



Digital Identity in India

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The World Bank (2016) identifies three main goals of any identification system:

1. Inclusion and access to essential services such as health care and education, electoral rights, financial services, and social safety net programs.
2. Effective and efficient administration of public services, transparent policy decisions and improved governance—particularly to reduce duplication and waste.
3. More accurate measure of development progress in areas such as reduction in maternal and infant mortality.

¹ The ID2020 Alliance (<https://id2020.org/>) is a worldwide initiative to create digital ID through a multi-stakeholder partnership, ensuring digital ID is responsibly implemented and widely accessible.

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With these goals in mind India embarked on a massive project in 2009 to generate a digital identity for more than one billion residents of the country.¹ Nandan Nilekani, an IT technologist who co-founded India's most iconic IT company, Infosys, was asked to oversee the creation and implementation of this project—creating a new cabinet minister level position—which was later given a name, Aadhaar, which in Hindi means “the foundation” (Parker 2011).

The role of an identity is to assert that you are who you say you are. To be more specific, the assertion links a physical body in the present moment to the physical body of the same person at another moment in time. So, for example if I go to a university and claim that I am Bhagwan Chowdhry, I am asserting that the person who is making this claim is the same Bhagwan Chowdhry who went to a school called St. Paul's in the city of Ajmer and received 98% marks in his high school examinations. This requires many previous steps of identity assertion and verification. When Bhagwan went to his high school, he also had to assert his identity when he took the high school exams in which he claims to have scored 98% marks.

Many identity protocols have existed, most beginning in the twentieth century. The most common is a photo identity in which a name of a person is linked to a picture of the person at the very minimum and is certified by some institution—a government, a school, a university, or a financial institution. Other data—a signature, a date of birth, a residential address, name of a family member (e.g., a parent or a spouse)—could be added to the picture identity. Forged and fake identities are ubiquitous and create nuisance, inefficiencies, and corruption at many levels.

A second widely used identification protocol is to link a unique number to each person. The ten-digit social security number in the U.S. is the most prominent example. The uniqueness of the number avoids the problem associated with names which may not be unique and may have variant spellings. If many events or transactions can be linked to the same unique number, it creates a linked history which can be used (or abused) for various purposes. The algorithm used to create and assign the ten-digit social security number is neither random nor particularly private, nor is it easy to ensure that no one is able to obtain more than Social Security Number; it was designed decades ago when privacy issues were not salient.

1 What Is Aadhaar?

Aadhaar strived to create an identity that would be unique, safe, portable, and extremely difficult to forge. Aadhaar provides a unique, randomized 12-digit number (that means 1 trillion numbers are available) to be assigned to over one billion residents in India. Since only one in a thousand numbers is used for each person, randomization makes it difficult to guess which number belongs to whom (UIDAI 2017).

This Aadhaar number is then bound to unique biometric markers for each individual. The biometric markers are fingerprint scans of ten fingers, retina scans of two eyes and a photograph. The biometrics are stored digitally (OECD 2018).

2 Technological Feat

A major challenge in generating and assigning a unique number to each individual's biometric markers is ensuring that no individual gets more than one Aadhaar number. This means that when the digital biometric data is collected and stored in computer servers, the system needs to check that the same data has not already been used to obtain another Aadhaar number already. As the number of registrations grow, potentially reaching nearly one billion, this involves checking the biometric data against biometric data for all individuals already registered and stored in the system. This is a non-trivial computation problem. It is worth noticing comparing digitized biometric data is not simply comparing numbers but rather looking for patterns in the digitized data to determine if they came from the same individual. This was a sophisticated technological feat achieved by Unique Identification Authority of India (UIDAI) engineers (Varma 2010; Gunipati 2017).

Another challenge was enrollment and capturing the biometric data. First it requires equipment—fingerprint readers and iris scanner cameras. The equipment had to be acquired and deployed all over the country. UIDAI, in addition to government centers, also incentivized private players to obtain the equipment, enroll the residents by paying a fee to the private operators for each successful enrollment and imposing a small penalty for any errors in capturing the biometric data. This was a huge undertaking but a relatively successful one. In just five years after the rollout, nearly 600 million residents were enrolled and by the end of 2019, nearly twice that number has already been enrolled.

This is nothing short of a miracle in a country where a large population is not highly educated, lives in villages and does not even bother to obtain a traditional identity such as a birth certificate.

3 Incentives and Coercion

Financial exclusion for a substantive fraction of the poor population in developing countries such as India is a serious concern. It has been recognized in the theoretical literature (Aghion and Bolton 1997; Banerjee and Newman 1993) that financial inclusion can help people transform their production and employment activities to enable them to exit poverty. Sen (2000) suggests that the very provision of services such as banking and credit enables generation of capabilities boosting economic growth. Reserve Bank of India's Committee on Financial Inclusion notes in its report (Rangarajan 2008) that financial inclusion to hitherto excluded segments of the population is critical to sustain and accelerate growth.

Many scholars and policy makers have proposed and attempted various ideas for financial inclusion. One prominent example of improved financial inclusion is through microfinance institutions such as the Grameen bank in Bangladesh. For these experiments, lack of identity is not a stumbling block as social contracts and collaterals are utilized in facilitating transactions and access to credit. However, the Grameen experiment also indicates the limits of the experiment and suggests that government intervention may be necessary to achieve bigger scale. Thus, the policy discourse has shifted from nudge to actively promoting the banking sector for financial inclusion with some arguing for creating incentives. For instance, in 2009, Financial Access at Birth (FAB) was proposed in which an incentive of \$100 dollar electronic bank deposit for every child born would be created to enroll the child and the parents in an electronic identity protocol linked to a savings bank account. Of course, this required substantial infusion of funds.²

Unlike the informal systems, formal systems of banking depend on codified information about customers. Digital identity can facilitate opening bank accounts thereby granting access to the formal financial sector. Note, however, that solving the demand side problem does not necessarily obviate the need for solving the supply side issue. If a business case for inclusive banking cannot be made for the banks, then digital initiatives may not achieve the

² <http://financialaccessatbirth.org/>.

desired scales. Thus, the last mile problem remains even with the advent of digital identity (Sriram 2014).

Recent theoretical literature (Besley and Persson 2009, 2010) highlights the importance of state capacity for economic development. Even though billions of dollars are spent worldwide on anti-poverty programs, one constraint in effective implementation is the lack of secure payment infrastructure to make payments to intended beneficiaries. Digital identity can improve access to government services as it makes it easier for the government to both accurately identify intended beneficiaries and transfer benefits directly to their bank (if digital identity also helps beneficiaries in opening bank accounts).

UIDAI by linking many Direct Benefit Transfers (DBT), such as food subsidy programs that are quite prevalent in India, to Aadhaar played the dual role of creating incentives and effective implementation of the DBT programs (Pande 2014). The prime minister of India Narendra Modi in 2014 implemented a program—called PMJDY—incentivizing opening and linking of bank accounts to Aadhaar by offering free life insurance to those who enrolled.³

It became clear, however, that incentives alone would not be enough to achieve near universal enrollment. For a large period until the Supreme Court of India made a ruling in 2018, it was not clear if Aadhaar was a mandatory requirement or voluntary. Many people felt it was mandatory and many private and public service providers acted as if it was. This confusion and resulting indirect coercion helped in achieving massive enrollment much to the chagrin of many civil society members of the country.

4 Costs and Benefits

Some have criticized the Aadhaar program by complaining that proper cost-benefit analysis was not performed before embarking on this ambitious program. This is correct in the sense that no formal analysis was done. This was a political decision by the government of previous Prime Minister Manmohan Singh of Congress Party who judged, perhaps informally, that at a very broad level this was an investment in infrastructure that would lead to a substantial increase in social welfare. When Narendra Modi of the opposition party BJP became the Prime Minister in 2014, he too was convinced by

³ <https://pmjdy.gov.in/>.

Nandan Nilekani's persuasion that Aadhaar would provide substantial benefits to the new India that was about to embrace digital technology in a big way (Aiyar 2017). It is thus incorrect to assert that no cost–benefit analysis was performed in making a decision to introduce and then to continue with the implementation of Aadhaar. Such informal calculations are not uncommon for many important political decisions of great significance—formal analyses are often a facade to justify decisions that have already been made.

The budget for Aadhaar was \$1.5 billion and so the direct cost per identity created was less than \$2. It is not unreasonable to estimate that the lifetime benefits of a unique ID might be many folds than that number. What are some of these benefits? Direct Benefits Transfers in India amount to approximately 3–4% of yearly GDP. Estimates of leakages vary but even with increasing efficiencies over the years, the leakages amount to tens of billions of dollars every year. Other positive externalities created by a fast, efficient identification protocol that could substantially reduce the costs of obtaining financial and other services probably dwarf the direct costs of implementing Aadhaar.

5 Indirect Costs

Critics of Aadhaar have argued that these benefits notwithstanding, the design of Aadhaar is flawed because it creates other injustices and inequities that were not carefully thought of in a comprehensive manner (Khera 2019).

6 Linking Digital Identity with Public Distribution System

Proponents of Aadhaar have often cited the benefits of linking a digital identity with public distribution system. However, there are some valid reasons to doubt the effectiveness of linking public distribution programs to digital identities. First, most-excluded beneficiaries might also be the same as those who are unable to obtain digital identities (Khera 2011) thus hurting the same segment of population that the program is designed to help the most. Second, implementation snafus might lead to failure of the undertaking limiting the program's effectiveness (Kremer 1993). Third, vested interests whose rents are threatened may subvert the implementation of the program (Krusell and Ríos-Rull 1996). Relatedly, reducing corruption could displace it

to other sectors (Yang 2008) or could even dampen the incentives for officials to implement these programs (Leff 1964; Niehaus and Sukhtankar 2013).

Jean Drèze, a Belgian born Indian economist and activist who has spent his lifetime working in India on development issues such as poverty, gender inequality, and financial exclusion has argued that a slight improvement in the identity system used in India for decades, known as the ration card which identifies and lists family members in a household, to a smart card (Bangladesh, for example, has implemented these⁴) would have led to many of the benefits associated with leakage of food subsidy transfers touted by proponents of Aadhaar.

Drèze worries that requiring Aadhaar to claim food subsidies, in fact, creates many difficulties for the very poor and marginalized sections of the society. This is because Aadhaar verification requires technological equipment, to scan fingerprint and irises, and ubiquitous high-speed internet that works all the time. Cases of people being denied their food rations because their Aadhaar identities could not be verified because of equipment failure, poor internet connectivity, or other behavioral difficulties highlighted these concerns (Ranjan 2018). Proponents of Aadhaar claim that such failures are minuscule compared to the cases of flawless identification but that does not pacify social activists such as Drèze who worry that it is the very poor who are severely hurt by these failures and their numbers being small is little consolation for those affected.

Even beyond technical failures in ensuring identification is the risk that formalizing identification might lead to a stronger divide between insiders and outsiders. Due to reduced incentives/opportunities of insiders to game the system, undocumented people might be further marginalized (the golden goose effect; Niehaus and Sukhtankar 2013). There is some evidence that Dominican Republic's 2006 experiment led to increased statelessness (Gelb and Clark 2013).

7 In the Pocket or in the Cloud?

For Nilekani, the fact Aadhaar is just a number and that biometric data could be stored and verified in the cloud, anywhere in the country, any time of the day, was the disruptive innovation—he describes this realization as an epiphany. Aadhaar obviates the need to carry anything in your pocket, it does not get lost, and cannot be forged, this was utterly remarkable.

⁴ https://en.wikipedia.org/wiki/Bangladeshi_National_Identity_Card.

How does identity verification work in Aadhaar? Suppose I go to a bank to open an account and say, “I am Bhagwan Chowdhry, my Aadhaar number is 1234 4321 6789 and I would like to open a bank account.” The bank scans my fingerprints and sends a query to UIDAI’s servers asking, “Can you verify that the person whose fingerprint we have sent you a scan of, is indeed linked to the Aadhaar number 1234 4321 6789?” Notice that verifying this information requires a trivial computation that can be performed nearly instantaneously. The servers send back an answer in the form of a “Yes” or a “No.” No other information is transferred from the UIDAI servers to the bank and the UIDAI servers do not keep or store that this query was made by a particular bank to verify Bhagwan’s identity.

True, this required a huge initial infrastructure costs but as a public infrastructure project, the per capita costs were trivial. Nilekani, with other technology optimists, further imagine that internet access will become very inexpensive and ubiquitous and financial inclusion will proceed rapidly in the country as the infrastructure develops (Nilekani 2018). Their focus is on India in the coming decades whereas Drèze and other critics are concerned about the damage to marginalized populations now.

8 Data and Privacy

All centralized systems cause many people to worry about another important issue—data privacy. These issues arise from linking additional demographic and financial data to the identity. This is particularly problematic because biometric data, unlike a password, cannot be changed if someone were to steal a person’s biometric data.

In addition to the photograph and biometric data, Aadhaar also lists the address where the individual resides. Notice that this additional data is not absolutely necessary for creating the unique ID. The fact that this data exists in central servers of the government raises the fears that government, and other nefarious actors, may engage in surveillance activities because they know where each individual resides. Servers could be hacked and the data could be compromised.⁵

Recent advances in computer science (Agarwal, Banerjee, and Sharma 2017) provide a solution to the hacking problem. This involves not storing

⁵ At the same time, some linkages can be beneficial as they reduce administrative overhead. For example, Argentina linked tax, real property, and social service data to reduce fraud and tax evasion. The estimated benefits of this program at \$104 million far outweighed the implementation costs of \$10 million (Gelb and Clark 2013).

the unencrypted data at all in any centralized servers but instead encrypt the data and distribute partial data across many servers geographically located at many independent institutions, such as universities, civil society organizations, etc., such that if any of these servers is hacked, the hacker will not get any useful data at all but when a legitimate verification query arrives, encrypted data from various servers is recombined and verified using zero knowledge proofs protocols (Chaum et al. 2017).

But this does not eliminate the data privacy issues (Khera 2018). This is because the identity data linked with other activities and transactions is also collected by other service providers such as banks. A printed Aadhaar card with a photograph, the Aadhaar number, and address has de facto become a photo identity that is being used as identity verification at airports, hotels, banks, and other service providers. If these organizations begin collecting data and store it electronically in databases, those databases are also subject to hacks making sensitive data vulnerable (Economist 2018a).

To minimize some of these issues UIDAI introduced the concept of a Virtual ID or VID which is a 16-digit number temporarily linked to the permanent 12-digit Aadhaar number. A VID can be used for authentication just like the Aadhaar number and a service provider cannot derive the original 12-digit Aadhaar number from the 16-digit VID.

To further address the data security issues, the Supreme Court of India in its 2018 judgment ruled that Aadhaar cannot be made mandatory for provision of most services except for filing tax returns and an associated identity known as the PAN card. Linking of all other services such as banking would require that parliament pass a separate law providing such permission in a limited and controlled fashion. The Supreme Court also directed the government to debate and pass an explicit data protection and privacy law by the parliament. The parliament proposed a new data privacy law in December 2019 that severely restricts private corporations from using consumers private data but it exempted the government itself from such restrictions if it is deemed necessary for “national security” (Wimmer and Maldoff 2019). The tradeoffs for the very poor, who are essentially excluded both socially and financially, and the relatively well-off who worry about their privacy a bit more, are starkly different. The regulatory framework, however, is uniform for all people. The issues and the solutions that evolve, in the context of India, often represent a *compromise* of “dignity and dignified living” (Singh 2019).

9 Survey Evidence from India

Dalberg conducted a pulse survey with 147,868 households in 28 states and union territories, and an in-depth survey with 19,209 households in 16 states and 1 union territory. Its findings from its State of Aadhaar report (Dalberg 2019) are reproduced below

1. Aadhaar is becoming ubiquitous in India

95% of adults have Aadhaar, and on an average use it once a month.
75% of children have Aadhaar.

2. A notable minority still does not have the ID

90% of residents in Assam and **61% of residents** in Meghalaya do not have Aadhaar.

30% of homeless, and 27% of third-gender residents do not have Aadhaar.

8% of people do not have Aadhaar—or an estimated 102 million people, 75 million of whom are children.

3. Updating is the hardest part of the Aadhaar process

33% of people who tried to update found the process difficult; one in five did not succeed.

4% of people currently have errors in the information on their Aadhaar card.

15% of people have an error in their linked mobile phone number; an additional **39%** have not linked a number at all.

4. Aadhaar has supported inclusion

49% of people used Aadhaar to access one or more services for the very first time (e.g., ration, MGNREGS, social pensions, SIM cards, and/or bank accounts).

For 8% of people, Aadhaar was their first ever ID.

5. For many residents Aadhaar has improved service delivery

80% of beneficiaries feel Aadhaar has made PDS rations, MGNREGS and social pensions more reliable.

Using Aadhaar, residents were 40% more likely to obtain a new SIM card within one day, compared to using other forms of ID.

6. Problems with Aadhaar can lead to denial of welfare services, and at times exclusion

0.8% of people experienced exclusion due to Aadhaar-related reasons from a key welfare service (PDS, MGNREGS, social pensions) which they had earlier received. (Our survey also found that 3.3% of people experienced exclusion because of non-Aadhaar related problems from a key welfare service which they had earlier received).

1% of MGNREGS job card holders did not get work the last time they tried due to Aadhaar-related reasons (compared to 31% due to non-Aadhaar related reasons).

0.5% of social pension beneficiaries did not receive their pension the last time they expected it due to problems with Aadhaar (compared to 5.7% who did not receive it due to non-Aadhaar related reasons and many more who could not identify a reason).

1.5% of PDS users experienced a biometric authentication failure and did not receive ration in their last attempt. However, 3.2% of PDS users received their rations despite biometric authentication failure.

7. **Despite the Supreme Court ruling, many people find that Aadhaar is de facto mandatory for bank accounts, SIM cards, and school enrollment**

More than half of all people who produced Aadhaar to get a SIM card or bank account, said their provider accepted only Aadhaar, even after the Supreme Court ruling.

3.3% of people were denied bank accounts, and 0.8% of people were denied SIM cards due to Aadhaar-related problems.

0.5% of 6 to 14-year old's could not enroll in school due to Aadhaar-related reasons.

65% of people mistakenly believe that providing Aadhaar is mandatory by law for bank accounts, SIM cards, and school enrollment.

8. **Most people appreciate Aadhaar's universal acceptance; some have concerns**

72% of residents appreciate the convenience of Aadhaar as a universal ID, but almost **half** of these same people worry about the risks of linking it to too many services.

92% of people are very satisfied or somewhat satisfied with Aadhaar.

67% of people who have been excluded from a service due to problems with Aadhaar still say they are satisfied.

9. **The newer digital features of Aadhaar are yet to be embraced**

77% of people have never used a newer digital feature of Aadhaar (such as the mAadhaar app, QR code scanning, virtual Aadhaar number, or masked Aadhaar).

Only 39% have linked a correct mobile phone number to their Aadhaar.

10. Most people trust the Aadhaar system

90% of people trust that their data are safe in the Aadhaar system.

61% of welfare beneficiaries trust that Aadhaar prevents others from accessing their benefits.

8% worry about the misuse of their Aadhaar and 2% have experienced fraud that they believe was related to Aadhaar.

10 Other Empirical Evidence

There is also some rigorous empirical evidence that documents the welfare improvements caused by the use of biometric identity such as Aadhaar and we focus on three such areas.

● Public Distribution Programs

There is burgeoning empirical evidence on the effectiveness of public distribution programs linked to some form of identity. Banerjee, Duflo, Imbert, Mathew, and Pande (2020) find that e-governance led to reduction of leakage of public funds but not improvement of delivery of public services. In contrast, Muralidharan, Niehaus, and Sukhtankar (2016) find that biometric identification improved beneficiary experiences in collection and reduced corruption without incurring a substantial cost for the state. Bossuroy, Delavallade, and Pons (2019) find that biometric tracking is useful in delivering healthcare in challenging areas. Agarwal, Prasad, Sharma, and Tantri (2018) find that digital identity card-based workfare programs make these programs counter-cyclical, thus fulfilling one of the stated objectives of these poverty alleviation programs.

● Financial Inclusion

Empirical evidence for usage of banking services relies mostly on micro-evidence (Cole, Sampson, and Zia 2011; Dupas, Dean, Robinson, and Diego 2018; Dupas and Robinson 2013; Jack and Suri 2014; and Prina 2015). Aker, Boumnijel, McClelland, and Tierney (2016) find that households

in Niger receiving mobile transfers had higher diet diversity and children consumed more meals per day which could partially be attributed to the time saved in travelling and waiting to receive their transfers. Giné, Goldberg, and Yang (2012) through a field experiment in Malawi find that fingerprinting borrowers when applying to loans led to substantially higher repayment rates for borrowers with the highest ex ante default risk but had no effect for the rest of the borrowers. Bruhn and Love (2014) and Burgess and Pande (2004) analyze the impact of access to banking on aggregate income and labor markets. Agarwal, Alok, Ghosh, Ghosh, Piskorski, and Seru (2017) study a large-scale experiment (related to Aadhaar) that led to 255 million new bank account opening in India. They find an increase in lending and default rate on new loans in regions with low ex-ante access to banking services. Balasubramanian, Chandra, Murlidharan, and Tantri (2019) document that “transaction failures do not deter the users from using the biometric platform” and that “convenience offered by technology seems to score over other conventional banking channels, despite high failure rate.”

- **Governance**

Digital identity can also help in improved governance. For example, Duflo, Hanna, and Ryan (2012) find that time-stamped photos and monetary incentives increased teacher attendance. There is also anecdotal evidence (Mookerji and Agarwal 2015) that Aadhaar resulted in government employees spending on average 20 min more daily at their work desk. Aadhaar enabled biometric attendance system has been implemented in the public healthcare system to address the problem of absent doctors (Yasmeen 2019). However, research on whether these initiatives have had an effect on performance is scant.

11 Other Identities

Many countries have closely watched the adoption and implementation of India’s ambitious identity system Aadhaar. There is a lot of interest in adopting a digital identity system to realize the benefits provided by digital architecture. At the same time, the ambitious nature of a centralized system and the privacy threats it engenders are making nations think carefully about data privacy and security issues (Rao and Nair (2019)). The Modular Open Source Identity Platform (MOSIP) developed in collaboration with many volunteers who were involved in the development of Aadhaar, anchored at the International Institute of Information Technology (IIIT), Bangalore,

integrates the lessons from Aadhaar and other identity systems around the world. An alternative to a centrally planned ID system is to let the private sector develop their own solutions and protocols that are not centralized (Allu, Deo, and Devalkar 2019). Many economists, including Nobel Laureate Paul Romer (India Today 2018), agree that establishing a robust, secure, and efficient identity protocol is vital (Carstens 2019). Exactly what form this will take will depend on each country's priorities and development goals (Economist 2018b).

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