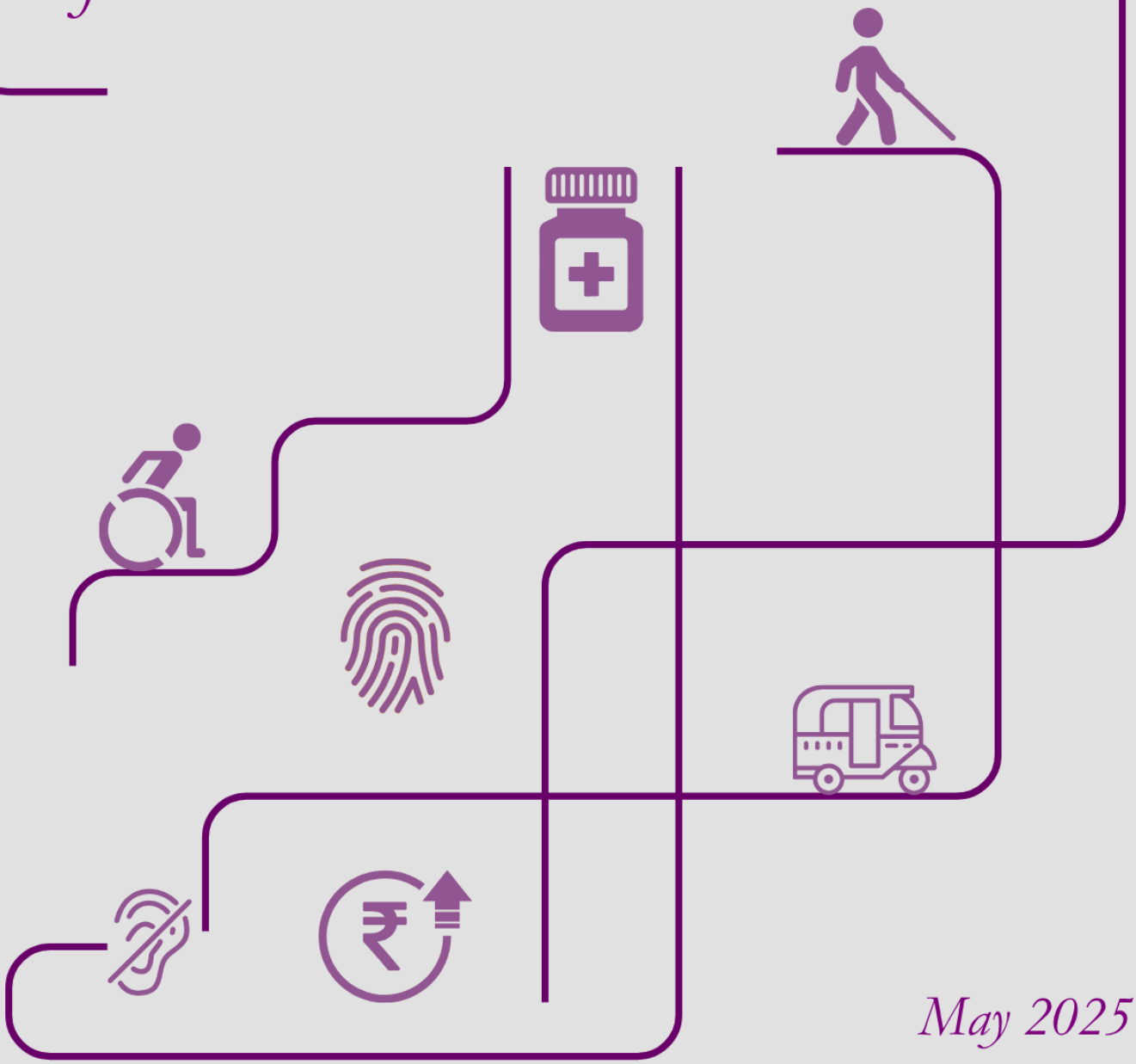
TQH

A Seat at the Digital Table

Centering Disability in Digital Public Infrastructure



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NOTE

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Whatever this paper gets right is due to the names above; all errors that remain are mine alone. I am particularly mindful of the inevitable oversights that readers will discover in a paper about disability authored by an able-bodied person. Special thanks as well are due to The Quantum Hub (TQH) in New Delhi for hosting me during the summer of 2024—to the entire staff for embracing me as part of their community, and especially to **Rohit Kumar**, **Nipun Malhotra** and **Deepro Guha** for their guidance on the research agenda.

ABOUT THE AUTHOR

Jeremy McKey holds an MPA from Princeton's School of Public and International Affairs, where he focused on democracy and technology issues, digital public infrastructure (DPI), and the U.S.-India relationship. He is currently a researcher on DPI at Princeton. Previously, he served as Director of Special Projects at the Rockefeller Brothers Fund, a philanthropic foundation in New York City, where he led a funding initiative that sought to strengthen political institutions and civic culture in the United States.

EXECUTIVE SUMMARY

This paper examines the intersection of disability and digital public infrastructure (DPI). Why disability? Persons with disabilities stand to benefit the most from the inclusive potential of DPI technologies. They stand to suffer the most when these technologies are designed without taking their needs into account. They stand to offer the most to economies and societies when new technologies enable their full participation. Nevertheless, to date, disability has largely remained at the periphery of the DPI conversation.

Three case studies from India—Aadhaar (identity), UPI (payments), and ONDC (e-commerce)—shed light on the reality of DPI and disability, as well as the possibility of building a more fully inclusive "Purple Stack." Each of these case studies highlights different aspects of disability inclusion, reflected through different roles of government, civil society, and the private sector. Lessons include:

- **Speed and scale alone do not guarantee inclusion**—accessibility must be an intentional design choice from the outset.
- **Processes are as important as products**—user journeys, not just discrete technologies, determine real-world accessibility.
- **Governance has a critical role to play**—just as security and privacy are embedded into DPI governance, accessibility must be codified through policies and standards.
- **Accessibility must exist at every level of the DPI stack**—from frontend applications to backend protocols.

To translate these lessons into action, the community of DPI architects and advocates should take steps to build an open-source repository of DPI accessibility solutions. An additional recommendation is to develop a structured research agenda to assess the impact of DPI on persons with disabilities—including by filling in data gaps and mapping user journeys.

Disability is a complex and evolving concept. After defining key terms such as "accessibility" and "universal design," this paper puts forward a working definition of a Purple Stack: a suite of digital public technologies that (a) embody the philosophy of universal design such that (b) the technologies themselves are accessible in ways that lead to (c) inclusive outcomes for persons with disabilities in key social, economic, and political domains.

Though a Purple Stack benefits persons with disabilities, disability inclusion is not the only reason to build one. Disability-inclusive DPI technologies are good for growth and

will benefit everyone, eventually. Moreover, a Purple Stack is a powerful argument in favor of the DPI approach to decentralization and modularity.

I. INTRODUCTION

Digital public infrastructure (DPI) technologies serve as the foundational building blocks for the delivery for digital public services. To establish one's identity digitally, to make payments, and to exchange data: These are the essential functions that underpin most online activities and that constitute the traditional trinity of DPI. Beyond identity, payments, data, DPI technologies also exist in health, agriculture, and e-commerce. There is, in theory, no domain in which a technology *couldn't* qualify as a DPI, as long as it satisfies the requisite technical specifications and normative standards. Those include: to be interoperable, extensible, and modular; to be scalable, decentralized, and potentially—a point of debate—open source; to prioritize privacy, embodying a spirit of data minimalism; to be governed through transparent processes, by institutions that are accountable to the public. The list of DPI attributes is long, contested, and evolving.

But whatever else lands on the list, "inclusive" ranks at the top. Ask 100 experts and practitioners to describe DPI, and "inclusion" will likely be at the center of the word cloud. In the consensus document on DPI that emerged from the Indian presidency's 2023 G20—the international event that put DPI on the global policy map—"inclusivity" is listed as the first of twelve suggested principles. More recently, DPI was endorsed by all 193 member states of the UN General Assembly as part of the Global Digital Compact, an appendix to the UN's Pact for the Future, as one of the "key drivers of inclusive digital transformation and innovation." When it comes to DPI, "inclusion" is both definitional and aspirational. It serves as a rationale for adopting a DPI approach to digitization, a guiding principle for implementation, and a benchmark for success.

This paper shines a spotlight on one dimension of DPI inclusion—disability. Sixteen percent of the world population has some sort of disability, according to the World Health Organization. If persons with disabilities were a country, their population would rival India's or China's. Among the most marginalized populations in the world, persons with disabilities stand to *benefit* the most from the inclusive aspirations of DPI, if designed well. They stand to *suffer* the most from DPIs that are designed haphazardly and without taking their needs and realities into account. Finally, they stand to *offer* the most to societies and economies when new technologies enable their full participation.

Nevertheless, disability has largely been overlooked within the broader conversation about DPI inclusion. One major report on DPI and financial inclusion paints a telling picture. In the report, the words "inclusion" and "inclusive" occur over 300 times. Among specific marginalized groups, "women" are mentioned 51 times, "youth" 18 times, "rural" 15 times, and "the elderly" 8 times. "Disabled" and "disability" are mentioned just 4 times – never in their own sentence, and once in a footnote. This pattern of attention is broadly consistent within the emerging literature on DPI. It also

reflects a perception shared among many interviewees for this project that disability remains peripheral to the DPI conversation, despite the transformative potential of DPI to improve the lives of persons with disabilities.

Marginalized and vulnerable identities, of course, are not mutually exclusive. Many persons with disabilities are also women, residents of rural areas, young and old, refugees and migrants. Inclusion is not zero-sum. The argument of this paper is not that the DPI community should devote more attention to disability at the expense of other dimensions of inclusion. Rather: by more explicitly including disability on the DPI agenda, we have an opportunity to build DPI technologies that will be more inclusive broadly and that will benefit everyone. A core argument of this paper is that a Purple Stack is not just *for* persons with disabilities; it is not a concession to a narrow constituency, but rather a strategy for creating better technology, stronger economies, and more inclusive societies.

The sections below examine disability and DPI from three distinct angles. Section II takes a theoretical perspective, addressing the question, "What do we mean when we speak of Purple Stack"? It introduces resources for conceptualizing disability-friendly DPI and provides arguments for why such an approach is essential. Section III shifts to an empirical question: "What are the disability implications of existing DPI technologies?" Through three case studies—identity, payments, and e-commerce in India—this section explores the real-world pitfalls and promises of DPI from a disability perspective. Finally, Section IV adopts a practical lens, offering lessons and recommendations for jurisdictions building new DPI technologies.

Several inputs inform the work that follows: first, semi-structured interviews conducted during the summer and fall of 2024 with DPI researchers and architects as well as with disability rights advocates in India; second, a literature review of research that investigates issues at the intersection of DPI and accessibility, including the accessibility of biometric identity systems and information and communications technologies (ICTs); and third, a close analysis of recent DPI "gray literature"—playbooks, templates, and whitepapers published by think tanks and multilaterals—that capture current thinking on how best to define and build DPI.

II. A PURPLE STACK: WHAT AND WHY?

American law legally defines 13 kinds of disability. South Korea recognizes 15 kinds. In India, the Rights of Persons with Disabilities (RPwD) Act, 2016 lists 21 kinds of disability, ranging from leprosy to thalassemia. There are many different kinds of disability, and some jurisdictions attempt to enumerate them. Others don't. In place of a classification scheme, Germany's disability law, for example, measures disability on a scale of 20 to 100, reflecting degree of impairment. This approach draws inspiration from the UN Convention on the Rights of Persons with Disabilities (UNCRPD), which clarifies that persons with disabilities *include* those who have "long-term physical, mental, intellectual or sensory impairments," without venturing to provide an exhaustive list.

The sheer number of kinds of disability, and the debate about how to measure and classify them, is among the challenges to conceptualizing a Purple Stack. Rather than a single value, the multiplication of disability and DPI, both evolving and contested concepts, is a complex matrix of different disabilities and different technologies, all embedded within different social and legal contexts. Some DPI technologies, moreover, sit so deep within the tech stack that it is hard to imagine how disability comes into play. What does it mean for a network protocol to be "accessible"?[1] And is accessibility even the right way of framing the goal? Or is that goal rather to be disability-friendly, universally designed, or something else entirely?

Without aiming to provide an authoritative definition, this section introduces tools to help secure an intuitive grasp of a "Purple Stack"—a multidimensional space where the complexities of disability and digital public infrastructure intersect. Moving beyond definitions, the section then lays out arguments in favor of "building purple," in spite of the conceptual challenges.

Box 1: Parable of the Shambala Stack

In interviews with technologists, researchers, and disability rights activists conducted for this project, the author invited participants to engage in a thought experiment. Imagine that the Chief Digital Minister of Shambala, a mythical kingdom nestled in the Himalayas, has been tasked with developing a suite of digital public technologies inspired by the India Stack. Her mission is to ensure that the Shambala Stack is designed to be accessible for people with disabilities. She seeks guidance: How should she proceed?

[1] See the E-Commerce Case Study below for a longer discussion.

In ancient Hindu texts, Shambala is believed to be the birthplace of Kalki, an avatar of the god Vishnu, prophesied to usher in a Golden Age. Sci-fi enthusiasts may also recognize the name from the recent Tollywood film *Kalki 2898 AD*, featuring Deepika Padukone as Kalki's mother and Amitabh Bachchan as her towering bodyguard. The film, a 3-hour allegory of good versus evil, portrays Shambala as a celebration of diversity and resilience—"a microcosm of people searching for hope," as described by the director.

What resources and principles should guide the Chief Digital Minister in her endeavor? What are the most common barriers that people with disabilities face when interacting with current DPI ecosystems? What are exemplary technology and governance solutions that address these barriers? What data exist—or need to be created—to understand them? Finally, how should we conceptualize "DPI accessibility" at all, given the diverse forms of disability and the multitude of DPIs, many of which bridge the digital and physical worlds? These are among the questions that guide this paper.

2.1. DEFINITIONS

Disability

Centuries ago, poor vision would have been classified as a disability. Today, four billion people wear glasses. The ubiquity of glasses today, technologies that mitigate the impairment of poor vision, highlights an essential truth: disability is not a static medical condition. Instead, it is shaped by the interaction between individuals, technology, and the environment. Future technologies, too, will redefine what qualifies as a disability. Conditions considered disabilities today may, a century from now, become as commonplace and normalized as nearsightedness.

This recognition—that disability is not solely a medical condition but intersects in complex ways with society, the environment, technology, and even psychology—underlies the contemporary "biopsychosocial model" of disability. The UNCRPD, for example, defines disability as arising from the "interaction between persons with impairments and attitudinal and environmental barriers that hinders their full and effective participation in society on an equal basis with others." From the perspective of DPI, the biopsychosocial model invites us to imagine how digital technologies can move beyond merely *accommodating* persons with disabilities to fundamentally *reshaping* the pattern of interactions between impairment and environment that, ultimately, constitute disability.

Accessibility

As we seek to reshape those patterns, however, it is important to distinguish between two concepts that are often confused: inclusion and accessibility. Inclusion, the broader of the two concepts, refers to meaningful participation in social, economic, and political life, not only for persons with disabilities, but for all marginalized and vulnerable groups. Inclusion is about participation. Accessibility, on the other hand, is about *access*—"to the physical environment, to transportation, to information and communications…and to other facilities and services open or provided to the public, both in urban and in rural areas," as the UNCRPD defines it.

Equal access is a necessary, but not sufficient, condition for full participation. An office building with ramps, elevators, automated doors, designated parking lots, and grab bars in the restroom may be accessible. That is no guarantee, however, of an inclusive office *culture* of the company whose name is on the lease. Beyond the physical and digital accessibility of structures and technologies, inclusion implicates questions of attitudes and outcomes. Are persons with disabilities made to feel welcome at the company? Are they given equal opportunities for prestigious roles and career development?

Box 2: Universal Design in Everyday Technology

In some cases, technologies designed *for* people with disabilities mature into successful consumer products that have "universal" appeal. In 2022, the global market for electric toothbrushes was valued at $7B. But how many of the millions of electric toothbrush users globally know that the original technology, patented in Switzerland in 1937, was designed for people with limited hand mobility? As another example, word prediction computer software was originally designed to increase the rate of text entry for persons with disabilities who found it difficult to type. Today, "autocomplete" is a familiar function to anyone who communicates over text or email. Arguably, ChatGPT and large language models represent the extrapolation of autocomplete into a world of big data, massive compute power, and neural networks—in which case, the approaching AI revolution will owe some debt, at least, to a technology originally designed for persons with disabilities.

Universal Design

The benefits of accessibility are not limited to persons with disabilities. Consider again the accessible building invoked above, supposing further that it contains residential apartments in addition to office space. Parents pushing strollers will be glad for the ramps. The elevators and automated doors will be a relief for anyone carrying heavy groceries. For an injured person temporarily on crutches, grab bars in the bathroom will be invaluable. The architects of the building may

have originally included accessibility features to comply with statutory requirements drafted with persons with disabilities in mind, but as result, the building is better for everyone.

This insight—that so-called "accessibility features" often, in fact, benefit everyone, regardless of disability status—underlies a further concept often brought into connection with disability: universal design. First theorized by the American architect Robert Mace, the philosophy of universal design calls for "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation…" Fundamentally, universal design challenges designers to think beyond the mythical archetype of the "normal user" and to design products and environments that are usable across the full diversity of human bodies and abilities. A traditional doorknob, for example, can be difficult to operate for people with limited hand mobility. By contrast, a door lever involves a simpler motion and is therefore more likely to be "usable by all people, to the greatest extent possible."

Purple Stack

The concepts of inclusion, accessibility, and universal design are tightly interwoven and easy to confuse. Even this paper will at times elide several of the distinctions above. Collectively, however, these definitions help us conceptualize a Purple Stack through a series of questions that we can imagine posing in the case of particular DPI technologies:

1. **Universal design:** *Was a given technology designed to be usable for everyone?* To what extent were persons with disabilities included in the image of the "hypothetical user" that informed the technology's design? If they weren't, what are the downstream implications for accessibility and inclusion? What would a version of the technology that embodies the universal design philosophy look like?

2. **Accessibility:** *Is a given technology actually accessible for persons with disabilities*? Does it comply with the Web Content Accessibility Guidelines (WCAG)? To the extent that physical processes are involved in accessing the technology, are those processes accessible to persons with limited mobility or other physical disabilities? For example, if accessing a technology involves visiting an enrollment center, is the center itself accessible? Is transportation available? The idea of a Purple Stack challenges us to think holistically about phygital accessibility, addressing barriers that span both the physical and digital domains.

3. **Inclusion:** *Does a given technology contribute to inclusive outcomes for persons with disabilities?* Broadly, what are the implications of the technology for the inclusion of persons with disabilities in key domains of social, economic, and political life, such as education, employment, health, and access to financial services? To the extent that the technology is inaccessible, from what domains of society are persons with disabilities thereby excluded?

Fundamentally, a *Purple* Stack is one for which the answer to each of the italicized questions is "yes." More precisely, we might propose as a working definition of a Purple Stack the following formulation: a suite of digital public technologies that (a) embody the philosophy of universal design such that (b) the technologies themselves are accessible in ways that lead to (c) inclusive outcomes for persons with disabilities in key social, economic, and political domains.

2.2. ARGUMENTS

Eighty percent of persons with disabilities reside in the Global South, where high rates of multidimensional poverty, food insecurity, and unemployment—coupled with inadequate access to healthcare, education, and banking—present formidable barriers to "full and effective participation in society on an equal basis with others." Persons with disabilities are among the most vulnerable in the world. This fact alone is a compelling reason to prioritize a Purple Stack and to explicitly place disability at the forefront of the DPI agenda. But it is not the only reason to do so. Others include:

i. A Purple Stack is good for growth

Researchers are beginning to shed light on the macro- and microeconomic benefits of the DPI approach. For instance, the UNDP estimates that DPI technologies could boost GDP growth in low- and middle-income countries by 1–1.4 percentage points by 2030, primarily through increased financial inclusion and more efficient social welfare programs. On the microeconomic side, a recent study using PhonePe data in India has causally linked digital payments to increased average household income and rates of entrepreneurship, especially among "financially weaker households" who are able to use their digital track record of payments to access credit more easily.

One out of six people alive today has some sort of disability. Countries that are able to effectively integrate these substantial populations into their economies, unlocking their creativity and entrepreneurship, stand to reap substantial dividends of growth. More research is needed to understand the economic impacts of disability inclusion on the national level, but we do already know that companies that prioritize disability inclusion earn, on average, 1.6 times more revenue than companies that don't.

ii. A Purple Stack will benefit everyone, eventually

The phrase "persons with disabilities" falsely implies that the opposite category is people without them. But the biopsychosocial model of disability helps us understand that there is no such thing as a "normal" person. A more accurate line to draw through the human population would be between people who are already experiencing disability and those who aren't yet, but who inevitably will. Whether through age, disease, or injury, we are all going to be disabled at some point—whether temporarily or permanently. Building accessible technologies, therefore, is an investment in the future for each of us. And as we saw above, the history of disability rights advocacy over the past century has illustrated time and again that "accessibility features," while perhaps originally designed to accommodate special needs, ultimately benefit everyone.

iii. A Purple Stack is a powerful argument in favor of the DPI approach

The DPI approach is fundamentally characterized by decentralization. In contrast to the centralized models of large platforms, the DPI approach favors modular building blocks that public and private sector actors can assemble and adapt into innovative digital services. The true test of the DPI approach lies in these services: Does a decentralized ecosystem foster greater creativity? Do the services it enables fulfill meaningful societal needs? Do these services reach and benefit more people? Disability offers a compelling argument for this model of innovation. While large platform companies can and often do build accessibility features into their products, the DPI approach lowers the barriers to entry for smaller players. Imagine a start-up that has developed a new accessibility technology; by integrating that technology within existing layers of a DPI stack, the start-up will be able to achieve population scale more quickly than would otherwise be possible under a platform-centric model of innovation.

III. THREE CASE STUDIES

DPI is a global story. According to the DPI Map, over 100 countries have some sort of DPI technology today, including 57 countries with digital IDs and 93 with digital payment programs. Each of these technologies in each of these countries will offer a different picture of disability and DPI: different stories of failure and success, different lessons and insights, different blueprints for building a Purple Stack. Yet, to begin this exploration, India—the undisputed leader of the DPI approach and country with the most developed DPI stack itself—stands out as a natural starting point.

This section examines disability and DPI through three case studies from India: identity (Aadhaar), payments (UPI), and e-commerce (ONDC). Why focus on these three? While other critical DPI technologies in India—such as those related to data exchange and health—deserve attention, Aadhaar, UPI, and ONDC collectively offer a multidimensional perspective. They reveal different and often unexpected ways in which disability and DPI intersect. This section highlights these intersections, setting the stage for the following section, which draws out broader lessons from the Indian context and presents actionable recommendations.

Box 3: State of Data and Research in India

One significant challenge in examining DPI and disability in India is the limited body of existing research. The most comprehensive study to date is Smriti Parsheera's 2020 paper, *"Participation of Persons with Disabilities in India's Aadhaar Project."* Other studies have addressed related topics, such as the visual accessibility of commonly used apps as well as the relative accessibility of different payment systems in India. However, no study to date, to this author's knowledge, has taken a broad approach to analyzing how India's rapid digitization over the past 15 years has holistically impacted the lives of persons with disabilities.

Such a study would inevitably face a major obstacle: the lack of reliable data. India's official estimate of disability prevalence, 2.2%, is widely regarded to be implausibly low, given the global disability incidence of 16% estimated by the WHO. This data gap leaves researchers reliant on anecdotal evidence to understand the intersection of disability and DPI technologies. One valuable source of data is Dalberg's 2019 *State of Aadhaar* report, which did include a question on disability status within a larger survey (nearly 150,000 households) about Aadhaar usage. Yet the relationship between DPI and disability extends well beyond Aadhaar, leaving much of the broader picture unexplored.

3.1. IDENTITY

Citizens of the Global North take for granted the frictionless ease with which, typically, they are able to prove that they are who they say they are. Yet for countless citizens of the Global South—still an estimated 850 million today—lack of formal identity presents crippling barriers to banking, healthcare, education, employment, government subsidies, legal redress, and other fundamental domains of social and economic life. These barriers are particularly acute for persons with disabilities, especially those living in rural areas, who are disproportionately likely to face challenges to obtaining and using IDs, according to the World Bank's ID4D program.

In 2009, when India introduced its Aadhaar identity system, the country had no national, multipurpose identification. A panoply of different identification systems—voter cards, ration cards, and tax cards, among others—contributed to a bureaucratic migraine for both citizens and government employees. Many Indians had no formal identification at all, with some estimating that 40% of the Indian population were unregistered at birth. The night-and-day contrast between the pre-Aadhaar world of 15 years ago and the India of today is hard to overstate. As of September 2023, the Unique Identification Authority of India (UIDAI) had issued close to 1.4 billion Aadhaar IDs, covering almost the entire adult population.

Meaning "foundation" in Hindi, Aadhaar is not only the foundation of the India Stack; it is also the technology that anchors the broader narrative of DPI inclusion. And rightfully so: Thanks to Aadhaar, countless millions in India have gained access to the financial sector and benefitted from more efficient delivery of government services. But for persons with disabilities, the Aadhaar story has been complex, with the technology's inclusive potential often overshadowed by poor incentive structures and bureaucratic hurdles.

Box 4: JAM Trinity

The impact of Aadhaar has been particularly dramatic in the realm of banking. In 2002, the Reserve Bank of India (RBI) instituted "Know Your Customer" (KYC) requirements for Indian banks. To open a bank account, an Indian resident would need to provide proof of name, address, and date of birth. Those who couldn't provide these proofs before, now could, as long as they held an Aadhaar ID. Between 2008 and 2017, bank account penetration in India shot up from 25% to 82%--a feat that might otherwise have taken close to 50 years, had India not "leapfrogged" over traditional development trajectories thanks to its innovative approach to identity.

In 2014, in fact, India set a world record for the most bank accounts opened in a

single week: 18 million. The week inaugurated Prime Minister Modi's "Pradhan Mantri Jan Dhan Yojana," a scheme to provide a bank account to every Indian adult. In addition to formal identification and bank accounts, mobile phones provided the third leg of the stool to the so-called "JAM trinity" – "Jan Dhan" bank accounts, Aadhaar IDs, and mobile phones—that anchored the Modi government's development strategy at the time. Between 2007 and 2016, mobile phone subscriptions in India increased from 17 to 85 subscriptions per 100 inhabitants.

The Indian resident who checked off the three boxes of JAM could now receive government benefits far more efficiently and reliably. The benefits would be transferred directly into the recipient's bank account with transactions confirmed through SMS. The linkage between Aadhaar records and government benefit databases helped to purge armies of "ghost recipients" and cut out corrupt middlemen. As of today, over 1,200 schemes are now part of India's Direct Benefit Transfer (DBT) program, serving over 1 billion Indians.

3.1.1. Biometric exemptions and the 2016 Aadhaar Act

An Aadhaar ID is a 12-digit number that links a person's biometric data – fingerprints, iris scans, and a facial photo – to key demographic details, including name, address, and date of birth. Even in their earliest concept papers and deliberations, the architects of India's national identity system recognized that factors such as "age, dirt, and cuts, and worn fingers" may affect fingerprint quality.[2] Similarly, certain optical conditions may preclude reliable iris scans. These realities beg the question: how does a biometric identity system deal with people who don't have a complete set of biometrics to give?

The UIDAI's answer is an evolving set of protocols that fall under the broad headline of "biometric exemptions." An early version of these protocols, published in a 2014 circular,[3] clarifies conditions under which a biometric exemption may be triggered and the steps that the enrolling agent must undertake to do so. These include confirming that the missing biometrics are not "temporary" (e.g., a finger covered by a bandage as opposed to a missing finger); taking a picture of the applicant in which the missing biometrics are visible, to the extent possible; and receiving authorization from a supervisor. Later circulars provide additional clarity around procedures related to the enrolment and update software itself.

[2] Cited in Parsheera, 2020.
[3] UIDAI. Circular No. 4(4)/57/19/QAP/2010-E&U-II; 2014, August 1. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://uidai.gov.in/images/Biometric_exception_guidelines_01-08-2014.pdf

Biometric exemptions are an important part of any biometric identity system. But in India, the stakes of getting these exemptions right rose dramatically after the Aadhaar (Targeted Delivery of Financial and Other Subsidies, Benefits and Services) Act, 2016 (Aadhaar Act). In addition to granting statutory authority to UIDAI, the Act formalized the authority of government agencies to mandate Aadhaar authentication for welfare services. Several welfare schemes, including the Public Distribution Scheme (PDS) for food subsidies, had by then already de facto mandated Aadhaar as a condition of service. But they had been operating in a legal gray area. The Aadhaar Act provided a statutory foundation for linking welfare to Aadhaar, setting the stage for its rapid acceleration. The path to the "Aadhaar-ization" of government services was further paved by a landmark Supreme Court decision in 2018 that upheld this linkage as constitutional, despite striking down a parallel provision that would have allowed private entities, too, to mandate Aadhaar authentication.

By formalizing the authority of government agencies to require Aadhaar authentication as a condition of service, the Aadhaar Act de facto transformed Aadhaar from a "voluntary" ID system, as it had originally been envisioned, into a requirement. Technically, according to the letter of law, no government agency could—due to lack of an Aadhaar ID—*deny* government benefits to which a person was entitled. Moreover, the Aadhaar Act stipulates that government agencies provide "onsite" enrolment facilities for Aadhaar or else the option to verify identity through alternative means. The Act also explicitly mandates that the government take "special care" to enroll "women, children, senior citizens, persons with disabilities, unskilled and unorganised workers, nomadic tribes and those who do not have a permanent dwelling house."[4]

But reality does not always conform to the letter and spirit of the law. In Calcutta, a 20-year-old with cerebral palsy, unable to straighten her fingers so that the scanner could capture her prints, is denied an Aadhaar card because of "unavoidable circumstances." A wheelchair-bound senior citizen who had undergone spinal cord surgery reports being unable to find a barrier-free Aadhaar enrollment center in Pune, despite trying at numerous locations. In Uttarakhand, a 62-widow is desperate to enroll her son – who, suffering from 60% disability, is unable to speak or move – in Aadhaar, without which he is cut off from the disability pension on which they both depend. He is one of thousands of residents of the state who, according to a *Times of India* investigation, lost access to their disability pension, once the scheme mandated Aadhaar authentication.

[4] The Aadhaar (Targeted Delivery of Financial and Other Subsidies, Benefits and Services) Act, 2016; section 5.

The stories above present a snapshot of media reporting on Aadhaar and disability in 2017, a year after the passage of the Aadhaar Act. The timing is not incidental, since many of the deadlines for linkages of government services to Aadhaar were scheduled for 2017, setting off an urgent rush to enroll in the system among those who hadn't yet. By then, cumulative Aadhaar enrollments since inception had crossed the threshold of one billion. Even so, not everyone who wanted to get an Aadhaar card was able to do so, and the stakes of *not* having an Aadhaar card were becoming more precarious.

Box 5: Enrollment, Authentication, and Updating

In the lifecycle of user engagement with Aadhaar, enrollment is only one moment when people with disabilities may experience obstacles. Another is authentication. In a 2017 study of the Public Distribution System (PDS) in Jharkhand, for example, economist Jean Drèze and coauthors document instances where eligible recipients, predominantly from marginalized communities, were not able to avail food subsidies due to the failure of authentication machines to verify fingerprints or otherwise to confirm the user's identity. Failure of authentication, of course, is not limited to people with disabilities. Yet there is reason to believe that people with disabilities are disproportionately affected by authentication failures, given evidence that "schemes targeted specifically at persons with disabilities might be seeing higher rates of failure compared to other schemes" (Parsheera, 2020).

Authentication can also fail when a user's Aadhaar ID contains an error—say, a misspelled name or outdated address. The 2019 State of Aadhaar report estimated a 4% Aadhaar error rate, based on a household survey of 150,000 households. This would mean close to 50 million Indian residents for whom an erroneous Aadhaar card could lead to authentication failure. The report also conveys, anecdotally, that users find it more difficult to *update* their Aadhaar cards than to enroll in the first place. Though the data does not support the conclusion that there is statistically significant difference in Aadhaar error rates among people with disabilities and those without, we might reasonably assume that people with disabilities do find it more difficult to update their cards (because, for example, centers for enrollment and updating may be inaccessible)—and therefore experience a higher burden when errors occur. Has the picture of Aadhaar error rates improved since 2019? Without new data, it is hard to say.

3.1.2. Gap between theory and reality

Why, in the early days of Aadhaar–and especially after the Aadhaar Act of 2016–did persons with disabilities struggle to enroll in the system? How do we make sense of the gap between the perception of Aadhaar as an inclusive social technology and the

reality, at least at first, of digital exclusion for persons with disabilities? Smriti Parsheera identifies several contributing factors:

- **Incentive structure for enrolling agents:** During the early Aadhaar enrolment drives, "enrolling agents" were paid on a per capita basis. Their profit incentives were to enroll as many people as possible. While this incentive structure contributes to speed and scale, it also clashes against the needs and realities of persons with disabilities, who may require more time to be guided through the enrollment process.

- **Bureaucratic hurdles:** The process for triggering a biometric exemption is complex and involves securing approval from the agent's supervisor. Even aside from the incentive structure, some agents may have shied away from triggering a biometric exemption because they didn't fully understand the process required or found it to be too onerous.

- **Limited conception of disability:** The primary strategy for accessibility in Aadhaar, biometric exemptions, is based on limited conception of disability. These existing exemptions don't take into account disabilities, such as severe autism, that can make it challenging for a person to engage with the biometric capture machines required to enroll in Aadhaar (for example, because of sensitivity to light or difficulty making eye contact).

It is important to note that biometric exemptions are not the only "strategy" for accessibility and disability inclusion in the Aadhaar system. Mobile Aadhaar units, which bring enrollment machines to the home of the person who is bed-ridden or otherwise unable to travel, represent another way in which Aadhaar addresses the challenges of persons with disabilities. These units are also valuable technologies for the elderly and people with temporary injuries, for example. Insofar as they benefit everyone, they represent a step in the direction of universal design.

But universal design is certainly not the direction that Aadhaar has come from. Like so many social technologies, Aadhaar was developed for a mythical ideal of the "normal" user and designed, as far as we can tell, in rooms of able-bodied people. The breathtaking speed and scale of Aadhaar's adoption may have surprised even its original architects. Ultimately, though, Aadhaar presents a cautionary tale for DPIs: speed and scale are not themselves a sufficient strategy for inclusion.

3.2. PAYMENTS

Thanks to Unified Payments Interface (UPI), an Indian bank account holder can unlock her or his phone, open a payments app of choice, and initiate a bank-to-bank transaction that settles instantly and without any transaction or processing fees. Now multiply that sequence by 130 billion. This is a picture of India's digital payments sector in FY2024, the largest in the world by number of transactions. Ubiquitous QR codes and "One Time Password" (OTP) requests are among the visible evidence of the staggering growth of digital payments in India over the past decade, a transformation encouraged by the government and sped along by demonetization and the pandemic.

Beneath the surface, however, the ripple effects of India's revolution in digital payments on its economy and society remain largely unexplored by researchers and policymakers. For persons with visual impairments (VIs), digital payments tend to offer significant advantages relative to cash. UPI in India is no exception. But there is still room for improvement, and more research is necessary to understand precisely how digital payments have affected the lives of VIs and other persons with disabilities in India.

3.2.1. The Inaccessibility of Cash

Persons with disabilities – especially the visually impaired – face numerous barriers to engaging in the cash economy in India. Consider first barriers to obtaining cash. In 2014, the Reserve Bank of India (RBI) issued guidelines advising banks to set up accessible ATMs through ramps, voiceover functionality, and Braille keypads. Nearly a decade later, a study conducted by the Goa Institute of Management found that not a single ATM, among a surveyed sample in that state, fully complied with the RBI's guidelines. And even if that survey is not representative of the country's estimated 250,000 ATMs, a person with disabilities seeking to withdraw cash will still at times face the common experience of discovering that a chosen ATM has run out of money, prompting a scramble from ATM to ATM.

After obtaining cash, the next barrier faced by the visually impaired is counting it. A decade ago, the length of Indian banknotes varied by denomination, allowing visually impaired individuals to identify the value of a note through tactile differences. New currency introduced after demonetization, however, jettisoned this feature of proportional length, replacing it with far less reliable embossing that fades with use. The result is that paper currency in India has become less, not more, accessible over time—a finding that motivated a 2023 directive issued by the Bombay High Court to RBI to improve the accessibility of paper cash.

In practice, therefore, VIs in India often depend on others to help count cash and identify denominations. In a 2019 study that assessed the relative accessibility of cash and digital payments in India, one VI participant interviewed by the authors described a system whereby family members would organize cash in the participant's wallet – lower denominations in the front, higher in the back. However, even the most meticulous system of organization can be overwhelmed by the fast-paced demands of real-world transactions. Reflecting on their experience using ride-hailing apps, VIs who participated in the study describe discomfort having to rely on drivers to return exact change—as well as the occasional experience of having not received the right amount from drivers who took advantage of the situation.

The frictions involved in cash transactions are not unique to VIs. Cash is an inherently clunky form of money. ATMs can be hard to find. Exact change is often elusive. Wallets are easily stolen. From the perspective of convenience and security, digital payments offer an attractive alternative to cash, regardless of disability status. But the intrinsic benefits of digital payments are magnified for VIs—a population for whom the ordinary frictions of cash transactions can present prohibitive obstacles to full participation in economic life.

3.2.2. Unified Payments Interface

UPI was launched in 2016 by the National Payments Corporation of India (NPCI) to facilitate real-time bank-to-bank transactions through mobile devices. Initially supported by just a few banks, UPI quickly gained traction, driven by the government's "Digital India" campaign; the rapid growth of bank accounts facilitated through Aadhaar; the overnight elimination of 86% of India's paper currency during demonetization; and the global shift toward digital ecosystems accelerated by the COVID-19 pandemic, which heightened the demand for contactless transactions. Today, UPI processes billions of transactions a month.

From an accessibility perspective, UPI provides significant advantages over other common digital payment methods such as credit/debit cards and mobile wallets. For VIs, barriers to credit and debit cards include memorizing the details of the card number, CVV, and expiration date—details often required to confirm transactions—while also navigating physical card readers, which can pose security risks. Mobile wallets typically require the additional step of "recharging" the wallet balance, which can involve navigating inaccessible apps and reinputting bank account or debit card information. In contrast, UPI facilitates a direct bank-to-bank connection that obviates the need to memorize account information or regularly check and recharge mobile balances.

An additional advantage of UPI over other digital payment methods is its interoperability. While UPI provides the infrastructure that enables communication between banks, it does not offer a direct user interface. Instead, the user-facing aspect of the UPI system is managed by Third Party Application Providers (TPAPs), which are licensed by NPCI to integrate with the UPI platform. Currently, 40 apps hold TPAP licenses, each with a different user interface. Many offer additional features such as automated bill payments. This flexibility is the essence of the DPI approach: UPI lays down the tracks, and various service providers build and operate the trains that run on them.

As a result, however, the inclusive potential of the UPI payments system overall is constrained by the accessibility of the third-party apps themselves. These show significant variability. A 2023 study assessing ten of the most widely used apps in India against the Web Content Accessibility Guidelines (WCAG) found Paytm, one of the largest TPAPs, to have the second highest number of accessibility violations—surpassed only by Flipkart, a leading Indian e-commerce platform. Issues identified included poor navigation order, inadequate color contrast, unmarked section headings, and images without text alternatives. PhonePe, the largest TPAP by market share, also had a significant number of accessibility violations, according to the study. A separate study found that, of the three apps that dominate the digital payments landscape in India— in order of market share: PhonePe, Google Pay, and Paytm—Google Pay was the most widely used by VIs and scored highest on accessibility metrics.

Box 6: TPAP Licensing Conditions

To operate within India's UPI ecosystem, Third Party Application Providers (TPAPs) must comply with licensing conditions that include: maintaining security and privacy policies in accordance with Indian law; storing all UPI transaction data locally; and establishing effective grievance redressal mechanisms. Eventually, a market cap will limit any single TPAP to 30% of the total UPI transaction volume. NPCI recently extended the initial compliance deadline of December 2024 by two years; now, the policy is set to take effect in December 2026.

It is good that VIs in India have one app, at least, that they can use to make UPI payments. One is better than none, but why only one? RBI already requires TPAP license applicants to demonstrate that their apps meet strict data security and privacy standards. Adding a requirement for minimum accessibility standards—such as achieving 80–90% compliance with WCAG, as suggested by one interviewee for this paper—would be a straightforward but impactful way to enhance the accessibility of the payments ecosystem. This addition, too, would send an important signal that

accessibility must not be an afterthought for DPI, but rather one of its essential components.

In the meantime, NPCI's recent introduction of "Conversational Payments on UPI," a feature that allows users to perform transactions via voice commands, represents a step in the right direction for accessibility. The feature is currently available in only English and Hindi, but its integration with Bhashini—the Ministry of Electronics and Information Technology's (MeitY) project to leverage AI for translation—will help it expand to other languages within India's vast linguistic pantheon. By doing so, "Conversational Payments on UPI" will not only improve accessibility for visually impaired users; it will also help bring the nearly 20% of India's population who are illiterate into the formal economy. Finally, it will offer an important precedent and proof of concept for the integration of AI into the India Stack toward goals of accessibility—a vision that has the potential to advance inclusion for persons with disabilities far beyond UPI.

3.3. E-COMMERCE

Launched in 2022, Open Network for Digital Commerce (ONDC) represents a new chapter in the Indian DPI story. In contrast to the platform-centric models that currently dominate e-commerce, ONDC is – as the name implies – an open network that any buyer or seller app can plug into. Though the long-term impact of ONDC on India's e-commerce market remains to be seen, early signs are encouraging. In July 2024, ONDC recorded 12 million transactions across over 500 cities and towns.

From a disability perspective, ONDC offers a compelling case study, because it enables us to conceptualize accessibility at the "protocol level" of the DPI stack. The best example so far is the Purple Rides feature of Namma Yatri, a ride-hailing platform operating on ONDC. However, ride-hailing is likely just the starting point for a broader reimagining of accessibility.

3.3.1. What is ONDC?

The juxtaposition of email to social media can help illustrate the innovation of ONDC relative to the existing platform-centric model of digital commerce. In the case of Facebook, a single, centralized entity controls everything that the user sees and doesn't see on the platform: the front-end user experience, the recommendation algorithms that curate news and other content, and above all, the universe of other users that an individual is able to interact with. A single person can have profiles on any number of different platforms, of course, but it is not possible to message a LinkedIn profile from the starting point of Facebook. Each platform is a closed system.

Email, by contrast, is open and interoperable. To gain entry to the world of email, the user must first set up an account with an email provider. There are numerous to choose from, each with its own value proposition of front-end design, algorithms that filter spam, integrations with other technologies, etc. The decision about which email provider to choose is, fundamentally, a decision about which value proposition to take most seriously. But it is *not* a decision about which network to participate in, since a Gmail subscriber can just as easily communicate with a subscriber on Hotmail as with a fellow Gmail user. Though Google and Microsoft, owners of Gmail and Hotmail, are themselves platforms with respect to certain of their businesses, email per se is an open network. It is not owned by any single company.

What there is, instead, is a set of protocols available to everyone, and owned by no one, that govern how the servers of different email providers communicate. For example, the Simple Mail Transfer Protocol (SMTP), devised in 1980 and updated several times since, provides a template for server A to send a "data packet" to server B that codes the recipient details, subject of the email, and body of the text: key pieces of information for any email, even if the email has no subject and no content. A data packet is just a string of 0s and 1s. SMTP, along with other email protocols, allows the sending and receiving servers to interpret such a string as an "email," rather than as delivery instructions.

In the case of ONDC, the protocol that enables interoperability between different buyer and seller apps is called Beckn. More precisely, Beckn is a set of open, domain-specific protocols—one for each category of services within ONDC, such as groceries, mobility, finance, and retail. There are over 20 such domains that together aim to encompass the broad landscape of digital commerce—not just buying and selling goods, but also services like ride-hailing, food delivery, and loan applications.

Each domain comes with its own context-specific requirements: How much? How many? When will it arrive? Where should it be delivered? Beckn protocols define standardized APIs and data schemas to organize relevant questions into templates for the millions of data packets that ricochet across the network.

For the user who stands thousands of feet above the code, the result is an experience of decentralized e-commerce: a buyer on any buyer app can see numerous options from sellers on different seller apps (for, say, toothpaste), oftentimes with third party logistics providers—yet another leg of the decentralized stool—offering competing quotes for deliveries. In particular, if a user doesn't like a given buyer app, she can access the exact same network on another. A room with a thousand doors, ONDC is an extension of the DPI logic—open, interoperable, decentralized—to the world of e-commerce.

Box 7: ONDC and the Economics of Platform Business Models

In the economics literature, a platform business model is one that, broadly, generates value from facilitating interactions among users as opposed to from directly producing or selling goods and services. Companies that employ some variation of this model – think of Google, Meta, and Amazon; or, in the Chinese context, Baidu, Alibaba and Tencent – are among the world's most highly-valued firms by market capitalization. Collectively, platform-based companies are projected to contribute 70% of all value created over the coming decade. But with these companies' growing power and expanding share of global GDP has come heightened scrutiny toward negative externalities borne by consumers, workers, and citizens.

In the case of e-commerce, users are buyers and sellers, and digital platforms provide infrastructure for the "two-sided" markets that connect them. Getting "both sides of the market on board," however, creates a chicken-and-egg problem. An e-commerce platform without buyers is useless to sellers; one without sellers is useless to buyers.

Consumers who have only ever engaged in online shopping through platform companies – which is to say, most consumers – might reasonably suppose that e-commerce *is*, simply, synonymous with a platform business model. To separate one from the other may seem as futile as peeling the quality of wetness away from water. But in fact this assumption shows the limits of our collective imagination about how the digital economy *might* be organized, if it wasn't organized in the way that it currently is.

But the value proposition of ONDC is more than just decentralized e-commerce; through decentralization, it also promises a more democratic digital economy. Currently just 6% of all Micro, Small and Medium Enterprises (MSMEs) in India actively sell on e-commerce platforms. One of the promises of ONDC is to make digital commerce accessible to the remaining 94%, and especially to hyperlocal enterprises that face the greatest obstacles—commission fees, lack of trust, and unfamiliarity with the technology, among others—to entering the digital economy under the current platform-centric status quo.

3.3.2. Namma Yatri and Purple Rides

Among the early success stories of ONDC is the ride-hailing app Namma Yatri. Launched in partnership with Bangalore's Auto Rickshaw Drivers Union (ARDU) in the fall of 2022, Namma Yatri is a "direct-to-driver" app whose business model is based on membership fees, rather than commissions. Drivers pay a small monthly commission to

have access to the app. Once they are on the road, 100% of rider fares go to the driver. Within two years, Namma Yatri is believed to have captured 25% of market share from Uber and Ola in Bangalore, the city of its origin. The app is now available in multiple cities and has facilitated close to 100 million rides since inception.

Those include close to 300,000 rides by early 2025 for persons with disabilities as part of the Purple Rides pilot program launched in 2023. Purple Rides allows riders on Namma Yatri to indicate disability status within their profiles, broadcasting that information as part of their requests for rides. The driver, therefore, is made aware of a passenger's disability before arriving at the pick-up location. He (yes, mostly, "he" in the case of drivers) will know, for example, to honk three times at an intersection when picking up a passenger with a visual impairment, rather than texting. Some of the functionality is managed entirely through the app. In the case of passengers with hearing impairments, the app will disable the calling function on its own.

The specifications of the Purple Rides program emerged through a consultative process led by EnAble India, a Bangalore-based NGO dedicated to promoting economic independence and dignity for persons with disabilities. Surveys and conversations with persons with disabilities inspired two other features of the program, in addition to the profile settings: a library of "nano videos" that sensitize drivers to specific disabilities; and a badging process, whereby a driver receives a virtual Purple Badge upon completion of Purple Ride. By October 2024, enabled drivers had earned 2.7 million INR through Purple Rides, proving the point that Purple Rides are not only ethical; they are also profitable.

Purple Rides also represent a significant advance in the DPI community's understanding of universal design. As we saw in the case study of UPI, much of the conversation around accessibility exists at the surface level of user experience and frontend design. By contrast, in addition to UX design, the features that constitute Purple Rides touch on two other layers: process guidelines and protocols. Process guidelines, including the nano videos, provide context to drivers about how to engage with riders with disabilities. On the protocol level, a parameter indicating the rider's disability status is passed from rider to driver—from buyer to seller—as part of the larger exchange of data.

For now, the parameter that "codes for purple" lives inside Namma Yatri's app, rather than in the ONDC rails on which the app is built. That will likely soon change. The success of the pilot program was sufficient proof of concept for ONDC to propose embedding a similar parameter within its own Beckn protocol. The proposal is currently undergoing final review. Once approved, "disability" will have become as fundamental a part of the semantics of ride-hailing within ONDC as, say, "pick up

location" and "cost." This means that any other ride-hailing service that chooses to integrate with ONDC—even, in theory, Uber or Ola—would have instant access to the technical and process specifications for Purple Rides that have been devised and tested by EnAble India and Namma Yatri.

But embedding a Purple Parameter within ONDC's domain of mobility is just the beginning. It is easy to imagine adapting the Purple Rides feature to other e-commerce verticals, such as food delivery. In that case, a Purple Parameter might help a delivery agent know not to ring a doorbell, if the customer has a hearing impediment. Of course, the benefits of this approach can flow in the opposite direction as well, in cases where the seller or delivery partner is the one with the disability, rather than the customer. Taken to its most ambitious conclusion, the example of Namma Yatri and Purple Rides invites us to imagine a future of digital commerce in India that is not only decentralized and democratic, but also radically accessible.

Box 8: Three Layers of Purple Rides

Purple Rides reflects a multilayered approach to embedding accessibility and disability inclusion within ride-hailing. These three layers offer a template for deepening the accessibility of ONDC technologies and building out a Purple Stack more broadly. They are:

1. **UX Level:** Visual accessibility at the user interface level allows people with disabilities to engage with the Namma Yatri app.
2. **Protocol Level**: Information about a rider's disability status is passed as a core parameter from rider to driver just like any other fundamental data exchanged within the protocol.
3. **Process Level**: Training materials provide actionable guidance for drivers.

IV. THE PATH AHEAD

The three case studies in the preceding section offer a window into the intersection of disability and DPI in India. Yet they represent only a fraction of the broader landscape. DPI technologies such as CoWIN (vaccine tracking), eSanjeevani (telemedicine), and DigiLocker (digital document storage) are also worth investigating from the perspective of disability inclusion. Each of these systems would implicate different dimensions of inclusion; exhibit different contradictions between intention and reality; and inhabit different configurations of government, private sector, and civil society. Nevertheless, even with an incomplete picture, **four key lessons** emerge that can serve as guiding principles for building Purple Stacks.

4.1. LESSONS

Lesson 1: Speed and scale alone do not guarantee inclusion.

A defining feature of DPI is its ability to scale rapidly. The Aadhaar identity system, for instance, enrolled over one billion people in less than a decade, while UPI transformed India's payment ecosystem in just a few years. In a context of bureaucratic red tape, the drive for efficiency can be a powerful force for progress. Speed and scale are justly celebrated as hallmarks of DPI's success, but neither guarantees inclusion. When DPI technologies are designed without intentional accessibility safeguards, the very populations that stand to benefit the most—including persons with disabilities and the elderly—are often left behind. The trajectory of Aadhaar exemplifies this challenge. Governments should ask: Who is being excluded in the rush to scale? What failure points emerge when accessibility is not built in from the beginning? How can DPI adoption be fast without compromising inclusion?

Lesson 2: Processes are as important as products.

It can be tempting to think of a Purple Stack as a set of discrete technologies, each of which is retrofitted with accessibility features. We should resist this temptation. DPI is a web of processes—a universe of verbs (applying, enrolling, buying, selling), rather than of nouns alone. The aspiration of a Purple Stack calls for a shift in perspective from static moments, such as obtaining an Aadhaar card, to dynamic user journeys that consider accessibility at every step. The surest way of shedding light on those processes is to have persons with disabilities in the room when important design decisions are on the agenda.

Lesson 3: Governance has a critical role to play.

DPI advocates acknowledge that governance mechanisms are as fundamental to the inclusive aspirations of DPI as are the technologies themselves. An emerging body of literature—including from the Aapti Institute and the UN's DPI Safeguards Project—have begun to codify best practices and imagine new approaches. When it comes to building a Purple Stack, governments and international institutions should embed accessibility into governance frameworks, just as they do for security and privacy. For example, governments can establish clear accessibility benchmarks; mandate accessibility audits for private digital platforms that plug into DPI rails; and ensure the representation of persons with disabilities during policymaking and design discussions.

Lesson 4: Accessibility belongs at every level of the stack.

DPI is often compared to the railroads of a digital ecosystem—a foundational layer upon which other services are built. However, when considering a Purple Stack, this analogy is somewhat limiting. In the physical world, the gauge of railroad tracks (e.g., whether narrow or wide) has no direct impact on accessibility. What matters are the trains that run on the tracks and the stations that bring people to the trains. In the digital world, however, the tracks themselves shape inclusion, influencing who can fully participate in digital systems. As we saw in the case of Namma Yatri's Purple Rides, accessibility belongs at every level of the stack, from the user-facing applications to the protocols themselves.

4.2. RECOMMENDATIONS

The trajectory of DPI over the past decade has been remarkable. Once a niche concept, DPI today is a cornerstone of global technology policy, endorsed by intergovernmental fora and organizations such as the G20, the United Nations, the World Bank, the IMF, and even the Quad. The rapid adoption of DPI reflects a paradigm shift in how governments think about public sector technology—away from siloed, proprietary systems and toward open, interoperable frameworks that promise greater inclusion and efficiency. The promise of DPI is vast, with much of its potential still untapped. But for DPI to truly fulfill its inclusive potential, disability must move from the margins of the conversation to the center.

For the growing community of DPI architects and advocates, one step that would help translate this vision into reality is to build an **open-source repository** of DPI solutions for disability. Many countries have benefitted from open-source DPI solutions offered by organizations such as the Modular Open Source Identity Platform (MOSIP). A key

recommendation that emerged in interviews undertaken for this project is that "Purple Stack solutions," too, should be collected in an open-source repository. This paper highlights several: mobile Aadhaar units, UPI conversational payments, and Purple Rides, for example. By collecting these and other innovations in a living resource, jurisdictions will be able to learn from each other and adapt proven solutions to local contexts.

A second step that the DPI community can take in the near-term: Design a **structured research agenda** for understanding the impact of DPI technologies on persons with disabilities in India and beyond. The case studies in this paper represent an initial effort to synthesize existing research, but much more work is needed to understand the impact of DPI on disability. A structured research agenda will require rigorous analysis of available data; collecting new data to fill important gaps; and ethnographic studies that map out the user journeys of persons with disabilities engaging in an increasingly digital world.

Finally, **cross-geographic collaboration** is essential. Disability rights activists, researchers, and policymakers from different regions can exchange knowledge, compare strategies, and refine best practices to advance disability-inclusive DPI. The project of building a Purple Stack is not just a national priority—it is a global challenge, requiring coordinated efforts, shared learning, and sustained commitment.

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The Quantum Hub (TQH)
Lala Lajpat Rai Marg,
Lajpat Nagar-3, New Delhi - 110024
office@thequantumhub.com