

Where ICT4D Meets Data Justice: A study of COVID-19 Tracking in India

Abstract. Discourse on data justice during the COVID-19 pandemic has problematised the techno-solutionism resulting in largely indiscriminate repurposing of technology towards disease surveillance. While studies of COVID-19 tracking are being conducted from a data justice perspective, these are yet to be put into explicit relation with issues, such as conditions of poverty and dependency affecting vulnerable groups, that fall in the traditional remit of information and communication technology for development (ICT4D). In this paper, we study the smartphone-based COVID-19 tracker enforced by the Indian government, Aarogya Setu, from a data justice perspective integrated with a design-reality gaps analysis from the ICT4D field. By doing so, we illuminate three data justice problems (technological, informational and institutional) posed by the Aarogya Setu app, which result in three gaps between the design of Aarogya Setu and the reality lived by disadvantaged residents of India. Our empirics illuminate the need for a conjoined study of ICT4D and data justice, contingently highlighting the relations between the two lenses in framing technology in a post-pandemic scenario.

Keywords: ICT4D; data justice; COVID-19; surveillance; socio-economic development; India

1. Introduction

Since the World Health Organisation declared COVID-19 a pandemic on 11 March 2020, strategies aimed at testing, tracing and isolating cases to contain the diffusion of the disease have characterised national responses. With the sudden, pressing need to minimise contagion, responses inspired by partnerships of national governments with large technology companies have entered the scene, with an unprecedented partnership between Apple and Google announced on 10 April 2020 towards the Exposure Notification system (The Guardian, 2020). In a scenario in which a large majority of COVID-19 apps are “de facto public-private partnerships between a government, Apple, and Google” (Taylor et al., 2020: 10), issues of data justice – conceptualised with Taylor (2017) as “fairness in the way in which people are made visible, represented and treated as a result of their production of data” – have emerged, leading to studies of COVID-19 tracking apps from a data justice perspective.

In a recent collection of case dispatches, Taylor et al. (2020) collect experiences of COVID-19 responses from 33 countries, narrating intersections between disease tracking and data justice issues, ranging from lack of data protection to abuse of state power (cf. Bogacs, 2020; Johns, 2020; Mwesigwa, 2020; Oduro-Marfo, 2020). Several core themes emerge in such a collection: a first one, referred to as the “hybrids of COVID-19” (Masiero, 2020), refers to partnerships of tech companies and governments repurposing extant technologies to build surveillance systems. A second theme refers to the data protection policies accompanying such hybrid arrangements, whose variation has substantial implications for vulnerable data subjects during the pandemic. A related theme, pertaining to datafied social protection policies, highlights the use of opaque algorithms for determining subsidies to vulnerable people, with cases of outright injustice in entitlement distribution (cf. Cerna Aragon, 2020; Krishna, 2020).

Against this backdrop, development studies research has highlighted the burdens caused by COVID-19 in the Global South, illuminating the exacerbation of economic, social and redistributive effects of the pandemic amidst health infrastructure crises (Drèze, 2020; Khera & Somanchi, 2020; Oldekop et al., 2020). In particular, research on information and communication technologies for development (ICT4D) has interrogated the opportunities and constraints of technology usage in the pandemic, highlighting its affordances for healthcare systems (Nicholson, 2020) and constraints lived by vulnerable actors such as informal labourers and gig workers (Krishna, 2020). As a post-pandemic scenario is being delineated at the supranational level, what is lacking is an intersection of the data justice perspective – highlighting injustices associated to datafication – with issues of poverty, vulnerability and skewed redistribution of economic resources, traditionally studied in ICT4D research.

A central contribution of this paper is that it is crucial to combine the perspectives of data justice and ICT4D to contextualise data injustices within pre-existing forms of inequality and invisibilisation. To

put such a combination into practice, we report from a study of Aarogya Setu, the COVID-19 tracking app enforced by the Indian government, from a data justice perspective combined with a lens, that of design-reality gaps (Heeks, 2003), proper of ICT4D research. The starting point of our analysis is the empirically elicited information, gathered by the by-then India-based author during the country's lockdown, on mistrust and suspicion towards the app from the general public, in spite of very high download rates. We draw on a dataset of 46 secondary sources, including press releases, government statements, news articles and blog posts, to ask: *how has Aarogya Setu met the needs of economically vulnerable communities during COVID-19 in India?*

In response to this question, the paper is structured as follows. We first outline a data justice perspective to responses to COVID-19, reviewing relevant studies and highlighting the gap in ICT4D research on such responses. We then illustrate our methodology, based on 46 web sources collected between April and October 2020, to study India's COVID-19 tracker – Aarogya Setu – from the combined angles of data justice and design-reality gaps. Our analysis reveals three data justice concerns in relation to the app, which we find to be related to design-reality gaps of technology, information and processes. Our discussion highlights the contribution of such a composite approach to understandings of disease tracking, illustrating the value of approaches that integrate data justice with ICT4D.

2. COVID-19 tracking: Data justice perspectives

The notion of data justice refers to visibility, representation and treatment of subjects in a datafied world, where public and private agents see individuals through their production of data. Theories of data justice stem from the availability of digital data on populations that were previously invisible (Taylor, 2017), which enables types of data-based administration purportedly oriented to improve public services, social protection and humanitarian assistance (Gelb & Metz, 2018). Over time, the conversion of individuals into machine-readable data was however found to result in injustices including lacks of data protection, misinformation on data usage, and conditionality of access to social protection schemes to enrolment into biometric databases (Dencik et al., 2019; Masiero & Das, 2019). This has led scholars (cf. Heeks & Renken, 2018) to theorise the need for structural understandings of data justice, to illuminate its causes in contexts of systemic socio-economic disadvantage of service users.

The advent of the COVID-19 pandemic, and the technology-based responses enacted worldwide following declarations of states of emergency, has intertwined with data justice concerns. Declared a pandemic by the World Health Organisation (WHO) on 11 March 2020, COVID-19 has placed significant burdens on global health systems, especially in countries already facing critical situations in health infrastructure. Against this backdrop, unprecedented partnerships have emerged between private

technology companies and governments in need for disease tracking, resulting into hybrid architectures finalised to the construction of pandemic surveillance technologies. Within this landscape, data justice scholars have engaged with the new hybrids of COVID-19, constellations combining government powers and the affordances of privately-developed technology for tracking the disease.

At least five core common themes emerge across studies of COVID-19 responses. A first theme relates directly to the new hybrid architectures of COVID-19, with examples ranging from Facebook's partnership with the Australian government, to Amazon's with the Canadian government, to the uptake of Palantir's Foundry system in the Hesse district of Germany. Data justice questions on such hybrid constellations pertain, in the first place, to balances of power between technology companies and national governments in such novel arrangements. The coexistence of logics of private profit and disease surveillance leads authors of the studies in point to explore how the two combine in the making, diffusion and uptake of COVID-19 tracking apps launched in the emergency (Taylor et al., 2020: 8-18).

A second theme, stemming directly from the presence of new hybrid architectures, pertains to the data protection implications of COVID-19 trackers. With the sudden and global advent of the pandemic, a need for rapid, immediate solutions has arguably overcome the need for data security (Edwards, 2020), leading to needs of coverage and effectiveness to be prioritised. While dictated by a situation of sudden and profound crisis, the rapid construction of public-private COVID-19 trackers has occurred in contexts of weak or lacking data protection laws (Whitley, 2020), leaving unanswered questions on data storage, interoperability and utilisation. While private companies seek to arise as guarantors of pandemic justice (Veale, 2020), problems of data control and access from third parties have remained largely unattended in the current scenario (Edwards, 2020).

Specific to the intersection of digital technologies and states of emergency, a third theme pertains to the overlapping of pandemic surveillance with abuses of power, reinforcing Winner's (1980) historical argument that artefacts have politics and embody them in practice. Power abuses illuminated by data justice perspectives include new forms of exclusion, such as native leaders in North America being excluded from decision-making around the Coronavirus Aid, Relief, and Economic Security (CARES) Act and technology response (Duarte, 2020). They include, at the same time, actions from regimes, such as the Philippines (Lucero, 2020) or Hungary (Bogacs, 2020), where the government response to COVID-19 acted to legitimise military rule, which was consolidated through digital surveillance (Lucero, 2020). Through these illustrations, technology again emerges as capable of consolidating oppressive regimes, increasing the problematicity of the hybrid architectures that emerged in the pandemic (Masiero, 2020).

Exploring a fourth theme, a stream of discourse has emerged on the perpetuation of inequalities and their crystallisation during the pandemic (Milan, 2020). At the core of this thread is the argument, put

forward by Milan and Treré (2020), that voices from historically invisibilised communities have been silenced during the pandemic, leaving narrations of oppression and systematic mistreatment in the dark (Cerna Aragon, 2020). Data injustices connected to perpetuated inequality embrace, in particular, social protection schemes, organised through algorithmic combinations that generated widespread uncertainty on how subsidies were to be distributed (Lopez, 2020). This overlaps with narrations, such as Magalhaes (2020), of urban poor areas being affected with systematic intensity by COVID-19, without this being reflected in statistics or enhanced forms of attention towards the most vulnerable.

Finally, a fifth theme pertains to the outright redistributive effects of COVID-19, and embraces the question on how social protection systems will change in the post-pandemic world. In the pandemic, government databases have been combined to arbitrate on subsidy eligibility (Lopez, 2020), with people induced into poverty by COVID-19 facing opaque rules for distribution of subsidies (Cerna Aragon, 2020). Assessed through data representations, the “new poor” of the pandemic suffer the redistributive consequences of absent or poorly developed statistics, resulting in denial of assistance or further forms of invisibilisation (Milan & Treré, 2020). Against this backdrop, data injustices under COVID-19 extend beyond the remit of disease tracking, to affect subjects induced into perpetuated vulnerability by the measures, such as lockdowns and business paralyses, that the pandemic has induced.

Overall, data justice perspectives have illuminated many sides of injustice during COVID-19, exploring their causes and consequences across diverse geographies. In the current context, it is especially needed to explore how structural issues of poverty and vulnerability overlap with data injustices. Centred on data justice themes, our review of the literature highlights a gap in terms of ICT4D engagements with responses to COVID-19, which is surprising especially due to the traditional engagement of ICT4D with structural imbalances of socio-economic power (Heeks & Renken, 2018). Based on these considerations, we set to explore responses to COVID-19 from the conjoined perspectives of data justice and ICT4D, finding a guiding lens in the notion of design-reality gaps as in Heeks (2003).

3. Design-Reality Gaps: Explaining failure in ICT4D

Over time, research has sought to grasp the reasons and nuances of diverse types of failure in ICT4D. In an early contribution on projects of e-government for development, Heeks (2003) noted how failure can be total or partial: cases of total failure refer to projects that were never implemented, or that were implemented but immediately abandoned. In cases of partial failure, major goals for the project were not achieved, or they were achieved at the cost of significant undesirable outcomes (Heeks, 2003: 2). Combining data from a poll of members of the E-Government for Development Information Exchange and the analysis of more than 40 reports on cases of e-government cases in developing and transitional

countries, Heeks (2003: 2) estimates 35% as total failures and 50% as partial failures, making risk of failure a substantial issue for ICT4D projects.

To explain such a phenomenon, Heeks (2003: 2-4) develops the intuition that failure does not necessarily come from outright errors in system design or implementation. He observes, instead, the systematic disjuncture between the worldview of designers – often private actors located away from the developing country of implementation – and the reality lived by users, which may not reflect the assumptions of designers. As a result, a theory explaining failure through design-reality gaps emerged: according to it, failures are motivated by the inability of system design to meet the reality of users and the needs they experience. Seven dimensions – information, technology, processes, objectives and values, staffing and skills, management systems and structures, and other factors – are proposed by Heeks (2003: 4) as areas where gaps can occur.

Over time, the design-reality gaps approach emerged as a constitutive theory of ICT4D, developed within the field and tailored to explain phenomena within it (Avgerou, 2008). Country context gaps – where designer and user adopt different perspectives, hence developing different conceptions of the same technology – have been dealt with by multiple managerial means, with varying degrees of success from the early formulation of the theory (Walsham, 2017). Over time, the normative value of the design-reality gaps approach has been increasingly taken up by research, with a view of overcoming gaps by incorporating the worldviews of recipients in system design. This has been combined with investigations of the causes of design-reality gaps (Masiero, 2016), aimed at reconstructing the causal chains of events and processes behind them.

As the field of ICT4D has explicitly turned to issues of ethics, power and justice (Heeks & Renken, 2018), the importance of design-reality gaps as a diagnostic tool has increased. Proposing to assess the alignment, or not, of technology with the worldviews of users, the approach acts as a route to directly empower project beneficiaries, leading a transition from the role of “beneficiary” to that of active shaper of projects (Walsham, 2017). Such a transition has evaluative consequences as attributions of success, traditionally predicated on supply-led criteria such as donor satisfaction, are subordinated to users’ voices and the ability of the system to work for them. It has, at the same time, normative consequences in that it requires proactive measures for bridging gaps, measures that involve users’ voices to directly shape the making of system design.

While converging in terms of a focus on technology users, and more at large on subjects of data capture in datafied regimes, perspectives on data justice and design-reality gaps have so far not been integrated with each other. An explanation for this can be sought in the different epistemic origins of the two perspectives, with data justice being a device to substantiate extant issues in critical data studies (Dencik

et al., 2019) and design-reality gaps being developed as a tool to face long-standing problems of failure in ICT4D. Nevertheless, as datafication puts vulnerable communities in positions of data poverty (Milan & Treré, 2020), it becomes important for research to grasp alignment of datafying technologies to users' needs, being aware of extant forms of data-induced oppression (Milan, 2020). It is against this backdrop that a conjoined perspective, combining data justice and design-reality gaps, is proposed here as a route to exploring the impact of COVID-19 tracking on vulnerable people in a large developing country.

4. Methodology

In response to our question on how Aarogya Setu, India's COVID-19 tracking app, has met the needs of economically vulnerable users in India, we collected 46 among press releases, government statements, news articles and blog posts following the launch of the app on 2 April 2020. Following Avgerou (2008), we have organised our source selection to avoid the pitfalls of *vulgar eclecticism* and *inbreeding*, respectively meaning the purposeful selection of ideas from a larger body of literature and a too narrow focus on sources aligning with one of the parts in the debate. Our literature review on technology-based responses to COVID-19 revealed three core dimensions of representativity that the dataset, presented in the Appendix, should ensure:

- *Government vs. public* – as we approached debates on Aarogya Setu in the first weeks from its launch, a discrepancy between government's advocacy of it (as an app developed in-house) and multiple sources of suspicion among the public became evident. We hence decided to ensure representativity of both angles by developing a diversified dataset, where 15 sources come from the Government of India and 31 from the general public through newspaper articles, blogs or media posts. Sources from the public have different degrees of alignment with government's views, ranging from embracing the government's perspective to questioning it under multiple fronts.
- *National vs. states* – India is a country consisting of 29 states and 7 special territories, presenting high degrees of variety in terms of state-level administrative systems, technology ownership and socio-economic conditions. While Aarogya Setu was launched on the whole national territory, we wanted our dataset to capture nuances across states, hence reflecting both the central government and the states' perspectives. In our dataset, 30 sources speak about national deployment and 16 add state-level nuances, highlighting how state administrations have adopted diverse approaches to the app (ranging from simple requests to download it to cases where fines and imprisonment were put into place for citizens who failed to do so).

- *Technical vs. social* – tracking of COVID-19 has a strong technical component, devised in specifications of technology requirements and app design. It has, at the same time, multiple social consequences, including enforcement measures, effects on disease diffusion, social stigma of non-compliant users, and changes in users' behaviour as a result of tracking. As we sought to capture both technical and social aspects in our dataset, we constructed it so to achieve a blend of the two. In our dataset, 18 sources are of a technical nature, whereas 28 have an overarching focus on social consequences including data protection, privacy violations, legal enforcements, and reactions of citizens to the new tracking app.

We have used the date when Aarogya Setu was launched, 2 April 2020, as a cut-off date for data collection. Sources, referred to through their progressive number [#] in the dataset, have been collected between this date and 28 October 2020, when the Government of India clarified the existence of a public-private partnership behind the deployment, launch and operations of Aarogya Setu.

5. Case description

Upon its launch in April 2020, the Aarogya Setu (meaning “a bridge to wellness”) application was touted as designed and developed in-house by the National Informatics Center (NIC), an applied research division under the Ministry of Electronics & Information Technology, Government of India. Available in over 11 national languages at that period, it gained traction at a fast pace and achieved significant download volumes in a short time driven by mass media marketing. As of 25 April 2020, it had been downloaded by 7.5 million registered users and as of 10 December, it has exceeded 100 million.

Hailed as an absolute need for effective COVID-19 spread monitoring and control, the Aarogya Setu app has two main functions: firstly, based on a self-diagnosis report, it registers and stores a person's COVID-19 status and details – demographic, personal and spatial. It generates a Unique Digital Identity for each user and assigns them a COVID-19 status: low risk, high risk, positive, or negative. Secondly, the app is designed to keep track of travel and contact histories of individual users, using a combination of GPS and Bluetooth communication technologies. By monitoring movements of people who test positive, the app informs individuals who have come in close contact with them about the chance of transmission, initiating reports to government databases and healthcare ecosystems. While the data of individuals have been argued to be retained within one's smartphone, for those who are assessed to be positive the data is transferred to national servers for assessment and communication [#10].

From the initial period, the Aarogya Setu app has been a subject of controversy in healthcare, policy, law and regulation circles. Concerns were raised about mandated policies of installing and registering

with the application, the effectiveness of the exercise in itself, security and the fundamental way the application operated to generate test results [#28]. The download of the application, touted initially as a voluntary act, soon became mandatory for accessing certain services, subsequently becoming mandated as an absolute requirement (Sahane, 2020). In early May mobility between states and regions was made dependent upon registration in the app, with mandate being made for employees of state and central government offices and organisations [#36]. Over time, with measured relaxation of lockdown rules, as private organisations restarted operations, mandates were generated for employees to install the app as a measure before resuming work in offices (PTI, 2020).

The Aarogya Setu policy on data storage makes data accessible to “persons carrying out medical and administrative interventions necessary in relation to COVID-19” - [#13] meaning staff of national healthcare systems, the nation’s Ministries, bureaucratic divisions and even private players contributing to COVID-19 redressal. Discussions of the India-based author with healthcare professionals during lockdown hinted at limited clarity on data storage and access mechanisms. Furthermore the provisioning of Unique Identity Numbers for each individual, linked with demographic and personal details, raised concerns of targeted monitoring and interoperability with national biometric databases. Given variations of immunity across regions based on differential lifestyles, doubts were also raised on effectiveness of a standard testing measure (Bhandari, 2020).

6. Analysis

6.1. Aarogya Setu: Data Justice Perspectives

In studying Aarogya Setu in relation to the needs of economically vulnerable communities in India, a data justice lens was initially useful to conceptualise strengths and concerns related to the app. This was for two reasons: firstly, Aarogya Setu stood in contrast with most of the hybrids of COVID-19, as developed in-house by the National Informatics Centre of the Government of India. Secondly, technical app descriptions by the Government of India clarified the intentionality of reaching the whole country’s population, building a “bridge to wellness” for all. Highlighted from government sources in our dataset, such a rationale prompted the possibility, for the Aarogya Setu model, to be an alternative to the hybrids of COVID-19, affording solutions to the challenges highlighted by the data justice literature.

Our dataset revealed, however, substantial questioning of both points. In terms of app development, an initial declaration by the Government of India read:

“Aarogya Setu is a digital service, primarily a mobile application, developed by the Government of India and is aimed at protecting the citizens during COVID-19. It is designed to augment the initiatives of the Government of India by informing the people of their potential risk of COVID-19 infection and the best practices to be followed to stay healthy, as well as providing them relevant and curated medical advisories, as per MoHFW and ICMR guidelines, pertaining to the COVID-19 pandemic.” [#15]

Clarification of such a statement came on 28 October 2020, after India’s Chief Information Commission (CIC) “sought explanation from the National Informatics Centre for claiming that it did not have any data regarding who made the app” [#31]. The week before, an “evasive reply” [#31] to a Right to Information application – a request for information in the public domain formulated under India’s Right to Information Act, 2005 – had resulted in a show-cause notice to central public information officers at the Ministry of Electronics and Information Technology, National Informatics Centre and National E-Governance Division. Response to the request clarified the public-private nature of app development, without however specifying the identity of the private actors involved [#22, #31].

In terms of the intentionality of building a “bridge to wellness” for all residents of India, technical specifications of Aarogya Setu [#9, #15] speak about multiple features of the service being available without a smartphone device. This is relevant due to the limited rates of smartphone ownership in the country (estimated at 36.7%), combined with the essential features – Bluetooth and GPS technology – required for the contact tracing system to function. In a document made available on the Aarogya Setu website, non-smartphone features of the service are specified:

For feature phone users, 1921 IVRS Aarogya Setu service has been launched wherein feature phone users are called back if they give a missed call to 1921 and then they are asked questions on their self-assessment which are similar to the questions on Aarogya Setu app. This IVRS service is available in 11 languages. After the self-assessment, users get a summary of their health condition on SMS. Those who report that they are unwell through their self-assessment also get calls for further assistance. Those who are assessed unwell on the Self-Assessment of Aarogya Setu are also called back by Ayushman Bharat and those who need medical help are also spoken to by doctors. [#9]

While relevant in affording self-assessment and summary of health conditions, both crucial functions under the transmission conditions of COVID-19, the app remains predicated on Bluetooth and GPS as features that require a smartphone, or advanced feature phone device, for contact tracing to work. It also requires, as highlighted in studies of COVID-19 tracing (Ferretti et al., 2020), a substantial percentage of the population to download the app. Combined with each other, these features cast doubt on the app’s ability to build an indiscriminate “bridge to wellness”, with coverage affordances limited by smartphone ownership rates and their variation across urban, rural and tribal areas.

All these notes became relevant as we approached our dataset from the point of view of economically disadvantaged residents of India. On the one hand, the notion of “economically disadvantaged” is limited in that it impedes an analysis structured by of state, caste, profession or other differentiators. On the other, it affords the possibility to formulate core data justice concerns, to be refined throughout studies of the app at the state or sub-state level. Three data justice concerns can be outlined on app design:

- 1) *Technological injustice* – an app designed on the assumption that the majority of the population will download it erases the context of a population whose rates of smartphone ownership are, as per ITU (2020) data, significantly lower. The issue is not solely in terms of ownership rates, but of their distribution across urban, rural and tribal areas, with urban areas in turn witnessing severe internal inequalities (ITU, 2020). Operating on the combination of Bluetooth and GPS, the app results into a form of protection from which non-owners of smartphones are effectively barred, albeit able to afford self-testing and the limited non-smartphone features detailed above.
- 2) *Informational injustice* – as outlined above, pieces of information produced by the app (specifically, proof of a negative status) are crucial for actors for whom mobility means the ability to gain livelihoods in the pandemic. Conversely, inability to prove such a status means a severely enhanced form of vulnerability, which non-neutrally hits groups at risk. This is especially so in states which adopted punitive measures (fines, imprisonment) as a result of inability to prove having downloaded the app [#25], an affordance that is again predicated on smartphone ownership. In a pandemic that non-neutrally hit vulnerable groups such as migrants, informal and gig workers (Drèze, 2020), app status is highly relevant to groups forced to keeping mobility, such as frontline operators and gig workers recognised as essential workers during lockdowns (Krishna, 2020).
- 3) *Institutional injustice* – Aarogya Setu constitutes a form of centralised COVID-19 tracking as defined by Whitley (2020), in that it is one central, governmental entity to be responsible for data collection, storage and deletion [#10, #12]. This occurs, however, in a national context which does not operate a data protection law, and at the time of writing is not a signatory of any data protection conventions. Centralisation of data management and lack of data protection systems can coexist, but may yield significant drawbacks in data protection ratings – such as the downgrading of the app, in May 2020, from two to one-star in the MIT in-house review [#45]. This has spurred NIC’s decision to make the app open source [#3], while leaving unchanged its centralised data storage model.

Overall, a data justice analysis of the app has enabled us to identify the three concerns detailed above. The non-neutrality of effects of COVID-19 on the economically poor (Drèze, 2020) has motivated our research question, and our choice to combine a data justice lens with an analysis of design-reality gaps.

6.2: Aarogya Setu: Design-Reality Gaps

Summarised in Section 3, Heeks' conceptual instrument for the identification of design-reality gaps consists of seven dimensions (information, technology, process, objectives and values, staff and skills; management systems and structures, other factors) along which gaps can occur. For all dimensions, a design-reality gaps analysis interrogates the perspectives of users and designers, capturing similarities and disparities between them.

In the case of Aarogya Setu, the overarching goal of protecting India's residents from disease diffusion was inbuilt in the app's design as a contact tracer [#15]. At the same time, multiple features of the app presented discrepancies with essential features characterizing the reality of poorer communities. Three orders of design-reality gaps emerged from our dataset, which are systematised in the dimensions of technology, information, and objectives-values as referred to in Heeks (2003).

- 1) *Technology* – according to research on COVID-19 tracking in Europe, smartphone-based COVID-19 tracking apps require activation from about 80% of the smartphone-owning population as a precondition for effectiveness [#1]. A first gap lies, however, in a design that presumes a “smartphone-owning” population and the reality of economically disadvantaged users in India, largely excluded from smartphone ownership as noted above. While the app presumes high rates of download, which it has achieved in absolute terms, it encounters a reality where relative penetration is affected by the economic condition of users, precluding the main affordance for adoption. Such a gap, resulting in the technological data injustice examined above, is especially serious in areas affected by high poverty rates and weak health infrastructures to face the outbreak.
- 2) *Information* – with the app shifting from voluntary to mandatory in given states and circumstances [#33] in May 2020, movement for vulnerable groups has been subjected to downloading the app, running it and displaying a status that allows travel. The app's design [#12] presumes equal rules on data sharing, but encounters a reality in which frontline operators, informal and gig workers bear the greater burden of information sharing, due to stranding or the need to keep working during the crisis. As a result, the same piece of information on COVID-19 status has different value across economic groups, with economically disadvantaged groups being disproportionately affected due to need for mobility. This generates different performative values of information, resulting in the informational injustice outlined above.
- 3) *Processes* – by their very design, COVID-19 trackers are made to handle sensitive data on the health status of users. Data from Aarogya Setu are transmitted to central authorities for those who test

positive, which presumes the presence of legal conditions for data protection. Such an assumption on data protection processes however clashes with India’s reality, characterised by absence of laws or conventions to protect user rights. Such a gap generates the institutional injustice identified above, positioning Aarogya Setu data treatment in a legal uncertainty needing clarification [#38].

Dimension	Data injustice	Design-Reality Gap
Technology	Vulnerable groups erased by an app that does not account for the consequences of their vulnerability (i.e. not owning the device needed to download the app)	Design – based on the assumption that “everyone” can download the app; reality – the majority of the Indian population does not own a smartphone
Information	Vulnerable groups subjected to a type of tracking that impairs their ability to generate livelihoods in a situation of crisis	Design – based on equality of all Indian residents downloading app; reality – much direr consequences of a positive or at-risk status for economically vulnerable people (migrants; gig workers)
Processes	Centralised COVID-19 tracking in a context of absent data protection laws	Design – based on the assumption of strong data protection laws; reality – absence of data protection laws or conventions

Table 1: Aarogya Setu – design-reality gaps and data injustices

Table 1 summarises the design-reality gaps found in Aarogya Setu, along with the forms of data injustice in which they result. On the one hand, a data justice analysis is sufficient to see concerns with regards to technological, informational and institutional dimensions of justice. But matched with a design-reality

gaps analysis, it reveals the disjunctures at the basis of such injustices, positioning them within gaps with the reality lived by economically vulnerable users. As a result, our analysis illuminates the relations between the two perspectives, combining data injustices with their sociotechnical underpinnings.

7. Discussion and Final Remarks

Analyses of COVID-19 tracking apps are predominantly conducted in terms of data justice perspectives, capable of highlighting relative distributions of power and information behind trackers. These analyses intersect with studies of extant forms of injustice, such as the epistemic injustice lived by indigenous communities in North America (Duarte, 2020) or the subalternity of economically vulnerable groups during the pandemic (Oduro-Marfo, 2020). Such analyses have not, however, been put in relation to systematic issues of poverty and vulnerability of users, which is particularly needed in the context of a global crisis such as the COVID-19 pandemic. In this paper, we have proposed a combination of data justice with design-reality gaps, an analytical tool from the ICT4D field, to assess the extent to which India's Aarogya Setu app meets the needs of economically vulnerable users.

There is a twofold value in the combined theorisation proposed here. First, data injustices – usually assessed in terms of consequences on data subjects – are put here in relation with their sociotechnical causes, found in disjunctures between technology design and the reality lived by users. Doing so affords the ability to illuminate systemic reasons of data injustice, to be sought, rather than in the technology alone, in its encounter with the lives of users. Applied here to a COVID-19 tracker, such an analysis can be applied across different research objects, illuminating the relation between design-reality gaps and the forms of data injustice that result from them.

Second, our analysis builds a bridge between research on data justice and ICT4D, ultimately framing data injustices as an object of ICT4D research. The importance of combining the two perspectives stems from the increased availability of data especially for poor and vulnerable users, who may face additional constraints in responding to data injustice (Taylor, 2017). Other works study data injustice in situations of urban poverty and datafied anti-poverty programmes (Masiero & Das, 2019), corroborating the point that poverty and vulnerability reinforce extant conditions of data injustice. Built through our analytical tool, a connection between the two research fields can systematically contextualise data injustices in contexts of poverty and vulnerability studied by ICT4D.

Three main orders of implications emerge from our analysis. In terms of COVID-19 tracking, our work intersects with Taylor et al.'s (2020) on the consequences of hybrid architectures, established in the pandemic between global technology companies and national governments. In India's case, an initial

declaration of in-house development subsequently admitted participation of private tech partners, without however specifying partners' identities or data sharing policies. While centralised tracking enhances the need for strong data protection systems (Whitley, 2020), ownership uncertainties in the Indian case leave open questions on data governance, ultimately generating data justice concerns on top of the lack of national data protection laws.

In terms of the design-reality gaps found here, a more nuanced picture would have been achieved through the ability of conducting primary data research on the matter, ideally across different states and contexts of economic vulnerability. While the international emergency has impeded primary research, our study of secondary data has enabled us to grasp technical features of the app that provide a strong basis for future studies of primary sources. In addition, our dataset allows positioning the Indian case in a global perspective, affording to ask across different contexts the question on impacts of COVID-19 tracking on vulnerable communities.

In addition, the analysis intersects with that of an issue – the non-neutral impact of the pandemic on economically disadvantaged communities – which has been highlighted since the beginning of national lockdowns (Drèze, 2020). Milan and Treré (2020) illustrate the systematic silencing of narratives from poor and otherwise invisibilised people in the pandemic, arguing for the importance of engaging forms of research that voice such silenced narratives through different means. Against this backdrop, the use of design-reality gaps as an analytical instrument aimed at voicing users from vulnerable communities has afforded the ability to engage silenced perspectives, joining research aimed at voicing the data poor in the pandemic (Milan & Treré, 2020). This leads us to argue for the lens proposed here as a suitable one in researching technology-mediated surveillance in the post-pandemic phase.

In conclusion, revealing core design-reality gaps in India's COVID-19 tracking systems, our study has illuminated several data justice concerns that the technology needs to deal with. On top of that, we have offered a theoretical perspective that combines data justice with ICT4D research, moving in the direction of building systematic interaction between the two fields. In advancing future research, we submit that such an interaction is much needed to explore structural causes of data injustice, tracing them to the contexts of poverty and vulnerability in which they develop.

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Appendix: Sources

	Author	Date	Type	Source	Geography	Focus
1	BBC	14.05.2020	News	Public	National	Social
2	Business Standard	25.04.2020	News	Public	National	Social
3	Deccan Chronicle	27.05.2020	News	Public	National	Technical
4	Elliot Alderson	06.05.2020	Blog	Public	National	Social
5	Entrackr	22.04.2020	News	Public	State	Social
6	Free Press Journal	25.05.2020	News	Public	State	Social
7	Free Press Journal	02.05.2020	News	Public	State	Social
8	Government of India	20.10.2020	Website	Government	National	Technical
9	Government of India	20.10.2020	Website	Government	National	Technical
10	Government of India	20.10.2020	Website	Government	National	Technical
11	Government of India	20.10.2020	Website	Government	National	Technical
12	Government of India	26.05.2020	Website	Government	National	Technical
13	Government of India	20.10.2020	Website	Government	National	Technical
14	Government of India	20.10.2020	Website	Government	National	Technical
15	Government of India	20.10.2020	Website	Government	National	Technical
16	Government of India	26.04.2020	Website	Government	National	Technical
17	Government of India	27.04.2020	Website	Government	National	Technical
18	Government of India	03.05.2020	Website	Government	National	Technical
19	Government of India	06.05.2020	Website	Government	National	Technical
20	Government of India	06.05.2020	Website	Government	National	Technical
21	Government of India	22.08.2020	Website	Government	National	Technical
22	Government of India	28.10.2020	Website	Government	National	Technical
23	Hindustan Times	25.04.2020	News	Public	State	Social
24	India Today	19.10.2020	News	Public	State	Social
25	Indian Express	06.05.2020	News	Public	State	Social
26	Indian Express	22.07.2020	News	Public	State	Social
27	Indian Express	14.05.2020	News	Public	National	Social
28	Internet Freedom Foundation	14.04.2020	Blog	Public	National	Social
29	Jagran English	22.08.2020	News	Public	National	Social
30	LiveMint	02.04.2020	News	Public	National	Social
31	LiveMint	28.10.2020	Website	Public	National	Social
32	National Herald	12.05.2020	News	Public	State	Social
33	National Herald	12.05.2020	News	Public	State	Social
34	National Herald	05.05.2020	News	Public	State	Social
35	New Indian Express	15.05.2020	News	Public	State	Social
36	Odisha Bytes Bureau	02.05.2020	News	Public	State	Social
37	Pranav Dixit	12.05.2020	News	Public	National	Social
38	Robbie Harb	30.04.2020	News	Public	National	Technical
39	Software Freedom Law Centre	08.04.2020	Blog	Public	National	Social
40	Soumyo Das	30.04.2020	Blog	Public	National	Social
41	The Economics Times	26.05.2020	News	Public	State	Social
42	The Hindu	20.10.2020	News	Public	State	Social
43	The Hindu	25.04.2020	News	Public	State	Social

44	The Hindu	08.05.2020	News	Public	National	Social
45	The Quint	22.05.2020	News	Public	National	Technical
46	Times of India	06.05.2020	News	Public	State	Social