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Digital Public Infrastructure for Cross-Border Inclusion: Insights from India–UK Collaboration

Mr. Thalabattula Raj Shekhar[1], Prof. Dr. Muktevi Srivenkatesh

[1]Student, [2]Asspociate Proffessor

ABSTRACT

Digital Public Infrastructure (DPI) has emerged as a transformative tool for governance, inclusion, and economic growth, with India and the United Kingdom serving as frontrunners in shaping global digital ecosystems. This paper aims to examine the role of DPI in fostering digital inclusion, enhancing remittances, and creating cross-border collaboration opportunities between India and the UK, while highlighting their joint potential in setting global benchmarks for secure and interoperable digital systems. The study employed a review-based methodology, drawing on policy reports, government documents, and international frameworks to analyze DPI's design principles, inclusivity frameworks, and case insights across sectors such as payments, identity systems, data governance, and healthcare. Findings reveal that India's innovations, such as Aadhaar, UPI, and DigiLocker, have achieved massive scalability and affordability, while the UK's strengths lie in its regulatory expertise, fintech ecosystem, and remittance networks. Together, they illustrate how DPI can reduce remittance costs, promote financial inclusion, and strengthen citizen trust in digital services. The discussion underscores that while significant progress has been made, challenges remain in areas such as cybersecurity, digital literacy, and equitable rural access. The paper concludes that India–UK collaboration has the potential to reduce global remittance costs, expand digital inclusion, and empower developing nations with adaptable DPI models. It recommends deepening bilateral cooperation in regulatory frameworks, promoting interoperable cross-border payment systems, investing in digital literacy, and supporting research-driven innovation to ensure that DPI contributes sustainably to achieving global development goals and fostering a digitally inclusive global economy.

Keywords: Digital Public Infrastructure (DPI), Cross-Border Remittances, India–UK Collaboration, Financial Inclusion

1. INTRODUCTION

Digital Public Infrastructure (DPI) has originated as a transformative foundation of present-day governance and inclusive economic growth. Anchored in the principles of affordability, accessibility, inclusion, and empowerment, DPI represents much more than just technology; it is a systemic enabler that redefines how citizens, businesses, and governments interact in the digital age. By integrating core pillars such as digital identity, frictionless payments, and secure data exchange, DPI has not only expanded connectivity but also advanced rapid innovation, strengthening e-governance, and nurturing digital entrepreneurship.

Ozili et al [1] states that globally, DPI is being recognized as a critical driver of financial inclusion, service delivery, and sustainable development, with India and the UK standing out as frontrunners in this digital transformation journey. India's scalable, low-cost, and inclusive digital models, such as Aadhaar, UPI, and DigiLocker, have exhibited the potential use of public digital infrastructure to empower billions, while the UK's robust regulatory frameworks, fintech ecosystem, and financial networks provide a strong foundation for secure and transparent adoption of digital solutions.

Together, both nations are uniquely positioned to collaborate and shape the next generation of global digital systems, with particular opportunities in cross-border payments, remittances, open finance, and cybersecurity resilience. Such a partnership not only promises mutual benefits for their economies and citizens but also holds the potential to set global benchmarks in creating a trusted, interoperable, and inclusive digital future.

Digital public infrastructure was set in motion in 2015 [2] . It connects public, statistics, and currency. It will be in charge reserves and allocates data safely. It fastens the world to each other and helps in interactions. It heartens recasting ideas and then approaches. It is a manifesto that smooths data trading across different organisations. In the case of government sectors, DPI is secure and supports the public in different areas. The main support from DPI is giving an identity to the citizen, the payment done by the citizens should be secured, and the related data to be secured. While giving a printing resolution, it determines the quality, detailed print, gap usage, and even the scanner also goes promptly. All this process goes in a dot process, which gives accurate information. The good thing is that everything goes cashless.

1.1 Statement of Problem

Despite the remarkable progress made in building Digital Public Infrastructure (DPI), significant challenges continue to limit its potential for fostering inclusive growth and reducing cross-border remittance costs. While India's DPI models such as Aadhaar, UPI, and DigiLocker have demonstrated scalability and affordability [1] [2], critical gaps remain in cybersecurity, digital literacy, and rural access [3]. Similarly, the United Kingdom's strengths in regulatory expertise and remittance networks [4] [5] are constrained by high transaction costs, averaging above 7%, well above the Sustainable Development Goal (SDG) target of 3% [4]. This disconnect underscores the urgent need for collaborative frameworks between India and the UK to develop interoperable, secure, and affordable DPI systems. Without such cooperation, both nations risk falling short of their shared objective to advance financial inclusion and global digital equity [6]

2. METHODOLOGY

The report [3] explains that the main methodology of DPI is to grow a strong bond between the Government and private organisations. The process is implemented for the setup of a powerful government, combining citizens and individuals, and implementing rules such as comprehensiveness and secrecy by blueprint, using this structure to expand and transport computerized services skillfully. This system is organised and expanded to confirm multiples and expand embracement. All parts of the

community can easily participate in this computerized process with minimal resources. It accepts the whole business area to use the technology with their own development strategies.

Ozili et al. [1] further notes that the extent of improvement procedure re-designing utilising a unified and compatible structure and placement of emerging machinery, such as a gloom and ambulances, would be tackled to strengthen the carriage of governance facility to the public

2.1 Design Guidelines of DPI

According to Bakshi & Asha, [6] The main motto of DPI is to create a cashless environment throughout the country. So, they designed the structure of the software in a very secure manner, which helps people to save themselves from cybersecurity risks. It highlights and unlocks, compatible, extensive, and safe innovation structure established on the standards like solitude by plan, worldwide entrance, and society involvement. It is planned to comprise each and every section of society. There are mainly three coats in DPI:

a. Identity coat - Photo identity cards come under this identity [6].
b. Payment coat- all the online payment platforms like UPI come under this identity [6].
c. Data Governance Coat - digilocker and account gathered comes under this identity [6] [3].

It subsequently grew very successfully globally. It needs a lasting sight, powerful common private companion ends, and large-scale partners' commitment everywhere in the complete system from plant to execution and observation. It is created with an easy structure to make any kind of changes or modifications for the updating of the platform to meet the citizens' needs. It creates a transparent transaction process that ensures the DPI systems run smoothly and easily answer the citizens' questions. It advertises the need for unlocked software and allocates the capacity to grow answers.

2.2 Case Insight of DPI

This paper emphasizes its skills to improve general help and economic incorporation through safe methods [1]. Every country has its own beneficial structure of this DPI in various areas. It optimizes all the public systems, such as a well-being allocation, tariff accumulation, and even citizens' identity checks are done in more productive manners. This method of cashless payment even helps in the expansion of one's business and shows a significant change in their lives. The main appreciable thing about DPI is secured transformation. This all can be done only when both the private and government sectors work in a planned manner. The main problems involved the online division, cybersecurity risks, and a lack of knowledge about the usage of DPI, etc. It has stimulated financial activities by joining country technicians to broad business areas and helping MSMEs with quick access to credit. Our country, India, proved itself in the quick circulation of DPI and even positive uses of gossip about DPI. Is playing a leadership quality, advertising the carbon discharge using online devices.

2.3 Prototype Development of DPI

This brings about creating a foundational partnership of many blocks, which helps them to develop the system with proper technical benefits [6] . It grows the basic connections of the system, such as super-speed broadband and mobile access, which are very important for any kind of DPI to work properly. It constructs the digital app with all necessary security policies to meet the inhabitants of any country. It meets all the lawful and controlling structures to guarantee the seclusion, safety, and clean challenge with this platform. It is planned irrespective of users' settings or economic status. In different countries, it is executed in different ways. For suppose, in India, Aadhar and UPI are the ways; when it comes to Brazil, it is the Pix payment system, etc. The main performers of DPI are the Gates Foundation, Codevelop, and Rohini Nilekani Philanthropies. It even includes the banking system, health sectors are also community service centres. It mainly brings fraud in the government sector down.

2.4 Recent ASR efforts of DPI

Nowadays, DPI is more focused on spreading basic systems for growth with the help of AI. [6] Some of the developments included are the Ayushman Bharat digital mission, which carries out the AI system. It is an open market that has started to improve the standards of digital marketing. Universal teamwork, like G20's main Motto, is to share and gather a lot of information in different parts of the Earth [7]. The nation's support for the NPCI digital payments platform was UPI [7]. The mission of certain groups, such as One Future Alliance and Social Impact Fund (SIF), is to implement the system to lower-income nations.

Even AI is integrating with this platform to increase citizen security. It seeks to increase the services offered by this app, which facilitates DPI adoption globally. NEP 2020 is another significant area that DPI has recently begun. It is the technology that is utilised more frequently to train instructors to improve student performance. The Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA) is the Digital India Program. According to the Press Information Bureau [8] the inclusion date was March 31, 2024**.**

2.5 Inclusivity frameworks of DPI

It verifies that enough internet connectivity is available in both urban and rural locations. despite the fact that it is inexpensive and accessible to a wide range of socioeconomic and ethnic groups. It even aids in system monitoring according to public needs. Additionally, a company called Data Empowerment and Protection Architecture (DEPA) was founded to combat cybersecurity risks in the nation. It is crucial when making any significant decisions for the program's well-being [3] . It keeps a balanced relationship between citizens, the market, and the government. As the system started spreading globally in a quick manner, its updating also became a tough task for the government. As it needs to check every individual's identity, payments, transactions, and even the exchange of data, everything should go in a smooth manner.

3. INDIA'S DIGITAL JOURNEY

Press Information Bureau [9] explains that by 2025, there will be 97 crore internet connections in India, up from 25.15 crore at the beginning of the country's digital journey. The initiative was launched by our

esteemed Prime Minister, Shri Narendra Modi. This program's primary goal is to transform India into a fully functional, digitally enabled society.

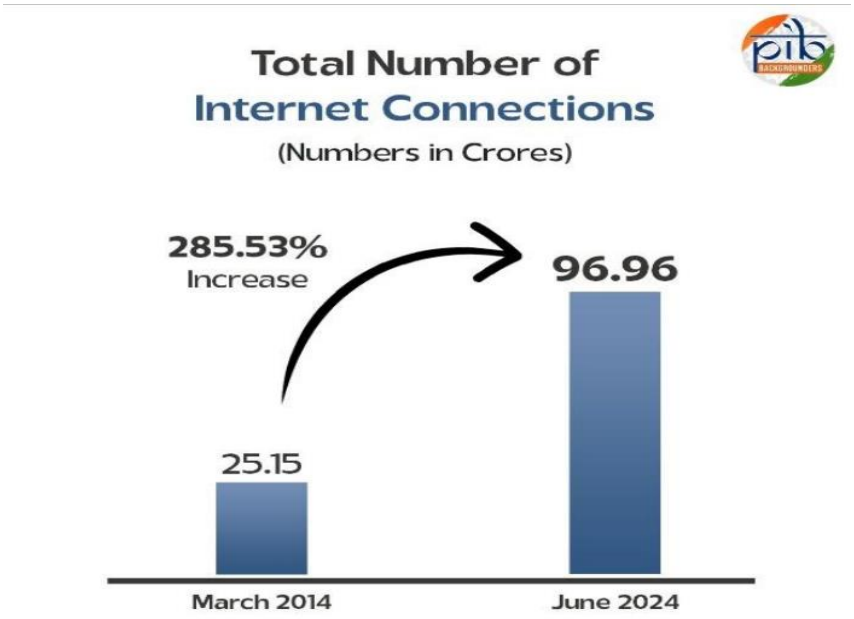

Figure 3.0 — India's Internet Revolution: 2014 vs 2024.

Source: Press Information Bureau [9]

The main routes of Digital India are:

a. Data super highways

This looks after all rural and urban particulars in infrastructure. DoT will be the nodal department, and it was estimated around 32 crores [10].

b. International approach, versatile consolidation

This cost around 16000 crores and covers all the remote villages in approaching mobile connectivity with all the village people [6].

c. People's cyberspace approach scheme

These work like flexible multi-use assistant hubs. A maximum number of post offices will be used as these centres to implement the scheme.

d. Electronic Governance

This is also called e-Governance or virtual governance with electronic administration, which implements the online transaction applications like certificates, Aadhar, voter cards, etc. This makes the work automatic, and verifications and status finding become easy for all the citizens [6] [3].

e. e-Kranti

Massive open online courses (MOOCs) are developed under this system. Healthcare centres, helping farmers, and even providing benefits to the common man, with the help of mobiles, will be monitored. This strengthens financial issues, the magistrate system, planning for growth or enlargement, blueprints, and even network safeguard within the country will also be verified [6].

f. Statistics for all

This program needs very few extra sources. As it uses the survival frameworks to pass the messages regarding any information about the government schemes and safety measures at a time to all the citizens.

g. Electronic Production

This helps with taxes, economic census, mobiles, setup boxes and ATM programs. This should be updated frequently as the existing information may not be sufficient.

h. IT for works

Many students will be trained under this IT program for jobs in different areas. These students will be selected from rural areas mostly. So this helps in the development of village areas too.

i. Advance gathering programmes

Biometric system and Wi-Fi to all government sectors is encouraged here this designs an e-mail system which helps in information transfer.

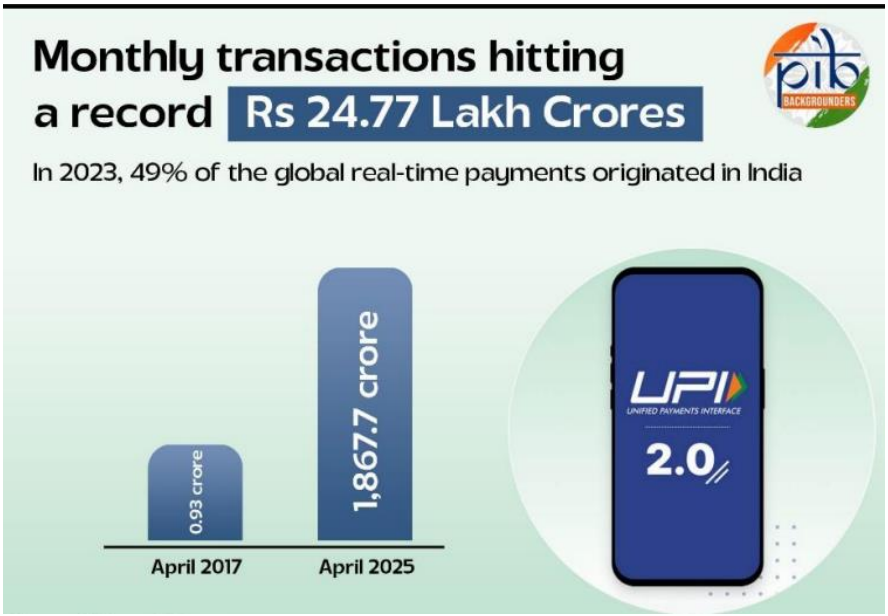

Figure 3.0.1: UPI 2.0, Powering India's Digital Payment Surge

Source: NPCI [11]

3.1 Connectivity & Access

India's digital transformation over the past decade has been nothing short of remarkable, driven by a relentless focus on improving connectivity and ensuring affordable access for all citizens. One of the most notable milestones has been the upgradation of broadband standards, with the minimum definition rising from 512 Kbps in 2014 to 2 Mbps in 2024, reflecting the country's ambition to align with global benchmarks for high-speed internet.

Internet speed has witnessed a massive 2,432% growth, leaping from 4.18 Mbps to 105.85 Mbps, dramatically enhancing the quality of digital experiences across education, healthcare, governance, and business. Parallel to this, subscriber numbers quadrupled from 251 million to 954 million, demonstrating the widespread adoption of internet services and the strengthening of India's position as one of the world's largest connected populations [2].

Perhaps the most transformative achievement has been the drastic reduction in data costs, from ₹268 per GB in 2014 to just ₹9.18 per GB in 2024—a 96% decline that has democratized internet access and enabled millions of low-income households to come online. This affordability, combined with improved connectivity, has fueled a surge in consumption: average monthly data usage skyrocketed from 0.26 GB to 20.27 GB per user, marking an extraordinary 7,696% increase [9].

Rural India, once constrained by limited access, has also made significant strides. Rural tele-density now stands at 59.19%, reflecting consistent efforts to bridge the digital divide and bring inclusive growth to underserved regions. Flagship initiatives like BharatNet have played a pivotal role by connecting over 2.1 lakh Gram Panchayats with optical fiber cables (OFC), enabling 10.5 lakh Fiber-to-the-Home (FTTH) connections, and establishing more than 1 lakh Wi-Fi hotspots across the nation [9].

Collectively, these achievements underline how India has transformed from a digitally under-connected society to a global leader in affordable, inclusive, and high-quality digital access within a single decade.

Table 1: Improvement in metrics of digital connectivity over the past decade (Adapted from Bakshi & Asha [6]**)**

Metric	March 2014	March 2024	% Increase / Change
Broadband Definition	≥ 512 Kbps	≥ 2 Mbps	300%
India's Ranking in Avg Internet Download Speed	130	16	Improved by 114 ranks
Average Download Speed	4.18 Mbps	105.85 Mbps	2432.29%
Internet Subscribers (in mn)	251.59	954.40	279.34%
Total Subscribers (in mn)	933	1199.28	28.54%
Urban Tele-density	145.78%	133.72%	-8.27%
Rural Tele-density	43.96%	59.19%	34.64%
Overall Tele-density	75.23%	85.69%	13.90%
Average Data Cost/GB	₹268.97	₹9.18	-96.58%
Average Data Consumption	0.26 GB	20.27 GB	7696%

3.2 Achievements under Digital India

The Digital India initiative has been the cornerstone of India's transformation into a digitally empowered society and knowledge economy. Over the past decade, it has delivered landmark achievements across governance, education, finance, healthcare, and citizen services, reshaping the way India interacts with technology. It is the system designed by the central government of India in one's hand. This removes the manual work in all departments, both private and government sectors. It aimed to improve living standards through inventions to provide the best administration. This improves learning and protects the personal data of the citizens. This came into force on July 1st, 2025. There are five different areas of digital media, like recordings, sound, content typing, profile, and multimedia. Helping to bring all the services required to the common man on one platform.

At the core of this transformation are NIC Data Centres and the MeghRaj Cloud, which provide secure hosting infrastructure for e-Governance applications, ensuring reliability, scalability, and efficiency in government digital services [1]. These centres are located in Delhi, Hyderabad, Pune, and Bhubaneswar. These are run with 30 sub-centres in all the states to help the central government with the smooth working of the system. These NIC centres in all states and at the Central supply solutions to all the concerns raised. This improves the system of governance and helps in the transparent growth of the society, and all the work will be properly progressed. These data centre requirements are increasing day by day to meet the needs of citizens' expectations. There is an unbroken requirement to construct planned frameworks that provide lofty accessibility, fast manageability, well-organized administration, and upgraded practice of assets.

In the domain of governance without paper, DigiLocker has originated as a groundbreaking platform, empowering over 37 crore users to store, access, and share official documents digitally—reducing dependency on physical records and promoting transparency [10]. This is a guarded program started by the digital government to take care of the important catalogue works like driving licences, academic certificates, and personal documents etc. This process starts with the manual documents and encourages the digilocker. Even though this is very helpful for scholars, in connection with mark sheets, certificates, etc., and even makes scholarships work very easily, the proper use of Digilocker requires a properly maintained internet speed connection. They have a proper security system with a well-organised confirmation code from the main furnishing organisation. Some of the security methods include OTP sent to recorded phone numbers, checked program forms, scanning documents, and citizen IDs, among others.

Also, education has undergone a paradigm shift with DIKSHA, the world's largest e-learning platform, enabling inclusive learning opportunities. With more than 556 crore sessions, DIKSHA has bridged classroom learning with digital pedagogy, ensuring that students, teachers, and institutions have access to quality resources at scale [2].

To simplify citizen access to government services, the UMANG App has become a one-stop solution, integrating 2,077 services across 23 languages and reaching over 700 million users. It stands as a symbol of accessibility, inclusivity, and linguistic diversity in governance. For using the different assistance given by the central, state, and local governments, UMANG is very helpful. All types of government-related payments, services, and their information can be easily known. This is also updated in multiple languages used in India. This can be easily used on Android mobiles. This is a benevolent usage app that provides all the details of individuals. This is under the control of the Ministry of Electronics and Information

Technology. Special features like demise benefits, tariff benefits, and payment are also available, and this can be used anytime and even anywhere that 24-hour service is provided [10].

The backbone of interoperability is powered by API Setu, which integrates 6,000 APIs and has already enabled more than 312 crore secure transactions, fostering innovation and seamless data exchange between government departments and service providers. This app is expanded by the Ministry of Electronics and IT, Government of India. This promotes the enduring of facts and particulars securely. The goal of API Setu is to open a manifesto that encourages the design of biosphere and even helps in savings. 'Setu' stands for self-employment and talent utilisation with supporting marketers. This also plays a vital role in the education sector, the health sector, and various business ideas. The communication point of view between businessmen and customers is maintained with high alert security with this app. This is controlled mostly by centralised brokers. There are various types of API, like open API, internal API, composite API, and partner API, which are completely free of cost to all the users [10].

On the financial front, UPI (Unified Payments Interface) has been a game-changer, enabling small companies, suppliers, and millions of consumers with quick, low-cost, and interoperable digital payments. India is now the world leader in the adoption of fintech, and it has completely changed the country's payments scene. Unified Payments Interface is what it stands for. It is a fully secure mobile application-based transaction solution. It is simple and safe to make various payments, such as money transfers and bill recharges. Beginning in 2016, the work has been underway.[6] [11]. All the affirmations can be done easily and wisely without any loss to the debtors. After the confirmation code by the deathly only takes the next step of fund transfer. This transfer can be made from anywhere and at any time, irrespective of holidays. They show cashless transactions, which are very helpful for every citizen. These are also done completely in free of cost. The complete control of UPI is made by the Reserve Bank of India RBI, which was first launched by the National Payments Corporation of India NPCI.

In healthcare, digital interventions like Ayushman Bharat, e-Sanjeevani, and Co-WIN have accelerated the digitization of healthcare delivery, ensuring accessible telemedicine, efficient vaccination drives, and universal health coverage for millions of citizens. Aayushman Bharat Pradhanmantri Jan Aarogya Yojana is also known as Modicare. It is a health insurance scheme that provides free services to all the needy in our country. This provides insurance of around 5 lakh rupees for the family in a year. It overall covers 50 crore citizens. This one is provided by both the state and the Central governments. This is a good beneficiary skin to all the citizens who cannot afford high amounts for serious diseases or injuries. This was started by the National Health Policy 2017. This is a huge government practice of health insurance on the whole planet. All citizens about 70 years old are suitable for the scheme [6].

Lastly, the National Knowledge Network (NKN) has been instrumental in building a high-speed digital backbone, interlinking research institutions, universities, states, and government bodies, thereby fueling innovation, collaboration, and digital governance. This was first launched in 2010 by the Cabinet Committee on Infrastructure CCI. The main theme of the National Knowledge Network is to discuss the investigation details for University education and all the educational institutions. It provides a broadband network, which makes the investigation process easy. In this process, the agriculture sector is also added to the health and educational sectors, etc. It even works on here after commands. This manifesto is designed with updated technologies and security processes. The street borders are properly maintained. It

is a successful method of collaborating, a method of collaborating soul and understanding expertise in the tracking of unique and institutional purposes [12].

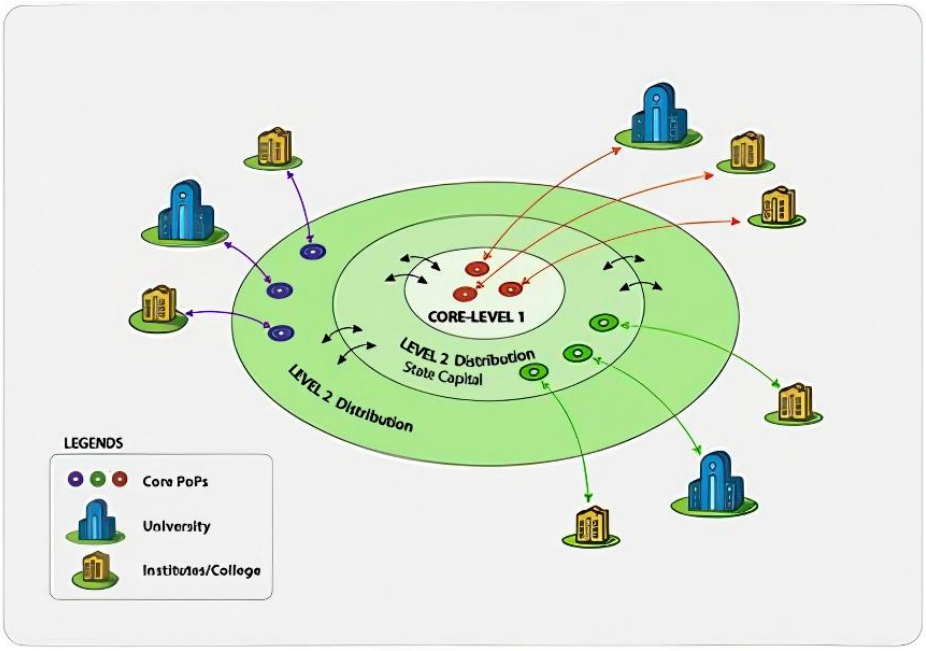

Figure 3.2: NKN layered network design

Source: NKN-[12]

Together, these initiatives showcase the breadth and depth of Digital India's achievements, transforming governance, empowering citizens, and positioning India as a global digital leader.

4. UK's Digital & Remittance Landscape

4.1 Remittance Trends

The United Kingdom plays a pivotal role in the global remittance ecosystem, with migrants using a wide range of channels such as Money Transfer Operators (MTOs), banks, digital wallets, and even informal networks involving friends and family [4].

According to the World Bank [4], the cost of sending £120 abroad averaged around £8.5, reflecting the continued importance and expense of these financial flows. Encouragingly, the average cost of remittances has seen a steady decline from 9.66% in 2009 to 7.12% in 2019. Yet, this remains well above the Sustainable Development Goal (SDG) target of reducing remittance transaction costs to 3% by 2030, underlining the scope for further progress. Remittance is the transfer of money from one account to another in return for something. This is done globally. This transfer can be done on different platforms. All industries are developing all aspects by digitalising with updated technology in their regular system. This makes the work in a hurried, planned, and translucent manner. This system is mostly helpful to low and middle-income countries. This leads to speculation of different countries to help all these low and middle-earning countries. Even in India, this is a good share from various other countries. This money is used mainly for food education to all the needy in those countries – World Bank [4].

Factors of UK Digital UK's digital always have a strong extension in its digital area. This shows a vigorous increase in retail operations by a growing worldwide earning system. This UK remittance market will be approximately 2.05 (US Billion). This dispatches a record by revealing to their dealer that an excellent bill has been paid. The UK provides most of its remittances to India, Pakistan, and Nigeria. These days, in the UK, 8% of its transactions are done digitally. There is no limit on remittance [3].

There are two types of remittances;

1) Inward remittance: It mentions the transfer of endowment from different countries to the local accounts. The process takes place through sanctioned banks from the centre to the receiver. When these are put to route through specific online banking websites. Then this sender's currency is transformed into the regional recipient currency, which helps with usage. Then the transformed amount is sent to all eligible accounts from the receiver bank or government. This inward remittance is used by every citizen, businessman, and NRI. etc [3].

2) Outward remittance: This is transferring an amount from the local government to other countries' banks for worldwide studies, different medical purposes, or for imports and exports. Hereafter, the local currency is transferred to the sent country's currency and then used by the government. Before the transfer of the amount, the centre's details are always verified. The main transfer is done through banks [3].

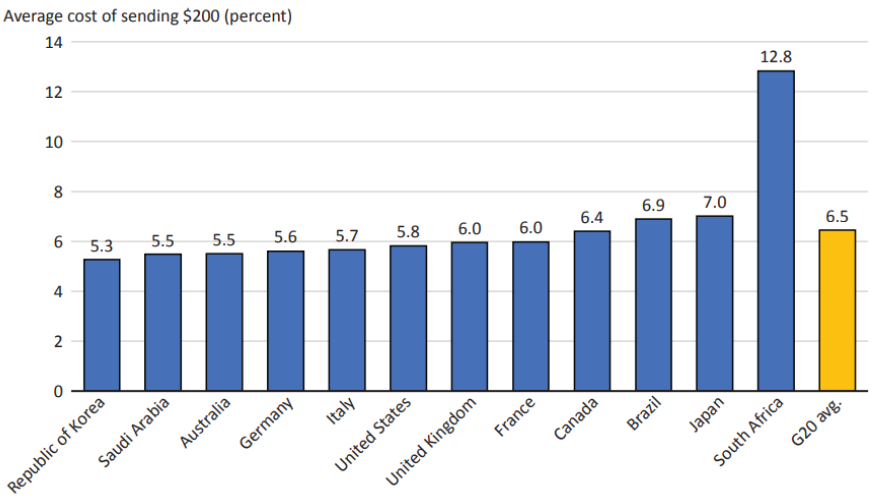

Figure 4.1: The Cost of Sending Money: G20 Remittance Comparison

Source: World Bank — [4]

4.2 Challenges

Despite this downward trend, significant cost disparities remain across countries and payment methods. For instance, sending remittances to Bangladesh can be nearly cost-free in certain cases, often due to promotional offers, whereas transferring the same amount to Lithuania in cash can cost as much as 24.8% (£29.86) [4]

- A key factor influencing costs is the mode of transfer: cash-based transactions are consistently more expensive compared to bank transfers and digital payments. In this landscape, India stands out as the least costly destination, with all the transfer methods priced below 6%, making it the benchmark for affordable remittances. Even though we have many benefits with digital payment, we have some issues too. Organisations face issues with the inheritance framework, A deficiency of transparency in payment and interchange costs. The requirement for in progress expenditure in innovation to stay competitive in a quickly moving trading market. A lot of classical remittance gives us dependence on old-fashioned clothes and isolated Central finance structures that are hard to lamina and modified to modern methods and on time present demands. The prominent expenditure needed for modern innovations like AI, blockchain, and real-time remittance structure can be a hurdle for small amount transmit traders.

Heavy usage of online payments may lead to cybersecurity risks, etc. They main paanchvein transactions and easily cheat the citizens. But frequently, in the absence of translucency in larger amounts and interchange causes, it may lead to loss of trust in the brands by the buyers. Some more challenges founder a remittance approach, legal problems, tariff problems, particular defence, working system, observance problem, etc. The government should be more accurate in designing the system to overcome all these issues.

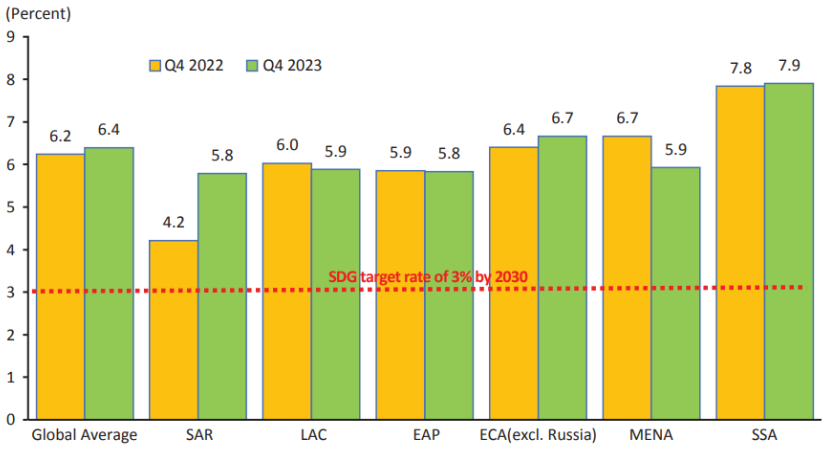

Figure 4.2: Remittance Costs by Region: Progress vs. Global SDG Goal

Source: World Bank — [4]

4.3 Policy Initiatives

- To address these issues, the UK has taken proactive steps through strategic policy measures. The 2023–25 White Paper on International Development emphasizes the need to reduce remittance costs, expand access to banking services, and strengthen mechanisms to combat money laundering [5]

- In parallel, the MSB (Money Service Business) Strategic Action Plan of 2020, led by HM Revenue & Customs along with HM Treasury and law enforcement authorities, was designed to curb

financial crime in the remittance sector, particularly among MTOs. This initiative focuses on enhanced supervision, targeted enforcement against illicit activities, and better collaboration with the private sector[13].

- Together, these efforts reflect the UK's firm commitment to establishing secure, transparent, and accessible remittance corridors, in line with G20 and SDG objectives, ensuring that migrants' hard-earned money reaches their families more affordably and safely.

5. CROSS-BORDER REMITTANCES & DPI

5.1 India as a Global Leader

India has firmly established itself as the world's largest recipient of remittances, recording an inflow of USD 111 billion in 2022 [4] This dominance underscores the country's central role in the global remittance ecosystem.

Notably, low- and middle-income countries (LMICs) account for nearly 76% of total global remittance flows, highlighting the critical importance of affordable remittance channels for economic stability and household welfare in these regions [4].

However, challenges remain: the global average cost of sending USD 200 stood at 6.65% in Q2 2024, which is more than double the UN's Sustainable Development Goal (SDG) target of 3% [4]. Within this landscape, digital remittances consistently prove to be cheaper and more efficient than traditional cash or bank-based transfers, further strengthening the case for accelerating the adoption of digital public infrastructure (DPI) [3].

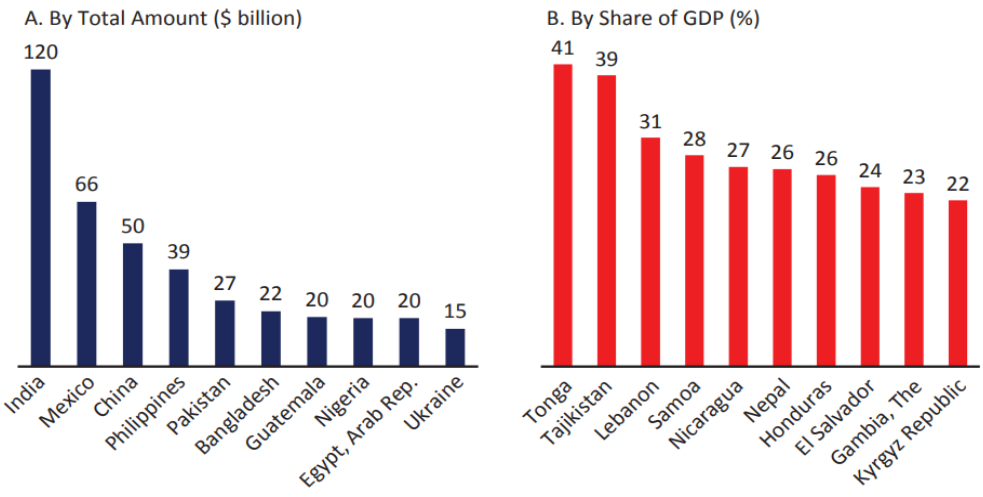

Figure 4.3: India Leads in Total Remittances; Tonga Tops by GDP Share (2023)

Source: World Bank — [4]

5.2 Potential Savings

World Bank [4] Briefs that even a marginal reduction in remittance costs could unlock significant financial benefits. Projections suggest that:

- In a moderate growth scenario (FY25–30), reducing transaction costs by 1–3% could generate savings between USD 8.6–25.9 billion
- In a high growth scenario, the potential savings are even greater—USD 9.8–29.4 billion over the same period.

These figures underscore the enormous potential for financial inclusion and wealth preservation among millions of migrant families worldwide if remittance costs are brought closer to the SDG benchmark.

5.3 Innovations Driving Change

This report emphasizes that India has been at the forefront of innovative solutions that reduce transaction costs and improve efficiency in cross-border payments. This was documented in one of the OECD reports [3] :

- UPI–PayNow Linkage (India–Singapore): This partnership enables instant, low-cost, cross-border transfers directly via mobile apps, with transaction fees as low as 1.42% for USD 200, setting a global benchmark for affordability[11] .

- BIS Project Nexus – Global UPI Collaborations (Project Nexus, BIS): India is actively integrating its Unified Payments Interface (UPI) with the Fast Payment Systems (FPS) of other nations through initiatives like Project Nexus, backed by the Bank for International Settlements (BIS)[14], to build scalable, interoperable, and cost-efficient cross-border corridors.

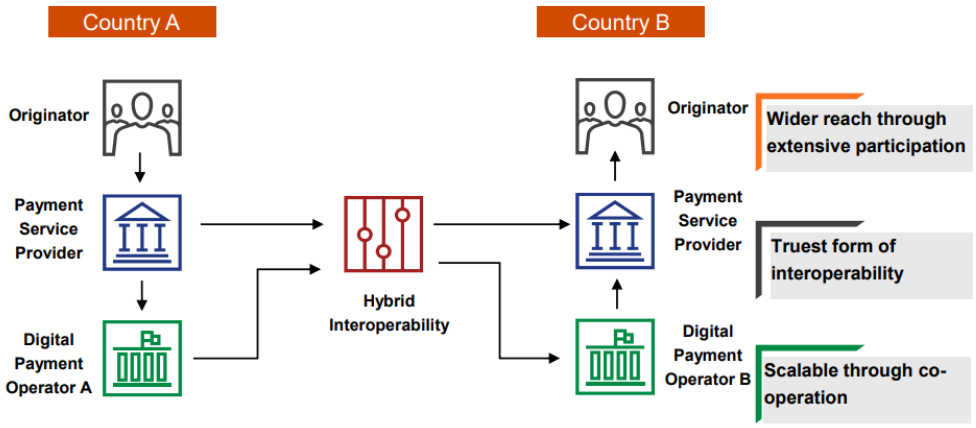

Figure 5.3: UPI & Global Counterpart: Hybrid Interoperability Between Real-Time Payment Systems

Source: *NPCI [11]*

- Central Bank Digital Currency (CBDC – e₹): The launch of India's CBDC represents the next leap in digital payments. Designed as the digital equivalent of cash, the e₹ is fully interoperable with

UPI, allowing seamless transactions through existing QR codes. This innovation holds the potential to further reduce remittance costs while ensuring secure, fast, and inclusive cross-border transfers [15] [11]

6. DEMAND-SIDE EVIDENCE

UK Perspective

- In the United Kingdom, citizen satisfaction with digital services has shown a slight decline, dropping from 70% to 68% in recent years [3]. While this still reflects a relatively strong acceptance of digital solutions, it highlights rising expectations from users who seek greater efficiency, accessibility, and integration in government services.
- The UK government has set an ambitious target of achieving 78% satisfaction with digital services by deepening the digitization of public pathways and minimizing reliance on traditional processes [3]. Achieving this goal, however, requires the creation of standardized integration frameworks, ensuring that institutions do not fall into the trap of fragmented and duplicated digital solutions. A more coherent and seamless ecosystem would allow citizens to experience end-to-end digital service delivery, ultimately restoring confidence and satisfaction.

India Perspective

- India's journey demonstrates the transformative power of DPI in accelerating financial inclusion. The combined effect of Aadhaar (digital identity), Jan Dhan Yojana (financial inclusion program), and Direct Benefit Transfers (DBT) helped the country achieve in just seven years what traditional growth paths would have taken nearly 47 years bringing the majority of its population into the formal banking system[6]
- Building on this foundation, Account Aggregators (AA) represent a paradigm shift towards Open Finance, extending well beyond banking to encompass insurance, investments, and pensions under regulators like RBI, SEBI, IRDA, and PFRDA. This ecosystem enables secure consent-based data sharing, fostering innovation and empowering both individuals and businesses with broader financial access [16].
- At the same time, the Unified Payments Interface (UPI) has been a game-changer, offering a simple, low-cost, and inclusive payment mechanism. Its impact has been particularly profound on small vendors, micro-enterprises, and migrant workers, who now enjoy frictionless money transfers and digital acceptance for daily transactions [11]
- The adoption of UPI was further rapidly grew during the Covid-19 pandemic, as the citizens chose safe, contactless alternatives to cash, embedding digital payments firmly into everyday life.

7.0 INDIA–UK COLLABORATION OPPORTUNITIES

Cross-Border Payments

- BIS Project Nexus –This blueprint is one of the most promising areas of collaboration lies in the creation of a UPI-based corridor between India and the UK[14]. Such a system could be leveraged not only for personal remittances but also for bilateral trade settlements, making financial flows faster, cheaper, and more transparent. By reducing reliance on traditional, costly intermediaries, this corridor has the potential to significantly lower remittance costs, directly benefiting millions of migrants and businesses across both economies [11].

Regulatory Cooperation

- Both India and the UK are global leaders in fintech innovation and digital governance, yet they face common risks around cybersecurity, fraud detection, and financial crime. A structured joint leadership on regulatory cooperation would allow the two nations to share expertise, harmonize standards, and develop risk-based regulation frameworks tailored to remittances and banking services. Such an approach would enhance trust, resilience, and safety nets in the digital financial ecosystem [5].

Global Digital Inclusion

- G20 Digital Economy Ministers – This annex states that India and the UK can extend their collaboration beyond bilateral priorities to play a global leadership role in driving digital inclusion [7]. By sharing their DPI models particularly India's success with Aadhaar, UPI, and DBT—they can guide digitally aspiring nations in building scalable, affordable, and inclusive digital ecosystems. Furthermore, both countries could partner to scale up multilateral projects such as BIS Project Nexus and mBridge, which focus on creating interoperable cross-border payment systems, amplifying their collective impact on global financial inclusion.

Research & Innovation

- This paper notes that on the innovation front, there is significant scope for joint research collaborations [10]. Building on the partnership between the Alan Turing Institute (UK) and MOSIP (India), the two countries could strengthen academic and industry linkages to drive AI-powered digital governance solutions. This would not only promote evidence-based policymaking but also open avenues for cutting-edge innovations in digital identity, payments, and secure data exchanges, with benefits extending well beyond their own borders.

7.1 What is the Model Used For:

This model is designed to assess and evaluate bias or unfairness in any machine learning applications used for Digital Public Infrastructure (DPI). For example, automated loan approval systems, benefit eligibility systems, and user verification systems.

In some instances, models may favor one group over another (i.e., male vs. female, rural vs. urban).

Ethics Sentinel aims to identify, quantify, and mitigate such unfairness.

How It Works:

1.Takes Input Data:

It accepts a dataset consisting of features (such as age, income), a target variable (such as approved or not approved), and one sensitive characteristic (such as gender or region).

2.Trains a Simple Model:

Asimple logistic machine learning model (Logistic Regression) is built and trained to predict the target.

3.Checks Fairness:

After prediction, the model assesses its performance across diverse groups. For instance, the model may assess metrics such as,

- the magnitude of selection bias in group 0 vs group 1 (Selection Rate) and
- the magnitude of bias vs the ideal of Demographic Parity.
- the ratio of the positive outcome rates (Disparate Impact).
- the execution outcome gap on real positive cases (Equal Opportunity).
- the precision gap (Predictive Parity).

Raises Alert if bias is detected:

If the gap between the groups is substantial (say over 10%), the system triggers Fairness Alert.

Fix Option:

It can balance the data with the following simple methods:

- Applying a greater weight to the under-represented group (Re-weighting)
- Using separate thresholds for different groups to achieve equalized fairness.

Utility/Usefulness:

- Ensures that both governmental and non-governmental systems uphold ethics and transparency.
- Helps ensure that no entity is discriminated against.
- Enhances user trust and confidence in the system.
- Assists in the preparation of audit and compliance documentation.
- Identifies bias at early stages, preventing harm to the users.

PYTHON CODE:

```
import numpy as np

import pandas as pd
```

```
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import confusion_matrix, roc_auc_score
from sklearnpreprocessing import StandardScaler

# Creating or Loading the Data
def make_data():
    np.random.seed(42)
    n = 2000
    s = np.random.binomial(1,0.5,n)
    x1 = np.random.normal(0 + 0.5*s,1,n)
    x2 = np.random.normal(1 - 0.3*s,1.2,n)
    logit = 0.5*x1 + 0.8*x2 + 0.3*s
    p = 1/(1 + np.exp(-logit))
    y = np.random.binomial(1,p)
    return np.c_[x1, x2], y,s

X,y,s = make_data()
X_train,X_test,y_train,y_test,s_train,s_test = train_test_split(X,y,s,test_size=0.3,random_state=42)

# Training the Logistic Regression
scaler=StandardScaler()
X_train=scaler.fit_transform(X_train)
X_test=scaler.transform(X_test)

model=LogisticRegression(max_iter=200)
model.fit(X_train, y_train)

y_pred=(model.predict_proba(X_test)[:,1] >= 0.5).astype(int)
```

```
auc=roc_auc_score(y_test,model.predict_proba(X_test)[:,1])

# Metrics for Fairness
def selection_rate(y_hat, s, g):  # portion of the predicted positives in the each group
    return np.mean(y_hat[s==g]==1)

def group_metrics(y_true,y_hat,s,g):
    tn,fp,fn,tp=confusion_matrix(y_true[s==g],y_hat[s==g],labels=[0,1]).ravel()
    if (tp+fn)>0: #recall
        tpr=tp/(tp+fn)
    else:
        tpr=0
    if (tp+fp)>0: #precision
        ppv=tp/(tp+fp)
    else:
        ppv=0
    return tpr,ppv

sr0,sr1=selection_rate(y_pred,s_test,0),selection_rate(y_pred,s_test,1)
tpr0,ppv0=group_metrics(y_test,y_pred,s_test,0)
tpr1,ppv1=group_metrics(y_test,y_pred,s_test,1)

dp_diff=sr1-sr0
if sr0 > 0:
    di_ratio=sr1/sr0
else:
    di_ratio=0
eopp_diff=tpr1-tpr0
ppv_diff=ppv1-ppv0
```

```
# Report
print("------ AI Ethics Sentinel Report -----")
print(f"AUC Score: {auc:.3f}")
print(f"Selection Rate Group0: {sr0:.3f} | Group1: {sr1:.3f}")
print(f"Demographic Parity Difference: {dp_diff:.3f}")
print(f"Disparate Impact: {di_ratio:.3f}")
print(f"Equal Opportunity Difference: {eopp_diff:.3f}")
print(f"Predictive Parity Difference: {ppv_diff:.3f}")

# Simple rule to flag the bias
if abs(dp_diff)>0.1 or not (0.8<= di_ratio<=1.25):
    print("Bias Alert: Model shows that there is potential unfairness between the groups")
else:
    print(" Model appears fair under initial evaluation")
```

OUTPUT:

```
===== AI Ethics Sentinel Report =====
AUC Score: 0.755
Selection Rate Group0: 0.814 | Group1: 0.771
Demographic Parity Diff: -0.043
Disparate Impact: 0.947
Equal Opportunity Diff: -0.057
Predictive Parity Diff: 0.134
 Model appears fair under initial evaluation.
```

8. CONCLUSION

This report emphasizes that India and the UK, as global leaders in Digital Public Infrastructure (DPI), now stand at a critical inflection point where collaboration can redefine the future of digital economies. India's

strengths lie in its scale, innovation, and cost efficiency, demonstrated through transformative initiatives in digital identity, payments, and data exchange. The UK's advantages come from its global financial networks, regulatory expertise, and well-established remittance corridors, making it a trusted hub in the international financial system.

By working together, both nations have the potential to: Lower global remittance costs, making financial flows more affordable and transparent; Advance digital inclusion, ensuring access to secure digital services for underserved communities worldwide; Set global benchmarks for interoperable and resilient cross-border digital systems; and Empower developing nations with scalable, adaptable DPI models tailored to their needs.

This partnership not only directly contributes to achieving the Sustainable Development Goal (SDG 10) on affordable remittances but also positions India and the UK as pioneers of a digitally inclusive global economy, leading by example, fostering innovation, and creating a roadmap for others to follow.

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