Seeing Like an Infrastructure: Low-resolution Citizens and the Aadhaar Identification Project

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Large-scale data systems play a central role in how state bureaucracies come to know and manage citizens. Such systems are endemically uneven in implementation, producing distributed and exclusionary consequences that are among their most important effects. These systems also operate as *infrastructures* in the rich and complex sense of the term that has been a core contribution of CSCW to the wider computing and social science fields. Building on James Scott's work on 'seeing like a state', we conceptualize 'seeing like an infrastructure' as a more supple analytic perspective that maps the distributed work and uneven consequences through which designers, bureaucrats, and users (here, citizens) assign or claim representation in the consequential data systems that increasingly shape and define citizenship. Drawing on eighteen months of ethnographic fieldwork into Aadhaar, India's biometrics-based identification project, and studies of infrastructure, marginalization, and citizenship in CSCW and allied fields, we argue that this perspective provides crucial insight into the strategies and mechanisms by which effective access to the basic rights and entitlements of citizenship are granted, claimed, and at times undermined. More specifically, we show how challenges in implementing Aadhaar's three key processes—enrollment, seeding, and authentication—give rise to a *spectrum of resolution* in which the rights and entitlements of 'high-resolution citizens' are expanded, while those of 'low-resolution citizens' are curtailed.

CCS Concepts: • **Human-centered computing → Collaborative and social computing → Collaborative and social computing design and evaluation methods → Ethnographic studies**; • Social and professional topics → Computing / technology policy → Government technology policy

KEYWORDS: Infrastructure; Biometrics; Governance; Bureaucracy; Citizenship; Data Politics.

1 INTRODUCTION

Large-scale data systems have become increasingly central to the work of contemporary governance, including in the last mile delivery of government services such as citizen identity verification and distribution of welfare [3,110]. This paper draws on and contributes to classic and

emerging work in CSCW around infrastructure, governance, and marginalization [11,16,23,38,94] in mapping the uneven consequences of these developments. CSCW scholarship has a long tradition of bringing to light systemic issues in design and implementation of large-scale data systems that shape and perpetuate conditions of marginalization [20,29,37,91,92]. As this research highlights, when such systems draw on and sink into existing practices of distributed and collaborative work, they also operate as infrastructures [93]. They "create both opportunities and limits; they promote some interests at the expense of others" [24:191]. Building on this tradition, we develop the analytic perspective of *seeing like an infrastructure* to show how large-scale data systems—in this case Aadhaar, India's (and the world's) largest biometric-based identification database—engender profound and uneven consequences in the everyday practice of claiming and exercising citizenship rights.

'Seeing like' already indicates a central claim of this paper: that knowledge (of others, ourselves, the world) is always partial and perspectival—perhaps especially in all-encompassing systems that purport to inclusion and universalism. Following a long history of standpoint epistemology [32,33], 'seeing like' means seeing from—a way of understanding and acting in the world that emerges from a particular perspective and experiential set. This in turn is connected to the categories through which experience presents itself—categories that are increasingly 'given' to us by consequential data systems that shape contemporary life and life chances. Seeing like an infrastructure, thus, invites us to place ourselves (as actors or analysts) in the perspective of these systems and attend to how they account for real-world entities through data categories. This perspective accounts for both: (1) erasure through simplification of the world in building categories; and (2) when consciously practiced, reflection and insight into how practices of representing people and people's efforts in claiming representation through categories mutually shape each other. Users see like an infrastructure in artfully navigating their data representations in systems that constitute their relationship with diverse organizations (though this ability is variably distributed, and essential to our work on *resolution* that will follow). Actors within organizations, such as designers, service managers and frontline workers, see like an infrastructure in making decisions about delivery of services based on data categories that best approximate their users. Analysts (including CSCW researchers) see like an infrastructure when they account for both the categorical logics of building and maintaining data systems, and the differential agencies and everyday experiences of actors in representing and claiming representation through data.

More specifically, we focus on the efforts of the government to use public data systems to manage citizens and how citizens respond to, navigate, and resist such efforts. We investigate the core and sometimes strategic questions for diverse actors involved as they work to see like an infrastructure. For citizens: How do my actions impact my visibility (or lack thereof) in core data categories of organizing government services? How can I better fit within (or strategically disappear from) data systems that constitute my relationship to the state? For designers and street-level bureaucrats: What data is required from citizens to deliver government services? How can this data be used to improve efficiency of and inclusion in government services? Finally, for analysts (including CSCW researchers): How do core data categories and government services mutually shape each other? How do actors (here, street-level bureaucrats and citizens) navigate or challenge the requirements posed by such categories? This plural and distributed vision is crucial for describing the uneven consequences of data systems when they become the infrastructure of mediating state-citizen relations. It further enables investigation of normative questions such as those around inclusion, equity, and justice [16,23,29,46] in organization of data-driven government services.

In the following sections, we unpack how data systems enact the making and management of difference in the everyday lives of citizens, while shaping the meaning of the state for bureaucrats and citizens alike. The topic of our analysis is Aadhaar, a centralized biometrics-based identification database that assigns a unique 12-digit number to every enrolled Indian resident based on their biometric (ten fingerprints, two irises, and facial photograph) and demographic (name, age, gender, and residential address) data [97]. Aadhaar enrollment began in 2010 with the ambitious goal of registering the entire Indian population; to date, it has enrolled more than 1.25 billion residents [104]. It is designed to provide a standardized legal identity to all Indian residents and ensure that people who did not have identity documents previously and were invisible to the state are afforded the means to represent themselves in bureaucratic procedures. It further promises uniqueness of residents' data records, providing a way to standardize identification procedures for both public and private (e.g., banks and telecommunication) service providers [2]. Residents identified through Aadhaar become citizens when they access other government services; they become customers when they interact with private agencies. This is accomplished through three key processes: (1) *enrollment* (in which residents provide biometric and demographic data to initiate a unique Aadhaar identity); (2) *seeding* (in which the Aadhaar number of a person is added to their records in other public and private organizations); and (3) *authentication* (in which the identity of Aadhaar enrollees is confirmed as a prerequisite for provision of public and private services). We show how these processes produce a *spectrum of resolution* built around the differential treatment of citizens based on their data representation in the organization of government services. Resolution brings to light the unevenness in creation and management of Aadhaar-enabled citizen data in bureaucracies. This unevenness in turn shapes access to the rights and entitlements of citizenship (here, food subsidies and related welfare benefits) such that those of 'high-resolution citizens' are expanded, while those of 'low-resolution citizens' are curtailed. It further highlights differential agencies with which citizens navigate their placements in data-driven government services (leaving some on the 'receiving end' of such systems more than others).

We follow the mundane practices and prosaic failures that characterize the work of state bureaucracies to see citizens and the efforts of citizens to be seen through their Aadhaar-enabled data in the following sections. The first section reviews theories of infrastructure, classification, and bureaucracy to conceptualize resolution and analyze how large-scale infrastructures like Aadhaar mediate, and sometimes disrupt or distort, state-citizen relations. We then document the limits and challenges in implementing Aadhaar's processes—enrollment, authentication, and seeding—and explore how these ramify in bureaucratic work that depends on Aadhaar: here, the work of the Public Distribution System (PDS) bureaucracy that provides access to food rights to below-poverty line (BPL) families. In the fourth section, we identify and discuss the mechanisms that recursively build on and shape each other to produce a spectrum of citizens' resolution. We conclude with reflections on the shifting conditions for claiming citizenship and agency in an increasingly data-driven world.

2 LITERATURE REVIEW

2.1 Infrastructure and Classification

Studies of infrastructure in CSCW and related fields showcase them as a critical resource in organizing distributed and collaborative work practices. Star and Ruhleder [93] describe several common features of infrastructure: its embedding in existing practices; its frequent transparency (or invisibility) in use; its reach or scope beyond single sites of practice; its dependency on (and

limitation by) standards and the installed base; its linkage to membership in defined communities of practice; and its tendency to 'reappear' (or return to conscious reflection) upon breakdown. Infrastructures are deeply embedded phenomena. They "cannot be theorized in terms of objects alone. What distinguishes infrastructures from technologies is that they are objects that create the grounds [the invisible background] on which other objects operate" [48:329]. Infrastructures are both *relational* and *ecological*: different groups impute different meanings to their function and differentially experience their emergence through time. A recent turn in infrastructure studies from the *noun*-form ('infrastructure') to *verb* ('infrastructur*ing*'), has shifted analytic attention away from infrastructures as accomplished objects and towards the complex and consequential processes by which infrastructures are achieved, maintained, and adapted over time [25,35,53,62]. Infrastructures are therefore neither fixed nor given, but always in a state of *becoming*.

Infrastructures are also central to ongoing processes of classification, inclusion, and exclusion that increasingly define the operations of states and other large-scale organizations [88]. Infrastructures require either data collection from scratch or data curation of existing datasets or both. Noting the potential of marginalization embedded in such practices, Bowker and Star [11] point to occasions when individual identities may not fit neatly into core data categories of classification, producing lived experiences of '*torque*'—situations when "the 'time' of the body and of [its] multiple identities cannot be aligned with the 'time' of the classification system" [11:190]. They offer the example of a woman under Apartheid who "might be of Indian national origin classified as Asian, married to a man classified as coloured, and live in a coloured zone but only be able to work or go to school in an Asian zone" [11:203]. This woman's lived experience of torque cascades from classification of her multi-faceted racial identity as "Asian" to her ability to move across and work in racially segregated geographical zones.

Data representations of people who do not fit neatly into an infrastructure's core data categories are often made invisible by placing them in residual categories, typically instantiated as 'none of the above' [1,92]. Residual categories doubly silence marginal people: problematizing their place in core data categories while simultaneously rendering invisible their individual identity and social history. As Star put it, "'None of the above' [...] works to create non-people [...] who do invisible work and have invisible lives" [49:7]. She outlined several ways whereby people may find themselves residual in a data infrastructure [49:7–8]: (1) their data is not registered; (2) they fall into two or more categories when only a single option is permitted; (3) they fall outside the infrastructure's representational scope; (4) they are not believed by data clerks or data clerks do not perform data entry competently. Residual categories produce varying forms of marginalization as people most in need of visibility find it hardest to secure. Since data is a malleable representation of a person's identity [9,87], this diffraction and unevenness in visibility can change over time. However, data representations of people can also endure with expansive consequences for their life chances as data infrastructures become the invisible background of state governance [19,41].

Lampland and Star [47] use the metaphor of a stone wall to illustrate this complex mixture of durability and becoming. Infrastructure, like a good stone wall, emerges as an uneven imbrication: the overlapping assemblage of uncemented things, "including discourses, actions, architecture, work, and standards/quantifications/ models" [47:20]. Infrastructures involve bringing diverse data systems together that do not seamlessly overlap as stacks on top of each other [21,88,107]. On one hand, under these conditions of partial overlaps, some users fall between the cracks and others must navigate the gaps [70,88]. On the other hand, designers, frontline workers, and community organizers must constantly respecify relations between these overlaps [30,107]. Infrastructuring

unfolds over time and across places to resolve the problems of managing this imbrication. Such problems only grow in scope when infrastructures ally with state power [79].

2.2 Bureaucracy and Abjection

Studies of bureaucracies have long argued that the state is not "a distinct, fixed and unitary entity that defines the terrain in which other institutions function" [84:8]. Rather, the state manifests in everyday bureaucratic procedures:

> What the state means to people such as government officials situated inside a bureaucracy, as well as to those outside, such as the clients of government programs and other citizens, is profoundly shaped through the *routine* and *repetitive* procedures of bureaucracies. [...] Mundane bureaucratic procedures thus provide important clues to understanding the micropolitics of state work, how state authority and government operate in people's daily lives, and how the state comes to be [...] encountered and reimagined by the population [84:11–12, emphasis in original].

Agrarian studies scholar James Scott [79] has characterized these bureaucratic procedures as high modernist, oriented towards simplification of complex phenomena to make them "legible" (translated into standards that underlie a state's synoptic view). Scott conceptualizes 'seeing like a state' as a specific way of understanding and acting in the world through bureaucratic procedures of the state. He uses examples ranging from scientific forestry to city design in critiquing how the high modernist perspective manifests in often violent simplifications of natural and social worlds, reshaping them in ways that better fit within the schematic operations of state power achieved when civil society "lacks the capacity to resist" it [79:5].

In the context of identification, seeing like a state showcases how bureaucratic procedures simplify and (re)organize citizens' identities to make them legible to state actors. Simplification and the pursuit of legibility, however, is only the beginning of the processes of building and maintaining data systems. An equally expansive domain of distributed and collaborative work in operationalizing data systems as public data infrastructures goes into securing the validity and legitimacy of its core data categories among citizens [76]. These data categories impute classificatory qualities to citizens. For example, income is used to represent how poor a citizen is and their eligibility to access welfare services. These categories are not only assigned top down to citizens by bureaucrats but must also be claimed by citizens from the ground up [31]. Analyzing how such categories are validated and legitimized, Martin and Lynch have argued that "Counting something as something is a condition for determining membership in the domain or field of things or persons counted. [...] 'Counting as' [...] is an epistemic achievement that involves categorical judgements" [51:246]. In our case, categorical judgments refer to making decisions on what data categories represent when they are used to organize state governance. These judgements predicate the circulation and interpretation of data across diverse databases that increasingly determine membership in and access to state services.

Seeing like a state is a singular perspective of state actors, which enables critique of how state practices reduce and simplify complex lives of citizens [79]. We draw on these critical arguments around legibility and recognize that erasure is a constitutive feature of working with data. However, this perspective also runs the risk of becoming monolithic—overstating the primacy of state vision and power, while understating the varied and heterogeneous forms of work by which actors of all levels negotiate data systems (with varied outcomes). Seeing like an infrastructure offers a more varied and plural way into these questions, nuancing our understanding of how data mediates the relationships between various actors. For example, in case of public data

infrastructures, citizens' accounts of how to navigate them are different from bureaucrats' accounts of how to operationalize them in delivery of government services.

Table 1. Analytic differences between Seeing like a State and Seeing like an Infrastructure

	Seeing like a State [79]	**Seeing like an Infrastructure**
Vantage	Singular and synoptic	Plural and distributed
Who does this work?	Planners and state officials	Frontline workers and users (here, citizens)
When is this work done?	In administering a state	In navigating data representations
How is this work done?	Simplification	Categorical judgments
Why is this work done?	Control	Membership and access
What does it produce?	*Legibility*	*Spectrum of resolution*

More broadly, seeing like an infrastructure is a plural and distributed perspective for mapping the collaborative work of organizational actors in representing users and of users in claiming representation through data. We focus on categorical judgements involved in designing and appropriating data categories as a core aspect of this work. For state governance, this work shapes the operation of bureaucratic procedures and the lived experience of citizenship.

Anthropological studies on lived experiences of citizenship have also called attention to the uneven consequences of bureaucratic procedures in mediating state-citizen relations. They describe asymmetrical forms of citizenship produced in navigating these procedures as they shape access to specific infrastructures ranging from identification [12,95] and water [4,78] to energy [17,108] and transportation [34,42]. Marginalization from such procedures poses not only immediate material consequences for citizens, but also undermines the category and meaning of citizenship itself [48]. A citizen without water or power becomes less of a citizen at all. Such marginalization results in new and distinctly modern forms of "abjection", characterized by Anand as "a social and political process through which particular populations are pushed beyond the biopolitical care of the state or other institutions, even as they remain central to the constitution of such social (or political) collectives" [5:488]. Abjection is neither a simple act of exclusion nor a full severing of relations [45]. Pushed to the margins but maintained as (tenuously) present, individuals and groups placed in this uneasy relationship with the state take on the role and burdens of the *abject*: that which stands outside of, and therefore troubles the social and organizational orders to which they (sort of) belong.

Nowhere are these dynamics more profound and fraught than in identification procedures, which provide the basic classificatory infrastructure of the state [12,28]. As Breckenridge argues, "processes of identification working together make up an infrastructure of citizenship—a set of slowly emerging rules, standards and networks of communication—which give any state [...] a distinctive political character" [12:8]. Registration and identification are as old as the state itself [80] and have come a long way from using permanent names to uniquely identify individuals [13]. Despite the use of biometrics, identification remains a process of simplifying citizens' 'thick' identities into 'thin' data categories [11,15]. However, identification procedures also produce the core data categories of public data infrastructures that mediate state-citizen relations. They establish legitimate membership in a state and access to its services. Thus, one of the ways citizens experience abjection is when they are placed in residual data categories [49] of identification procedures.

In contrast to these experiences of abjection, Azoulay has shown how photography is used as a resource "for contesting injuries to citizenship" by Palestinian noncitizens of Israel to coin the term: "citizenry of photography." Being photographed, she argues, "marks the beginning of a

demand to become citizens" for marginal populations [6:132]. Similarly, being placed in core data categories enables citizens to strategically employ their visibility to represent themselves to and make demands of the state. For example, marginal and migrant communities in India use identity documents not only to represent themselves in claiming welfare, but also to protect themselves from harassment by police [63,89]. Visibility is not just a resource, as Scott [79] argues, to control a population and make it legible. We argue that visibility also manifests the existence of a person in a population. It is a recognition of their rights, entitlements, and obligations; it is a condition for participation in a democracy. Practically achieving visibility requires efforts of both bureaucrats and citizens [31,76]. *Both* must participate in the building of an infrastructure that affords seeing (and materialization) of what previously was not seen, and thus, was outside the state's synoptic view. Aadhaar produces a new form of this visibility by standardizing resident data. In its appropriation, knowing residents as citizens becomes a matter of identifying, managing, and interpreting their Aadhaar-enabled data.

2.3 Resolution as an Analytic Resource

We conceptualize 'resolution' as a core analytic feature of seeing like an infrastructure. We use it to map the differential treatment of users based on their data representation in the organization of services. Taken most literally, it refers to the level of detail in an object captured through an imaging system. This is often expressed as a matter of scale: the lower the resolution, the less detailed the image becomes. Conversely, images at higher resolution show more detail, nuance, and complexity, and can often reveal the presence of novel or unique entities. For example, a low-resolution telescopic image will show the planet Jupiter as a small round 'star' (as in Galileo's classic descriptions) while a higher-resolution image will reveal a large reddish spot, and still higher resolutions will reveal swirls and bands. Analogously, data works in much the same way, with certain combinations of data providing more detailed and comprehensive data representations of people than others. While the absence of data renders people and their activities less visible to infrastructures (placing them, in effect, in 'low resolution'), the presence of data renders others more visible—in effect, in 'high resolution'. Resolution is also a matter of adjustment and scale: add, improve, or cross-reference data (rather like the zoom and focus of a camera lens), and resolution increases; subtract, degrade, or de-link, and resolution declines. As public data systems become central to delivery of state services and citizens become subject to their data [26,77], we argue that the infrastructure for building and managing this distributed data about citizens produces their resolution in state services. People must fall within core data categories *to be seen as* citizens. When their data is not available, miscategorized, or placed in residual categories [49,92], they become harder to see.

On the one hand, when the efforts to represent and claim representation through data align, they produce visibility in high resolution. High-resolution citizens find it easier to align their data with their way of life. Higher resolutions pose the problem of knowing-too-much and contend with the potential of invasion of privacy and surveillance. On the other hand, when the work of representing and claiming representation through data is misaligned, it produces visibility in low resolution. Low-resolution citizens struggle to overcome the ineluctable differences between their data and their way of life. Lower resolutions run the problem of not-knowing-enough and manifest within challenges of data-driven marginalization and abjection. This spectrum between low- and high-resolution is crucial for analyzing the politics and uneven consequences of data infrastructures.

Data systems have inevitable constraints in representing complex lifeworlds of people. *Although their resolution is configured by their data, people are not passive recipients of automated data-driven decisions.* They may choose to be low-resolution citizens for their own purposes in the face of long histories of surveillance and tracking [14]. They often also find creative and practical solutions to their problems of claiming representation through data. These solutions showcase how an individual's knowledge and experience of living with their data is deeply intertwined with their positionality in relation to gender, race, class, and caste. A person's resolution and their efforts to work with, around, and against it are the conditions for making citizenship claims and holding the state accountable in delivery of services. Resolution thus sets the terms and the limits of data-driven state-citizen relations.

By articulating seeing like an infrastructure, we seek to contribute to existing CSCW research on infrastructures and marginalization and connect it with studies of state bureaucracy and citizenship in *three* ways. First, we map the unevenly distributed consequences of data infrastructures in delivery of services by combining CSCW concerns around their design and deployment with social science-based research on inequities in citizenship. Second, we develop 'resolution' as a resource to unpack the challenges of (1) configuring data parameters for unique identification and entity resolution; and (2) securing representation through data. Finally, with the emerging research interest in how the reliance on citizen data and algorithms tends to automate inequality in government services [26], we position the challenges of data collection and curation as a crucial site to uncover how automation perpetuates inequality.

3   METHODS

Empirical data for this paper comes from ethnographic fieldwork conducted by the first author in three rounds: between June 2015 and January 2016; July 2016 to January 2017; and January to March 2018. While both authors are based at US institutions, the first author is an Indian citizen and has been researching the implementation of government programs in India for the past ten years. We began with a review of government reports, legal documents, and news stories that offered detailed plans on the background and implementation of Aadhaar. Documentary analysis [10] of these primary and secondary sources revealed how Aadhaar was envisioned to standardize citizen data and renovate last mile delivery of government services, such as, the Public Distribution System (PDS): a government scheme to provide subsidized food grains to below-poverty line (BPL) families in India.

We conducted multi-sited ethnographic fieldwork [50] at various locations such as startup workspaces in Bengaluru; and offices of the Unique Identification Authority of India (UIDAI, in-charge of implementing Aadhaar), other Aadhaar-related service outlets, the Supreme Court of India, and activist organizations in Delhi. Most initial members of the design team of Aadhaar are no longer a part of the UIDAI. We setup contacts to interview them at their new startups in Bengaluru. We followed the Right to Food (RTF) activists [73] and participated in conducting their surveys on the implementation of Aadhaar-enabled PDS at various sites in Chandigarh in 2015 and Delhi in 2016. We observed All-Hands meetings and group discussions organized by NGO representatives on Aadhaar-related issues in Delhi and Ranchi in 2016. We conducted more than 100 semi-structured qualitative interviews in English and Hindi with Supreme Court lawyers, RTF activists, Aadhaar technology designers, NGO representatives involved in helping residents use Aadhaar, and finally, residents navigating different processes of Aadhaar. All respondents were adults and our interviews covered respondents' backgrounds, experiences with Aadhaar's processes, and opinions on its utility and possible futures.

Our analysis of field stories followed a grounded theory approach [18], beginning with substantive description of the uneven implementation of these key processes and its consequences and moving to more abstract analytic perspective of seeing like an infrastructure. Given the constraints of length of this paper, we only provide a snapshot of our field stories with excerpts from bureaucratic documents, news stories, and conversations with Aadhaar's design team members, NGO representatives, and RTF activists. All respondents have been anonymized and their affiliations masked to protect privacy. While in our field stories we focus on low-resolution citizens, we have also met and interviewed many high-resolution citizens for whom Aadhaar works seamlessly when accessing services. The first author has an Aadhaar number and has successfully authenticated his identity using it several times. While for high-resolution citizens Aadhaar often works in its designed way, for low-resolution citizens it breaks down in unevenly distributed ways.

4   STORIES FROM THE FIELD: AADHAAR AND THE LAST MILE DELIVERY OF WELFARE BENEFITS

The immediate origins of Aadhaar can be traced to national security concerns after the Kargil War between India and Pakistan in 1999 [2]. In the aftermath of this war, the center-right government conceptualized plans for "registration of citizens and non-citizens living in India [...and issue] a Multi-purpose National Identity Card" [as cited in 68:155–156] to all citizens. These plans changed significantly when the center-left government came to power in 2004. The new government introduced Aadhaar with the ambition of building a biometrics-based Unique ID for below poverty line families to streamline identification and targeting of welfare beneficiaries [2]. The project was later expanded to identify every Indian resident "through a single system rather than all government departments individually and independently investing in creating infrastructure, systems and procedures for verifying entitlement" [36:1288].

Aadhaar is designed to uniquely identify Indian residents for any public/private service. It implements an hourglass architecture where:

> minimal standardization at the waist of a layered architecture (e.g. the IP layer of the internet) enables burgeoning innovation above (e.g. apps) and below (e.g. wireless, wired networks, etc.) it. [... In Aadhaar's case,] the waist consists of the Aadhaar number – a unique identifier for every individual – and authentication services linked to this number. Below the waist lies innovation in design, in this case biometrics devices that can capture fingerprints and iris data. [...] Above the waist lies any application that might require an identity verification service [57:224].

This architecture is the core organizational principle used to operationalize Aadhaar as a public data infrastructure [86]. Aadhaar, as a putatively 'clean' database devoid of duplicate entries, has been increasingly made central to the distribution of uniquely identified know-your-resident information (name, age, gender, and address) on the Indian population. It standardizes the way Indian residents interact with an ecosystem of public and private services using their Aadhaar number and personal data [100]. This standardization is intended to minimize the role of intermediaries and thus limit corruption in the last mile delivery of government services. For example, in addressing leakages in the Public Distribution System (PDS), the UIDAI estimated that only 25% of benefits reach PDS beneficiaries [96]. Aadhaar is posited to solve these problems by accurately tracking the uptake of subsidized food grains.

In 2015, when we started fieldwork, there were only a few pilot projects conducted in different parts of India to test the feasibility of Aadhaar-enabled PDS. The plan was to either transfer cash

into Aadhaar-enabled bank accounts of beneficiaries in lieu of their subsidized food grains or to distribute subsidized food grains to beneficiaries from Fair Price Shops after biometric authentication. At the time, Right to Food activists, who track the implementation of PDS in India, had mixed responses to these plans. There was enthusiasm: Kaavya, a Delhi-based activist involved in managing the Right to Food Campaign, observed "If there is anything at all, as an identity proof... that will really help" [personal communication, 4 August 2015]. There was also skepticism: "linking [Aadhaar with PDS] is a problem for the campaign. Making Aadhaar compulsory to access any social sector benefits is what we are all opposed to" [Kaavya, personal communication, 4 August 2015]. These conversations from 2015 indicate the initial position of activists; they had only begun to articulate their specific concerns [44,72].

It was only in February 2017 that the Department of Food & Public Distribution issued a notification making Aadhaar mandatory for PDS beneficiaries [59]. While the deadlines for seeding shifted over time, ration cards were digitized across India. Ration cards are existing paper-based identity documents that certify below poverty line families as PDS beneficiaries. One ration card is issued to each family. In the transition to Aadhaar-based PDS, all family members were required to enroll into Aadhaar. Then, Aadhaar numbers of all members are seeded into one digitized ration record of the family in the PDS database. The cash-based subsidy for PDS is transferred into the Aadhaar-enabled bank account of the eldest woman in the family. For subsidized food grains, any member can authenticate their Aadhaar identity at a Fair Price Shop to claim their family's entitlement. The Department of Food & Public Distribution in its annual review of PDS in 2018 noted that "85.61% of all ration cards have been seeded" with Aadhaar numbers and "3.61 lakh [100 thousand]" out of total 5.34 lakh Fair Price Shops have electronic Point of Sale machines for biometric authentication across the country [61]. Legitimizing these efforts, in September 2018, the Supreme Court in its final verdict on petitions filed by activists and citizens resisting Aadhaar allowed its use in last mile distribution of welfare entitlements [40]. Since then, the government has announced plans to implement "one nation-one ration card" scheme across the country to link all ration cards with Aadhaar and distribute subsidized food grains through Point of Sale machines [85]. This new scheme ensures portability such that beneficiaries can claim their entitlements from anywhere, instead of being limited to the Fair Price Shop they are registered at. We began documenting the stories we narrate in the following sections in mid-2015. They capture the struggles and challenges of implementing Aadhaar-enabled PDS and its uneven consequences.

4.1 Enrollment: Establishing Uniqueness

The process of registering into Aadhaar begins with collection of mandatory biometric data (ten fingerprints, two irises, and facial photograph) and basic demographic data (name, age, gender, and address) along with a variety of conditional fields such as name and Aadhaar number of a resident's mother, father, wife, husband, and two optional fields: mobile phone number and email address. Residents must also provide their existing proof of identity and address to initiate enrollment. Enrolling agents included both public and private agencies, ranging from public sector insurance companies and welfare bureaucracies to IT companies and banks. Once data of a new enrollee is collected, their biometric information is deduplicated against all existing Aadhaar records. An Aadhaar number is only issued if the new data is determined to be unique after deduplication [97]. Initial decisions on core data categories for enrollment were rife with tensions over the scope of data collection. Enrollment presented a unique opportunity within bureaucratic circles to gather a broader database on Indian residents, which could include data such as blood group, caste, etc. [57]. Aadhaar's design team, however, had a different perspective. As Kairav, a

Bengaluru-based team member, elaborated: "Identity should be inclusive. [...] The more questions we ask, the more filter criteria we are putting, more exclusive [Aadhaar] will become. If you cannot provide proof [for data categories], somebody will reject you. [...] We removed literally everything into just four [demographic] attributes" [Kairav, personal communication, 24 September 2015].

This focus on inclusivity breaks down, however, in encounters of dissonance between Aadhaar's imagined enrollee (who has this enrollment information always already available) and the diversity of its actual enrollees. This dissonance was evident in enrollment struggles of specific populations: (1) the elderly and manual laborers as they encountered troubles in recording their fingerprints and irises [44,71]; (2) the transgendered who experienced discrimination at enrollment centers and challenges in effectively certifying their gender identity [67,83]; and (3) the homeless, who not only faced troubles in recording their biometric data, but also often lacked proofs of identity and address [65]. Devdatt, an ex-fieldworker with Aashraya, a Delhi-based NGO, involved in enrolling the homeless, recounted his experiences:

> There was a point where [enrolling agents] would take four impressions of all fingers. We realized that... in all the four... [the images of the fingers were not very clear]. We asked, 'It is not coming, so what are you going to do?' They said, 'We will take the best out of the four.' The problem really was that if the best of four does not work, all the stuff that is going to be built [in the future], what use is it going to be? Tomorrow, suppose they get their [Aadhaar-enabled] bank accounts, they get the money from some government program into the account, what happens when they cannot take out the money [because of authentication errors]? [...] Your money will be there, but you can't access it [Devdatt, personal communication, 20 October 2015].

These difficulties were also recognized by Aadhaar's design team, who chose to supplement the "poorer biometric samples" [105:44] coming from fingerprint collection with iris scans. However, this workaround ran into problems of its own, as "corneal scars, corneal blindness, cataract resulting from nutritional deficiencies" disrupted the uniqueness of enrollees [69]. Such problems of differential exclusion—whether described in the statistical language of errors that need to be minimized [57] or the more politicized claims of activists pointing to their disproportionate impact on marginal populations [22,43]—are central to the ongoing debate around consequences of infrastructuring Aadhaar in everyday lives of Indian residents.

Recognizing problems with the (mandatory) address field faced by homeless populations, UIDAI implemented an Introducer system, like an existing procedure used by banks in India, which allows an existing customer to introduce new customers to the bank. Here, however, other difficulties arose. On the UIDAI's side, the Introducer system was required to establish "a data environment around individuals who do not have sufficient documentation" [66:140]. On the introducer side, Devdatt raised concerns around the potential legal liability of individuals or organizations acting as introducers. The problems faced by both sides became apparent when an Aashraya fieldworker was detained in connection with the death of a homeless person. In stark contrast to an established Supreme Court ruling that an introducer cannot be held liable for fraud committed by a bank account holder without other evidence [66], the police detained and started questioning the Aashraya fieldworker because they found an enrollment slip in the deceased's pocket with his name on it. The Mother NGO, leading the enrollment drive on behalf of the Delhi Government, insisted that such liability was limited to knowing the introduced person to the best of the introducer's knowledge. However, Aashraya fieldworkers remained unconvinced as they put in their own resources to fight the detainment in court. Chetan, another ex-fieldworker, explained how this problem also grew with scale: "As our people started introducing the homeless

into Aadhaar, we quickly realized that each of us will eventually introduce thousands of them. That is a lot of people when it comes to Introducer liability" [Chetan, personal communication, 23 October 2015].

In another workaround for the address field, fieldworkers were instructed to provide Aashraya's address as a short-term solution to the enrollment barrier and site of potential Aadhaar-related mail delivery. But this raised further concerns. What would happen if Aadhaar letters issued by the UIDAI upon successful enrollment did not arrive at Aashraya's address? Or if they were unable to find these homeless enrollees later? In response, the Mother NGO insisted that such issues be dealt with on a case-by-case basis. Aashraya fieldworkers, however, could not overlook these concerns and discontinued their enrollment work in April 2011.

Such breakdowns in process and subsequent workarounds are indicative of the challenges faced by people with no identity documents during Aadhaar enrollment. In April 2015, responding to a Right to Information application, the UIDAI revealed that out "of 83.5 crore [835 million] Aadhaar numbers issued till then, [...] only 0.21 million (0.03%) used the 'introducer system'" [111]. For critics, this information raised questions around Aadhaar's core commitment to inclusion. "How many people in India have no ID at all is hard to guess [...]. If the number is large, [...] then Aadhaar is doing little to solve the problem. And if the number is small, then what was the basis of the claim that 'an inability to prove identity is one of the biggest barriers preventing the poor from accessing benefits and subsidies'" [109]. Although this critique overlooks Aadhaar's crucial role in standardizing identification procedures in India, it points to the long history of issues faced by people with no identity documents, and how challenges of achieving visibility through older identification practices have in fact been carried forward into the new system, despite its very claim to overcome such exclusions [89]. Aashraya's challenges in enrolling the homeless reveals how visibilities afforded by new infrastructures like Aadhaar are contingent upon prior relationships with the state. Forms of marginality and exclusion thus travel from old to new identification practices.

Enrollment difficulties illustrate how fitting into core data categories can be harder for some enrollees than others. Residential address remains an exclusionary 'filter criteria' in the design of bureaucratic procedures, which expect citizens to have a place of residence. For Indians with stable addresses, existing relationships with the state, and distinct biometric features, enrollment is not difficult to navigate, and is relatively unproblematic. However, for those who do not have them, the failure to enroll, despite the project's core rhetoric of inclusion, perpetuates a vicious and rapidly widening circle of consequences. Given its role in standardizing delivery of services in India, being excluded from Aadhaar (unlike other more targeted or single-function identity documents, like voter ID cards) raises challenges of claiming membership and access that quickly multiply and ramify across multiple spheres from government services to financial and telecommunication services.

4.2 Seeding: Circulating Uniqueness

Once enrolled, Indian citizens are confronted with the challenge of leveraging their Aadhaar identity to make claims on a variety of private and public services. Seeding is the process of adding Aadhaar numbers to the records of other public and private databases. It is only possible after obtaining informed consent to seeding from residents and verifying their eligibility to access the seeded service. It is conducted in two ways: *inorganic* and *organic* seeding. Inorganic seeding involves computational comparison between the demographic data of a resident in the Aadhaar database with their data stored in the seeded database. When a resident's record is accurately disambiguated, their Aadhaar numbers are added automatically to the seeded database. However,

"the process of matching two datasets electronically becomes very difficult" [102:6]. Hence, organic seeding, which requires residents to actively update their data in seeded databases with their Aadhaar numbers, is the preferred and more common method. This involves door-to-door campaigns, crowdsourcing, organization of camps, and data collection at points-of-service disbursement (such as Fair Price Shops for PDS), and text messages asking residents to re-enroll. Once existing data is seeded with Aadhaar numbers, it is bureaucratically interpreted as 'unique,' while the rest is rendered 'duplicate' or 'ghost' entries [99].

For the homeless, seeding posed new challenges. As Chetan from Aashraya explained:

> Suppose we put in Aashraya address in South Delhi for a homeless person who lives in North Delhi. This is a problem because if, for example, [he gets his Voter ID based on Aadhaar] he would only be eligible to vote for a constituency in South Delhi instead of North Delhi. Or worse, this person may not be able to lay any claim on where he lives in North Delhi, despite the fact that he has been living there for more than 20 years. He could also be potentially excluded from [Aadhaar-enabled] PDS if the ration shop dealer asks him to access his ration from South Delhi. [...] Address matters! [Chetan, Personal communication, 23 October 2015]

Even after securing an Aadhaar number, the consequences of makeshift entries for residential address magnify as the use of Aadhaar expands. Aadhaar is putatively designed to accommodate the movement of people, for example, Aadhaar records can be updated electronically, and Aadhaar-enabled bank accounts can be accessed from anywhere. However, bureaucratic work in adjudicating place-based entitlements such as recognition of voting rights or housing and land rights depends on residential address as evidence of entitlement. Incorrect address on Aadhaar records can make it difficult for citizens to claim their place-based entitlements. Thus, Chetan's account above points to how incorrect data such as makeshift data entries can make it harder for citizens to effectively represent themselves to state bureaucracies.

Moreover, seeding can be messy, raising significant and sometimes insurmountable difficulties. This came out in our participant observation of a survey conducted by Right to Food activists around the transition from food-based PDS to Aadhaar-enabled cash based PDS in the urban slums of Chandigarh in 2015. This process involved seeding Aadhaar numbers in both the PDS database and individual bank accounts (after which the cash subsidy was routed directly to the Aadhaar-enabled bank account of the eldest woman in beneficiary families per PDS distribution policy). For some, this process worked as advertised, instantiating welcome gains in efficiency and access. For others, the process was less straightforward. At the beginning of 2016, the Department of Food and Supplies in Chandigarh reported that 24.8% of PDS-eligible families had not received their payments because their Aadhaar numbers were not properly seeded in their bank account [56]. The situation had not changed significantly by March 2017, when an independent study by researchers from University of California, San Diego (UCSD) reported that, "Though official records indicate a transfer failure rate of less than 1%, around 20% of beneficiaries report not receiving benefits" [55:5] after transition to cash based PDS. As evidenced in the Right to Food survey, many beneficiaries did not understand the steps involved in the transition and had not received any cash. Others who had purportedly completed the steps had either not checked their bank accounts in the four months since the transition or were looking for cash in the wrong account. This had significant, even life-threatening, consequences for citizens who previously had access to food grains through Fair Price Shops.

These consequences were brought home in our conversations with Shravan and Rekha, an elderly couple who had not received any cash. "We get by", Shravan said. "But it was easier when we could get rations from the [shop]. What will you do? We cannot afford the prices of food in the

market, so you cut back on what you eat." (Sarwan, personal communication, 22 December 2015). Their local Fair Price Shop was shut down with the shift to cash based subsidies. Rekha went inside her small kitchen and brought out empty canisters of food. "These used to be full when the [shop] was around, now we have nothing" (Rekha, personal communication, 22 December 2015). A representative from an NGO experienced in implementing such cash transfer pilot projects in Delhi and Indore, has poignantly summarized these consequences: "The burden of transition is falling on the poorest. Those most excluded have the least capacity to approach the system. The burden of change should be on the administration" [82].

These stories foreground the uneven distribution of breakdowns in transitioning from a paper-based standard for identification (the ration card) to a digital standard for identification (Aadhaar) in PDS. Navigating this transition was conditioned upon beneficiaries' ability to manage the circulation of their Aadhaar identity, interact with the banking system, file a complaint in cases of not receiving cash subsidy, and use it to ensure food security. This ability actively determined who among beneficiaries are included/excluded from cash based PDS. At the same time, despite the "non-trivial challenges" in implementation, the beneficiary preference for cash based subsidies over food-based subsidies grew from 35% to 65% over the course of the UCSD study between January 2016 to March 2017 [55]. While beneficiaries who received cash felt empowered to make choices regarding the quality of food grains they purchased, beneficiaries who did not receive cash struggled to make ends meet.

Our stories of seeding showcase the cascading impact of the circulation of Aadhaar data. For those able to understand and manage this circulation, Aadhaar provided new efficiencies and securities in last mile delivery of public entitlements. For those less digitally competent, this circulation became a trap, effectively suspending or removing their often relied upon citizenship entitlements. Many of these citizens were able to access their PDS entitlements when it was organized as a standalone government service that relied on paper-based ration cards. Their access was curtailed when they failed to manage the circulation of their Aadhaar data. They became harder to see in the reorganization of PDS through Aadhaar. Efforts to bureaucratically fix the problem of duplicate entries by seeding Aadhaar numbers across other databases produced in turn cascading forms of exclusion, as existing records in these databases became at risk of being flagged and put into residual categories such as "duplicates," further effacing, on occasions, rightful claims to services. The messy imbrication of Aadhaar with PDS and banking services produced a set of networked breakdowns further amplifying the effects of exclusions or messy workarounds during enrollment.

4.3 Authentication: Verifying Uniqueness

The final barrier confronting citizens is the challenge of effective authentication. After enrollment, resident data is stored in the Aadhaar database, where it is checked against various calls for 'authentication'. The Aadhaar Authentication Framework [98] documents five types of user authentications, leveraging different combinations of demographic information, mobile numbers, and biometric information. Type 1 authentication, the least secure, involves a simple comparison of demographic data provided by a resident with the demographic data stored in Aadhaar database. Type 2 relies solely on a One-Time-Password (OTP) for authentication sent to resident's mobile number. The remaining three types of authentication (Type 3, 4, and 5) combine biometric data with OTPs and demographic data. In each of these authentication types, residents are also required to provide their Aadhaar number in addition to other data outlined above. On the backend, authentication involves 1:1 comparison between other data provided by the resident and the data stored in the Aadhaar database against their number [101].

Enrollees require a UIDAI-issued certificate of enrollment (or Aadhaar letter) for any authenticating agent to certify their identity against demographic data stored in the Aadhaar database. Here, residential address (or lack thereof) combined with the very scale of the project to raise difficulties once again. "As Ashok Pal Singh [Deputy Director General of UIDAI between 2010 and 2014] recollects, 'India Post never took us seriously when we told them that in a short time frame, one million Aadhaars will be generated daily [...]'. Very soon, the printed letters piled up, and people were waiting for months to receive them" [57:43]. Reasons for these delays ranged from staffing challenges at the Post Office [27] and incomplete addresses and wrong pin codes provided by enrollees [64], to the failure of enrolling agencies to upload enrollment data in time [58]. The UIDAI responded to these delays by encouraging enrollees to download an 'e-Aadhaar' letter using a One-Time-Password sent to the mobile number on record [103]. However, as mobile numbers were explicitly optional during enrollment and many did not provide them (nor in all cases have them), residents failing to receive their Aadhaar letters were unable to obtain them online as well.

Apart from pilot projects on cash based PDS in union territories such as Chandigarh [55], states governments across the country such as in Delhi, Andhra Pradesh, and Rajasthan are seeding Aadhaar numbers into their PDS database. They plan to distribute subsidized food grains after authenticating beneficiaries using electronic Point of Sale machines with fingerprint readers [60,81,112]. This transition to fingerprint-based authentication was challenging for both bureaucracies and beneficiaries. Even in Andhra Pradesh, where experiments with biometrics have been ongoing since 2006 [54], a government survey in May 2015 reported that fingerprints for the majority of beneficiaries did not match during authentication in one of the districts [90]. In another district, more than half of the beneficiaries were reported to have collected their entitlement without authentication, because the shop owner did not know how to use the machine [90:6]. Critics of Aadhaar-enabled PDS argue that such workarounds open the possibility of incorrectly counting legitimate beneficiaries as "fakes or duplicates" [81]. Since beneficiaries prove their uniqueness through authentication every time in accessing entitlements, a pattern of failed/absent authentications can potentially be used by bureaucracies to move the data of these beneficiaries into residual categories of either "duplicates" or "beneficiaries who have forsaken their entitlements."

The Delhi government, for instance, has been working on connecting Aadhaar with PDS since 2013 [7]. It ran a pilot project in early 2016 to test the feasibility of using authentication in 42 Fair Price Shops. Suhaani, a Delhi-based Right to Food activist, explained how these pilot projects rendered many beneficiaries as having forsaken their entitlement:

> They capture data in three columns. The first column contains people who came to the [shop], their biometrics matched, and they got their [food grains]. The second column contains people who came to the [shop], but their biometrics did not match, therefore, they did not get any [food grains]. And the third column contains people who never came to the shop. Since January [2016], we have data of all 42 shops and there is a 0% error rate [in authentications], meaning that in column two, there is not a single entry. Even UIDAI claims that there is 5% error rate in authentications. When we pointed this out to the Department [of Food Supplies] and asked why you are not populating [the second] column, they [...] said we know there is a problem in the software and we only capture these two data [in first and third column]. Now they plan to cancel the ration cards of beneficiaries who have not come to the shop to claim their benefits at all between the months of January and July [2016] because clearly they are not invested in coming to the shop. Whereas the reality is that they are going to the shop, but their biometrics are not registered. So, this becomes another way of throwing people out of the food security net [Suhaani, Personal Communication, 25 August 2016].

Filling column two requires differentiating between true negatives (fraudulent person trying to authenticate against Aadhaar number of rightful beneficiaries) and false negatives (failure to authenticate rightful beneficiaries due to reasons such as bad internet connectivity and lack of distinct fingerprints). Since this work remained unaccounted in the system's design, rightful beneficiaries whose fingerprints did not match were labeled as people who never came to the shop. Rendered invisible, such beneficiaries were removed from Aadhaar-enabled PDS in Delhi.

A Right to Food activist recounted that by the end of this pilot project, "only about 20 shops [out of 42] remained" because Point of Sale machines were not working in others and "so the pilot failed miserably" [8]. Despite protests, these machines slowly became mandatory in all Fair Price Shops in Delhi. In January 2018, within a month of completely switching to the new process, breakdowns emerged excluding more than 100,000 beneficiaries [7]. A study conducted by researchers from the Indian School of Business (ISB) noted that the Point of Sale machines encountered frequent breakdowns because of outdated PDS servers. "Days with relatively higher number of authentication attempts were marred by frequent disconnection of [Point of Sale] devices from the state PDS server. These devices had to be frequently restarted; sometimes there is delayed or no response from the server, resulting in decreased efficiency of" delivering food grains [106]. The problem, thus the study argues, is not with Aadhaar, but with Delhi's PDS servers. However, these PDS servers have made authentication difficult for Delhi-based PDS beneficiaries. In the distribution of its implementation across organizations, authentication is only as reliable as the weakest link in the network.

The Delhi government withdrew the system within three months as subsidized food grains were "allegedly issued to several fake cardholders and genuine beneficiaries were unable to avail the facility due to biometric authentication failure, poor internet connectivity," etc. [52]. The government started advocating doorstep delivery of subsidized food grains through Point of Sale system as a new alternative [8,52]. Despite challenges in individual states like Delhi, the central government reported in July 2018 that "in 13 states, the percentage of food grain distribution through biometric authentication is above 90%" [52]. Suhaani's account raises questions around how this high efficiency is achieved. If beneficiaries who came to the shop, but their biometrics did not match are removed based on the interpretation of their data as 'duplicates' or 'beneficiaries who have forsaken their entitlements', the system will only record transactions where Aadhaar authentication worked and thereby reflect high efficiency.

We were a part of many conversations among Right to Food activists where these discussions on efficiency of biometric authentications and such anecdotes were abundant. In the early years between 2015 and 2017 when Aadhaar was only being used sporadically in PDS, activists began with attempts to map how food consumption patterns of PDS beneficiaries had changed because of Aadhaar. For example, the survey on cash based PDS in Chandigarh in December 2015 was organized around questions of mapping what the beneficiaries used to eat before the switch to cash subsidies in September 2015 and what they did after. Activists struggled with quantifying the impact of the switch on consumption patterns [Fieldnotes, 15 January 2016]. The activists' approach changed after news broke about a girl, Santoshi Kumari, who died of starvation in Jharkhand on 28 September 2017 because her family did not have an Aadhaar-enabled ration card and lost access to subsidized food grains [39]. They started building a record of starvation deaths reported in the news media and/or verified by their own teams on a Google document [74]. They filed a Right to Information application on 3 May 2019 to the Department of Food & Public Distribution inquiring about the number of starvation deaths reported between May 2014 and April 2019 [75]. The department promptly replied on 8 May 2019 stating that, "No State or UT [Union Territory] Government has reported any incidence of starvation death so far" [75]. Their

struggle for the Indian state's recognition of the dire consequences of failures in Aadhaar-enabled PDS will continue.

Like seeding, successful authentication relies on effective coordination between multiple organizations and many moving parts of the Indian bureaucracy. Aadhaar authentication is held together by a fragile and uneven imbrication of UIDAI, India Post, governmental and private agencies, mobile phones, Fair Price Shops, Point of Sale machines, PDS servers, and internet connectivity. Successful navigation of these periodic breakdowns depends on two crucial forms of work: the work performed by street-level bureaucrats in appropriating Aadhaar to deliver government services, and the work citizens as beneficiaries are frequently called to do in the face of failed (or mis-categorized) authentications to maintain their access to these services. These kinds of work together sustain the visibility of a citizen to state bureaucracies and co-constitute what it means to be unique data of a rightful beneficiary in a welfare database. It is crucial for ongoing interpretation of 'duplicates' in the identification of 'unique' beneficiaries. Beneficiaries who fall into the residual category of 'duplicate' because of repeated authentication failures (false negatives) over time will not only have to prove that they are unique, but also that they have not forsaken their entitlements. This double-edged work of interpreting citizen data, thus, is crucial for ongoing efforts at effective inclusion of citizens in Aadhaar-enabled services. It is not equally granted or available to all and is therefore central to citizens' resolution rendered through Aadhaar.

5 DISCUSSION: MECHANISMS OF RESOLUTION

The struggles narrated above offer a window into how distributed and collaborative practices of delivering government services are shaped by data systems such as Aadhaar. Bureaucratic procedures in India have increasingly come to rely on Aadhaar-based data of citizens. Aadhaar, thus, has become the infrastructure of organizing government services. Our field stories show that citizens are rendered through Aadhaar in varying degrees of resolution and their resolution produces costly and unevenly distributed consequences for their life chances. Aadhaar initially standardizes citizen data by enrolling their 'thick' identities into 'thin' data categories and biometric markers. As this data circulates and expands through the networked and situated practices of seeding and authentication, it produces a new category of 'unique' citizens in government services. It simultaneously engenders new forms of exclusion and residual categories with citizens who used to receive their entitlements before Aadhaar showing up as 'duplicates' and 'beneficiaries who have forsaken their entitlements.'

These categorical judgments on citizen data deeply shape their membership in and access to government services. If citizens are expected to express their identity in core data categories prescribed by Aadhaar, they are also required to use them effectively to claim welfare entitlements and wider rights of citizenship—an ability that is also not equally distributed. For their part, state bureaucracies are expected to manage this Aadhaar-based citizen data competently to provide government services. In situations where either of them is unable to meet these expectations, citizens are rendered low-resolution citizens, subject to the losses and exclusions that such a status confers. Leveraging an infrastructure to manage state-citizen relations does not produce resolution as a binary—either low or high—rather it emerges as a spectrum, mutating in time, and layered across a variety of organized practices in the imbrication of data systems with existing government services. The more alignment there is between the efforts to represent and claim representation through data, the higher is the resolution. This spectrum deeply shapes the boundaries between those inside and outside the realm of biopolitical care in state welfare

programs. In our stories, at the lowest end of this spectrum are the homeless with no identity documents. They are often invisible and struggle for recognition from the state. In experiences of data-driven marginalization in Aadhaar-based services, 'torque' pulls low-resolution citizens back in their efforts to overcome the challenges of aligning with core data categories. At the highest end are beneficiaries receiving cash based PDS subsidies in their bank accounts. They are not only bureaucratically recognized as citizens but are also full-fledged members of India's formal economy. In experiences of data-driven efficiency through Aadhaar, 'torque' pushes high-resolution citizens forward as they experience alignment with core data categories.

Each actor in our field stories engages in seeing like an infrastructure; they either account for or challenge categorical judgements at particular moments in designing or navigating Aadhaar's processes. Kairav talks about building consensus on minimizing core data categories for enrollment to ensure Aadhaar's reach and legitimacy in representing India's population. Despite these efforts, Devdutt recounts the challenges of registering residential address for homeless citizens and how data collection itself became challenging for people who do not have identity documents. Chetan elaborates on how seeding incorrect residential address can make it difficult to make categorical judgements on place-based entitlements and thereby renders access to services even harder for the homeless. Finally, Suhaani narrates how miscategorized authentication failures can put rightful beneficiaries into residual categories of 'duplicates' or 'beneficiaries who have forsaken their entitlement.' They place themselves in the infrastructure's perspective to account for how Aadhaar "works" in highlighting the challenges of using Aadhaar-enabled data to see citizens and the struggles of citizens to be seen through their data in delivery of government services.

Together they point to three mechanisms that configure resolution: (1) *Registration*: The process of producing initial resolution of a citizen by torquing their identity into alignment with core data categories. (2) *Circulation*: The movement of data across databases that produces resolution on a spectrum of high to low resolution as data systems imbricate with existing state practices. (3) *Interpretation*: The work of making decisions about users (here, citizens) based on their resolution using the situated meaning of data categories within organizations and algorithms that operate on their available data. Our field stories showcase how these mechanisms manifest in each key process of Aadhaar. *Enrollment* requires circulation of existing ID documents and interpretation of biometric data collected to ensure a citizen's uniqueness before their registration into Aadhaar. *Seeding* requires registration into the seeded database and interpretation of a citizen's eligibility and informed consent to access services in the circulation of Aadhaar numbers. *Authentication* requires registration and circulation of Aadhaar-based service transactions and authentication requests. The authentication data, thus produced, is central to the interpretation of the validity of a citizen's claim to access services. These mechanisms produce a spectrum of citizens' resolution. For example, a situation when a citizen is unable to register into Aadhaar is different from when citizen data is registered correctly but is not seeded appropriately into other databases. Furthermore, these mechanisms recursively build on and shape each other. The interpretation of the uniqueness of Aadhaar numbers, for example, builds on registration of biometric data and shapes the conditions for their circulation in other databases. In the discussion that follows, we take each of these mechanisms separately and discuss how they shape resolution.

Registration involves simultaneously simplifying and standardizing real-world entities through data categories. The processes of making categorical judgements and building consensus over these data categories shape not only the nature of the data collected, but also the understanding of the real-world entity being represented through data. In collecting data, certain aspects of the entity become visible and amenable to standardized forms of representation, while other aspects

remain invisible and unaccounted. Seeing like an infrastructure involves combining data categories to develop a picture of an entity. For example, an infrastructure can only see a real-world box as a box when data is collected along three categories of its dimensions: length, breadth, and height. If data is collected only for one of these three categories, the box will look like a line. If data is collected for two categories, the box manifests as a rectangle. How categories are combined, and what data is collected, thus, deeply shape the efforts to see a real-world entity. However, as members of Aadhaar's design team noted, maximizing the number of mandatory data categories during enrollment excludes citizens who cannot provide data for them. Data categories enact filters of exclusion. Members conceived of a minimal combination of demographic and biometric data categories necessary for registration in Aadhaar and sufficient to represent oneself in other services. They simplified data representation of individuals to foster inclusion. Simplification excludes but can also serve to include. While most citizens have been able to enroll into Aadhaar, others struggled to provide data even for these simplified categories. Furthermore, citizens' registration in and access to other Aadhaar-based services exacerbated this challenge because it involved providing more data for new categories of evaluating their eligibility for services (during seeding) and the validity of their claims to services (during authentication). Expanding data categories reduces the scale of the inclusion of citizens. It increases resolution of a citizen, and at the same time, decreases its consistency across citizenry.

Circulation requires abstracting contingencies of registration to standardize data as stable representations of citizens. While correct data underlies everyday experiences of data-driven efficiencies in last mile delivery of services, incorrect data further marginalizes citizens from accessing them. For example, in the context of the homeless, makeshift addresses can potentially result in the denial of place-based entitlements. Circulation is agnostic to the correctness of collected data and the resolution of citizens, the flow of correct data increases and incorrect data decreases resolution. Circulation is also the kernel of controversies over invasion of privacy and potential of surveillance embedded in the potential of data convergence through data systems. Once citizens can be uniquely identified, it becomes easier to collate data about them across various databases to produce high-resolution when their data is correct. Members of the design team addressed this problem by making circulation conditional and dependent on citizens' informed consent. In mandating consent for data circulation, they imagined citizens to be in control of their data. However, consent was often coerced by making Aadhaar mandatory to access government services. From bureaucrats' perspective, everyone availing government services must be registered on Aadhaar and consent to seed their Aadhaar numbers into public databases. Otherwise, their efforts remove 'duplicate' entries from these databases will inevitably fail. Achieving consistency in resolution is only possible through participation of citizens who must consent to sharing their data. Citizens were also expected to possess competence in navigating the networked logic of appropriating Aadhaar in government services. The ability of citizens to navigate data circulation and their agency in claiming entitlements mutually shape each other. Citizens who did not have an Aadhaar number or did not consent to data sharing or lacked this ability to navigate data circulation struggled in maintaining the connections between databases and were rendered in lower resolution.

Interpretation relies on manual as well as algorithmic ways of processing data to identify patterns and produce new interpretive categories for classifying citizens. For example, manual addition of Aadhaar numbers to government databases simultaneously produced two categories for interpreting citizen data: 'unique' and 'duplicate' records. While being recognized as 'unique' increased the resolution of citizens, being categorized in the residual category of 'duplicate' rendered them invisible. Falling into core categories of classification increases resolution; falling

into residual categories decreases it. However, falling into any of these categories is not given. It depends on: (1) the nature of the available data; and (2) the techniques used for interpretation. Starting with the nature of available data, incorrect data inevitably makes interpretation harder. Furthermore, how, and when data is stored or not stored also shapes the possibilities of interpretation. For example, when the data of beneficiaries who struggled with authentication at Fair Price Shops in Delhi was not stored, they were eventually interpreted as having 'forsaken their entitlements.' Moving onto the techniques of interpretation, they require consistency in formulation of the problems they address. For example, the problem of targeting beneficiaries manifests differently when it is oriented to inclusion (which requires relaxing the eligibility conditions to access government services) as compared to when it is geared towards efficiency (which requires tightening them). Resolution is contingent upon how the problem of managing citizens is formulated, the affordances and limits of available techniques to process data, and the quality of available citizen data.

To conclude, resolution—and the affordances and limits that it confers—is a contingent and accountable relationship between actors mediated through data infrastructures over time and across places. Focusing on the spectrum of citizens' resolution opens possibilities of examining the varying degrees of success in mediating state-citizen relations through citizen data. While we have focused on low resolution to uncover moments when infrastructures marginalize, high resolution can also potentially marginalize people in diverse ways, for example, in the struggles of the formerly incarcerated in securing employment because of their criminal record. More generally, *resolution is an analytic resource to map the making and management of difference enacted by data infrastructures in everyday lives of data subjects.* While a data infrastructure can make many data subjects visible to organizational actors in delivery of services, it can also easily efface accounts of others that it cannot and does not see. Here the politics of resolution is deeply intertwined with the prescribed purpose of the infrastructure that produces it. For example, on one hand, high resolution in the context of a public data infrastructure geared towards distributing welfare means inclusion. On the other hand, it implies greater potential of surveillance and invasion of privacy when the same infrastructure is used for criminal investigations or differentiating between citizens and immigrants. Such infrastructures are often deployed to systemically target marginal and minoritized communities that have already been subject to long histories of surveillance and tracking [14]. Low resolution when employed strategically and creatively by these communities can become a powerful resource for resistance in these contexts. More broadly, the lived experience of resolution is deeply shaped by the (democratic or authoritarian) nature of the state and the socio-political purpose of its infrastructuring efforts.

6 IMPLICATIONS OF SEEING LIKE AN INFRASTRUCTURE

As a standpoint, seeing like an infrastructure engenders a consciousness around how data infrastructures mediate relations between organizations and users through mechanisms of registration, circulation, and interpretation of user data. In the context of state-citizen relations, on the one hand, understanding these mechanisms is important for state bureaucracies as citizen data becomes a foundational resource for delivery of government services. On the other hand, these mechanisms offer a toolkit for citizens to understand how they are represented through data and concomitant challenges of claiming citizenship rights. Here questions of how citizens are rendered residual and how they work with and around core data categories to secure or challenge their data representation offers a generative site to unpack their political, social, and material work to

(re)claim and maintain standing as citizens. These mechanisms, thus, offers a window into the challenges and politics of larger and longer organizational processes of digitalizing statecraft.

Resolution also helps map diverse experiences and struggles of living with data. It captures the emerging tensions in relationships between organizations (here, the state) enacting the role of observers and users (here, citizens) who are observed through data. When the observed are afforded a broader scope of participation including, but not limited to, learning to navigate the networked logic of infrastructures, capacity to leave without penalty of losing access to services, and opportunities to speak back and seek redress when faced with harms, their data can effectively represent their lives. For computational tools that track behavior, which expect people to behave as if these tools are not there [114], the lesser the opportunities afforded to the observed in shaping their data, the more oppressive this relationship becomes. At the same time, the greater the opportunities provided, the easier it becomes to "game" the infrastructure [113]. Resolution, thus, is crucial to map the balance of power in relations between actors increasingly organized around and through data infrastructures and their differential agencies in navigating and negotiating these relations.

However, these relations also existed prior to current efforts at infrastructuring data systems. In analyzing the impact of resolution on the nature and meaning of citizenship, placing oneself in the perspective of seeing like an infrastructure without critical reflection on the politics of existing state-citizen relations can potentially obscure the role of the state in perpetuating oppression and domination through data systems. Following the mechanisms of resolution must be supplemented by questions that focus on: (1) why and how do certain data categories become central to organizing state governance?; (2) what is the nature and type of knowledge about a given population (e.g., Indian citizens in the case of Aadhaar) that is produced and shaped by this way of seeing?; (3) how do particular group of stakeholders (with specific interests) use this knowledge?; and finally, (4) what are the consequences of using this knowledge? These questions are crucial to the pursuit of accountability and justice in building, appropriating, and relying on data infrastructures.

7 CONCLUSION

Neither citizenship nor the state are fixed and stable entities; rather, the two co-construct each other through lived practices and experiences of bureaucratic procedures. As infrastructures become increasingly integral to statecraft, these procedures in turn are increasingly driven by data systems long studied by CSCW scholars. As state bureaucracies produce and manage more data about citizens, they also increasingly rely on this data to organize their services. To be a citizen is to be able to make claims on these services; and to do so, citizens must be visible to state bureaucracies through their data. The focus of this paper was on the cascading key processes of Aadhaar and how they produce or enhance this visibility for many, while complicating and reducing it for others. It has also shown how citizens respond to this situation, seeking to manage and navigate their visibility through such systems (albeit with widely varying degrees of agency and success). The spectrum of resolution thus embeds multiple meanings of citizenship, each with its own promise and peril. Low-resolution citizens of the kind foregrounded here face challenges of data-driven marginalization while high-resolution citizens must often contend with invasion of privacy and surveillance. The work of building an ecosystem of rights and obligations for citizens and a corresponding set of obligations and due process procedures on the part of state bureaucrats is, thus, crucial to more equitable and inclusive forms of governance, in India as elsewhere. It is at the very heart of the social and moral problem of infrastructuring data systems in existing

practices of state governance: social, because making up and interpreting a population as data requires work, organization, and discipline; moral, because using data to represent citizens inevitably raises practical and normative questions of fairness, accountability, and inclusion. Learning to see like an infrastructure can help us follow this work and better analyze the emerging conditions of surveillance, precarity, and inequality perpetuated through data and algorithms.

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REFERENCES

[1] Syed Ishtiaque Ahmed, Nusrat Jahan Mim, and Steven J Jackson. 2015. Residual Mobilities: Infrastructural Displacement and Post-Colonial Computing in Bangladesh. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (CHI '15), 437–446. https://doi.org/10.1145/2702123.2702573

[2] Shankkar Aiyar. 2017. *Aadhaar: A Biometric History of India's 12-Digit Revolution.* Westland, Delhi.

[3] Philip Alston. 2019. *Report of the Special rapporteur on extreme poverty and human rights.* Geneva: Office of the United Nations High Commissioner for Human Rights (OHCHR). Retrieved from https://undocs.org/A/74/493

[4] Nikhil Anand. 2011. PRESSURE: The PoliTechnics of Water Supply in Mumbai. *Cultural Anthropology* 26, 4: 542–564. https://doi.org/10.1111/j.1548-1360.2011.01111.x

[5] Nikhil Anand. 2012. Municipal disconnect: On abject water and its urban infrastructures. *Ethnography* 13, 4: 487–509. https://doi.org/10.1177/1466138111435743

[6] Ariella Azoulay. 2008. *The Civil Contract of Photography.* Zone Books, New York.

[7] Gaurav Vivek Bhatnagar. 2018. PDS Shopkeepers in Delhi Found Diverting Rations by Misusing Point of Sale Machines. *The Wire.* Retrieved from https://thewire.in/government/pds-shopkeepers-delhi-found-diverting-rations-misusing-point-sale-machines

[8] Gaurav Vivek Bhatnagar. 2018. After Universalising PoS and Iris Readers for PDS, AAP Govt Approves Doorstep Delivery of Rations. *The Wire.* Retrieved from https://thewire.in/government/universalising-pos-iris-readers-pds-aap-govt-approves-doorstep-delivery-rations

[9] Chris Bopp. 2019. Doing "Good" with Data? Understanding and Working Around Data Doubles in Human Services Organizations. In *Conference Companion Publication of the 2019 on Computer Supported Cooperative Work and Social Computing* (CSCW '19), 33–37. https://doi.org/10.1145/3311957.3361850

[10] Glenn A. Bowen. 2009. Document Analysis as a Qualitative Research Method. *Qualitative Research Journal* 9, 2: 27–40. https://doi.org/10.3316/QRJ0902027

[11] Geoffrey C Bowker and Susan Leigh Star. 1999. *Sorting Things Out: Classification and its Consequences.* MIT Press, Cambridge, MA.

[12] Keith Breckenridge. 2014. *Biometric State: The Global Politics of Identification and Surveillance in South Africa, 1850 to the Present.* Cambridge University Press, Cambridge.

[13] Keith Breckenridge and Simon Szreter (eds.). 2012. *Registration and Recognition: Documenting the Person in World History (Proceedings of the British Academy).* Oxford University Press, Oxford.

[14] Simone Browne. 2015. *Dark Matters: On the Surveillance of Blackness.* Duke University Press, Durham, NC.

[15] Jane Caplan and John Torpey (eds.). 2001. *Documenting Individual Identity: The Development of State Practices in the Modern World.* Princeton University Press, Princeton.

[16] Stevie Chancellor, Shion Guha, Jofish Kaye, Jen King, Niloufar Salehi, Sarita Schoenebeck, and Elizabeth Stowell. 2019. The Relationships between Data, Power, and Justice in CSCW Research. In *Conference Companion Publication of the 2019 on Computer Supported Cooperative Work and Social Computing* (CSCW '19), 102–105. https://doi.org/10.1145/3311957.3358609

[17]   Stephen J Collier. 2011. *Post-Soviet Social: Neoliberalism, Social Modernity, Biopolitics*. Princeton University Press, Princeton.

[18]   Juliet Corbin and Anselm Strauss. 2015. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. Sage Publications, Thousand Oaks, CA.

[19]   John Danaher, Michael J. Hogan, Chris Noone, Rónán Kennedy, Anthony Behan, Aisling De Paor, Heike Felzmann, Muki Haklay, Su Ming Khoo, John Morison, Maria Helen Murphy, Niall O'Brolchain, Burkhard Schafer, and Kalpana Shankar. 2017. Algorithmic governance: Developing a research agenda through the power of collective intelligence. *Big Data and Society* 4, 2: 1–21. https://doi.org/10.1177/2053951717726554

[20]   Nicola Dell and Neha Kumar. 2016. The Ins and Outs of HCI for Development. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI '16), 2220–2232. https://doi.org/10.1145/2858036.2858081

[21]   Paul Dourish and Scott D Mainwaring. 2012. Ubicomp's Colonial Impulse. In *Proceedings of the 2012 ACM Conference on Ubiquitous Computing* (UbiComp '12), 133–142. https://doi.org/10.1145/2370216.2370238

[22]   Jean Drèze. 2015. JAM and the Pursuit of Nirvana. *The Wire*. Retrieved from http://thewire.in/2015/11/06/jam-and-the-pursuit-of-nirvana-14873/

[23]   Michaelanne Dye, Neha Kumar, Ari Schlesinger, Marisol Wong-Villacres, Morgan G Ames, Rajesh Veeraraghavan, Jacki O'Neill, Joyojeet Pal, and Mary L Gray. 2018. Solidarity Across Borders: Navigating Intersections Towards Equity and Inclusion. In *Companion of the 2018 ACM Conference on Computer Supported Cooperative Work and Social Computing* (CSCW '18), 487–494. https://doi.org/10.1145/3272973.3273007

[24]   Paul N Edwards. 2003. Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems. In *Modernity and Technology*, Thomas J Misa, Philip Brey and Andrew Feenberg (eds.). MIT Press, Cambridge, MA, 185–225.

[25]   Paul N Edwards, Steven J Jackson, Geoffrey C Bowker, and Robin Williams. 2009. Introduction: An Agenda for Infrastructure Studies. *Journal of the Association for Information Systems* 10, 5: 364–374. Retrieved from https://aisel.aisnet.org/jais/vol10/iss5/6/

[26]   Virginia Eubanks. 2017. *Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor*. St. Martin's Press, New York.

[27]   Express News Service. 2013. Aadhaar gives hard time to postman. *The New Indian Express*. Retrieved from http://newindianexpress.com/cities/hyderabad/article1460030.ece

[28]   Marion Fourcade. 2021. Ordinal citizenship. *The British Journal of Sociology* 72, 2: 154-173. https://doi.org/10.1111/1468-4446.12839

[29]   Sarah Fox, Amanda Menking, Stephanie Steinhardt, Anna Lauren Hoffmann, and Shaowen Bardzell. 2017. Imagining Intersectional Futures: Feminist Approaches in CSCW. In *Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing* (CSCW '17 Companion), 387–393. https://doi.org/10.1145/3022198.3022665

[30]   Sucheta Ghoshal, Rishma Mendhekar, and Amy Bruckman. 2020. Toward a Grassroots Culture of Technology Practice. *Proc. ACM Hum.-Comput. Interact.* 4, CSCW1. https://doi.org/10.1145/3392862

[31]   Ian Hacking. 2006. Making Up People. *London Review of Books* 28, 16: 23–26.

[32]   Donna J Haraway. 1991. Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. In *Simians, Cyborgs and Women: The Reinvention of Nature*. Routledge, New York, 183–201.

[33]   Sandra Harding. 2000. Feminist Standpoint Epistemology. In *The Gender and Science Reader*, Muriel Lederman and Ingrid Bartsch (eds.). Routledge, London, 145–168.

[34]   Penelope Harvey. 2012. The Topological Quality of Infrastructural Relation: An Ethnographic Approach. *Theory, Culture & Society* 29, 4–5: 76–92. https://doi.org/10.1177/0263276412448827

[35]   Ola Henfridsson and Bendik Bygstad. 2013. The Generative Mechanisms of Digital Infrastructure Evolution. *MIS Quarterly* 37, 3: 907–932. https://doi.org/10.25300/MISQ/2013/37.3.11

[36]   Mangala Anil Hirwade. 2012. Implementation of E-Governance in India. In *Encyclopedia of Cyber Behavior Volume III*, Zheng Yan (ed.). IGI Global, Hershey, PA, 1282–1304.

[37]   Lilly Irani, Janet Vertesi, Paul Dourish, Kavita Philip, and Rebecca E Grinter. 2010. Postcolonial Computing: A Lens on Design and Development. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '10), 1311–1320. https://doi.org/10.1145/1753326.1753522

[38]   Steven J Jackson, Paul N Edwards, Geoffrey C Bowker, and Cory P Knobel. 2007. Understanding infrastructure: history, heuristics, and cyberinfrastructure policy. *First Monday* 12, 6. Retrieved from http://journals.uic.edu/ojs/index.php/fm/article/view/1904/1786

[39]   Aarefa Johari. 2017. Denied food because she did not have Aadhaar-linked ration card, Jharkhand girl dies of starvation. *Scroll.in*. Retrieved from https://scroll.in/article/854225/denied-food-because-she-did-not-have-aadhaar-linked-ration-card-jharkhand-girl-dies-of-starvation

[40]   Justice K.S. Puttaswamy and Anr. vs. Union of India and Ors. 2018. *Writ Petition (Civil) No. 494 of 2012*. Retrieved from https://www.dropbox.com/s/hy85sx3holenizr/Aadhaar_Judgement_26-Sep-2018.pdf

[41] Helen Kennedy. 2018. Living with data: Aligning data studies and data activism through a focus on everyday experiences of datafication. *Krisis: Journal for Contemporary Philosophy*, 1: 18–30. Retrieved from https://krisis.eu/living-with-data/

[42] Naveeda Khan. 2006. Flaws in the Flow: Roads and their Modernity in Pakistan. *Social Text* 24, 4 89: 87–113.

[43] Reetika Khera. 2016. On Aadhaar Success, It's All Hype - That Includes the World Bank. *NDTV*. Retrieved from http://www.ndtv.com/opinion/yes-aadhaar-is-a-game-changer-in-wrecking-welfare-schemes-1434424

[44] Reetika Khera (ed.). 2018. *Dissent on Aadhaar: Big Data Meets Big Brother*. Orient BlackSwan, Delhi.

[45] Julia Kristeva. 1982. *Power of Horror: An Essay of Abjection*. Columbia University Press, New York.

[46] Neha Kumar, Naveena Karusala, Azra Ismail, Marisol Wong-Villacres, and Aditya Vishwanath. 2019. Engaging Feminist Solidarity for Comparative Research, Design, and Practice. *Proc. ACM Hum.-Comput. Interact.* 3, CSCW. https://doi.org/10.1145/3359269

[47] Martha Lampland and Susan Leigh Star. 2009. *Standards and their Stories: How Quantifying, Classifying, and Formalizing Practices shape Everyday Life*. Cornell University Press, Ithaca.

[48] Brian Larkin. 2013. The Politics and Poetics of Infrastructure. *Annual Review of Anthropology* 42: 327–343.

[49] Ann Light. 2007. *The Future of Computing—Visions and Reflections*. Oxford. Retrieved from https://www.oii.ox.ac.uk/archive/downloads/publications/FD11.pdf

[50] George E Marcus. 1995. Ethnography in/of the World System: The Emergence of Multi-Sited Ethnography. *Annual Review of Anthropology* 24, 1: 95–117. https://doi.org/10.1146/annurev.an.24.100195.000523

[51] Aryn Martin and Michael Lynch. 2009. Counting Things and People: The Practices and Politics of Counting. *Social Problems* 56, 2: 243–266. https://doi.org/10.1525/sp.2009.56.2.243

[52] Alok KN Mishra. 2019. Centre wants ration disbursal via e-PoS, Delhi says fix loopholes first. *The Times of India*. Retrieved from https://timesofindia.indiatimes.com/city/delhi/centre-wants-ration-disbursal-via-e-pos-delhi-says-fix-loopholes-first/articleshow/67858111.cms

[53] Eric Monteiro, Neil Pollock, and Robin Williams. 2014. Innovation in Information Infrastructures: Introduction to the Special Issue. *Journal of the Association for Information Systems* 15, 4: ii–x. http://aisel.aisnet.org/jais/vol15/iss4/4

[54] Karthik Muralidharan, Paul Niehaus, and Sandip Sukhtankar. 2013. Improving Governance Through Biometric Authentication and Secure Payments in India. *Abdul Latif Jameel Poverty Action Lab (J-PAL)*. Retrieved March 3, 2019 from https://www.povertyactionlab.org/evaluation/improving-governance-through-biometric-authentication-and-secure-payments-india

[55] Karthik Muralidharan, Paul Niehaus, and Sandip Sukhtankar. 2017. *Direct Benefits Transfer in Food: Results from One Year of Process Monitoring in Union Territories*. San Diego. Retrieved from https://bit.ly/2tKLUrD

[56] Shikha Nehra. 2016. Ration to cash, a harsh transition. *India Together*. Retrieved January 1, 2016 from http://indiatogether.org/ration-to-cash-a-harsh-transition-poverty

[57] Nandan Nilekani and Viral Shah. 2015. *Rebooting India: Realizing a Billion Aspirations*. Penguin Books India, Gurgaon.

[58] Neelam Pandey. 2013. Govt cracks the whip on firms behind delay in delivery of Aadhar cards. *Hindustan Times*. Retrieved from http://www.hindustantimes.com/India-news/NewDelhi/Govt-cracks-the-whip-on-firms-behind-delay-in-delivery-of-Aadhar-cards/Article1-1040585.aspx

[59] PIB. 2017. Individual beneficiaries having Ration Cards under NFSA to furnish proof of possession of Aadhaar number or undergo Aadhaar authentication to receive subsidies under NFSA. *Press Information Bureau, Government of India*. Retrieved January 1, 2018 from http://pib.nic.in/newsite/PrintRelease.aspx?relid=158329

[60] PIB. 2017. Year End Review-2017: Department of Food & Public Distribution. *Press Information Bureau, Government of India*. Retrieved from http://pib.nic.in/PressReleseDetail.aspx?PRID=1513302

[61] PIB. 2018. Year End Review-2018: Department of Food & Public Distribution. *Press Information Bureau*. Retrieved from https://pib.gov.in/newsite/PrintRelease.aspx?relid=186388

[62] Volkmar Pipek and Volker Wulf. 2009. Infrastructuring: Toward an Integrated Perspective on the Design and Use of Information Technology. *Journal of the Association for Information Systems* 10, 447–473. http://aisel.aisnet.org/jais/vol10/iss5/1

[63] Mythri Prasad-Aleyamma. 2018. Cards and carriers: migration, identification and surveillance in Kerala, South India. *Contemporary South Asia* 26, 2: 191–205. https://doi.org/10.1080/09584935.2017.1407293

[64] PTI. 2013. Andhra Pradesh Postal Department faces problems in delivery of Aadhaar card. *NDTV*. Retrieved from http://www.ndtv.com/article/south/andhra-pradesh-postal-department-faces-problems-in-delivery-of-aadhaar-card-341913

[65] Ashish Rajadhyaksha (ed.). 2013. *In the Wake of Aadhaar: The Digital Ecosystem of Governance in India*. Centre for the Study of Culture & Society, Bengaluru. Retrieved from https://pad.ma/documents/PI

[66] Ashish Rajadhyaksha and Arun Menon. 2013. The Social Category of the "Introducer." In *In the Wake of Aadhaar: The Digital Ecosystem of Governance in India*, Ashish Rajadhyaksha (ed.). Centre for the Study of Culture & Society, Bengaluru, 131–155. Retrieved from https://pad.ma/documents/PI

[67] Madhavi Rajadhyaksha. 2013. Will India recognize a third gender? *Times of India*. Retrieved from http://timesofindia.indiatimes.com/india/Will-India-recognize-a-third-gender/articleshow/27050953.cms

[68] R. Ramakumar. 2010. The Unique ID Project in India: A Skeptical Note. In *Ethics and Policy of Biometrics*. Springer-Verlag, Berlin and New York, 154–168.

[69] Usha Ramanathan. 2013. Biometrics ~ the story so far. *The Statesman*. Retrieved from http://www.thestatesman.com/india/biometrics-the-story-so-far-4139.html

[70] Nimmi Rangaswamy and Nithya Sambasivan. 2011. Cutting Chai, Jugaad, and Here Pheri: towards UbiComp for a global community. *Personal and Ubiquitous Computing* 15, 6: 553–564. https://doi.org/10.1007/s00779-010-0349-x

[71] Ursula Rao. 2013. Biometric Marginality. *Economic and Political Weekly* 48, 13: 72–77. Retrieved from http://www.epw.in/review-urban-affairs/biometric-marginality.html

[72] Rethink Aadhaar. 2016. Aadhaar and Welfare. *https://rethinkaadhaar.in/*. Retrieved May 4, 2018 from https://rethinkaadhaar.in/faqs/welfare/

[73] RTF Campaign. About | Right to Food Campaign. *RTF Campaign Website*. Retrieved August 4, 2020 from http://www.righttofoodcampaign.in/about

[74] RTF Campaign. 2019. *Record of hunger deaths reported in newspapers and/or verified through independent fact finding teams, 2015-2018*. New Delhi: Right to Food Campaign. Retrieved from https://drive.google.com/file/d/0B8BOT0emNxfqWm5hWTM1Ulg0bjBlUVpPR3FfdlFrSlI3aG53

[75] RTF Campaign. 2019. RTF Update about Regional Convention of Right to Food Campaign, two more starvation deaths in Telangana and one in Odisha, RTI response to our questions on reported starvation deaths, Jan Sarokar - People's Agenda 2019, Manifestoes comparison, Maternity E. *RTF Updates Google Group*. Retrieved May 20, 2020 from https://groups.google.com/d/msg/rtf-updates/tuDunVcMU_Y/i4Lf7Oe1BAAJ

[76] Evelyn S Ruppert. 2008. "I Is; Therefore I Am": The Census as Practice of Double Identification. *Sociological Research Online* 13, 4. Retrieved from http://www.socresonline.org.uk/13/4/6.html

[77] Evelyn S Ruppert, Engin Isin, and Didier Bigo. 2017. Data politics. *Big Data & Society* 4, 2: 1–7. https://doi.org/10.1177/2053951717717749

[78] Antina von Schnitzler. 2008. Citizenship Prepaid: Water, Calculability, and Techno-Politics in South Africa*. *Journal of Southern African Studies* 34, 4: 899–917. https://doi.org/10.1080/03057070802456821

[79] James C Scott. 1998. *Seeing like a State: How Certain Schemes to improve the Human Condition have Failed*. Yale University Press, New Haven.

[80] James C Scott. 2017. *Against the Grain: A Deep History of the Earliest States*. Yale University Press, New Haven and London.

[81] Scroll Staff. 2015. An official Andhra survey shows why Modi government should stop pushing Aadhaar so doggedly. *Scroll.in*. Retrieved from http://scroll.in/article/760530/an-official-andhra-survey-shows-why-modi-government-should-stop-pushing-aadhaar-so-doggedly

[82] Seetha. 2017. Evaluating direct cash transfers Part-II: Correct the mistakes and go ahead, junking PDS reforms wholesale is no solution. *FirstPost*. Retrieved from https://www.firstpost.com/business/evaluating-direct-cash-transfers-part-ii-correct-the-mistakes-and-go-ahead-junking-pds-reforms-wholesale-is-no-solution-4018771.html

[83] Ashpreet Sethi. 2012. Getting Aadhaar card big challenge for transgenders. *Deccan Herald*. http://www.deccanherald.com/content/250353/getting-aadhaar-card-big-challenge.html

[84] Aradhana. Sharma and Akhil Gupta (eds.). 2006. *The Anthropology of the State: A Reader*. Blackwell Publishing, Malden, MA.

[85] Harikishan Sharma. 2020. Explained: What is the 'One Nation, One Ration Card' system? *The Indian Express*. Retrieved from https://indianexpress.com/article/explained/one-nation-one-ration-card-system-explained-6410179/

[86] Ranjit Singh. 2019. Give me a Database, and I will raise the nation state. *South Asia: Journal of South Asian Studies* 42, 3: 501–518. https://doi.org/10.1080/00856401.2019.1602810

[87] Ranjit Singh. 2020. "The Living Dead": Orphaning in Aadhaar-enabled Distribution of Welfare Pensions in Rajasthan. *Public* 30, 60: 92–104. https://doi.org/10.1386/public_00008_7

[88] Ranjit Singh and Steven J. Jackson. 2017. From Margins to Seams: Imbrication, Inclusion, and Torque in the Aadhaar Identification Project. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*.

[89] Tarangini Sriraman. 2018. *In Pursuit of Proof: A History of Identification Documents in India*. Oxford University Press, New Delhi.

[90] SSAAT Team. 2015. *FP Shops Left Over Beneficiaries Report: Findings from 5 FP shops*. Hyderabad: Society for Social Audit, Accountability, and Transparency (SSAAT). Retrieved from https://www.dropbox.com/s/abd7g1vkm9l6j5g/SSAAT FP Shops Left Over Beneficiaries Report Findings from 5 FP shops 2015.pdf

[91] Susan Leigh Star. 1999. The Ethnography of Infrastructure. *American Behavioral Scientist* 43, 3: 377–391.

[92] Susan Leigh Star and Geoffrey C Bowker. 2007. Enacting Silence: Residual Categories As a Challenge for Ethics, Information Systems, and Communication. *Ethics and Information Technology* 9, 4: 273–280.

[93]   Susan Leigh Star and Karen Ruhleder. 1996. Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. *Information Systems Research* 7, 1: 111–134.

[94]   Susan Leigh Star and Anselm Strauss. 1999. Layers of Silence, Arenas of Voice: The Ecology of Visible and Invisible Work. *Computer Supported Cooperative Work (CSCW)* 8, 1–2: 9–30.

[95]   John Torpey. 2000. *The Invention of the Passport: Surveillance, Citizenship, and the State.* Cambridge University Press, Cambridge.

[96]   UIDAI. *UID and PDS System*. New Delhi: Unique Identification Authority of India. Retrieved from https://www.dropbox.com/s/ly25htxl9hru8u4/uid_and_pds.pdf

[97]   UIDAI. 2010. *UIDAI Strategy Overview: Creating a Unique Identity Number for Every Resident in India.* New Delhi: Unique Identification Authority of India. Retrieved from https://www.dropbox.com/s/eg9p5uzucsd9t5r/UIDAI_Strategy_Overview_2010.pdf

[98]   UIDAI. 2011. *Aadhaar Authentication Framework (Version 1.0).* New Delhi: Unique Identification Authority of India. Retrieved from https://www.dropbox.com/s/srf98k8kb2he7dj/d2_authentication_framework_v1.pdf

[99]   UIDAI. 2012. *Aadhaar Enabled Service Delivery.* New Delhi: Unique Identification Authority of India. Retrieved from https://www.dropbox.com/s/zk6zd7p53prw0wh/whitepaper_aadhaarenabledservice_delivery.pdf

[100]   UIDAI. 2014. *Aadhaar Technology Strategy: Ecosystem, Technology, & Governance.* New Delhi: Unique Identification Authority of India. Retrieved from https://www.dropbox.com/s/qrsgt9a4u950cbw/AadhaarTechnologyStrategy_March2014.pdf

[101]   UIDAI. 2014. *Aadhaar Technology and Architecture: Principles, Design, Best Practices, & Key Lessons.* New Delhi: Unique Identification Authority of India. Retrieved from https://www.dropbox.com/s/i9wj30isb0up9yd/AadhaarTechnologyArchitecture_March2014.pdf

[102]   UIDAI. 2015. *Standard Protocol Covering the Approach and Process for Seeding Aadhaar Numbers in Service Delivery Databases.* New Delhi: Unique Identification Authority of India. Retrieved from https://www.dropbox.com/s/jxu98lpap1a4qk8/Aadhaar Seeding June 2015 v1.1.pdf

[103]   UIDAI. 2019. Frequently Asked Questions - E-Aadhaar. *Unique Identification Authority of India.* Retrieved August 5, 2020 from https://uidai.gov.in/contact-support/have-any-question/283-faqs/aadhaar-online-services/e-aadhaar.html

[104]   UIDAI. 2019. Now 125 Crore residents of India have Aadhaar. *UIDAI Press Releases.* Retrieved from https://uidai.gov.in/images/Now_125_crore_residents_of_India_have_Aadhaar.pdf

[105]   UIDAI Committee on Biometrics. 2009. *Biometrics Design Standards for UID Applications.* New Delhi: Unique Identification Authority of India. Retrieved from https://www.dropbox.com/s/vhhjas2cnrafupt/biometrics_standards_committee-report.pdf

[106]   Vandana. 2018. Infrastructure issues marred Aadhar-enabled PDS in Delhi. *The Week.* Retrieved from https://www.theweek.in/news/biz-tech/2018/06/13/Infrastructure-issues-marred-Aadhar-enabled-PDS-in-Delhi.html

[107]   Janet Vertesi. 2014. Seamful Spaces: Heterogeneous Infrastructures in Interaction. *Science, Technology & Human Values* 39, 2: 264–284. http://sth.sagepub.com/content/39/2/264.abstract

[108]   Tanja Winther. 2008. The Impact of Electricity: Development, Desires and Dilemmas. Berghahn Books, New York.

[109]   Wire Staff. 2015. 'Most Aadhar Cards Issued to Those Who Already Have IDs.' *The Wire.* Retrieved from https://thewire.in/law/most-aadhar-cards-issued-to-those-who-already-have-ids

[110]   World Bank Group. 2016. *Digital Dividends.* Washington, DC: World Bank. Retrieved from https://www.worldbank.org/en/publication/wdr2016

[111]   Anumeha Yadav. 2016. Seven reasons why Parliament should debate the Aadhaar bill (and not pass it in a rush). *Scroll.in.* Retrieved from http://scroll.in/article/804922/seven-reasons-why-parliament-should-debate-the-aadhaar-bill-and-not-pass-it-in-a-rush

[112]   Anumeha Yadav. 2016. In Rajasthan, there is 'unrest at the ration shop' because of error-ridden Aadhaar. *Scroll.in.* Retrieved from http://scroll.in/article/805909/in-rajasthan-there-is-unrest-at-the-ration-shop-because-of-error-ridden-aadhaar

[113]   Malte Ziewitz. 2019. Rethinking gaming: The ethical work of optimization in web search engines. *Social Studies of Science* 49, 5: 707–731. https://doi.org/10.1177/0306312719865607

[114]   Shoshana Zuboff. 2019. The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. Hachette Book Group, New York.