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Role of Digital Public Infrastructure in Inclusive Public Health Delivery in India

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***Abstract*— India's public health system continues to face challenges related to access, equity, and administrative efficiency, particularly for marginalized populations. Persistent issues such as identity exclusion, fragmented health records, benefit leakages, and rural–urban disparities have limited the effectiveness of public healthcare delivery. In recent years, Digital Public Infrastructure (DPI) has emerged as a foundational public good aimed at strengthening state capacity and improving inclusion at scale. This paper presents a conceptual analysis of the role of DPI in enabling inclusive public health delivery in India. Drawing upon theoretical perspectives from the capability approach, digital inclusion theory, and state capacity theory, the paper examines how digital identity, health platforms, and interoperable data systems interact to improve access to healthcare services. Using India's digital health ecosystem—including Aadhaar, Ayushman Bharat (PM-JAY), CoWIN, and the Ayushman Bharat Digital Mission (ABDM)—the paper highlights mechanisms through which identity-linked systems enhance enrollment, portability, and accountability. At the same time, it critically examines exclusion risks arising from biometric failures, digital literacy gaps, gendered access to technology, and data governance concerns. The paper argues that while DPI has significant potential to promote inclusive health outcomes, its success is conditional upon governance quality, hybrid service design, and privacy-first implementation. The study contributes to policy-oriented discussions on digital health by offering design and governance recommendations for inclusive DPI deployment in the Global South.**

***Keywords*— Digital Public Infrastructure; Digital Health; Inclusion; Aadhaar; Ayushman Bharat; Health Governance; India**

I. INTRODUCTION: DIGITAL HEALTH AND THE INCLUSION IMPERATIVE

India's public health delivery system has long been constrained by deep-rooted structural, institutional, and administrative challenges. Despite notable improvements in national health indicators, access to affordable and quality healthcare remains uneven across regions and population groups. Rural–urban disparities in healthcare infrastructure, shortages of trained medical professionals in public facilities, and uneven distribution of hospitals and diagnostic services continue to shape health outcomes.

These challenges are further intensified by high levels of out-of-pocket expenditure, which expose households to catastrophic health spending and push millions into poverty each year.

A major source of exclusion in public health delivery has been the inability of the state to accurately identify beneficiaries and ensure continuity of care. Individuals lacking formal identity documents often face difficulties in enrolling for public health schemes or accessing services across state boundaries. Migrant workers, homeless populations, informal sector employees, and seasonal laborers are particularly vulnerable to such exclusion. Fragmented and paper-based health records further undermine care coordination, resulting in repeated diagnostic tests, inefficient treatment pathways, delays in care, and suboptimal health outcomes. These administrative limitations reflect broader challenges of state capacity, information asymmetry, and weak institutional integration within the health system.

In response to these systemic constraints, Digital Public Infrastructure (DPI) has emerged as a strategic policy response aimed at transforming governance and service delivery. DPI refers to population-scale digital systems—such as digital identity, payment platforms, and interoperable data exchange architectures—that are designed as public goods and can be reused across sectors (G20, 2023). Unlike traditional e-governance initiatives, which often focus on digitizing individual services in isolation, DPI provides a shared digital backbone that enables integration, scalability, and interoperability across programs and institutions. This architectural shift allows governments to move from scheme-based delivery to platform-based governance.

Within the health sector, DPI seeks to integrate identity, financial protection, and health information into a unified digital ecosystem. Digital identity systems enable accurate beneficiary targeting and authentication; digital insurance and payment platforms reduce financial barriers to care; and interoperable health data systems support continuity, quality, and accountability in service delivery. Together, these components aim to address long-standing inclusion failures in public health delivery.

However, the rapid expansion of digital health systems has also raised important concerns regarding exclusion. Digitalization may inadvertently marginalize individuals who lack access to smartphones, reliable internet connectivity, digital literacy, or biometric compatibility. Elderly individuals, persons with disabilities, women, and populations in remote regions may face greater barriers to using digital systems. This creates an inclusion paradox, where systems designed to expand access and efficiency may simultaneously exclude those most in need if appropriate safeguards are not built into system design and implementation.

II. PROBLEM STATEMENT

Despite large-scale adoption of digital health platforms in India, there remains limited clarity on whether Digital Public Infrastructure consistently enhances inclusion in public health delivery or whether it simultaneously produces new forms of exclusion. While digital identity and interoperable health systems aim to reduce inefficiencies and expand access, evidence suggests that biometric failures, digital literacy gaps, connectivity constraints, and data governance challenges may disproportionately affect vulnerable populations. This raises a critical policy and research problem: to what extent does DPI function as an inclusive public good in healthcare, and under what conditions might it reinforce existing inequalities?

III. RESEARCH OBJECTIVES

The specific objectives of this study are to:

- Examine the conceptual foundations of Digital Public Infrastructure in the context of public health delivery.
- Analyze how India’s digital health DPI ecosystem links identity, health services, and financial access.
- Assess the inclusion outcomes of DPI-enabled health systems across economic, social, geographic, and administrative dimensions.
- Identify exclusion risks and digital divide concerns associated with digital health implementation.
- Derive policy-relevant insights for designing inclusive and accountable *digital health infrastructure.*

IV. CONCEPTUAL FRAMEWORK: DIGITAL PUBLIC INFRASTRUCTURE IN HEALTH

Digital Public Infrastructure in health comprises three interlinked layers: digital identity systems, digital payment and insurance platforms, and interoperable health data exchange mechanisms Digital identity systems enable unique and verifiable identification of individuals, which is essential for beneficiary targeting and service portability. Digital payment and insurance platforms facilitate cashless transactions, reimbursements, and financial protection. Interoperable data exchange platforms allow health information to be shared securely across providers and jurisdictions.

DPI differs fundamentally from traditional e-governance. While e-governance initiatives often digitize front-end services, DPI emphasizes back-end integration, open standards, and reusability. Core principles of DPI include interoperability, scalability, openness, and privacy by design (G20, 2023). These principles allow multiple public and private actors to build services on top of a shared digital backbone.

This paper draws on three theoretical perspectives to link DPI with inclusive public service delivery. The capability approach conceptualizes development as the expansion of individuals’ real freedoms to lead healthy lives (Sen, 1999). From this perspective, access to healthcare is not merely a service outcome but a fundamental capability. Digital inclusion theory highlights that access to technology alone is insufficient; meaningful inclusion depends on affordability, skills, and social context (van Dijk, 2020). State capacity theory emphasizes the role of administrative and informational capacity in enabling effective governance and welfare delivery (Mann, 1984). Together, these frameworks help explain both the inclusion potential and exclusion risks of digital health DPI.

V. INDIA’S DIGITAL HEALTH DPI ECOSYSTEM

India’s digital health transformation is driven by an interconnected ecosystem rather than isolated schemes. Aadhaar provides a foundational digital identity that enables authentication across welfare programs (UIDAI, 2023). Ayushman Bharat – Pradhan Mantri Jan Arogya Yojana (PM-JAY) offers financial protection through cashless secondary and tertiary healthcare for economically vulnerable households (National Health Authority [NHA], 2023).

The CoWIN platform demonstrated the feasibility of population-scale digital health delivery by managing vaccination registration, scheduling, and certification during the COVID-19 pandemic (MoHFW, 2022).

The Ayushman Bharat Digital Mission (ABDM) represents a further evolution of this ecosystem by establishing unique Health IDs and interoperable electronic health records (NHA, 2024). ABDM is designed as a federated architecture, allowing data to remain with providers while enabling secure exchange with patient consent. These systems interact to create a digital public health ecosystem where identity verification, financial access, and health data are integrated rather than siloed.

VI. MECHANISMS LINKING IDENTITY TO HEALTH ACCESS

Digital identity is a critical enabler of inclusive health access. Aadhaar-based authentication reduces duplication and ghost beneficiaries, improving targeting efficiency and fiscal sustainability (Gelb & Clark, 2013). Real-time verification allows faster enrollment and minimizes service denial due to documentation gaps. Identity-linked systems also enable portability of health entitlements, which is particularly important for inter-state migrants and mobile workers.

Under PM-JAY, digital identity facilitates cashless treatment and faster claim settlement, improving provider participation and accountability (NHA, 2023). These mechanisms strengthen trust between beneficiaries, providers, and the state, while reducing administrative burdens.

VII. INCLUSION OUTCOMES IN PUBLIC HEALTH DELIVERY

Digital Public Infrastructure–enabled health systems contribute to inclusion across multiple and interrelated dimensions by addressing both demand-side and supply-side barriers to healthcare access. One of the most visible inclusion outcomes is economic inclusion. Historically, high out-of-pocket expenditure has been a major cause of healthcare-induced poverty in India. The implementation of PM-JAY, supported by digital identity verification, real-time authentication, and automated claims processing, has reduced the financial burden on beneficiary households by enabling cashless treatment for secondary and tertiary care services (National Health Accounts, 2022). By eliminating upfront payments and reducing informal costs, digital platforms improve financial risk protection for low-income households. At the same time, digital claims management systems reduce delays in provider reimbursement, encouraging wider participation of both public and private hospitals.

This expansion of the empanelled provider network indirectly improves access for beneficiaries and strengthens trust in publicly funded health schemes.

Geographic inclusion represents another important outcome of DPI-enabled public health delivery. India's health system has long been marked by disparities between urban centers and rural, tribal, and remote regions. Digital platforms improve geographic inclusion by enabling digital enrollment, portability of entitlements, and access to services independent of location. The portability feature of PM-JAY allows inter-state migrants to access healthcare services outside their home states, addressing a significant source of exclusion faced by mobile populations. In addition, DPI supports telemedicine services, electronic referrals, and remote consultations, which extend specialist care to underserved areas. While digital systems cannot replace physical infrastructure, they mitigate geographic barriers by improving referral efficiency, continuity of care, and information flow across facilities.

Social inclusion outcomes are observed among population groups that were previously underserved or excluded from public health systems. Women, elderly individuals, migrants, persons with disabilities, and informal sector workers benefit from simplified enrollment processes and reduced documentation requirements enabled by digital identity systems. The availability of digital records reduces dependence on intermediaries or male household members, particularly for women seeking access to healthcare services. However, social inclusion outcomes remain uneven and are mediated by factors such as digital literacy, access to mobile devices, and prevailing social norms. While DPI expands formal eligibility and coverage, effective inclusion depends on complementary interventions that address gendered, social, and cultural barriers to technology use.

Administrative inclusion reflects improvements in how citizens interact with the health system. DPI simplifies enrollment, verification, and service delivery by automating processes and reducing reliance on paper-based documentation and discretionary decision-making. Real-time dashboards and digital workflows enhance monitoring, auditing, and grievance redressal, thereby reducing exclusion errors and service denial. Indicators such as enrollment rates, utilization patterns, claim settlement timelines, reductions in duplicate beneficiaries, and grievance resolution outcomes provide measurable evidence of administrative inclusion. Collectively, these outcomes signal improvements in both state capacity and the quality of citizen experience in accessing public health services.

VIII. Evidence From Existing Studies And Government Data

Evidence from existing studies, national surveys, and government administrative data provides important support for understanding the inclusion effects of digital health DPI in India. Although this paper adopts a conceptual approach, secondary evidence helps substantiate claims related to access, utilization, financial protection, and governance outcomes. Administrative data from the National Health Authority show a steady increase in hospital admissions and service utilization under PM-JAY since its launch, with beneficiary households accessing a wide range of secondary and tertiary care services that were previously unaffordable (National Health Authority [NHA], 2023). National Health Accounts data further indicate a gradual decline in the share of out-of-pocket expenditure in total health spending, suggesting improvements in financial protection, even though absolute levels remain high by global standards (National Health Accounts, 2022). Empirical assessments also suggest that digital beneficiary identification and automated claims processing have reduced fraud, duplicate claims, and delays in reimbursement, thereby improving provider confidence and expanding the network of empanelled hospitals.

The CoWIN platform provides a prominent example of DPI-enabled public health delivery at population scale. Government data indicate that CoWIN enabled real-time monitoring of vaccination coverage, vaccine supply chains, and adverse events during the COVID-19 vaccination drive (MoHFW, 2022). Digital scheduling, certification, and data dashboards improved transparency and coordination across levels of government. At the same time, early phases of the vaccination rollout revealed access barriers for individuals without smartphones, internet connectivity, or digital literacy. Subsequent policy adaptations, including walk-in registrations and assisted modes, highlight the importance of hybrid service delivery models in addressing digital exclusion.

Evidence from the Ayushman Bharat Digital Mission further illustrates the potential of interoperable health data systems. Initial progress reports indicate increasing adoption of Health IDs and growing participation by public and private healthcare facilities (NHA, 2024). Interoperable electronic health records have the potential to reduce fragmentation, improve continuity of care, and support data-driven policymaking. International evidence suggests that such interoperable health information systems can improve care coordination and system efficiency when supported by strong governance, regulatory oversight, and data protection frameworks (World Bank, 2021).

At the same time, survey-based studies and audit reports draw attention to persistent exclusion risks associated with digital systems. Research documents biometric authentication failures among elderly individuals, manual laborers, and persons with disabilities, leading to service denial in some contexts (Abraham et al., 2017). Data from NFHS-5 reveal significant gender gaps in mobile phone ownership and internet use, with direct implications for access to digital health platforms (NFHS-5, 2021). Together, these findings suggest that while digital health DPI has improved efficiency, transparency, and reach, inclusion outcomes remain uneven and contingent upon complementary policy measures, institutional capacity, and inclusion-sensitive system design.

IX. Exclusion Risks And Digital Divide Concerns

While Digital Public Infrastructure has expanded the reach and efficiency of public health delivery, it also gives rise to a critical inclusion paradox: the very technologies designed to universalize access may simultaneously exclude the most vulnerable populations. This paradox emerges when access to healthcare becomes contingent upon digital identity, authentication, connectivity, or digital literacy—resources that are unevenly distributed across society.

Biometric authentication failures represent one of the most widely documented sources of exclusion in digital welfare systems. Elderly individuals, manual laborers, and persons with disabilities often experience higher rates of authentication failure due to worn fingerprints, physiological changes, or assistive device dependencies (Abraham et al., 2017). In the absence of reliable fallback mechanisms, such failures can translate into denial of healthcare services, undermining the very objective of inclusion. Although policy guidelines increasingly recognize the need for alternative authentication modes, implementation remains inconsistent across facilities and regions.

The digital divide further exacerbates exclusion risks. Access to smartphones, stable internet connectivity, and digital skills varies significantly by gender, income, education, geography, and age. NFHS-5 data highlight substantial gender disparities in mobile phone ownership and internet use, particularly in rural areas, limiting women's ability to independently access digital health platforms (NFHS-5, 2021). For older adults and low-literacy populations, complex user interfaces, English-dominant platforms, and consent-heavy processes create additional barriers to meaningful participation in digital health systems.

Geographic and infrastructural inequalities compound these challenges. In remote, tribal, and low-connectivity regions, unreliable internet access and electricity shortages constrain the functionality of digital platforms at the point of service delivery. Frontline health workers in such contexts often rely on manual workarounds, which may not always be recognized by digital systems, increasing the risk of exclusion errors.

Beyond access barriers, the expansion of digital health DPI raises ethical and governance concerns related to data privacy, surveillance, and power asymmetries. Large-scale health data collection enhances the informational capacity of the state and private actors, creating risks of misuse, profiling, or exclusionary decision-making if governance safeguards are weak. Consent fatigue and limited awareness of data rights further weaken the ability of individuals—particularly marginalized groups—to exercise meaningful control over their data.

These dynamics underscore that inclusion through digitalization is not a linear or automatic process. Technology can expand access, transparency, and efficiency, but without deliberate inclusion-sensitive design, hybrid delivery models, and robust governance frameworks, it may reinforce existing inequalities or create new forms of exclusion. Recognizing and addressing this paradox is essential for ensuring that digital public infrastructure in health functions as an equitable public good rather than a technocratic barrier to care.

Governance, Ethics, and Data Protection

Effective DPI implementation requires robust governance frameworks. ABDM emphasizes consent-based data sharing and federated data storage to protect privacy (NHA, 2024). However, concerns remain regarding accountability, grievance redressal, and the role of private actors in health data ecosystems. Strong legal and institutional safeguards are essential for maintaining public trust.

Policy Implications and Design Recommendations

The analysis of Digital Public Infrastructure in India's health sector carries important policy implications for governments, platform designers, and implementing agencies. While DPI has demonstrated significant potential to improve inclusion, efficiency, and accountability, these outcomes are not automatic. They depend on deliberate design choices, institutional capacity, and governance safeguards.

This section outlines concrete policy implications and design recommendations to ensure that digital health DPI functions as an inclusive public good rather than a source of new exclusion.

Policy Implications

First, DPI should be treated as core public infrastructure, similar to physical health infrastructure such as hospitals and primary health centers. This implies sustained public investment, long-term institutional ownership, and clear accountability mechanisms rather than short-term project-based implementation. Viewing DPI as infrastructure emphasizes reliability, universality, and equity as primary objectives rather than mere efficiency gains.

Second, digital health systems must be embedded within broader health system strengthening efforts. DPI cannot compensate for shortages of health personnel, inadequate facilities, or weak referral systems. Policymakers should therefore align digital health investments with parallel investments in physical infrastructure, human resources, and service quality to avoid creating technologically advanced but substantively weak systems.

Third, the expansion of DPI increases the informational power of the state, raising important questions about surveillance, consent, and data use. Strong legal and regulatory frameworks are required to ensure that health data are used strictly for public interest purposes and not for discriminatory profiling or commercial exploitation. Data protection must be treated as a core component of health governance rather than a technical afterthought.

Fourth, the involvement of private actors in building and operating DPI-based health services requires clear rules regarding data access, interoperability, competition, and accountability. Without appropriate regulation, platform concentration and asymmetries of power may undermine public control over critical health infrastructure.

Design Recommendations for Inclusive Digital Health DPI

Based on the analysis, the following concrete design recommendations are proposed:

X. HYBRID SERVICE DELIVERY MODELS

Digital systems should be complemented by assisted and offline service options. Frontline health workers, help desks, and community service centers should support enrollment, authentication, and grievance redressal for individuals with limited digital literacy or access. Hybrid models reduce exclusion while maintaining the efficiency benefits of digital platforms.

Alternative and Flexible Authentication Mechanisms

Reliance solely on biometric authentication should be avoided. Systems should offer alternatives such as one-time passwords, demographic verification, or offline tokens to address biometric failure among elderly individuals, manual laborers, and persons with disabilities.

Strengthening Digital Health Literacy

Targeted digital literacy programs should be integrated into public health initiatives. Awareness campaigns, community training, and user-friendly interfaces can improve effective usage of digital health platforms, particularly among women, elderly populations, and marginalized groups.

Inclusive Platform and Interface Design

Digital health platforms should follow universal design principles, including multilingual interfaces, low-bandwidth functionality, and accessibility features for persons with disabilities. User-centered design processes involving beneficiaries can help identify and address usability barriers.

Privacy-by-Design and Consent Simplification

Consent architectures should be transparent, granular, and easy to understand. Privacy-by-design principles—such as data minimization, purpose limitation, and federated storage—should be enforced across all DPI components. Simplifying consent processes can reduce consent fatigue while preserving user control.

Robust Grievance Redressal and Accountability Mechanisms

Clear, accessible grievance redressal mechanisms are essential to address service denial, authentication failures, and data-related complaints. Independent oversight bodies and social audits can enhance accountability and public trust in digital health systems.

Continuous Monitoring and Inclusion Audits

Governments should institutionalize regular inclusion audits to assess who is being excluded from digital health systems and why. Disaggregated data by gender, age, geography, and socio-economic status can inform corrective design and policy interventions.

XI. RESEARCH GAP AND CONTRIBUTION

Existing literature largely focuses on individual digital health programs or technical implementation challenges.

There is limited conceptual work that examines digital health initiatives as an integrated DPI ecosystem and systematically links them to inclusion outcomes and exclusion risks using established theoretical frameworks. This paper addresses this gap by offering a holistic, theory-driven analysis that connects digital identity, health platforms, and governance mechanisms. It contributes to digital governance and public health literature by emphasizing the conditional nature of inclusion and by translating conceptual insights into concrete policy and design recommendations for India and other Global South contexts.

XII. CONCLUSION

Digital Public Infrastructure has emerged as a transformative enabler of inclusive public health delivery in India. By integrating identity, health data, and financial access, DPI strengthens state capacity and expands service reach. However, inclusion outcomes are not automatic and depend on governance quality, hybrid service delivery models, and privacy-first design. A balanced approach that combines technological innovation with institutional safeguards is essential for achieving equitable and inclusive digital health systems.

REFERENCES

[1] Abraham, R., Bennett, E. S., Sen, N., & Shah, N. B. (2017). State of Aadhaar report 2016–17. IDinsight. https://www.idinsight.org/publication/state-of-aadhaar-report-2016-17/

[2] Gelb, A., & Clark, J. (2013). Identification for development: The biometrics revolution. Center for Global Development. https://www.cgdev.org/publication/identification-development-biometrics-revolution

[3] G20. (2023). Digital public infrastructure: A framework for building DPI. G20 India Presidency. https://www.g20.org/en/documents/

[4] Mann, M. (1984). The autonomous power of the state: Its origins, mechanisms and results. European Journal of Sociology, 25(2), 185 213. https://doi.org/10.1017/S0003975600004239

[5] Ministry of Health and Family Welfare. (2022). COVID-19 vaccination: CoWIN dashboard and progress report. Government of India. https://www.mohfw.gov.in/

[6] National Health Accounts. (2022). National health accounts estimates for India (2019–20). Ministry of Health and Family Welfare, Government of India. https://nhsrcindia.org/nha

[7] National Health Authority. (2023). Ayushman Bharat – PM-JAY: Annual report. Government of India. https://pmjay.gov.in/

[8] National Health Authority. (2024). Ayushman Bharat Digital Mission: Blueprint and progress update. Government of India. https://abdm.gov.in/

[9] NFHS-5. (2021). National Family Health Survey (NFHS-5), 2019–21: India fact sheet. International Institute for Population Sciences. https://rchiips.org/nfhs/

[10] Planning Commission. (2011). High level expert group report on universal health coverage for India. Government of India. https://www.niti.gov.in/

[11] Sen, A. (1999). Development as freedom. Oxford University Press.

[12] UIDAI. (2023). Aadhaar dashboard and statistics. Unique Identification Authority of India. https://uidai.gov.in/van Dijk, J. (2020). The digital divide. Polity Press.

[13] World Bank. (2021). Digital dividends revisited: Welfare impacts of digital identification. World Bank Group. https://www.worldbank.org/