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Co-Design Smart Disaster Management Systems with Indigenous Communities

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Tribal governments bear an uneven burden in the face of escalating disaster risks, climate change, and environmental degradation, primarily due to their deeply entrenched ties to the environment and its resources. Regrettably, accessing vital information and evidence to secure adequate funding or support poses difficulties for enrolled tribal members and their lands. In response to these challenges, this article collaborates with tribal nations to co-design intelligent disaster management systems using AI chatbots and drone technologies. The primary objective is to explore how tribal governments perceive and experience these emerging technologies in the realm of disaster reporting practices. This article presents participatory design studies. First, we interviewed seasoned first-line emergency managers and hosted an in-person design workshop to introduce the *Emergency Reporter* chatbot. Second, we organized a follow-up design workshop on tribal land to deliberate the utilization of drones within their community. Through qualitative analysis, we unveiled key themes surrounding integrating these emergency technologies within the jurisdiction of tribal governments. The findings disclosed substantial backing from tribal governments and their tribal members for the proposed technologies. Moreover, we delved into the potential of chatbots and drones to empower tribal governments in disaster management, safeguard their sovereignty, and facilitate collaboration with other agencies.[1]

CCS Concepts: • **Social and professional topics → Race and ethnicity**; • **Human-centered computing → Field studies**; **Participatory design;**

Additional Key Words and Phrases: Chatbot, drone, tribal, sovereignty, FEMA

[1]This article represents an expanded edition of [57].

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1 Introduction

Federally Recognized Indian tribes [hereinafter referred to as tribal governments] and their enrolled tribal members [hereinafter referred to as tribal members] have confronted significant challenges arising from both natural and man-made disasters. In the past decade alone, tribal lands have witnessed over 70 natural disasters, with some communities enduring multiple calamities in a single year [26]. The COVID-19 pandemic further exacerbated the hardships faced by tribal members, as they struggled with limited resources to combat the disease and provide effective support to those residing on tribal lands. By mid-May 2020, American Indians accounted for 18 percent of COVID-19-related deaths and 11 percent of SARSCoV-2 cases in Arizona while comprising only 4 percent of the total population. In New Mexico, they represented 57 percent of cases while being 9 percent of the total population. In Wyoming, they accounted for 30 percent of cases, as opposed to 2 percent of the total population [6, 38]. Responding on May 26, 2020, Tribal government leaders from all 574 tribal nations addressed U.S. Senate leaders, emphasizing the necessity for Congress to grant access to critical disaster funding and flexibility to combat COVID-19 in tribal communities effectively.

The lack of adequate funding from federal government entities presents a significant challenge for tribal governments and their tribal members to gather the necessary evidence of losses caused by disasters [16]. To resolve this, the emergence of **artificial intelligence** (**AI**) technologies offers opportunities to assist tribal governments in securing funds from agencies such as **Federal Emergency Management Agency** (**FEMA**) with substantial proof and documentation [58]. For instance, using AI-based chatbots and drones can alleviate some of the difficulties faced by tribal members and emergency managers in documenting and reporting damages incurred during disasters. These technologies facilitate effective communication and real-time data collection. Through this AI application, tribal governments can file reports without needing to call emergency managers, instead listing the losses they have experienced during the disaster and detailing their situation regarding repairs and restoration of damaged property. Furthermore, tribal members and emergency managers can use the images and information obtained from the **unmanned aircraft system** (**UAS**) to file reports and prioritize their work based on identifying those who require immediate assistance and help [18]. This streamlined process, facilitated by AI technologies, holds promise in alleviating the burdens faced by tribal governments and enhancing their access to essential resources for recovery and restoration efforts. Additionally, it could ease the burden of collaborating with multi-jurisdictional units in mitigating risks and responding to severe incidents [15].

As observed in a previous co-design project involving Māori communities in New Zealand [24], participatory co-design places its primary emphasis not on the technological solution but on community engagement, with the co-design outcome guided by tribal members. These insightful findings have inspired our current study design, which seeks to establish and redefine project goals while evaluating the appropriateness of a chatbot and drone for tribal government disaster management. Specifically, this article employs user-centric participatory methods to explore whether these solutions can effectively aid tribal members and emergency managers during, before, and after disasters. Two research questions guide our work: (1) Can an AI-based chatbot and drone be co-designed to empower tribal members in managing natural disasters? (2) What are the user perceptions and experiences of using these emerging AI technologies within tribal lands? To achieve this, we are collaborating with two Midwest tribal nations in the United States, the Omaha Tribe of Nebraska [hereinafter referred to as Omaha Tribe] and the Sac and Fox Nation of Missouri in Kansas and Nebraska [hereinafter referred to as Sac and Fox Nation], through a participatory design process. Our proposed solutions aim at simplifying the process

of applying for FEMA and other grant funds by enabling the sharing and preservation of information regarding costs, expenses, time, and effort with emergency managers [48, 62].

This article presents two participatory design studies. In the first study, we conducted semi-structured interviews with four emergency managers, two of whom held official positions within their respective tribes. Based on their valuable feedback, we refined and improved the initial design of the chatbot. Subsequently, we organized a design workshop at the University of Nebraska at Omaha (N = 28), where we introduced the updated chatbot design called *Emergency Reporter*, an AI-based chatbot tailored for flood damage reporting. Attendees included tribal government leaders from the Omaha Tribe and Sac and Fox Nation as well as their emergency management staff. All participants had the opportunity to test the proposed chatbot, engage in group discussions, and share their thoughts. In the second study, we conducted an in-person design workshop with the Omaha Tribe (N = 14). In a gesture of reverence towards our stakeholders, we organized this design workshop on the tribal land where the researcher engaged with tribal members. During this study, we collaboratively interacted with tribal members, fostering a sense of togetherness. During this study, we introduced the practices of using drones for smart emergency management within tribal lands. We provided an AI drone design artifact to facilitate discussions and collect feedback on the AI drone design and its potential use [31].

Through these interactions and discussions, we obtained valuable insights into the user perceptions and experiences of these emerging AI technologies for smart emergency management within tribal lands. Employing a qualitative thematic analysis, we identified significant themes that emerged from the studies. In the first study, we found that emergency managers expressed enthusiasm for the chatbot, as it enables people to report damage directly through text and document everything with photos, alleviating the need for overwhelming phone calls. They highlighted that chatbots efficiently facilitate two-way communication, especially during and before disasters, allowing accurate information on weather, surrounding conditions, and alerts to be disseminated. During the workshop, tribal members recognized the value of using the chatbot to report their individual or family's condition and the well-being of their neighbors after a disaster. This information would enable emergency managers to identify their current location and condition, prioritize immediate assistance, and promptly share relevant information. The chatbot interaction could streamline documentation difficulties, enhancing and facilitating the acquisition and reimbursement process for funds. We also gained insights into design implications based on feedback on usability and functionality.

During the second phase of our study, we further explored the application of drones for intelligent emergency management. The consensus among participants was a strong belief in the promising potential of integrating this innovative technology with tribal members and their lands. Several noteworthy topics emerged through the course of discussions, encompassing concerns and solutions tied to emergency management, technological prerequisites, and active involvement. Attendees also expressed apprehensions about sustainability, forthcoming initiatives, educational opportunities, and community-oriented programs. These findings provide a foundation for future collaborations and partnerships to continue the work on designing an emergency management system utilizing novel emergency technologies within tribal realms.

This article presents three significant contributions. Firstly, we introduced a series of co-design processes focusing on intelligent disaster management systems in collaboration with tribal governments while respecting their sovereignty. This approach acknowledges the significance of tribal government autonomy and involvement in the design process. Secondly, we conducted two design workshops in a real-world setting, inviting tribal members to actively participate in discussing and refining the proposed design and technologies. This hands-on approach deepens our understanding of the implications of introducing emerging technology for vulnerable populations in emergency management and reveals how technology can help overcome barriers they face. Thirdly, we shared our experiences working with traditionally vulnerable populations and derived design implications for future AI-based solutions tailored to tribal government intelligent disaster management. These contributions contribute to our knowledge of how technology can effectively support vulnerable populations in emergency

management, underscoring the crucial role of considering social and cultural contexts when designing innovative government solutions.

2 Background

2.1 Tribal Government Sovereignty and Emergency Management

Tribal governments maintain a government-to-government relationship with the United States Federal Government and have always been sovereign. Since the beginning, tribal governments have exercised their sovereignty over their people and lands while enjoying their traditional form of governance. The United States has made treaties with separate tribal governments, as recognized in *Cherokee Nation v. Georgia* and *Worcester v. Georgia*. Chief Justice John Marshall wrote concerning treaties made by the Cherokee Nation that it was "*explicitly recognizing the national character of the Cherokees and their right to self-government, thus guarantying their lands…*"[2] He further clarified that "*The Indian nations had always been considered as distinct, independent political communities retaining their original natural rights as undisputed possessors of the soil, from time immemorial…*" In the Worcester case, a state infringed upon the rights of a Tribal nation to govern itself and to impose upon the Tribe's land. The ruling declared the Tribe to be a distinct community, occupying its territory and having boundaries laid out. It also stated that state laws where the Tribe occupied land could have no authority. Therefore, the responsibility of working with Tribes lies with the Federal Government. Article I, Section 8 of the Constitution explicitly states that "*Congress shall have Power… To regulate Commerce with foreign Nations, and among the several States, and the Indian Tribes.*"

The current Federal Indian Policy is focused on Self-Determination and a government-to-government relationship between Tribal governments and the Federal Government. Under this policy, most tribal governance is carried out through PL 93-638, Title I Contracting provisions, which authorizes tribal governments to contract with the U.S. government to provide governmental services such as courts, law enforcement, health, education, and other essential infrastructure. The law allows Tribal governments to receive funding for Courts and set up their own Courthouses, Judges, and other legal infrastructure. However, this policy diverges when declaring disasters and receiving funds from FEMA. Historically, under the Disaster Relief Act of 1974, Tribal governments were considered "local governments" under the jurisdiction of State governments. Tribal governments had to rely on state governments to receive U.S. disaster relief funding, i.e., Tribal governments have had to go through the states where they have lands to receive funding after a disaster. The Disaster Relief Act was amended and is now called *The Robert T. Stafford Disaster Relief and Emergency Assistance Act* [referred to as the Stafford Act 1988]. However, The Stafford Act was not amended to reflect the sovereign status of Tribal governments. Tribal governments were still defined as a "local government" under the jurisdiction of State governments.

In response to Hurricane Sandy in 2012, the U.S. Congress passed the Sandy Recovery Improvement Act of 2013. Congress finally recognized the sovereign status of Tribal governments and authorized them to request a Presidential Disaster Declaration independent from State governments [36]. In 2017, FEMA developed the Tribal Declarations Pilot Guidance program to foster the tribal government disaster declaration process. This pilot program allowed Tribal governments to declare a disaster and directly petition the President of the United States for Federal Disaster funds and assistance. However, this process was not without its challenges. The Tribal Chief Executive[3] is required to declare a disaster after an event. Then, the Tribal Chief Executive must contact the local FEMA office to initiate the disaster declaration process [20]. At that time, the Tribal government's Emergency Plan should be activated, which details the Tribe's response in the event of a disaster, including the assistance it can provide and other agencies it can call upon for support. The Emergency Plan instructs on the four phases of a disaster: Mitigation, Preparedness, Response, and Recovery. Mitigation Plans are also created

[2]See Cherokee Nation v. Georgia, 30 U.S. (5 Pet.) 1 (1831) and Worcester v. Georgia, 31 U.S. 515 (1832) at 516, respectively
[3]https://www.fema.gov/disaster/tribal-declarations

to help Tribal governments (and other governments) understand the hazards and risks in their area and develop ways to reduce or mitigate the impacts of those hazards or dangers, especially in the case of a disaster.

Presently, there are 574 Federally Recognized Indian tribes in the United States [50], which refers to tribal governments that have made treaties and have a political status and relationship with the Federal Government.[4] It is the mission of each tribal government to retain and strengthen their sovereignty over their lands and protect their members. Tribal government sovereignty is exercised and strengthened by the day-to-day governance activities, such as fire and police protection, healthcare, water and sewer infrastructure, and education responsibilities. Emergency Operations Plans and Mitigation Plans are mandatory for FEMA disaster declarations. However, Tribal governments face challenges in obtaining and maintaining these plans, which can be costly and time-consuming. An Initial Damage Assessment is also necessary to determine the extent of the damages incurred, which can be challenging due to limited resources and the time it takes to gather data and travel to affected areas. This is followed by a Joint Preliminary Damage Assessment by FEMA, which can be challenging for tribal governments with limited funds and technology. As a result, many Tribal governments rely on state declarations and may not declare disasters themselves, which limits their sovereignty and may impact their ability to receive FEMA funds. Additionally, managing expenses, paying a cost share ranging from 10–25% of damages, and tracking in-kind payments remain barriers for Tribal Governments. Therefore, FEMA, the government, and individuals must understand tribal governance, sovereignty, and how to work with tribal governments during all phases of disasters to minimize risks and vulnerabilities. According to the existing literature on tribal government disaster management, these challenges are exacerbated in disaster scenarios, necessitating an interdisciplinary, multi-organizational, and multi-jurisdictional approach for mitigating risk and responding to severe incidents such as nature emergency and environmental policy [15, 53]. Ensuring that these initiatives are spearheaded by the community and demonstrate reverence for Indigenous knowledge is crucial in comprehending and mitigating disasters [17, 61].

2.2 Co-Designing Smart Systems for Tribal Emergency Management

Disaster and emergency management within tribal lands require a unique approach that considers their distinct ways of coping and recovering from disasters. In the United States, leaders need to improve emergency operations to serve tribal members living within tribal lands to better serve and integrate their unique cultural and social constructs [7]. The role of ethnicity and race cannot be ignored when developing effective disaster response plans for tribal governments and their members. Studies suggest that vulnerable populations are more likely to accept decisions made by individuals who share their demographic traits [35]. While AI and cloud computing offer new possibilities for designing solutions for tribal members, ethical considerations in technology design must be considered to ensure their acceptance and benefit. Incorporating tribal members' knowledge systems into discussions around AI and society can lead to alternative approaches that address the unique challenges faced by these communities [34].

The current literature on applying ethical principles to technology design for disaster recovery and management is insufficient. Culturally sensitive research incorporates the historical context and cultural experiences, norms, values, beliefs, and behaviors of a distinct ethnic or cultural group into its design and implementation [10]. A few studies have utilized culturally sensitive approaches while conducting research within tribal lands, with some exceptions such as co-designing health programs, technical documentation, and indigenous museums [23, 24, 29]. Research conducted within tribal lands could be detrimental to tribal governments and their members, as researchers could approach it from the perspective of European colonization [22]. Hence, there is a pressing need to be more culturally humble and learn from tribal members' epistemology. In the academic literature, research ethics as a development framework for collaborating with tribal members remains an ongoing topic of discussion. University review boards do not sufficiently incorporate all protectionist values while

[4] 87 FR 4636 (Jan. 28, 2022)

researchers work with tribal members. One study states that tribal governments and their members have the right to self-determination in all aspects of their lives, including establishing research ethics protocols [25].

Studies have shown that including tribal members as co-participants in the research team can improve the overall research initiative by understanding and applying tribal member knowledge sharing and practices, making it more representative of tribal culture and way of doing things [48]. Instead of data collection and argument, research proceeds can focus on storytelling and reflection to acknowledge local epistemologies in HCI research and prioritize harmony and humanness as primary values guiding community-based interactions [46]. Co-designing a solution with tribal members can be a proper mechanism not only to include tribal member knowledge sharing but also to make them feel ownership of their work and see the benefits they can produce for their community. Co-design approaches place end-user value at their core, with implementation and broader dissemination part of their design from inception [47]. However, information dissimilarities may arise when tribal members have a knowledge mismatch with researchers on a topic. To overcome this misunderstanding, research team members can unlearn from Eurocentric epistemology and re-learn tribal ontological ways of thinking to become embedded participants in relational and collaborative research. Additionally, research ethics frameworks need to be established that prioritize the right of tribal members to self-determination, including the establishment of research ethics protocols [25].

In terms of the broader implications for **human-computer interaction** (**HCI**) research, only a few studies can help us understand how to align the design field with tribal member knowledge-sharing practices and design epistemology. One study suggests that successful intercultural HCI design requires a departure from the typical design process and should consider different mentalities, thought patterns, and problem-solving strategies anchored in different cultures. This includes considering attitudes towards authority or social etiquette that may differ across cultures [1]. Tribal culture and ways of thinking will continue to play a role in shaping how HCI research is conducted within tribal member settings in the years to come. Co-design will also be an essential part of any research design initiative. While previous research has acknowledged the importance of incorporating the values of tribal members, there are limited examples of holistic co-design products and processes that involve the target users, particularly in emergency management.

In our research, we align our co-design workshop approach with the principles of tribal government sovereignty, a concept advocating for tribal governments' self-determination control over their data, encapsulating social, political, and legal dimensions [32, 60]. This methodology addresses challenges posed by the enduring impacts of colonialism on contemporary information systems, an issue critically examined in the literature [11, 12]. Our design sessions are crafted to navigate these complexities in creating and applying emergency management systems that incorporate AI and other technologies, with a commitment to avoiding the perpetuation of tribal members' marginalization. The practice of tribal government data generation is inherently collaborative, with knowledge frequently produced orally or collectively within communities. This notion is affirmed by the **National Congress of American Indians** (**NCAI**), which articulates that *tribes have always been data creators, users, and stewards. Data were and are embedded in Indigenous instructional practices and cultural principles, such as community roles and responsibilities* [40].

2.3 Smart Chatbot and UAS

Smart chatbots are AI-enabled systems providing interactive and personalized support to accomplish specific tasks. These tasks encompass functions such as retrieving relevant service information and processing service requests [2]. Furthermore, smart chatbots, equipped with natural language processing capabilities, also facilitate voice inputs and possess the flexibility to adapt to user capabilities and preferences [5]. Including text and voice options on mobile phones caters comprehensively to a diverse range of user abilities and preferences. Additionally, smart chatbots exhibit the ability to customize information and assistance based on user knowledge and needs [30]. The design could potentially be expanded to offer services to rural communities, including mental health support, as demonstrated by Potts et al. in their work [49].

The decision to embrace a conversation-based design over traditional WIMP (Windows, Icons, Menus, and Pointers) interfaces was driven by the array of advantages it offers [37]. This design mirrors a natural and familiar approach for users to engage with the system, enhancing its usability and revitalizing the user's mental representation of the system. This interface design replicates the flexibility of a dialogue [55], accommodating diverse user requests without imposing a predetermined path, as opposed to controllable interfaces [56]. Moreover, this design can be enriched by integrating a personified persona, employing anthropomorphic features to capture user attention and cultivate user trust [52]. The proficient conversational capabilities of intelligent chatbots align seamlessly with the oral history traditions that hold significance in tribal communities. Conversations are pivotal tools for interaction, learning, and organization in both contexts. We posit that this alignment could indeed prove feasible for emergency management scenarios within tribal governments.

The rapid evolution of UAS and related technologies, such as remote sensing, **geographic information systems** (**GIS**), and AI-powered data analytics, has facilitated various integrative and innovative uses of UAS in different fields. Construction, agriculture, infrastructure inspection, and public safety are famous application fields. Emergency and disaster management are no exceptions, and have swiftly embraced UAS technology for various tasks in recent years. Mapping, search and rescue, transportation, and training are primary application categories across all four phases of emergency management [18, 33]. Numerous federal, state, and local governments have established UAS programs. For instance, New York State established a UAS program under the **Division of Homeland Security and Emergency Services** (**DHSES**) for public safety and emergency response purposes [43]. Similarly, the Office of Emergency Management of the City of Philadelphia has launched its own UAS program for handling emergency events [45]. Recognizing the value of UAS in emergency management, several training courses are certified by the FEMA. They are offered to first responders and emergency managers through educational organizations. These courses are listed on the National Preparedness Course Catalog [54]. Given the unparalleled advantages of UAS in terms of speed, safety, accessibility, and cost within emergency management, we can anticipate the broader-scale implementation of UAS technology in this field.

The increasing frequency of disasters in recent years has heightened the vulnerability of residents within tribal lands to significant disaster impacts [21]. While emerging technologies offer alternative and effective strategies in emergency management, tribal governments, and their members have unfortunately not widely reaped the benefits of these technological advancements. Among the 574 recognized American Indian tribes and Alaska Native entities in the U.S., only a handful of tribal governments have used UAS to bolster their communities. Notably, the Choctaw Nation of Oklahoma has emerged as a standout among them, deeply engaging in federal government UAS initiatives, including the UAS **Integration Pilot Program** (**IPP**) and the BEYOND program [3]. As a result, the Choctaw Nation of Oklahoma has taken a leading role in propelling emerging aviation technology for the betterment of the region [39]. However, when considering the broader demographic landscape of tribal governments, historical challenges persist due to the absence of requisite technologies, a skilled workforce, and enabling governance and management. A crucial lesson derived from successful tribal government programs, exemplified by the Choctaw Nation, is the active involvement of the tribal members throughout the entirety of program development and implementation [44]. Co-designing smart systems within tribal lands harmonizes well with these valuable insights. It is a pivotal element for the triumph of system development and implementation in tribal government emergency management.

3 Methodology

3.1 Study Design and Participant Recruitment

To address the research questions, we utilized a participatory design approach to collaboratively design an AI-based smart chatbot and UAS (i.e., drone) with tribal members. Participatory design approaches aim at establishing a more equitable partnership between users and designers during the design process [51]. While designers and researchers still lead the design process, stakeholders and target users are invited to participate as equal partners. This article consists of two design workshops.

3.1.1 Design Workshop 1: Co-Design a Disaster Management Chatbot. Employing the participatory design process, we jointly embraced collaborative design principles to create the proposed chatbot. This approach enabled stakeholders to engage in the design actively and ensured their retention of control and leadership throughout the process [48]. The resultant co-designed chatbot was crafted to aid tribal members in reporting damage caused by natural disasters to FEMA. To realize this, we leveraged *Google Dialogflow*, a versatile platform that supports both web and voice interfaces, granting users the option to interact with the chatbot through web browsers or by utilizing a phone gateway.[5]

Workshop 1 consisted of two stages. In the first stage, we invited four first-line tribal government emergency managers to gain an understanding of their duties and receive their reflections on the proposed chatbot design. The emergency managers' responsibilities include providing information to the tribal members they serve and communicating about threats, hazards, and associated risks or losses in their area [14]. All four participants had at least one year of experience in coordinating tribal emergency business, such as setting up plans and procedures for responding to natural disasters and other emergencies for local tribal governments. This stage aimed at co-designing a disaster management chatbot through semi-structured interviews. During the interviews, a generic version of the chatbot was presented, which could engage in basic conversations such as "*What is FEMA?*", "*My house was damaged, what can I do?*", and so on. All the responses were retrieved from the FEMA website.[6] The chatbot was used to demonstrate how it could be used in emergency management and elicit participant feedback. All interviews were conducted virtually through Zoom and lasted for approximately 1 hour.

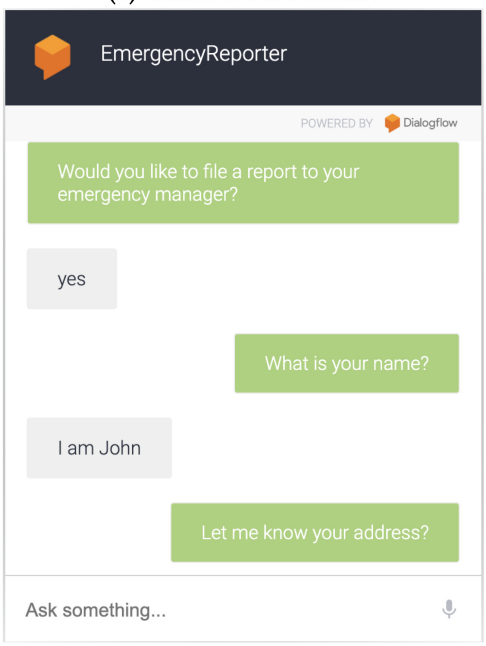
After receiving feedback from stage 1, we proposed *Emergency Reporter*, an AI-based chatbot that allows users to report flood damage (as shown in Figure 1(a)). We chose the flooding scenario because it is the most common natural disaster in the tribes (as identified by the stage 1 participants). Figure 1(b) presents a sample conversation demonstrating how a tribal member could use the chatbot to report flood damage. All user inputs are stored in a back-end database for later analysis or query. Figure 2 illustrates how the submitted reports could be stored and presented to the emergency managers. The proposed system will be used and demonstrated in the next stage.

During the second stage, we invited two Nebraska tribal governments—the Sac and Fox Nation and the Omaha Tribe—to participate in a design workshop where we gathered their feedback and experience using the proposed system, as well as design implications. A total of 28 participants joined the design workshop, which was part of a full-day conference hosted by the Tribal Management and Emergency Services Program at the University of Nebraska at Omaha. The conference aimed at investigating the technical challenges faced by tribal members when communicating with FEMA for disaster resource applications and funding allocation. We allocated a specific time during the conference to extend an invitation to all attendees, including tribal government leaders and their members, students, faculty, and staff participating in the workshop, for our one-hour design workshop. During the workshop, two authors of the article presented the idea of using an AI chatbot for natural disaster reporting (approximately 15 minutes). We then introduced our proposed chatbot (Figures 1 and 2) and invited all attendees to use and test the chatbot on their personal devices, such as laptops or cellphones (about 15 minutes). We encouraged them to submit a flood damage report. After the presentation and hands-on session, we joined as a group to discuss and share the experience of using the proposed app (about 30 minutes). The workshop was held in November 2022.

3.1.2 Workshop 2: Using Drones for Smart Emergency Management. The absence of effective communication and coordination mechanisms between tribes and FEMA has significantly impeded disaster recovery (NCAI, [4, 41]). Tribal members receive only about $3 per person annually from the federal government for natural disaster recovery, while their U.S. counterparts receive an average of $26 per person ([42]). Integrating UAS and GIS has proven effective for emergency management across various entities and offers a potential solution

[5]https://cloud.google.com/dialogflow/docs
[6]https://www.fema.gov/

(a) Chatbot Screenshot



(b) Sample Conversation

Hi
Hi, this is Emergency Reporter. How can I help you?
I would like to report a flood damage.
Is it an emergency?
no
Would you like to file a report to your emergency manager?
yes
What is your name?
I am John
Let me know your address?
12345 Center Ave
Got it, What is your phone number?
my number is 12345678
Tell me about your loss?
I have water damage doors.
Got it, Have you tried to restoring your home after flooding?
yes
What was your expense?
$100
How long did it take?
two hours
What has been repaired by you?
I purchased two new doors.
Thank you. We have received your damage report.
We will get in touch with you soon.

Fig. 1. (a) Screenshot of *Emergency Reporter* and (b) a sample conversation showing how tribal members could file a flood damage report to their emergency managers. The user inputs were labeled in grey, and the agent responses were highlighted in green.

This is Tribal Emergency Reporting Dashboard, we have 29 reports now.

ID	Name	Phone ▲	Address	Situation	Labor	Cost	Repair	Score	Int.	Time	Form
webdemo-d9d48b7c-715a-33a4-585c-76a9735f80df	my name is Jack	402123456	my address is 123 centre ave	the front door was broken	2 hours	100 dollar	thank you	0.10	14	2022-11-15 13:26:57	PDF
webdemo-2c2c312c-6368-88c9-e4d8-5ba09747e39f	Jack	402123456	412233 centree ave	my front door was broken also the windows	2 hours	100 dollar	thank you	0.12	13	2022-11-15 13:35:33	PDF
webdemo-7cd96ef8-2feb-cf2b-64b3-337a05f084b9	my name is john	523524542	omaha	water all over my house				-0.03	9	2022-11-15 17:07:41	PDF
webdemo-db13c118-23f5-7ab7-604d-02f1d43a6db4	john	124134425	377 centre ave	my house was water all over the place....	2 hours	$500	I tried remove the water myself...	0.03	20	2022-11-15 17:14:10	PDF

Fig. 2. All submitted flood reports were stored in the database and could be presented in a table-style dashboard.

for tribal governments and their members. However, successfully using UAS and GIS technology must align harmoniously with tribal governance, cater to specific issues within tribal lands, and foster collaboration between tribal governments and FEMA.

Therefore, a co-design approach involving tribal government was implemented to develop a smart emergency management system grounded in UAS-GIS technology. This approach was facilitated through a co-designing workshop. The overarching objective was to create a scalable socio-technical framework with a computational

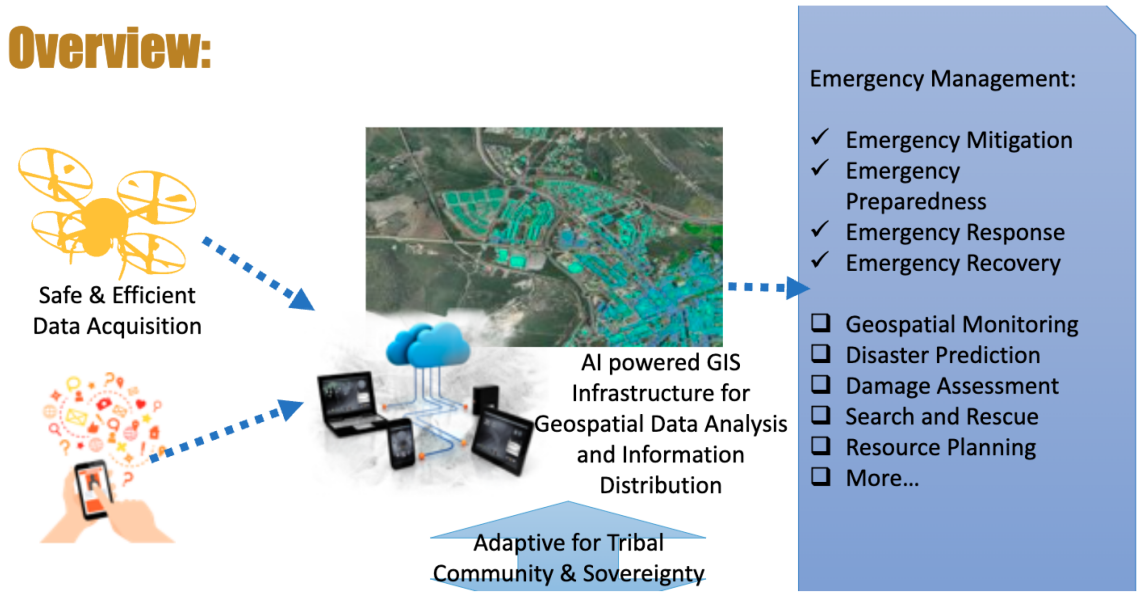


Fig. 3. The framework utilized in study 2: Focus group discussion.

platform and training modules. This framework integrated UAS, GIS, and deep learning-powered data analytical models, all supported by effective governance and management. The aim was to establish a rapid, accurate, and versatile infrastructure to bolster tribal government emergency management.

Workshop 2 occurred on tribal lands of the Omaha Tribe of Nebraska. The Omaha tribe, also known as "*Umoho*" in the Omaha-Ponca language, is a federally recognized Native American tribe residing on the Omaha Reservation in northeastern Nebraska and western Iowa, United States. The Omaha tribe has a total of 5,427 enrolled members.[7] This design workshop constituted a continuation of the initial session conducted at the university, albeit with a distinct methodology. Rather than having tribal members come to our study site, we, researchers and designers, traveled to their tribal lands and organized the workshop in the nearby community center. The workshop was held in March 2023 and spanned approximately two hours.

We extended an invitation to the members of the Omaha Tribe of Nebraska to participate in this design workshop, during which we sought their valuable feedback and insights on the proposed AI drone system, as well as its design implications. A total of 14 participants attended the workshop, each with their own unique background. The workshop began with a 15-minute presentation by two article authors explaining the concept of using an AI drone for natural disaster reporting. The presentation was facilitated through a projector and slides, and a drone design framework (shown in Figure 3) was introduced. We posed the following questions to stimulate discussion during the focus group: *(1) Have you (as a tribal member) used drones before? If so, for what purposes? (2) Have you (as a tribal member) utilized GIS before? (tribal affairs vs. personal matters). (3) What GIS technology is currently accessible by the Omaha Nation?* After the presentation, all attendees were encouraged to share their experiences and ideas regarding using drones in tribal emergency management.

3.2 Data Collection and Analysis

Qualitative data from all interviews and design workshops were collected. An inductive, qualitative thematic analysis was employed to open-code the transcribed recordings of the semi-structured interviews, identifying

[7] https://www.bia.gov/regional-offices/great-plains/nebraska/winnebago-agency

Table 1. Participants Demographic Information of Workshop 1

Code	Gender	Ethnicity	Education Level
P1-1	M	Omaha Tribe	
P1-2	M	Sac and Fox Nation	Graduate
P1-3	M		Undergraduate
P1-4	M	Hispanic/Latino	
P2-1	F	Yankton Sioux Tribe	Doctoral
P2-2	M	Ponca Tribe	Graduate
P2-3	F	Sicangu Lakota	Graduate
P2-4	F	Omaha Tribe	
P2-5	M	Omaha Tribe	
P2-6	M	Omaha Tribe	
P2-7	M	Omaha Tribe	Doctoral
P2-8	M	Asian	Doctoral
P2-9	F	Omaha Tribe	Juris Doctorate
P2-10	F	Sicangu Lakota	
P2-11	M	White	Doctoral
P2-12	M	Asian	Graduate
P2-13	M	Omaha Tribe	Undergraduate
P2-14	F	Omaha Tribe	Doctoral
P2-15	M		Graduate
P2-16	M	White	Doctoral
P2-17	M	White	Doctoral
P2-18	M	Omaha Tribe	Undergraduate
P2-19	F	Rosebud Sioux Tribe	Undergraduate
P2-20	M	Omaha Tribe	Undergraduate
P2-21	M		Undergraduate
P2-22	M		Undergraduate
P2-23	M		Undergraduate
P2-24	M	Asian	Undergraduate
P2-25	F	Omaha Tribe	
P2-26	M	Omaha Tribe	
P2-27	F	Omaha Tribe	
P2-28	M	White	Doctoral

emergent themes [9]. Three authors of this article then engaged in discussions and iterations to develop key and high-level themes related to chatbot and drone design, emergency management, and user experience, primarily derived from the design workshops with the tribal members. After data collection, each researcher thoroughly reviewed the dataset to gain an initial understanding of its content. Frequent meetings were held during the first two weeks (approximately once every three or four days) to discuss impressions of the dataset and insights from the co-design process. Initial codes were generated for all transcripts, and in the findings section, data from the first and second workshops were reported separately. Moreover, three out of four Stage 1 participants attended Stage 2 in the first workshop. A total of 10 participants participated in both workshops 1 and 2.

3.3 Privacy, Ethics, and Disclosure

We acknowledge and reflect upon our positionality as researchers, recognizing the significance of our subject positions in relation to the participants in this study [19]. In the formulation and implementation of this study, conscientious attention was devoted to the ethical complexities inherent in engaging with vulnerable populations. The research team established collaborative partnerships with three members of the university's faculty and staff (co-authors of this article), each of whom is an enrolled tribal member, two of them with the Omaha Tribe. These affiliations proved to be critical in facilitating the recruitment of study participants. Additionally, acknowledging our diverse backgrounds, with three authors of Asian descent, we were keenly aware of our racial identities during the interview. This consciousness and an understanding of racial dynamics enriched our analysis, mainly when participants discussed their views and experiences related to colonial history.

Throughout the research's planning and execution phases, we maintained a vigilant approach to the ethical considerations necessary when interfacing with environmentally vulnerable populations [59]. Two authors, being American Indians, leveraged their networks within local emergency management and the Omaha tribe to assist in participant recruitment. We have documented the demographic characteristics of all participants within Tables 1 and 2, noting that specific data points may be absent due to the voluntary nature of providing information on race, educational attainment, and occupation.

The University's **Institutional Review Board** (**IRB**) reviewed and approved the user-centric research protocol, ensuring that ethical standards were met. Furthermore, the execution of the second workshop was contingent upon securing formal resolutions of support from the Omaha Tribe and Sac and Fox Nation, highlighting the critical importance of establishing a foundation of trust and mutual respect with the involved communities. This also

Table 2. Participants Demographic Information of Workshop 2

Code	Gender	Ethnicity	Occupation
P3-1	F	Omaha Tribe	Tribal Land Manager
P3-2	M	Hispanic/Latino	Emergency Manager
P3-3	F	Omaha Tribe	Vice Chairwoman
P3-4	M	Sac and Fox Nation	Communication Manager
P3-5	M		
P3-6	M	Omaha Tribe	Tribal Council
P3-7	M	Omaha Tribe	Environmental Dept
P3-8	M	Omaha Tribe	Chief Tribal Operations
P3-9	M	White	Chief Financial Officer
P3-10	M	Omaha Tribe	Tribal Council Member
P3-11	F	White	K-12 Teacher
P3-12	M		
P3-13	M	Omaha Tribe	Housing
P3-14	F	White	K-12 Teacher

serves as evidence of the support we received from the partnered tribal governments following the first workshop, indicating their willingness to continue collaboration with us under formal tribal government approval. This methodological approach facilitated a depth of dialogue and learning among participants, underpinned by a long-term, trust-based collaboration framework.

4 Findings

In this section, we present our findings on implementing an AI chatbot and drone in the tribal government emergency management practice within tribal lands. We report thematic themes and design implications resulting from the co-design process with the indigenous communities.

4.1 Design Workshop 1: Disaster Management Chatbot

4.1.1 Theme 1: Emergency Communication. Our findings suggest that the proposed chatbot can facilitate emergency communication between tribal members and their local emergency managers. Before a disaster, the chatbot could be used to keep tribal members informed, reducing communication costs, especially during and after a disaster.

> **P1-1:** "*I need about six of me to make that process easy. Okay, communication would probably be, seems to be the hardest part, because in the phone or my phone's always ringing. It's Councils calling me basically You know it's It's communication, communication is always going to be an issue...(For example,) Hey, I have damage. I'm going to need some resources. This is the resource I need. Instead of making four or five phone calls, it just sends it to them, and then resource can start coming.*"

> **P1-2:** "*Yeah, I mean, I could see some people expecting damages trying to like, you know. Okay, we're gonna have damages. What do I need to be aware of after the storm? Um! I can see people uh during the storm. Who do I call to get help? And then, of course, afterward, everybody trying to file plans and get cleaned up. Okay, Yeah, It seems like they need a different kind of information.*"

P1-1 stated the importance of sharing accurate information, such as weather alerts, from the emergency manager and department through the chatbot to the public before a disaster. Both P1-1 and P1-2 expressed that using the chatbot to report damage and provide updates during and after a disaster would be beneficial to alleviate the issue of multiple people calling the emergency manager's cell phone at once. P1-2 suggested that

allowing people to share images during and after an emergency would enable the emergency manager to locate the damage and people's whereabouts quickly. Additionally, P1-2 emphasized the importance of keeping people informed through the chatbot before a disaster strikes to ensure prompt reporting of damage and preparedness.

> **P2-28:** "*...maybe (adding) a question about how their neighbors are looking. Like if this situation whether they can see whether then the neighbors are in similar kind of as similar situation and maybe the other people on the block if they are able to assist there. Just to kind of expand the reach beyond that individual household even just to the people either side it might just help get a better picture of how the whole community is looking.*"

P2-28, a faculty member and participant in the design workshop suggested adding a question to inquire about the status of neighbors to users. This would allow emergency managers to assess the situation better and understand how the entire community is doing, potentially preventing anyone from being overlooked and needing immediate assistance.

> **P2-18:** "*Yeah, it is more efficient than having someone on the call like talk to another person that they can give us all the information right away through text*"

During the workshop, P2-18, an undergraduate student and member of the Omaha tribe commented on the demo and suggested that it would be more efficient to send all information to the emergency manager via text rather than calling during times of disaster when phone lines may be flooded. A tribal government leader also suggested that in addition to floods and tornadoes, the chatbot should include other emergencies such as blizzards, ice storms, fire, and windstorms, as many people may not know what to do in those situations, making the chatbot a helpful resource for the public.

4.1.2 Theme 2: Documentation and Cost-Sharing. Several participants highlighted the chatbot's potential to collect and store critical information from tribal members, including damage reports, financial assistance, and cost-sharing. For example, P1-1, who served as the tribal emergency manager for the Omaha tribe and was also interviewed for the study, suggested allowing users to share images of the damage to their property, such as lawns, porches, kitchens, balconies, and yards, would aid in documentation. This documentation could be helpful when the tribal government files for cost-sharing or seeks assistance from FEMA or other federal or state emergency agencies, as it would help meet threshold requirements.

> **P1-1:** "*If we didn't document, it didn't happen.... You gotta write things down. Okay. I went to someone to his house at midnight, and I left there at one o'clock that way if you wanted to get um what they call, and administration fees the reimburse your time tracking your time to all It's There's a lot of documentation being document like I said it, it happened*"

P1-1 further suggested that the chatbot could help document the time it takes to complete tasks, such as driving around a community to assess damage or assisting a community member to restore their property and remove fallen trees. Tracking these activities through the chatbot would make it easier to record everything done, which could then be used to submit relevant documents and proofs to FEMA and other emergency funds grant bodies.

> **P1-2:** "*I was in Brown County, and the State of Kansas was looking for flood damage to reach a threshold, and um they couldn't do it without some of the damage that occurred on the reservation. So we went ahead and documented that damage and sent it along with the rest of the county's report... They need to wait until you send the data to them so they can declare an emergency.*"

P1-2 explained that their tribal government filed for funds with the state of Kansas through Brown County after documenting the damage on their tribal lands, which helped them reach the threshold for requesting funds from the state. The chatbot could also assist with documentation in this case, including documenting the time spent working on the damage, any expenses incurred, and the number of people who worked on it for cost-share reporting purposes. It is typically difficult to track these details since tribal members may not organize to keep track of their contributions. An interactive system like a chatbot could improve accessibility, enabling

stakeholders to report their efforts promptly. P2-7 suggested that the chatbot could be valuable in documenting everything people do, particularly for cost-share purposes, as there is an in-kind cost-share that people can contribute to.

> **P2-7:** "*One of the things that I think this can would be of value, I think you heard Larry Wright talking about documenting everything that people do. The reason why that's important is that we mentioned cost share and there is an in-kind cost share that we can contribute to that so if the damage is a million dollars, the tribe will only get reimbursed up to 75%.*"

During the design workshop, P2-7, a judge in the tribal court of the Omaha Tribe, provided an important insight regarding the chatbot. He emphasized the value of documenting everything people do during, before, and after a disaster. He stated that better documentation could help with cost sharing and in-kind contributions towards filing reports to organizations such as FEMA for funds. As FEMA only covers 75 percent of the total loss incurred by the tribe, better documentation could maintain tribal government sovereignty.

> **P2-8:** "*I think the idea for the extended function notice from this technology would be automatic documentation because when you are handling those emergency situations you can't really ask them to type things or have a sheet of paper there to write up how much and how many hours they spent their material to use if we could have the type of app version of this technology this chatbot or whatever to help them automatically translate to their natural language into the database record what information they have there I think would be very efficient and collect tons of information for the final cost share documentation or whatever could be used for the final reporting.*"

P2-8 suggested an exciting feature that could be added to the chatbot: automatic documentation. During emergencies, it can be difficult for people to take notes or jot things down. Technology like a chatbot could be helpful in automatically documenting and translating the information into their natural language and a database record. This would be an efficient way to collect such information for the final cost-share documentation or final reporting. P2-8 suggested that if there could be an app version of this AI technology, the chatbot could help people automatically translate their voice into natural language and store the information in the database. This would be a more efficient way to collect information for cost-share documentation or final reporting.

4.1.3 Theme 3: Chatbot Adoption and User Experience. In this section, we report on the user experience and expectations regarding using chatbots to report natural disaster damage in the practice of first-line emergency managers and tribal governments. Overall, the participants expressed optimism about the chatbot design and would like to see more use cases added, such as blizzards, ice storms, fire, and windstorms, to provide more options to people. The members of the Omaha Tribe and Sac and Fox Nation who were invited expressed a willingness to continue the co-design process in the future. For example, P1-1 suggested designing a chatbot usable for tribal members with diverse backgrounds.

> **P1-1:** "*the older, the elders and stuff around your voice will probably be a lot better for them... the voice would help with like looking for this document in it pops up and tells you or I need to. I need to document my time. It is now this time when I leave. Okay, Now it is this so that way. You don't have to type anything down. It's all there. Then I can, later on, get it, and then put it on paper, because Fema wants some papers like put on paper and send it.*"

According to P1-1, the tribal members use multiple interfaces across various devices, such as iPads, laptops, mobile phones, and PDAs, to report damage and contact emergency management. Thus, embedding the chatbot application in different types of devices would be beneficial in this context. P1-1 also suggested that older tribal members who are not technologically adept may prefer the voice option in the chatbot to communicate their issues to the emergency manager instead of using text-based communication.

> **P1-3:** "*They're posting where you know photos and tornado. Well, they are all GPS-tagged photos, so you can find out exactly where it is. so there are a lot of things that it would, I could see helping as the emergency manager who's already tech savvy, anyways, at least as a user we don't.*"

One of our interviewees, P1-3, also an emergency manager at Rubicon, a veteran-run non-profit, suggested that the images shared by people through the chatbot could be tagged with geo-location capabilities, which would help emergency managers locate and assist them more efficiently. Another participant, P2-28, suggested that the chatbot could ask emotional wellness questions such as how the user feels and copes, instead of relying solely on automated sentiment analysis as shown in Figure 2 under the column labeled "Score".

> **P1-1:** "*That's an issue there too because a lot of tribal members don't have cell service. They can use their phone but they have to be Wi-Fi connected. You will be surprised how many people sit out in front of my office to use my Wi-Fi.* "

During our design workshop at the conference, two participants (P1-1 and P2-18) highlighted the issue of poor internet connectivity on tribal lands. They mentioned that people may not have access to cell service in emergencies, which can be problematic. P1-1 suggested that some people sit outside his office to connect to his Wi-Fi during such times. However, he also noted that some tribal lands may lack internet connectivity when power lines go off, making it challenging to adopt chatbots and AI. Despite these challenges, the potential benefits of using chatbots in emergency management were widely recognized.

> **P2-9:** "*So it may be instead of asking if it's an emergency maybe ask if Is your life in immediate danger or something like that. Cause then people will like, Oh, if my driveway is flooded, then I would think that would be an emergency, but you are not really in danger. So that way, you can move on and continue to put stuff in the app without people being stopped and like get help.*"

P2-9 recommended a modification for the chatbot's emergency response process. Instead of asking if the situation is an emergency, she suggested the chatbot ask a follow-up question to determine if the person's life is in immediate danger. For example, if someone reports a flooded driveway, it may not be an emergency if they are not in danger. P2-9 explained at the conference that the term "emergency" can have various interpretations and that asking a question like *Is your life in immediate danger?* could provide clarity for both the user and emergency managers. This suggestion could aid in prioritizing emergency management resources and help emergency managers assess the situation of people stranded at home or on the streets.

4.2 Design Workshop 2: Drones and Smart Emergency Management

Throughout this workshop, we introduced the concept of the drone artifact using presentation slides, fostering an open format for subsequent discussions. In contrast to a focus group approach, we presented the drone's potential use cases and guided the conversation. However, to gain richer insights from the participants, we refrained from imposing constraints on the aspects of the drone design that the responses should address. In the subsequent subsection, we have distilled two fundamental themes from the dialogues that unfolded during the workshop.

4.2.1 Theme 1: Concerns and Solutions for Emergency Management. Within this thematic context, P3-2 highlighted significant concerns regarding emergency management and water pollution, particularly about the 2023 Ohio derailment incident.[8] The individual underscored the imperative of averting similar occurrences in the future and emphasized the necessity of implementing checkpoints to ensure adherence to guidelines. The importance of water quality for the tribal government's populace was acknowledged, with measures to uphold it being underscored. This theme encompasses the drone's applications in both emergency response and monitoring. P3-7 proposed leveraging drones for wildfire management and surveillance, encompassing fire direction

[8] https://en.wikipedia.org/wiki/2023_Ohio_train_derailment

detection and stream monitoring tasks. Furthermore, P3-8 underscored the significance of engaging K-12 students in drone applications, highlighting the value of user-friendly tools and accessible training resources for local personnel. Additionally, P3-13 explored using drones to diversify messages within the checkpoint system, augmenting emergency response capabilities. P3-10 delved into potential drone applications, including documenting and measuring county and hill areas, conducting production surveys, and exploring their viability as alternatives to traditional shovel testing.

Derived from the findings, a prominent drone application in tribal government emergency management becomes apparent, encompassing land management, wildfire control, and water quality assessment. Drones effectively establish checkpoints and bolster response capabilities over vast tribal land regions, aligning seamlessly with the distinct tribal government context. Additionally, this theme encompasses comprehending the tribal government's technological necessities while upholding their sovereignty. The focal point of this theme revolves around exploring the community's technical demands and fostering engagement with technological progress. An AI-driven drone takes the initiative to gather information concerning the tribe's technology requirements. In this regard, P3-9 contributes to the discourse by discussing the potential application of E911 messaging and location services for fleet and vehicle management, highlighting the crucial role of streamlined technology within local resources management.

4.2.2 Theme 2: Sustainability and Community Programs. This thematic aspect delves into concerns associated with program sustainability and future initiatives. P3-4 articulates a keen interest in maintaining the longevity of the technology program beyond the initial one-year grant period. This underscores the significance of consistent support and funding, thereby initiating discussions on the vital incorporation of technology within education and community programs over the long term. This, in turn, points toward future planning and implementation. Within this theme, participants discuss technology integration within education and community programs. P3-6 proposes integrating technology education into K-12 curricula, contemplating the feasibility of funding through grants. Expanding upon this notion, extending technology programs to encompass the broader population emerges, underscoring a commitment to inclusivity. P3-2 shares personal insights into drone applications, particularly in measurement and GIS. Similarly, P3-1 recognizes the potential of drones in capturing real-time imagery, noting their pertinence to GIS-based applications. Furthermore, P3-2 emphasizes his familiarity with drones and their diverse applications, including measurement tasks.

Based on these findings, it is evident that attendees demonstrated significant interest, resources, and expertise in engaging with drone systems within the context of emergency management. An exciting observation is that tribal members exhibited enthusiasm for introducing this new technology to K-12 education, encompassing the school district within the community. This initiative could extend the impact of this solution to the next generation and potentially gain further momentum by securing additional funding for these endeavors. However, there are also concerns regarding the sustainability of funding to support these initiatives. Attendees expressed worries about the possibility of funding cessation leading to the discontinuation of the initiative, raising questions about the program's continuity.

5 Discussion

In this article, we qualitatively analyzed a co-design process for an AI chatbot and drone with tribal governments and their members. In the first design workshop, the study involved experienced emergency managers and tribal members. Through a two-stage process, we identified three themes related to how the chatbot could improve emergency communication and damage reporting. We also examined the usability and adoption of chatbots in emergency management and discussed the practical implications for tribal members and AI technology. Our study confirms that effective communication and documentation are crucial for obtaining a 25% cost-share from FEMA during emergency declarations [27]. We found that chatbots can streamline the declaration process by quickly retrieving relevant documents and facilitating collaborative damage reporting among tribal members.

Furthermore, chatbots can aid communication during rushed disaster periods and provide location and emergency procedure updates. Additionally, voice capabilities can help older tribal members. Finally, the chatbot can facilitate communication with those who can assist with disaster declaration paperwork for other state or federal governments, such as FEMA.

Building upon the interactions and connections established during the initial workshop, we further solidified our collaboration in the second design workshop. This subsequent session was held at the community center within tribal land, strategically positioned closer to the designated study site where we aimed at introducing a technological solution. In contrast to the hands-on artifact in the first workshop, the second workshop adopted a different approach. Instead of furnishing a tangible artifact for participants' interaction, attendees shared many potential use cases for drones in tribal government emergency management systems through presentations. It is important to highlight that the objective of this co-design workshop was not to task participants with refining or creating a new system. Instead, it allowed us to learn from the participants, explore challenges and prospects, and introduce the new technology to tribal government emergency management [8]. In a broader context, we discerned that the attendees displayed receptiveness toward adopting this novel technology and expressed their enthusiasm for sustained involvement in the program. Despite concerns about budgetary constraints, tribal members showcased a strong inclination toward incorporating emergency technology into the K-12 curriculum, foreseeing the potential benefits for the younger generation. The discussions and feedback extended beyond drone usage, exemplifying an approach that values comprehending genuine user needs rather than solely concentrating on technical inquiries [28].

Our study's findings support the argument that co-designing an AI-based chatbot and drone could empower tribal members in natural disaster loss reporting (RQ1). The first co-design process took approximately eight weeks to complete, with the first four weeks focused on implementing the generic chatbot and recruiting participants for stage 1. Coordinating and communicating for the second workshop spanned approximately four weeks. As researchers outside of the realm of tribal government emergency management, we aimed at understanding better the duties and practices of first-line emergency managers, as well as the difficulties and challenges faced by tribal members during the co-design process. This step was crucial in selecting suitable scenarios, interaction mechanisms, and appropriate language for the designated system. The proposed chatbot and drone solution can enhance disaster management and response capability while preserving the sovereignty of tribal governments. Additionally, the co-design process helped establish a relationship of trust between the researchers and stakeholders.

Our study findings demonstrate the positive user perception and experience of utilizing the proposed AI-based chatbot and drones within tribal governments and their lands (RQ2), as supported by our design workshop. During the workshops, we engaged face-to-face with the tribal members, demonstrating and guiding them on using the proposed chatbot to file a report via their cell phone or laptop, either in a web browser or by calling a Gateway number. Most participants reported positive experiences during the workshop, providing helpful feedback to refine the system design. At the end of the workshop, we asked the participants if they would like to continue the co-design process with the authors, and we received a verbal agreement. Both Omaha Tribe and Sac and Fox Nations leaders then presented a resolution to their respective tribal governments, which was voted on and passed one month after the first design workshop. This official support from both tribal governments indicates strong potential for the success of this participatory study. We argue that engaging with the users can establish a relationship of trust and improve the system design. The participants' readiness to engage in the second workshop held on tribal lands underscores their commitment. In summary, the co-design process proved to be a fulfilling endeavor that aided in cultivating a valuable partnership between university researchers and the tribal nation's community stakeholders [13].

Our findings support the argument that new technology can offer fresh opportunities for tribal governments to preserve and strengthen their sovereignty. Our study demonstrates how AI can facilitate collecting and recording critical data necessary to claim resources from other agencies. Including tribal member knowledge systems in

discussions concerning AI and society can lead to alternative approaches that tackle the distinctive challenges faced by tribal governments and their members [34]. Our findings highlight the potential of using new technology to empower tribal governments to improve their capabilities in the emergency management process, which is a labor-intensive and time-consuming process. Our study also emphasized the importance of considering cross-sovereignty systems to ensure transparency and accountability, which have received less attention in previous tribal government co-design projects [23, 24]. For example, the FEMA disaster declaration procedure may not be feasible for tribal governments to collect and document all receipts and reports simultaneously for submission. Instead, a community-based storytelling approach and in-kind labor cost-share might be more appropriate to acknowledge and honor the on-site efforts in responding to natural disasters [62].

This article outlines fundamental design considerations for crafting intelligent disaster management systems tailored to tribal governments and their members. It addresses challenges such as inadequate internet connectivity during natural disasters and the constraints posed by limited budgets and resources. To tackle this issue, these systems should be designed to accommodate fragmented responses and operate offline or with restricted cloud connectivity. For instance, users should be able to engage with the chatbot through various mediums, including apps, web browsers, voice calls, or text messages. The conversational design of the chatbot should be personalized to match the specific requirements and preferences of each tribe. Building trust within the community is a critical prerequisite before implementing the system. Integrating drones could enhance local educational programs, deepen knowledge, and ensure program continuity. Our research underscores existing literature in highlighting that the technology itself is not the primary focus; instead, it should be adaptable and geared towards benefiting tribal governments and their members while fostering active community engagement within co-design initiatives [29].

We acknowledge certain limitations to this study. Firstly, our co-design participants were predominantly highly educated, which may not represent most tribal members. Further research is needed to investigate the impact of education on co-design findings. Secondly, we recognize the value of FEMA's existing informational app[9] as a baseline for future research, particularly in exploring how AI technologies can be tailored to various environmental challenges. Moreover, incorporating feedback mechanisms for continuous improvement can enhance the effectiveness of these AI technologies. Thirdly, the co-design process usually requires a more extended collaboration to establish mutual trust between designers and stakeholders, but our study period was less than six months. Fourthly, it's worth noting that the second workshop revealed that participants' limited hands-on familiarity with drones could pose challenges when offering comprehensive insights into emergency management. Moving forward, we intend to address these limitations in our future collaborations with the Omaha Tribe and Sac and Fox Nation that we have partnered with by exploring the scalability of our co-design approach across various cultural and disaster contexts. Moreover, evaluating the long-term impacts on these communities could offer valuable insights into the sustainability of such interventions.

6 Conclusion

Employing a participatory design approach, this study collaboratively developed a disaster management chatbot and drone solution, engaging frontline emergency managers and two tribal governments and their members. The co-design process unfolded with a deep understanding of cultural sensitivities, emphasizing the importance of nurturing trust and fostering strong connections between researchers and participants. Through this iterative journey, two in-person design workshops were conducted, culminating in conceptualizing, refining, and evaluating the envisaged chatbot design and the integration of drones. The workshops honed explicitly in on scenarios associated with reporting damages caused by natural disasters. The resultant design was met with positive reception from participants, who eagerly expressed their commitment to carrying forward the co-design process under the auspices of a formal tribal government-endorsed resolution.

[9] https://www.fema.gov/about/news-multimedia/mobile-products

References

[1] José Abdelnour-Nocera, Torkil Clemmensen, and Masaaki Kurosu. 2013. Reframing HCI through local and indigenous perspectives. *International Journal of Human-Computer Interaction* 29, 4 (2013), 201–204. DOI: https://doi.org/10.1080/10447318.2013.765759

[2] Eleni Adamopoulou and Lefteris Moussiades. 2020. Chatbots: History, technology, and applications. *Machine Learning with Applications* 2 (2020), 100006.

[3] Federal Aviation Administration. 2023. *BEYOND*. Retrieved from https://www.faa.gov/uas/programs_partnerships/beyond

[4] U. S. Federal Emergency Management Agency. 2022. *2022-2026 FEMA National Tribal Strategy*. Retrieved from https://www.fema.gov/sites/default/files/documents/fema_national-tribal-strategy_08182022.pdf

[5] Ebtesam H. Almansor and Farookh Khadeer Hussain. 2020. Survey on intelligent chatbots: State-of-the-art and future research directions. In *Complex, Intelligent, and Software Intensive Systems: Proceedings of the 13th International Conference on Complex, Intelligent, and Software Intensive Systems (CISIS-2019)*. Springer, 534–543.

[6] Samantha Artiga and Kendal Orgera. 2021. *Covid-19 Presents Significant Risks for American Indian and Alaska Native People*. Retrieved from https://www.kff.org/coronavirus-covid-19/issue-brief/covid-19-presents-significant-risks-for-american-indian-and-alaska-native-people/

[7] Jason Thomas Barnosky, Andrew Lauland, Michelle E. Miro, Jay Balagna, Liisa Ecola, Soo Kim, Chelsea Kolb, Kristin J. Leuschner, Ian Mitch, Andrew M. Parker, Leslie Adrienne Payne, Carter C. Price, Tucker Reese, Liam Regan, Susan A. Resetar, Christopher M. Schnaubelt, Rachel Steratore, and Karen M. Sudkamp. 2022. *Streamlining Emergency Management: Issues, Impacts, and Options for Improvement*. Technical Report. RAND Corporation. Retrieved from https://www.rand.org/pubs/research_reports/RRA1440-5.html

[8] Emma Blomkamp. 2018. The promise of co-design for public policy. *Australian Journal of Public Administration* 77, 4 (2018), 729–743.

[9] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3, 2 (2006), 77–101.

[10] Catherine E. Burnette, Sara Sanders, Howard K. Butcher, and Jacki T. Rand. 2014. A toolkit for ethical and culturally sensitive research: An application with indigenous communities. *Ethics and Social Welfare* 8, 4 (2014), 364–382. DOI: https://doi.org/10.1080/17496535.2014.885987

[11] Ashley Caranto Morford and Jeffrey Ansloos. 2021. Indigenous sovereignty in digital territory: A qualitative study on land-based relations with# NativeTwitter. *AlterNative: An International Journal of Indigenous Peoples* 17, 2 (2021), 293–305.

[12] Stephanie Russo Carroll, Desi Rodriguez-Lonebear, and Andrew Martinez. 2019. Indigenous data governance: Strategies from United States native nations. *Data Science Journal* 18 (2019).

[13] Rachel Elizabeth Clarke, Jo Briggs, Andrea Armstrong, Alistair MacDonald, John Vines, Emma Flynn, and Karen Salt. 2021. Sociomateriality of trust: Co-design with a resource limited community organisation. *CoDesign* 17, 3 (2021), 258–277.

[14] Stephen Combs. 2021. Successfully navigating media for the emergency manager. In *Proceedings of the Principles of Emergency Management and Emergency Operations Centers (EOC)*. CRC Press, 183–197.

[15] Louise K. Comfort, William L. Waugh, and Beverly A. Cigler. 2012. Emergency management research and practice in public administration: Emergence, evolution, expansion, and future directions. *Public Administration Review* 72, 4 (2012), 539–547.

[16] Samantha J. Cordova. 2022. Federal indian policy and the fulfillment of the trust responsibility for disaster management in Indian Country. *Justice, Equity, and Emergency Management*. Emerald Publishing Limited.

[17] Ginbert Permejo Cuaton and Yvonne Su. 2020. Local-indigenous knowledge on disaster risk reduction: Insights from the mamanwa indigenous peoples in basey, samar after typhoon haiyan in the philippines. *International Journal of Disaster Risk Reduction* 48 (2020), 101596.

[18] Sharifah Mastura Syed Mohd Daud, Mohd Yusmiaidil Putera Mohd Yusof, Chong Chin Heo, Lay See Khoo, Mansharan Kaur Chainchel Singh, Mohd Shah Mahmood, and Hapizah Nawawi. 2022. Applications of drone in disaster management: A scoping review. *Science and Justice* 62, 1 (2022), 30–42.

[19] Jennifer Esposito and Venus Evans-Winters. 2021. *Introduction to Intersectional Qualitative Research*. SAGE Publications, Incorporated.

[20] FEMA. 2023. *Tribal Declarations Pilot Guidance, US Department of Homeland Security*. Retrieved from https://www.fema.gov/sites/default/files/2020-04/tribal-declaration-pilot-guidance.pdf

[21] Christopher Flavelle, Kalen Goodluck, and In Chefornak. 2021. Dispossessed, again: Climate change hits Native Americans especially hard. *New York Times* 27 (2021).

[22] Sheena Gilbert, Emily M. Wright, Raquel DeHerrera, and Tara Richards. 2021. Conducting research in indigenous communities: Recommendations for research partnerships. *The Criminologist* 46, 3 (2021), 1.

[23] Laura Gonzales, Robin Lewy, Erika Hernández Cuevas, and Vianna Lucía González Ajiataz. 2022. (Re) designing technical documentation about COVID-19 with and for indigenous communities in gainesville, florida, oaxaca de Juárez, Mexico, and Quetzaltenango, Guatemala. *IEEE Transactions on Professional Communication* 65, 1 (2022), 34–49.

[24] Truely Harding, John G. Oetzel, Jeff Foote, and Maria Hepi. 2021. Perceptions of co-designing health promotion interventions with Indigenous communities in New Zealand. *Health Promotion International* 36, 4 (2021), 964–975.

[25] Ashley Hayward, Erynne Sjoblom, Stephanie Sinclair, and Jaime Cidro. 2021. A new era of indigenous research: Community-based indigenous research ethics protocols in Canada. *Journal of Empirical Research on Human Research Ethics* 16, 4 (2021), 403–417. DOI: https://doi.org/10.1177/15562646211023705

[26] Allison Herrera. 2019. When Disaster Strikes, Indigenous Communities Receive Unequal Recovery Aid. Retrieved from http://publicintegrity.org/environment/one-disaster-away/when-disaster-strikes-indigenous-communities-receive-unequal-recovery-aid/
[27] Mikio Ishiwatari, Daniel P. Aldrich, and Daisuke Sasaki. 2023. Who pays? cost-sharing for disaster management in the US and Japan. *Journal of Disaster Research* 18, 5 (2023), 467–474.
[28] Rebecca M. Jonas and Benjamin V. Hanrahan. 2022. Designing for shared values: Exploring ethical dilemmas of conducting values inclusive design research. *Proceedings of the ACM on Human-Computer Interaction* 6, CSCW2 (2022), 1–20.
[29] Meghan Kelly and Simone Taffe. 2022. When digital doesn't work: Experiences of co-designing an indigenous community museum. *Multimodal Technologies and Interaction* 6, 5 (2022), 34.
[30] Heeyoung Kim, Sunmi Jung, and Gihwan Ryu. 2020. A study on the restaurant recommendation service app based on AI chatbot using personalization information. *International Journal of Advanced Culture Technology* 8, 4 (2020), 263–270.
[31] Joyce Hwee Ling Koh, Ching Sing Chai, Benjamin Wong, Huang-Yao Hong, Joyce Hwee Ling Koh, Ching Sing Chai, Benjamin Wong, and Huang-Yao Hong. 2015. *Design Thinking and Education*. Springer.
[32] Tahu Kukutai and John Taylor. 2016. *Indigenous Data Sovereignty: Toward an Agenda*. ANU Press.
[33] Catherine T. Lawson and Karthik Soundara Rajan. 2023. Unmanned aircraft systems (UAS): Applications and integration into hazard mitigation planning. *Journal of Homeland Security and Emergency Management* 0 (2023).
[34] Jason Edward Lewis, Angie Abdilla, Noelani Arista, Kaipulaumakaniolono Baker, Scott Benesiinaabandan, Michelle Brown, Melanie Cheung, Meredith Coleman, Ashley Cordes, Joel Davison, and others. 2020. Indigenous Protocol and Artificial Intelligence Position Paper.
[35] Eddie Lucero, Jessica Trounstine, Jennifer M. Connolly, and Casey Klofstad. 2022. A matter of life or death: How racial representation shapes compliance with city disaster preparedness orders. *Journal of Urban Affairs* 44, 8 (2022), 1168–1185. DOI: https://doi.org/10.1080/07352166.2020.1785303
[36] Rachel E. Luft. 2016. Governing disaster: The politics of tribal sovereignty in the context of (un) natural disaster. *Ethnic and Racial Studies* 39, 5 (2016), 802–820.
[37] Ewa Luger and Abigail Sellen. 2016. " Like having a really bad PA" the gulf between user expectation and experience of conversational agents. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. 5286–5297.
[38] Spero M. Manson and Dedra Buchwald. 2021. Bringing light to the darkness: COVID-19 and survivance of american indians and alaska natives. *Health Equity* 5, 1 (2021), 59–63.
[39] Choctaw Nation. 2023. *Advanced Technology Initiatives*. Retrieved from https://cnoaa.com/
[40] National Congress of American Indians. 2018. *Resolution KAN-18-011: Support of US Indigenous Data Sovereignty and Inclusion of Tribes in the Development of Tribal Data Governance Principles*. Retrieved from https://wwwe.ncai.org/attachments/Resolution_gbuJbEHWpkOgcwCICRtgMJHMsUNofqYvuMSnzLFzOdxBlMlRjij_KAN-18-011%20Final.pdf
[41] National Congress of American Indians. 2020. COVID-19 recovery legislative proposal. In *Proceedings of the COVID-19 Recovery Legislative Proposal (Phase #4)*. NCAI Letter to Congress. Washington D.C.
[42] National Congress of American Indians. 2022. *Tribal Infrastructure: Investing in Indian Country for a Stronger America*. Retrieved from https://www.ncai.org/NCAI-InfrastructureReport-FINAL.pdf
[43] New York State Office of Emergency Management. 2023. *Unmanned Aircraft Systems (UAS) Program*. Retrieved from https://www.dhses.ny.gov/unmanned-aircraft-systems-uas-program
[44] U. S. Department of Justice. 2020. *The Choctaw Nation and its Use of Drones: One on One with James Grimsley*. Retrieved from https://cops.usdoj.gov/html/dispatch/11-2020/The_Chowctaw_Nation_and_its_use_of_drones.html
[45] City of Philadelphia Office of Emergency Management. 2023. *Unmanned Aircraft System (UAS)*. Retrieved from https://www.phila.gov/departments/oem/programs/unmanned-aircraft-system-uas/
[46] Marcia Ostashewski, Shaylene Johnson, Graham Marshall, and Clifford Paul. 2020. Fostering reconciliation through collaborative research in unama'ki: Engaging communities through indigenous methodologies and research-creation. *Yearbook for Traditional Music* 52 (2020), 23–40. DOI: https://doi.org/10.1017/ytm.2020.7
[47] Meg Parsons, Karen Fisher, and Johanna Nalau. 2016. Alternative approaches to co-design: Insights from indigenous/academic research collaborations. *Current Opinion in Environmental Sustainability* 20 (2016), 99–105. DOI: https://doi.org/10.1016/j.cosust.2016.07.001
[48] Dorian Peters, Susan Hansen, Jenny McMullan, Theresa Ardler, Janet Mooney, and Rafael A. Calvo. 2018. " Participation is not enough" towards indigenous-led co-design. In *Proceedings of the 30th Australian Conference on Computer-Human Interaction*. 97–101.
[49] Courtney Potts, Edel Ennis, R. B. Bond, M. D. Mulvenna, Michael F. McTear, Kyle Boyd, Thomas Broderick, Martin Malcolm, Lauri Kuosmanen, Heidi Nieminen, et al. 2021. Chatbots to support mental wellbeing of people living in rural areas: Can user groups contribute to co-design? *Journal of Technology in Behavioral Science* 6 (2021), 652–665.
[50] M. A. Schwartz. 2023. The 574 federally recognized Indian tribes in the United States. *Washington, DC: Congressional Research Service* (2023).
[51] Jesper Simonsen and Toni Robertson. 2013. *Routledge International Handbook of Participatory Design*. Routledge New York.
[52] Lee Sproull, Mani Subramani, Sara Kiesler, Janet H. Walker, and Keith Waters. 1996. When the interface is a face. *Human-Computer Interaction* 11, 2 (1996), 97–124.

[53] Manuel P. Teodoro, Mellie Haider, and David Switzer. 2018. US environmental policy implementation on tribal lands: trust, neglect, and justice. *Policy Studies Journal* 46, 1 (2018), 37–59.
[54] National Training and Education Division. 2023. *National Preparedness Course Catalog*. Retrieved from https://www.firstrespondertraining.gov/frts/npccatalog?catalog=EMI
[55] David Traum. 2017. Computational approaches to dialogue. *The Routledge Handbook of Language and Dialogue. Taylor and Francis* (2017), 143–161.
[56] Chun-Hua Tsai and Peter Brusilovsky. 2020. The effects of controllability and explainability in a social recommender system. *User Modeling and User-Adapted Interaction* (2020), 1–37.
[57] Chun-Hua Tsai, Paul Rayi, Sathvik Kadire, Yi-Fan Wang, Sarah Krafka, Edouardo Zendejas, and Yu-Che Chen. 2023. Co-design disaster management chatbot with indigenous communities. In *Proceedings of the 20th International Conference on Information Systems for Crisis Response and Management (ISCRAM)*. 1.
[58] Meng-Han Tsai, James Yichu Chen, and Shih-Chung Kang. 2019. Ask Diana: A keyword-based chatbot system for water-related disaster management. *Water* 11, 2 (2019), 234.
[59] Jamie Vickery and Lori M. Hunter. 2016. Native Americans: Where in environmental justice research? *Society and Natural Resources* 29, 1 (2016), 36–52.
[60] Maggie Walter, Tahu Kukutai, Stephanie Russo Carroll, and Desi Rodriguez-Lonebear. 2021. *Indigenous Data Sovereignty and Policy*. Taylor and Francis.
[61] Lilia Yumagulova, Meg Parsons, Darlene Yellow Old Woman-Munro, Emily Dicken, Simon Lambert, Naura Vergustina, John C. Scott, Patrick Michell, and Waylon Black. 2023. Indigenous perspectives on climate mobility justice and displacement-mobility-immobility continuum. *Climate and Development* (2023), 1–18.
[62] Lilia Yumagulova, Suzanne Phibbs, Christine M. Kenney, Darlene Yellow Old Woman-Munro, Amy Cardinal Christianson, Tara K. McGee, and Rosalita Whitehair. 2021. The role of disaster volunteering in Indigenous communities. *Environmental Hazards* 20, 1 (2021), 45–62.

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