

Developing an Affordance-Practice Framework to Data Practices: How Civic Technologists Practice Data Literacy Cross-Regionally

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Data literacy is integral for civic technologists to work with data and develop technologies to affect civic outcomes. However, the techno-civic capacities afforded by data literacy remain understudied because the contexts in which civic technologists learn to work with data vary worldwide. This article advances an affordance-practice framework to characterize and compare the data literacy practices of civic technologists in the Global South and Global North—primarily in India and the United States. Through a thematic analysis of 14 interviews with civic technologists, I argue that data literacy practices are comprised of dimensions including data patchworking, remediating accountability, multimodal communication, and scaling relations. I conclude by discussing the significance of data literacy practices for civic tech and data activism more generally.

Keywords: affordances, critical data studies, civic technology, cross-cultural practices, data literacy, data activism

The ability to work effectively with data is a key feature of the state of 21st-century society. Such an ability requires individuals to develop some level of data literacy. Generally, data literacy refers to the competencies and skills needed to manage data collection on social activities and relations (Mayer-Schönberger & Cukier, 2014). However, notions of data literacy have shifted from a how-to approach to a more critical approach (Hobbs, 2016). Rather than focusing on the technical expertise needed to analyze data, critical perspectives question why and how such expertise is developed in the first place. These critical perspectives have been explored in relation to personal data (Pangrazio & Selwyn, 2019), addressing dis/misinformation (Carmi Yates, Lockley, & Pawluczuk, 2020), and understanding citizenship practices in datafied societies (Yates, Carmi, Lockley, Wessels, & Pawluczuk, 2021). As a “critical data practice” (Gray, 2018, p. 13), or rather a set of practices (Fotopoulou, 2020), data literacy involves learning to question data systems and equitably reorganize them.

Data literacy is increasingly pertinent to the civic technology (civic tech) domain. In civic tech, data are integral to the design of public-interest technologies and evidence-based policies that foster the “democratic capacity of governance” (Hou, 2018, p. 14). The proliferation of data types such as open government data, crowdsourced data, and industry data, coupled with partnerships between corporate, state, and civil society, has surfaced opportunities for civic tech to influence the data governance landscape.

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Date submitted: 2022-10-02

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From establishing private-public partnerships to build smart cities to rendering the COVID-19 pandemic knowable through dashboards and mapping technologies, data are deeply intertwined with civic tech culture. Indeed, the data-related experiences of civic technologists—individuals who work directly with data technologies in civic tech initiatives—vary depending on the process and outcomes of civic tech (Gordon & Mulgar, 2018).

For civic technologists, their “practices, ideas and motivations” (Baack, 2018, p. 45) guide the design and application of data technologies. The work of civic technologists rarely materializes outside the demands of the state and the needs of the citizenry. From a critical perspective, data literacy enables civic technologists to reflect on and interrogate such conditions. The relationship between data, civics, and technological design engenders contentious issues for civic technologists because interpreting and acting on data for civic ends is contingent on one’s position in the civic sphere (Boehner & DiSalvo, 2016). Therefore, the range of civic technologists’ practices reflective of data literacy rests on the “material conditions within which learning takes place” (Fotopoulou, 2020, p. 3). Accounting for the different conditions that shape civic technologists’ experiences with data are necessary to understand the emergence of data literacy practices.

In this article, I investigate the range of civic technologists’ experiences working with data across different geographical regions and how such experiences mutually shape data literacy practices. Specifically, I apply a framework to systematically identify the co-constitution of data practices and the affordances of data technologies as a function of data literacy practices (Baack, 2018; Davis & Chouinard, 2017). This affordance-practice framework advances a comparative empirical account of the conditions and mechanisms through which data literacy emerges as a set of practices. The identified data literacy practices informed by the framework account for the competencies and skills of civic technologists to conduct data work, the sociocultural backgrounds influencing interpretations of data, and the institutional space shaping the development of civic data technologies (Fotopoulou, 2020). I present four themes from a thematic analysis of 14 interviews with civic technologists from the Global North and South, concentrating on India and the United States. These themes refer to four key features of data literacy practices: data patchworking, remediating accountability, multimodal data communication, and scaling relations.

The article begins with a review of conceptual debates on data literacy, followed by a discussion of their significance for civic tech and data-driven participation. Then, I outline the conceptual framework used to systematize the identification of data literacy practices. Next, I explain the motivations for constructing the sample and analyzing the interviews, focusing on India and the United States. Lastly, I describe the four themes of data literacy practices, along with their implications for civic tech and data activism more generally.

Literature Review

Literacy in the Datafication Paradigm

The notion of literacy has changed significantly over time. Literacy is considered the pursuit of an “educational enterprise” (Berlin, 1987, p. 1) to develop the abilities and competencies of writing, reading, speaking, and listening (Hobbs, 2016). For Ong (1979), these techniques mark a shift from

oratory cultures to writing and reading cultures in which descriptions of ourselves and the world formalize. While literacy has been primarily associated with literary techniques, a more nuanced framing shifts “the mechanics of reading to a focus on meaning” (Street, 2013, p. 53). This treatment of literacy as a social practice inscribes sociocultural nuances that are linked to multiple literacies and technological development (Street, 2013). Meaning is dynamic because cultural structures and technology change. This reorientation foregrounds the intersection between “textuality, competence, and power” (Livingstone, 2004, p. 12); that is, the mediation of symbolic and material resources to create meaning are matters of literacy. Indeed, as a social practice, literacy is “specific to the political and ideological context” (Street, 1995, p. 31). Thus, literacy practices consist of inscribing and deciphering meaning through both interpretation and action for knowledge production.

Notions of literacy continue to evolve in the datafication paradigm. Social activities and relations have been transformed into political and economic data resources for governments and markets to organize society (Couldry & Mejias, 2019). Data have become a key medium for creating and communicating meaning, as accounts of the world are increasingly presented through data. Importantly, Gutiérrez (2019) notes that “participation in the datafied public sphere is not exactly equal” (p. 41) because working with data demands a level of expertise that can exclude ordinary citizens. Moreover, Markham (2019) suggests that deriving knowledge from data implicates different types of media, statistical, and algorithmic literacies. These types of literacies underscore the range of techniques that constitute data literacy. Inscribing and deciphering meaning through data is a function of critical data practices for understanding the consequences that data production and application have on social and political life.

Recent scholarship has engaged with the concept of data literacy in several ways. Carmi et al. (2020) locate data literacy in relation to individual and collective responsibility to manage disinformation, misinformation, and malinformation. Similarly, Sander (2020) foregrounds public awareness and civic imagination as critical expressions of data literacy. Extending data techniques, Bhargava and D’Ignazio (2015) define data literacy as the ability to “read, work with, analyze and argue with data as part of a larger inquiry process” (p. 1). Focusing on personal data, Pangrazio and Selwyn (2019) conceptualize data literacy in relation to personal data. More critically, Pangrazio and Sefton-Green (2019) interrogate the association between data and literacy to make sense of the varying “operational and critical understandings” (p. 28) of data that attribute different meanings to discourses and practices. Among these perspectives, Yates et al. (2021) investigate how ordinary publics figure as data citizens by recognizing ideologically charged practices with data.

Such approaches to data literacy provide different and complementary angles for examining how data becomes socially meaningful. For this article, I draw from Fotopoulou’s (2020) definition of data literacy as a set of data literacy practices that consists of “social literacies, [where] the real-life material conditions within which learning takes place, and the social contexts within which data practices acquire their meaning” (p. 3). This definition recognizes both expertise and the relations between actors’ positions and affects, as well as their relationship to the social environment. From this perspective, data literacy practices encompass the emergence of “opportunities to participate in data processes” (Gutiérrez & Landa, 2022, p. 123). Learning how to analyze data implies developing the capacity to develop and change data systems (Gray, Gerlitz, & Bounegru, 2018).

Data Literacy as a Civic Tech Matter

Data literacy practices are increasingly pertinent to civic life. In what Lyon (2017) qualifies as “digital modernity,” everyday social interactions transpire through digital technologies. The digitalization of human experience in data asserts new logics of quantification, which “redefine modes of solidarity, participation, and knowledge production along shifting notions of community, agency, and engagement” (Renzi & Langlois, 2015, p. 203). For example, digitally mediated movements on social media, government transparency efforts from open data, and data-driven markets redefine ideas and modes of civic participation (van Dijk & Hacker, 2000). Different ways of relating to one another as citizens are defined in the data’s terms. Indeed, such reliance on data by government and market actors “demands active participation of ordinary people and organizations both creating opportunities to use data and putting them to use” (Gutiérrez, 2019, p. 50). Data literacy practices enable civically minded individuals to foster the critical capacity to recognize data’s potential for the public good.

Civic technologists are pivotal in developing data technologies that facilitate participation in civic outcome data (Baack, 2018). Generally, civic tech has been associated with bottom-up “co-creation in the public sector” (Skaržauskienė & Mačiulienė, 2020, p. 131). However, the permeation of data ideologies and practices into civic tech complicates bottom-up approaches because public and private partnerships change the co-creation of direct and indirect value through data (Shaw, 2014). This co-creation is a form of data politics that manifests in the increasing use of data to govern citizens (Ruppert, Isin, & Bigo, 2017). Civic technologists reconfigure such governing power by using data to advance or resist data-driven policies. Indeed, a key principle in civic tech is “to hack and reconfigure institutional arrangements that dictate how [knowledge] resources are distributed” (Schrock, 2019, p. 131). Civic tech encompasses different approaches to the co-creation of value by reshaping the operations of institutional logics and the environment that affords the capacity for participation. These types of civic tech participation manifest in the contestation of data infrastructures and the political use of data infrastructures (Gutiérrez, 2019). In other words, civic tech has the potential to address existing data processes that fail to meet civic needs and to establish more civic-oriented data processes.

The relationship between data literacy practices and civic tech can be further described in relation to data activism. Data activism involves critical engagement with the politics of datafication and mass surveillance toward social change (Milan & Gutiérrez, 2015). Such critical engagements seek to contest knowledge produced by data infrastructures (Gutiérrez, 2019). Research on data activism has examined the capacity to scrutinize government data (Cinnamon, 2020), enable civic hacking of open data (Schrock, 2016), and publicize controversial state practices through data leaks (Postill, 2018). For civic tech, the contestation of knowledge is performed through the data literacy practices of civic technologists. These practices contribute to fostering an “understanding power relations and power asymmetries” (Špiranec, Kos, & George, 2019, para. 5) in addressing civic concerns. Locating power involves accounting for the design, implementation, and maintenance of data technologies for civic engagement. As an expression of data activism, civic tech encompasses proactive uses of data for the public good (Milan & Gutiérrez, 2015).

Data literacy practices capacitate civic technologists in their engagement with datafication politics. By situating ideas, actions, and contexts that attribute data with meaning, users and designers

of data technologies in civic tech reshape how data becomes actionable in civic outcomes (Gutiérrez & Landa, 2022). In other words, civic technologists practice data literacy to form a connection between “system and experience” (Couldry & Powell, 2014, p. 4). Data literacy practices foster participative qualities in the design and application of data technologies (Gutiérrez, 2019). Recent studies have discussed the significance of data practices, literacy, and civic tech. For instance, Baack (2017) investigated the knowledge production processes in data journalism in relation to civic tech; Cheruiyot, Baack, and Ferrer-Conill (2019) observed the transnational implications of data journalistic practices; and Gutiérrez and Landa (2022) examined the role that data literacy plays in making open data useful. Building on this literature, this study takes a comparative approach to the sociocultural and political contexts that shape civic technologists’ data literacy practices.

Theoretical Framework

Data Practice as Mediative and Communicative

This study presents data literacy as data practices for learning to work with data to contest and use data technologies. Data practices are actions that legitimize experience with data. Following the logic of media practice theory, data practices organize contexts by doing and thinking in relation to data (Couldry, 2004, 2012; Milan, 2019). This means that data practices are recurring actions with data that become meaningful through shared understandings of these precise actions in a social context (Schatzki, 1996). Fundamentally, data practices are “socially legible conduct” (Burchell, Driessens, & Mattoni, 2020, p. 2777); they are both structures and outcomes implicated in “the social, semantic, and material settings” (Pentzold, 2020, p. 2966). For instance, data practices invested in the design of data dashboards, analyses, and visualizations exhibit different meanings across distinct situations, ranging from efforts to advocate for data justice to optimizing data-driven business intelligence. Data practices reflect an individual’s or community’s understanding of the role of data in a particular context.

Data practices are integral to data-driven participation. Data practices foreground “human subjects and their (critical) engagement with datafication” (Milan, 2019, p. 213), setting the conditions for communication to reassemble relations for critical collective action (Fotopoulou, 2020). Collective involvement with data takes various forms, from leveraging crowdsourced datasets to disseminating data-based information on social media platforms. Data practices are critical orderings achieved by acting on and through data (Milan, 2019). For civic tech, data practices reveal the means and outcomes of a particular reflexive culture of civic participation. However, data practices must be recognized and enacted through data literacy for world-building (Gray, 2018). In effect, data literacy informs data practices for “making sense of the world so as to act within it” (Couldry, 2014, p. 891).

Toward an Affordance-Practice Framework for Data Practices

Systematic frameworks to identify data practices—specifically data literacy practices—remain understudied. Integrating the concept of imagined affordances with the concept of data practices addresses this gap by underscoring “the material and the perceptual” (Nagy & Neff, 2015, p. 2) interaction between data, digital technologies, and social actors. Affordances frame the potential for “agentic action in relation

to an object" (Hutchby, 2001, p. 444). This means that anticipated applications and attitudes toward data mutually shape interactions with the data itself. Therefore, imagined affordances are the "interplay of embodied capabilities and material design" (Pentzold, 2020, p. 2977) that organizes the attribution of meaning and actions into data practices. For data literacy practices, one's experience with data involves a degree of reflexivity to discern the interaction between social contexts and data processes to transform data processes.

Studies have examined the relationship between imagined affordances and data practices. For instance, Sirén-Heikel, Leppänen, Lindén, and Bäck (2019) investigate how news workers' visions of news automation technologies materialize organizational practices. Furthermore, Baack (2018) theorizes the data practices of civic technologists in the United Kingdom in an open-source context. Notably, Baack's findings of data practices deep linking structured data, crowdsourcing databases, value recognition, and scaling influence serve as a starting point for further conceptualizing data practices. Although these studies inform the value and applicability of imagined affordances to data, how data become meaningful as a function of data literacy is secondary. Furthermore, the processes that reveal how data practices are afforded remain specific to the Global North and to a single organization. A cross-context comparison of data literacy practices is necessary to understand differences in world-making through data.

Identifying what and how data literacy practices are afforded demands a systematic approach. Affordances encompass the mechanisms and conditions that structure data practices in a particular situation (Davis & Chouinard, 2017). For imagined affordances of data, mechanisms request or demand possible practices from a subject's engagement with data; these may encourage, discourage, or refuse actions in the face of resistance from the subject. Conditions capture the context diversity of "perception, dexterity, and cultural and institutional legitimacy" (Davis & Chouinard, 2017, p. 245). Perception and dexterity refer to the subject's knowledge and competencies about data; cultural and institutional legitimacy are the logics that structure one's experience with data. The mechanisms and conditions identified by Davis and Chouinard (2017) outline the factors that constitute data literacy practices (see Figure 1). Systematizing data literacy practices allow for a robust comparison of the varying qualities of individuals' experiences working with data.

The affordance-practice framework is important for describing how civic technologists understand and practice data literacy. Civic technologists work with data to design and develop technologies that contribute to the public good. The capacity for data to attain such quality is contingent on the technical features of data technologies and the social expectations of civic technologists to fulfill the interests of the communities they serve. Data literacy practices emerge from drawing on material and symbolic resources, namely, the recognition of the practical and imaginary potential of data. Understanding the competencies and skills required to work with data technologies in cultural and political contexts informs the array of possible actions at the disposal of civic technologists. In turn, these actions reinforce or change the level of competence and skills. Data literacy practices materialize the possibilities for learning to work with data technologies.

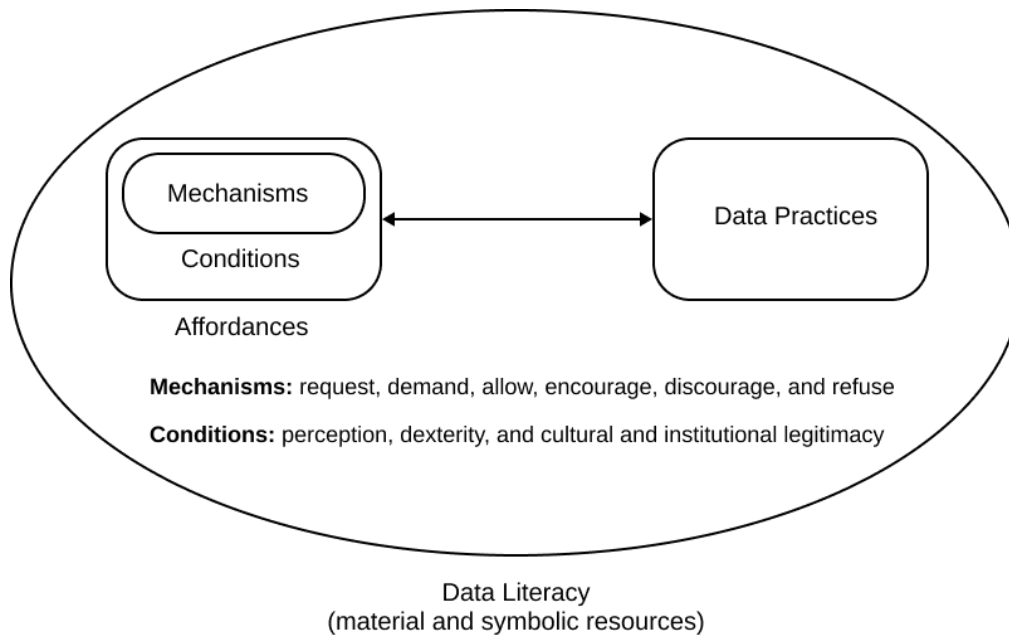


Figure 1. Conceptual framework illustrating the relationship between affordances, data practices, and data literacy.

Methodology

Sampling Technique

Civic technologists were interviewed to investigate how they defined and practiced data literacy. Fourteen individual online semi-structured interviews, each lasting 45–60 minutes, were conducted throughout April 2021. Participants were recruited using a purposive and convenience sampling strategy because of challenges in accessing participants throughout the COVID-19 pandemic (Robinson, 2014). Extensive online searches using keywords, including “civic technology,” “open data,” and “civic data,” were performed to identify civic tech organizations. From these organizations, participants were contacted to their publicly listed emails. Participants were selected based on their involvement in the ideation, design, implementation, use, or maintenance stages of data technologies. Additionally, call-for-participant messages were shared on the organizations’ public online communication channels, such as Slack. The final sample ($N = 14$) included participants over the age of 18, three self-identified females and 11 self-identified males who were interviewed in the English language and whose identities were anonymized at their request (see Table 1).

The participants’ professional backgrounds included scientists, economists, statisticians, and analysts whose experiences extend across regions in Southern Africa, Southern Asia, North America, and Latin America. Participants were interviewed about their experience working with data in projects from open government budgeting, public safety, anti-eviction programs, open data standards, and human rights

frameworks. Although civic tech organizations varied in size and resources, they were all invested in the co-creation of public value (Skaržauskienė & Mačiulienė, 2020). The commonality across these cases is that the participants self-describe as civic technologists who perform data work. Despite the challenges in recruiting a large participant sample, the diversity of backgrounds, roles, and data technologies in the sample provided the opportunity to compare data literacy practices from participants in the contexts of India and the United States.

Table 1. Background Information of Participants Interviewed.

Participant ID	Professional Background	Organization Description	Geography
1	Economist	Research lab	India
2	Statistician	Research lab	India
3	Statistician	Research lab	India
4	Electric engineer	Research lab	India
5	Data scientist	NGO to advance social justice	United States
6	Data scientist	NGO to advance data science for the public good	United States
7	Statistician	Government consulting firm	United States
8	Chief analyst	Fire and public safety	United States
9	Data steward	Information technology company	Australia
10	Project manager	NGO to advance social justice	Argentina
11	Computer and data scientist	NGO to advance social justice	South Africa
12	Data scientist	NGO to advance digital rights	Malaysia
13	Research analyst	Fire and public safety	United States
14	Statistician	Fire and public safety	United States

Interview and Analysis Design

Interviews were deemed appropriate because they functioned as a window into the meaning-making processes of participants' worlds through "what people say, the ways they act, and the artifacts they use" (Warren, 2001, p. 86). Participants articulated their knowledge about "contexts of living and subjective points" (Flick, 2009, p. 423) on how data literacy practices become meaningful in dynamic environments. The interview questions covered personal understandings of data literacy, expectations of data technologies to drive civic participation, data ethics, and cultural and political influence on their capacity to work with data.

The interviews were thematically analyzed using NVivo 12 to understand how participants construct social reality by considering the "material experiences and contexts" (Evans, 2018, p. 3). Thematic analysis consists of identifying "repeated patterns of meaning" (Braun & Clarke, 2006, p. 86). Themes are analytical outputs generated by reflexive inquiry into the coding procedure. Braun and Clarke (2013) suggest that "analytic sensibility" (p. 217) is required for theoretical sophistication to allow for novelty in code and theme generation. Therefore, the coding process was partially guided by Baack's (2018) previously identified

imagined affordances of data—deep linking structured data, crowdsourcing databases, value recognition, and scaling influence. Additionally, the generated themes cross-examined Fotopoulou’s (2020) critical data literacy dimensions of multiliteracies, contextuality, and agency.

Findings

Identified Clusters: India and U.S. Contexts

The findings are primarily discussed in relation to the Indian and U.S. contexts because of the concentration of the participants’ experiences. These experiences comprise the nature of the data work and their respective cultural and political environments. Participants from India developed an open government budgeting project to increase transparency and expose local and national governments’ deficiencies in reporting data to their constituents. In the United States, participants participated in open data projects for fire and public safety to increase accountability for local governments as well as antieviction projects to increase transparency for housing communities. Participants’ experiences from other regions are incorporated to further elaborate on the four identified themes (see Table 2): *Data patchworking* refers to approaches for making data useful under conditions of data precarity; *remediating accountability* emphasizes the different ways of data are implicated, defining accountability in stakeholder relations; *multimodal communication* focuses on the contextual attribution of meaning to data; and *scaling relations* emphasizes the organizational and environmental factors that shape data’s value.

Table 2. Corresponding Themes to Features of Data Literacy Practices.

Theme	Description	Example
Data Patchworking	Developing the capacity to recognize the incompleteness and precarity of public data to device circumvention strategies	(Dis)integrating multiple disconnected database
Remediating Accountability	Addressing accountability gaps between governments, citizens, and civic technologists	Using metadata to trace suspicious changes to data systems
Multimodal Communication	Contextualizing data-related issues as a communication processes	Framing data as a solution to a problem; medium selection for data visualizations
Scaling Relations	Overcoming structural tensions such as limited resources, political processes, and local experiences as data flows across organizational scales	Resistance to new data systems from lack of funding, leadership inertia, or localization

Data Patchworking: Actualizing Fragmented Potential

Access to data is a key concern for civic technologists. For instance, in developing open data portals to increase government fiscal transparency in India, Participant 1 asserted that the “availability of data or identifying what data is available is crucial to the scope of a particular project... and then using our advocacy

efforts to reach out to governments.” In this initiative, civic technologists expect to meet the projects’ goals with incomplete data. Under these conditions, civic technologists can play a civic role by demanding increased access to public data. However, incompleteness of data can also afford a more adversarial approach to increasing access. Participant 3 commented that “putting scrapers on [government websites] periodically to get the data” is part of their repertoire because the institutional conditions of the government make public data unavailable. Indeed, if the “finance management systems that are being created for the Indian government by the Indian government don’t have checks in place,” as Participant 2 said, then the precarity of data access becomes both a political and a technical matter. These accounts show that civic technologists learn to adapt and respond to data infrastructures in diverse ways under limited data provision.

Data patchworking affords a shared understanding of data ethics and principles. The prevailing notion that open data portals advance government transparency is in tension when data infrastructures are fragmented. For instance, working on geo-map tools to visualize eviction records in the United States, Participant 5 stated that “the data that we’re engaging with has a lot of flaws to it, and a lot of oversimplifications and inaccuracies that can cause harm and are often left, you know, unchecked or invisible to the eyes.” Ethical considerations present a “potential risk,” said Participant 5, making fragmentation of the value of data more pronounced. These expectations of data precarity demand increased awareness of the unintended consequences of designers and users of data technologies, especially when dealing with personally identifiable and sensitive information. Most participants in the organizations shared this experience, becoming more evident in Participant 6’s account: “We’re kind of having to shift our methodology, as the project goes on to encompass data that’s not necessarily what we would consider to be ideal.” The experiences of civic technologists in these examples indicate that under circumstances, fragmentation of data infrastructures is necessary to protect data subjects. Data patchworking involves learning how to identify methods to access more data when necessary and how to treat the incompleteness of data as a feature of ethically responsible data practices work.

Remediating Accountability: From Facilitation to Transformation

Civic technologists encounter challenges and opportunities when enacting transparency and accountability. Practices to increase the transparency of data systems revolve around the expectation that data can transform citizens’ positions in the political landscape. For instance, working on a police violence tracking database in Argentina, Participant 10 commented:

With government data that we use, making sure that the metadata makes sense through time, because there are cases in which governments decide to just change something overnight. And a good thing about data portals is that those things are stored in different ways, right? So, even if metadata has changed, there is a change log.

This suggests that holding the publishers of data portals accountable, such as governments, involves working with different dimensions of data. The data *itself* on data portals faces limitations, but working with metadata can leverage inquiry into the data infrastructure. Similarly, in India, Participant 1 explained how changes in government budget logs reconfigure the potential for accountability: “The government changed the files overnight to make them identical and in this year’s budget, they just stopped

publishing the data." Changes in metadata instantiate new relations between data and civic technologists to make accountability issues salient. In these contexts, civic technologists approach the design and use of data technologies, such as data portals, differently because metadata affords different opportunities to interrogate data access. Learning about metadata implies identifying the *changes* made to data infrastructures to contextualize the degree of accuracy of *representations* in data.

Conversely, enacting accountability differs when data publishers and civic technologists collaborate to build data infrastructures. Working with fire safety budget and performance data in the United States, Participant 9 stated, "I'm accountable to the elected officials that are in these different municipalities, so I have to have them feeling comfortable that the resources that are in their city or not being taken advantage of." In this context, budget and performance data operate as the mediator of public interests between government stakeholders—fire safety is indeed a public concern. However, there are also civic interests. In building a fire safety data dashboard by gathering the public's input, Participant 13 commented that "not all citizens are that much technology savvy." Civic technologists must do their work to engage the public while being self-accountable. Expecting the citizen to define and enact accountability can be contentious, as stakeholders involved need to be "completely sensitive and considerate of that chain of consequence," said Participant 8. These experiences indicate that civic technologists develop a reflexive edge when data processes intersect with stakeholders' interests to remediate accountability. In other words, civic technologists play a dynamic role by holding actors accountable while also being accountable to their publics.

Multimodal Communication: Forming Meaning in Data

Data literacy practices embed diverse ways of communicating meaning through data. As Participant 4 mentioned, "the first step in civic tech is to, you know, make [the audience] aware of the importance of data." Communicative forms of data vary greatly. For instance, Participant 11 stated that there are various tools and ways "for folks to be able to visualize data or put-up nice graphics and websites with data stories, but it's been really hard to bridge the gap between telling a story and effecting change." Civic technologists struggle with the "constant use of data and data visualizations to convince someone of something that is not true...because of that whole nationalistic structure," said Participant 4. Therefore, the meaning discerned from the communication of data is contingent on political and cultural contexts. Data literacy practices involve learning to disentangle political and cultural nuances in data stories and visualizations.

Civic technologists also recalibrate their communication when sharing insights from their work with data. When dealing with governments and policymakers, "if I say open data will help in ABC, they can't visualize that, you have to show that to them," said Participant 1. Similarly, Participant 4 stated that "most policymakers work in a very different universe." Communicating data as results corresponds to the institutional environment to serve policymakers' interests. Indeed, data become meaningful when "communicated in the context of your audience" mentioned Participant 7. In a similar vein, civic technologists working with fire safety data assert the communicative elements of the data. Participant 14 explained that to communicate fire response and call data, "you need to provide the context and actually talk to the folks instead of just sending out a report because every number has a story behind it." These accounts indicate that data have a social quality when communicated. Civic technologists learn

to translate data from portals to graphs and summaries in their attempts to communicate meaningful aspects of the data.

Data literacy practices also inform the usefulness of communicating problems in the form of data; what counts as a problem and how problems are made countable require varying degrees of data literacy. The data-problem dialectic requires “a purpose [in the] life cycle” of data to inform solutions to problems, said Participant 11. However, conflicts arise when assumptions “treat data as Gospel [or the] absolute source of truth,” commented Participant 5. Civic technologists interrogate the truth-making capacity of data as a function of their concern for the citizenry. However, ambiguity remains between working with data and discerning the truth from it. As Participant 12 said, “we are expecting to shift all the learning obligations to the user [where] technical knowledge [becomes a] burden” for those that lack domain expertise. In effect, “figuring out what exactly the question is,” stated Participant 9, is increasingly a contested process between civic technologists, policymakers, and citizens because defining the data-problem relation rests on differing assumptions and abilities. Civic technologists practice data literacy by learning to identify the overlapping nuances implicated in communicating data problems.

Scaling Relations: Traversing Organizational Orders

Data literacy practices facilitate the process of scaling the meanings and values associated with data across geographical, cultural, and political domains. Changing organizational logics and environmental resources shape the affordances of data. Data faces friction when data processes are translated into contexts different from their source: “The idea of open data is political by the nature of its existence itself,” commented Participant 3. The design of data portals assumes different values and beliefs depending on the geographic region. Indeed, normative beliefs of data openness and transparency are contingent on local conditions; data initiatives in civic tech are “subject to the jurisdictional authorities,” said Participant 8. Therefore, data literacy practices involve learning to engage with organizational structures, jurisdictions, and communicative framings of data across scales.

Informed by all the participant’s experiences, the mechanisms and conditions of scaling data processes can be unpacked from different angles. In terms of resources, data literacy practices are paramount in scaling the data operations of emerging civic tech organizations because data operations become “an existential threat” when funding is directly tied to “changes in the law,” explained Participant 1. Thus, the capacity to make data actionable is contingent on the government’s willingness to “open up their data,” said Participant 3. Conversely, other instances show that funding can be secured through “501(c)(3) status,” in the case of Participant 5, or through “taxing districts,” as mentioned by Participant 9. These comments by civic technologists indicate that jurisdiction and funding are key factors influencing opportunities for scaling data processes. Civic technologists in India indicated a greater concern for top-down changes in access to data and funding compared with the United States. These differences set conditions for how civic technologists learn to scale data processes while recognizing how such practices shape the nature of their work.

Another important dimension in scaling data processes is decision making. Participant 10 mentioned that civic tech projects are generally built “from the outside,” implying the need for leadership

frameworks to navigate insider socio-political cultures. Along this thread, Participant 13 stressed the importance of sharing a “common understanding about the objects you explore together” when working with data technologies. Participant 14 mentioned that comparing fire safety data across departments as one would “compare apples to apples” can be challenging because of “organizational inertia” because data faces resistance when interweaving into different organizational cultures, which results in stakeholders having “an aversion to it.” The seeming agreement from participating in the friction resulting from the scaling data process across contexts is an important indicator of data literacy. Civic technologists learn about the limitations of reproducing data processes that may not fit within the institutional environment or organizational cultures.

Discussion

The findings suggest that data literacy practices in civic tech vary to some extent as civic technologists learn to adapt and respond to data infrastructures in their local environments. Specifically, the four themes or markers of data literacy practices generated from the thematic analysis were *data patchworking*, *remediating accountability*, *multimodal communication*, and *scaling relations*. These themes underscore the productive and consequential qualities of data literacy practices for the formation of ideas, problems, values, and relations in civic tech. By extending previously identified facets of data literacy into civic tech—agency, multiliteracies, and contextuality (Fotopoulou, 2020)—civic technologists create conditions for learning to work with data by reconfiguring data infrastructures. Data literacy practices outline different qualities of data work to foster the capacity for participation in the datafied public sphere (Gutiérrez, 2019).

The theme of *data patchworking* foregrounds how data literacy practices are implicated in conditions of precarity. The incompleteness of data across data systems heavily influences civic technologists’ expectations and actions with data. Civic technologists learn to make sense of their experiences with incomplete and invalid data. Data patchworking accounts for the learning capacity of civic technologists to leverage opportunities to address data reliability and provision issues (Gutiérrez, 2019). This learning capacity emerges by recognizing practices concerning disjointed data, such as data scrapping and designing ethical data methodologies, exemplified by the participants’ experiences (Fotopoulou, 2020; Milan, 2019). Civic technologists make data actionable (Gutiérrez & Landa, 2022) and useful for the public by adapting to the conditions of data provision.

Furthermore, *data patchworking* illustrates the connection between multiliteracies and the contextuality of data literacy (Fotopoulou, 2020). Literacies are important for building civic tech identity (Livingstone, 2004). Civic technologists attune to the consequences and opportunities of digital transformation in their efforts to serve the public good. Under conditions of data precarity, civic technologists not only learn to develop tools that circumvent deficient data infrastructures but also exercise their civic literacies. From using Freedom of Information Act requests to introducing safeguards to protect data subjects’ privacy, civic technologists have taken on a civic role in the development of data technologies. The context in which data patchworking becomes a meaningful dimension of data literacy also matters. A connection can be made regarding the differences and similarities in civic technologists’ experiences from India and the United States in relation to expertise, the nature of the problems under interest, the

institutionalization of open data, the repercussions of engaging in activism, and the recognition of the characteristics of publics being addressed. Data patchworking is a prominent feature of data literacy practices in both contexts.

On the theme of *remediating accountability*, civic technologists learn to recognize how different types of data afford opportunities to enforce and question accountability mechanisms. Under conditions where data publishers retain control over deficient data infrastructures, metadata affords civic technologists the mechanisms for demanding accountability from actors such as government entities. *Remediating accountability* also implicates stakeholders in the struggle for power. Civic technologists in the U.S. fire safety programs interfaced between positions of accountability—the public value of fire safety data instituted accountability to the state, to the public, and to civic technologists themselves. Although such interfacing may not be exclusive to the U.S. context, the examples of government budgeting in India underscore more complex expectations of accountability. Through data literacy practices, civic technologists learn that enacting accountability is contingent on data quality and the interests of social actors.

Remediating accountability has important implications for civic tech in fostering democratic data governance (van Dijk & Hacker, 2000). Data literacy practices reconfigure agency to address (un)anticipated data consequences and structures that reproduce information inequalities (Fotopoulou, 2020). From circumventing to complying with institutional expectations, the features of data literacy practiced by civic technologists evidenced that working with data entails shifting perspectives and positions in assessing accountability. Data literacy practices implicate civic technologists responding to various publics, including their own.

Multimodal communication exemplifies the process of building a shared understanding of data. Communicating the meaning of data involves more than transferring information. Civic technologists actively engage with their assumptions to understand how data is significant to solving public problems (Fotopoulou, 2019). This feature of data literacy enables civic technologists to enter into communicative relations with their stakeholders by negotiating data-driven responses to the issues under consideration. Nonetheless, challenges pertinent to communicating the meaning of data emerge as the cultural and political environments in which civic technologists work to shape the truth-making capacity of data. The forms and types of data that are useful for civic technologists need to be communicated in a way that fits the established norms for data sensemaking. Building a sense of the utility of data via data literacy practices taps into the participative potential of civic-oriented data processes (Gutiérrez, 2019). By communicating data in a tangible and personal form, data becomes social through dialogue. The pursuit of common or ordered meanings and actions for participation is an important function of data literacy practices (Couldry, 2012).

Communicating data effectively is an ongoing process that demands a degree of data literacy. *Multimodal communication* underscores the “dynamic aspect of data practices” (Fotopoulou, 2019, p. 3) upon which the affordances of data shift with changing social and material conditions (Nagy & Neff, 2015). This suggests that the definitions of what is considered a problem approached from a data-driven perspective should necessarily be open to interpretation. In effect, civic technologists learn to recalibrate their communication by contextualizing the significance of data in relation to the problems that concern the citizenry. This dynamism of data practices is predicated on how civic technologists, states, private actors,

and publics contest knowledge from and through data (Ruppert et al., 2017). The forms in which data is communicated—stories, graphs, tables, reports, visualizations—foreground assumptions and interests that have the potential to reify the contexts while also allowing for a space to deliberate the meaningfulness of data for understanding the problems at hand.

Scaling relations illustrate how data processes face friction when traversing organizational and environmental contexts. As Gray (2018) notes, “the way we see and think about things, serve as a common point of connection across situations, and help to conventionalize ways of organizing the world” (p. 4). Data literacy practices enable civic unpacking of the organizing mechanisms that render aspects of the world knowable. Recognizing how social, cultural, and political aspects of data processes afford different interpretations of the state of affairs is paramount for civic technologists. Indeed, data actions and the meaning derived from them need to be made constant across scales. This means that civic technologists learn to work within and across organizational cultures and institutional landscapes. Such factors are critical for realizing a more participatory, datafied sphere (Gutiérrez, 2019).

Working across contexts makes visible the frictions in relations and expectations that shape the meaning of data. These ruptures surface “the material and symbolic conditions” (Fotopoulou, 2020, p. 12) that afford particular values and actions on data. For civic technologists, data literacy practices have the potential to scale data processes by reorganizing relations and positions among citizens, governments, and private actors. Data literacy facilitates the recognition of factors that could make the scalability of data processes a useful and meaningful endeavor for publics. As data intermediaries between the state and the public (Gutiérrez & Landa, 2022), civic technologists organize, internalize, and practice data values according to environmental constraints, typically tied to funding, political climate, and provenance of data.

The findings of this study reaffirm and expand previous understandings of data literacy by examining how civic technologists make sense of their work with data. Data literacy practices are integral in fostering the capacity for “affecting scaling technological solutions to support a distributed form of agency” (Baack, 2018, p. 47) and influencing “perceptions and self-understandings” (Baack, 2018, p. 53). This study concretized the emergence of data literacy practices by identifying the mechanisms and conditions that make data meaningful through the four identified themes (Davis & Chouinard, 2017). These themes served as analytical constructs to explicate how data literacy is constituted as a set of data practices by civic technologists in the United States and India (Fotopoulou, 2020). Data literacy practices illuminate how data are understood and acted on to realize the civic potential of civic tech initiatives as a form of data activism.

Conclusion

“Datafication has transformed how people participate in political life” (Gutiérrez, 2019, p. 41). Learning to engage and intervene in data processes is increasingly a matter of data literacy. This study investigates how civic technologists’ experiences working with data vary cross-regionally to understand the mutual shaping of such experiences through data literacy practices. Specifically, I argue for an affordance-practice framework to conceptualize data literacy as data practices. Following Fotopoulou (2020), learning to work with data is contingent on the material conditions of the data and the social situations that afford meaning to the data. Therefore, this study applies the affordance-practice framework to civic technologist

initiatives across geographical regions to compare the sociocultural and political factors that influence civic technologists' data literacy practices. From the thematic analysis of interviews, data literacy practices express the qualities of *data patchworking*, *remediating accountability*, *multimodal communication*, and *scaling relations*. Such qualities describe how civic technologists learn to work with data to respond to or adapt to data infrastructures.

The four identified dimensions of data literacy practices are important for conceptualizing factors for participation in the datafication paradigm. Data literacy practices afford the capacity to experiment, change, and respond to data infrastructures (Gray et al., 2018). Civic tech is an important site for creating and transforming data infrastructures for the public interest. Although civic technologists assume a level of expertise in working with data technologies, their work demands an "understanding of local information ecosystems" (Bhargava, Deahl, Letouzé, Sangokoya, & Shoup, 2015, p. 13). Indeed, civic technologists learn to navigate and work under local conditions to make data actionable (Gutiérrez & Landa, 2022). By comparing the Indian and U.S. contexts, different cultural and political aspects proved salient in shaping how civic technologists learn to design and intervene in data processes. These differences are significant for conceptualizing aspects of data sensemaking to participate in the transformation of data infrastructures (Gutiérrez, 2019).

The contributions and limitations of this study pave the way for future studies on data literacy and data activism. This study contributes to the debate on data literacy by providing empirical evidence of how data literacy practices in civic tech vary cross-regionally. Cross-context comparison is an important step forward toward decentering research on datafication (Milan & Treré, 2019). Further, this advances the conceptualization of data literacy practices through the application of the affordance-practice framework (Davis & Chouinard, 2017). Such a framework allows for the identification of the participatory capacities and barriers afforded by the data. Limitations are equally important. Although comparing the contextual variability of civic tech initiatives and organizations generated rich descriptions, these descriptions remain idiosyncratic to their respective contexts. Incorporating other methods, such as ethnographies or focus groups, can elaborate on the cultural rituals and political experiences of data literacy. Alternatively, survey methods can be deployed to scale the dimensions of data literacy practices. Future studies should also account for the role of racial, gender, and class identities in shaping experiences with data and developing the capacities to develop data literacy practices.

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