge and material creation, innovation, and research. [33] It can be said that the primary philosophy of letting technological innovation flourish in the USA has been to establish a well secured 'enabling' ecosystem.

Developed and recognised in the late 20th century, the National Innovation System (NIS), defined by Christopher Freeman as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies," contributed highly to the diffusion and development of technologies, as well as digital goods and services in the U.S.. [34] With the three elements of the U.S. NIS being developing a business environment, a regulatory environment, and an innovation policy environment, the government made attempts to inculcate an attitude of risk-taking, entrepreneurship, and a collaborative culture. [35] Under the vision of designing an appropriate innovation policy environment, the U.S. system began financing mission oriented (e.g., health and defense), and curiosity-driven research. [36]

The U.S. NIS through the following initiatives, stimulated the nation's technological and innovative aspiration: [37]

- University Fundings
- Research Labs/Institutes
- Technology Transfer Systems (transfering tech from universities or federal labs to the commercial marketplaces)
- Educating and Skill Training to build a competent Human Capital System

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[31] Mowery, David. "Technological Change and the Evolution of the U.S. 'National Innovation System', 1880-1990 | OpenMind." *OpenMind*, www.bbvaopenmind.com/en/articles/technological-change-and-the-evolution-of-the-u-s-national-innovation-system-1880-1990.

[32] Id

[33] Id

[34] Atkinson, Robert D. "Understanding the US national innovation system." *ITIF, June* (2014). https://deliverypdf.ssrn.com/delivery.php?ID=521087021095126102010119009106114098033054052039028007076097100111066094069088075068054032007059016029043022071088116122113019016038095048036072103064066118065030068061049124126025007100077072088077108084090024066116127122096097094031025105003065020&EXT=pdf&INDEX=TRUE.

[35] Id

[36] Id

[37] Id

So it can be said that ever since World War II, the federal government has focused on mobilizing technical resources to further national programmes, including national security, medical sciences, space exploration, etc. [38] Therefore, it is the federally-funded R&D in technology over the years that provided emerging industries and companies, including the major tech giants like Facebook, Apple, etc, a foundation to innovate and thrive.

Growth of Big Tech

Various acronyms have been given to the Big Tech U.S. companies. Goldman Sachs coined FAAMG (Facebook, Amazon, Apple, Microsoft, and Google).[39] In 2013, Jim Carter coined FANG, to which a second 'A' was added to make FAANG in 2017 (Facebook, Amazon, Apple, Netflix, and Google). [40] After several of the companies rebranded, FAANG became MAMAA (Meta, Amazon, Microsoft, Apple, and Alphabet), which was also introduced by Jim Cramer.[41]

Alphabet, Amazon, Apple, Meta, and Microsoft collectively make up 7.5% of the total value of publicly traded companies worldwide.[42] Yet, their true potential lies not just in their financial success, but in their capacity to unlock the collective potential of individuals. With access to approximately half the world's population and the potential to digitally include the other half, these tech titans have the opportunity to become massive 'forces for good,' driving global sustainability, inclusion, and development on a massive scale.

It is hard to deny that these Leviathan-like American Big Tech companies generate huge amounts of consumer data and revenue, making it incredibly challenging to regulate them.[43] Rapidly shifting towards becoming like oligopolies, these companies continue to wrestle over customers and control over their data. [44]

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[38] "Mastering a New Role." *National Academies Press eBooks*, 1993, https://doi.org/10.17226/2103.

[39] Rosencrance, Linda. "Big Tech." *WhatIs.com*, Mar. 2021, www.techtarget.com/whatis/definition/Big-Tech#:~:text=This%20is%20the%20acronym%20for,Apple%20was%20added%20in%202017.

[40] Id

[41] Duggan, Wayne. "What Happened to FAANG Stocks? They Became MAMAA Stocks." *Forbes Advisor*, 29 Sept. 2023, www.forbes.com/advisor/investing/faang-stocks-mamaa.

[42] "Making Big Tech a Force for Good", Greater Pacific, https://www.greaterpacificcapital.com/thought-leadership/making-big-tech-a-force-for-good

[43] Beard, Alison. "Can Big Tech Be Disrupted?" *Harvard Business Review*, 14 Dec. 2021, www.hbr.org/2022/01/can-big-tech-be-disrupted#:~:text=And%20Amazon%20takes%20in%20more,%247.5%20trillion%20by%20year's%20end.

[44] The Economist. "The Rules of the Tech Game Are Changing." *The Economist*, 25 Feb. 2021, www.economist.com/leaders/2021/02/27/the-rules-of-the-tech-game-are-changing.

As Big Tech firms navigate the complex waters of global expansion, antitrust scrutiny, and societal expectations, 2023 has marked a watershed moment for these behemoths. The advent of regulatory frameworks focusing on digital privacy, data portability, and platform neutrality has prompted a reevaluation of business models, fostering an environment ripe for innovation in data ethics and user empowerment. The trend towards decentralization, epitomized by the growing interest in blockchain and decentralized autonomous organizations (DAOs), suggests a potential shift in the digital economy's power dynamics. This evolution, driven by a quest for transparency and user-centric governance, heralds a new era where Big Tech's influence is balanced with a commitment to societal welfare and digital rights.

Alphabet Inc.

Alphabet Inc., the parent company of Google, stands as a colossus in the tech industry, with a diverse portfolio that spans search engines, cloud computing, software, and hardware products. Founded in 1998 and headquartered in Mountain View, California, Alphabet operates through three main segments: Google Services, Google Cloud, and Other Bets. Google Services includes widely-used products like Search, YouTube, Maps, Ads, Gmail, Google Play, and Android, which collectively generate substantial advertising revenue. Google Cloud offers infrastructure, cybersecurity, AI, and enterprise services, contributing to Alphabet's significant presence in the cloud computing market.[45]

Alphabet has consistently shown strong financial performance, with Q1 2024 revenues reaching $80.5 billion, a 15% increase from the previous year. This growth reflects robust demand for Google Cloud services, driven by the rising need for data-intensive AI workloads. The company's focus on artificial intelligence and machine learning continues to drive innovation across its product offerings. Alphabet's commitment to R&D, with expenditures amounting to $45.4 billion in 2023, underlines its strategy to stay at the forefront of technological advancements.[46]

Alphabet's influence extends beyond financial metrics; it is a pivotal player in shaping the digital economy and driving global technological trends. Its expansive ecosystem of services and products, combined with strategic investments in AI and cloud infrastructure, positions Alphabet as a leader in the ongoing digital transformation. The company's ability to innovate and adapt ensures its continued relevance and impact on a global scale.[47]

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[45] "Alphabet Inc. - Company Profile & Overview," Stock Analysis. Accessed May 2024.

[46] "Alphabet Stock Forecast 2024, 2025 & Beyond," Techopedia. Accessed May 2024.

[47] "Alphabet Inc Analysis & Company Information," GlobalData. Accessed May 2024.

Apple

With a market capitalisation of $2.75 trillion as of May 2023, Apple was the world's largest company that year. [48] It's history of success and dominance can be traced back to when it launched its flagship products iPod and iPhone, reflecting on how it disrupted the industry and ended Nokia's dominance in the cell phone market[49]. The launch of iPods set up a niche for itself in the audio market which led to people buying music through iTunes.[50] Apple depicts strong monopolistic behavior, being the sole provider of the apps on iOS, keeping both the app developers choosing the platform and consumers' access to them, under the company's control. [51]

Based on a study by Stratton, Apple's strong emergence as a platform ecosystem is due to its carefully strategized integration of hardware (iPhone, iPod, iWatch, Mac PC, and Laptops, etc) and the software (iOS, iPadOS, tvOS, and macOS), which in turn provide incomparable services and user interface. [52] To quote Stratton,

> *"Apple's ability to produce, maintain, develop, and extract value from its platform ecosystem has made it one of the most valuable companies in history."* [53]

Using Swift programming language throughout all Apple platforms, the company aims at facilitating third-party app developers. The company has also established managerial mechanisms at three different levels: quality-control standards, values and norms, and programming resources to manage its distributive third-party software production [54].

In 2015, Apple announced that Swift will be an open-source language, however, the ambiguity in the concept of 'open-source' gives corporates an advantage to derive benefit from the 'free labor' of the coders and Apple used 'open sourcing' of Swift for enhancing its business strategy. [55]

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[48] *Statista*, 30 Aug. 2023, www.statista.com/statistics/263264/top-companies-in-the-world-by-market-capitalization/#:~:text=With%20a%20market%20capitalization%20of,parent%20company%20Alphabet%2C%20and%20Amazon.

[49] Gilbert, Martin. "What Apple Can Teach Business About Disruption." *Fortune*, 9 June 2021, www.fortune.com/2017/01/12/apple-world-economic-forum-davos.

[50] Id

[51] Liu, Andy. "Apple's Monopolistic Control Over the Tech Industry." *SLC Undergraduate Writing Contest* 5 (2021).

[52] *View of Platform Politics: Software as Strategy in Apple's Platform Ecosystem First Monday*. firstmonday.org/ojs/index.php/fm/article/view/9948/8333.https://firstmonday.org/ojs/index.php/fm/article/view/9948/8333.

[53] Id

[54] Id

[55] Id

Microsoft

The trading value of Microsoft stands at $2.6 trillion, making it the second largest company based on market capitalization.[56] After decades of being known as arcane, monolithic, and monopolistic and failing to break into the digital advertising market, the board appointed Satya Nadella as the new CEO in 2014. Nadella soon declared his vision to 'rediscover Microsoft's soul, our reason for being', emphasizing on renewing the company's operations, and taking more risks. The company decided to pivot from the realm of mundane and irrelevant softwares to becoming a dominant player with skyrocketing profits.[57]

Amazon

Amazon is known to its users as an E-commerce company providing a plethora of goods on its retail website. It started in 1994 as an online bookselling platform, which today has become one of the largest companies by market capitalization. The platform model on Amazon business communicates directly with customers and also facilitates this interaction in business-to-business markets as well. The company now sells anything a user can think of- clothes, grocery, electric items, health and hygiene, etc. except for medicines.

Amazon has diversified its offerings not only in terms of products for sale in its platform but also services that are causing disruptions and giving competition to competitors such as Alexa for voice search, AWS (cloud service), Kindle, Prime Music, and Video, Fire Tablets and TV. The success and dominance of Amazon in the E-commerce market are portrayed in its annual revenue. In 2022, Amazon reported a loss of approximately $2.7 billion, while the company's sales revenue in the same fiscal year amounted to around $514 billion. [58]

Amazon Web Services

Amazon offers more than one kind of retail service, it has a platform based cloud computing setup offering solutions to companies since 2005, called Amazon Web Services (AWS). Since the time AWS was introduced; the ways of doing business, use of data, and client retention have completely changed. In the world of technology, it was a major disruption as other companies had to follow suit to sustain themselves in the market. The affordable, scalable and reliable platform is crucial for businesses to scale their operations as per their requirements. Amazon has used its resources to innovate and bring

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[56] Auslender, Viki. "From Dormancy to Dominance: Microsoft's 1000% Share Surge Defines a Pivotal Decade." *Ctech*, 27 July 2023, www.calcalistech.com/ctechnews/article/hyg59mtqn#:~:text=From%202014%20to%202022%2C%20Microsoft,dominant%20player%20with%20staggering%20profits.

[57] Id

[58] Coppola, Daniela. "Amazon Annual Net Income 2022." *Statista*, 29 Aug. 2023, www.statista.com/statistics/266288/annual-et-income-of-amazoncom/.

revolution in the technology business. AWS has built its platform model on different layers which explains its operations. These layers include: [59]

- Lower level building blocks
- High-level building blocks
- Cross-service features
- Tools to access services

The AWS has disrupted the earlier models of storing and operation. Although the series of innovative ideas by Amazon has encouraged other companies to adapt and sustain in the market, the same cannot be said for those players who have been providing software technology solutions to enterprises. The companies are struggling to match and challenge Amazon (here AWS) because of its large scale business and turnover. Due to its user-friendly investment, consumption flexibility, affordability, scalability, negligible infrastructure drag, and 99.9% accessibility on the cloud via API, the platform model has been able to leverage better business in the market. In 2022, the annual revenue of this segment rounded off to around $80 billion, where in the first quarter of the year, it accounted for at least 33% of the global cloud infrastructure service market. [60]

Meta Platforms

Founded by Mark Zuckerberg in 2004, Facebook transformed lives by enabling registered users to connect with each other, send messages, and upload pictures and videos. Facebook rebranded as Meta in October 2021, and now owns Facebook, Instagram, WhatsApp, and now Threads, amongst other products and services. With more than 3.5 billion users across its networks, approximately 50% of global online ad spending goes through Meta or Alphabet. [61]

The Role of California State in Big Tech

[59] "AWS." *Chetan*, 29 Sept. 2017, www.chetanspblog.wordpress.com/aws.

[60] Coppola, Daniela. "Amazon Annual Net Income 2022." *Statista*, 29 Aug. 2023, www.statista.com/statistics/266288/annual-et-income-of-amazoncom/.

[61] Id

The State of California has witnessed the rise of some of the world's biggest tech giants- Apple, Google, and Facebook. The non-compete clause is prohibited in California and it empowers people to leave their organizations and test new ideas[62].

The strong legislations that focus on the welfare of consumers, (through the California Consumer Privacy Act (CCPA)), and workers, make it a desired place to work and subsequently tech start-ups emerged in the region. California has the strongest net neutrality law in the US and under this the internet service providers are forbidden from blocking websites, slowing down websites and/or applications, and also acceptance of payments to provide online services faster. [63] The State was also the first one to enact appliance-and equipment-efficiency standards and gave a mandate that companies must hire female directors in their boards. [64]

Being a global leader in technological innovation, its workforce is 1.88 million strong, and has added more jobs than any other state since 2010. [65] As of 2021, seven of the world's top ten AI investors are based in California, and approximately half of all the venture capital dollars in AI went to California. [66]

The Silicon Valley, stretching from San Jose to San Francisco, is home to some of the largest technology companies in the world. [67] The largest tech companies in California by revenue are: Apple, Alphabet (Google), Meta (Facebook), Intel Corporation, etc. [68]

California's unparalleled ecosystem, a crucible of innovation and entrepreneurship, continues to be the heartland of Big Tech, nurturing advancements that shape our digital future. In 2023, California introduced groundbreaking regulatory frameworks aimed at enhancing data privacy protections, ensuring fair competition, and fostering sustainable technological development. These initiatives reflect a nuanced understanding of the tech industry's complexity and its societal impacts,

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[62] Alton, Larry. "The Secrets of Successful Silicon Valley Startups." *LiveAbout*, Dec. 2018, www.thebalance.com/what-is-silicon-valley-3305808.

[63] Lazo, Alejandro, and John D. McKinnon. "California Advances Net-Neutrality Rules in Rebuke to Trump FCC." *WSJ*, 30 Aug. 2018, www.wsj.com/articles/california-advances-net-neutrality-rules-in-rebuke-to-trump-fcc-1535669946?mod=article_inline

[64] Herrera, Sebastian, and Abigail Summerville. "California Fostered America's Tech Industry. It Is Becoming a Great Adversary." *WSJ*, 11 Aug. 2019, www.wsj.com/articles/california-fostered-americas-tech-industry-it-is-becoming-a-great-adversary-11565532002.

[65] California, State Of. *High Tech - California Governor's Office of Business and Economic Development*. www.business.ca.gov/industries/high-tech.

[66] Id

[67] Staff, History Computer. "The Largest Tech Companies in California." *History-Computer*, Aug. 2023, www.history-computer.com/largest-tech-companies-in-california.

[68] Id

reinforcing California's status not only as a technological powerhouse but also as a steward of responsible innovation. The state's commitment to environmental sustainability and diversity in tech further cements its role as a beacon for progressive tech policies, influencing global standards and practices

The Emergence of China in Platform Technology

China has always stood clear on its vision of becoming a global leader in technology. Like any war torn country, it was a journey for China to become a global leader in Science and Technology. The Government had strategically devised *Five Year Plans* (FYPs) to develop technological infrastructures for the country's economic growth, military expansion, and geopolitical advantage.

China's technological development can be said to be characterized by a strong '*state-led*' approach, where the Chinese government plays a major role in guiding and supporting the nation's technological aspirations. China has recently stated its goals to seek further strengthening of its state-led system to achieve breakthroughs of core technologies.[69] Attempting to improve its mechanism for strengthening the ruling Communist Party's leadership in tech innovations, the country is supposedly working towards harnessing the advantages of being a socialist system and unveiling a 'new whole-nation system.' [70] This concept signals pooling national resources together, reducing foreign dependency, promoting self-reliance, and active involvement of the political system.

The leadership in the country has continued using state interventions to encourage and sustain the growth of private sectors for emerging new technologies. The world has already realized the potential of technology and the Governments across the world are leaving no stone unturned to be a part of this technological revolution. Although the standardization process may look like a collaborative effort between the state and the private sector, on a closer look, the party-state is actually involved at every decision-making stage, where the final decision clearly lies with the state.[71] China's initiatives like 'Made in China 2025' and 'Standards 2035' advance on its aim of reducing its reliance on foreign tech imports, and become a leader in the domestic and international arenas.

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[69] Reuters. "China to Strengthen State-led System in Core Tech Breakthroughs, Xi Says." *Reuters*, www.reuters.com/world/china/china-improve-mechanism-core-tech-innovations-state-media-2022-09-06.

[70] Id

[71] Gargeyas 25, A. (2023) *China's '2035 Standards' quest to dominate global standard-setting*, *Hinrich Foundation*. Available at: https://www.hinrichfoundation.com/research/article/trade-and-geopolitics/china-2035-standards-project-restructure-global-economy/. (Accessed: 12 October 2023).

The History of Technological Development

Sparing no chances to emerge as the global leader in technology, China began intensively building on technological capacity. In the 1980s, the country started piecing together a strategy to build on manufacturing capabilities and cost innovation in major product categories.[72] The next course of action for them was to enhance acquisition of foreign intellectual property (IP), accompanied by reverse engineering.[73]

Beginning from the late 1990s, China tried to maximize technology transfer through Foreign Direct Investment (FDI) by encouraging MNCs to conduct their R&D in China.[74] However, when MNCs realized that IP would be compromised, they were hesitant to introduce new technologies, after which China decided to increase its efforts at technological upgradation, indigenous innovation, takeover foreign firms, and build their brand image, thus expanding their share of global markets. [75]

In 2006, the Chinese government introduced its 'National Program Outline for Medium and Long Term Development of Science and Technology' (2006-2020), the key pillars of which included: [76]

- Indigenous innovation
- Leap forward in key areas
- Sustainable Development
- Setting the stage for future

This action plan called for increasing R&D in priority areas such as; ICT, biotechnology, nano-sciences and nanotechnologies, materials and energy, etc.

China's dominance in the technology sector was a gradual process that took almost three decades of strategizing, innovation, and investment by the Government. In the 11th five-year plan (FYP) period, the government's expenditure on Science and Technology increased by 22% per year and in 2010, R&D accounted for 1.75% of the GDP.[77]

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[72] https://www.worldbank.org/content/dam/Worldbank/document/SR2--161-228.pdf

[73] Id

[74] Id

[75] Id

[76] Id

[77] Id

The pathway to strengthening the digital technology environment has been consistently developed by the Government in their consecutive 5-year plans. The 12th FYP saw innovation and technology development, where the key priority areas were:[78]

- Strategic industries- environmental protection, next-generation IT, biotechnology, high-end manufacturing, new energy, new materials, and clean energy vehicles
- Promoting enterprise led innovation
- Strengthening supporting services
- Increasing the expenditure on R&D to 2.2% of GDP
- Increasing the rates of patenting to 3.3% per 10,000 people

China experienced massive growth in mobile networks from 2006 to 2010. In 2010 there were 860 million users, which was an increase of 460 million users from 2006; while 450 million people had access to broadband services in the same year, which was more than the population of the US in 2010.[79]

Here are some of the key indicators which pointed towards China's future in the tech industry:[80]

- Full-time R&D personnel tripled from 0.75 million to 2.3 million people
- In 2008, the total number of people engaged in Science and Technology activities reached 4.97 million
- From 1996-2000, China's global SCI ranking measured in publications went from 14th place to 2nd place.
- The output of publications increased from 20,000 in 1998 to 112,000 in 2008, which was equal to 8.5% of the global output of scientific publications.
- As per the study conducted by Britain's Royal Society from 2004-2008, China produced one-tenth of the published scientific articles and secured second place, trailing behind the US.
- Chinese research publications lead in areas like; Science, Physics, Chemistry, and Mathematics
- From 1995-2006, the patents granted to Chinese enterprises increased from 5,386 in 1995 to 76,379 in 2006. In the same series, the number of patent applications with WIPO increased from 23,000 in 1996 to 290,000 in 2008. Although the quality of patents and innovation is also an important criteria, this increase in numbers, if nothing else, at least signifies the emergence of China in the global technology sector.

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[78] Id

[79] Id

[80] Id

- ➢ Chinese companies started performing well in the areas of auto assembly, PVCs, biopharmaceuticals, nanotechnology, stem cell therapeutics, high-speed trains, telecommunication equipment, wind turbines, single-aisle passenger aircraft, supercomputers, space satellites, internet, etc.

Dominance of China and its Key Industries

China's path to dominance didn't happen overnight. The country transformed its reputation from being 'copiers' to 'originators', challenging the hegemony of the West. Similar views were reflected by Rebecca Fannin in her book 'Tech Titans of China,' examining Chinese tech, startup and investor dynamics.[81] She writes,

> *"In less than two decades, China tech innovation has evolved and gone through three phases of development: from copy to China, to invented in China, and now today, the biggest trend to watch is copied from China."*[82]

Classifying the development of technology as 'waves and series of transformation,' the following pictorial representation explains it better:

[81] Rao, Madanmohan. "From Dominance to Disputes: The Rise of China's Technology Giants." *YourStory.com*, Sept. 2020, https://yourstory.com/2020/09/china-tech-titans-dominance-disputes.

[82] Id

TABLE 1: THE RISE OF CHINA'S TECH TITANS	
Wave 1	BAT giants (Baidu, Alibaba, Tencent). Sector dominance, ecosystem moats, innovation, expansion via acquisitions, investments in Silicon Valley startups.
Wave 2	XTMD (Xiaomi, Toutiao, TikTok, Meituan, Didi Chuxing). Riding the wave of the 'mobile first' generation; innovative business models powered by AI.
Wave 3	AI, electric vehicles, drones, robotics, e-commerce, sharing economy. 'Master Plan for AI Dominance.' Hardware accelerators, AI funds.
Chinese investors	Focus: from clones and local players to globalising firms. Investments in China, Silicon Valley, rest of Asia. Dampeners: disputes, regulations.
Political dimensions	Protectionism, IP theft, data sovereignty, security, trade disputes, supply blockages, visa restrictions, surveillance, censorship; battle for tech leadership.

Source: YourStory

Although countries like Japan, South Korea, and Taiwan have well developed technological infrastructure, the US was the leading force. For the Asian community or rather developing countries, the growth of China came as a direct threat or challenge to the Western hegemony.

China's relentless pursuit of technological supremacy is increasingly characterized by significant breakthroughs in artificial intelligence, 5G technology, and digital infrastructure, marking 2023 as a year of robust technological ascendancy. The nation's strategic emphasis on self-reliance in core technologies has spurred innovations that challenge global norms, propelling Chinese platforms onto the international stage. Yet, this rapid advancement underscores a growing need for a global dialogue on cybersecurity, data governance, and international cooperation in technology standards. As China positions itself as a global tech leader, the implications for global market dynamics and geopolitical relations invite a reevaluation of collaborative and competitive strategies in the digital age.

The Growth of BBAT

BBAT is an acronym for Chinese technology giants: Baidu, ByteDance, Alibaba, and Tencent. Collectively, these companies represent China's significant technological advancements and market

influence. The Chinese government's state-led model has played a crucial role in nurturing these companies by creating a protective environment that restricts foreign competitors. This strategic approach has enabled BBAT companies to flourish domestically and expand globally.

Baidu

Baidu Search stands out as the widely used search engine in China.[83] The popularity of Baidu in China can be attributed to several factors, one such factor if understood from the perspective of China it would be to use the Chinese language. Baidu understands the users better than Google can because the search engine understands their local language and gives relevant results to Chinese users.

In 2001, the company introduced its website: Baidu.com, and used the website to sell advertising space before Google came up with their Pay per click (PPC) campaign. [84] The website allowed people to bid for advertising space and then Baidu will be paid every time the advertisement is clicked[85]. Since then Baidu has expanded and emerged in other sectors as well such as Baidu Youa (e-commerce), Baidu Baike, Baidu MP3, and Baidu Zhidao (a Q and A platform for communities to interact).[86]

ByteDance

ByteDance, the parent company of the globally popular TikTok, has emerged as a significant force in the tech industry. Founded in 2012, ByteDance has rapidly expanded its influence through innovative products that leverage artificial intelligence and machine learning to deliver personalized content. TikTok's success is a testament to ByteDance's ability to tap into global markets, attracting millions of users worldwide. The company's portfolio also includes the news aggregator Toutiao and various other apps that cater to diverse user needs, reflecting ByteDance's broad and adaptive approach to technology.[87]

Alibaba

With its branches extending to various sectors like e-commerce, cloud computing, AI, Alibaba Group is now emerging as a giant tech corporation.[88] Alibaba has been received very well by the Chinese

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[83] Id

[84] Williams, Janet. "The Baidu Success Story." *PromptCloud*, June 2023, www.promptcloud.com/blog/baidu-success-story.

[85] Id

[86] Id

[87] ByteDance: The Rise of TikTok's Parent Company," Financial Times. Accessed May 2024.

[88] Chen, James. "BATX Stocks." *Investopedia*, Oct. 2022, www.investopedia.com/terms/b/batx-stocks.asp.

Government during its inception. Founded in 1999, the company has grown with a market capitalization of over $500 bn (as of May 2023).[89]

Based on a platform-based approach, Alibaba operates a number of platforms such as Taobao, Tmall, and Alipay, enabling business to customer connections and transaction facilitations. [90] Due to this particular approach, Alibaba has started to emerge as a one-stop shop for businesses, eliminating their need to invest in their infrastructures by providing them one. [91] By building such a powerful ecosystem of a network of businesses and customers, the company benefits from its high revenue generation through these platform-based services in the form of advertising and transaction fees. [92] This way, Alibaba is turning out as one of the growing leaders in the e-commerce industry. [93]

Tencent

Tencent is being best recognised as the most used social networking platform, especially a messaging platform, in China. [94] Founded in 1998, this technology company has today become the international powerhouse, with its products like WeChat and QQ, and games like Honor of Kings and League of Legends, attracting billions of users globally. [95] Providing services like social media platforms, online gaming services, digital payment system, and cloud services, it is now being recognised as the world's most powerful and innovative companies. [96]

Xiaomi

While Baidu, ByteDance, Alibaba, and Tencent dominate various sectors of the technology market, Xiaomi's inclusion in BBAT reflects the comprehensive reach of Chinese technology firms across different areas of digital innovation. Xiaomi specializes in the development of high-tech smart devices, including smartphones, smart homes, and smart TVs. [97] According to Canalys, Xiaomi has

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[89] Magazine, Isn. "Why Alibaba Is Such a Success Story?" *International Supermarket News*, 31 May 2023, www.internationalsupermarketnews.com/why-alibaba-is-such-a-success-story/#:~:text=How%20Alibaba's%20Innovative%20Business%20Model,capitalization%20of%20over%20%24500%20billion.

[90] Id

[91] Id

[92] Id

[93] Id

[94] Chen, James. "BATX Stocks." *Investopedia*, Oct. 2022, www.investopedia.com/terms/b/batx-stocks.asp.

[95] Sen, Manish. "Tencent Company Success Story - TheCconnects." *TheCconnects*, 27 June 2023, www.thecconnects.com/tencent-company-success-story/#:~:text=Sohu-,Company%20History%20%26%20Growth%3A,social%20media%2C%20and%20payment%20app.

[96] Id

[97] Chen, James. "BATX Stocks." *Investopedia*, Oct. 2022, www.investopedia.com/terms/b/batx-stocks.asp.

maintained its No.3 ranking in the global smartphone market. [98] It has also ranked No. 1 in brand loyalty in the Android smartphone brands market in China for two consecutive years now. [99] With a continued acceleration in its growth rate, it has now become a global Internet of Things (IoT) Powerhouse.

Despite being primarily known for its hardware, Xiaomi's business model, which integrates hardware, software, and internet services, aligns with the expansive and innovative approaches of Baidu, ByteDance, Alibaba, and Tencent. Xiaomi's extensive IoT ecosystem and its global market reach demonstrate its significant role in China's technological landscape, warranting its inclusion in BBAT as a key player alongside its peers.

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[98] "Xiaomi Global Home." *Mi Global Home*, www.mi.com/global/discover/article?id=2905.

[99] Id

India’s Digital Innovations

Background

Science, technology, and innovation has played a key role in the upliftment of India's social and economic status. The big tech platforms in India depict a dynamic picture of a rapidly evolving landscape within the country’s digital ecosystem. Encompassing a wide range of services including e-commerce, digital payments, social media, etc, these platforms play a key role in reshaping the peoples’ ways of communicating, conducting businesses, accessing information, and an overall way of living.

The Chinese state-led approach has its own drawbacks and concerns. From exercising strict control over the country’s internet and online content, to lack of privacy and transparency, the protectionist approach of the Chinese government over its big tech platforms makes it less appealing to be adopted by other countries. Their authoritarian reach over the country’s tech industry, terms it as controversial and lowers the likeliness of its features to be espoused by other nations with respect to their tech ecosystems.

India chose not to replicate China’s model into their agenda for technological transformation. This is attributed to a list of factors, such as prioritizing individual freedom, free expression, and rule of law, which sit in contract with China’s model. Keeping in mind India’s cultural and historical background, combined with its diversity and pluralism, leaning towards deep state-ownership would not be the optimum alternative.

India’s developmental graph for technology has been singular in its own way. Having different historical experiences, economic systems, and national interests, India opted for a rather interventionist model, as compared to the light touch regulatory approach of the U.S.. The U.S. allows for its market to determine their direction for the tech industry. With its high global presence and limited direct governmental involvement, the U.S. model for Big Tech is infamous for being non-inclusive and prohibitive, leading to ethical and environmental concerns. Due to these concerns, India did not adopt USA’s strategy regarding its Big Tech development.

Being committed to addressing issues about data security, digital sovereignty, and protecting its domestic data, India kept in mind its large population, huge digital divide and economic disparities early

on. With the vision of meeting the dual goals, i.e., technological success and combating the deeply rooted socio-economic divide, India decided to implement a model that would carefully balance these both.

Therefore, India attempted to develop a distinctive model that would cater to the country's social, political, and economic situation. The idea was to create an ecosystem where its private-owned companies would most definitely thrive, whilst meeting with necessary regulatory laws of the government. The Indian government made clear stands on allowing private companies to be the main drivers of innovation and growth in this domain, while also balancing the socio-economic goals for a more holistic development. This has led to the rise of prominent Indian tech players in the digital sector at a global level. India's startups and tech companies are today successfully gaining global recognition for their contributions to the digital space and the tech world.

Historical Background

The technological transformative journey in India can be examined in two parts, the pre-liberalisation period i.e., before the 1990s, and the post-liberalisation period i.e., after the 1990s. [100] Immediately after India gained her independence, the leaders of the country decided to experiment with socialism, which continued for at least the next four decades. [101] This period kept the foreign capital as well as technologies out, and tried shifting all focus on indigenous innovation and technology creation.

It was because of these certain decisions, India's economic growth rate was stagnant and didn't start growing until the 1990s. It was when the government introduced the New Economic Reforms, which amongst many goals, aimed at encouraging the participation of the private sector in accelerating the country's developmental process. By this time, due to previous lack of foreign capital and technology, the local companies in the country were small in scale, size, and resources. Consequently, businessmen and entrepreneurs started inclining towards undertaking small-scale projects, using indigenous technology (well enough to act as import substitutes), but huge capital efficiency and gains. [102] India was resource, budget, and research deficit, but had great ambition, inspiration, and an innovation-driven mindset, which ignited its technological innovation and success. [103]

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[100] "India's Technology Journey - R A Mashelkar." *R A Mashelkar*, 12 July 2022, www.mashelkar.com/articles/indias-technology-journey/#:~:text=India%20developed%20diverse%20missiles%20and,Take%20nuclear%20energy.

[101] Id

[102] Id

[103] Id

In the year 1999-2000, the IT sector in India witnessed a growth of over $5.7 bn, with a stable annual growth of 50% since 1991. [104] It was during this time, the legalities for the Information Technology Act, 2000, were laid down, focusing on electronic transactions and e-commerce. [105]

The internet was opened for commercial use in India in the early 1990s. [106] It was from this period onwards, that B2B online portals, online stores, and other such sites began being set up. [107] Around 2005, there was a sharp shift in consumer lifestyle, where convenience started acting as a key catalyst in decision making. [108] This period marked the beginning of the era of e-tailing, revolutionizing B2B and B2C sales of products and services. [109]

Post 2007, the new age of e-commerce was initiated. [110] A number of start-ups stepped into the Indian e-commerce market, including companies like Flipkart, Myntra, Snapdeal, Infibeam, etc. [111] Ever since this period, the revenues and numbers for the Indian e-commerce sector have kept on increasing. Some factors for the growth of online commerce include: [112]

- Increasing internet penetration
- Online payment systems
- Positive user experience
- Wider product range compared to the bricks and mortar retailers

Having introduced many socio-economic programs for people's welfare, India faced huge challenges in identification of beneficiaries. [113] Due to inadequate identity records and verification processes, tremendous amounts of resources would be wasted and not meet the intended beneficiaries.

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[104] Diengdoh, Namrata. "THE PAST, PRESENT AND FUTURE THE IT INDUSTRY IN INDIA." *Medium*, 10 Dec. 2021, www.medium.com/@namratadiengdoh/the-past-present-and-future-the-it-industry-in-india-dff75ec999f8#:~:text=THE%202000s,growth%20of%2050%25%20since%201991.

[105] Id

[106] Karunakar, B., and Bisheswar Sinha. "E-commerce in India: evolution and growth." *International Journal of Management Research and Business Strategy* 5.3 (2016).https://www.researchgate.net/profile/Karunakar-B/publication/329238151_E-Commerce_in_India_Evolution_and_Growth/links/607aec1c907dcf667ba82a74/E-Commerce-in-India-Evolution-and-Growth.pdf.

[107] Id

[108] Id

[109] Id

[110] Id

[111] Id

[112] Id

[113] "Aadhaar India - Case Study." *OECD,* 10 Feb. 2018. https://www.oecd.org/gov/innovative-government/India-case-study-UAE-report-2018.pdf.

[114] In this view, the Government of India introduced Aadhaar under the Aadhaar Act, 2016. [115] Built on a strong technology backbone, the Aadhaar system has evolved into a vital digital identity infrastructure. [116]

Some key trends witnessed in India's technological sector are: [117]

- According to the NASSCOM report, India is expected to take the total employee count to 5.4 Mn in FY 2023. [118] The country is continuously heavily investing in new talent hiring, skill development, and enhancing the skill pool in the tech domain.
- The government is focused on establishing an enabling policy environment, with favorable regulatory policies. With strategic initiatives like Digital India, Make in India, Start-up India, etc, the country has secured a pathway for a successful technological industry.
- To gain a competitive edge in the global tech market, India has been actively investing in developing and deploying digital solutions. By establishing Centers of Excellence (CoE), the government has envisioned to promote knowledge and expertise in emerging fields such as quantum computing, AI, and Internet of Things (IoT), enabling advanced data analysis, automation, predictive modeling, and optimization, which are key to revolutionizing the tech industry.
- India used its G20 presidency (2023) to induce discussions on cybercrime and cybersecurity amongst the member nations. Recognising the escalating risks of cyberthreats and the pressing need to enact stringent laws to counter them, India showcases its commitment to tackle the majority of these concerns through its recent Digital Personal Data Protection (DPDP) Law. This proves the country's vision of maintaining its citizens' privacy, security, and rights.
- The country has been witnessing increasing interest in electronic manufacturing, IT hardware, and Semiconductors, especially from global companies. India being a consumer-driven nation, is investing immensely in local manufacturing facilities.

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[114] Id

[115] Desk, Web. "Aadhaar Through the Years, a Quick Timeline." *The Week*, 26 Sept. 2018, www.theweek.in/news/india/2018/09/26/aadhaar-through-the-years-quick-timeline.html.

[116] *Aadhaar-Digital Biometric Identity Infrastructure | Ministry of Electronics and Information Technology, Government of India*. www.meity.gov.in/aadhaar-digital-biometric-identity-infrastructure.

[117] Lahiri, Raja. "India's Technology Industry: Driving GDP Growth, Employment, and Innovation." *Grant Thornton Bharat*, 17 Aug. 2023, www.grantthornton.in/insights/blogs/indias-tech-industry-driving-gdp-employment-and-innovation/#:~:text=With%20the%20surge%20in%20digitisation,the%20way%20for%20unprecedented%20growth.

[118] *Technology Sector in India 2023: Strategic Review | Nasscom*. www.nasscom.in/knowledge-center/publications/technology-sector-india-2023-strategic-review#:~:text=This%20year's%20nasscom's%20Strategic%20Review,over%20the%20past%20two%20years.

With a strong government support for digitisation, AI, and electronics & semiconductor manufacturing, India's technology domain is well-positioned to expect substantial growth and success within this sector in the coming decade. [119]

In the vibrant tapestry of India's digital evolution, 2023 stands as a year of significant milestones, with the nation embarking on ambitious projects aimed at digital inclusivity and technological self-reliance. The launch of the Digital India Bhashini project, aimed at breaking language barriers online, exemplifies India's commitment to harnessing technology for societal benefit. Moreover, the country's strides in developing a homegrown semiconductor industry underline a strategic shift towards technological sovereignty, reducing dependence on global supply chains. These initiatives, coupled with India's burgeoning startup ecosystem, underscore a holistic approach to digital transformation, prioritizing innovation, inclusivity, and sustainable development. As India continues to chart its unique digital journey, it emerges as a key player in shaping the global digital future, advocating for a balanced approach between technological advancement and societal good.

To understand India Stack, we must first know what *Digital Public Goods* (DPG) and *Digital Public Infrastructures* (DPI) are.

Digital Public Goods and Digital Public Infrastructure

Digital Public Goods (DPG)

The UN defines DPG as:

"open-source software, open data, open artificial intelligence models, open standards and open content" [120]

DPG comes from the economic concept of 'public goods', which are to be non-excludable and non-rivalrous. [121] In the era of digitisation, the context for public goods evolves into involving digital technologies like tools, systems, devices, and resources. These public goods can be used by an individual without limiting someone else's ability to do the same. [122]

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[119] Lahiri, Raja. "India's Technology Industry: Driving GDP Growth, Employment, and Innovation." *Grant Thornton Bharat*, 17 Aug. 2023, www.grantthornton.in/insights/blogs/indias-tech-industry-driving-gdp-employment-and-innovation/#:~:text=With%20the%20surge%20in%20digitisation,the%20way%20for%20unprecedented%20growth.

[120] *Digital Public Goods | Office of the Secretary-General's Envoy on Technology*. www.un.org/techenvoy/content/digital-public-goods.

[121] *Digital Public Goods » Digital Public Goods Alliance*. www.digitalpublicgoods.net/digital-public-goods.

[122] Id

DPGs are characterised by their open-source nature, which allows anyone to use, modify, and distribute the software or data. This openness fosters innovation, transparency, and collaboration. They operate on interoperable standards or specifications, ensuring that various systems and platforms can work together seamlessly. This interoperability is crucial for creating integrated and scalable digital ecosystems. Moreover, DPGs are designed to be accessible to everyone, including marginalised communities, thus promoting inclusivity and bridging the digital divide.

By being freely available, DPGs reduce the cost of technology adoption and implementation, making it easier for governments, businesses, and individuals to leverage digital tools and services. The open nature of DPGs enhances trust among users, as the transparency and collaborative development processes ensure robust security and reliability. Examples of DPGs include publicly available data sets that can be used for research, policy-making, and innovation; open-source software like Linux, which can be freely used and modified by anyone; and publicly accessible artificial intelligence models, allowing for widespread use and further development.

The significance of DPGs extends beyond mere accessibility. They are instrumental in fostering a culture of innovation and collaboration. Open-source software, for example, allows developers from around the world to contribute to and improve upon existing technologies, leading to more robust and versatile tools. Similarly, open data initiatives enable researchers to access vast amounts of information that can drive advancements in various fields, from healthcare to urban planning. This collaborative environment not only accelerates technological progress but also ensures that the benefits of such progress are widely shared.

Digital Public Infrastructure (DPI)

The UN defines DPI as:

> *"...a combination of (i) networked open technology standards built for public interest, (ii) enabling governance, and (iii) a community of innovative and competitive market players working to drive innovation, especially across public programs."*

DPI refers to a set of digital building blocks in the form of platforms, applications, and systems, predominantly functioning on interoperable standards or specifications. India has built its digital public goods as open data platforms for everyone to use—open and interoperable digital infrastructure. This leads to financial inclusion by providing mobile phones, bank accounts, and unique identities for all. It empowers users and gives them control over their data. Trust is the key factor for financial inclusion and development; the presence of the government as an intermediary enables this trust.

Features/ Aspects	Digital Public Infrastructure (DPI)	Private Platforms[123] [124]
Objective	- Public welfare & inclusivity - Universal access	- Profit maximization - User engagement & market dominance
Control & Governance	- Decentralized with public oversight - Transparent decision-making	- Centralized corporate governance - Business-driven decisions
Data Handling	- Open standards - Transparent data policies - Emphasis on user privacy	- Proprietary standards - Data monetization - Varied privacy practices
Economic Model	- Public funding & grants - Focus on sustainability	- Revenue-driven (ads, subscriptions) - Premium services & features
User Base	- Aims for universal access - No discrimination based on payment	- Often prioritizes premium users - May limit features for free users
Development & Innovation	- Collaborative & open-source - Public interest-driven innovations	- Competitive & proprietary - Market-driven innovations

Table: DPI and Private Platforms: A Comparative

[123] "Should We Regulate Digital Platforms? A New Framework for Evaluating Policy Options." Policy & Internet, Volume 10, Issue 3, September 2018, Pages 241-367. doi: https://doi.org/10.1002/poi3.177

[124] "The Platform Play: How to Operate Like a Tech Company." McKinsey & Company. Feb. 2019. www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the-platform-play-how-to-operate-like-a-tech-company.

Public infrastructures like transportation networks, electric grids, telecommunication systems, etc, are critical to our daily lives, and they also play a catalyzing role in social, economic, and political progress.[125] These infrastructures help create and deliver various public and private goods. [126] In today's era of rapid digitisation, a range of government to private services, activities, and goods, are mediated through digital systems. [127] With a global recognition for its significance, several countries have converged on three fundamentals of DPIs: [128]

1. Identity
2. Payments
3. Data management

DPI facilitates access to financial services for all, including mobile banking and digital payment systems. By providing control over their data, DPI empowers users and enhances trust in digital systems. DPI is designed to be scalable to serve large populations and sustainable to withstand challenges such as the COVID-19 pandemic.

The impact of DPI is far-reaching. In the financial sector, DPI enables secure and efficient transactions, reducing the reliance on cash and promoting digital payments. This shift not only enhances convenience for users but also contributes to greater transparency and accountability in financial transactions. In healthcare, DPI can facilitate the sharing of medical records and other health data, improving patient care and enabling more effective public health interventions. By standardising and streamlining these processes, DPI helps to ensure that digital services are accessible, reliable, and secure.

India Stack

India is one of the first countries to develop the three foundational layers of Digital Public Infrastructure (DPI), and called it the 'India Stack.' India stack is a collection of open Application Programming Interfaces (API), and DPGs, designed to enable a widespread access to these three fundamental layers of identity, data, and payment systems.[129] By integrating these three crucial components, India Stack not only facilitates seamless interactions between citizens and the state but also

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[125] Eaves, David, and Jordan Sandman. "What Is Digital Public Infrastructure? — Co-Develop." *Co-Develop*, www.codevelop.fund/what-is-digital-public-infrastructure.

[126] Id

[127] Id

[128] Id

[129] Harvard Business Review. "The Ups and Downs of India's Digital Transformation," May 6, 2019. https://hbr.org/2019/05/the-ups-and-downs-of-indias-digital-transformation.

promotes financial inclusion, transparency, and efficiency. The strategic implementation of India Stack underscores India's commitment to leveraging technology for societal benefit, creating a robust framework that supports both economic growth and social equity.

The foundation of India's DPI success lies in the collaborative synergy between government entities, the private sector, academia, and civil society. This model of collaboration drives innovation, ensuring that digital platforms are adaptable, resilient, and aligned with the diverse needs of the population. It highlights the strength of partnerships in navigating the complexities of digital evolution, providing a template for international cooperation in digital advancements.

India's approach to Digital Public Infrastructure (DPI) contrasts sharply with private platforms. While DPI aims for public welfare, inclusivity, and universal access with decentralized control and open standards, private platforms often prioritize profit maximization, user engagement, and market dominance with centralized corporate governance and proprietary standards. This fundamental difference underscores India's strategy to build a more inclusive and transparent digital ecosystem through initiatives like India Stack and UPI.

Some of the key components of the India Stack are Aadhaar, Unified Payments Interface (UPI), eKYC, and DigiLocker. [130]

Aadhaar

Aadhaar is a 12-digit unique individual identification number, serving as a proof of identity as well as a proof of address for Indian residents. [131] Establishing uniqueness of every resident based on their demographic and biometric, this number is issued on behalf of the Government of India. [132] Any individual being a resident of India and meeting the verification requirements laid down by the Unique Identification Authority of India (UIDAI), can apply for an Aadhaar. [133] This number can be used to avail a number of services including banking, mobile phone connections, and various other governmental and non-governmental services. [134]

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[130] *The Four Pillars of India Stack: Aadhaar, UPI, eKYC, and DigiLocker Explained*. www.myhubble.money/blog/the-four-pillars-of-india-stack-aadhaar-upi-ekyc-and-digilocker-explained.

[131] "What Is Aadhaar? - Unique Identification Authority of India | Government of India." *Unique Identification Authority of India | Government of India*, www.uidai.gov.in/en/16-english-uk/aapka-aadhaar/14-what-is-aadhaar.html.

[132] Id

[133] Id

[134] Id

Aadhaar was introduced to address the need for a universal digital identity for all residents, particularly those without any existing identity documents. The aim was to create a centralised system providing one definitive form of recognizable ID for all Indian residents. Aadhaar was conceptualised to ensure efficient, transparent, and targeted delivery of subsidies, benefits, and services. Today, 99% of Indian adults possess a universally accepted, seamlessly connected digital identity through Aadhaar, which serves multiple purposes across various sectors.

Aadhaar's unique identification system is based on biometric data, including iris scans and fingerprinting, ensuring the uniqueness of each identity. This system helps eliminate redundancies and prevents pilferage, ensuring that subsidies and benefits reach authentic beneficiaries. The inclusive design of Aadhaar allows easy access to government services without discrimination, with minimal human intervention. Moreover, Aadhaar's privacy-by-design architecture, framework, and protocols ensure the security of personal data.

To understand Aadhaar, eKYC plays an important role in identification and verification. eKYC is an automated process through which companies can undergo customer identity verification, through digital means. [135] It acts as a great alternative to the traditional process of requiring to go through physical documents. [136] Using technology, eKYC presents as a more efficient, scalable, and reliable solution to carrying out the process of KYC. [137]

In the context of rapid digitisation, the traditional KYC methods are generally slower and more complicated as compared to the other aspects included in the process of customer onboarding. [138] Traditional KYC required significantly more effort from both the customer and the institution's side involving manually handling physical documents. [139] Not only does this slow down the process, but also increases chances of human errors, and barriers to inclusion. [140]

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[135] Cameron, Sarah. "What Is eKYC (Electronic Know Your Customer)?" *ComplyAdvantage*, 11 July 2023, www.complyadvantage.com/insights/what-is-ekyc/#:~:text=eKYC%20(electronic%20Know%20Your%20Customer)%20is%20the%20automated%20process%20through,evolved%20significantly%20in%20recent%20years.

[136] Id

[137] Id

[138] Id

[139] Id

[140] Id

eKYC on the other hand, leverages automated systems to expedite the KYC process, completing the process in a matter of minutes or hours, rather than days or weeks. [141] Offering substantial time and cost efficiency, eKYC provides businesses many advantages including enabling them to provide their customers with a low-effort and efficient KYC experience. [142]

Aadhaar facilitates various services across multiple domains, including telecom, health, KYC (Know Your Customer), skills, mobility, and food distribution. For instance, in the telecom sector, Aadhaar-based eKYC has streamlined the process of customer verification, reducing the time and cost associated with obtaining a new mobile connection. In healthcare, Aadhaar enables the secure and efficient management of patient records and facilitates the delivery of health services to remote areas. In financial services, Aadhaar-linked bank accounts and eKYC processes have significantly enhanced financial inclusion, enabling millions of previously unbanked individuals to access banking services.

The primary goal of Aadhaar was to reduce identity fraud, enhance financial inclusion, and improve government service delivery. Being a unique way of eliminating duplication and fake identities, Aadhaar is used as a primary identifier to roll out several Government welfare schemes and programmes. [143] This enhances effectiveness in service delivery, thereby promoting transparency and good governance. [144] Devoid of any profiling based on caste, religion, income, health, and geography, Aadhaar is used as a crucial strategic policy tool for social and financial inclusion, public sector delivery reforms, managing fiscal budgets, increasing convenience, and promoting hassle-free people-centric governance. [145] This way, the Government of India reaches the residents of India directly with respect to delivery of a list of subsidies, benefits, and services, using their Aadhaar numbers only. [146]

DigiLocker

Before the advent of DigiLocker, there was no central system for the issuance and verification of documents and certificates in a digital format, making it difficult for citizens to access important documents at their fingertips. The lack of a unified digital platform resulted in significant administrative overload for bureaucrats, who spent a considerable amount of time fulfilling physical document requests and verifications, leaving little time for governance. Additionally, the paper-based processes

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[141] Id

[142] Id

[143] Ravi. *State Aadhaar Portal*. www.aadhaar.rajasthan.gov.in/about-aadhar.aspx.

[144] Id

[145] Id

[146] Id

were unable to meet the unique needs and preferences of vulnerable and marginalized groups, as there was no way to facilitate e-KYC (Know Your Customer).

DigiLocker, famously known as 'document wallet', is a flagship initiative under the Digital India Programme, aiming at 'Digital Empowerment' of the citizens. [147] Being a secure cloud-based platform, DigiLocker enables users to share, store, and verify documents and certificates, such as PAN card, Voter ID card, driving licence, policy documents, etc.[148] This eliminates the need for physical documentation. [149]

DigiLocker offers several features that revolutionise document management and verification:

- **Digitization of e-Records and Documents:** DigiLocker allows for the digital issuance and storage of documents and certificates, making them easily accessible to citizens.
- **1GB Free Cloud Storage:** Each user is provided with 1GB of free cloud storage to store their digital documents securely.
- **Certified at Source:** Documents stored in DigiLocker are certified at the source, ensuring their authenticity and eliminating the need for physical verification.
- **e-KYC:** DigiLocker supports e-KYC, enabling electronic verification of identity for various services.
- **e-Sign:** The platform allows users to digitally sign documents using the e-Sign facility, further reducing the need for physical signatures and paperwork.

DigiLocker is revolutionising the system of document management. Ensuring document safety through robust encryption, it safeguards users personal information, and minimises the risk of fraud. [150] By providing a unique locker number for government agencies to efficiently verify one's identity, DigitLocker reduces the requirement of carrying and manually handling original documents. [151] Promoting paperless documentation, it emphasises streamlining document management, benefitting both the individuals and the institutions. [152]

Jan Dhan and the JAM Trinity

In 2011, only 58% of Indians had bank accounts despite decades of independence, highlighting a financially excluded society. The lack of financial inclusion was particularly pronounced among women and marginalised groups who did not have access to banking services. More than 60% of Indians had zero or no savings, and maintaining a zero-balance bank account was problematic. According to the World Bank's Findex Report 2014, 67% of respondents cited 'lack of money' as the primary reason for

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[147] Jain, Komal. "DigiLocker: What Is It? Steps to Open an Account, Benefits, Steps to Upload Documents." *BQ Prime*, 19 Aug. 2023, www.bqprime.com/technology/bqc-how-to-open-digilocker-account.

[148] "What Is DigiLocker: Advantages, Benefits and How to Use It?" *Digit Insurance*, 27 Oct. 2023, www.godigit.com/digilocker.

[149] Id

[150] Id

[151] Id

[152] Id

not having a bank account. Additionally, the paper-based KYC documentation process and high banking charges further hindered financial inclusion.

The Pradhan Mantri Jan Dhan Yojana (PMJDY), launched in 2014, marked a significant step towards financial inclusion. It aimed to provide every household in India with access to banking facilities, ensuring that even the most marginalised sections of society could benefit from financial services. Since its inception, over 510 million bank accounts have been opened under the Jan Dhan scheme. The share of zero-balance accounts has significantly decreased from over 60% in 2015 to 8.2% in August 2022.[153]

Jan Dhan has had a transformative impact on financial inclusion in India. By providing access to banking services, it has enabled a more equitable distribution of financial resources. The integration of Aadhaar for eKYC authentication has covered 99.9% of the adult Indian population, further streamlining the process of opening and managing bank accounts. The increase in smartphone penetration to 1 billion in 2023 has also facilitated greater access to digital financial services. According to a BIS paper, what India achieved in financial inclusion in nine years would have taken 47 years through traditional means.[154]

The JAM Trinity: Jan Dhan, Aadhaar, Mobile

The synergy between Jan Dhan, Aadhaar, and mobile technology, known as the JAM Trinity, has revolutionised the delivery of subsidies, benefits, and services. The JAM Trinity leverages the strengths of each component to create a robust and inclusive digital infrastructure.

- **Jan Dhan Accounts:** Provide the foundation for financial inclusion by ensuring that every household has access to a bank account.
- **Aadhaar:** Acts as a unique identifier, enabling efficient and transparent verification processes through eKYC. This has helped in reducing fraud and ensuring that benefits reach the intended beneficiaries.
- **Mobile Technology:** Facilitates access to banking and financial services, allowing users to manage their accounts and conduct transactions conveniently.

The JAM Trinity has enabled the government to directly transfer subsidies and benefits to the bank accounts of beneficiaries, reducing leakages and ensuring timely delivery. It has also empowered individuals by providing them with greater control over their finances and access to a wide range of financial products and services.[155]

Unified Payments Interface (UPI)

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[153] Press Information Bureau, Government of India. "Pradhan Mantri Jan Dhan Yojana (PMJDY) - National Mission for Financial Inclusion, completes nine years of successful implementation." August 28, 2023.

[154] Hindustan Times. "Pradhan Mantri Jan-Dhan Yojana crosses 500 million mark." Accessed May 2024.

[155] Arvind Gupta and Nipun Jain. "Technology in the Times of a Global Pandemic: Lessons from India." Global Policy Journal. Accessed May 2024.

Before the introduction of UPI, India's payments ecosystem faced several significant challenges. There was no common approach to paying for 'last-mile delivery' through general-purpose instruments, and separating identity verification from payments was difficult. High taxation on digital transactions discouraged both user adoption and merchant acceptance. Additionally, tax administration and audit requirements mandated paper receipts and records, adding complexity and cost to digital transactions. The payments system itself was fragmented, with no effective way to interconnect banks, and shared infrastructure, such as cell towers and agents, promoted exclusivity, limiting the expansion of mobile and financial services.

The National Payments Corporation of India (NPCI) is a 2008 not-for-profit organisation, introduced as an initiative by the Reserve Bank of India (RBI) and Indian Banks' Association (IBA). [156] It is entrusted with the responsibility to operate retail payments and settlement systems nationwide, aiming towards the goal of creating a nationwide standard for business and retail payments. [157]

NPCI developed Unified Payments Interface (UPI) in 2016, which is an application-based system facilitating funds transfer from one bank account to another, in real-time and round the clock. [158] It merges several bank features, provides seamless fund routing, and merchant payments all under one application. [159]

UPI recently achieved its new milestone of crossing the 10 Bn mark in September for the number of transactions in volume, whereas in terms of value, it stood at around 15,791 Bn.[160] In terms of Peer-to-Peer (P2P), the number of transactions was estimated at around 11,829 Bn for value, and 4.3 Bn for volume. [161] Similarly, for Peer-to-Merchant (P2M) transactions, the numbers stood at 3,962 Bn for value and 6 Bn in volume. [162] These numbers were however dwarfed by the subsequent months with December seeing over 12 Bn transactions.

UPI's design promotes interoperability, allowing users to link multiple bank accounts to a single mobile application, enabling transactions across different banks and payment systems. As of October

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[156] Parikh, Saurin. "National Payments Corporation of India: What Is NPCI &Amp; Its Services?" *Razorpay Learn*, 21 Aug. 2022, www.razorpay.com/learn/national-payments-corporation-of-india-services

[157] Id

[158] *Cashless India*. www.cashlessindia.gov.in/upi.html

[159] Id

[160] "UPI: Unified Payments Interface Product Review." *National Payments Corporation of India*. https://www.npci.org.in/what-we-do/upi/product-overview

[161] Id

[162] Id

2023, UPI has facilitated over 11,408.79 million transactions. This widespread adoption highlights UPI's ability to integrate a vast network of banks and payment providers, fostering a more inclusive financial ecosystem. Over 200 banks participate in UPI, and it supports hassle-free payments for visitors to India from abroad, demonstrating its international appeal.

India's vision is to provide an enabling ecosystem for the private sector to flourish. Amongst the many components of the India Stack, UPI is a critical part of this vision. As an enabling platform, it provides third party private companies like Paytm, GooglePay, etc, to establish their businesses on the forefront. UPI is a sort of public option provided by the GoI, in the sense that the public may have available options to make payments using any mode that they prefer. UPI is not here to replace cash, but is merely a more convenient and efficient option, aligning with the digitising values of the world today. Moreover, the public may still choose to not adopt UPI, and maybe use cards or cash to make payments. It is just a matter of shifting the inclinations of the people in an ecosystem which is being dominated by technology very rapidly, shaping people's preferences and perceptions.

UPI has also played a crucial role in preventing monopolisation in the digital payment space. By providing a common platform for various payment needs, UPI ensures that multiple private applications can operate on its infrastructure, promoting competition and consumer choice. The average Indian has about 40 fast payment apps to choose from, ensuring a diverse and competitive market for digital transactions.

There are various developments and upgrades within the UPI system to cater to the public in a much better and realistic way. These include:

- **Offline payments:** Payments using UPI do not require internet connection. These transactions can be done by dialling '*99#' on one's mobile device. [163]
- **Feature phone payments:** Also called '123PAY', feature phone users can now leverage the benefits of UPI payments. A UPI ID can be created by dialling *99#, and payment can be made by dialling 080451 63666. [164]

[163] Biswas, Sujaini. "Offline UPI Payment: How to Do UPI Payment Without Internet?" *Cleartax*, 24 May 2023, www.cleartax.in/s/offline-upi-payment.

[164] Maiti, Meghna. "Make UPI Payments Using Your Feature Phone: A Convenient Solution." *https://www.outlookindia.com/*, 24 May 2023, www.outlookindia.com/business/make-upi-payments-using-your-feature-phone-a-convenient-solution-news-288899

- **Voice payments:** This feature is known as 'Hello UPI', and is to be introduced very soon. Using voice-based inputs, users will now be able to make payments at the command of their voice. [165]
- **UPI Lite:** Also known as 'On-Device Wallet', is an efficient way of making small-value offline transactions, without using a pin. [166]

DBT: Leveraging Technology for Effective Delivery

The Government of India introduced the Direct Benefit Transfer (DBT) scheme to address the existing issues and improve the efficiency and transparency of benefit distribution. DBT aims to transfer subsidies and other financial benefits directly to the bank accounts of beneficiaries, thus eliminating intermediaries and reducing leakages.

Since its launch, DBT has become a game-changer in the delivery of government services. As of December 2023, over 1.66 billion beneficiaries have received benefits directly in their accounts across 314 government schemes. The total amount transferred directly to beneficiaries has exceeded $412.7 billion, with the government saving approximately $33 billion through reduced leakages and improved targeting of benefits.[167]

Key Achievements and Impact

- **Reduction in Leakage:** By transferring benefits directly to the beneficiaries' bank accounts, DBT has significantly reduced the leakage of funds that used to occur through middlemen and corruption.
- **Efficiency and Convenience:** Beneficiaries now receive their entitlements more efficiently, without having to waste time and money to collect them. This has particularly benefited marginalised groups and those living in remote areas.
- **Accurate Targeting:** The integration of Aadhaar and the creation of comprehensive beneficiary databases have improved the accuracy of identifying and delivering benefits to eligible recipients.
- **Enhanced Accountability:** DBT has enhanced accountability in service delivery, as the direct transfer mechanism is more transparent and traceable.
- **Real-time Governance:** The implementation of DBT has enabled real-time monitoring and governance, allowing for immediate feedback and improvements in the quality of public services and transfers.

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[165] Ray, Anulekha. "Hello, UPI: Use Voice Commands to Send Money, Pay Bills; Know New UPI Features and How They Work." *The Economic Times*, 7 Sept. 2023, www.economictimes.indiatimes.com/wealth/save/hello-upi-use-voice-commands-to-send-money-pay-bills-know-new-upi-features-and-how-they-work/articleshow/103464077.cms.

[166] "How to Do Offline UPI Payments With *99# Service." *BankBazaar*, www.bankbazaar.com/ifsc/upi-offline-payment.html.

[167] DBT Bharat. "DBT Dashboard." Accessed May 2024.

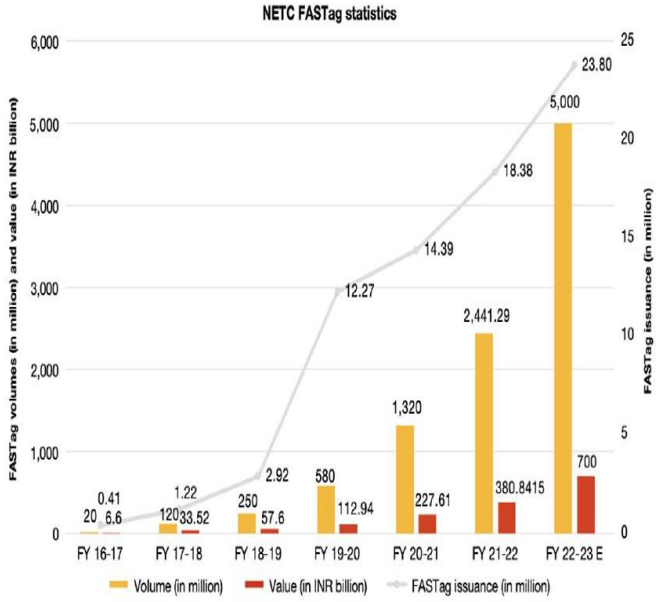
Examples of DBT Schemes:

- **Pradhan Mantri Kisan Samman Nidhi (PM-KISAN):** Provides income support to farmers.
- **Pradhan Mantri Ujjwala Yojana (PMUY):** Offers LPG connections to women from Below Poverty Line (BPL) households.
- **National Social Assistance Programme (NSAP):** Provides financial assistance to the elderly, widows, and disabled individuals.

FASTag: Enhancing Roadway Efficiency and Financial Transparency

The FASTag system, launched by the National Highways Authority of India (NHAI), represents a transformative step in modernising the toll collection process across India's vast network of highways. Employing Radio Frequency Identification (RFID) technology, FASTag automates toll payments, facilitating a direct debit from the vehicle owner's prepaid or linked bank account as they pass through toll plazas. This innovative approach ensures non-stop movement of traffic, significantly reducing congestion and waiting times at toll booths.

Introduced as a part of the Digital India initiative, FASTag aims to bolster digital financial transactions and promote the use of digital services across transportation networks. By January 2021, the installation of FASTag became mandatory for all new and existing vehicles, which underscores the government's push towards electronic toll collection systems that promise transparency and efficiency[168].



[168] National Highways Authority of India. 2019. "National Electronic Toll Collection." Accessed April 15, 2024. https://nhai.gov.in/nhai/national-electronic-toll-collection

The benefits of FASTag extend beyond simple conveniences; they include environmental advantages by reducing idle times and emissions at toll booths, and operational efficiencies that improve the lifespan of the roadway infrastructure. The system is interoperable across over 830 toll plazas and has been integrated with more than 40 banks, providing users a range of options for account linkage and top-ups. A penetration rate of around 97 percent. This widespread compatibility ensures that FASTag can be easily adopted by all vehicle owners across the country.

Furthermore, the implementation of FASTag has enabled precise and real-time toll revenue collections, providing NHAI with critical data to better manage and allocate resources for highway maintenance and expansion projects. As reported in 2024, the adoption of FASTag has led to a significant increase in electronic toll collection, evidencing the successful integration of technology in public infrastructure management[169].

Other Key Initiatives by the Government of India

India in the past few years has showcased a consistent sharpening of focus on the development and deployment of Digital Public Infrastructure (DPI), aiming to benefit both its citizens and the institutions. The country in recent years has also been experiencing a boom in internet and technological penetration. With the rapid rise in internet users and smartphone penetration, combined with increasing incomes, has accelerated the growth of India's e-commerce sector. [170]

Some key initiatives include:

- **Government e-Marketplace (GeM):**
  - Launched on August 9, 2016, GeM is an online platform for public procurement. The aim is to create an inclusive, efficient, and transparent platform for the buyers and sellers, in order to conduct procurement activities in a fair and competitive manner. In FY23, procurement on this portal crossed Rs. 2 lakh crore ($24 Bn) mark. [171]
- **Open Network for Digital Commerce (ONDC):**
  - With the vision to streamline the onboarding of retailers on e-commerce platforms, the Department for Promotion of Industry and Internal Trade (DPIIT) utilises the ONDC platform. This involves standardised protocols for cataloguing, price discovery, and vendor discovery. This initiative aims to provide fair and equal opportunities to all marketplace players to make the utmost use of the e-commerce system. [172]

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[169] National Highways Authority of India. 2024. "Press Release: One Vehicle One FASTag." Accessed April 15, 2024. https://nhai.gov.in/nhai/sites/default/files/2024-01/Press_Release-One_Vehicle_One_FASTag_0.pdf

[170] "E-commerce in India: Industry Overview, Market Size and Growth| IBEF." *India Brand Equity Foundation*, www.ibef.org/industry/ecommerce.

[171] Id

[172] Id

- **Open Credit Enablement Network (OCEN):**
  - OCEN operates through the consolidation and automation of various manual processes within the lending value chain. These processes include verifying the creditworthiness of the loan-worthy customers and facilitating the onboarding of new borrowers. By doing so, the overall operational expenses are immensely reduced, and the efficiency of these lending institutions also increases. [173] OCEN allows platforms and markets, called the Loan Service Providers (LSPs), to link with banks and non-bank lenders. It plays a big role in helping fill the credit gap amongst micro, small, and medium enterprises (MSME).[174]

Conclusion

Between two distinctly apart systems of the U.S. and China, India found its balance somewhere in the middle. Learning different lessons from both sides, India focused on curating a unique system that would fit its current social, political, and economic status, as well as its aspirations in each of these segments. Having experimented with socialism for a few decades, the country in 1990 decided to shift its mindset and open up to the world and its marketplace. Once the Government of India introduced the New Economic Policy, the newly liberalised country started taking more risks and exploring more avenues, allowing learning, falling, and getting back up faster and more confidently. This decision accelerated the process of growth and automatically began improving people's lives. It is the Government that has played a critical role in creating an environment that supports private entities in creating and innovating. The initiatives of the Government prove its commitment to enhancing the lives of its citizens through technology, promoting financial inclusion, and fostering transparent and efficient systems.

Today, India is emerging as a world leader in technology. The nation utilised its 2023 G20 presidency to promote serious discussions on the development and deployment of DPIs, while including important aspects like cyber threats and Cybersecurity, AI, data regulation, and digital financial inclusion. India has been at the forefront of a transformative digital revolution, with a series of

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[173] CredAble, Team. "What Is Open Credit Enablement Network (OCEN)?" *Credable*, 24 Feb. 2023, www.credable.in/insights-by-credable/what-is-open-credit-enablement-network-ocen.

[174] Dani, Aniket. "How Open Credit Enablement Network (OCEN) Will Accelerate Digital Lending." *ETBFSI.com*, 15 July 2023, www.bfsi.economictimes.indiatimes.com/news/fintech/how-open-credit-enablement-network-ocen-will-accelerate-digital-lending/101760985#:~:text=Open%20networks%20such%20as%20OCEN,between%20financial%20institutions%20and%20LSPs.

initiatives and programmes aiming at streamlining processes, empowering the citizens, and fostering economic growth. India is successfully drawing global attention.

As we reflect on the transformative journey of digital technology across the globe, India's pioneering role stands out, charting a course towards an inclusive and sustainable digital future. In 2023, India has not only continued to innovate within its digital ecosystem but also set global benchmarks in digital governance and technology deployment for societal benefit.[175] Through initiatives like India Stack, the nation has demonstrated the profound impact of harmonising technology with policy to empower citizens and foster economic inclusivity.

India's approach offers a blueprint for leveraging digital technology as a cornerstone of societal development, emphasising open access, security, and user empowerment. As the world navigates the complexities of the digital age, India's model serves as a beacon, guiding towards a future where technology enhances human life, bridging divides and nurturing global collaboration.

In closing, India's digital journey inspires a vision where technology transcends boundaries, ensuring benefits for all. It advocates for a collaborative global effort, drawing from India's example, to embrace technology's potential responsibly and inclusively.

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[175] Harvard Business Review. "How India Is Moving Toward a Digital-First Economy," November 8, 2017. https://hbr.org/2017/11/how-india-is-moving-toward-a-digital-first-economy?referral=03758&cm_vc=rr_item_page.top_right.

Expanding Horizons: The Evolution of Inclusive Payment Systems in India

Navigating the Maze of Financial Inclusion Barriers in India

Visa and Mastercard Duopoly

Visa and MasterCard duopoly has become synonymous with card payments across the world.[176] The duopoly of Visa and Mastercard had a substantial global impact, extending to India's burgeoning digital economy in 2010. Their widespread presence was marked by extensive transaction volumes and credit card circulation. Visa processed an enormous number of transactions and held significant market shares in the US, while Mastercard also maintained a considerable share of the global and US markets, with billions of transactions annually. These figures underpin their global might and the challenges faced by local markets, like India, where high fees and a lack of suitable infrastructure posed hurdles to financial inclusion and the acceptance of card payments. [177]

The dominance of Visa and Mastercard in the global payments landscape created several financial challenges, especially for emerging economies like India. Their high transaction fees posed a significant burden on both merchants and consumers, making digital transactions expensive. For many small businesses and low-income individuals, the costs associated with using Visa and Mastercard were prohibitive, leading to low adoption rates of digital payments. Additionally, the lack of infrastructure to support widespread card acceptance meant that many rural and remote areas remained financially excluded.[178]

The high fees charged by Visa and Mastercard not only impacted consumers but also created a substantial barrier for merchants, particularly small and medium enterprises (SMEs). These businesses often operate on thin margins, and the additional cost of card transaction fees could be significant enough to dissuade them from accepting card payments altogether. This situation further entrenched the reliance on cash transactions, which are less efficient and harder to trace, thereby contributing to the persistence of the informal economy.

Additionally, Visa and Mastercard's global dominance meant that local financial ecosystems were overshadowed, with little room for homegrown solutions to flourish. This dominance created a monopolistic environment where innovation was stifled, and the financial needs of diverse populations, particularly in emerging markets like India, were not adequately met. The reliance on these international

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[176] Westberg, Peter. “Visa and Mastercard: The Global Payment Duopoly.” Accessed May 14, 2024. https://quartr.com/insights/company-research/visa-and-mastercard-the-global-payment-duopoly.

[177] "Visa and Mastercard in India: The Competitive Landscape." Economic Times. Accessed May 2024.

[178] "The Impact of High Transaction Fees on Financial Inclusion in Emerging Markets." Journal of Financial Services Research. Accessed May 2024.

card networks also meant that a significant portion of transaction fees was funnelled out of the local economy, rather than being reinvested domestically.

The friction caused by these high fees and the cumbersome processes involved in card payments also discouraged consumers from adopting digital payments. The need for extensive paperwork and compliance requirements added layers of complexity and cost, making the process less attractive for both consumers and merchants. Moreover, the exclusivity of infrastructure necessary for mobile and financial services, such as cell towers and agent networks, created monopolistic conditions that inhibited new entrants and limited competition. This exclusivity led to increased costs for service provision, which ultimately were passed on to consumers, stifling the widespread adoption of digital payments .

Other Financial Barriers:

In addition to the duopoly, India's payment landscape faced several barriers that hindered the process of financial inclusion, and these issues became the driving force behind the eventual success of the Unified Payments Interface (UPI). The lack of a unified approach for last-mile delivery in financial services meant that customers faced inconsistent experiences, particularly in rural areas where establishing identity verification separate from payment procedures was challenging due to the absence of standardisation. This fragmentation within the banking sector led to difficulties in providing a seamless payment experience.

High taxation on digital transactions and a cumbersome payments administration process further discouraged the use of digital payments. The payments system at the time not only demanded extensive paper trails and receipts, thereby negating the efficiencies offered by digital payments but also levied high charges on digital transactions, dampening merchant and consumer enthusiasm towards digital payment adoption. The banking systems suffered from a lack of interconnectedness, making it nearly impossible to create a cohesive digital payments ecosystem. This disconnection between banks contributed to a fractured payments system that could not support a streamlined, country-wide digital payment strategy. Finally, the exclusivity of the infrastructure necessary for mobile and financial services, such as cell towers and agent networks, created conditions that inhibited new entrants and limited competition. This exclusivity led to increased costs for service provision, which ultimately were passed on to consumers, thus stifling the widespread adoption of digital payments .

Why UPI and RuPay Were Crucial:

The introduction of UPI and RuPay by the Government of India was crucial in addressing these financial barriers. UPI provided a platform that was not only cost-effective but also interoperable, allowing seamless transactions across different banks and financial institutions. This system was designed to be highly scalable and adaptable, making it easier for a wide range of users, from urban tech-

savvy individuals to rural residents with limited access to digital infrastructure, to adopt digital payments .[179]

RuPay, a domestic card payment network launched by NPCI, aimed to reduce India's reliance on international card schemes like Visa and Mastercard. By offering lower transaction fees and promoting local infrastructure development, RuPay helped in making digital payments more accessible and affordable for a broader population. This move was part of a broader strategy to create a more inclusive financial ecosystem that could support India's vast and diverse population. The success of UPI and RuPay demonstrated the potential of local innovation to solve local problems effectively, providing a model that could be replicated in other emerging economies facing similar challenges.[180]

The creation of UPI and RuPay also emphasised the importance of financial sovereignty and the benefits of keeping transaction fees within the domestic economy. By reducing dependence on international networks, India could ensure that more of the economic benefits of digital payments were retained domestically, supporting further investment and innovation in the local financial sector.[181]

An Introduction to the Unified Payments Interface (UPI)

With increasing digitisation and the inclusion of technology in almost all possible spheres of human life, developing reliable, secure, and efficient digital frameworks becomes an unquestionable necessity. India in recent years started realising the significance of developing technology in order to keep up with the global progress. It is with this aim that the nation began its journey of digital transformation while ensuring self-sufficiency and efficiency.

One of the important milestones in this journey is the introduction of the UPI. As a system developed by the NPCI, based on enabling multiple bank accounts into a single application, UPI has started to emerge as the next stop in electronic payments and digital services.[182] It is completely redefining the process of instantly transferring money from one bank account to another. Before the introduction of UPI as a payment method, transactions used to take place through cash, mobile/net banking, and credit/debit cards. Set up by the Reserve Bank of India (RBI) in 2009, NPCI works to facilitate the growth of digital payments in India. It is NPCI, in association with the RBI and Indian

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[179] "The Challenges of Financial Inclusion in India and the Role of Digital Payments." Global Policy Journal. Accessed May 2024.

[180] Mohammad Asif et al., "The Impact of Fintech and Digital Financial Services on Financial Inclusion in India," Journal of Risk and Financial Management, 2023.

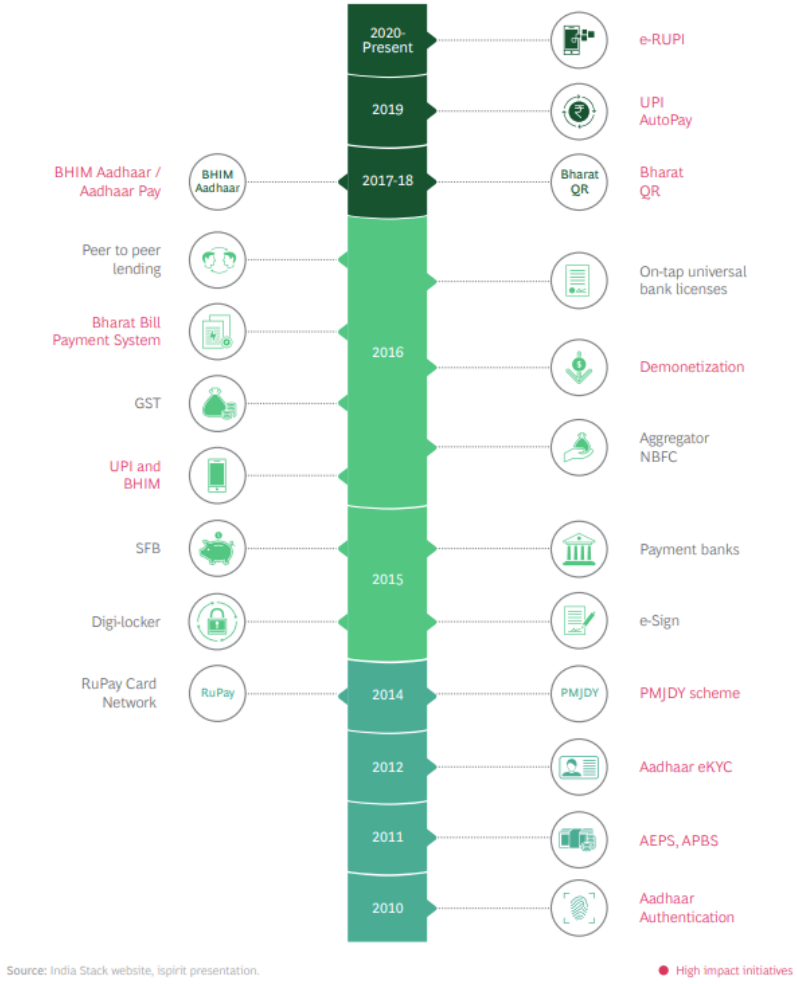
[181] Digital Innovation and Transformation. "Visa and Mastercard Are LOSING Fast to Indian Alternatives," February 11, 2020. https://d3.harvard.edu/platform-digit/submission/visa-and-mastercard-are-losing-fast-to-indian-alternatives/.

[182] "UPI: Unified Payments Interface Product Review." *National Payments Corporation of India*. https://www.npci.org.in/what-we-do/upi/product-overview (Accessed: 28 June 2023).

Banks Association (IBA), that created the UPI interface, the pilot of which was launched on 11th April 2016 by the then RBI Governor.

Indians are early adopters of digital payments, and based on a study conducted in 2021 by **People Research on India's Consumer Economy (PRICE)** and **NPCI**.[183] It was revealed that a third of Indian households across different economic sections of society use digital payments. Encompassing approximately 5,314 households in 25 states, the study revealed that about 40% of the country's households fall into the low-income category, whereas 20% belong to the high-income bracket. The research revealed that one-fourth of the low-income households use digital payments, in contrast to the half of the high-income households (refer to fig.1). This implies a notable difference in the adoption of digital payments between these two groups. While only 25% of the low-income households have adopted this mode, a higher proportion of 50% among the high-income households have embraced digital payments, which could potentially be due to factors such as access to technology, financial stability, and a possible familiarity with and trust on electronic devices and payments. The study also brought to light the suppressed demand of people who positively seek to adopt methods of digital payments, also called the 'ready' demand. This demand refers to people seeking to be guided properly on the usage and benefits of digital payment methods. Hence, if India is to tap into this potential through effective training and education, 151 million households (approximately 54% of all households) will turn into digital payment users, out of which 55 million of them will belong to the lowest income group of 40%.

[183] "Digital Payments well entrenched in Indian households across income groups, reveals PRICE and NPCI pan India Survey." *NPCI Press Release*. https://npci.org.in/PDF/npci/press-releases/2021/NPCI-Press-Release-Digital-Payments-well-entrenched-in-Indian-household.pdf (Accessed: 28 June 2023).



Revolutions in India's Financial Landscape[184]

[184] BCG Global. "Digital Payments in India Projected To Reach $10 Trillion by 2026: BCG and PhonePe Pulse Release Report on Digital Payments." Accessed April 16, 2024. https://www.bcg.com/press/2june2022-digital-payments-in-india-projected-to-reach-10-trillion-by-2026.

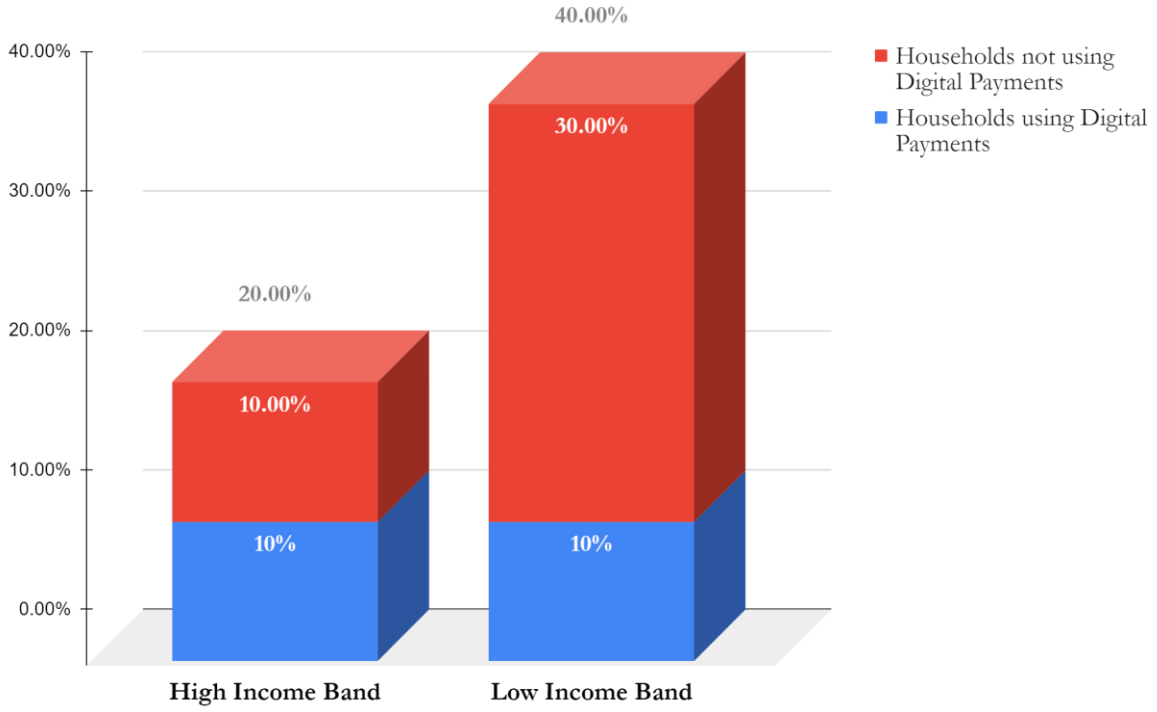


Fig. 1

Prior to the launch of UPI, non-cash transactions in India were less than desired. According to a secondary analysis by Mint,[185] Referring to data from the Bank for International Settlements (BIS), in 2015, non-cash payment transactions in India were limited to only 11 transactions per person. But, ever since the launch of UPI in 2016, non-cash transactions in India have immensely accelerated, drastically shifting the country's fintech landscape. In a research conducted by Bain & Company, it is expected that in the next three years, India would become a 50% non-cash economy in consumption, with approximately 350-400 million digital consumers.[186]

According to the **NPCI**. One of the many distinguishing features of UPI is its 'Peer to Peer' payment request, which can be carried out at the convenience of the parties. The other features are[187]:

- The transactions can take place around the clock, 24x7.
- A single mobile application can be used to access different bank accounts.

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[185] Kundu , T. "India lags peers in its bid towards a cashless economy." *Mint.* (2016) https://www.livemint.com/Industry/aTleRokAn7TAqa5ALnZZhP/India-lags-peers-in-its-bid-towards-a-cashless-economy.html. (Accessed: 28 June 2023).

[186] FP Staff. "India Expected to Become 50% Non-cash Economy in Consumption by 2026." *Firstpost*, 5 May 2023, https://www.firstpost.com/india/india-expected-to-become-50-non-cash-economy-in-consumption-by-2026-12550432.html#:~:text=India%20is%20expected%20to%20become,by%20the%20Financial%20Year%202026. (Accessed 21 Aug. 2023).

[187] "UPI: Unified Payments Interface Product Review." *National Payments Corporation of India*. https://www.npci.org.in/what-we-do/upi/product-overview. (Accessed: 28 June 2023).

- ➢ Single-click two-factor authentication (2FA), which refers to two layers of authentication, where additional information apart from the user's name and password is required to confirm the payment. This additional information in most cases is a one-time password (OTP) generated and received on the user's mobile phone. This feature adds a layer of security.
- ➢ It provides incremental security by using the virtual address of the customer for Pull and Push payments. A push payment is when the payer initiates sending the money to the payee, signifying that the payer is in control of the payment, including both the amount to be transferred and the end destination, whereas a pull payment is where the payee is in control, giving instructions to the payer w.r.t. sending money. But in this case, the payer is expected to give authorization beforehand.
- ➢ The best solution to on-the-spot transactions.
- ➢ Merchant payments are made easier through In-App or Single-Application Payment options.
- ➢ Increased convenience in paying utility bills, over-the-counter payments, etc. through UPI with the QR Code scanning and paying feature.
- ➢ Complaints can be raised directly from the mobile application.

The participants in the UPI interface include Payer Payment Service Provider (PSP), Payee PSP, Remitter Bank, Beneficiary Bank, NPCI, Bank Account holders, and Merchants.[188]

Understanding Payment Service Providers and Interchanging Fee in UPI

The United Nations Development Program[189] (UNDP) defines Digital Public Infrastructure (DPI) as "a critical enabler of digital transformation", referring to it as a shared means to many ends. The Government of India (GoI) has been constantly innovating the nation's DPI, and UPI is critical to the nation's DPI. So, before proceeding to understand UPI's advantages and evolution, it becomes imperative to understand the concept of the Payment Service Provider (PSP) fee and Interchanging fee.

In the words of Razorpay[190], a **Payment Service Provider (PSP)** is a SaaS-based service that primarily serves as an intermediary between businesses and customers, enabling digital payments via cards, bank transfers, and UPI. PSPs levy a fee for overseeing payment transactions and maintaining security. This fee is different for every PSP, with either fixed or variable structures. Some also charge setup and maintenance fees. Therefore, it becomes essential for businesses to evaluate these charges and

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[188] Id

[189] "Digital Public Infrastructure" *UNDP*. https://www.undp.org/digital/digital-public-infrastructure#:~:text=Digital%20public%20infrastructure%20(DPI)%20is,Digital%20Development%20Compass (Accessed: 29 June 2023)

[190] "MDR, PSP Fee & Interchange Fee- All Payment Fee Explained" *Razorpay.* https://razorpay.com/learn/what-is-mdr-psp-fee-switching-fee-interchange-fee/ (Accessed: 29 June 2023)

other related terms diligently when it comes to choosing a PSP so that any chances of pricey blunders are minimised. Businesses can discover what works best for them by researching and comparing different PSPs.[191]

So in other words, because these PSPs manage the processes involved in making the transaction successful, they charge a '**processing fee**' for facilitating and providing the service.[192] As mentioned by the Consultative Group to Assist the Poor (CGAP)[193] In 2019, India's Ministry of Finance revised the guidelines which prohibited charging any customer or merchant fee in the application. In August 2020, the Central Board of Direct Taxes (CBDT) asked banks to refund any fees they have charged for payments using UPI.[194] Many payment gateway service providers are still charging fees from merchants for enabling UPI, which is against the notification issued by the Government.[195] The CBDT has also directed a query to these payment service providers for imposing fees on UPI transactions.[196] The NPCI also removed payment service provider (PSP) fees in February 2020 for domestic UPI peer-to-merchant (P2M) transactions.[197]

Interchange fee is a fee which the merchant has to bear every time their customer swipes a debit or a credit card to make a payment. Recently, NPCI announced an interchange fee between 0.5% to 1.1% (depending on the merchant category codes) for all UPI transactions made through prepaid instruments, beginning from April 2023. So, if a customer digitally pays the merchant using a PhonePe QR code, the merchant will have to bear the interchange fee and pay it to the PSP, which in this particular case would be PhonePe. This fee is only applicable to a specific category of merchants with a sale of more than ₹2,000 per month, and not to any P2P or peer-to-peer merchant (P2PM) transactions. Peer-to-peer merchant (P2PM) is a new classification by the NPCI, referring to those small businesses with a monthly inward UPI transaction of less than or equal to ₹50,000.

Benefits of UPI

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[191] Id

[192] Id

[193] Cook, William. "Comparing India's UPI and Brazil's New Instant PaymentSystem, PIX." *CGAP*, 2 February 2021. https://www.cgap.org/blog/comparing-indias-upi-and-brazils-new-instant-payment-system-pix (Accessed: 29 June 2023)

[194] Shetty, Mayur. "*Payment gateways still charge for UPI, RuPay.*" The Times of India, 13 January 2021. https://timesofindia.indiatimes.com/business/india-business/payment-gateways-still-charge-for-upi-rupay/articleshow/80241228.cms (Accessed: 29 June 2023)

[195] Id

[196] Id

[197] "*UPI- Unified Payments Interface- Registration, Login, Transactions*." *paisabazaar*. https://www.paisabazaar.com/banking/upi-charges/ (Accessed: 29 June 2023)

According to the NPCI, the advantages of using UPI payment methods vary for different participants- banks, customers, and merchants.[198] For the **Merchants**, the benefits would be as follows:

- ➢ Payment is seamlessly collected from the customers, through single and unique identifiers as UPI IDs.
- ➢ Storing the customer's Virtual Payment Addresses (VPAs), which is a unique identifier/ID linked to the user's UPI account, is no longer a requirement. In this way, the financial details of the user are protected.
- ➢ The reach of businesses has also increased, including customers not using credit/debit cards.
- ➢ Best fitted for E-commerce and M-commerce transactions, where there are no longer troubles of cash payments.
- ➢ Cash on Delivery (CoD) collection has become hassle-free as many people choose to pay through UPI.
- ➢ Single-click 2-factor authentication and authorization of both direct pays (push) and collect pays (pull) transactions.
- ➢ Availability of In-App Payments (IAP), where the customers are not required to leave the application to make the payment.

However, the benefits that UPI provides for Customers are the reasons behind the spike in its popularity, some of which are –

- ➢ Availability round the clock, 24x7
- ➢ Multiple accounts can be accessed from a single application
- ➢ Single-Click Authentication
- ➢ Use of virtual ID instead of sharing financial credentials, which is more secure
- ➢ Complaints can be raised directly from the mobile app
- ➢ Facilities of In-App purchases

Rogers' Characteristics of Innovation Diffusion:

[198] "UPI: Unified Payments Interface Product Review." *National Payments Corporation of India*. https://www.npci.org.in/what-we-do/upi/product-overview (Accessed: 29 June 2023)

The Unified Payments Interface (UPI) stands out due to several key characteristics that have driven its widespread adoption and success. These characteristics align with Rogers' characteristics of innovation diffusion, which include relative advantage, compatibility, trialability, simplicity, and observability.[199]

- **Relative Advantage:** Technical Effectiveness
    - UPI offers significant technical effectiveness over traditional payment methods. It allows for instant, real-time money transfers between bank accounts, reducing the need for physical cash and minimizing transaction times.
- **Compatibility:** Mobile First
    - Designed with a mobile-first approach, UPI seamlessly integrates with the increasing use of smartphones in India. This compatibility with mobile technology has been crucial in its widespread acceptance.
- **Trialability:** Assisted Mode
    - UPI's assisted mode feature allows users to try the service with minimal risk. This feature enables users, especially those unfamiliar with digital payments, to receive guidance and support, making it easier to adopt the technology.
- **Simplicity:** Ease of Use
    - The platform's ease of use is a major factor in its adoption. UPI simplifies the payment process by requiring minimal steps to complete transactions, making it accessible to users across different age groups and technological proficiency levels.
- **Observability:** Efficiency and Zero Cost
    - The efficiency and zero cost of transactions through UPI are easily observable benefits that have driven its popularity. Users can quickly see the advantages of using UPI over other payment methods, leading to increased word-of-mouth recommendations and further adoption.

These characteristics collectively ensure that UPI meets the diverse needs of its users, offering a compelling value proposition that promotes trust and widespread usage. By addressing these key

[199] Rogers, Everett M. "Diffusion of Innovations." 5th ed., Free Press, 2003.

characteristics, UPI has successfully positioned itself as a leading digital payment platform that meets the needs of a diverse user base.

Growth of UPI in India

India has been experiencing exponential growth in UPI transactions ever since its launch in 2016. According to MyGovIndia's statistics, India topped the global ranking in digital payments in the year 2022.[200] UPI recently achieved its new milestone of crossing the 12 Bn mark in December for the number of transactions in volume.[201] For the month of September which taken as a representative month, based on the month-on-month statistics, the number of transactions rose by 8%, while the value of transactions grew by about 8.6%. [202]

The numbers depicted by NPCI paint a realistic picture of the citizens' evolving payment perceptions and behaviours. The formation of robust mobile networks and the availability of financially affordable entry points in India's mobile market have been key to building the foundations of technological evolution. UPI has simplified the process for all participants involved in the payments ecosystem. The major reasons for the widespread adoption of UPI can be attributed to the combination of speed, convenience, and appealing cashback. Additionally, regulatory support, interoperability, the introduction of Virtual Payment Address (VPA), and direct, instant bank transfers have played a pivotal role in the progress of UPI.

The addition of three fundamental features- **Innovation, Simplicity, and Inclusion**[203] has made UPI a household name in India. Previously, according to the business process rule, the user would have to submit debit instructions to the bank to withdraw any amount. But with the coming of UPI, third-party applications can collect debit instructions, and submit them to the account holder's bank through a secure backend system managed by NPCI.[204] The separation between the entity collecting permission for debiting a user's account and the bank has led to competition and innovation among

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[200] "India tops digital payments rankings globally, shows MyGovIndia data." *The Economic Times,* 10 June 2023. https://economictimes.indiatimes.com/industry/banking/finance/banking/india-tops-digital-payments-rankings-globally-shows-mygovindia-data/articleshow/100892312.cms (Acccessed: 25 July 2023)

[201] Sarkar, Gargi. "UPI Transactions Continue to Rise, Cross 11 Bn Mark in October." *Inc42 Media*, 1 Nov. 2023, www.inc42.com/buzz/upi-transactions-continue-to-rise-cross-11-bn-mark-in-october/#:~:text=the%20first%20time.-,UPI%20recorded%20over%201%2C141%20Cr%20transactions%20in%20October%2C%20with%20transaction,from%20INR%2015.8%20Lakh%20Cr.

[202] Id

[203] Hariharan, Venkatesh. "UPIs rapid growth proves India can build world-class payments infrastructure from scratch." *ThePrint*, 29 January 2020. https://theprint.in/opinion/upis-rapid-growth-proves-india-can-build-world-class-payments-infrastructure-from-scratch/355480/ (Accessed: 1 July 2023)

[204] Id

applications such as PhonePe, PayTM, Google Pay, Amazon Pay, and others, competing to become popular payment apps[205]. UPI was designed keeping the feature of '**interoperability**' in mind since day one, also making it a policy innovation, unlike the trajectory in cases of platforms like WeChat and Alipay, where it was enabled only after its rapid growth.[206]

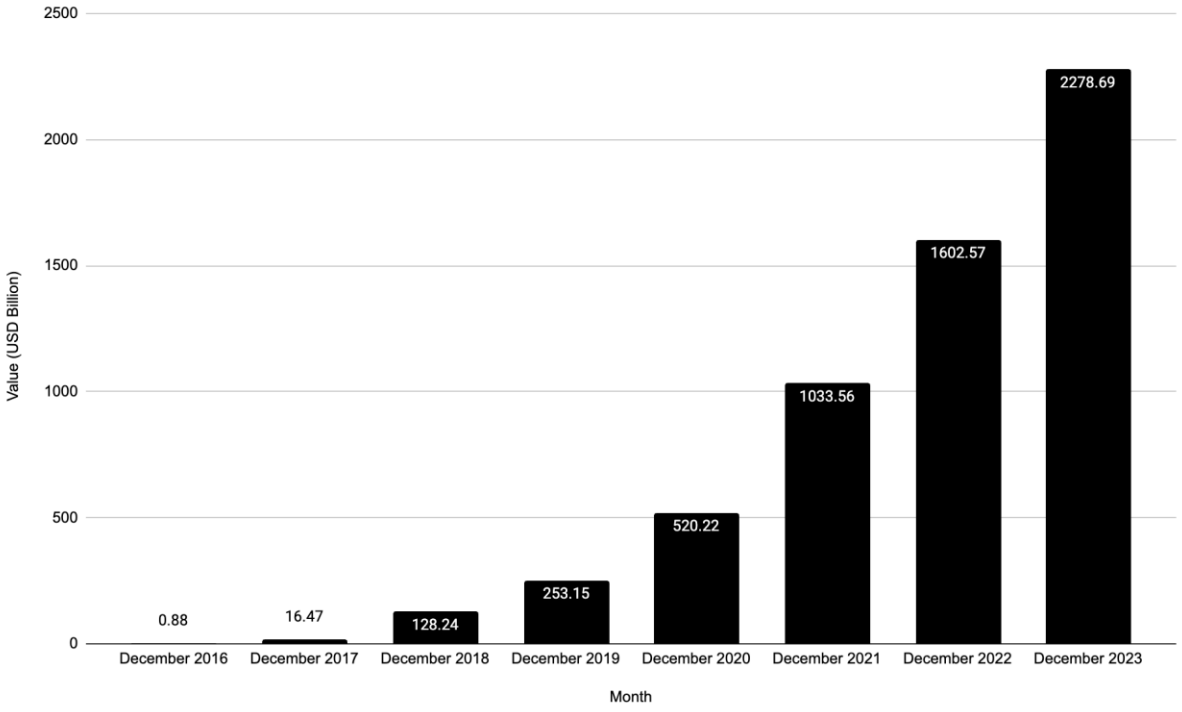

Fig. 2

The graph shown in Fig.2 illustrates the year-over-year (YoY) value of transactions conducted in the month of December, presented in terms of US billion dollars. The data clearly reveals a significant increase in the amounts transacted. Similarly, Fig. 3 depicts the YoY volume of transactions carried out in December, highlighting a notable surge in the number of transactions.

[205] Id

[206] Id

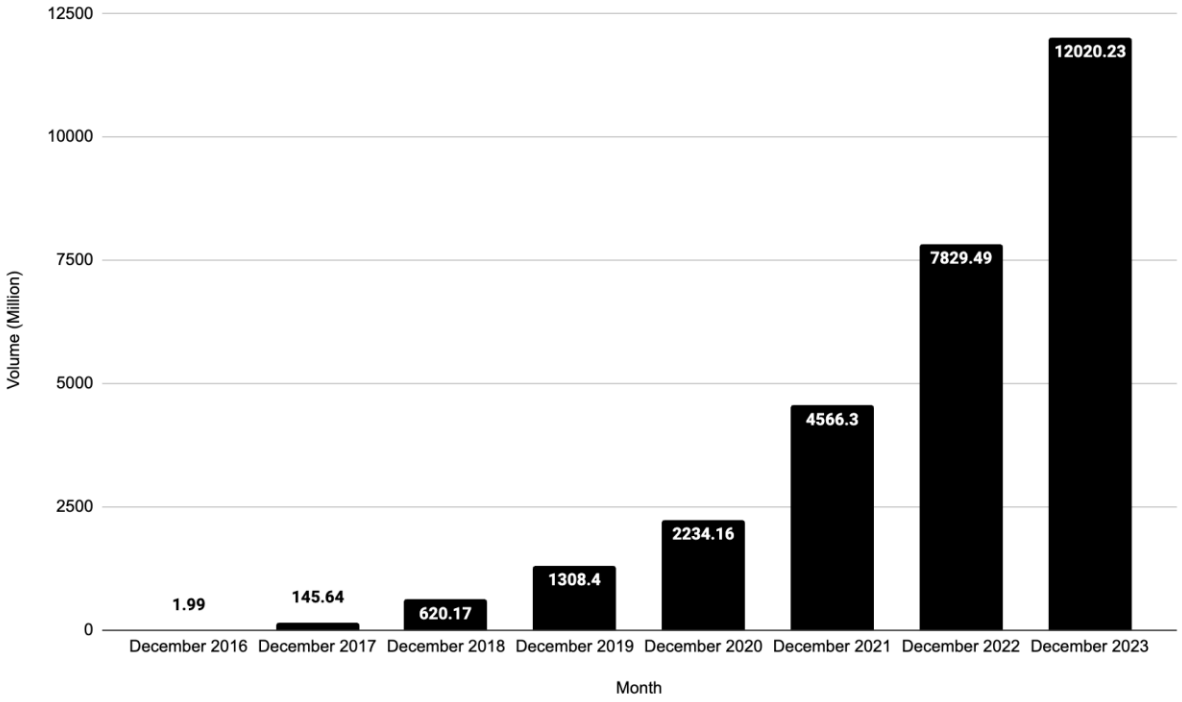

Fig. 3

Third-Party Application Provider (TPAP) in UPI

In the context of UPI, third-party applications are either standalone applications or add functionality to the existing parent program/application/system. Although the UPI ecosystem is designed for banks, other non-banking entities may also participate by developing Application Programming Interface (API) in the form of Third-Party Application Provider (TPAP). These apps are made in collaboration with the existing banking entity present on the UPI platform. By acting as a facilitator for transactions, these third party apps provide the users with the option to choose their preferred mode. When used during a transaction process, the app asks for permission to access the user's banking information from the linked bank app, where this request is authenticated by the user itself. By this process, the user's trust is ensured by keeping the operational and financial liability of the transactions with the bank. [207] Some of these third party apps include Amazon Pay, Bajaj Finserv, CoinTab, CRED, Google Pay, Make My Trip, MobiKwik, PhonePe, Samsung Pay, WhatsApp, YuvaPay, and Goibibo.[208]

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[207] "Third-Party Application Provider (TPAP)." *Optimize IAS,* 3 Dec. 2022, https://www.optimizeias.com/third-party-application-provider-tpap/#:~:text=in%20UPI.,customer%20to%20authenticate%20the%20request. (Accessed: 05-08-2023)

[208] "UPI 3rd Party Apps." *National Payments Corporation of India.*

Credit in UPI

Adding the concept of credit has transformed the credit landscape in the country. This initiative has extended credit services to users who might not have a credit history or good credit score, therefore providing accessibility of credit on UPI to enable users to obtain credit rapidly, and easily. Considering how micro, small, and medium enterprises (MSMEs) struggle to obtain credit from traditional sources/lenders, credit in UPI acts as a ground-breaking initiative for them. This simplifies the process of acquiring finances, enabling them to expand their operations and job creation.[209]

RBI recently announced that users could now link RuPay, credit cards backed by the government, with UPI, which has the potential to transform the digital payments system in the country.[210] By enabling credit cards on UPI, users now have the choice to use their Line of Credit (LOC) for their transactions.

Advantages of UPI credit include:

- Instant credit approval by using the user's digital data, eliminating the need for paperwork or other proofs, saving time and effort[211]
- Reduction in borrowing costs, offering loans at cheaper interest rates and fees due to quick and smooth creditworthiness determination[212]
- Promoting financial inclusion by providing credit to underbanked groups and members who were previously unable to obtain loans, further enhancing the digital economy[213]

Nonetheless, a significant hurdle here is the constrained acceptance of this technology among merchants, with a considerable number still favouring traditional cash payments. Several reasons contribute to this trend, which include unreliable infrastructure, lack of awareness, and the comfort of familiarity with cash payments. This engenders a great sense of trust when compared to newer modes, in this case, UPI. Therefore, it becomes necessary to encourage MSMEs.[214]

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https://www.npci.org.in/what-we-do/upi/3rd-party-apps (Accessed: 3 July 2023)

[209] Jain, Riddhi. "Transforming India's Credit Landscape: The Game-changing Role of UPI Credit." *Times of India Blog*, 12 May 2023, https://www.timesofindia.indiatimes.com/blogs/voices/transforming-indias-credit-landscape-the-game-changing-role-of-upi-credit. (Accessed: 7 August 2023)

[210] Id

[211] Id

[212] Id

[213] Id

[214] Id

Recognizing the pivotal role of the government in motivating both retailers and consumers to embrace digital payment technologies, alternative approaches such as gentle nudges may come into focus.

The Nudge Theory and UPI

Based on the belief that people's behaviour and decisions can be influenced by external forces, Mr Richard Thaler introduced the Nobel Prize-winning concept of the 'Nudge Theory', where through gentle nudges and interventions, people's choices could be altered while maintaining their freedom of choice and control on decision-making. In other words, nudging is about encouraging, not forcing. Some of the main prerequisites of this theory, according to Thaler, are that the nudges should be transparent and clear, deceptive nudges should not be used, the individual's free will should be maintained, and the intention behind the nudge should be in the best interest of the one being nudged.[215]

It is believed that the risk factors associated with the use of credit/debit cards have created a space for the promotion of faster, safer, and beneficial UPIs and wallets. In order to encourage the shift to UPI, the users have been incentivised through rewards provided by apps such as Google Pay, Amazon Pay, Paytm, etc. In very informative research conducted by Carnegie Mellon University CyLab and the University of Michigan which studied the impact of nudge interventions in encouraging people to use mobile payments, the findings revealed that the test group which had access to 'education materials' as nudges adopted safer mobile payments than the control group which did not have similar access. The education materials broadly referred to increasing people's awareness about the security risks associated with other forms of payments and formulating plans to use mobile payment solutions. Hence, nudging could prove to be a useful method to encourage digital payments, where increasing awareness and informing about the risks associated could be the nudges.[216]

Inclusion and Trust

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[215] "How Nudge Theory Influences The Behaviour." *Communication Theory.* https://www.communicationtheory.org/how-nudge-theory-influences-the-behaviour/#:~:text=Thaler%20gave%20three%20principles%20to,whenever%20he%2Fshe%20feels%20like. (Accessed: 4 July 2023)

[216] Tkacik, Daniel. "Simple 'nudges' can encourage people to use a safer payment method." *TechXplore*, 19 August 2020. https://techxplore.com/news/2020-08-simple-nudges-people-safer-payment.html (Accessed: 4 July 2023)

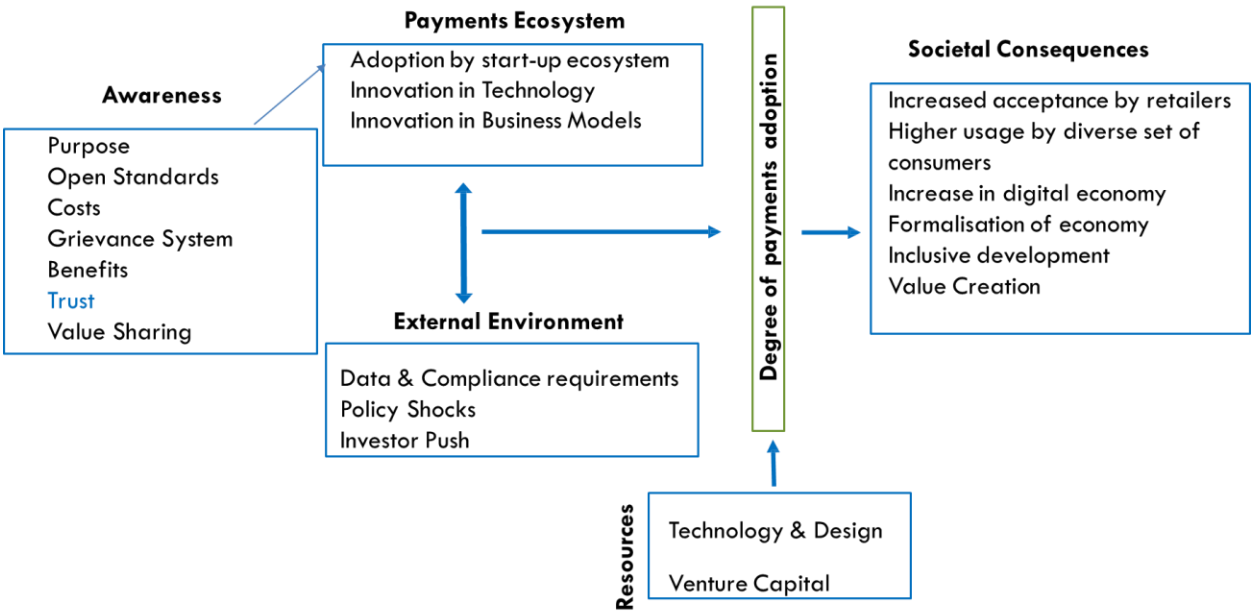

Fig. Trust Based Ecosystem

Digital access to financial services, without a medium cost, has immensely led to financial inclusion among different communities across the world. In India, UPI was introduced by the government as a major intervention with the aim of targeting and ensuring financial inclusion, especially amongst the weakest of the weak sections of the country. With the introduction of JAM (short for Jan Dhan-Aadhaar-Mobile) Trinity in the year 2014-15, as a stepping stone for increasing financial inclusion, a suitable framework was set up to empower and nudge people towards adopting digital financial practices. The launch of UPI in 2016, was the next big step in this journey. [217]

Trust in technology is a critical factor influencing the adoption and success of digital platforms.[218] Research indicates that individuals are more likely to adopt technology that demonstrates reliability, security, and positive user experiences. In the context of India's UPI, achieving high levels of trust has been paramount. The platform's transparent data policies, robust security measures, and user-centric design have fostered trust among millions of users. This trust translates into greater ecosystem

[217] Rastogi, Shailesh, et al. "Unified Payment Interface (UPI): A Digital Innovation and Its Impact on Financial Inclusion and Economic Development". *Universal Journal of Accounting and Finance*, vol. 9(3), pp. 518-530. DOI: 10.13189/ujaf.2021.090326

[218] Batya Friedman, Peter H. Kahn, and Daniel C. Howe, "Trust Online," Communications of the ACM 43, no. 12 (2000): 34-40.

value and more widespread financial inclusion, as users feel confident in the security and reliability of the platform.[219]

Trust in digital financial services can be perceived in the backdrop of a list of parameters. However, digital platforms being built on the government's back play a crucial role in amplifying people's 'trust' in this digital ecosystem.[220] [221]

Trust is a multifaceted concept in payment systems, encompassing various elements that contribute to the overall confidence users have in the technology. While there is no single definition of trust in payment systems, UPI has successfully invoked trust among consumers and retailers through its robust infrastructure and user-friendly features. UPI's trustworthiness is evidenced by its widespread adoption and the dependency of startups and venture capitalists on the platform for success. Policy makers are actively proposing UPI-based solutions to other nations, leveraging India's digital payments expertise as a form of soft power. Additionally, UPI's zero MDR (Merchant Discount Rate) regime for transactions below INR 2000 has resulted in significant cost savings, contributing approximately 0.1% to India's GDP.[222]

Various factors contribute to building and maintaining this trust among different stakeholders, including consumers, retailers, policymakers, and complementors. Key trust factors in UPI include human oversight, technical robustness, privacy and data governance, transparency, fairness and non-discrimination, societal impact, and accountability. Human oversight ensures that there is a human element involved in overseeing processes, which enhances accountability and responsiveness. Technical robustness means UPI's infrastructure is designed to be resilient and secure, ensuring reliable performance. Privacy and data governance emphasize protecting user data and managing it transparently, which helps build user trust. Transparency in operations and policies allows stakeholders to understand the system and how decisions are made, further enhancing trust.

Ensuring fairness and non-discrimination in access and use of the platform builds trust among all users, promoting inclusivity. Positive societal impact through financial inclusion and economic empowerment further reinforces trust in the platform. Clear accountability mechanisms ensure that any issues or discrepancies are addressed promptly, maintaining user confidence.

Although UPI may not perfectly meet every criterion for each stakeholder group, it provides a strong overall value proposition that enhances trust across the board. For instance, while consumers and

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[219] "Building Trust in Technology." Pew Research Center, 2023. Accessed June 12, 2024. https://www.pewresearch.org/internet/2023/04/07/building-trust-in-technology/.

[220] Id

[221] "Comparing India's UPI and Brazil's New Instant Payment System PIX." CGAP, 2 February 2021. https://www.cgap.org/blog/comparing-indias-upi-and-brazils-new-instant-payment-system-pix (Accessed: 29 June 2023).

[222] Financial Times. "India's Digital Public Infrastructure Revolution." Accessed June 12, 2024. https://www.ft.com/india-dpi.

retailers might prioritize technical robustness and privacy, policymakers may focus on human oversight and transparency. Complementors, on the other hand, value fairness, non-discrimination, and accountability. This comprehensive approach ensures that while individual trust factors may vary in importance among different groups, the overall framework of UPI effectively addresses the collective needs of all stakeholders, thus ensuring widespread adoption and trust in the system.

Factor	Consumers/Retailers	Policy	Complementors
Human Oversight		✓	✓
Technical Robustness	✓		✓
Privacy & Data Governance	✓	✓	✓
Transparency		✓	✓
Fairness & Non-Discrimination	✓		✓
Societal Impact	✓		
Accountability		✓	✓

Trust Factors in UPI

In addition to the trust factors previously discussed, Stahl's work on trust in digital environments provides further valuable insights. Stahl identifies several critical dimensions of trust that are particularly relevant to digital payment systems like UPI. These dimensions include competence, integrity, benevolence, and predictability. Competence refers to the system's technical capability to perform its intended functions effectively. Integrity involves the adherence to ethical standards and transparency in operations. Benevolence is about the system's perceived goodwill and the prioritization of user interests. Predictability encompasses the consistency and reliability of the system's performance over time.

Stahl's framework emphasizes that trust is not only built through technical and procedural means but also through the ethical and relational dimensions of digital interactions. For UPI,

incorporating these dimensions means ensuring that the platform not only functions effectively and securely but also operates transparently, prioritizes user welfare, and maintains consistent performance. By addressing these additional trust factors, UPI can further strengthen its trustworthiness among users and stakeholders, fostering greater adoption and sustained usage.[223]

The platform's design emphasizes cost-effectiveness, ease of use, and security, which collectively enhance financial inclusion. By providing pricing flexibility to retailers, UPI has created a more competitive and dynamic market. However, it is crucial to manage concentration risks to ensure the platform's sustainability and resilience.

Road Ahead and Global Utilisation

India is one of the leading countries in having established the essential digital rails of DPI, namely India Stack–a set of open source APIs– for identity, e-KYC, health, e-commerce and payment. With UPI as central to the payments layer, ensuring financial and digital inclusion has been the main agenda of the revolutionary initiative.

DPI serves as a cornerstone for ensuring public welfare and universal access, contrasting with private platforms that often prioritize profit maximization and market dominance. DPI is characterized by decentralized public oversight, transparent decision-making, and open standards that emphasize user privacy and data security. These principles foster a collaborative and open-source development environment that drives societal innovations and sustainable growth.

The International Monetary Fund (IMF) acknowledges that India's journey in developing world-class digital public infrastructure provides valuable lessons for other nations embarking on their digital transformation journeys. By prioritizing inclusivity and interoperability, India has created a resilient digital ecosystem that can adapt to various socioeconomic contexts globally.

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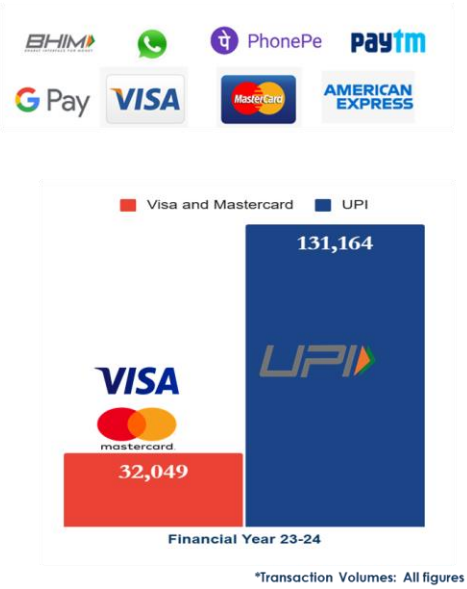
[223] Stahl, Bernd Carsten. 2004. "Responsible Management of Information Systems." Hershey: IGI Global. https://doi.org/10.4018/978-1-59140-274-5.



The meteoric rise in daily UPI transactions reflects not just the system's efficiency and user-friendly design but also indicates a growing public confidence in digital financial services. This transition to digital payments, embraced by a wide demographic across the country, underscores a pivotal shift in the perception and utilisation of financial technology. The comprehensive study within this compendium explores this relationship, highlighting how UPI's integration into the fabric of daily commerce and personal finance is emblematic of an increasing trust among the Indian populace in digital transactions.

The Nasscom-Arthur D. Little report estimates that by 2030, the adoption of mature and budding DPIs could potentially increase India's GDP by up to 4.2%, from 0.9% in 2022. This highlights the significant economic impact that comprehensive digital infrastructure can have on national growth .

Trust in technology is crucial for the widespread adoption and success of digital platforms. Digital Public Infrastructures like UPI build this trust by ensuring transparency, security, and user-centric policies. This trust results in higher adoption rates and the creation of significant ecosystem value, as evidenced by the rapid growth of UPI in India.

One of the remarkable aspects of India's digital financial landscape is the plethora of payment options available to its citizens, unmatched by any other country. From QR code-based payments to mobile banking apps and UPI, Indians have access to a variety of secure and convenient payment methods. This diversity not only fosters consumer choice and convenience but also promotes a competitive marketplace that drives innovation and service improvement. Such a robust digital

payments ecosystem positions India as a leader in financial technology, providing valuable lessons for countries aspiring to enhance their digital infrastructure.

UPI's success has extended beyond India's borders, marking a significant milestone in the international financial landscape. UPI is now facilitating digital transactions in several countries[224], including Singapore, Bhutan, Malaysia, the United Arab Emirates, Nepal, and France, with plans to expand to Australia and Russia. Strategic partnerships with organisations like Liquid Group and the Arab Monetary Fund highlight UPI's potential in enabling multi-currency cross-border payments. This expansion underscores the growing trend of interoperable financial services, fostering greater ease and security in international commerce and remittances.[225] [226]

As countries around the world seek to establish or upgrade their DPIs, UPI's success story offers compelling insights into the transformative impact of such systems on financial inclusion, economic growth, and societal well-being. The international interest in replicating India's DPI framework, especially UPI's model, is indicative of its potential to serve as a blueprint for global financial inclusivity.[227]

Despite its remarkable success, UPI's global adoption faces challenges such as regulatory differences, cybersecurity concerns, and the need for technological harmonisation across borders. Addressing these issues will require collaborative efforts between governments, financial institutions, and technology providers. Initiatives like the integration of UPI with Singapore's PayNow and the collaboration with the Arab Monetary Fund's Buna Payment Platform are steps towards overcoming these hurdles and ensuring a secure, efficient global payment system

Looking ahead, the potential for UPI to revolutionise global digital payments is immense. The continued expansion into new markets, along with partnerships with international payment networks, will facilitate cross-border transactions and support a more interconnected global digital economy. As more countries recognize the benefits of adopting UPI, it could become a standard for global digital payments, providing a model for other nations to follow. The emphasis on security, inclusivity, and adaptability will remain crucial as UPI evolves to meet the needs of an increasingly digital world .[228]

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[224] Gupta, Arvind, and Nipun Jain. "Technology in the Times of a Global Pandemic: Lessons from India." Global Policy Journal.

[225] UPI goes global: Here's where it is being used around the world," Business Today. Accessed May 2024.

[226] "NPCI International Partners with Liquid Group to Expand UPI in Southeast Asia," Business Standard, 2021.

[227] UPI's Global Expansion: A New Era in International Digital Payments," PC-Tablet. Accessed May 2024.

[228] Unified Payments Interface (UPI): A Revolutionary Financial Technology," Journal of Risk and Financial Management. Accessed May 2024.

UPI is more than a payment system; it's a testament to India's commitment to harnessing technology for societal advancement. As we contemplate the future of digital payments, both within India and globally, UPI stands as a beacon of potential, guiding efforts towards a world where financial services are accessible to all. The global utilisation of India's digital payment innovations will undoubtedly play a pivotal role in shaping the next generation of financial infrastructure worldwide, fostering a more inclusive and connected global economy.

Exploring Unified Payments Interface's (UPI) Adoption Factors and Trust Variables: Insights from Retailers and Consumers across Low and Middle-Income Communities

This research piece has been cross-published via the Social Science Research Network in the following journals:

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Abstract

The ubiquity of technology has transformed the way humans live their lives. In this digital age, technology plays a pivotal role in digital inclusivity and extending essential benefits to people in every corner of the world. In the context of India, the launch of the Unified Payment Interface (UPI) marked the beginning of revolutionising both the traditional process of sending and receiving money and accelerating the country's economy. This paper attempts to look at factors responsible for why the people in the country decided to trust (or not) to digital mobile payments by adopting UPI. Beginning with a brief familiarisation with the background of this research in the form of a review of literature, and an introductory segment seeking to understand digital payment technology and the meaning and importance of financial inclusion in establishing an equitable society, the paper subsequently delves into examining how technology is inevitably penetrating every segment of our lives. These evaluations are made carefully in the backdrop of identifying the central significance of 'trust' in the realm of digital mobile payments through UPI. This research endeavour aims to grasp the most frequently occurring factors that influence the users' decision-making behind the adoption of this digital payment technology, by conducting a survey on 150 consumers and retailers (combined), in and around Delhi-NCR, Meerut, and Sonipat.

Keywords: UPI, Consumers, Retailers, Mobile Payments, Trust, Technology

Introduction

Technology can simply be defined as the application of scientific knowledge to achieve defined practical goals. Emmanuel Mesthene in his book titled *Technological Change: Its Impact on Man and Society (1970),* defined technology as "the organization of knowledge for the achievement of practical purposes," whereas the economist John Fernald in his 2014 presentation entitled *Technology and the American Economy: Or, What's the New Normal,* described technology as "the ability to convert society's resources (labour and capital) into output (goods and services that we value)," depicting how particular resources could be converted into productive outputs, increasing overall efficiency and effectiveness.[229]

The governments of the world started to recognise the importance of prioritizing and advancing technology in order to not be left behind in the global race for progress. Exploring ways in which technology could increase people's access to resources and opportunities, many countries began adopting digital means of both governance (called e-governance) and providing their people with public goods and services. One of the greatest digital service technologies provided is digital payments, referring to a contactless mode of transferring money from one account to another using a portable electronic device or channel. Some of the many benefits of digital payments are increased convenience, transparency and security, women's economic participation, inclusive growth, and financial inclusion.[230]

The Government of India (GoI) strongly realized the significance of a technological shift in traditional ways and hence launched the Digital India Programme on the 1st of July, 2015. With the aim of creating a 'Faceless, Paperless, and Cashless' economy, this programme envisioned connecting and empowering Indians through leveraging technology for key areas like education, health care, and financial inclusion.[231] This strategic mission centres around three key areas, namely, Digital Public Infrastructure (DPI), Digital Services and Governance, and Digital Empowerment.

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[229] Theirer, Adam. "Defining 'Technology.'" *Technology Liberation Front*, 29 Apr. 2014. https://techliberation.com/2014/04/29/defining-technology/#:~:text=John%20Kenneth%20Galbraith,organized%20knowledge%20to%20practical%20tasks.%E2%80%9D (Accessed: 29 July 2023)

[230] "Define Digital Payments." *Better Than Cash Alliance*. www.betterthancash.org/define-digital-payments.(Accessed 30 July 2023)

[231] Bhatia, Shubhangi. "Digital Payments: Definition and Methods - Razorpay Payment Gateway." *Razorpay Learn*, 9 Nov. 2022. https://razorpay.com/learn/digital-payments-india-definition-methods-importance/ (Accessed: 30 July 2023)

One of the key layers of DPI is the digital payments layer, under which Unified Payment Interface (UPI) is critical. Developed by the National Payment Corporation of India (NPCI), UPI is a system that enables multiple bank accounts into a single application, allowing seamless peer-to-peer (P2P) and peer-to-merchant (P2M) transactions. UPI was launched in April 2016 by the RBI.[232] According to the data by MyGovIndia, in 2022, India topped with 89.5 mn digital transactions amongst the list of five leading countries in digital payments, accounting for almost 46% of the global real-time payments and making it more than the other four countries combined.[233] According to the India Digital Payments Report by Worldline, for the first half of 2023, the P2M transactions grew from 18.62 billion transactions in H1 2022 to 22.75 billion in H1 2023, depicting a 22% increase.[234] Not only is India succeeding domestically, but is also taking UPI and other DPI utilities to a global level, by establishing partnerships with emerging countries. These numbers and data are a testament to UPI's growing penetration and usage.

There are multiple factors as to why people choose or intend to use a particular technology. These factors all come down to users' trust in the technology, which decides their willingness and intention to use as well as shapes their perception, behaviour, and attitude toward the technology. Therefore, it becomes imperative for the government to develop and instil these trust factors amongst both digital natives and digital migrants.[235] Now, whether the degree of trust in a particular technology is also affected if and whether a service or its infrastructure is provided and promoted by the government, is something to be established through this study.

The aim of this study is to understand the underlying factors responsible for why middle and low-income communities (LMICs) consumers and retailers in India use UPI while establishing correlations between their rationales for trusting UPI and adopting it. The analysis is qualitative and involves primary data collection through a survey approach. Using two separate sets of questions for

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[232] "UPI: Unified Payments Interface - Instant Mobile Payments: NPCI." *National Payments Corporation of India (NPCI)*, www.npci.org.in/what-we-do/upi/product-overview. (Accessed 30 July 2023)

[233] Ani. "India Leads Global Digital Payments with 89.5 Million Transactions in 2022: MyGovIndia Data." *The Hindu*, 10 June 2023. www.thehindu.com/business/Economy/india-leads-global-digital-payments-with-895-million-transactions-in-2022-mygovindia-data/article66953386.ece. (Accessed: 30 July 2023)

[234] Kothari, Saloni. "UPI Transactions Cross 10 Billion Mark for Second Month in September." *BQ Prime*, 2 Oct. 2023, www.bqprime.com/business/upi-transactions-cross-10-billion-mark-for-second-month-in-september.

[235] *Digital natives* refer to individuals who have grown up in this digital age and are relatively familiar with as well as exposed to digital technology e.g., computers, smartphones, and the internet. Along with being proficient, they have an intuitive understanding of digital tools and techniques, making it easier for them to adapt to newer technologies. *Digital migrants* are individuals who were born and spent their early years before the widespread adoption of and exposure to digital technologies, making them a little hesitant to learn and adapt to technology in their later stages of life.

both consumers and retailers, this method helps generate an in-depth understanding of the complexities revolving around possible trust variables behind the adoption UPI and draw a general conclusion around the supposition in testing.

Motivation of the Study

Upon researching the area of digital mobile payments in India, we decided to undertake a qualitative study based on interviewing users at the ground level to gain a better and more realistic understanding of the role of trust in the UPI ecosystem. The research targets particular socio-economic classes of the middle and low income communities (LMICs).

The findings of this study seek to actively contribute to theory-building in the fields of trust, adoption factors, and digital financial technology, offering important insights into the broader literature. Along with this, these results will assist policymakers and other influential actors in shaping laws, policies, and regulations in the better interest of UPI users, while expanding its adoption base.

Literature Review

The factors shaping users' trust in UPI are critical to understanding the link between them and advancing ways to improve this relationship. This section attempts to review the literature regarding the segments of the digital payments ecosystem, and factors of adoption and trust.

To grasp a holistic outlook on the digital payments ecosystem, it becomes imperative to look at the multiple studies that have attempted to relate its features and facilities with its dynamic components including financial literacy, inclusion, and economic growth, while studying its benefits and bottlenecks. Shalest Rastogi et al. (2021) found that UPI has a positive relationship with *financial literacy*, and significantly impacts *financial inclusion*, which in turn contributes to *economic development*. Similarly, Mahesh A. and Ganesh Bhat S. (2022) talked about both the specific role of UPI and its need in promoting *financial inclusion*. They were of the opinion that India under the transition from a cash-based economy to a cash-less (or less-cash) economy has a lot to do with increasing adoption of smartphones and internet, which further facilitates *acceptability* of technological services such as digital financial transactions. Dr. A. Shaji George et al. (2023) revealed the key benefits of UPI to include *minimal transaction costs,* and *eliminating the need to share sensitive banking information;* and the challenges to include *security concerns* like data breaches, fraud, and cyberattacks. Abhishek Kumar et al. (2022) talked about the growth and significance of UPI in India and its global reach, while bringing to light the recurrent challenges of increasing *transaction failures, connectivity problems, server challenges,* and *cyber frauds*. In the same context, Vijith Raghavendra and Pundikala Veersha (2023) found that

some portions of the market were being retained due to factors like *upper transaction limits on UPI, security concerns,* and *accessibility issues*.

Many scholars have previously explored the probable reasons why users adopt UPI, using various theories, lenses, and explanations. Lata Saini and Satish Khasa (2023), while using the Unified Theory of Acceptance and Use of Technology (UTAUT) model, stated that the elements impacting behavioral intention w.r.t using mobile payments are *performance expectancy, social influence, effort expectancy, hedonic motivation, facilitating conditions, habit,* and *price value*, where performance expectancy emerges as the most critical predictor of intentions. Vishal Vyas and Priyanka Jain (2020) discovered factors like *perceived ease of use, perceived credibility, perceived self-efficacy, attitude, utility* and *risk perceptions* as factors impacting the adoption of mobile payments. Similarly, Ghana Shyam Kafler and Dr M. Chandrasekaran (2021) arrived at the following factors, namely, *security, trust, social influence, internet connectivity, perceived ease of use, perceived usefulness,* and *intention to use.* Studies by Dr Ashutosh Nigam and Dr Sima Kumari (2018), and Dr Sonal Purohit et al. (2022), looked at the adoption factors through the generational lens of Gen Y and Gen Z users[236], respectively. For Gen Y, it was found that the *perception* of the technology's usefulness, having *strong governmental support,* and *diminishing poor customer care perception* drive them to adopt the payment technology, whereas, for Gen Z, *social influenc*e is the most relevant factor of adoption, with *effort expectancy* and *performance expectancy* being the other significant factors.

Consumers are simply those individuals who purchase a product or service for their own needs and consumption. Their factors for the adoption of digital payment technology, including reasons that drive or restrict adoption and acceptance, become important to analyze. The study by Sudiksha Shree et al. (2021) showed that *positive perceptions of digital payments* and *negative views of cash* drive consumers towards digital payment adoption, further revealing instances where customers demonstrated a willingness to overlook online fraud experiences due to digital payment methods offering higher convenience. Dr Kiran J Patel et al. (2019) was of the opinion that the factors driving e-payment acceptance are *perceived usefulness* and *perceived ease of use.* In a similar context, Dr Sumathy and Vipin KP (2017) found having a *favorable regulatory environment*, the *emergence of next-generation payment service providers,* and an *enhanced customer experience,* as key drivers of adoption. Dr Ranjith PV et al. (2021) revealed that the reasons for embracing digital payment methods are *ease of use* and *convenience*. Qing Pan (2019) talked about how users perceive mobile payment methods as a *cost-effective*

[236] *Generation Y*, also known as millennials, refers to people born between the early 1980s and mid 1990s, whereas *Generation Z*, also known as the post-millennials, refer to people born between mid 1990s and 2010

and *efficient* means of conducting transactions, which in a way appeals to the users and contributes to the reasons behind its adoption.

A retailer, or a merchant, is an entity that sells goods and services to consumers. Many scholars have attempted to develop an understanding as to why retailers in India decided to introduce mobile payment alternatives to their customers. Bharti Ramtiyal et al. (2022) focused on studying the interrelationships amongst various types of *perceived risk* and behavioral intentions in the adoption of mobile payments, while addressing the need to consider the previously overlooked aspect of users' *situational/contextual factors*. Directing attention towards the digitisation of Kirana Stores in India's retail sector, Preeti Kapuria and Harish S Nalawade (2021) emphasized on how Kirana Stores, in order to remain competitive and meet the changing demands of the customers, decided to adopt digital payment technologies. Interestingly, the authors suggested two approaches for Kirana Stores to digitize successfully, the *'phygital'* model (which integrates physical retail shops with digital payments, online operations, and a digital presence) and the *convergence* model (which suggests collaborations and partnerships between large retailers, e-commerce firms, and Kirana Stores, providing benefits to all stakeholders). Naman Pare and Chitsimran (2021) revealed that *ease of use* and *user satisfaction* were discussed as driving factors, whereas the major hindering factor found in the study was *online security challenges*. Ethan Ligon et al. (2019) realized that considerations like *supply-side barriers* and *feasibility*, *adoption rate* and *usage*, the role of *demand-side factors*, the importance of *customer demand,* and the impact of *tax concerns,* are the key influencers of digital payments adoption among this particular section of merchants. Joyojeet Pal et al. (2018) argued that the *transaction nature* and *scope*, *the type of products sold*, and the shop owners' *comfort and familiarity* with the technology play a role in determining the extent of adoption. So, in other words, the underlying factors include *normative aspects, social perceptions,* and *emotional appeal.*

Various scholars attempted to examine the relationship between trust and technology, revealing significant factors influencing user trust. Nancy K. Lankton et al. (2015) talked about *trusting beliefs* and *trusting intentions*, which in the context of UPI adoption suggest that it is the users' beliefs regarding the features and facilities of UPI that influences the users' intention to use it. Domingos Mondego and Ergun Gide (2018) in their multi-country review, revealed that *trust, perceived usefulness, perceived ease of use,* and *perceived risk* were the most studied variables affecting users' trust in digital payments. Similarly, the factors in the work by Hong Yan and Zhonghua Yang (2015), were, *structural assurance, ubiquity, perceived ease of use,* and *perceived usefulness*. Tomi Dahlberg, Niina Mallat, and Anssi Oorni (2003) revealed that *perceived security* and *perceived trustworthiness* vital for shaping users' trust and

eventual intentions of the technology usage while identifying specific security concerns negatively affecting trust such as unauthorized use, privacy concerns, transaction errors, and device reliability.

This review of literature suggests that the most recurring variables of trust would be:

- Perceived Ease of Use (PEoU)
- Perceived Usefulness (PU)
- Perceived Risk (PR)
- Structural/ Institutional Assurance

To briefly understand these constructs, they can be defined in terms of their meanings illustrated by the *Technology Acceptance Model (TAM)* (Davis, 1989).[237] The TAM states that the actual technology use is in a way directly dependent on the individual's intentions to use the technology. So, as the intention to use increases, higher are the chances that they'll actually use the technology.[238] Perceived Ease of Use (PEoU) can be defined as the degree to which the user believes the technology would be easy to use and free from effort. So, higher the user's PEoU, higher will be their intention to actually use the technology.[239] Similarly, Perceived Usefulness (PU) could be understood as the degree to which an individual believes that using the technology will be beneficial for them in meeting their goal.[240] Perceived Risk (PR) on the other hand could be referred to as the users subjective evaluation of the potential risks or negative consequences attached to using the technology, leading to a sort of uncertainty. Apart from these three factors, structural and institutional assurance, commonly known as institution-based trust, could be defined as the degree to which people believe the institutional structures through guarantees, regulations, and/or legal recourse are in place to promote the success of the technology.[241]

Research Questions

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[237] Davis, Fred D. "Perceived usefulness, perceived ease of use, and user acceptance of information technology." *MIS quarterly* (1989): 319-340.

[238] Worthington, Amber K. "Technology Acceptance Model." *Pressbooks*, 30 May 2021, https://ua.pressbooks.pub/persuasiontheoryinaction/chapter/technology-acceptance-model/#:~:text=Perceived%20ease%20of%20use%20is,use%20the%20technology%20also%20increase.

[239] Id

[240] Id

[241] Sha, Wei. "Types of structural assurance and their relationships with trusting intentions in business-to-consumer e-commerce." *Springer,* 9 December 2008. http://www.electronicmarkets.org/fileadmin/user_upload/doc/Issues/Volume_19/Issue_01/V19I1_Types_of_structural_assurance_and_their_relationships_with_trusting_intentions_in_b2c_e-commerce.pdf.

- ➢ What are the parameters that define 'trust' in a digital financial technology i.e., UPI in this case, amongst consumers and retailers?
- ➢ Why do users decide to switch from traditional modes of payment such as cash, debit/credit cards, online banking, and mobile banking, to UPI?
- ➢ Why are consumers and retailers adopting UPI as a technological alternative to traditional modes, for performing financial activities?
- ➢ Why do people trust UPI?

Hypothesis: The adoption of UPI is correlated with the users' trust in the particular technology being a government-owned infrastructure.

Research Methodology

The data was collected through primary means, in and around Delhi NCR, Meerut, and Sonipat. Data collection was primarily based on Random Sampling while following certain conditions regarding interviewing retailers and consumers. A total of 150 recordings were identified for data analysis.

The methodology encompasses awareness of the payments ecosystem, the degree of payments adoption, adoption by the startup ecosystem, and innovation in technology and business models. It evaluates the purpose of open standards, costs, grievance systems, benefits, trust, and value sharing. The external environment, including data and compliance requirements, policy shocks, and investor push, is also considered. Resources such as technology and design, venture capital, and societal consequences are examined to understand increased acceptance by retailers, higher usage by diverse consumer sets, and the overall impact on the digital economy and societal improvement.

Methodology - Triangulation

The research methodology employs triangulation, drawing on theories from case study research with a focus on various units of analysis, including digital natives, digital migrants, retailers, policymakers, startups, and venture capitalists. Data is triangulated with industry reports, extant literature, and open data from sources such as NPCI and PhonePe Pulse. This approach ensures a comprehensive understanding of the payments ecosystem, adoption rates, and innovation in technology and business models .[242]

[242] Eisenhardt, Kathleen M. "Building Theories from Case Study Research." Academy of Management Review, vol. 14, no. 4, 1989, pp. 532-550.

Analysis

Upon analyzing the responses of 150 (consumers and retailers combined), the following insights related to prevalent factors for adoption, trust variables, and cases to understand the gender-specific willingness to learn using mobile payments technology and the consideration of efficiency, can be affirmed through the responses.

It is crucial to consider the influence of demographic factors on the findings of this study. The interviews were conducted in urban/semi-urban areas of the NCR, which inherently depicts a bias towards individuals who are more likely to use and have access to digital infrastructure. These areas are equipped with better internet connectivity and higher penetration of smartphones, which facilitate familiarization with digital payment systems like UPI, including their access and use.

Touching upon the possible trust variables that drive users' intention to use UPI, and drawing the relationship between them both is the underlying objective of this paper. This is in conjunction with testing whether UPI being a community-controlled infrastructure holds any justification for it being trusted, and resultantly, accepted.

UPI's success story offers invaluable insights into the potential of digital platforms to drive economic transformation. It exemplifies how policy innovation, coupled with technological advancement, can create a digital public good that not only streamlines financial transactions but also lays the foundation for a digital economy that is accessible, inclusive, and equitable.

As UPI continues to evolve, integrating advanced features like cross-border transactions and linking with international payment systems, it paves the way for India to establish itself as a global leader in digital payment innovations. This progression also highlights the critical role of government and regulatory bodies in fostering an environment conducive to technological innovation and in ensuring that digital platforms serve the broader goals of economic development and social welfare.

Adoption Factors

Adoption factors, in the context of this study, tend to reflect factors motivating consumers and retailers to adopt UPI. The following factors for UPI adoption resurfaced the most in our surveys:

Growing Consumers Demand

In order to secure the regular consumer base, and broaden it further, retailers of a variety of sizes confessed to adopting UPI for similar reasons. As more and more people started shifting to mobile payments, retailers started realizing the sharp inclination and the need to align their services to promote

business growth. To keep up with the rapidly changing trend, and avoid being left behind, retailers including big luxury stores to the ones small as a paan shop, began providing UPI payment options to their customers through QR Codes.

No Trouble Handling Cash

An uptake in consumer demand for online transactions has propelled the adoption of UPI payment system amongst retailers. This adoption provides a cash alternative, resulting in reduced hassle for the retailers by no longer having to manage physical cash, and are relieved from the burden of having to provide change. This rationale is consistently cited by retailers as one of the primary reasons for adopting UPI. Allowing retailers to avoid dealing with large denominations of currency, improves efficiency in the process of completing transactions, as well as increased security. This benefit aligns well with UPI's *Perceived Usefulness (PU)*, where this payment infrastructure acts as a valuable alternative to other modes of payment by enhancing overall productivity, efficiency, and effectiveness.

However, a handful of retailers point out that lesser cash payments lead to reduced cash flow, which creates challenges in their daily business operations. This is a commonly encountered predicament where retailers claim to have payments conducted mostly through digital means, resulting in limited amounts of readily available cash on hand. In such cases, to maintain sufficient cash reserves for their use, the retailers must make deliberate efforts to physically withdraw cash. This underscores an imbalance in their input and output, primarily driven by their inputs mostly driven by online modes, and the output is characterized by the scarcity of cash available for their use. This contributes to an asymmetry and transactional difficulties for the retailers.

Rising Popularity

In this digital era, and with the Digital India Mission in its place, every corner of the country has started changing its traditional mediums of services and activities to fulfill them with the help of technology. Ever since its launch in 2016, UPI started gaining immense popularity very quickly. Due to its *Perceived Ease of Use (PEoU)*, and easy accessibility through technological devices as omnipresent as smartphones, people started finding mobile payments through UPI as a competitive alternative to conventional payment methods, including cash and cards.

Trust Variables

There have been certain consistent variables determining why users trust UPI enough to use it as a payment alternative. Upon identifying the most recurrent in the survey responses, the following can be confirmed as the trust variables backed by positive connotations:

Positive Consistent Experience

The smooth functioning of the UPI infrastructure, especially as a service provided by third-party applications facilitates ease of transactions, both for the customer and the retailer. Trust is fostered due to the availability of a myriad of apps using the government-backed open-source infrastructure, as well as other services like quick grievance resolution provided by these apps.

Many respondents admitted to having a positive consistent transaction experience with UPI, where they faced rare instances of transaction failures or frauds. Considering this, the minimal cases of transaction failures and frauds are attributed mostly to network issues, and connectivity problems on either end. Nevertheless, these first-hand experiences with mobile payments through UPI play a key role in deciding the future of India's digital payments system, while providing a technical gap to be bridged by the Government to meet its promise of seamless and reliable online transaction facility.

Convenience

The convenience of performing transactions using UPI can be correlated with smartphone accessibility, and its preference over cash. In the era that we are today, smartphones are in the hands of almost everyone. Considering UPI payments are primarily processed via user-friendly mobile applications, the technology ensures nothing less than convenient, efficient, and quick payments from anywhere to anywhere. This concept of convenience sits well with and validates UPI's *Perceived Ease of Use (PEoU)*, where ease of using UPI for payments contributes to its convenience and quickness, making it the eventual choice of mode. Therefore, UPI eliminated the hassle of carrying physical cash, the inconvenience of writing and depositing cheques, and the need to visit the banks to withdraw cash.

Based on the responses, two preferred methods of payment have emerged. One includes a group of people who use both online and offline modes of payment, while the other group is those who noticeably use online modes more than offline modes. The ones using UPI more, reason it with convenience in the process as compared to paying with cash.

Reduction in Safety Concerns

Money being transferred digitally from one bank account to another eliminates the chances of the money being physically stolen or lost. The dilemma of pickpocketing, especially in bustling cities and areas is not unheard of. This common phenomenon has led people to switch from carrying cash, specifically larger bills with higher risks of loss if stolen, to safer alternatives such as making payments through easily accessible and handled mobile devices.

Many retailers on the highways in Sonipat confessed to feeling more confident ever since they decided to adopt UPI. Through UPI, the money goes seamlessly to the owner's bank account, reducing the chances of theft to as minimal as possible.

Similarly, consumers stressed how there used to be very frequent cases of stealing and snatching physical cash. But with online payments now, individuals are less likely to carry large amounts of cash, subsequently reducing opportunities for cash to be stolen or lost.

Understanding how security is paramount, UPI's security features through their multi-layered protocols, including 2-factor authentication (2FA) and biometric verification, ensure that every transaction is safeguarded against unauthorized access or interference.[243] These incorporations add an extra layer of security to the transactions.

In this view, people's assessment of the potential risks and security associated with UPI significantly impacts their decisions in terms of the adoption and usage of this payment technology. This underscores the relevance of *Perceived Risk (PR)* as a crucial factor contributing to people's trust in UPI adoption

Structured and Detailed Information of Transactions Available

UPI plays a significant role in record-keeping. With the traditional modes of payments, people would often find it challenging to keep track of their expenses and manage their accounts. But with the coming of UPI as a preferred mode of payment in the country, users can now refer to their transaction history, which captures every payment made through the application, at the palm of their hands.

Small retailers hitherto did not keep track of their cash-based transactions. However, with the advent of the use of UPI as the preferred mode of payment, there is structured and detailed information on all the transactions available in the palm of their hand. Retailers now can access this information either through third-party apps or their bank passbooks.

UPI provides a detailed record of every payment made or received, including information such as the date, time, payer's and payee's name, unique transaction ID, etc. This information is however missing in case of transactions made through cash. So, UPI, in a way, provides simplified record-keeping for their users' reference.[244]

UPI as a Product of Government of India (GoI)

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[243] Bisht, Shubham."What Is UPI (Unified Payments Interface) and How It Works?" *Razorpay Blog*, 23 Sept. 2023, razorpay.com/blog/what-is-upi-and-how-it-works/#Benefits_of_UPI_for_Merchants.

[244] Bisht, Shubham."What Is UPI (Unified Payments Interface) and How It Works?" *Razorpay Blog*, 23 Sept. 2023, razorpay.com/blog/what-is-upi-and-how-it-works/#Benefits_of_UPI_for_Merchants.

Based on a document[245] released by the GoI in 2016, India, before the launch of UPI, was believed to be a cash-dependent society, lacking:

- Trust in digital payments
- Incentives for digital payments
- Adequate infrastructure for acceptance and high-speed network
- Financial inclusion
- People's participation, including Start-ups, Fin-techs, and Big-techs

Due to UPI being endorsed by the Reserve Bank of India (RBI) and the Government of India (GoI), the general public perceives it as a secure method for conducting financial transactions, leading to the development of trust. Numerous government initiatives and programs are dedicated to promoting the agenda of expanding the reach of UPI further into every corner of the country.[246] This demonstrates the pivotal role of *structural support and assurance* in shaping the trajectory of UPI as a payment system.

Trust Amongst Wider Community and Word of Mouth

The adoption of UPI at a mass level as well as it being the chosen option for daily transactions has led to society-wide trust being fostered in it. UPI's ubiquitous status in society's everyday lives drives its non-users to try using it and experience its features for themselves. As UPI gains trust amongst the wider community, the positive experience of UPI users and word-of-mouth play a vital role in motivating non-users to adopt UPI.

Providing gentle nudges through word of mouth and subtle recommendations from trusted members, such as friends, family, peers, etc, serve as both social proof of UPI's positive experience, and an encouragement to others to adopt the mobile payment system as well, causing a sort of ripple effect.

Female Empowerment and Willingness to Learn

Female empowerment is a concept closely and inseparably linked to women's financial status, independence, and practices. Based on an observation made by Arati Deo, Engineering Director at Google Pay, although UPI has been increasingly adopted in India since the pandemic, women make up less than 30% of the users.[247] But these numbers are rapidly evolving.

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[245] https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/may/doc202351190501.pdf

[246] Id

[247] Gaur, Vatsala. "UPI Use among Women Low, Assisted Onboarding Can Drive Uptake: GPay's Arati Deo." *The Economic Times*, 25 May 2023, https://economictimes.indiatimes.com/industry/banking/finance/upi-use-among-women-low-assisted-onboarding-can-drive-uptake-gpays-arati-deo/articleshow/100497224.cms

Providing women with assistance and guidance on how to use digital payments plays a big role in helping them overcome fear or any other related barrier. Educating women about digital payments and giving them access to digital payment systems empowers them to have a sense of control over their financial powers, helping them make informed decisions about saving, investing, and managing finances. Tailored assistance could help meet the specific needs of different groups of women, such as differently-abled, low-income earners, and non-literates. Therefore, awareness and guidance solutions for them could be customized accordingly, increasing gender-based inclusivity in India's digital payments ecosystem.

In our survey, the women who did not use UPI attributed their reasons to:

- being uneducated
- not having a smartphone
- dependent on the male family member that they're affiliated with, e.g., their husbands or sons

Our interviewers inquired if they would be willing to learn and/or be assisted in using the technology, to which almost all the female non-users of UPI gave a favorable response (with 2-3 exceptions). This crucial insight proves an opportunistic space for the GoI and/or related entities to expand the reach of UPI.

With this aim, initiatives in the form of the following could be introduced:

- Awareness Campaigns
- Assistance Drives
- Partnerships with NGOs, and Self-Help Groups
- Financial Literacy Workshops for Rural Areas
- Improved Feedback Mechanisms and Regulatory Support

By working towards implementing these recommendations, UPI's user base could be made more inclusive to women, especially the ones in underserved areas, thereby enhancing women's financial inclusion and empowerment.

The Concept of Efficiency

From a traditional standpoint, the concept of payments has been inexorably linked to a two-entity operation in terms of the ability of the recipient to concurrently undertake multiple payments

from different people with conventional payment methods (focusing primarily on cash or other such forms of payment) being limited. With the advent of new methods for payments such as bank transfers, wire payments, etc, this situation has changed somewhat in terms of usage for large transactions. However, when considering general payments for groceries, household items or basic utilities, for the average citizen, the only reasonable option for such payments is cash.

UPI has significantly altered the status quo in this regard. Ever since its launch in 2016, the graph for its transaction rate has only increased with respect to its previous months. The general public started using UPI for the smallest of the small transactions, covering P2P, P2M, and even B2B. Due to its facilities of higher convenience, quickness, interoperability, security, and factors like Perceived ease of Use (PEoU), Perceived Usefulness (PU), etc, the general public very rapidly began shifting to digital mobile payments from the earlier predominant modes of cash transactions.

With UPI's noticeably higher efficiency in processing one complete payment as compared to cash or other traditionally oriented modes, retailers as well as consumers can now avoid wasting time and effort, and complete multiple payments in a matter of a few seconds. This is a very recurrent response recorded of the retailers in the survey conducted in our study, where there has been a consistent expression of satisfaction regarding enhanced productivity and time-saving, accompanied with the other many benefits of adopting UPI. The consumers in our survey too affirmed UPI being time-efficient and labor-saving, contributing to their rationale behind adopting this commendable alternative to cash. Therefore, efficiency is certainly UPI's key driving force.

The Unseen Hand of the Government in UPI

UPI is regulated and supervised by government associated entities i.e., the Reserve Bank of India (RBI) and the National Payments Corporation of India (NPCI). Although their primary responsibilities are to ensure the security, reliability, and smooth operation of the UPI system, their presence might not be "visible" in casual everyday UPI transactions. But this does not dilute its vital positioning in promoting and establishing trust and stability of the system.

Although carefully curated legal frameworks and policies have been put in place by the government to govern digital payment systems, and in this case, UPI, laying out the establishment of rights and responsibilities of both the users and the service providers/ third parties involved. UPI users consequently have a given right to expect understandable levels of security, privacy, and recourse in case of issues with the system

With successful intention, UPI has been promoted as an immensely important tool for financial inclusion, playing the role of an 'enabling' platform, or a stepping stone for other services to work and depend upon for ease of efficient delivery. The aim aligns well with the government's vision of financial

inclusion, the goal of which is to ensure all citizens have access as well as opportunity to participate in digital banking and payment services.

UPI users may come to experience and expect convenience and efficiency of digital payments service as a natural part of their everyday financial practices. This expectation of a standard is fueled by the government's efforts to promote the goal of a digital economy, which is relatively more transparent, secure, and efficient.

In this view, the government's 'invisible presence or hand' in the functioning of UPI can be seen flowing from a combination of regulatory oversight, policy support, and governing framework, ensuring meeting with the users' expectations and rights whilst using UPI. Therefore, it is imperative to note the government's role as an 'enabler' and 'regulator' of UPI, even when the system's primary operations actively involve banks and third-party service providers.

Recommendations

Based on our interviews and evaluation, our team would like to suggest the following recommendations to the policymakers, and possible areas of theory-building and discussions for researchers and academicians:

➢ Focus on Promoting UPI in Underserved and Underbanked Areas

There are areas or communities in the country where access to essential traditional banking services are insufficient or limited. Because of this, UPI's penetration in these regions may consequently be extremely low to almost none. It becomes critical to address this issue by providing them with education and awareness about UPI and its usage, especially amongst these underserved sections.

➢ Workshops, Training Sessions, and Drives for Text and Voice-Based Transactions

These may be held on 'Introduction to the Application', which could include a 'Supervisory Demo and Initial Transactions', where agents may assist new users on their first few transactions. Such onboarding assistance could be provided in their local languages for a smoother learning experience. Our suggestion would most likely be targeted towards the UPI ecosystem, including Banks, the NPCI, Payment Aggregators and Microbanks, for looking into this process.

A network of agents could make drives across the country, especially in remote areas and amongst groups needing higher or specialized assistance. The agenda for awareness may include imparting knowledge on:

1. How to make offline UPI payments by dialling '*99#' on one's mobile phone. [248]
2. How to make UPI payments using a feature phone. This is also known as '123PAY', where UPI ID can be made by dialing '*99#', and a UPI payment can be made by dialing 080451 63666. [249]
3. How to make voice payments using UPI. This feature is also known as 'Hello UPI', where with the help of voice inputs, payments can be initiated. [250]
4. The use of UPI lite, also known as 'On-Device Wallet'. This is an efficient way of making small value payments without the use of a pin.[251]

A feedback mechanism could also be created, where the agents may periodically revisit their assigned groupings and monitor their transition. By implementing this suggestion, people's resistance to change would be reduced effectively, and more users will be able to derive maximum benefit from this technology investment.

➢ Partnerships with Non-Governmental Organizations (NGOs), and Self-Help Groups (SHGs)

These partnerships could prove fruitful in fostering financial inclusion through UPI, if strategized in an optimal fashion. These alliances could conduct community outreach programs, by organizing awareness campaigns and community events. Partnerships could be made with the ecosystem players including the NPCI, Banks and Microbanks, and Philanthropic Foundations, etc. Relatable examples and tailored communication could be ways to address people's queries and technical issues to the best.

Further Scope for Research

Keeping in mind the basis of this study is qualitative, the findings derived have negligible statistical value, and are rather indicative. A large-scale quantitative study could be conducted to validate these findings and provide statistical weight to the observed trends in this study.

Further research options may also include conducting a comparative study between different demographics, such as a Rural vs. Urban study.

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[248] Biswas, Sujaini. "Offline UPI Payment: How to Do UPI Payment Without Internet?" *Cleartax*, May 2023, www.cleartax.in/s/offline-upi-payment.

[249] Maiti, Meghna. "Make UPI Payments Using Your Feature Phone: A Convenient Solution." *https://www.outlookindia.com/*, 24 May 2023, www.outlookindia.com/business/make-upi-payments-using-your-feature-phone-a-convenient-solution-news-288899.

[250] Ray, Anulekha. "Hello, UPI: Use Voice Commands to Send Money, Pay Bills; Know New UPI Features and How They Work." *The Economic Times*, 7 Sept. 2023, www.economictimes.indiatimes.com/wealth/save/hello-upi-use-voice-commands-to-send-money-pay-bills-know-new-upi-features-and-how-they-work/articleshow/103464077.cms.

[251] "How to Do Offline UPI Payments With *99# Service." *BankBazaar*, www.bankbazaar.com/ifsc/upi-offline-payment.html.

Conclusion

UPI provides undeniable benefits to its users in terms of facilities discussed meticulously in this piece. To conceptualize the insights gained from the responses received in our survey, factors in this study were identified and categorized into two, adoption factors and trust factors. The adoption factors relate the most with UPI's growing consumer demand, rising popularity, and a reduction in troubles of handling cash, whereas the factors for trust are bolstered by the benefits UPI provides in terms of convenience, positive consistent transaction experience, reduction in safety concerns, and many more.

Acting as a brilliant platform for enabling the government's digital schemes and programs, UPI helps foster digital financial inclusion by extending its roots further to the underserved and underbanked areas in the country. This in turn boosts people's participation in the digitisation of financial practices, further giving rise to e-commerce and e-services. Great examples here could be the Open Network for Digital Commerce (ONDC), and data-sharing framework by Account Aggregator (AA), which when complimented with UPI, are set to revolutionize the digital ecosystem of the country, and all related service fields.

In the backdrop of these initiatives, UPI has become a pivotal tool in various lenses. To grasp an understanding of the rationales behind why people decide to use the technology (or not) helps essentially in remodeling and upgrading the mobile payment technology, whilst paving ways for it to penetrate further into the nooks and corners of the country, and gradually, the world.

Annexure

Questionnaires

Two different sets of questionnaires were prepared, keeping in mind the different perspectives of both the groupings and specific questions to be addressed.

Consumers' Questions

The following are the set of questions specific to the consumers:

- What do you do for a living?
- How do you receive your salary– online or cash?
- Do you have a smartphone?
- Are you a native of Delhi NCR or a migrant?
    - If a migrant, how do you send money home?
    - If another person does the transaction for you, do they take a commission?
- How do you do your everyday transactions– online or cash?
- Which app do you prefer for UPI transactions? And why?
- When did you start using UPI for your transactions? What has your overall experience been like with UPI?
- Why do you trust UPI?

Retailers' Questions:

The following are the set of questions specific to the retailers:

- How many customers pay with cash, and how many use UPI at your store? What is the average % of people who use UPI at your store?
- When did you start using UPI QR Code at your store? Do you have a soundbox?
- What made you decide to start using UPI at your store? Have you witnessed any changes since you started using UPI?
- Have you ever received any cashback from your UPI app?
- Is the bank account connected to the UPI your own?
- What are the challenges that you have faced while using UPI? What did you do to address those problems?
- What kind of method do you use to pay for the materials you buy for your business– cash or UPI?
- Why do you trust UPI?

Informed Verbal Consent

The consent of the respondents was verbally sought before moving on to the questions, where they were informed about the need to record their responses. They were also guaranteed confidentiality and anonymity.

Harnessing UPI's Success: A Catalyst for Expanding DPI

From UPI's Foundations to a Comprehensive DPI Strategy

Expanding upon UPI's foundational success, India's foray into developing a holistic Digital Public Infrastructure (DPI) ecosystem has been both ambitious and strategic. UPI revolutionized digital payments with its secure, simple, and inclusive platform, serving as a beacon for subsequent DPIs aimed at bridging gaps across various sectors. This progression underscores a unified vision to harness technology for public good, seamlessly integrating services ranging from e-commerce and healthcare to secure document exchange and beyond.[252]

- **E-Commerce and Financial Inclusion with ONDC and OCEN**: Following UPI's lead, the Open Network for Digital Commerce (ONDC) seeks to democratize e-commerce, offering a level platform for all retailers. Similarly, the Open Credit Enablement Network (OCEN) is pioneering a shift in lending, facilitating access to credit for small businesses and entrepreneurs. Both ONDC and OCEN embody UPI's principles of openness and inclusivity, extending these ideals from digital payments to broader economic activities.[253]
- **Healthcare and Well-being through CoWIN and e-Sanjeevani:** DPI initiatives like CoWIN and e-Sanjeevani have taken cues from UPI's success to enhance healthcare delivery. CoWIN's efficient management of vaccination drives and e-Sanjeevani's telehealth services showcase how DPI can make healthcare more accessible and responsive, leveraging digital solutions to meet urgent and everyday health needs.
- **Secure and Accessible Document Exchange with DigiLocker:** DigiLocker extends the DPI's reach into document management and exchange, providing a secure platform for storing and sharing personal documents. Inspired by UPI's security measures, DigiLocker ensures that individuals have easy and safe access to their essential documents, facilitating a variety of civic and financial engagements.
- **Language Inclusivity with Bhashini:** Embracing the inclusive spirit of UPI, Bhashini aims to eliminate language barriers in the digital space, ensuring that the benefits of

[252] IBEF. "Unified Payments Interface (UPI): Transforming India's Payment Landscape." IBEF, February 27, 2023. www.ibef.org.

[253] "ONDC: B2B Digital Commerce Revolution in India." Deloitte Insights, August 31, 2023

India's digital revolution reach every citizen, irrespective of their linguistic background. This initiative reflects the DPI's commitment to making digital services universally accessible.

- **Public Procurement with GeM:** The Government e-Marketplace (GeM) transforms public procurement by creating an open and transparent platform for buying goods and services. GeM leverages DPI principles to ensure efficiency, transparency, and inclusivity in government procurement, mirroring UPI's impact in fostering a transparent digital payments ecosystem.

By weaving together DPIs like ONDC, OCEN, CoWIN, e-Sanjeevani, DigiLocker, Bhashini, and GeM, India is not just building upon UPI's legacy but is also crafting a comprehensive digital ecosystem. This ecosystem is designed to be inclusive, secure, and user-friendly, offering a wide range of public and private services at scale. Through these interconnected DPIs, India is setting a global standard for digital transformation, demonstrating how technology can be a powerful tool for societal advancement, economic growth, and inclusive development.

Integrating DPIs for Holistic Development

India's journey through digital public infrastructure (DPI) development is marked by a strategic integration of various platforms, each designed to serve distinct but complementary societal needs. This holistic development strategy leverages the success and foundational principles of UPI, expanding them across sectors to achieve a seamless, interconnected digital ecosystem. The integration of DPIs—spanning financial transactions, healthcare, education, commerce, and document management—aims to foster a comprehensive approach to digital transformation, enhancing the ease of living, doing business, and governance.[254]

At the core of India's DPI strategy is the seamless integration of financial and commercial ecosystems. UPI's interoperability model has been extended through ONDC to create an inclusive e-commerce environment, and through OCEN to democratize access to credit. This trinity of platforms is creating a unified financial and commercial infrastructure that supports a wide range of economic activities, from simple transactions to complex commercial engagements, making digital commerce and financial services accessible to all segments of society.

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[254] Sharma, A., & Kumar, P. "Integrating Digital Public Infrastructures: A Pathway to Inclusive Development in India." Journal of Digital Governance and Innovation 1, no. 2 (2023): 45-60.

The integration of DPIs in healthcare, particularly through CoWIN and e-Sanjeevani, showcases India's commitment to using technology for enhanced public health delivery. These platforms not only streamline the provision of health services but also ensure that healthcare is accessible and equitable, leveraging digital technology to bridge the gap between urban and rural healthcare access.

DigiLocker and Bhashini exemplify the integration of DPIs in the realms of education and information, ensuring universal access to essential services. DigiLocker provides a secure repository for educational documents, facilitating seamless verification and sharing. Simultaneously, Bhashini's focus on breaking language barriers through technology ensures that educational materials and government services are accessible to a linguistically diverse population, promoting inclusivity and understanding.

The Government e-Marketplace (GeM) integrates with other DPIs to streamline governance and procurement processes, embodying the principles of efficiency, transparency, and inclusivity. This platform simplifies procurement, reduces costs, and promotes transparency, aligning with the DPI's overarching goal of enhancing ease of governance.

The strategic integration of these DPIs underlines India's vision for a digitally empowered society and knowledge economy. By fostering a unified digital ecosystem that is accessible, affordable, and user-friendly, India is not only enhancing service delivery across sectors but also setting a global standard for holistic development through digital transformation. As India continues to expand its DPI ecosystem, the focus remains on ensuring that these infrastructures are interoperable, secure, and capable of adapting to future technological advancements. The integration of DPIs signifies a move towards a more connected, digital-first approach to development, where technology serves as a backbone for achieving sustainable growth, equity, and access to services for all citizens.

ONDC: Pioneering Next-Generation E-Commerce

The Open Network for Digital Commerce (ONDC) marks a significant leap in India's journey towards creating a more inclusive and equitable digital economy. As a pioneering initiative inspired by the principles of openness and interoperability first popularised by UPI, ONDC aims to transform the e-commerce landscape by fostering an environment that supports fair competition and broadens consumer choice. This ambitious project is not just an expansion of digital infrastructure; it's a reimagining of how e-commerce operates, breaking away from the monopolistic structures that dominate the digital marketplace.

ONDC's mission is to democratize e-commerce by making it accessible to every retailer and consumer, irrespective of their size or financial capacity. By creating a level playing field, ONDC enables small vendors and local shops to compete directly with e-commerce giants, potentially transforming the way India shops and sells online. This initiative represents a move towards dismantling the digital monopolies that currently exist, ensuring that the benefits of e-commerce reach the smallest of retailers. One of the most significant impacts of ONDC is its potential to empower small businesses by connecting them with a broader consumer base. Small and medium-sized enterprises (SMEs), which form the backbone of India's economy, stand to gain immensely from this increased visibility and access. Moreover, consumers benefit from an expanded range of choices, competitive pricing, and the convenience of shopping from a myriad of sellers through a single platform. The promise of ONDC lies in its ability to offer a more diverse, vibrant, and competitive market environment.[255]

ONDC leverages the key lessons learned from UPI's success—primarily, the importance of creating an open, interoperable system that encourages wide participation. Like UPI, which facilitated a seamless transaction experience across different banking platforms, ONDC aims to standardize the way digital commerce is conducted, ensuring interoperability among diverse e-commerce platforms. This standardization is expected to drive innovation, reduce costs, and enhance the user experience across the digital commerce spectrum. By lowering entry barriers and encouraging competition, ONDC is set to become a catalyst for innovation and growth in the digital economy. It opens up new opportunities for startups and tech innovators to develop unique solutions for cataloging, logistics, payments, and customer service, among others. This ecosystem approach encourages a collaborative model of growth, where different players contribute to and benefit from the network effect of an open digital commerce platform.[256]

As ONDC progresses, its potential to reshape the e-commerce sector aligns closely with India's broader digital ambitions. It not only aims to enhance economic efficiency but also to promote social equity by ensuring that the dividends of the digital commerce boom are shared widely and equitably. Looking ahead, ONDC is poised to set a global benchmark for how open digital platforms can drive the next generation of e-commerce, making it more inclusive, competitive, and innovative. ONDC is not just pioneering a new approach to e-commerce in India; it's laying the groundwork for a more inclusive digital future. Through its commitment to open standards and equitable access, ONDC embodies the

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[255] Tiwari, Richa, Swarnika Rastogi, Ronil Kothari, Lakshay Dungarwal, Devansh Bhootra, and Preksha J. "The Impact of Open Network Digital Commerce (ONDC) on India's E-Commerce Ecosystem." International Journal of Research 11, no. 3 (2024).

[256] Kotnala, Snigdha. "ONDC – A Journey of Democratizing Digital Commerce for Social Impact." Capgemini, August 17, 2023.

spirit of India's digital revolution—aiming to ensure that the benefits of technology reach every corner of society.

Lessons from UPI: Enhancing Future DPIs

The Unified Payments Interface (UPI) stands as a testament to India's innovative approach to digital public infrastructure (DPI), offering profound lessons for enhancing and developing future DPIs. The unparalleled success of UPI, driven by its user-centric design, interoperability, and security, provides a robust blueprint for the next generation of digital services across various sectors. Here, we distill key learnings from UPI that can guide the evolution of future DPIs, ensuring they are as impactful and transformative.

- UPI's success is largely attributed to its interoperable framework, allowing transactions across diverse banking platforms seamlessly. This principle of interoperability is crucial for future DPIs, ensuring different systems can communicate and work together efficiently. For instance, the Open Network for Digital Commerce (ONDC) adopts this lesson by enabling various e-commerce platforms to interconnect, promoting fair competition and consumer choice.
- The intuitive and straightforward design of UPI has been pivotal in its widespread adoption, demonstrating the importance of a user-centric approach in DPI development. Future DPIs, such as digital health platforms like e-Sanjeevani or educational resources like SWAYAM, must prioritize ease of use to ensure they cater to the broadest audience, including those with limited digital literacy.
- UPI has set high standards for security, employing multi-layered protocols to protect user data and transactions, thereby earning user trust. As new DPIs emerge, embedding robust security measures from the outset is imperative. This involves not just technological safeguards but also transparent policies around data usage and privacy, as seen with platforms like DigiLocker, enhancing public confidence in digital services.
- UPI's architecture was designed for scalability, a feature that has allowed it to handle the exponential growth in transaction volumes. Future DPIs must similarly be scalable, capable of expanding to meet growing demand without compromising performance. This is particularly relevant for platforms like Bhashini, which must evolve to support India's vast and diverse linguistic landscape.
- At its core, UPI is an inclusive platform, designed to bring digital financial services to every stratum of society. Future DPIs must continue this legacy of inclusivity, ensuring that digital services are accessible to all citizens, regardless of their socio-economic status, geographic

location, or digital proficiency. Initiatives like ONDC and OCEN are prime examples, aiming to level the playing field for small businesses and consumers alike.

- UPI's development and success have been bolstered by collaboration between the government, private sector, and civil society. This collaborative approach is essential for future DPIs, fostering innovation and ensuring that digital infrastructures meet the diverse needs of the population. Such partnerships can accelerate the deployment of DPIs and facilitate the integration of cutting-edge technologies.

The lessons from UPI's journey offer invaluable insights for the development of future Digital Public Infrastructures. By adhering to principles of interoperability, user-centricity, security, scalability, inclusivity, and collaboration, India can continue to build DPIs that not only enhance service delivery across sectors but also drive societal transformation. As India looks forward to the next phase of its digital revolution, leveraging these lessons will be critical in ensuring that DPIs remain powerful tools for inclusive growth and development, embodying the spirit of innovation that UPI so exemplarily showcased.[257]

As India continues to innovate and expand its DPI ecosystem, the focus remains on ensuring that these digital infrastructures are scalable, secure, and sustainable. The ongoing commitment to bridging digital divides across all facets of life not only enhances India's digital sovereignty but also serves as a model for the world on leveraging technology for inclusive development. In this journey towards a digitally inclusive society, India reaffirms the principle that technology should be an enabler for all, ensuring that the dividends of the digital revolution are equitably shared, thereby fostering a more inclusive, empowered, and connected society.

Envisioning a Unified Digital Infrastructure

India's journey through the deployment of DPIs, from the pioneering UPI to the expansive reach of the ONDC, and beyond, symbolizes a forward-thinking approach to technology deployment for public good. This journey underscores an ambitious vision: to establish a unified digital infrastructure that seamlessly integrates various services across sectors, enhancing the quality of life for all citizens and propelling the nation towards comprehensive digital empowerment. The vision for a unified digital infrastructure in India is centered on creating a cohesive ecosystem where services, whether related to finance, health, education, or commerce, are interoperable and accessible through a

[257] Ministry of Electronics & Information Technology, Government of India. "Digital India: A Vision for Inclusive Growth." New Delhi, 2022.

single digital framework. This ecosystem aims to eliminate silos between different services, allowing for a seamless flow of information and transactions that can significantly enhance efficiency and user experience.

The cornerstone of this unified infrastructure is interoperability, inspired by UPI's success in facilitating transactions across diverse banking systems. Extending this principle, a unified digital infrastructure envisions a future where citizens can access a wide range of services with minimal friction, regardless of the platform or service provider. This approach not only simplifies the user experience but also fosters a competitive and innovative environment where service providers can focus on enhancing their offerings. Trust and security, hallmarks of successful DPI implementations like UPI and DigiLocker, are foundational to the envisioned unified digital infrastructure. Protecting user data and ensuring secure transactions will be paramount, necessitating the adoption of advanced cybersecurity measures and privacy-by-design principles. This commitment to security and privacy will be crucial in maintaining public trust and encouraging widespread adoption of digital services.

A unified digital infrastructure inherently champions inclusivity, aiming to bridge the digital divide by making digital services accessible to every Indian, regardless of socio-economic status, geographic location, or digital literacy levels. This inclusivity extends to ensuring services are available in multiple languages, accommodating India's vast linguistic diversity, and providing accessible interfaces for people with disabilities, ensuring that digital transformation is equitable. The development of a unified digital infrastructure will be bolstered by collaboration between the government, private sector, academia, and civil society. This collaborative model, which has been effective in the roll-out of UPI and other DPIs, will encourage innovation, leveraging the strengths and insights of each sector to create a dynamic and responsive digital ecosystem.

Envisioning a unified digital infrastructure is about imagining a future where technology serves as a backbone for societal advancement and economic growth. It's a vision where digital services are not just tools for convenience but catalysts for empowerment, education, and health for the entire population. As India moves forward with this vision, the lessons learned from the successful deployment of DPIs like UPI, ONDC, and others will be invaluable. They provide a roadmap for how to build digital infrastructure that is inclusive, secure, and capable of transforming the nation. The unified digital infrastructure represents not just the next step in India's digital evolution but a commitment to building a future where everyone can benefit from the opportunities that technology brings.

Illuminating the Path for Global Digital Evolution

The DPI model championed by India has set new international benchmarks for digital equity and access. UPI's transformative approach to financial transactions has laid the groundwork for other countries to reimagine their digital payment systems, making financial services more accessible and user-friendly. Similarly, the principles guiding ONDC and initiatives like DigiLocker are redefining commerce and document management for the digital era, promoting a more inclusive digital economy that benefits everyone. India's approach to DPI offers a comprehensive blueprint for digital transformation that can inspire nations worldwide. By seamlessly integrating diverse digital services across healthcare, education, commerce, and governance, India illustrates a vision where digital infrastructures catalyze broad societal change. This integrated ecosystem showcases the power of digital solutions in creating a unified platform that amplifies service delivery and societal wellbeing.

The foundation of India's DPI success lies in the collaborative synergy between government entities, the private sector, academia, and civil society. This collaborative model is instrumental in driving the innovation that underpins DPI, ensuring that digital platforms are adaptable, resilient, and aligned with the diverse needs of the population. It's a testament to the strength of partnerships in navigating the complexities of digital evolution, providing a template for international cooperation in digital advancements. India's DPI ecosystem transcends national success, sparking a vital international discourse on the role of digital infrastructure in modern governance and development. By sharing its journey, India encourages a global exchange of ideas, strategies, and lessons learned, essential for shaping a collective vision for the future of digital public services. This dialogue is crucial for harmonizing global efforts towards a cohesive digital future.

The trajectory of India's DPI initiatives hints at the exciting possibility of a globally interconnected digital infrastructure. Such a future envisions digital services that cross borders, making the digital economy a truly global, inclusive, and equitable space. It's a vision that builds on India's innovations, aiming for a world where digital access and efficiency are universally available, ensuring global participation in the digital revolution. India's DPI narrative is more than a national achievement; it's a guiding light for the global community, showcasing how thoughtful integration of technology can uplift societies. As the world progresses into an increasingly digital future, India's DPI model, with its core values of inclusivity, interoperability, and security, offers inspiration and guidance, proving the transformative potential of digital infrastructures in fostering a connected, inclusive, and prosperous global society.

As nations illuminate the path for global digital evolution, the movement towards DPI becomes a beacon for transformative change. The "50-in-5" campaign[258], supported by a consortium including the UNDP and various other international organizations, represents an ambitious leap, bringing together 11 countries from diverse economic backgrounds, such as Bangladesh, Estonia, and Singapore. These 'First-Mover' countries are not merely adopting DPI but also setting benchmarks and sharing key learnings to accelerate global adoption. The goal for 50 countries to implement DPI components by 2028 heralds a new era of cooperation and digital solidarity. In parallel, the World Bank's "Digital Progress and Trends Report 2023"[259] sheds light on how digital technologies are critical in bridging the developmental divide. This report emphasizes the stark digital divide that mirrors the development gap and the potential of DPI to combat this issue. It documents the economic and job creation benefits realized through digital sectors, while also advocating for strategic policy shifts to foster inclusive digital adoption, particularly in developing nations. The International Telecommunication Union (ITU) underscores DPI's role in achieving the Sustainable Development Goals by 2030[260]. By promoting a people-centered and interoperable approach to digital services, DPI can unleash a multitude of socioeconomic benefits, from bolstering economic resilience to enhancing gender equality.

The narrative of digital progress is increasingly shaped by these global efforts, emphasising that today's choices in building DPI will define tomorrow's opportunities for innovation and growth.

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