



Coproducing Support Together: Sustainable and Reciprocal Civic Disaster Relief during COVID-19

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COVID-19 changed society in terms of employment, food security, and mental health, affecting all segments of the population. Surging demands for a wide range of support could not be met solely by government-led disaster assistance that experienced breakdowns in the initial phase of the pandemic. The nature of the pandemic as a global, long-haul disaster necessitated sustained, diverse, and extensive civic disaster relief to complement government response. In this paper, we explore how civic disaster relief groups carry out online and offline coordination activities to engage different actors and their positive effects on individuals and local communities, drawing on interviews with civic disaster relief organizers and volunteers in the United States. We interpret our findings with the lens of coproduction that can increase the sustainability, diversity, and extent of civic relief efforts. We then suggest design implications for coproducing disaster relief and discuss the importance and benefits of involving stakeholders who are less likely to be engaged in producing relief.

CCS Concepts: • **Human-centered computing** → **Empirical studies in HCI**.

Additional Key Words and Phrases: citizen-based disaster relief; disaster relief; community resilience; coproduction

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1 INTRODUCTION

COVID-19, which the WHO declared a worldwide pandemic on March 11, 2020 [62], has posed a threat to public health in over 200 countries for over two years at the time of this writing. As of late July 2022, the United States has diagnosed over 91 million cases, resulting in at least 1,045,000 deaths [92]. The pandemic was incomparable with other common disasters (e.g., hurricanes, floods, or earthquakes) for its scope and duration. However, the societal challenges that occurred during the pandemic were not limited to virus transmission or its biological effect [70].

The bulk of destruction from natural hazards is the result of human choices, which frequently have disproportionate impacts on the vulnerability of each individual [10, 32]. Existing structural, social, and economic inequalities in our society account for individual differences in vulnerability

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to disaster [47]. Likewise, unequal human decisions exacerbated the societal effects of COVID-19 virus transmission, altering the natural hazard into a series of disasters. Older adults and people with preexisting health conditions did not feel safe leaving their houses. Frontline workers were overburdened and exhausted. Numerous people lost their jobs, and housing and food insecurity issues skyrocketed. The nature of the pandemic as a global, long-haul crisis with varying societal impacts necessitated extensive, sustained, and diverse relief efforts. The COVID-19 outbreak affected all segments of the population, and two years after its initial outbreak in the U.S., our economic and social recovery from this crisis is still ongoing at the time of this writing.

The pandemic exposed our unpreparedness for an extensive and prolonged epidemic crisis, resulting in social chaos in the initial phase. Support from official authorities was insufficient to recover from the severe healthcare, economic, and social consequences of the pandemic, and their resources stretched thin. Research to date in CSCW and crisis informatics (CI) has studied how citizens coordinated disaster relief activities via social media in real-time and in the aftermath of disasters [29, 81] and how these efforts filled in gaps in aid when government agencies were unable to provide sufficient relief [55, 64, 73]. However, traditional approaches to disaster relief, whether top-down or bottom-up, may not have been ideal during COVID-19, given its unprecedented spatial and temporal scale and broader societal effects.

Citizens endeavored to collaboratively cope with the pandemic by voluntarily forming support networks with their local community members. However, certain relief efforts were distinguishable from others due to their novel ways of providing support or assistance unique to the pandemic situation (e.g., self-quarantine, shortage of personal protective equipment (PPE)). We were interested in these novel civic relief efforts, which we will refer to as civic initiatives throughout this paper. We conducted 13 interviews with organizers and participants of civic initiatives in the United States.

We discovered that engagement in civic initiatives provided opportunities for social interactions and the ability to make meaningful social impacts when depression and anxiety were prevalent [6]. Beyond the individual level, good deeds from civic initiatives were infectious, and more local community members joined to be a part of them. Even those who joined late were welcomed to play a more active role and initiate new support activities. Similarly, initiatives developed in local contexts spread through emulation to other communities, where they actively reconstructed original activities for improvements. We also observed that civic initiatives made things visible in communities that were less visible before. Participants recognized more vulnerable neighbors and underappreciated essential workers, which motivated them to redefine their social connections and responsibility toward other local community members.

We noticed that the civic disaster relief initiatives we observed exemplify the concept of coproduction. Regardless of when they joined initiatives or lived in the same local community, participants played an active role in producing and reciprocally exchanging support. This is consistent with key characteristics of coproduction, where all stakeholders have equal authority and responsibility to shape activities and accomplish desired outcomes, and their interdependence is valued [16, 63]. Expected benefits of coproduction include more responsive participants, reduced costs, and the increase in the quality, quantity, and diversity of activities [15, 16]. In this regard, a deeper understanding of how citizens coproduced disaster relief can lay the groundwork for more extensive, sustained, and diverse relief efforts that could be used in the event of future disaster breakouts.

Although identifying and involving relevant stakeholders is a priority for coproduction, physical separation measures forced by COVID-19 confined social interactions to online modes, making it challenging for initiative organizers to identify relevant stakeholders, individuals in need and those who could provide support. We were also particularly interested in the broader benefits of coproducing disaster relief on participants and local communities, not just the direct benefits of

coproduced support. Thus, we structure our findings in order to address the following research questions:

RQ1. How did civic initiatives engage different stakeholders in the coproduction of disaster relief during the initial phase of the pandemic?

RQ2. What were the broader positive impacts of coproduced disaster relief on individuals and communities?

This study contributes to the field of CI in human-computer interaction (HCI) by adopting coproduction as an analytical lens to understand the coordination of civic disaster relief during the COVID-19 pandemic. We discuss how the attributes of coproduction are reflected in the dynamics of civic initiatives, with references to how diverse stakeholders participated actively and how reciprocity was built in local communities. Coproduction of disaster relief resulted in sustainability, diversity, and expansion of the civic initiatives, which have been core concerns of CI research [35, 74]. We also contribute to the CI literature by providing rich online-meets-offline accounts of different disaster relief groups. Because the temporal and geographical dimensions of COVID-19 were significantly different from those of more common disasters, the nature of relief coordination works we studied was not only similar to those explored in a substantial amount of past CI work, but also different; relief activities were less immediate but more complex during the pandemic. Drawing upon our findings regarding civic initiatives (e.g., fluid roles of participants with heterogeneous expertise; improvisational relief activities; expansion of civic initiatives; collaboratively coproducing resources; and the exchange of gratitude), we propose socio-technical design implications to facilitate the initiation, development, and sustainability of coproductive disaster relief. The study concludes by outlining the significance and advantages of ensuring relief activities are coproductive through a comprehensive understanding of all stakeholders' perspectives and the involvement of those often regarded to be in a position of receiving support in coproduction of relief.

2 RELATED WORK

Community is a broad term with many meanings; over 100 have been identified by Lyon in *The Community in Urban Society* [54]. For our purposes, community is a shared geographic locality, such as a city or town, and members are those who live or work in the local area. In this section, we examine how citizens have complemented government disaster response and discuss how community disaster relief could be augmented through coproduction.

2.1 Citizen-based Disaster Relief

Disaster management can take either a top-down or bottom-up approach. The top-down approach is led by government agencies who decide what to do when a crisis occurs and implement a disaster response strategy [36]. As an example of top-down government-led disaster response in the United States, the Federal Emergency Management Agency (FEMA) offers programs to which disaster survivors may apply for different sorts of assistance, such as financial and crisis counseling [3]. Although this approach can efficiently distribute emergency resources on a large scale, infrastructural breakdowns can occur when the magnitude of a disaster overwhelms capacities, and societal needs surge dramatically. For instance, the Centers for Disease Control and Prevention (CDC) of the United States was unprepared for a global epidemic, and when COVID-19 broke out, PPE essential for reducing the virus' transmission was severely depleted [45].

In these situations, the bottom-up approach for disaster management can complement government-led emergency response [76]. Bottom-up relief is a grassroots model where citizens play a proactive role and mobilize social capital to provide support in their local communities [36]. Contrary to the common belief of government authorities that citizens panic and passively wait for top-down

emergency aid to arrive when a disaster occurs [43], citizens have spontaneously coordinated disaster relief activities and effectively supported one another in past disasters [24, 37]. With the advancement of Information and Communications Technology (ICT), citizen participation in disaster relief greatly increased. Online volunteers assist in the collection and dissemination of crisis information, which is sometimes more accurate, up-to-date, and detailed than that provided by the mainstream media [40, 44, 79]. Social media also connects geographically dispersed populations during crises and enables citizens to effectively distribute tangible assistance on-site, such as food aid [48], rescue and relief actions [69], and clothing donations [83], to list just a few examples.

As social media vastly extended the roles of ordinary individuals in disaster relief, public digital traces have become a rich resource for CI research. However, the vast majority of research focused on online coordination work or observed only one or two social media, mostly Facebook or Twitter. CI researchers have raised concerns about focusing solely on public digital traces to inspect disaster relief activities [94], as they cannot give a complete picture of citizen-based disaster relief efforts [29]. For instance, to circumvent government surveillance, social movement participants adjusted their Facebook privacy settings and spoke via private messengers to leave no public traces on social media [94]. Even when surveillance was not a concern, volunteers were too busy coordinating relief efforts to use social media on the ground [30]; instead, they communicated via email, phone, and face-to-face [29]. Occasionally, implicit knowledge of community norms shaped relief efforts and reduced explicit coordination work, leaving fewer digital traces [29].

Few CI studies that investigated the intersections of online and offline relief coordination work reported that social media is mostly utilized to collect widely dispersed expertise that is later realized in offline settings [90]. Despite the fact that volunteers lacked prior experience in such relief activities, civic disaster relief was feasible due to their trust in their own and others' expertise [90]. Volunteers directly engaged with key informants in affected areas, rather than going through social media posts to stay abreast of changing community needs and identify victims [29, 91], or utilized well-established social networks to rapidly mobilize relief efforts [29, 51]. Some of them selected face-to-face interactions over social media communications to develop a sense of social closeness and trust with their peers [91].

CI researchers called attention to the need to examine “invisible” relief works occurring outside of public digital records on social media, which can reveal social, cultural, and geographic factors that shape coordination work for a more comprehensive understanding of citizen-based disaster relief [29, 51, 91, 94]. They also urged exploring how volunteerism varies by disaster setting, given that the dynamics and strategies of relief coordination work can differ in the context of disaster, depending on its duration, visibility, and dimension [42, 61]. For instance, during COVID-19, the sustainability and extendability of civic relief were of more concern than in other common disasters. However, owing to the decline of face-to-face interactions, coordinating citizen-based COVID-19 relief efforts was not easy, while they were needed the most to fill in gaps in government disaster response and varying aid was needed due to incidental social effects of the pandemic [48]. Volunteers were forced to limit offline work for coordination and rely heavily on online tools [42, 49]. This is not to say, however, that observing social media data is sufficient to observe civic relief during COVID-19, as research to date has revealed that not all coordination work is manifested on public digital traces [29, 51, 91, 94] and coordinating relief primarily on social media has limitations, e.g., a lack of trust compared to face-to-face interactions [91] and technology choices indeliberately excluding some people from receiving aid [75].

This study addresses the lack of prior research that provides an online-meets-offline account of relief efforts by examining how diverse civic groups coordinated disaster relief on-the-ground to make it sustainable and extensive. Similar to collaborative relief efforts in other crisis contexts, we discovered that emergent COVID-19 relief groups interacted with local key informants or

established organizations to identify those in need [29, 91]; improvised their expertise to provide relief [90]; assembled different digital tools for varying coordination work [30]. However, COVID-19 being an unusual disaster with simultaneous global effects, we observed the collaboration and extension of relief efforts across multiple communities, as well as other psychological and social factors that sustained civic disaster relief, which we will discuss in more detail in the Findings section.

2.2 Coproduction and Disaster Relief

The concept “coproduction” was coined by Elinor Ostrom [63] to describe a process through which to engage actors from different organizations to produce public goods or services collectively. It is different from classic service delivery, where only providers produce services and deliver them to recipients. The roles of providers and recipients are fixed, limiting the number of people capable of producing and receiving outcomes. In contrast, in coproduction, the roles of producers and recipients are fluid, since each actor collaborates to produce and receive the outcome [63]. Because the distinction between providers and recipients is blurred, they are reconfigured as “initiators” and “joiners” [18]. Initiators initiate the production of services, while joiners later participate in the production and delivery processes and may initiate the production of other services. A reciprocal collaboration between initiators and joiners can improve the quality and quantity of products and benefit all parties [16]. One of the goals of coproduction is to ensure that all participants have the authority and responsibility to achieve the outcome, taking their different contexts into account and directly engaging all relevant stakeholders [95].

Cahn [16] broadened the scope of coproduction to include not only partnerships between organizations and agencies but also collaborations between individuals. Numerous person-to-person interactions can be thought of as coproductions; for example, individuals suffering from mild depression checked in for other patients and supported them as a company while also experiencing improvement on their own depressive symptoms [16]. Patients, who are regarded as recipients of healthcare services under the delivery model, successfully collaborated to bidirectionally produce and deliver mental well-being.

The concept of coproduction has been applied in many different domains, from public safety, healthcare, education, to urban planning [5, 9, 50, 63], where citizens have shown contributions of their skills and resources for better outcomes of public services. Disaster management was not exceptional; previous studies have proposed the application of coproduction to disaster management to engage citizens as valuable actors. However, most of them focus on partnerships between government and citizen rather than citizen-to-citizen support exchange. For instance, Díaz et al. [33] and Chatfield et al. [19] discussed how citizens could work with emergency management agencies to generate more precise disaster-related information. Thomas et al. [82] narrated how citizens in non-governmental organizations collaborated with government agencies to organize rehabilitation programs in the aftermath of an earthquake.

Citizen-to-citizen disaster relief can also be implemented through coproduction, which engages loosely coupled, self-organized individuals rather than collaboration with the government agencies or formal organizations [53]. However, research that studied citizen-to-citizen disaster relief is mostly about less affected citizens (e.g., people from surrounding communities) providing support to those heavily affected by a crisis [37, 65], which is more aligned with unilateral support delivery or limited to peer-to-peer information sharing [65]. Unilateral support might have been sufficient to take care of affected people in previous disasters, however during COVID-19, the number of people “affected” by the crisis was massive. Due to the wide reach of the pandemic, those infected with the virus were not the only ones who needed support. A lot of others were also affected by economic and social repercussions the pandemic has brought (e.g., financial, housing, mental health) [70],

and even those considered as “providers” in the traditional service delivery system needed support. Healthcare and social workers, for instance, often suffered from psychological distress as they had to constantly serve other’s needs [14].

Due to multiple pandemic waves, situations fluctuated, and regions that were less affected today could have been more affected tomorrow. People could not simply get support from those outside the disaster, as everyone was affected by either immediate biological or broader social consequences of COVID-19. Coproduction of disaster relief regards every actor, even those harmed by the pandemic, as contributors for producing support. It helps us recognize potential contributions each can make and enables bidirectional support exchange. Therefore, we analyze our findings through the lens of coproduction to understand how support can be disseminated to a broad range of individuals.

3 METHODOLOGY

A lot of civic relief efforts emerged in local communities in the United States immediately after the outbreak of the pandemic. We initially collected examples of them and had weekly peer debriefing sessions to discuss each example [41]. We conducted interviews with organizers and volunteers of novel relief efforts and followed inductive thematic analysis [12] to investigate how disaster relief activities were initiated, how they were able to sustain, and their impacts on individuals and local communities.

3.1 Collecting Civic Relief Efforts

From March 20 to July 17, 2020, a study team of 10 researchers collected different cases of citizen-based COVID-19 relief in the United States. We individually added cases from publicly available online articles in local or national press, social media, or email listservs to a shared spreadsheet. The study team had iterative peer debriefing sessions each week during the data collection period to share their new observations, based on Guba [41]. We shared how each case was operated, what support it produced, and who benefited from it, and discussed how similar or different each case was from others.

After four months of documentation of citizen-based COVID-19 relief cases, we had enough examples to thematically group the cases based on what they offered to the community at large or to individual community members. For the preliminary thematic framework, we referred to the indices of community resilience to disasters developed by Cutter et al. [27], which consisted of *Economic Resilience*, *Infrastructure Resilience*, and *Community Capital*. Based on the initial thematic grouping, we continued to collect data for specific themes that had fewer cases until we achieved a similar amount of cases for each theme. We concluded data collection when we noticed that newly discovered relief cases are similar to those already existing in the collected list and ended up with 158 cases in total. There were 50, 65, and 43 cases under Economic Resilience, Infrastructure Resilience, and Community Capital, respectively. The most prevalent cases within Economic Resilience was the donation of food, groceries, or hot meals. The most prevalent cases under Infrastructure Resilience was relevant to physical and mental health, such as sewing face masks or virtual activities for psychological well-being. The most prevalent cases in Community Capital was an expression of gratitude, such as online/offline collective actions for healthcare workers like projecting blue lights or using specific hashtags.

During multiple debriefing sessions, we observed that some relief efforts were relatively novel compared to other ones or those carried out in the aftermath of prior common crises. The physical distancing measures implemented to prevent the spread of the COVID-19 hindered citizens from making relief efforts in the same manner as before. They modified conventional disaster relief actions, for instance, by shopping for groceries on behalf of vulnerable individuals and delivering them to their doorsteps, instead of distributing hot meals to groups of people in an emergency

shelter. We were interested in these cases and filtered data according to Wachtendorf et al. [88]’s concept of community innovation in disaster relief, where innovation was demonstrated during a disaster through “[emergent] structural arrangements in operation, resources utilized, or tasks and activities engaged in [13, 52, 89].” Wachtendorf et al. [88]’s concept reflects Merton [57]’s Strain Theory, which posits that strain creates an environment for individuals to seek to attain socially desirable goals through non-routine means, which he calls innovation. Disasters, such as COVID-19 in this study, put a strain on community-based relief efforts and force them to make unconventional and innovative adaptations.

We examined the data we collected to discover innovative community-based disaster relief. Guided by Wachtendorf et al. [88] and Merton [57], we found 42 cases that reflect community innovation in disaster relief, which we will refer to as “civic initiatives” throughout this paper. For instance, they were innovative in that they expanded to multiple local communities with emergent partnerships with private companies; volunteers provided support in novel ways (e.g., doing grocery shopping on behalf of vulnerable individuals and dropping off the groceries on their doorsteps); or they manufactured pandemic-specific necessities (e.g., sewing face masks, 3D printing plastic face shields) without prior experience.

We originally sought to describe how community innovation was manifested in citizen-based disaster relief during the unique COVID-19 crisis. However, during the data analysis process, we were struck by how reciprocal exchanges of support established a connected support network in local communities and how individuals actively played their unique roles while leveraging their expertise to collaboratively produce disaster relief. We noticed that these patterns echoed key properties of coproduction, so we interpreted collected civic initiatives through the lens of coproduction.

3.2 Interviews & Participants

To understand how the civic initiatives were implemented and how they turned out, we conducted interviews with organizers and volunteers. We found contact information of the selected civic initiatives through their email listservs, websites, or social media accounts. We sent out 42 interview invitations, of which 14 people responded affirmatively. They were people who started initiatives or were on the coordination team. In this paper, we refer to them as civic initiative organizers. We used snowball sampling to interview three individuals who were not in the coordination team but volunteered for initiatives when their contact information was presented to us with consent by organizers. Table 1 shows whether each interview participant was an organizer or a volunteer, gives a description of the initiative they engaged in, and the community resilience index theme associated with the initiative.

We conducted 10 interview sessions with 14 organizers and three sessions with three volunteers. We had three sessions where more than two organizers joined, and the rest of the sessions were one-on-one. Our semi-structured interviews were conducted remotely via a Zoom video or voice call for around 40 to 80 minutes with no compensation. Before asking interview questions, we explained the purpose of the study and obtained verbal consent from interview participants. All the interview sessions were recorded under participants’ consent. For organizers, we asked them how their disaster relief group was initiated, how they supported community members, any challenges they faced, strategies to cope with challenges, feedback from aid recipients, and their future aspirations or plans, and followed up with other questions based on their response. We asked volunteers how they heard about the disaster relief initiative and to reflect on their experiences with respect to their motives, participation procedures, and feelings after supporting others. This study was approved by the university Institutional Review Board (IRB).

Table 1. Interview Participants and Civic Initiatives

Participant	Role	Initiative Description	Community Resilience Index
P1	organizer	Local members manufacture PPE for local hospitals and nursing homes	Infrastructure Resilience
P2	organizer	Public transit agency delivers groceries, meals, and prescriptions for the vulnerable	Infrastructure Resilience
P3	organizer	The group serves as an intermediary between the vulnerable who must stay in shelter and others who can provide donations or do delivery	Infrastructure Resilience
P4, P5, P6 *	organizer	The group collects laptop donations and distributes to people without computers	Infrastructure Resilience
P7	organizer	A group of college students sends isolated nursing home residents a video for encouragement	Community Capital
P8	volunteer	A group of college students sends isolated nursing home residents a video for encouragement	Community Capital
P9	organizer	Online platform where local members can share their artworks or writings that reflect their experience during the pandemic	Community Capital
P10	organizer	The group delivers donated groceries and meals to people experiencing food insecurity	Economic Resilience
P11, P12 *	organizer	The group delivers donated groceries and meals to people experiencing food insecurity	Economic Resilience
P13	organizer	The group delivers local restaurant food donated by locals to frontline workers and people experiencing food insecurity	Economic Resilience & Community Capital
P14, P15 *	organizer	The group delivers local restaurant food donated by locals to frontline and community workers	Economic Resilience & Community Capital
P16	volunteer	The group delivers local restaurant food donated by locals to frontline and community workers	Economic Resilience & Community Capital
P17	volunteer	The group delivers local restaurant food donated by locals to frontline and community workers	Economic Resilience & Community Capital

* These interviewees were interviewed in the same session.

3.3 Data Analysis

The recordings of the 13 interviews were transcribed and examined following inductive thematic analysis [12]. For the preliminary analysis, two researchers independently read and performed open coding for six and seven transcripts respectively. Preliminary codes included, for instance, challenges the initiatives faced, outstanding impacts on society, and collaboration with multiple parties. After this, the first author independently read eight transcripts, which overlapped with the ones that the two researchers had read, and referred to open codes generated by the other two researchers earlier to make an initial codebook. The codebook consisted of code names, descriptions, and

exemplary quotes. The first author and the other two researchers collectively refined the codebook, adding more codes or aggregating codes into themes after discussion to reach a stable codebook. The two researchers re-coded the transcripts that were initially assigned to them, and the first author re-coded all 13 interview transcripts. Any code discrepancies were reviewed together and discussed until agreement was reached. We then applied axial coding to group similar codes into a higher level themes. Themes and codes irrelevant to our research questions were removed, and the remaining ones formed our findings. Sections in our findings represent our themes and their subsections represent our codes.

4 FINDINGS

This section examines the coordination process and the outcomes of coproductive disaster relief. We begin by describing the challenges civic initiative organizers encountered and the strategies they employed to identify and engage those who needed support and those who could participate in coproducing disaster relief. We next discuss the broader impacts of coproducing disaster relief on individuals and communities.

4.1 Identifying and Involving Those in Need

The primary theme that arose from our analysis was the limited access to technology and lack of digital literacy of people who needed support. During the pandemic, not having a digital device or Internet connectivity made it difficult for many people to access support systems. Existing organizations moved their communications online and began operating through online tools such as video conferencing software. New organizations were reliant on online tools to organize and to get the word out about their services. During the early days of the pandemic, most people who could stay home did so, and those without reliable access to ICTs became invisible in society. From our interviews, we noticed that civic initiative organizers took different measures to identify those who needed support but who did not have access to ICTs, by providing digital devices and training and collaborating with local organizations that already existed before COVID-19.

4.1.1 Difficulty in Identifying Those in Need. Restrictions on face-to-face interactions led a lot of civic initiatives to depend on online platforms to coordinate relief activities. However, because of the close relationship between the digital divide, poverty and/or age, many of those who needed support could have been underserved due to a lack of access. One of the initiative organizers was concerned that some of those in need did not have technologies, which was a prerequisite to make use of and even be aware of the support initiative she led: *“A lot of people who were looking for this kind of service don’t necessarily have a smartphone or Internet access...and won’t be familiar with [our initiative]”* (P3), implying that those in need without technology were less likely to realize that civic initiatives that could assist them even existed. On the other hand, their lack of access to digital devices or the Internet made it hard for civic initiatives to identify people who needed support. One of the initiative organizers mentioned that *“a challenge [was] in trying to figure out where [we were] needed the most”* (P12).

One unexpected challenge was convincing people who did not want to own a digital device that doing so would help them out. P5, whose initiative distributed laptops to those without one free of charge, told us that some refused to receive them. P4, his colleague, said she almost had to persuade some people to take a device: *“I had to do so much pushing on the recipient-end...I almost had to beg [people] to say, ‘Yes, I would like a computer’...I repeated efforts to try to draw the recipients into our program.”*

Digital illiteracy was another hindrance to providing support. Although people could have physical access to devices or the Internet, our participants told us that it did not necessarily mean

that they could fully leverage technologies. For instance, P2 explained that although a local grocery store had an app for the delivery or pickup service, there were “so many [elderly] who couldn’t use the app.” In another case, P6, who organized an initiative that distributed secondhand laptops, mostly to Spanish-speaking students taking an English as a Second Language program, told us that some students “don’t know anything about the computer except turning it on” (P6), which made it difficult for them to continue their course in the new virtual learning environment. These examples suggest that simply providing digital technologies is not enough; further training on how to use technology is necessary.

4.1.2 Approach to identify Those in Need. One direct strategy to identify people negatively affected by the digital divide was to lower the barrier to access by giving them an alternative option to request support without a complicated technical process. P2 explained that when those who needed delivery service called her public transit agency, she told them about a grocery delivery app. If they did not know how to use the app, she connected them with a local church group who would shop for groceries for them, which were then picked up and delivered by P2’s transit agency. Another approach was to design simple interfaces with easy-to-understand instructions, as P3 did when she “[made] the website purposely simple so that anyone who has access can figure it out and use it” (P3). P3’s initiative also included a feature that allowed someone else to submit support requests on behalf of those who needed support but did not have a smartphone or Internet access, or were not familiar with using their app.

P4, P5, and P6 strove to bridge the digital divide by providing second-hand laptops to students without one, so they could continue education during the pandemic when schools moved online. They had taught recipients how to operate laptops in person but had to halt the training when local COVID-19 situations got severe. However, they endeavored to continue the training virtually by making a booklet and offering step-by-step online instructions for installing software and following up with Zoom tutorials.

Another approach to reaching out to those in need at scale was through collaboration with pre-existing local organizations. The initiatives that was formed after the COVID-19 outbreak were emerging grassroots efforts. Six out of 10 of the civic initiatives we investigated partnered with established formal organizations who “[let them] know there was a need” (P12). Having partnerships with such groups was effective in that existing groups had “done lot of direct outreach to people [in need]” (P13), for example, a “better understanding of large communities that need help [with] a list of people that [were] in need of food or other assistance” (P3). These partnerships helped our organizer’s nascent civic initiatives “find where [support seekers were] located and how [they could] reach them at scale” (P3). P2 collaborated with an established organization that served senior citizens, which shared information about P2’s initiative on their social media and newsletters. P2 said, “that’s been real helpful to push that information out to people, so people can take advantage of the services we are providing.” Another benefit of working with existing established organizations was that civic initiatives did not have to expend effort to determine who should be prioritized to receive support:

“We find it easier to work through institutions rather than ending it up to individual...we are working through the schools, ..., Parents for Homeschooling¹, ..., and the [city recreation] center, so we don’t have to make judgments about who deserves one, who doesn’t.” (P5)

Pre-existing local organizations acted as a bridge to connect those who needed support with emergent civic initiatives, who were thereby able to distribute aid to populations that needed support the most.

¹anonymized

4.2 Civic Initiatives Reaching Out to Volunteers and Vice Versa

Recruiting new volunteers and maintaining participation for existing ones was not easy during COVID-19 when risks persisted in everyday life and social interactions were restricted for a long term. Civic initiative organizers encouraged their community members and members of other local communities to join disaster relief activities by promoting their initiatives online and by sharing resources to help others replicate their initiatives. They also tried to limit face-to-face contact and gave out PPE to make sure volunteers were safe. We also discovered that people having attachments to community members and local places stepped forward as volunteers to give civic initiatives a hand. They devoted resources and time without expecting anything in return.

4.2.1 Finding and Engaging Volunteers. Physical separation measures mandated by COVID-19 impeded the progress of drawing new volunteers into initiatives as it got harder to “[get] the word out about [it]” (P9). Face-to-face contact was reduced, and initiative organizers were unable to simply “grab someone in the hallway...[and] accost anyone to try and get anyone to do what [they] needed” (P7). Seven out of 10 organizers mentioned the significance of getting the word out about their initiatives online. P9 described the diverse channels her initiative used to recruit more volunteers:

“We had a press release out, we were on a Podcast, ..., [we] promoted in...college department social media and websites, ..., we are putting in abstracts to talk about the project at conferences,..., I have my team reaching out to all sorts of entities...making them be aware of the project...trying to get the word out.” (P9)

One of the organizers described how a lot of people “*wanted to help but they weren’t sure how*” (P1) before joining initiatives. Many participants told us that with a long-lasting global pandemic that was unprecedented to most of this generation, people did not realize their potential to help others unless they were healthcare workers. P1 provided daily updates on his initiative via a university listserv, which included people who were not necessarily involved in the initiative, in order to “*make people aware of everything that [was] going on and communicate progress on the various tasks*”. He said daily updates prompted people to recognize what they could contribute to pandemic relief and inspired them to join the initiative.

Promoting an initiative online also motivated people in other communities to initiate similar relief efforts. P1 described how he started an initiative similar to the one he read about online: “*I saw articles on how people were 3D printing face shields and other PPE masks and things for COVID...I was also sharing those articles with friends...so it was...what then exploded and turned into [our initiative].*” Similarly, P14 said that she read an article about an initiative that originated in Boston and spread out to other local communities, which motivated her to coordinate a similar disaster relief activity for her community members. P5, whose initiative was to reset secondhand computers for donation, wrote an online article about his initiative, hoping it could provide enough information to be replicated in other regions. Three local communities reached out to him to ask how he coordinated the initiative.

Some organizers shared open-source resources to make it easy for organizers in other local communities to launch a similar relief activity. P6 said his initiative worked on creating an instruction manual to explain the process of receiving a donated secondhand computer, wiping data from it, installing an operating system and software, and handing it to those in need of laptops to help others replicate the initiative in their communities. Similarly, P1 told us that he originally got open-source 3D printed designs for a plastic face shield shared by Prusa Research in the Czech Republic. P1 made modifications to the 3D printed designs to make the face shields sturdier and to reduce the printing time, and he shared the modified designs online. P1 said, “*Very unique about this whole pandemic response is the open-source sort of response...around the world...there was this whole*

sort of global collaboration going on.” These efforts towards sharing resources to help other local communities replicate what they are doing imply that citizens went beyond coproducing relief with their community members, and coproduced relief with people in other local communities as well, which benefited those in other parts of the globe.

Another reason for the difficulties of recruiting new volunteers was that the pool of people who could provide support decreased *“because of immune disorders or their physical health [was] just not ideal for volunteering at this point”* (P11). Unlike earthquakes, hurricanes, bombings, or other disasters, this global pandemic was different in that it was a largely invisible threat with countless epicenters. People wanted to help, but going out to the field indicated increased exposure to the virus. P12 echoed this sentiment, *“They couldn’t help for their own safety. They wanted to, but they couldn’t, and it was hard on them.”*

Seven out of the 10 civic initiatives in this study provided ways for volunteers to provide support without being in close contact with others. For instance, in P7’s initiative, people only had to film videos or take photos and upload them onto cloud storage, which were then integrated and shared with senior citizens in nursing homes for encouragement. People only had to send off a laptop they no longer used to the P4, P5, and P6’s initiative to donate it to people who needed it. Members of P1’s community were given 3D printed designs for plastic face shields or instructions to sew masks or gowns, so that they could easily support local healthcare workers without leaving home. P16, one of the donors who paid for hot meals delivered to healthcare workers, mentioned how the initiative made the process of helping those in the frontlines easy without her physically having to go out in the field:

“It’s a way of community to come together and do something for people actually on the frontlines and be in the background...I did not have to physically do something. How easy can they make it for me to help in something like this...this was a no brainer for me.”
(P16)

For volunteers who did have to go out in the field (e.g., delivering groceries), most of our initiative organizers shared that they were vigilant in securing a safe environment for them and the community as a whole: *“[Volunteers] certified that they [had] not been in contact with someone with COVID-19 to their knowledge...that they [weren’t] having symptoms of COVID-19 and [had] to wear a mask during the delivery”* (P3). Interestingly, some individuals adapted their skills to this unusual disaster situation and improvised to help civic initiatives serve the community in a safe environment. P2 described the PPE donations they received from local businesses that switched to manufacturing PPE when there was a PPE shortage. Local distilleries in P2’s community repurposed their equipment to distill hand sanitizer, and a family business that originally made snow skis switched over and produced plastic face shields, which were donated to P2’s initiative and local hospitals.

4.2.2 Volunteers Joining Civic Initiatives. In the previous section, we described how initiatives reached out to recruit volunteers. However, we also found that many citizens voluntarily reached out to initiatives to give and do whatever they could to support community members immediately after the pandemic hit. As P12 shared, *“A lot of people said they wanted to help out. They knew that there was a need right away when this first hit”*. P1 was surprised at how much people were willing to make donations: *“[He] reached out to me and said, ‘Hey, I heard the great things you guys are doing. How can I contribute financially to help the project?’ When does that happen, when someone reaches out and wants to give you money?”* P13 saw art galleries, fitness professionals, and comedians reaching out to organize fundraisers on their own to benefit her initiative: *“It’s people reaching out to us. We haven’t really proactively forged many of those partnerships...[people] saw what we were doing and wanted to help and reached out if [they] could be a fundraiser.”*

P10 had some local restaurant owners join his initiative to start a hot meal delivery program and brought in more restaurant volunteers:

“[Anonymized], she’s the one who started that. She approached us. She is very community-oriented. She ...[reached] out to some other restaurants in the area to be involved in a partnership...she spearheaded that and she did a phenomenal job...we did not go out and approach them. They came on board when [anonymized] got the ball rolling.” (P10)

Several of our participants offered anecdotes that reflect how altruism and humanitarianism were their motivating factors [23, 78]. Many volunteers devoted their time and energy to helping the local community without expecting anything in return: *“Nobody was paid to do any of this...Extra time at nights and weekends to step up and do this...People put in a lot of time and energy to make this happen”* (P1). Similarly, although most local restaurants faced significant decreases in revenue, they gave out free hot meals or discounts to initiatives rather than seeking compensation:

“The restaurant partnership has been huge. There were no strings attached to that, most will go as far as they could go...[they] didn’t give back for any type of PR (public relations) or anything like that.” (P10)

“[Local restaurants] gave us a pretty good discount because they knew it was for healthcare workers...They were super accommodating.” (P15)

When we asked our participants about the volunteers’ motivations for supporting their local communities, some told us that they *“wanted to kick in and give back to the communities...[because they] cared about people living in their communities”* (P10), which reflects their connectedness and belonging to the local community. Similarly, P9, who runs a website where people can share artwork they have completed during the pandemic to resonate with others, told us that she saw *“a lot of people expressing how they are recognizing and caring in different ways.”*

Another motivating factor was their attachment to local places. Although the pandemic did not physically destroy areas in the way that fire, floods, or hurricanes do, it prompted many local businesses to close their doors. P13 speculated that people sponsored the initiative she led, the objective of which was to save the local economy, because of their willingness to support the local businesses they were attached to:

“A lot of the restaurants we work with are really our neighbors. So people wanted to keep their businesses flowing. It’s what people feel very attached to, knowing that the place was where you were getting your morning coffee for ten years, knowing that that place might not survive the crisis and being given an avenue to support them...I think that was really attractive to people.” (P13)

These comments suggest that attachment to community members and to place motivates people to voluntarily join civic initiatives and participate in coproducing disaster relief, which echoed prior research in community resilience that emphasized how the sense of community encourages participation in community responses to disasters [68].

4.3 Broader Impacts of Coproduced Disaster Relief

Civic initiatives were aimed at specific social outcomes, such as attenuating food insecurity, increasing access to technologies, addressing PPE shortages, or encouraging overburdened workers or isolated elderly in nursing homes. In addition to achieving their missions, they also had broader positive impacts on individual volunteers and the wider community. On the individual level, engagement in civic initiatives to coproduce disaster relief promoted psychological well-being. On the

community level, civic initiatives paved the way for the community to become aware of chronic social issues, help the most vulnerable members amongst them, and recognize less visible community workers.

4.3.1 *Promoting Psychological Well-being of Individuals.*

Beyond its direct threats to public health, COVID-19 brought significant psychological consequences by disrupting daily life practices [84]. A lot of people got laid off or were asked to shelter in place; social activities that reminded them that they mattered suddenly disappeared. Our participants said they started to feel “*anxious and helpless*” (P13) and felt bad while “[*staying*] home [*when*] frontline workers [*were*] working hard” (P14). One of the volunteers who donated to feed frontline workers explained how she felt before joining the initiative: “*I couldn’t help healthcare workers...[I felt] so bad and [wanted] to do something*” (P16).

One way to cope with these depressive emotions was to participate in civic initiatives, “*to make an impact and do something positive*” (P13). P8 said, “*it was nice to see that...I can do something to help*”. Many people “*wanted to keep [themselves] busy due to unemployment*” (P11) and civic disaster relief initiatives allowed them to “*channel their energy and they saw an immediate impact*” (P1), which seemed to have helped them focus on coproducing support with others. For instance, P15, who organized the initiative to feed frontline workers, shared the feedback she got from volunteers: “*Providing the funds for this [gave volunteers] a sense of helping the healthcare workers in a way that [they] would not have been able to do so before.*” P17, who joined P15’s initiative, felt “*rewarding*” to support healthcare workers. P14 stated that some volunteers thanked her for spearheading the initiative: “*they felt great and...so grateful that they could be a part of [the initiative]*”.

By being part of the initiative to coproduce support, our organizers and volunteers received appreciation from the people they helped, which enhanced their psychological well-being. P2 said, “*Extra things we did...seem to be appreciated by the community...we feel good about what we’ve done...to help the community out*”. The social impacts of even “*small acts of appreciation...can go a long way*” (P17) and can be significant. For example, P17 told us that a local grocery store purchased meals from her restaurant to thank their staff for doing essential work during the pandemic. P17 joined the act of appreciation by writing a thank-you card with an uplifting message for grocery store workers: “*You have always been essential. Have a great day, and keep your head up.*” This simple thank-you card made grocery store workers realize that their work was valued and appreciated. They uploaded a photo of the card on social media, saying: “*Look at what [P17’s business] did for my day and put a smile on my face for today!*” and visited her restaurant and appreciated her back:

“Being part of a greater cause has come back tenfold...because we were supporting that cause, it made people more comfortable or happier to support our business...We showed our appreciation, and then they showed their appreciation to us.” (P17)

Participating in coproduction of disaster relief empowered people by letting them focus on meaningful activities when depression and hopelessness were prevalent. Small good deeds, such as expressing appreciation, resulted in the coproduction of emotional support as others joined to express gratitude. This exchange of gratitude started a cycle of prosocial behaviors that can have a longer-lasting impact throughout the community, which is integral during a long-haul crisis.

4.3.2 *A Starting Point to Serving Local Community and Beyond.*

Volunteering in civic initiatives altered how people think about their own scope of action and responsibility toward neighbors. Before COVID-19, although people knew that vulnerable members had always existed, they did not take the issue seriously enough to take action. COVID-19 made people recognize and start providing support for vulnerable community members who had been easily unnoticed and been left out of society.

For example, the original intention of P13 and her friends was to feed healthcare workers and revive local businesses. However, they gradually realized that *“people who [might] have been in tough situations even before the crisis...[were] in more dire situations”* and shifted their attention *“more and more to supporting people with severe food insecurity or house insecurity”* (P13). P2 told us that the pandemic prompted her team to provide extra services to local members who felt unsafe or were unable to go outside, which *“gave [them] a platform to work on for if anything should ever happen again.”* P2 felt confident that they could serve locals better next time when the situation got severe again and said: *“It has been a growth experience for a lot of us.”* Many civic initiative organizers and volunteers aspired to continue their initiatives even after the pandemic. For instance, P3 said: *“There always, unfortunately, will be people in need, there are always people who want to help. So we are aiming to continue this effort far beyond COVID-19.”* P11 was also ambitious enough to continue the initiative even after the pandemic to resolve food insecurity and further extend it to neighboring local communities.

Civic initiatives also helped local communities realize and appreciate community service workers who were often under-recognized. The initiative P17 volunteered for fed not only doctors and nurses but also relatively less recognized frontline workers, such as those at testing centers, postal workers, and social workers. P17 said she was unaware of essential workers at testing centers outside hospitals until she delivered donated meals to the site, participating in the initiative. She hoped that even after the pandemic, *“just regular everyday, people remember about...anybody that is in a social service role [who] does thousands of work for the community”* (P17). P16 also wished for the initiative to continue after the pandemic to appreciate more community workers: *“They should continue with it even after COVID-19... lots of people do lots of things in our community that make it worth living...we can appreciate other groups of people doing so much to our community.”*

5 DISCUSSION

In the following sections, we first discuss how the lens of coproduction provides a different angle to interpret civic disaster relief and how it increases its sustainability, diversity, and extension, drawing from our findings on how people joined civic initiatives and later initiated new ones. Then, we derive design implications that can boost coproductive civic disaster relief, based on the collaboration of people with diverse capacities within and across local communities observed in our analysis. Finally, we highlight the importance and benefits of identifying and involving less visible stakeholders in coproducing disaster relief.

5.1 Coproduction for Sustainable, Diverse, and Extended Disaster Relief

Coproduction emphasizes the importance of developing social exchange systems where all involved actors participate in service production [18]. Participation in coproducing disaster relief transcends the role of citizens, or affected people, who are frequently viewed as passive recipients of aid. Citizens actively assisted frontline workers, who usually do not receive support under the traditional disaster relief delivery model. They ensured that local hospitals and nursing homes did not run out of PPE, and their expressions of gratitude encouraged overburdened frontline workers. Taking care of frontline workers was especially critical during the COVID-19 crisis, when they were forced to work in extremely challenging conditions for an extended period of time, which could lead to mental health problems [28]. Bidirectional aid flow in coproduction shifted the vertical relationship between support providers and recipients to a symmetrical relationship between partners collaborating to combat a crisis. A sense of partnership within the local community can elicit solidarity, reinforcing the collective belief that the community will overcome adversity and increasing participation in volunteering [34], thereby making disaster relief more sustainable during a prolonged crisis.

Citizens also benefited from coproducing disaster relief. Many of our participants stated that they felt helpless prior to joining civic initiatives. However, coproducing support for others resulted in self-care as they felt psychologically rewarded when they made social impacts, which increased their sense of hope amidst the pandemic. This finding is consistent with previous research that found coproducing services can help to boost self-esteem, which contributes to subjective well-being [15, 25, 95]. Having higher self-esteem can also reduce psychological distress following a crisis [1, 2]; thus, additional research that elucidates the effectiveness of coproducing disaster relief in mitigating negative psychological effects of a disaster is needed.

The reciprocity between initiators and joiners is another aspect of coproduction that contributes to the sustainability of disaster relief. Initiators start relief activities and joiners continue them. For example, one of the organizers we spoke with initiated a relief effort to deliver hot meals to overburdened healthcare workers. Citizens joined the relief effort by donating money to purchase hot meals from local restaurants that were struggling throughout the pandemic. Local restaurants joined by offering discounts on purchased meals. When healthcare workers got meals through the initiative, they joined the support network by ordering from the local restaurants in return. The chain of initiators and joiners helped the local community holistically survive the long-haul crises.

The roles of participants are fluid in coproduction and their interchangeable roles can help to increase the diversity and expansion of disaster relief, as coproduced activities are constantly evolving based on the expertise of involved stakeholders [15, 16]. Our findings indicate that joiners later became active initiators, launching new relief efforts. Recalling a narrative from one of our participants, a local restaurant owner who joined a civic initiative, used her network with other restaurants to launch a hot meal delivery service to combat food insecurity. Some local businesses partnered with existing initiatives and started fundraising events. Several of our participants said that reading a news article about civic initiatives taking place in another local community inspired them to join the prosocial movement and launch similar initiatives in their own communities.

Based on the aforementioned attributes of coproduction, we describe how coproduction can serve as an appropriate lens for framing civic disaster relief when a geographically extensive and extraordinarily long-lasting disaster strikes. COVID-19 affected 228 countries [93], whereas the majority of other common disasters, such as hurricanes and earthquakes, are geographically limited to a few regions. As discussed in Section 2.2, the number of “affected” people was significantly higher during COVID-19 compared to previous disasters. Almost everyone was affected in some way, whether it was their mental health due to isolation or overwork, their finances due to unemployment or business closures, or their lack of resources such as PPE. If the number of affected individuals is limited, the conventional support delivery model may be sufficient to describe civic disaster relief; relief producers only provide help, while recipients only get support. However, a crisis like COVID-19, in which nearly everyone requires support, necessitates an alternative model that blurs the boundary between relief providers and recipients. Coproduction dismantles the vertical structure of support providers and recipients and regards every individual as a valuable human resource, regardless of whether or not they are affected by a disaster [63]. It encourages actors involved in the support system to consider how they could contribute to the production of aid and thereby fully mobilize the social capital embedded in the local community [8], resulting in diversified and expanded disaster relief.

Prior studies categorized civic disaster relief volunteers into key contributors and micro-contributors [21, 66, 67]. Key contributors facilitate emergent volunteer networks where micro-contributors undertake small disaster relief tasks. This static hierarchical structure of contributors can clearly inform volunteers of their tasks and whom to contact in specific circumstances, which can be useful in crisis situations where immediate response is a top priority. However, when a disaster lasts for an extended period of time, the sustainability of relief efforts and the commitment of volunteers

become more of a concern. It can be exhausting to be a key contributor for an extended period of time during a disaster that might persist for years. Micro-contributors may also experience boredom while constantly performing the same small tasks they are assigned to. In the context of such a long-lasting disaster, a model like coproduction that retains the flexibility of volunteers' roles may be more appropriate for describing relief efforts. Coproduction stresses that anyone can become an initiator or a joiner of volunteering work. Volunteer activity can be initiated or joined by anybody, and no single individual is endowed with authority or assigned fixed predetermined tasks. Volunteers with fluid roles have a greater sense of ownership over relief activities, redefine their scope of responsibility towards the local community, and are committed to achieving shared goals for a long period [8, 11, 95]. We conclude this section by stating that disaster relief priorities (e.g., immediate or sustainable response) can vary depending on the nature of a disaster. We encourage CI scholars to explore the dynamics involved in the coordination of disaster relief, taking into account the peculiarities of the disaster under investigation.

5.2 Designing to Support Coproductive Disaster Relief

CI research has shown that social media (e.g., Facebook, Twitter) play a significant role in facilitating the spontaneous emergence of voluntary responses to share information and provide tangible assistance [20, 39, 91]. However, volunteer networks that rely heavily on social media are often deactivated and dissolved in the aftermath of disasters [66, 83], making it challenging to learn from past relief efforts. This suggests that while social media is effective in bringing together volunteers, it may not be helpful in transmitting knowledge related to relief practices. Furthermore, technology design for tangible disaster relief lags behind tools suggested for crisis information communication [71]. We fill in these gaps by proposing a socio-technical platform that can mobilize and record tangible disaster relief activities. The subsections introduce its design features that emerged from our findings, which are to facilitate the initiation, development, and sustainability of coproductive disaster relief, respectively.

5.2.1 Designs for the Initiation of Coproductive Disaster Relief. When a disaster strikes, geographic dispersion restricts in-person interactions, making it difficult to initiate relief activities or preventing many of them from being noticed by potential volunteers, resulting in limited cooperation. An open platform that compiles an integrated list of ongoing relief activities can resolve this issue. For instance, as initiators, users can publish a relief activity project with a description of its aims and the required resources or skills, and other users can engage in launched projects as joiners. To ensure that a joiner may also become an initiator, the core attribute of coproduction, the platform can be designed to allow flexibility in redesigning existing activities or to enable joiners to build a project derived from an original one.

The viability of the civic initiatives we interviewed was attributable to a group of people with different skills and resources coming together to do their part to realize a collective goal. This supports the findings from prior CI research that the inclusion of individuals with heterogeneous skills, knowledge, and resources is vital for successful coproduction and disaster relief [16, 42, 66, 72]. Diverse volunteer backgrounds can inspire ingenuity and creativity, which are necessary for managing extraordinary breakdowns [7]. At the onset of a crisis, however, it is hard to identify individuals with certain resources or expertise appropriate for a relief effort [60]. To assist civic disaster relief groups in locating and mobilizing individuals with the appropriate capabilities more promptly, users of the suggested platform can be asked to build a profile detailing their expertise and resources. User profiles with tagged expertise or resources can be used to automatically match and recommend suitable projects for users to join, or to offer relief groups a list of users with relevant capabilities to invite to their relief efforts.

Emergent situations require volunteers to make adaptations to their expertise to make it applicable to unusual disaster contexts [29, 60, 86, 87]. However, a required degree of adaptations can vary by the nature of disasters. For example, White and Palen [90] observed that volunteers successfully evacuated livestock from flooding, which requires an immediate response. In this case, disaster relief was successful because transporting animals is not very different from what volunteers are already familiar with, and thus they were able to make small but quick adaptations. In this study, we noticed that some community members adjusted their skills and resources to manufacture PPE. Compared to flooding or other types of disasters, COVID-19 lasted longer, as did previous epidemics [38]. Therefore, immediate response was less required, and volunteers had more time to make greater adjustments. In our case, disaster relief was successful although volunteers did not have experience similar to making PPE, as they were able to prepare technical and sophisticated relief measures because immediate response was less required.

However, several of our participants did not know whether they were capable of supporting others or how to do so before joining civic initiatives. It was unclear to them how their skills could be adapted for disaster relief. According to Cobb et al. [23], knowing that one's efforts have had a definitive impact is a key motivator for continued volunteering. Recalling that daily updates of our participant's civic initiative helped individuals realize how they could contribute and inspired them to join the initiative, knowing the initiative's impacts may also help to attract new volunteers. By making the improvisational work of individual volunteers more visible, others with similar skills or resources could see how they could help disaster relief and be inspired to join initiatives.

The simultaneous impact of COVID-19 on multiple locations prompted us to see the value in cross-community coproduction of disaster relief. We did not have enough opportunities to see how replications of one relief activity occurred in other local communities due to the fact that common disasters (e.g., hurricanes, floods) affect comparatively fewer locations than an unusual global hazard like a pandemic. The majority of CI research examined how members of a single affected community responded to a disaster or how global volunteer networks converged to assist a single affected community. During COVID-19, however, there were virtually no "unaffected" communities, all requiring some form of relief. We noticed that individuals replicated relief efforts carried out in other communities, which showed the roles of initiators and joiners interchanging across different local communities. Reading online articles about relief efforts in other communities inspired our participants to initiate similar relief in their own communities, emphasizing the importance of documenting relief activities. However, articles were dispersed over multiple channels, which might have made it more time-consuming to identify feasible relief activities for certain concerns. This is an apparent design opportunity for the platform discussed in this work to be not tied to a single community, and let users learn about relief efforts conducted in other local areas. Initiators can illustrate their experience organizing relief efforts and coproduced outputs, with tags indicating the challenges they sought to address (e.g., food insecurity, lack of shelters, PPE shortages), to make it easier for joiners to find viable relief efforts to address similar concerns in their community.

5.2.2 Designs for the Development of Coproductive Disaster Relief. Cross-community coproduction can reinforce cumulative learning, which can result in enhancements to relief efforts beyond their replication. A slot for each relief effort can allow joiners to add branches to describe adjustments made to localize the original relief activity. Other joiners can see branches and understand what localized adjustments were made to make the initiative applicable in various settings. For resources needed for relief efforts, the platform can be structured to allow commons-based peer production, in which individuals "collaborate together to create something, merging their contributions" [4]. Our participant stated that he obtained open-source 3D printed designs for a face shield, made refinements, and republished the improved version online. Such commons-based peer production

enables multiple contributors to incrementally enhance shared commons, and volunteers can expedite the coordination of relief efforts by not having to make a needed resource from scratch.

The proposed platform for sharing disaster relief ideas can not only cross spatial but also temporal boundaries, serving as a repository. Volunteers can observe how others have handled similar crises in the past or utilize already-existing resources. They have often followed a learn-by-doing model to quickly respond to evolving, uncommon crisis situations [56, 58]. Although this approach reduces the amount of time spent considering the potential consequences of actions or selecting the course of action that may offer the best expected outcome [22], some volunteers have found it challenging to effectively coordinate relief activities at the initial stage through trial and error due to a lack of training and experience [91]. They remarked that receiving relevant information on relief activities beforehand might have accelerated their learning process and enabled a more prompt response. The system suggested here might be a solution to this issue, since it preserves the improvisational nature of citizen-based disaster relief while allowing users to forecast the consequences of each relief activity by referencing its previous records.

5.2.3 Designs for the Sustainability of Coproductive Disaster Relief. The platform dedicated to coproductive disaster relief can make an effort that is often hidden more visible [77, 80]. Recognizing relief efforts in their local communities increases collective efficacy, or the belief that they can work together to manage crises successfully [17]. In terms of those performing what was previously invisible work, greater awareness of their efforts can lead to public recognition, instilling them with a sense of social worth as we have observed in our findings. Public recognition, coupled with enhanced reputation, has been identified as a motivating factor for individuals to continue their voluntary relief efforts [23, 31, 66], indicating that the proposed platform can boost continued participation in coproducting disaster relief.

The exchange of gratitude, which is covered in Section 4.3.1, is a unique factor that contributes to the sustainability of disaster relief. When an initiator (in our example, a local grocery store) started acts of gratitude (purchasing meals for grocery workers), a joiner (a local restaurant) participated in practicing gratitude (writing a thank-you note), and another joiner (grocery workers) also engaged in the practice (purchasing meals at the local restaurant), continuing a cycle of prosocial behaviors that coproduced emotional support. Observing disaster relief phenomena without the lens of coproduction can make it easy to overlook this cycle and interpret it as merely support recipients expressing gratitude to support providers. The proposed platform may regularly prompt users to reciprocate gratitude with other users via push notifications, so a loop of prosocial behavior can be generated and the emotional support for volunteers is ensured. This design may tap into multiple volunteer motives, including recognition and reputation and social ties.

5.3 Identifying Less Visible Stakeholders of Coproductive Disaster Relief

While identifying and involving all relevant stakeholders is a key to coproduction, it is easier to engage people who share similar backgrounds than to engage those less alike. For example, during the pandemic, reliance on ICT increased, and those not part of the digital culture were less able to participate in coproduction. Individuals without access to technology or a sufficient level of digital literacy were not able to easily seek help via online channels, or were unaware of support networks due to lack of access to their website or social media. Support networks and those without access to technology might have been invisible to each other. However, those who suffer the most from a disaster could be those who are less likely to access technology [66, 85]. The heavy reliance on ICTs for the coordination of relief activities might have inadvertently created barriers to participate in coproduction for some of the most affected people [75], exacerbating the inequities that made them more vulnerable to disasters. Those involved in coproduction should be wary that increased

similarity among themselves may indicate that the distribution of coproduced outcomes can be restricted to a certain social fabric.

Initiative organizers made efforts to reach out to people on the wrong side of the digital divide. They obtained a list of senior citizens in need of assistance through partnerships with pre-existing local organizations that already had a clear understanding of where the elderly resided and what assistance they needed. Established organizations assisted the initiatives by reducing the time and effort to identify those in need, and the civic initiatives complemented established organizations' efforts to support vulnerable people. This finding corroborates earlier research that revealed that established local groups or a key informant in the community gave a list of victims and their needs to emergent citizen-based relief groups [29, 91]. These overlapping findings emphasize the significance of collaborating with a community-savvy actor for more efficient and at-scale delivery of disaster relief.

Utilizing low-tech (e.g., SMS, local community radios) [26, 46] or non-digital tools (e.g., distributing or posting flyers on community bulletin boards) [29] is another common approach for reaching out to those who lack access to technology. Similarly, we observed that some initiatives provided alternative options for making support requests without using the Internet. They added a phone service or developed a system that allows a digitally literate individual to fill out a support request form on behalf of digitally excluded individuals. However, the suggested solutions cannot fully address the issue of exclusion from coproduction that resulted from the digital divide. For instance, some may not have a friend who can submit a request form on their behalf, or these support networks may be invisible to those without technology, preventing them from utilizing alternative measures.

Presumably because COVID-19 sped up digital transformation in our society, we discovered that some other approaches involved very direct measures to attenuate the digital divide. Some initiatives offered digital devices and training sessions for digitally excluded individuals, which has not been commonly observed in prior disaster scenarios. These measures need long-term preparation, and the emergent civic initiative that executed them made preparations during COVID-19, not prior to the disaster. We can infer that our society was not fully prepared for these direct measures since a global pandemic that accelerates the digital transformation of many facets of our society is not common. We can also assume that making these time-consuming preparations after the outbreak of COVID-19 was possible, given that it was a long-lasting disaster that less required immediate response.

However, our participants said that some people refused to accept donated laptops and they had to persuade them to accept them, indicating that simply offering digital equipment is not a panacea for digital exclusion. Similarly, although digital training is offered, knowledge cannot be automatically "delivered" to those in need unless they are willing to learn. People receiving digital equipment or training have to realize that they are on the wrong side of the digital divide and they will likely be remain to do so if they did not voluntarily engage in accepting it. This is consistent with earlier research, which argued that coproduction requires the reciprocal participation of involved actors [18] and cooperation is contingent on each individual's desire to learn [42].

In our example, the lack of motivation to receive and use technology may have resulted from not fully understanding the benefits technology can bring. Whatever the reason was, understanding why they were averse to receiving digital equipment was vital to accomplish disaster relief. Murthy [59] argues that crisis information collected online can be biased and may not reflect the full scope of a disaster since those most affected are likely to be digitally excluded. Extending this argument, we propose that future research should investigate whether the perspectives of those most affected, who are in the recipient role in the support delivery model, are thoroughly understood when disaster relief is distributed. Without proper comprehension, distributed support may be underutilized or

rejected, preventing relief efforts from being accomplished. Disaster relief can be coproduced not merely via the exchange of artifacts but also once all the stakeholders' viewpoints are holistically understood.

The benefit of including more stakeholders in disaster relief through coproduction is that it expands the pool of individuals who can produce aid and fully mobilize social capital that may be under or not leveraged at present. The support delivery model clearly defines the roles of recipients and providers, based on the notion that those affected by crises merely need protection and assistance. In contrast, the coproduction model considers all involved actors as potential contributors capable of producing aid [63], making disaster relief more synergistic. For instance, the initiative that provides digital equipment and training could become more coproductive by inviting digitally excluded people to join relief activities and become community assets. They can later learn how to run digital training sessions for others that remain to be digitally excluded, or they can browse civic initiatives online and volunteer. A shift away from the lens that sees affected people as recipients toward one that perceives them as potential assets and actively seeking opportunities to involve them as disaster relief coproducers will help the community cope with crises more effectively.

5.4 Limitations

In this study, we report on 13 civic initiatives from the first four months of the COVID-19 pandemic in the United States. We acknowledge that non-U.S.-based localities may have provided different types or levels of civic disaster relief and the number of cases we studied are limited, and therefore we cannot generalize our findings to a global population. However, the aim of this paper is to set a starting point for applying coproduction to interpret citizen-based disaster relief efforts and to see that coproductive disaster relief does happen, rather than to measure how much it does. Future work could explore how other civic initiatives in the U.S. or in non-U.S. locales coproduced relief efforts and their impacts to see if new themes arise.

6 CONCLUSION

In this study, we interviewed organizers and volunteers of civic initiatives for disaster relief from the initial months of the COVID-19 pandemic to understand their online and offline coordination work, how they engaged different stakeholders, and their positive impacts on individuals and local communities. We reflect on our findings to discuss how disaster relief can be more sustainable, extensive, and diverse through the fluid roles of actors in coproduction. Our analysis surfaced design implications for a digital platform that can further enhance collaboration of support networks within and across local communities for creative relief efforts. The lens of coproduction prompts more inclusive relief efforts, by transforming a paradigm that regards vulnerable people as mere support recipients towards one that sees them as potential contributors for producing support. We discovered that the dynamics and impacts of some civic disaster relief during the COVID-19 pandemic were less immediate but more complex than those explored in a lot of prior CI literature. This is because the temporal and geographical dimensions of the pandemic were significantly different from those of more frequent disasters.

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