Co-Designing a Participatory Community Mapping Method for Informal Sheltering in Puerto Rico

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Executive Summary

Overview

A deeper understanding of strategies to improve informal emergency shelter planning and management can be achieved through a participatory action and design research framework. We explored a novel approach of participatory community mapping (or crowdsourcing) in Puerto Rico to be applied under the physical distancing constraints imposed by the COVID-19 pandemic.

Recognizing the resources and capacity limitations of formal disaster management systems, individuals and community-based organizations have filled a vital role in crisis response even before the pandemic. Puerto Rico faces unique risks from climate change, earthquakes, the COVID-19 global pandemic, and the slow recovery from Hurricane Maria. In the face of these cascading disasters, building capacity for community-led disaster planning and management is paramount.

Building on previous disaster research and community engagement projects, we collaborated with residents, community-based organizations (CBOs), and humanitarian aid agencies (thereafter agencies) to co-design the process of gathering data for our study using the cultural probe method to crowdsource information from remote and underserved communities while following the limitations imposed by the

COVID-19 pandemic. The cultural probe is a unique ethnographic research method which uses multiple methods to collect qualitative data on the lived experience of research participants.

Research questions

Key research questions include:

- How have individuals and CBOs been planning and managing emergency shelters, if at all? What challenges do they face in these efforts?
- What are the information needs of CBOs and their constituencies (including vulnerable populations) related to informal sheltering in the study areas?
- Can rich data from cultural probe techniques, including a community mapping exercise, be collected using during a pandemic scenario?
- Can sufficient information be gathered to plan for the location, resources, and management of informal emergency shelters through these approaches?

We seek to identify innovative, effective community mapping approaches to reduce harm with this project, especially for at-risk populations. We also hope this work will improve shelter planning and management, strengthen social connections by increasing community participation, and facilitate collaboration and coordination among stakeholders to achieve disaster management goals.

Research Design

We conducted a series of remote participatory action and design research activities, including key informant interviews, co-design workshops, and pilot tests with our civic partners. This helped identify and test key design opportunities for using the cultural probe method to crowdsource local knowledge for shelter planning and management.

Results

Interviews with CBO representatives showed a strong desire to participate in a collaborative planning process that includes the community members, the government, and the CBOs themselves. A key distinction made between formal and informal shelters depended on the lead-time before a disaster arrived. CBOs see these informal shelters as vital to their community and are not necessarily imagined as a brick-and-mortar structure, but rather as a community hub for sharing and delivering material and social resources. The concept of vulnerable populations brings to mind common population subgroups such as the elderly, those experiencing homelessness, and children, but appears to overlook people with medical conditions and those of all ages with access and functional needs. Finally, cultural probe methodology was supported as an effective means to gather rich information to enhance disaster planning. Participatory action research was also shown to be an appropriate way to design probes for use in limited resource settings.

Conclusions and Implications

Participatory Action Research methods can be a valuable tool for designing cultural probes and for listening and responding to the voice of a community. CBOs serve an even more valuable role as health educators, trusted communicators, and emerging responders to meet the growing needs of communities after compounding crises, particularly in the wake of a threat to infrastructure safety. The cultural probe provides the ability to see a place through the eyes of the community and within the context of a pandemic. It has been effective even though pandemic restrictions required a hands-off approach to the distribution, completion, and analysis of our research materials.

Keywords: ***informal shelters, cultural probe, co-design, community mapping, Puerto Rico***

Introduction

A deeper understanding of strategies to improve informal emergency shelter planning and management can be achieved through a participatory action and design research framework. We explored a novel approach of participatory community mapping (or crowdsourcing) in Puerto Rico that could be

applied under the physical distancing constraints imposed by the COVID-19 pandemic. Formal disaster management systems have limited resources and capacity, so individuals and community-based organizations have filled a vital role in crisis response even before the pandemic. Puerto Rico faces unique risks from climate change, earthquakes, the COVID-19 global pandemic, and the slow recovery from Hurricane Maria. In the face of these cascading disasters, building capacity for community-led disaster planning and management is paramount.

With scarce resources during the pandemic, not all households were able to shelter-in-place for extended periods of time. By building community capacity, some services related to sheltering can be led by local citizens and grassroots organizations. The earthquake swarm of 2019–2020 drove residents out of their homes and many found safety and community at informal shelters rather than formal shelters, which were less desirable to many residents after their experiences during Hurricane Maria.

Building on previous disaster research and community engagement projects, we collaborated with residents, community-based organizations (CBOs), and humanitarian aid agencies (thereafter agencies) to co-design the process of gathering data for our study using the cultural probe method to crowdsource information from remote and underserved communities while following the limitations imposed by the COVID-19 pandemic. The cultural probe is a unique ethnographic research method which uses multiple methods to collect qualitative data on the lived experience of research participants.

We conducted a series of remote participatory action and design research activities, including key informant interviews, co-design workshops, and pilot tests with our civic partners. This helped us identify and test key design opportunities for using the cultural probe method to crowdsource local knowledge for shelter planning and management.

With this project, we seek to identify innovative, effective community mapping approaches, especially for at-risk populations. We also hope this work will improve shelter planning and management, strengthen social connections by increasing community participation, and facilitate collaboration and coordination among stakeholders to achieve disaster management goals.

Literature Review

Cascading Disasters and Emergency Shelters

Disasters continue to grow in frequency and severity and all levels of government are grappling with the limitations of their resources and capacities (FEMA, 2018). The emergency management sector is facing increased pressure to direct responses for co-occurring emergencies on top of complex recovery processes in Puerto Rico. Changing demographic characteristics and technology usage trends make the effects of disasters more complex to manage and engaging and empowering individuals and communities to become a more integral part of disaster management has become undeniably vital (FEMA, 2011; Hore et al., 2020). One of the key areas that will benefit from improved community participation in places like Puerto Rico is emergency shelter planning and management.

In accordance with FEMA's National Response Framework, emergency shelters are planned under Emergency Support Function #6 (ESF-6): Mass Care, Emergency Assistance, Temporary Housing, and Human Services (U.S. Department of Homeland Security, 2019). These services are typically coordinated through state and local emergency management agencies. Often the main responsibilities fall to departments of housing or social services. These agencies take the lead on running and staffing emergency shelters. However, there are various reasons why these shelters are not fully used: distance or transportation limitations, lack of trust in government, inadequate conditions, or people feeling safer in their own communities (Lee & Chen, 2018).

The decentralized nature of emergency management structures in Puerto Rico resulted in disparate management styles, structures, and resources for emergency sheltering. These factors, along with prior lived disaster experience, has left many residents in non-urban areas to take sheltering into their own hands, as a community. This scenario is not the first of its kind post-disaster. After Hurricane Katrina, many faith-based organizations stepped up to provide sheltering services and have often been formally engaged in shelter planning and operations (Pant et al., 2008). Non-profit or Community Based Organizations (CBO) are able to fill resource or service gaps and provide locally appropriate services to a

community. Throughout the COVID-19 pandemic, mutual aid organizations have played a critical role in fillinge these service gaps, particularly for hard to reach populations. Sheltering is not typically a community-led operation. Formal responsibility for providing shelter often belongs to social services, housing, and emergency management agencies, or larger non-profits, such as the American Red Cross. If communities desire to take on this responsibility, they may require guidance to do so safely and effectively to meet the many needs of their community members.

The public health principle of harm reduction, typically applied to injection drug use or alcohol consumption, is founded on an acknowledgement that a population may engage in an activity that is considered risky so it is in the best interest of public health to create the opportunity for these activities to be carried out as safely as possible (e.g., clean needle exchange programs, condom distribution, etc.) (Ezard, 2001). We can apply this principle to emergent sheltering, where during a disaster, communities establish informal shelters to fill a service gap in their locality. By acknowledging the phenomena of these informal shelters emerging until formal options fully meet the needs of a community, it is critical to take a locally coordinated approach to fill a community's need or service gap (Schlegelmilch et al., 2020). This project aims to ensure these informal shelters are not only located appropriately, but that they also have adequate resources to meet the needs of children and other at-risk populations such as the elderly, those with special health care needs, and people with access and functional needs. The idea is that if we are able to take care of the most vulnerable in a community, particularly children, then it will ultimately build the resilience of the whole community.

Community Information and Participatory Research in Disaster Response

Disaster research and accounts from various studies demonstrate the adaptability, innovation, and responsiveness of community groups in the face of crisis where strong social networks and structures are important factors in recovery after disasters (Aldrich & Meyer, 2015; Liboiron, 2015; Whittaker et al., 2015). However, individuals and groups working outside of the official disaster management system have been undervalued by formal institutional structures and arrangements, which has led to the

marginalization of local information and knowledge in disaster risk reduction (Gaillard & Peek 2019). In the context of complex and growing hazards, the understanding of and respect for local knowledge can help agencies improve their disaster management planning; project performance; and acceptance, ownership, and responsibility (Dekens, 2007; Spiekermann et al., 2015). These findings call for a different type of disaster information and knowledge management system that values the time, skill, knowledge, and resources that residents and community groups offer (Gaillard et al., 2019; Wachtendorf et al., 2017). To truly engage and empower individuals and community groups will require the disaster management community to transform their thinking, planning, and practice.

Participatory action research (PAR) seeks to reduce hierarchies between the researcher and participants and focuses research questions on the needs and priorities of communities who are often excluded from decision-making processes. Anecdotally, shelter plans are devised without community input, which creates an opportunity to facilitate such participation. Crucially, knowledge produced by PAR processes are considered valid when it helps to resolve pressing questions in the context of the research location. Thus generalizability is considered to be less important than practicability, and while the results of PAR methods can inform other work in other settings, the knowledge they yield is always understood to be situated and contextual (Greenwood & Levin, 2006; Kemmis et al., 2014). PAR methods have been paired extensively with design research (Greenbaum & Loi, 2012; Hayes, 2011). There is also increasing interest from disaster researchers to ensure that public participation in disaster planning processes is robust and meaningful. This is accomplished by participation in mapping processes where inequities between experts and at-risk or affected communities can lead to local needs and perspectives being left out of formal disaster management processes (Gaillard et al., 2015; Hore et al., 2020; Soden & Palen, 2018).

The constraints imposed by the COVID-19 pandemic, such as physical distancing and uneven and unequal access to electricity and technology, make many standard approaches to facilitating participation in disaster management (such as in-person workshops, design charrettes, or online crowd-sourcing

techniques) impossible at this time. Furthermore, the complexity and context specificity of sheltering decision-making and planning made us concerned that highly constrained methods of data collection, such as surveys via SMS or interactive voice response (IVR), would be note capture the depth of information necessary. To address this problem, we experimented with a design research method known as a cultural probe.

Cultural probes are used by design researchers to collect information about the perspectives, daily lives, and desires of diverse participants (Gaver et al., 1999; Wyeth & Diercke, 2006). Cultural probes take many forms, but they generally consist of packets of paper materials that are mailed or delivered to participants. Depending on the probe, participants may have several days to a few weeks to complete and return the materials. Probes can take many forms. Depending on the research goals, participants may be asked to draw pictures, provide written responses to short prompts, or draw maps or take photos of particular aspects of their environment. In some cases, designers ask participants to produce creative or artistic responses (Gaver et al., 2004). They have been used in diverse design settings, including campus sustainability planning (Davis, 2010), childhood education (Wyeth & Diercke, 2006), and international development (Wyche, 2020). There are significant debates within the design community around the evaluation of probe results, particularly if the findings are used as research methods as opposed to inputs into individual design processes (Boehner et al., 2007). Appendix A presents examples of cultural probes that have been used in other studies. We return to this issue in our section on data analysis. Cultural probes have the ability to capture rich data on the lived experiences of an individual in their environment, so we believe this method provides unique perspectives for understanding how residents perceive the community environment and live their daily lives. It can also help identify the priorities of those who require more specialized services in a shelter.

Methods

Research Questions

In collaboration with civic partners in Puerto Rico, we explored how to effectively deploy cultural probes to enhance informal shelter planning, particular community mapping activities that could enhance informal shelter planning. Building on previous research, community engagements, and existing literature in disaster management research, we use a set of premises to guide our research:

- Effective information and knowledge management is foundational to achieving disaster response and recovery goals.
- Local knowledge is a key component of disaster information and knowledge management, but it is not consistently integrated into formal response mechanisms due to functional, structural, and social barriers.
- Leveraging a community's existing strength and innovation enhances collaboration between individuals, CBOs, and aid agencies to achieve disaster resilience goals.

In this study, we apply PAR and design research approaches to facilitate conversations on the needs and capacities of individuals and CBOs, strengths and weaknesses of existing practices, and opportunities for innovation in designing a new participatory community mapping and data gathering approach. In particular, we aimed to answer the following core research questions that correspond with the three key components of our project:

1. How have individuals and CBOs engaged in the planning and managing of emergency shelters, if at all? What challenges do they face?
2. What are the information needs of CBOs and their constituencies (including vulnerable populations) related to informal sheltering in the study areas?
3. Can rich data from cultural probe techniques, including a community mapping exercise, be collected effectively under pandemic restrictions?

4. Can sufficient information be gathered to plan for the location, resources, and management of informal emergency shelters using these approaches?

These core research questions guided our engagements with our civic partners and residents to co-design and test cultural probe processes for crowdsourcing community information about informal sheltering.

Study Site Description

Located in the northeast Caribbean Sea, Puerto Rico is home to 3.2 million people and exposed to a range of natural hazards, including hurricanes, earthquakes, tsunamis, landslides, subsidence, and flooding (Palm & Hodgson, 1993). In September 2017, two landfalling Category-5 hurricanes, Irma and Maria, caused catastrophic damage to homes and critical infrastructure in Puerto Rico (Segarra, 2017). Before the island had recovered from the hurricanes, Puerto Rico suffered a series of earthquakes at the end of 2019 and start of 2020. Then the COVID-19 global pandemic struck in early 2020 (Ayala et al., 2020). These back-to-back disasters exposed the widening gaps in providing mass care and sheltering for the residents who had been affected and exacerbated by a pre-existing housing crisis (Hinojosa & Meléndez, 2018). The earthquakes forced residents into the streets out of fear and sometimes necessity. It was reminiscent of their experiences during Hurricane Maria (Acevedo & Gutierrez, 2020). Across the island, residents and CBOs provided emergency shelter and mass care (Posada, 2018).

Data, Methods, and Procedures

This project used participatory action and design research methods to help civic partners in Puerto Rico explore the use of cultural probes to gather community information to plan and manage informal emergency shelters under the constraints imposed by the pandemic. The work was rooted in deep community engagement and done in accordance with public health advisories. We conducted virtual primary research, including key informant interviews, cultural probe co-design workshops, and pilot tests, to identify the needs and capacities of stakeholders, co-create design concepts of the cultural probe

package, and evaluate the efficacy of the cultural probes. We carried out the project in five stages, as seen in Figure 1. Activities and timeline summary can be found in Table 1.

Recruiting Participants and Planning Research

With the support of a Puerto Rico-based community liaison and research coordinator, we designed an application process to recruit three partner CBOs. The application included a short written component and interview. It was provided to several CBOs that were refered by experts in Puerto Rico. The selected CBOs represent geographic diversity, demonstrate prior experience working directly with local communities on response and recovery, and serve populations that could benefit from the project.

Each selected partner CBO received a microgrant to support their time, effort, and resources for this study, including the distribution of incentives to the study participants they recruited. Moderate incentives were provided to community members and key informants for their participation in the PAR and design research activities. All research protocols were approved through Columbia University Institutional Review Board (IRB), protocol IRB-AAAT5061. All project staff and CBO partners involved in human subjects research, including recruitment, completed the necessary human subjects research training.

Each of the selected CBOs then recruited a target of eight local residents to participate in the co-design workshops and ten others to complete the cultural probe activity packet. A convenience sample of three target subpopulations were recruited by the CBOs. These populations included caregivers of children, caregivers of the elderly, and the elderly population (65+ years old), all of whom were identified as vulnerable or at-risk by the CBOs. Based on expert referrals, we recruited five humanitarian aid agency representatives who work in functions related to emergency shelter planning and management to complete key informant interviews. Key informant interviews were also conducted with CBO representatives. Throughout the research project, we collaborated with CBO and agency representatives.

Co-Designing Cultural Probes with Partners

After recruiting workshop participants (n=28) and consolidating PAR and design research plans, we conducted key informant interviews (n=7) and facilitated three co-design workshops to inform the probe design. Interviews and co-design workshops were conducted in Spanish and facilitated by Puerto Rican research team members. Two-hour long semi-structured key informant interviews with seven civic partner (CBOs and agencies) representatives gathered in-depth information on their emergency sheltering planning and management processes as well as their relevant information needs. The key informant interview guiding questions are included in Appendix B.

In each community, we worked with CBOs to conduct a virtual two-hour co-design workshop with up to eight residents using the video-conferencing platform Zoom. Throughout these co-design workshops, we used a human-centered design process to guide resident participants to co-create the cultural probe concepts. The general workshop process included discovery and problem definition, ideation and prototyping, concept evaluation, and workshop feedback. The workshops were hosted by one facilitator, one notetaker, and one technology support and time-keeping staff member. The research team went through an iterative process and modified workshop activities based on feedback from previous ones to improve participant experience and research outcomes. The key activities and workshop prompts are included in Appendix C.

Findings from the PAR and design research activities were then used to create the final cultural probe packages to be distributed for pilot testing. Based on workshop recordings and notes, we created virtual Post-it notes using Miro, an online collaborative workspace, and grouped them by themes related to shelter planning and disaster management, disaster experience, social network, skills/resources, food, mental health, communication/information, normalcy/fun, structure/design. Each of the five researchers were given seven votes to pick their top choices, and preference was given to ideas generated by workshop participants. Among the top choices, we combined similar concepts and modified them for clarity. The research team then reviewed the modified concepts using the following criteria, each

receiving a low, medium, and high rating: ease of use for participants, ease of manufacturing, data analysis complexity, ease of distribution/collection, enjoyability, trust-building/community-focused, prioritizing at-risk populations, meeting existing disaster management mandates/protocols, and workshop participant contribution. Finally, based on an evaluation score, estimation of time required for completing the activities, and coverage of key shelter planning and disaster management aspects, we created a cultural probe package consisting of 11 activities and a demographic questionnaire on that covered a range of shelter planning and disaster management functions. The cultural probe package was translated into and administered in Spanish. The co-created cultural probe (in English) used in this study is included in Appendix D.

Distributing Cultural Probes and Collecting Data

The cultural probes were designed to take five to 10 hours to complete over the course of one week. The CBOs distributed and collected the cultural probe packages that consisted of packets of materials and exercises. Each packet included a paper set of activities, disposable camera, pen, colored pencils, and a pencil sharpener. Derived from the PAR and design research findings, the cultural probe packages provided clear guidance for participants to document a range of information on their activities, perspectives, feelings, and motivations relevant to sheltering and mass care in their communities. The participants were able to carry out these activities in their communities and with minimal interference.

Overall, 30 packets were completed (n=30), 10 respondents per community. Participants included 11 males and 19 females. Participant age groups included 18–30 (n=2), 31–49 (n=13), 50–64 (n=8), and 65+ (n=7). Participants by sub-population included caregivers of children (n=8), caregivers of the elderly (n=9), dual caregivers (n=1), and elderly living alone (n=7).

Analyzing Cultural Probe Results

Data from cultural probes is notoriously difficult to interpret in ways that align with the epistemic commitments of other areas of the social sciences because the approach is rooted in design practice and

research (Boehner et al., 2007; Gaver et al., 2004). Gaver, credited for popularizing cultural probes, has noted that they are not meant to deliver "a list of facts" about participants and wondered in 2004 if the data that probes return was "impossible" to evaluate in a manner that would be legible to other disciplines (Gaver et al., 2004). However since the time of writing, cross-traffic between ethnography and design research has increased (Dourish, 2006; Gunn & Donovan, 2016; Suchman, 2011) and probe methodology has been taken up in more practical ways than Gaver initially envisioned (e.g. Celikoglu et al., 2017; Wyeth & Diercke, 2006). Nevertheless, interpretation of probe data remains inherently subjective and requires significant reflexivity (Wyche, 2020).

Our team—composed of a disaster informaticist, a human-centered designer, community psychologist, anthropologist, and a disaster and public health researcher—examined the probe results in a collaborative fashion. Our specific research concerns related to: (a) participants' lived experience during previous disasters; (b) facets of the local context or environment that may support (or hinder) sheltering during storms; and (c) relationships between individuals, CBOs, and other institutions that would impact shelter planning. We considered these sensitizing questions for the process. After reviewing the data individually, we met twice as a group to discuss emergent themes and share representative examples to allow opportunity for further reflection on our analyses. These discussions helped us examine our own assumptions and biases. This was important given each member of the research team's different relationships to, and levels of familiarity with, our study site. At the second meeting we agreed upon an initial set of themes to orient our analysis. Several members of the team drafted thematic memos, which were reviewed and edited by the full team.

Disseminating and Evaluating Results

After data analysis, we disseminated the results to all participants and conducted review sessions with CBO and agency partners to evaluate the effectiveness of the cultural probes for meeting the partners' needs concerning emergency shelter planning and management. Participants in the feedback workshops at the end of the process were given short surveys to complete in order to help evaluate the

value of the findings produced for shelter planning and reflections on the process itself. These findings were summarized by one member of the team along with qualitative data collected during the workshops.

Researcher Positionality, Reciprocity, and Other Ethical Considerations

All research activities were conducted after approval of the Columbia University Institutional Review Board. The data and information collected do not contain personally identifiable information or protected health information. In light of the COVID-19 global pandemic, all research activities were conducted virtually to protect the research team, local collaborators, and research participants. The study design was based on principles of community-based participatory research and, as such, directly involves the and collaborates beneficiary communities in all phases of research. Study findings and final product materials were made available to participants and their communities. All interactions with CBOs and study participants were facilitated in Spanish by a Puerto Rican project community liaison and research coordinator based in Puerto Rico. At least one co-investigator was present at all data collection activities.

Findings

Results

Interviews with CBO representatives show a strong desire to participate in a collaborative planning process that also includes the community members and government agencies. We made an important distinction in our research between formal and informal shelters. Informal shelters tend to be used more often when there is not much lead-time before a disaster arrives. Hurricanes provide much more time to prepare than a no-notice disaster such as an earthquake, which may lead more displaced residents to use informal shelters. CBOs see these informal shelters as vital to their communities and are not necessarily imagined as purely brick-and-mortar structures but rather as a community hub for sharing and delivering social and material resources. Communities also need reliable communication networks to receive accurate and up-to-date information and to communicate the community's needs. Some agencies understand that poor communication does not foster trust with their constituents. The concept of

"vulnerable populations" brings to mind the elderly, the homeless, and children, but appears to overlook the medically fragile and those of all ages with access and functional needs. Finally, we found that cultural probe methodology was an effective means to gather information that could be used to enhance disaster planning. The participatory action research approach was an appropriate way to design probes for use in limited resource settings.

Below, we present initial results from three select probe activities: shelter design, community mapping, and sources of information. Appendix D contains detailed activity instructions.

Shelter Design (Activity 11)

Participants were asked to imagine a hypothetical situation in which relocating to a shelter would be the safest option and then design their ideal shelter. They listed and described the most important elements and services, and made drawings of the shelter considering comfort, safety, and necessary elements. We analyzed the lists and drawings, paying attention to what elements were included, how they were prioritized, the layout and sizing of items, and other details in order to understand the participants' perception of ideal shelters.

Although a few of the participants focused solely on basic necessities such as bathrooms, beds, and food, many of them enhanced the shelter with options for entertainment, collective spaces and activities, accessibility for people with disabilities or special healthcare needs, and educational and cultural components. Some participants emphasized the need for psychosocial support and community activities to buffer the emotional impact and trauma that can result from experiencing a disaster. Others focused on important characteristics related to the context of natural disasters, including weather-resistant structures and reliable water and energy sources. A few participants considered the unique context of the COVID-19 pandemic, including hand-washing stations, special medical equipment, and distancing between beds.

Community Mapping (Activity 10)

To help identify potential locations for shelters, participants were asked to mark, draw, and label the following elements on a blank page (or pages as needed): their home, place(s) they would put a shelter, their route from home to shelter and describe how they would get there, community landmarks or points of interest (schools, government buildings, etc.), areas they would avoid during a disaster, and areas they think are safe during a disaster. The maps were analyzed with a focus on topography, community features, areas to avoid, and our evaluation of how useful the maps are for shelter planning.

Participants who live close to water commonly identified rivers and beaches as topographical features and areas to avoid. Other areas identified as places to avoid included broken infrastructure and areas prone to landslide. The most common community features participants identified included houses (their own and of neighbors and families), businesses (such as local stores known as *colmados*), streets and roads, churches, parks and plazas, sports fields (*canchas)*, schools, parking, and community centers. While some participants identified empty lots as potential shelter locations, many considered churches, schools, and community centers to be ideal shelter locations. Most participants identified key community features around their residence and potential locations for shelters. It's important to note that many of the maps may need additional references, scale, and labeling of streets and landmarks to make them understandable to people from outside their communities.

Trusted Information Sources (Activity 7)

To understand how people obtain trusted information, we asked participants to identify up to four sources of information. We also asked when and how often they go to that source, and if it would be a trustworthy source of information during an emergency.

Among the sources reported, neighbors, family, friends, and other personal contacts (especially those with connections to the government, emergency management and first response, and/or in other leadership positions such as community leaders) were the most common. The other important sources

also include radio, television, newspaper, municipality and emergency management entities, social media (such as Facebook).

Demographic Survey

Several questions were posed to respondents regarding the prior shelter experience and anticipated use. Regarding prior shelter use, 73% (n=22) of respondents have never stayed in a shelter, 17% (n=5) have stayed in a formal government-run shelter, and 10% (n=3) have used an informal shelter. In the event of a major disaster 40% (n=12) would opt to shelter-in-place at their current home, 40% (n=12) would stay with a friend or relative, 16% (n=5) would go to a formal shelter, and 3% (n=1) would stay at an informal shelter. Regarding the future use of shelters, 40% (n=12) said they would prefer to stay in their home, 40% (n=12) stated they would stay with a friend or relative, 17% (n=5) would go to a formal shelter, and 3% (n=1) would use an informal shelter.

Discussion of Findings

Qualitative interviews with community-based organizations (CBOs) revealed their essential but overlooked and undernourished capacity to provide shelter-related services during a crisis. They expressed their desire to be integrated into formal government emergency shelter planning and response efforts and identified their role as a critical link to the needs of their communities regardless of an inherent distrust based on previous disaster experiences. As expected, some CBOs have been assuming responsibility and defining their roles to support community emergency planning since the 2019/2020 earthquakes and Hurricane Maria. These findings suggest the role of these organizations as central actors in a community's resilience to disasters, and that they have a desire to gain capacity, education, and resources to reach the most vulnerable people in a community.

Findings from the co-design workshops and from the cultural probe data show that participants expressed varied ideas on shelter design. Most striking however, was how many participants considered aspects such as community orientation, psychosocial support, accommodations for vulnerable groups

such as nursing mothers or the elderly, and even entertainment as essential elements of shelter planning and design. Such features range far beyond rudimentary views of shelters as simple structures to provide temporary refuge of displaced people for physical security and basic needs. While our participants were not emergency managers, or experts in shelter planning, they have experienced disasters before and have important knowledge about their communities' needs and were therefore able to provide useful feedback to the shelter planning process.

The time and effort needed to evaluate cultural probe results is significant. It also relies on different methods and sensibilities than researchers or planners would draw upon to assess more narrow or quantitative research instruments. CBOs and planners will require some training and resources to use these tools. As described above, our probes were designed provide more interpretive findings that help to expand the design space in which shelter planners work, construct rich understanding of participants' lived experience of thorny and personal concepts like safety, shelter, and danger. It also can illuminate surface issues or other ideas that may be missed through more narrowly targeted research approaches.

This approach was unfamiliar to some members of our research team and collaborators, and so required additional attentiveness and care in both evaluating and communicating the results. Further development of the cultural probe may provide response organizations with a better way to understand the desires of the people who may be in the extreme circumstance of needing shelter when no safer alternative exists. This process will not only help plan for more contextually appropriate shelters but offer an opportunity to build trust between all stakeholders.

CONCLUSIONS

Key Findings

Participatory action research methods to design and deploy cultural probes as a method of community inquiry can be a valuable tool for listening and actively responding to a community. CBOs serve an even more valuable role as health educators, trusted communicators, and emergency responders

to meet the growing needs of communities during compounding crises, particularly in the wake of a threat to infrastructure safety.

Implications for Public Health Practice

Climate change is a public health crisis which is continuing to stress the resources and human capital of disaster response systems. In 2015, an estimated 67% of Americans believed climate change was making disasters more severe, and 40% of Americans were not confident in the government's ability to adequately respond to a major disaster (Petkova et al., 2016). One year after Hurricane Maria, many people in Puerto Rico were still struggling to meet their basic needs. According to a poll, Puerto Ricans saw a failure in the government response to Hurricane Maria at all levels including municipal governments, the Puerto Rican government, and federal agencies, giving negative ratings to President Trump and former Governor Ricardo Rosselló (DiJulio & Muñana, 2018) for their handling of the disaster. There were major concerns about whether authorities would be able to help if another storm hit the island. The majority worried that the government was still not prepared to deal with future hurricanes and believed that most Puerto Ricans were not ready.

Emergency shelters, also known as mass care facilities, provide immediate shelter after a disaster when a person's home or residence is not livable. These temporary shelters provide the community with food, social services, the ability to apply for disaster aid, access disaster case workers, and first aid or medical referrals for specialty care. These shelters are critical to a community's resilience because they buffer the impact of disasters on individuals and households. A well-run shelter that addresses the specialized needs of vulnerable populations requires significant planning and serves a critical public health function—but it is important to note that recovery and response cycles frequently overlap and disaster plans have fallen short of community expectations. Disaster systems, volunteers, formal disaster response agencies, and humanitarian aid organizations in Puerto Rico have been fatigued by multiple disasters.

Community-based participatory research methods connects directly with the value of social capital before and after a disaster (Aldrich & Meyer, 2015; Nakagawa & Shaw, 2004). By involving communities in shelter planning and design we hope to provide an example of a mutually beneficial activity that strengthens the fabric of a community and provides a vital service in a crisis. This process helps locate and identify the most marginalized and at-risk members of a community—including the elderly, medically fragile, people with disabilities, access, and functional needs—who require the assistance of the whole community. This method of data collection may be less familiar to the public health research community, but it could hold promise as a tool for gaining a deeper contextual understanding of affected communities. The role of place in a person's health and well-being is deeply connected to their community—geographic space, cultural fabric, and connectedness (i.e. social capital). The cultural probe provides researchers with the ability to see place through the eyes of the community. It was also effective while pandemic restrictions, such as social distancing, were in place, given the hands-off distribution, completion, and analysis.

Finally, we worked to facilitate collaboration between emerging citizen groups and official disaster management agencies to bridge the planning and communication gap. Organizational, functional, and cultural differences, can make collaboration and communication between key stakeholders challenging. By facilitating partnership building, this project bridges the current gaps among these groups using new ways of information management and sharing.

Dissemination of Findings

The project leads will present all findings and research materials to collaborating community members in a webinar no later than the project end date of October 30, 2021. During this event, we will share the results of the probes with anyone who participated in either the workshops or the cultural probes. The webinar will walk viewers through the participatory action research, design process, and explains the implications of the findings to community organizations and activists in Puerto Rico and

other territories. In addition to this report, the team will draft a paper for peer-reviewed publication to present the novel concepts we have tested and their potential for implementation on a practical level.

Limitations

The exploratory nature of our research serves as a proof of concept, but the design and implementation processes require further analysis. The scalability of this research process, given the resource limitations that CBOs often face, and the constraints of working during a global pandemic are a major concern, but can be addressed with a well-matched research partner and modest funding. These findings may not be generalizable to other communities given its small sample size and how new the research methods are. Furthermore, these results are also not generalizable to all vulnerable populations in Puerto Rico. These limitations may be due to recruitment strategies, the fact that the interactions took place online, or the topography of the selected study areas.

Future Research Directions

Further research is needed to validate the scalability of using cultural probes as a method for integrating community knowledge and information for informal sheltering or other public health issues. Further refinement of this specific probe would be recommended with a more robust examination of how actionable it is for policymakers, emergency planners, and community-based organizations. Implementation science can be used to examine process and feasibility issues. We recommend further exploration of the shelter as a fluid concept using a cultural anthropological approach to determine if alternative disaster shelter models would be used and trusted more .

References

Acevedo, N., & Gutierrez, G. (2020, January 16). Aftershocks rattle Puerto Rico as islanders confront new crisis. *NBC News*. https://www.nbcnews.com/news/latino/displaced-earthquake-puerto-ricans-cope-constant-aftershocks-uncertainty-n1116706

Aldrich, D. P., & Meyer, M. A. (2015). Social Capital and Community Resilience. *American Behavioral Scientist*, *59*(2), 254–269. https://doi.org/10.1177/0002764214550299

Almohamed, A., & Vyas, D. (2016). Vulnerability of displacement: Challenges for integrating refugees and asylum seekers in host communities. *Proceedings of the 28th Australian Conference on Computer-Human Interaction*, 125–134. https://doi.org/10.1145/3010915.3010948

Ayala, E., Mazzei, P., Robles, F., & Garcia, S. E. (2020, August 7). 'Scarier' Than Hurricane Maria: A Deadly Earthquake Terrifies Puerto Rico. *The New York Times*. https://www.nytimes.com/2020/01/07/us/puerto-rico-earthquake.html

Belloni, N., Holmquist, L. E., & Tholander, J. (2009). See you on the subway: Exploring mobile social software. *CHI '09 Extended Abstracts on Human Factors in Computing Systems*, 4543–4548. https://doi.org/10.1145/1520340.1520697

Berkovich, M. (2009). Perspective probe: Many parts add up to a whole perspective. *CHI '09 Extended Abstracts on Human Factors in Computing Systems*, 2945–2954. https://doi.org/10.1145/1520340.1520422

Blythe, M. (2004). Pastiche scenarios. *Interactions*, *11*(5), 51–53. https://doi.org/10.1145/1015530.1015554

Boehner, K., Vertesi, J., Sengers, P., & Dourish, P. (2007). How HCI interprets the probes. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems 2007, CHI 2007*, 1077–1086. https://doi.org/10.1145/1240624.1240789

Bredies, K., Buchmüller, S., & Joost, G. (2008). The gender perspective in cultural probes. *Proceedings of the Tenth Anniversary Conference on Participatory Design 2008*, 146–149.

Burrows, A., Mitchell, V., & Nicolle, C. (2015). Cultural probes and levels of creativity. *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct*, 920–923. https://doi.org/10.1145/2786567.2794302

Celikoglu, O., Ogut, S., & Krippendorff, K. (2017). How Do User Stories Inspire Design? A Study of Cultural Probes. *Design Issues*, *33*(2), 84–98. https://doi.org/10.1162/DESI_a_00441

Davis, J. (2010). Participatory design for sustainable campus living. *Conference on Human Factors in Computing Systems - Proceedings*, 3877–3882. https://dl.acm.org/doi/abs/10.1145/1753846.1754072

Dekens, J. (2007). *Local Knowledge for Disaster Preparedness: A Literature Review*. International Centre for Integrated Mountain Development.

DiJulio, B., & Muñana, C. (2018, September 12). Views and Experiences of Puerto Ricans One Year After Hurricane Maria - Section 2: Moving Forward with Recovery and Continued Need. *The Henry J. Kaiser Family Foundation*. https://www.kff.org/report-section/views-and-experiences-of-puerto-ricans-one-year-after-hurricane-maria-section-2-moving-forward-with-recovery-and-continued-need/

Dourish, P. (2006). Implications for design. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 541–550. https://doi.org/10.1145/1124772.1124855

Ezard, N. (2001). Public health, human rights and the harm reduction paradigm: From risk reduction to vulnerability reduction. *International Journal of Drug Policy*, *12*(3), 207–219. https://doi.org/10.1016/S0955-3959(01)00093-7

FEMA. (2011). *A Whole Community Approach to Emergency Management: Principles, Themes, and Pathways for Action*.

FEMA. (2018). *2017 Hurricane Season FEMA After-Action Report*. Federal Emergency Management

Agency. https://www.hsdl.org/?abstract&did=
Gaillard, J. C., Cadag, J. R. D., & Rampengan, M. M. F. (2019). People's capacities in facing hazards and disasters: An overview. *Natural Hazards*, *95*(3), 863–876. https://doi.org/10.1007/s11069-018-3519-1
Gaillard, J. C., Hore, K., & Cadag, J. R. D. (2015). Participatory mapping for disaster risk reduction: A review. *The Globe*, *76*, 31–39.
Gaver, W., Boucher, A., Pennington, S., & Walker, B. (2004). Cultural probes and the value of uncertainty. *Interactions - Funology*, *11*(5), 53–56.
Gaver, W., Dunne, A., & Pacenti, E. (1999). Design: Cultural probes. *INTR*. https://doi.org/10.1145/291224.291235
Graham, C., Rouncefield, M., Gibbs, M., Vetere, F., & Cheverst, K. (2007). How probes work. *Proceedings of the 19th Australasian Conference on Computer-Human Interaction: Entertaining User Interfaces*, 29–37. https://doi.org/10.1145/1324892.1324899
Greenbaum, J., & Loi, D. (2012). Participation, the camel and the elephant of design: An introduction. *CoDesign*, *8*(2–3), 81–85. https://doi.org/10.1080/15710882.2012.690232
Greenwood, D. J., & Levin, M. (2006). *Introduction to Action Research* (2nd ed.). SAGE Publications Ltd. https://us.sagepub.com/en-us/nam/introduction-to-action-research/book227935
Gunn, W., & Donovan, J. (2016). *Design and Anthropology*. Routledge.
Halpern, M. K., Erickson, I., Forlano, L., & Gay, G. K. (2013). Designing collaboration: Comparing cases exploring cultural probes as boundary-negotiating objects. *Proceedings of the 2013 Conference on Computer Supported Cooperative Work*, 1093–1102. https://doi.org/10.1145/2441776.2441900
Hayes, G. R. (2011). The relationship of action research to human-computer interaction. *ACM Transactions on Computer-Human Interaction*, *18*(3), 15:1-15:20. https://doi.org/10.1145/1993060.1993065
Hinojosa, J., & Meléndez, E. (2018). *The Housing Crisis in Puerto Rico and the Impact of Hurricane Maria | Centro de Estudios Puertorriqueños*. https://centropr.hunter.cuny.edu/research/data-center/research-briefs/housing-crisis-puerto-rico-and-impact-hurricane-maria
Hore, K., Gaillard, J. C., Davies, T., & Kearns, R. (2020). People's Participation in Disaster-Risk Reduction: Recentering Power. *Natural Hazards Review*, *21*(2), 04020009. https://doi.org/10.1061/(ASCE)NH.1527-6996.0000353
Kemmis, S., McTaggart, R., & Nixon, R. (2014). *The Action Research Planner: Doing Critical Participatory Action Research*. Springer Singapore. https://doi.org/10.1007/978-981-4560-67-2
Lee, H.-C., & Chen, H. (2018). Social determinants in choice of shelter: An evidence-based analysis. *Natural Hazards: Journal of the International Society for the Prevention and Mitigation of Natural Hazards*, *93*(3), 1277–1294.
Liboiron, M. (2015). Disaster Data, Data Activism: Grassroots Responses to Representations of Superstorm Sandy. In D. Negra & J. Leyda (Eds.), *Extreme Weather and Global Media.* Routledge.
Mols, I., Hoven, E. van den, & Eggen, B. (2014). Making memories: A cultural probe study into the remembering of everyday life. *Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational*, 256–265. https://doi.org/10.1145/2639189.2639209
Nakagawa, Y., & Shaw, R. (2004). Social Capital: A Missing Link to Disaster Recovery. *International Journal of Mass Emergencies and Disasters*, *22*(1), 5–34.
Palm, R., & Hodgson, M. (1993). Natural Hazards in Puerto Rico. *Geosciences Faculty Publications*. https://scholarworks.gsu.edu/geosciences_facpub/6
Pant, A. T., Kirsch, T. D., Subbarao, I. R., Hsieh, Y.-H., & Vu, A. (2008). Faith-based organizations and sustainable sheltering operations in Mississippi after Hurricane Katrina: Implications for informal network utilization. *Prehospital and Disaster Medicine*, *23*(1), 48–54; discussion 55-56. https://doi.org/10.1017/s1049023x00005550
Pantidi, N., Selinas, P., Flintham, M., Baurley, S., & Rodden, T. (2017). Bread stories: Understanding the

drivers of bread consumption for digital food customisation. *Proceedings of the 29th Australian Conference on Computer-Human Interaction*, 152–161. https://doi.org/10.1145/3152771.3152788

Petkova, E. P., Schlegelmilch, J., Sury, J., Chandler, T. E., Duran Herrera, C., Bhaskar, S., Sehnert, E. M., Martinez, S., Marx, S. M., & Redlener, I. E. (2016). *The American Preparedness Project: Where the US Public Stands in 2015*. https://doi.org/10.7916/D84Q7TZN

Posada, T. W. (2018, July 5). *Brigades in Action: Puerto Ricans Attempt to Recover from Hurricane Maria*. Pulitzer Center. https://pulitzercenter.org/projects/brigades-action-puerto-ricans-attempt-recover-hurricane-maria

Schlegelmilch, J., Sury, J., Brooks, J., & Chandler, T. (2020). A Philanthropic Approach to Supporting Emergent Disaster Response and Recovery. *Disaster Medicine and Public Health Preparedness*, *14*(1), 158–160. https://doi.org/10.1017/dmp.2019.97

Segarra, L. M. (2017). *Hurricane Maria Made Landfall in Yabucoa, Puerto Rico*. https://time.com/4949664/hurricane-maria-yabucoa-puerto-rico-map/

Soden, R., & Palen, L. (2018). Informating Crisis: Expanding Critical Perspectives in Crisis Informatics. *Proceedings of the ACM on Human-Computer Interaction*, *2*(CSCW), 162:1-162:22. https://doi.org/10.1145/3274431

Spiekermann, R., Kienberger, S., Norton, J., Briones, F., & Weichselgartner, J. (2015). The Disaster-Knowledge Matrix – Reframing and evaluating the knowledge challenges in disaster risk reduction. *International Journal of Disaster Risk Reduction*, *13*, 96–108. https://doi.org/10.1016/j.ijdrr.2015.05.002

Suchman, L. (2011). Anthropological Relocations and the Limits of Design. *Annual Review of Anthropology*, *40*(1), 1–18. https://doi.org/10.1146/annurev.anthro.041608.105640

U.S. Department of Homeland Security. (2019). *National Response Framework, Fourth Edition*. US Department of Homeland Security.

Wachtendorf, T., Kendra, J., & DeYoung, S. (2017). Community Innovation and Disasters. In H. Rodríguez, W. Donner, & J. Trainor (Eds.), *Handbook of Disaster Research* (pp. 387–410). https://doi.org/10.1007/978-3-319-63254-4_19

Whittaker, J., McLennan, B., & Handmer, J. (2015). A review of informal volunteerism in emergencies and disasters: Definition, opportunities and challenges. *International Journal of Disaster Risk Reduction*, *13*, 358–368. https://doi.org/10.1016/j.ijdrr.2015.07.010

Wyche, S. (2020). Using Cultural Probes in HCI4D/ICTD: A Design Case Study from Bungoma, Kenya. *Proceedings of the ACM on Human-Computer Interaction*, *4*(CSCW1), 063:1-063:23. https://doi.org/10.1145/3392873

Wyche, S. (2019). Using Cultural Probes In New Contexts: Exploring the Benefits of Probes in HCI4D/ICTD. *Conference Companion Publication of the 2019 on Computer Supported Cooperative Work and Social Computing*, 423–427. https://doi.org/10.1145/3311957.3359454

Wyeth, P., & Diercke, C. (2006). Designing cultural probes for children. *Proceedings of the 18th Australia Conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments*, 385–388. https://doi.org/10.1145/1228175.1228252

Tables and Figures

Figure 1. Research Activities and Procedures

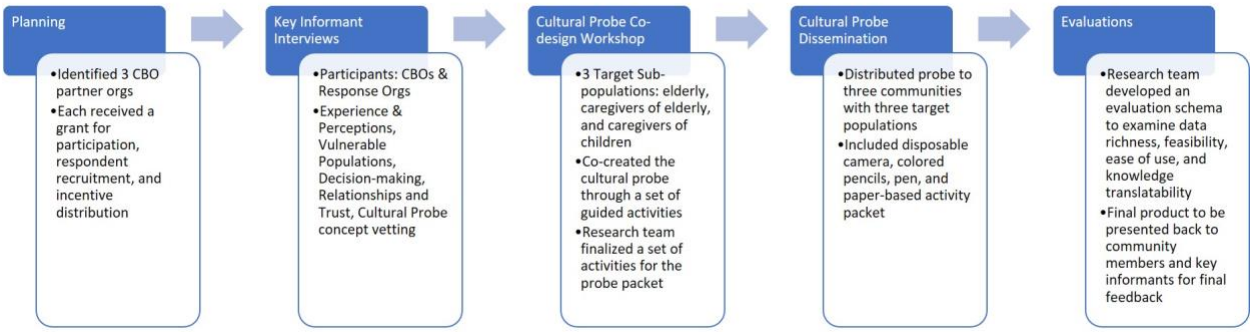

Table 1. Participatory Action Research Objectives and Activities

Objective	Activities
Recruit participants and plan research	• Recruit three CBO and five agency civic partners to co-create research plans • Recruit eight resident participants from each of the three communities for co-design workshops • Recruit 10 resident participants from each of the three communities for cultural probes
Co-design cultural probes with partners	• Conduct one key informant interview with each one of the five agencies • Conduct one key informant interview and one co-design workshops to co-design cultural probe prototypes in each of the three communities
Distribute cultural probes and collect data	Distribute cultural probes to 10 participants across three communities and retrieve after one week
Analyze cultural probe results	Analyze data collected via cultural probes in partnership with CBO and agency partners
Disseminate and evaluate results	Disseminate and evaluate cultural probe results with research participants

Appendix A. Examples of Cultural Probes

Cultural Probe Examples	Citation
● Postcards ○ Pre-addressed and stamped for return (to researchers) ○ Images on front ○ Questions on back with questions that elicited info about the attitudes participants held ○ Used in order to approach the questions in a causal way ● Maps ○ Used to gauge attitudes about participant's environment ○ Questions which prompted participants to mark certain locations with stickers (e.g. Where have you been? Where would you go to do X?) ○ Printed on textured papers to emphasize individuality ● Disposable camera ○ Prompts for photos listed on the back of the camera packaging ○ Unassigned photos used for "whatever they wanted to show us" ● Photo album ○ Use photos (from their life) to tell a story ● Media Diary (records made for a week) ○ Record TV, radio use—what they watched, with who, when ○ Record incoming/outgoing calls—who, when, subject of call	(Gaver et al., 1999)
● Disposable camera ○ Labelled with requests for particular pictures ○ Prompted people to take pictures of their home that they normally would not have ● Friends and family map ○ Diagramming their relationships with others ○ Provided a visual framework to encourage participants to see relations in new ways ● Dream recorder ○ Digital memo maker repacked with instructions to use when waking up from a vivid dream (10 seconds to record, no deleting, reviewing, or editing)	(Blythe, 2004)
● Collage ○ Asked children to collect and paste pictures of "technology that looks fun" from the internet, magazines, newspapers, or other media. ● Subject Ratings ○ Allowed children to rate subject areas (for example reading, mathematics, art and music) on two scales: enjoyment and ease. ● Classroom Architect ○ Required children to draw a picture of their current classroom and a picture of a classroom of the future. ● Technology Gadget Design	(Wyeth & Diercke, 2006)

○ Asked children to design and describe their own gadget to assist with learning at school. ● Brainstorming Bubbles ○ Asked children questions such as: What makes science interesting? What makes science boring? How could I make science more interesting? ● Excursion Day Plan ○ Allowed children to plan an excursion as an alternative to their next mathematics lesson. ● Science Toy ○ Asked children to create a new science toy that would help them to understand their science homework. ● Open ended writing prompt ○ When I grow up... ○ Required children to describe the work they would like to do when they grew up. ● Journal ○ Allowed children to record their thoughts, ideas and memories from school in text and in pictures.	
● Capture artifacts ○ a repackaged digital memo-taker enabling participants to describe a vivid dream upon waking ○ stickers of cartoon faces and other illustrations to support humorous, emotional responses ○ Polaroid cameras for taking photos of participants' own rooms, friends, visitors and other 'important' things; hand-written addressed and stamped postcards ○ a messaging technology allowing logging of communication using digital Post It notes ● (Auto)-biographical accounts ● Making the invisible, visible ○ taking a photograph ○ writing something in a diary ○ speaking into a Dictaphone ○ scrapbook ● Participant as expert ● Dialogue and conversation	(Graham et al., 2007)
● Prompt card ○ "Capture your day" ○ No other prompts given, meant to have them discuss the mundane events in their life ● Dictionary exercise ● Notebook ● Exercise cards on: ○ People ○ Rituals ○ Small things ○ Repetition	(Mols et al., 2014)

○ Media creation ● USB stick ● CD ● Pedestal for a 'museum' ● Photo folder and exercise cards on missing media	
● Map ○ A map with colored self-adhesive dots and picto-grams to visualize one's social network (friends, family, and colleagues) and preferable ways of communicating with each person. ● Telephone diary ○ A journal of communication partners, the form of communication and the associated thoughts and moods ● A disposable camera ○ Initial instructions what to take pictures of (e.g., 'the favourite place to be', 'the tele- phone's place', 'the pet') ● Postcards ○ Providing open-ended questions about mobile phones (e.g., 'how would you call your mobile phone by name?'). ● Bag ○ To collect olfactory and sensual probes. ● Material examples (rubber, fabric, metal, and paper) ○ For inspiration and as raw material for collages. ● Blank notebook ○ For drawings, collages, to collect things	(Bredies et al., 2008)
● "DRAW YOUR FINANCIAL LIFE." ○ Research question: What items comprise their financial life? What tools do they use? ○ Activity: Participants were given an 11x17 piece of paper and instructed to draw the important items, tools, and flows that make up their financial lives. (Similar to the method that Adams described) ● "LETTER FROM THE FUTURE" ○ Research question: What are people's financial goals? ○ Activity: Participants were asked to write a letter to their present selves from their future self who had accomplished their financial goals, telling them what they've achieved and how they got there. ● "PORTFOLIO DEFINITION" ○ Research question: What is included or excluded from their portfolio? ○ Activity: Participants completed a dictionary definition based on their own view of what a portfolio was. ● "GUIDED TOUR OF YOUR PORTFOLIO" ○ Research question: How do they currently use their online portfolio? ○ Activity: Participants filled a museum tour booklet of their portfolio and took photos of highlights on the tour. They covered private information with the provided sticky notes.	(Berkovich, 2009)

● "TEAMS OF INVESTMENTS" ○ Research question: What categories are important in their investments? ○ Activity: Participants completed a booklet of "teams" (groups) of investments that they had in their portfolios. They named each team and listed its members. ● "PORTFOLIO REPORT CARD" ○ Research question: How do they evaluate their portfolios? ○ Activity: Participants listed "subjects" on which to evaluate their portfolio and then graded it. ● ACTIVITY 7: "PHOTO CHECKLIST" ○ Research question: What else is important? ○ Activity: Participants were given a checklist of open-ended items to take pictures of to show their environment—such as where they keep track of investments, good sources of information about investing, etc.	
● Pictures taken by participants on phones ○ Given prompts as to what to capture ○ Something good during their journey ○ Something unexpected ○ Something that makes the journey shorter ○ Unique, annoying ○ Something to be changed ○ Something of their choice	(Belloni et al., 2009)
● The Sustainability Diary ○ Directs participants to record green acts they are proud of and things they wish they had done differently. ● Several cards with questions and images ○ Intended to provoke visual or metaphorical thinking ● Cards offering "three wishes" for new tech for EcoHouse ● Disposable camera ○ Photo prompts such as "something green" and "a guilty pleasure" ● House floor plans ○ Annotate	(Davis, 2010)
● Image "Tweets" ○ Take a picture of something that represents a certain hashtag e.g. #family, #opportunity, #culture ● Describe the community ○ "As you walk around the neighborhood, tweet a list of words that describe the kind of community you see" ○ Tweet a description of the character of the community with the hashtag	(Halpern et al., 2013)

● Postcards ○ "tell me" prompt ○ "what do you associate with certain terms?" ● Social map ○ Six activities of daily living—some needed to involve technology, others could be facilitated by technology ○ Looked to see what activities were shared with other people, and who those people were ○ Participants placed stickers farther or closer to "them" on the map depending on how "involved" the other person was in the activity ● Disposable camera ○ Given prompts for what photos to take (abstract) ● Story prompts ○ "Remember when" story prompts meant to have participants provide a recount of when they were in certain situations	(Burrows et al., 2015)
● Photo elicitation book ○ With a set of photos and questions related to them ○ This was done to elicit experiences pertaining to certain life events such as the boat journey (during immigration to AUS) ● Disposable camera ○ Instructions to take photos of specific objects, places and situations. ● Logbook ○ to record daily activities and communications with friends and family members and their reaction after these communications. ● Sketchbook ○ To draw a design idea that will help their existing situation. ● Map of the city ○ To highlight important areas of personal and social significance, with colored stickers. ● Audio recorder ○ For participants to express their feelings complementing any of the other material.	(Almohamed & Vyas, 2016)
● Digital camera ○ Prompted to take photos during the week of different things related to bread ● Photo journal ○ Prompted to write about each photo they took in the journal ○ Stickers to show frequency ○ Coloring pencils (for fun) ● Set of postcards ○ Prompted to draw or write a response to the questions on the postcard ● Deck of cards ○ Free association card game ○ five question cards, 29 images	(Pantidi et al., 2017).

● Comment cards ○ Open ended prompts/questions ○ Instructed to write a response on the card ● Digital camera ○ Prompted to take photographs of certain things	(Wyche, 2020, 2019)

Appendix B. Key Informant Interview Guiding Questions

1. Community-Based Organizations

1.1 Experience & Perceptions

- What do emergency shelters mean to you? (Not to be confused with homeless or women's/family shelters.)
- Please describe your most recent experiences managing or supporting emergency shelters: the event, location, stakeholders involved, and general process. This may also include providing goods, services such as food or case management, or any other support.
- Under what conditions informal shelters pop up? Who manages and uses them? What challenges do they face? When do people use informal vs. formal shelters? Where do they get the materials (i.e. construction materials, etc.) and resources?
- In the case that your organization has not had experience in planning and managing informal shelters, but have observed the need for them, what considerations should you have for their implementation and their effectiveness? Are they important? If so, why? Would they fill a need in the community?

1.2 Vulnerable Populations

- Who are the most vulnerable populations? In other words, who in the community you serve does not have equitable access to resources or assistance after a disaster? What are their needs? What measures are in place to care for vulnerable populations, before, during and after? (transportation, communication, relationship/trust building)

1.3 Decision making & information

- What were the key considerations/decisions you had to make in planning and managing emergency shelters? (location, supplies, etc.) If you have not managed a shelter, what information

would you need to open one? What services would you provide? What will be the greatest needs of your community?

- What types of protocols are already in place? How were they developed and who are the key individual, organizational, and agency leaders/decision-makers? Who would you look to for guidance? How were decisions made? Who participated?
- What types of information do you [or the groups that co-manage the shelters together] need to make these decisions? Where do you currently obtain such information? What challenges do you experience in accessing or using the information? For community leaders to support the vulnerable populations, what information would they need to do their part?

1.4 Relationships & Trust

- What is your/your institution's relationship with informal emergency shelters? Do you see your organization playing an important role in providing community shelters or assisting in their operation? Other entities? Especially when gov is not providing adequate support?
- What do you need in order to play/grow into the role you'd like to be part of supporting your communities in managing shelters and building resilience?
- Could you tell us a bit about the institutional responses or the government's capacity to offer support in emergency situations that require sheltering management? Which organizations are the most important in managing shelters in a disaster setting?
- What suggestions do you have in regards to improving informal emergency shelters?

1.5 Feedback on Cultural Probe

- How do you feel about cultural probes as a way to rapidly collect rich information about your community members and their needs?
- Do you foresee any challenges in distributing cultural probes and collecting the data?

- Would the government or other stakeholders be interested in getting information from this form? What are the barriers you may foresee?
- Would the residents have concerns about sharing their information? What types of concerns? Why?

2. Humanitarian Aid Agencies

2.1 Experience & Perceptions

- What does emergency shelters mean to you or the agency you represent? (Not to be confused with homeless or women's/family shelters.)
- Please describe the agency's most recent experiences managing or supporting emergency shelters: the event, location, stakeholders involved, and general process. This may also include providing goods, services such as food or case management, or any other support.
- What do you see your agency's role in providing sheltering services in relation to other organizations and government agencies? How do you relate to each other?
- What are the gaps & challenges facing your organization or other institutional/government agencies in their capacity in providing sheltering services? What are the underlying causes for these challenges?
- Under what conditions informal shelters pop up? What is your/your institution's relationship with informal emergency shelters? Do you see your organization playing an important role in providing community shelters or assisting in their operation?

2.2 Vulnerable populations

- Who are the most vulnerable populations? In other words, who in the community you serve does not have equitable access to resources or assistance after a disaster? What are their needs (e.g.

transportation, communication, relationship/trust building)? What measures are in place to care for vulnerable populations, before, during and after?

2.3 Decision making & information

- What were the key considerations/decisions you had to make in planning and managing emergency shelters (i.e. location, supplies, etc.) What types of protocols are already in place? How were they developed and who are the key individual, organizational, and agency leaders/decision-makers? Who would you look to for guidance?
- What types of information do you need to make these decisions? Where do you currently obtain such information? What challenges do you experience in accessing or using the information?
- What is the role of communities & residents in sheltering planning and management? In what way do you work with them?
- If you had resources to make improvements to the current situation, what would you change?
- What types of information do you receive from communities? How do you integrate community information in your decision making process? What are the barriers to integrating community information into your agency's work process?

2.4 Feedback on Cultural Probe

- How do you feel about cultural probes as a way to rapidly collect rich information about community members and their needs?
- Would the government or other stakeholders be interested in getting information from this form? What are the barriers you may foresee?
- Would the residents have concerns about sharing their information? What types of concerns? Why?

Appendix C. Co-Design Activities and Prompts

1. Set the Stage

1.1 Welcome & Introductions

- My name is…
- I am from … community
- I live with … and take care of …
- In today's workshop, I'd like to …

1.2 Workshop Purpose, Process, and Ground Rules

- Introduction to workshop objectives
- What are cultural probes and examples
- Workshop process: explore, identify, ideate, create, and evaluate
- Ground rules (based on IDEO U 7 Simple Rules of Brainstorming): Defer Judgment; Encourage Wild Ideas; Build on the Ideas of Others; Stay Focused on the Topic; One Conversation at a Time; Be Visual; Go for Quantity

2. Explore

- What comes to mind when we talk about shelter?
- Imagine that you are a planner in charge of planning a shelter for your community, how does the ideal shelter look like?

3. Identify

- What are the most important aspects of shelter design?

4. Ideate

- If you are a planner to improve shelters, you will need information and understand people's experiences and needs. Using cultural probe (*paquete de actividades*), what type of information

would you need to obtain in order to improve the important aspects of shelter design (identified in previous activity)? How would you obtain the information?

5. Feedback and Evaluate

- Who should have access to the information collected through cultural probe?
- How should the information be shared and used?
- What challenges, doubts or concerns do you have in relation to this method?

Appendix D. Cultural Probe Package and Sample Responses

Cultural Probe Pilot Activity Instructions

Demographics

Please tell us a little bit about yourself. Please circle the best answer.

1) Age Group
    - 18–30
    - 31–49
    - 50–64
    - 65 and above
2) Gender
    - Male
    - Female
    - Other: _____
3) Population (select all that apply)
    - Elderly - living alone or with another elderly family member
    - Caregiver of an elderly person
    - Caregiver of a child
4) Recruiting CBO
    - Surcando La Historia
    - Programa REDES
    - Ponce NHS
5) Have you ever stayed in an emergency shelter?
    - Yes, an informal shelter
    - Yes, a formal government shelter

- No, I have never stay in a shelter

6) In the event of a major disaster or emergency, which of the following would be your first choice to evacuate to? Use the space below to explain why that would be your first choice.
    - Formal shelter
    - Informal shelter
    - Stay at your home
    - Stay with a friend or relative
        - Explanation: _____

Cultural Probe Activities

Activity 1: Your Super Powers and Resources

Everyone can play a part in supporting each other during an emergency. Share a few of your super powers and up to 5 resources that you could share with your community when a disaster happens. Some examples include: Super powers: cooking, driving, construction, design, planning, DJ, arts / performance, etc. Resources: generator, car, extra space or empty building, water, food, etc.

Activity 2: Your Social Network

When disasters or emergencies happen, people from your community may have the right skills, resources, and information to help each other survive and recover. Thinking of your own social network, please map up to ten (10) of the most important individuals or organizations that play an important role in assisting your community. This may include caregivers, information sources, critical resources, etc. They can be family, friends, your job or church, or other acquaintances. List their relation to you and describe how they could be helpful for you or your community in the face of a disaster.

Activity 3: Words of Support

Please write a note of support to someone who may be experiencing a difficult situation in life. Share up to four (4) tips that you find helpful when facing challenging situations.

Activity 4: Care Routine

If you are the caretaker for a child or an elderly person, design a “routine board” that outlines a “care routine” or care plan. Include specific needs of the person for which you are caring. This plan should aim to provide the best care and comfort to your loved one during an emergency, especially if you they are displaced from their home. Feel free to search for “routine board” ideas on the internet and adapt it to represent daily activities.

If you are an elderly person who does not have a caregiver, please create a route board which captures your typical day and describes your routine which help ensure you are safe, healthy, and happy.

Some activities you may want to consider include medications, school, meeting with friends and family, mental health support, hygiene, transportation, food, and any other part of a day you consider important.

Activity 5: Go-Bag Emergency Items

If you had to leave your house to stay at a shelter during a disaster, what are the key items you want to bring for yourself and those you care for? Take pictures of those items and add explanations of why they’re important. See page 2 for instructions on using the camera.

Activity 6: Design a Food Menu

Design a menu for yourself, your family, and close friends. Imagine that you are meeting to celebrate a special occasion and that you will be together from morning to night. Adults, children and the elderly are coming. What are your guests' dietary preferences or restrictions? What foods

or dishes would you prepare? If there is a lot of variability between the people in your family and friends, design two options per plate to meet the needs and preferences of as many guests as possible.

Activity 7: Trusted Information & Sources

Where do you go for information? List up to four (4) sources, from the media or your social networks that are most important for staying up to date on news, events, and latest details about what is going on in the community. When and how often do you go to that source? Would this be a trustworthy source of information in a disaster? In each box, write one source, the kind of information you get from the source, when and how you access it, and if you consider it trustworthy in an emergency and why.

Activity 8: Write a Story or Memory

The goal of this activity is to learn more about your prior experiences during a disaster. Choose between writing a short story or making a short personal account about a disaster or emergency that most impacted you, the greatest challenges or difficulties you faced, how you adapted to the circumstances.Describe the lessons you learned why that experience would be valuable to share with others. Illustrate your story and write your story on the following pages.

Activity 9: Where do you feel safe?

Identify three (3) places around your neighborhood or community that you consider safe during an emergency. Take a photo of each place. Include the photo number and a short explanation of why the place makes you feel safe. See page 2 for instructions on using the camera.

Activity 10: Community Map

Using a pen and/or colored pencils draw a community map(s) in the space provided on the next two pages. Clearly mark, draw, and label the following items to the best of your ability. The map does not need to be perfect! Include::

- Your home;
- Place(s) you would put a shelter;
- Your route from home to shelter and describe how you would get there;
- Community landmarks or points of interest (schools, govt buildings, etc);
- Areas that you would avoid during a disaster.
- Areas you think are safe during a disaster.

If you use symbols, please provide a legend. You may create multiple maps as needed.

Activity 11: Design Your Ideal Shelter

In this activity, please take a moment to think about the most ideal emergency shelter you can imagine. It may be that you would not like to go to a shelter, but for this exercise imagine it is the safest place for you to be for a temporary time.

Part 1: List and/or describe features or services you think would be important in a shelter.

Part 2: Use the next page to draw out each shelter component or service you think would be important to ensure your comfort and safety with special consideration given to your specific needs, or those of whom you are caring.

Some considerations for your shelter design may include indoor vs. outdoor space, whether or not you plan on spending the night, specific medical needs, personal hygiene, and anything else about the environment or setting of the shelter you think is important.

2. Cultural Probe Pilot Example Responses

Figure D-1. Response on community mapping (Activity 10).

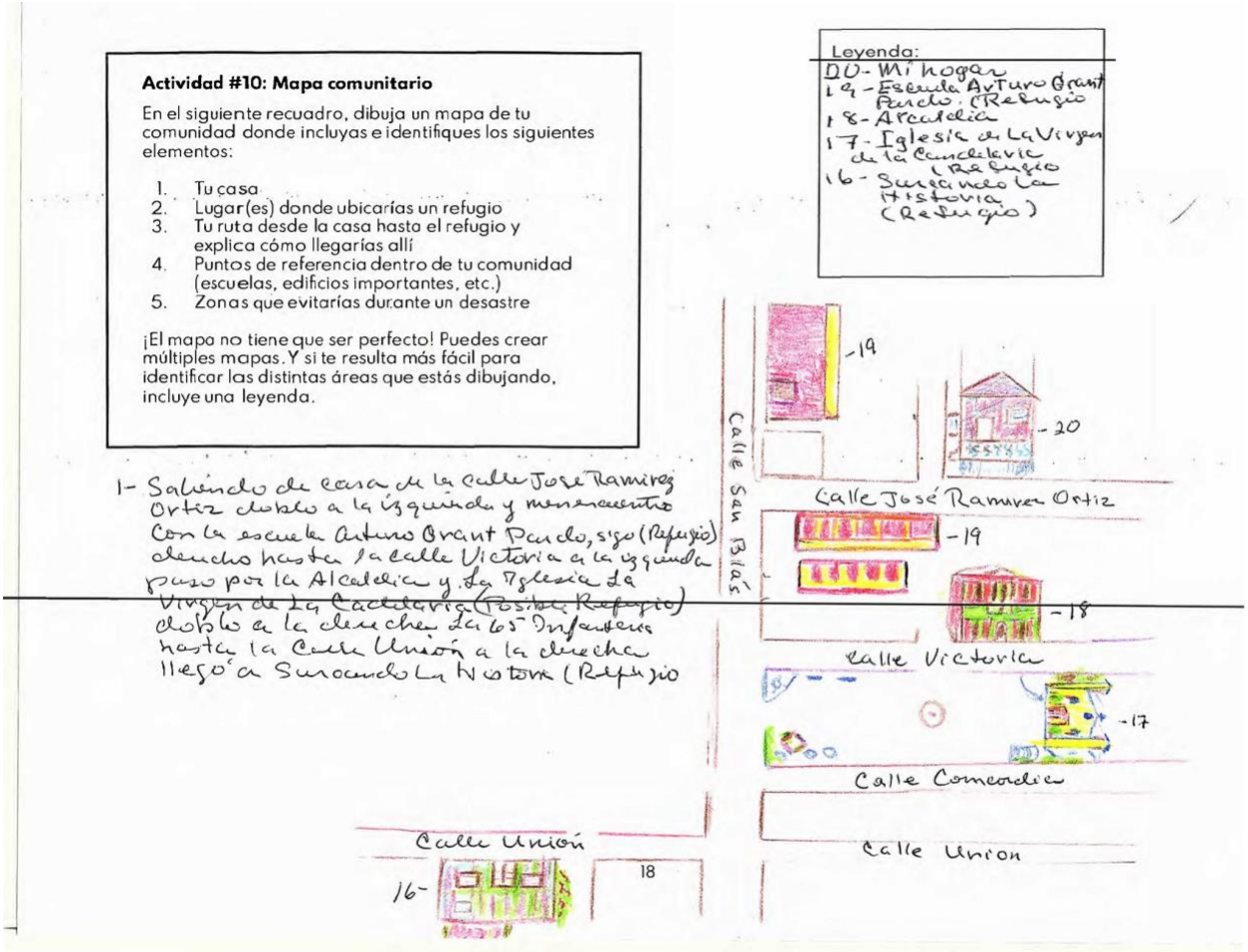

Figure D-2. Response on shelter design (Activity 11).