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Improving Online Community Engagement Practices for Infrastructure Decision-Making: Experiences from Stormwater Infrastructure Management in Houston, Texas during the COVID-19 Pandemic

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Abstract

In response to the COVID-19 pandemic, many community engagement efforts were moved exclusively online. Robust community engagement practices are vital to ensure equitable, inclusive stormwater management and infrastructure decision-making, and the impact of this online shift on community access, representation, and quality of interaction and feedback is not well understood. While in-person community engagement as currently practiced in stormwater management poses several challenges, including achieving representative participation by the target community, cost and time barriers, limited training of on-the-ground facilitators, and the lack of standardization and assessment methods, the challenges, advantages, and best practices of community engagement in online settings is unknown. The need to understand these aspects of online community engagement became more urgent as a result of the rapid and unanticipated shift to online approaches during the COVID-19 pandemic. This paper provides an exploration of the advantages, challenges, and opportunities of online community engagement through a thematic analysis of interviews conducted with 10 facilitators of stormwater projects in the greater Houston, Texas region during the COVID-19 pandemic. Using qualitative thematic analysis, responses were coded into categories and then themes and subthemes based on frequency and salience. Key themes that characterize challenges include perceived access limitations (digital divide - physical), digital literacy (digital divide - cognitive), quality of interaction, community trust, and resistance to online formats. Online community engagement is likely to continue well beyond

the pandemic. Therefore, designing community engagement programs with these challenges in mind is essential for building upon the advantages afforded by online tools. As found in this study, these include increased attendance, removal of transportation barriers and time conflicts, access to non-local experts, resilient communication strategies, organizational efficiencies, improved data collection, and expanded access to information and participation opportunities through recorded events posted online. These findings contribute to improved online community engagement practices for infrastructure decision-making.

Introduction

Scholars, planners, and other decision-makers widely acknowledge the importance of community engagement in infrastructure and environmental decision-making for more democratic processes and better outcomes (Beierle 1999; Carr et al. 2012; Gilman. Hollie Russon 2016; OECD 2001; USACE 2019). Many public agencies funding infrastructure projects require community engagement, and many businesses have included such practices as part of their social responsibility and infrastructure delivery (USACE 2019). While robust community participation in infrastructure planning is vital, ineffective practices, such as placation or symbolic participation (i.e., checking the box), consultation without follow-up and action, public hearings, and opaque decision-making (Arnstein 1969; King et al. 1998), often prevent agencies and communities from reaping these benefits. Instead, these ineffective practices deteriorate community trust in decision-makers and the planning process (Coleman 1988, 1990; Newig and Fritsch 2009; Pretty and Ward 2001; Putnam 1995), contribute to perceptions of unfairness (Abelson et al. 2003; Carr et al. 2012; Lee 1986; Renn 1992), and negatively impact the quality of responses (Abelson et al. 2003; Coote and Lenaghan 1997).

Factors Driving the Engagement Gap

While there are many contributors to ineffective community engagement practices (Cross and Chappell 2022; Dempsey 2010), one factor is that engineers and planners are often tasked with organizing and facilitating community engagement events. Although engineers have the necessary technical knowledge and expertise, they may lack formal community engagement preparation during their education (i.e., the 'engagement gap') (Harsh et al. 2017). Some institutions have incorporated service-learning projects in their engineering curriculum to address this gap (Harsh et al. 2017; Natarajarathinam et al. 2021). However, time and funding have made it difficult for some engineering students to properly engage with service projects and connect their academic work to community desires and knowledge (Dewoolkar et al. 2009; Harsh et al. 2017). Consequently, some engineers struggle to explain

complex, technical material to non-technical community members. While it may be assumed that planners are more skilled at incorporating community priorities gathered during engagement events, a study by the American Planning Association showed that one-third of planners surveyed lacked confidence in determining if planning strategies align with the community resilience priorities (Gomez 2020). At the same time, 70% claimed to be unfamiliar with assessing and analyzing local plans for community resilience (Gomez 2020). Many individuals leading community engagement processes do not have the confidence or skills to facilitate meaningful dialogue with the community or assess the engagement process.

As a result, there is a need for better approaches to bring community preferences and input into the infrastructure design process. Currently, many of these individuals and agencies avoid conflict altogether by deliberately introducing controversial material later in the planning process when little can be done to mediate the community's concerns (Blahna and Yonts-Shepard 1989). This pattern of avoiding controversy by agencies is most evident in their formal adoption of community engagement approaches that strive for broad support and consensus rather than approaches that support discussions around a diverse array of community concerns and iterative design processes (van de Kerkhof 2006).

Factors that Undermine Trust in Community Engagement

An important factor contributing to ineffective community engagement is trust. Some researchers have attributed community sentiments of distrust and infrastructure hesitance to cognitive barriers (Dhakal and Chevalier 2017). These cognitive barriers are information limitations that perpetuate negative perceptions. Researchers have proposed different ways to combat cognitive barriers within communities including through educational programs (Broussard et al. 2001), early and sustained community engagement, and improving access to information (Thorne et al. 2018). Others believe mistrust may be a product of agency personnel, citing low levels of bonding social capital (Putnam 1995, 2000).

Personnel composition in community engagement efforts and, specifically, the lack of inclusion of under-represented minorities (URMs) interferes with building the social capital needed for trust (Fernandez and Nichols 2002). One survey found that Black Americans reported higher trust in the information they received from Black sources (e.g., Black journalists)(Edelman 2020) – a sentiment possibly reflected among other minoritized groups. Black, Latin, and Native Americans have long been under-represented in STEM faculty and students, particularly in environmental engineering and urban planning, with numbers that significantly fail to reflect national demographics

(Blaney et al. 2016, 2018). Well-intentioned, policies and programs aimed at increasing under-represented minorities (URM) in STEM have failed to close these gaps, resulting in rippling effects further down the professional pipeline (Blaney et al. 2018; Hatfield et al. 2022; Montoya et al. 2020). These ineffective policies and the long-standing diversity gaps in agencies add to sentiments of distrust, where communities may feel misled by false promises of change (Edelman 2020). Beyond the obstacles that must be overcome to create a diverse academic to industry pipeline, the issue of how diversity in organizations impacts community engagement, especially in building trust, remains a topic that requires more in-depth investigation.

Community Engagement Frameworks and Standardization

Other researchers have argued that ineffective community engagement may have less to do with facilitators and attributed adverse outcomes to the fact that community engagement practices are not standardized. These practices can vary in efficacy across agencies and suffer limitations of budget and time constraints (Barclay and Klotz 2019; Bice et al. 2019; Innes and Booher 2004). Some proposed frameworks attempt to assist facilitators in adopting reproducible, standard practices. For instance, the International Association for Public Participation (IAP2) and U.S. Environmental Protection Agency (EPA) have developed a spectrum for public participation that has been widely used to both assess and inform the development of community engagement practices (Bice et al. 2019; IAP2 2015; Victorian Auditor-General Office [VAGO] 2017). The United Nations has published several reports on minimum standards and guidelines for community engagement at the international level (Bedson et al. 2020; UN Department of Economic and Social Affairs Division for Public Administration and Development Management 2013). Arnstein's famous "Ladder of Participation" attempts to guide agencies away from processes that lead to "Non-Participation" and "Tokenism" and instead toward "Citizen Control" (Arnstein 1969). Ahmed et al. (2017) developed the Community Engagement Components Practical Model, composed of five components that aim to reduce confusion and increase interaction between facilitators and the community (Ahmed et al. 2017). Some proposed frameworks specifically target facilitators in a specific field (e.g., watershed management) (Sabatier 2005). However, these frameworks often focus on in-person strategies.

Virtual Bridges in a Time of Isolation

As a result of the COVID-19 pandemic, online tools for community engagement have accelerated as a medium for conducting community engagement. While research is limited, there is some evidence that such tools can aid in democratizing knowledge production and expanding opportunities for community members to participate

in the decision-making process. Luke et al. (2018) and Sanders et al. (2020) employed online surveys and in-person focus groups (i.e., a hybrid approach) to co-develop flood hazard maps and recorded improvements in community perceptions of flood risk. Researchers have also explored online tools for community engagement using GIS to foster collaborative discussions with the capabilities of spatial referencing (Hopfer and Maceachren 2007; Rinner and Bird 2009). Other researchers are looking to leverage social media and other online platforms to gauge opinion and suggestions for infrastructure projects through a text-matching scheme (Ashktorab et al. 2014; Evans-Cowley and Griffin 2012; Li et al. 2017). However, these efforts to minimize infrastructure development time and cost while fitting civic activity more conveniently into the lives of the community are confronted by community mistrust in social media, which has been reported globally (YouGov 2020). The use of social media would need to be coupled with online tools dedicated to community engagement. Still, these and work from other sectors can provide a guiding framework to better leverage online community engagement methods for water resource and infrastructure research and decisions.

As the social distancing measures imposed during the pandemic continue to be relaxed, it is unknown how online strategies popularized during the pandemic may permanently change community engagement practices. It is reasonable to hypothesize that hybrid engagement options will emerge, attempting to benefit from the advantages of both in-person and online engagement. One of the leading advantages of online community engagement for facilitating agencies is its high return on investment (ROI) due in part to its time and cost savings (Dougald and Williams 2022). In-person events may need to budget for security, venue rental fees, childcare services, and food, making virtual engagement appealing for agencies seeking to stretch their engagement dollars. Online tools also allow agencies to collect more data with less effort and money than in-person strategies, which rely on budgets for printing event materials and staff time to manually transcribe data (Fan and Fox 2022). However, Fan and Fox (2022) warn that the datafication of civic engagement can also be perceived as a form of surveillance or an invasion of privacy. There are representation advantages afforded by online strategies, including giving temporally or spatially restricted end-users flexibility to attend events. These online strategies can attract more participants and diverse community voices, and without venue occupancy constraints, they are also better equipped to deal with larger quantities of participants. While some community members may benefit from expanded opportunities to participate in civic activity through virtual engagement, some researchers have argued that older populations may be less knowledgeable about the internet and digital devices than younger generations (Harwood 2007). Other

researchers have added that economic (i.e., low-income), geographic (i.e., rural), and social factors (i.e., level of education) may also make online formats prohibitive for some communities or community members (Marshall et al. 2003). However, the digital divide may be less relevant today than it was in the past. A recent poll found that 82% of Americans get their news online (Forman-Katz and Matsa 2022), primarily from organizations' websites, apps, social media accounts, and email alerts (Mitchell et al. 2017), with 67% of adults 65 and older obtaining their news through digital devices at least occasionally (Forman-Katz and Matsa 2022). Another study found that older adults preferred online civic engagement due to their chronic illnesses and mobility concerns (Mukherjee 2011). Online community engagement events are a valuable strategy that agencies can utilize, especially when incorporated in a hybrid community engagement approach. Some evidence in the literature suggests that these methods may be highly effective. For instance, using social media platforms, which were already widely used prior to the COVID-19 pandemic, can help address community challenges and create a space for knowledge sharing (UN Department of Economic and Social Affairs Division for Public Administration and Development Management 2013). Mosconi et al. (2017) found that Social Streets, which are streets or neighborhoods that utilize social media, help increase community turnout for in-person events and assist the community in creating and executing tangible projects.

Study Contexts, Objectives, and Method Overview

The objective of this study is to advance understanding of how online community engagement approaches popularized during the COVID-19 pandemic might continue to impact infrastructure planning and design after the pandemic concludes. To do this, we focus on community engagement for flood mitigation infrastructure in Harris County and the City of Houston, Texas as a case study. Following Hurricane Harvey in 2017, congress approved $4.3B in Department of Housing and Urban Development (HUD) aid for Texas (Willis 2019), while Harris County's 2018 Bond Program approved an additional $2.5B through a county-wide vote (Harris County Flood Control District 2021). These and other financial resources available to Harris County and the City of Houston have allowed the area to become a testbed for innovative watershed management planning and practice as well as allowed the region to address its resiliency challenges, including communication. Dunning (2020) found that some locations impacted by Hurricane Harvey benefited from primed emergency managers who lent their expertise with natural disaster recovery efforts to navigate the complex federal aid process; further, these experts were able to maximize funding from federal grants. Coastal communities and communities confronted by natural disaster across the US can leverage similar funding opportunities and expertise to maximize these opportunities, as demonstrated by Norfolk,

Virginia, New Orleans, Louisiana, and New York, New York for recovery efforts following devastating natural disasters (Morales 2023; Noe 2023)(Layne 2021) (Lander 2022). Still, some communities may need to wait for alternative infrastructure investments (e.g., Infrastructure Investment and Jobs Act (IIJA) of 2021, Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) Act of 2021, and America's Water Infrastructure Act (AWIA) of 2018). In addition to funding, there are also regional contexts. Southern states, such as Texas, tend to have more favorable attitudes toward individual rights as opposed to government-led initiatives (Dunning 2020). For this reason, responses to the transition to virtual engagement formats may reflect underlying sentiments about government imposed social distancing measures. Urban and rural areas may also experience variable sentiments toward COVID-19 preventative measures (Kahanek et al. 2021).

Federal funding sources for Harris County and the City of Houston mandate public participation, while some local agencies have adopted self-imposed public participation for their projects. This case study provides an opportunity to explore online tools utilized by facilitators in Harris County to meet these formal and informal mandates for community engagement in stormwater management and quantify their effectiveness through a qualitative analysis of interviews conducted with key facilitators involved in the process. Findings reflect perspectives of facilitators in the region.

Methods

We utilized interviews with local, state, and federal stakeholders to understand facilitator perspectives on community engagement practices in the case study region of Harris County and the City of Houston, Texas around stormwater infrastructure pre-, during, and post- COVID-19 pandemic-mandated social distancing measures. Before data could be collected, the research protocol, consent forms, recruitment material, and interview materials were submitted to the University of Virginia Institutional Review Board for the Social and Behavioral Sciences (UVA IRB-SBS) and approved. Study interviews were semi-structured to permit participants the freedom to answer questions in a manner most appropriate for their experience; this method also allowed for follow-up questions and discussion. All interviews were conducted during the COVID-19 pandemic through video conferencing tools, Zoom and Google Meet. All references to pre-COVID-19 pandemic engagement refer to reflections and data provided by participants. In this study, post-pandemic refers to the period when local social distancing mandates were eased, and in-person engagement events resumed. The beginning of post-pandemic varies among the facilitators interviewed for this study, and therefore influenced the structure of follow-up interviews. Some of the agencies and

196 organizations that the participants are affiliated with were identified through publicly available reports assessing the
197 study area's stormwater risks. Others were identified by how relevant the agency or organization's goals were to
198 stormwater infrastructure and management. All agencies and organizations identified were denoted as agencies and
199 organizations of interest with relevant stormwater and community engagement experience.
200
201 *Identifying Participants*
202 Participants were identified from the researchers' network and the agencies and organizations of interest
203 identified. From the original sample pool, additional participants were identified through snowball sampling.
204 Individuals were contacted through email to ask if they might be suitable participants in the study; the solicitation
205 also included a request to provide contact information for other individuals with relevant experience. This process
206 identified relevant and accessible individuals with current or previous experience facilitating community
207 engagement for stormwater management and infrastructure. The interviews were conducted across seven
208 organizations and agencies operating at the federal, state, and local levels, with varying involvement in
209 infrastructure projects and planning (Table 1).
210 *Study Participants*
211 A total of 10 participants representing key agencies in stormwater management infrastructure in the study
212 region were interviewed (Table 1). All participants interviewed in this study were associated with agencies
213 facilitating community engagement events except for one participant whose employment history included both
214 facilitator and, more recently, participant experiences. Some agencies were dedicated to the region's stormwater
215 needs while other agencies had broader interests that included stormwater management. These participants and their
216 associated agencies had varying levels of political influence; for example, some agencies had community
217 engagement mandates or were subject to election results which influenced the way the participants representing
218 these entities interacted with the community and viewed community engagement. One participant was deeply
219 engaged with the community and often assisted other agencies with connecting to local leaders for marketing and
220 engagement purposes. Some participants were heavily involved in the community engagement process, but their
221 community engagement events were unidirectional and, at times, singular; therefore, their responses were expected
222 to reflect the conveniences offered by online tools as they primarily relate to their agency's objectives.
223 *Interview Process*

Interviews were first conducted between July 2020 and April 2021 with follow-up interviews (using the same participants) conducted between June 2022 through July 2022. The goal of the follow-up interviews was to identify the common community engagement practices prior to COVID-19 and examine strategies remaining as social-distancing measures were loosened. The levels of involvement assigned to participants in Table 1 follows the International Association for Public Participation (IAP2) Spectrum of Public Participation (IAP2 2015). Figure 1 lists critical features for each low, medium, and high involvement classification.

Each interview was conducted online using video conferencing and was recorded with the participant's informed consent. Participants were asked about their position, familiarity with the study area, frequency of community interaction, how their organization interacts with the community on large stormwater infrastructure projects, and community engagement methods utilized by their organization. Participants were also asked to compare pre-pandemic and pandemic practices and what practices they have kept (or intend to keep) following their agencies return to pre-pandemic protocols. We customized our interview guide before each interview based on the participants' occupation and role in the community engagement process within their organization. Because this was an iterative, qualitative study, we adapted our interview guide as the study progressed.

Data Analysis

All interviews were transcribed using the Rev transcription services, a commonly used software service for translating oral interview recordings into transcribed text. Once the interviews were transcribed, we then began a manual coding of each transcript to begin the process of identifying common themes. We did this by first reading each interview and performing a line-by-line qualitative coding (i.e., first cycle descriptive coding), which is a process of assigning units of meaning that describe what is most salient and essential (Saldaña 2009). Qualitative coding was first performed in Microsoft Word and discussed within the research team; all interviews and codes were then transferred to Dedoose software, a qualitative analysis tool that allows users to monitor code frequency, view excerpts associated with a code, and analyze codes with other input information (e.g., descriptors). Second cycle coding consisted of focused and pattern coding, which took note of patterns that aided grouping of significant and frequent codes into potential themes. We identified and defined salient themes in the interview data during continued, iterative rounds of analysis (Braun and Clarke 2006). While many themes were identified by frequency, some themes were identified by salience, richness, and relevance to "addressing the overall research questions" (Braun and Clarke 2006; Campbell et al. 2021) rather than prevalence of code appearances.

Each theme and its relevant codes helped obtain a greater depth of knowledge on online tools for community engagement in stormwater management and infrastructure through the lens of the facilitator. These themes also helped to identify existing formal and informal metrics for assessing the success of a community engagement event. For example, interviewees sometimes used words such as "evaluation" or "metric" when describing their agency's internal process for assessing community engagement events. In other instances, the interviewee did not use these words explicitly, but would instead refer to characteristics of the event that made it "good" or "justified." In all, these assessments helped us understand why and how agencies would use hybrid options in the future.

Results and Discussion

From iterative coding of participant interviews, we identified nine main themes as particularly salient: 1) efficiencies of online engagement tools, 2) the digital divide as a barrier to adoption, 3) continued challenges to online engagement, 4) importance of the facilitator, 5) broadening participation through online engagement, 6) impact of the COVID-19 pandemic on online participation, 7) importance of funding on online engagement adoption, 8) overcoming the learning curve for online engagement tools, and 9) opportunities for tracking social impact through online engagement. In the following subsections, we discuss the subthemes relevant to each theme, and provide excerpts from our interviews as evidence. Excerpts have been modified as needed to summarize more succinctly (see Table S1 in appendix). Figure 2 provides a micro-level thematic map that visually demonstrates the cross-connection among the main themes and sub-themes identified in this study. While themes and sub-themes have been color coded to visually identify advantages, challenges, and opportunities, it is important to recognize the categorization of these themes is not universal. Even within this study, some agencies had variable responses and perceptions about the content within these themes. The color coding used here reflects a conservative assignment of themes as challenges where we found that the responses of interviewees regarding these themes posed a risk to adopting online engagement. Throughout the subsections, we compare online engagement formats with traditional, in-person formats. Table 4 at the end of our Results and Discussion section summaries the key findings (i.e., themes) and their limitations.

Efficiencies of Online Engagement Tools

The efficiencies provided by online tools was one of the themes that emerged frequently from our analysis. One major contributing factor to this was the facilitator's increased efficiency of conducting community meetings

via online tools. One interviewee stated, "We can host meetings more regularly because of the logistics of virtual formats. With virtual formats, we don't have to worry about reserving venues, hiring security, or staff time." Another interviewee commented how these efficiencies have also translated to cost savings: "We've experienced cost-savings with the virtual formats, especially for our geographically dispersed communities. We don't have to worry about travel, lodging, meals, per diem, or staff time." Other efficiencies emerged in how data is captured and stored in the virtual meeting format: "We're able to retrieve virtual meeting data with SalesForce, and our phone systems now transcribe voicemails." This contrasts with methods used with in-person meetings, where the interviewee reflected on the copious amount of time spent on transcription of input, "I think about the days when everything was handwritten comment cards that we had to transcribe."

The Digital Divide as a Barrier to Adoption

Early in our study, which began in July 2020 after COVID-19 was declared a pandemic, the digital divide was the most frequently identified barrier to implementing online community engagement. Participants expressed concerns that some community members lacked internet access or the tools to participate with online community engagement methods. One interviewee rhetorically asked, "Do they have cameras, technology, and internet bandwidth to participate?" Faulty internet connection is a legitimate concern for rural residents and those living within the metro Houston area. One interviewee noted, "I'm having issues staying connected in the middle of Houston. There's certainly some discrepancies in access." Internet access was cited as one of the reasons a workshop was postponed. Specifically, the interviewee stated, "one meeting was postponed because the stakeholders lacked the high-speed internet capabilities necessary for streaming."

Other participants cited internet access as a barrier to other forms of community engagement, specifically information dissemination and emergency warning systems. As one interviewee noted when discussing challenges to inform the community about risks and critical emergency information, "people are scared when floods come because there's a lot of misinformation and they may not have internet." These findings reflect what has been observed in the literature for online tools in various sectors. Those most impacted by this barrier appear to be the rural (Ramsetty and Adams 2020), elderly (Hargittai et al. 2019), immigrant (Wang et al. 2018), and low-level education populations. Existing literature suggests that the built environment (i.e., lack of physical access), digital literacy, and literacy are the most significant contributors to this barrier within rural, immigrant, homeless, and low-level education communities (Ramsetty and Adams 2020). However, there are notable differences across

socioeconomic statuses as well, with some households unable to afford internet access (or the quality of access) or the technology needed to participate (Freeman 2012).

While individuals impacted by the digital divide may not have computers, one interviewee speculated that many of these individuals own a smart phone and suggested using smart phones to deliver life-saving information during a stormwater emergency. According to another interviewee, many residents in this information vacuum were already using their smart phones to access social media for emergency information: “social media saved lives during Hurricane Harvey. People used social media to contact the city when they needed help.”

Apart from limited access to tools necessary for interacting and communicating on the internet, Harvey and other storm emergencies shed light on the digital infrastructure gaps that would later be identified as challenges for Houston’s larger resiliency goals: “we understood that the digital divide was happening in the city prior to COVID. So, we awarded grants for communities to close that [digital] infrastructure gap in creative ways.” The interviewee emphasized that their experience with the transition to virtual meetings was influenced by their ability to leverage these resources, stating, “we built this robust communications system in response to flood emergencies, but it allowed us to be responsive to the pandemic.” In addition to investments in Houston and Harris County’s communication systems, organizations were already beginning to incorporate virtual meeting options. When asked about community engagement events hosted online pre-pandemic, one interviewee stated, “virtual meetings were already integrated with in-person meetings prior to COVID, and this allowed us to pivot quickly.” This ability to pivot online at the onset of the pandemic was critical for engaging the community about ongoing stormwater infrastructure projects. As one interviewee noted, “That was very instrumental in our success in keeping the communication lines open.”

Part of the agency's success can be attributed to these continuous, bi-directional information flows between the agency and the community, which help build necessary relationships: “relationships are so important. When you have the rapport with the community and you have the communication structure established, you can just ramp it up in time of need.” The ability of different agencies to connect and learn from each other’s experience before and during the pandemic also contributed to agency success, as was highlighted by another interviewee: “also learning from other agencies that have to do what initially starts as crisis communications and then evolves into long term strategic communications.” In another excerpt, collaborative efforts around developing robust and resilient

communication systems were once again recognized as contributors to virtual meeting success: “addressing digital infrastructure gaps was a collaborative effort prior to the pandemic.”

Continued Challenges to Online Engagement

While the COVID-19 pandemic has helped increase usage and familiarity with online tools, some community members still resist these transitions. An interviewee expressed that they think “people aren't comfortable with Zoom. They hide with their cameras off and don't participate.” Overall, the sentiment frequently expressed by some facilitators was that there was a deterioration in the interaction quality with the virtual format — a feature deemed by some agencies as essential for successful engagement. This observation may be attributed to a more recent phenomenon referred to as “Zoom fatigue.” The pandemic and “Zoom fatigue” have revealed the psychological and social consequences of online tools, particularly when used extensively and across numerous communication settings. Bailenson (2021) and Sklar (2020) hypothesize that this fatigue can be attributed to forced eye gazing at close distances that invade personal space, cognitive load due to omission of non-verbal cues, perpetual self-evaluation, and reduced mobility that may interfere with ideation and learning retention. Other researchers examining remote work found strong evidence that camera use was the largest contributor to fatigue and reduced how engaged employees felt (Shockley et al. 2021). They also found that the number of hours spent in virtual meetings was not correlated with fatigue, and women were more likely to experience fatigue due to disproportionate levels of childcare and the “grooming gap” (i.e., the higher expectation of always looking physically presentable). Murphy found that cameras induce an invasion of privacy, where participants may feel judged for their home or personal belongings- especially if meetings are recorded (Murphy 2020). Apart from camera use, technical glitches may also impact interaction quality by disrupting a participant’s ability to focus (Murphy 2020).

Another salient hypothesis arose during one of our interviews: Zoom fatigue in the context of a global pandemic and the associated community losses and deaths. In many neighborhoods, community activism is often spearheaded by older community members, who are the most vulnerable to COVID-19: “many key community leaders passed away from COVID, and that was really devastating for communication. All this information and history passed away with these leaders and that left a significant gap.” Social movements during the summer of 2020, such as the racial justice movement led by Black Lives Matter (BLM), may have also increased anxiety and depression within the community, as suggested in other studies (Hou et al. 2021). People physically and emotionally

invested in these movements may also experience activist burnout, a condition brought about by activism-related stress that overwhelms and debilitates activists' abilities to remain engaged in activism (Gorski 2019; Gorski and Chen 2015; Weixia et al. 2015). In turn, these compounding stressors may have impacted community interactions with facilitators.

Conversations facilitators had with the community validated concerns about Zoom-fatigue, and how extensively Zoom and other real-time online meeting tools were used. One participant reflected on how these conversations shaped their communication strategy: "we understood many residents were Zoom-fatigued. They had to use Zoom for work, to communicate with family, to check on people. Then we were asking them to Zoom with us." Combating Zoom fatigue as it emerged remained key to virtual meeting success. Constant feedback loops helped one interviewee and their organization adapt to the community's needs without compromising a successful engagement event with mentally checked-out participants. The interviewee explained, "we modified our meeting frequency because people were on Zoom for 9-10 hours day, and that gets old quick." The interviewee elaborated further, stating that, "even though participants were tired, we didn't have a lot of absentee because of how we modified our meeting frequency."

Beyond the presence of death, possible activist burnout, and extensive use of online tools during the pandemic, there were also other stress factors present prior to and exacerbated by the pandemic. While this was not mentioned frequently by interviewees, the salience of this observation provides key insight into barriers confronting vulnerable communities transitioning virtually during a pandemic. People in historically marginalized communities "were struggling with food insecurity, affordable housing, paying their bills, or keeping employment." Job loss, health, death, and social isolation have been linked with adverse physical and psychological health outcomes; COVID -19 was an amplified confluence of these stressors (Holmes et al. 2020). Pointing to the contrast between most facilitators and marginalized communities, one interviewee stated, "facilitators often come from a different economic and education status than the community. Many residents don't have college degrees and don't work for employers who prioritize their safety."

In addition to the compounding stress factors experienced by the community, another salient observation was turn over. Facilitating agencies were experiencing high turnover as many of their employees struggled to cope with the pandemic and its associated psychological stresses on top of other events that left them "burnt out": "there was a lot of turnover in many organizations during the pandemic. People were burnt out from Harvey. We were just

seeing progress with the recovery work, and then COVID hit. There was emotional and physical fatigue for many of the workers serving vulnerable communities."

The impact of funding sources on the adoption of online tools was frequently brought up by interviewees. Like some community members, some funding sources that require community engagement prefer traditional methods for engagement, such as in-person meetings. One interviewee facilitating engagement statewide gave the example of a repeatedly postponed community engagement event. The interviewee explained, "our partner's funder did not want them to host the meeting virtually. So, we kept pushing it back." This example highlights the reluctance to adopt online tools for community engagement and resistance to modern technology among entities involved in funding stormwater projects. Contradicting some agencies' sense of reluctance among their funding sources and participants, other agencies working solely within Houston and Harris County felt community members were accustomed to these formats and actively using them as part of their communication toolbox. One interviewee noted when talking about pre-pandemic online tools and their agency's transition to operating completely virtual: "people were accustomed to meeting online for group debriefings or updates." With about 75% of Texas counties listed as rural (Texas Commission on the Arts 2023), the conflicting statements between the facilitators working statewide and facilitators working solely within the urban study area highlight a possible divide between rural and urban engagement preferences. Hong et al. (2018) noticed a similar divide between urban and rural concerns and frequency of engagement with local governments when examining snowstorm tweet communications between citizens and local governments. COVID-19 may have contributed to this study's divide in communication preferences and willingness to adopt virtual formats. Kahanek et al. (2021) found that sentiments toward preventative practices were significantly more negative in rural areas than urban areas. Transitions to virtual formats as a response to social distancing mandates may have spurred control-averse sentiments in rural communities and across the state, where attitudes tend to be more favorable to autonomy and individual rights rather than government-led initiatives (Dunning 2020). Spatial patterns in control-aversion are well documented in the literature (González-Riancho et al. 2017; Schmelz 2021), as well as probable sources for these sentiments (Falk and Kosfeld 2006). It is possible that funding sources and facilitators were influenced by regional attitudes when forming their own opinions about transitioning virtually.

In addition to intangible metrics for meeting success, such as the quality of interaction, agencies frequently cited reliance upon tangible metrics, such as post-meeting surveys. "We've had response rate issues with the virtual

format," stated one interviewee. They continued, "we look at attendance and input, and make revisions to our program to reach more people and provide content and programming relevant to the community." As Table 2 shows for meetings held across Texas since 2020, the interviewee's organization had an average response rate of 22.6% for virtual format events compared to an average response rate of 86.21% for in-person events. This interviewee, in these exact words, went on to describe that participants at in-person events were a "captive audience" that could not easily avoid completing the survey. In a follow-up interview, the interviewee also noted that the virtual format allowed participants to attend during portions of the event that were most relevant or important to them. Without the pressure from the facilitators and their peers, participants engaged in manner that was most meaningful for them, despite the data loss experienced by the facilitator.

Other interviewees felt differently about the response rates between the two formats. One interviewee stated that there was no noticeable difference in response rates between the two formats, but that they did experience a different type of feedback. Elaborating on the responses received for the virtual format, the interviewee stated, "opinionated people are the main ones giving their opinion." The interviewee provided survey responses from two virtual events, which supported his claims. Some of the results are shown in Figure 3 below. Figure 3A shows the percentage of responses received for each of the five options provided for a question about participant satisfaction from the survey. Eighty-two percent of respondents reported feeling satisfied or very satisfied with the virtual format while only 9% reported feeling dissatisfied or very dissatisfied. In another part of the survey, respondents were provided with an opportunity to make a comment or ask a question. Only half of respondents chose to answer this question, and of the responses received, 40% were related to technical difficulties (Figure 3B). Differences between the data provided by both study participants may not necessarily indicate conflicting evidence. The data in Table 2 was provided by a participant who conducts community engagement events across Texas, whereas the data in Figure 3 was provided by a participant who conducts community engagement events only in Harris County. Harris County and the City of Houston were investing in and using online communication systems before the COVID-19 pandemic, likely leading to better online engagement outcomes during the pandemic.

Importance of the Facilitator

Many participants frequently cited previous experiences the community has had with facilitators as influential in community perceptions about agencies and new practices. Previous community engagement events have left some community members feeling that facilitators were not genuinely interested in their input and

feedback; instead, the community felt facilitators were "checking the box." As one interviewee noted, "a lot of residents felt like no one cared about what they needed, what they wanted, and how they felt." These sentiments reflect inadequate community outreach, minimal consideration of community feedback, and a lack of community inclusion in the decision-making process. This is consistent with Bagherian et al. (2009) findings that previous experiences with facilitators are influential in participation in watershed programs in Iran. The community has not refrained from expressing their opinions about the organizations and agencies behind stormwater infrastructure projects. "They're very vocal about it," one interviewee stated, "They're not shy. They'll tell you, 'No one cares. No one's coming into our community and investing [for] decades'." One interviewee believes many of these issues stem from how regional agencies have historically approached engagement events as more of an outreach effort. Goodsell (1985) discussed how negative encounters with government agencies were more memorable and often led communities to discount and minimize positive experiences - a phenomenon known as availability heuristic. The interviewee continued that recent leadership changes have addressed many of the community's grievances with agencies working in stormwater management. Elaborating on the impact of this leadership, they explained, "one major point the community highlighted was previously, they felt the leadership treated their community engagement programs as outreach rather than engagement, where it necessitates to hear what the residents' concerns, questions, preferences are. With the recent changes, the community feels these meetings are more like an engagement and their voices are finally being heard."

This new leadership was not only interested in bridging the communication gaps but also in data gaps. In the wake of Hurricane Harvey and other stormwater emergencies, the region experienced a data revolution. Decision-makers became interested in how data can inform decision-making and designs, and how the community's voices can be part of that data. According to one interviewee, "everybody started to look at how data can, should, and will inform our decisions to make the best choices for the people we're trying to serve. We already started this culture of participatory planning, going into the communities, having meetings with the residents, hearing their voices, hearing their real experiences. And then coming back to the table to create solutions that they have shared with us will work." Reactions from the community to changes in leadership and improved transparency of decision-making through data support Berman (1997) theory that responsiveness to community cynicism can improve trust.

Broadening Participation through Online Engagement

Interviewees frequently discussed how some community members who faced physical barriers to in-person participation in the past found the new virtual format particularly appealing. One interviewee pointed out that community members may have time conflicts with in-person community engagement events: “people work, and sometimes these meetings are in the morning when everyone is at work.” This interviewee added that virtual formats “allowed more people to participate because they don't have to worry about transportation, time conflicts, or childcare. Technology has opened the field to have more diverse voices at the decision-making table.” Evidence in the literature supports this observation that some groups, disproportionally historically marginalized communities, more often encounter these specific barriers to participation (King et al. 1998; McBride et al. 2006). However, the lack of demographic information accompanying attendance makes it difficult to measure how virtual engagement formats may have improved representation of these marginalized groups. Dougald and Williams (2022) found that only half of state Departments of Transportation (DOTs) collect demographic information, making these results in the stormwater sector relatable to the challenges other sectors face in improving equity in public infrastructure projects. Despite the omission of demographic information, reported increases in attendance are still a valuable metric for some facilitating agencies who may use attendance as a proxy for representation and quality. This highlights the nuances of attendance and the way facilitating agencies value and use it.

Data provided by another interviewee support claims of increased attendance (Table 3, Figure 4). Their agency experienced a 32% increase in overall attendance using the virtual format compared with the in-person format. Additionally, the average number of participants per event increased by 64%. Their agency experienced a turnout of 646 participants at one virtual event. This event is an outlier, and all factors contributing to this large turnout cannot be delineated from the data provided. However, the statistics are telling even with its removal (Table 3). Figure 4 shows that while both data are positively skewed, the virtual format has more events with high turnout. Moreover, this agency is not alone in this surge of attendance through online formats. Another agency also observed record high attendance at one of its online events. This interviewee attributed their large turnout to the accessibility of their event and their ability to attract a broader range of experts and participants. While initially concerned over accessibility prior to transitioning online, other virtual events hosted by this agency following our first interview have benefited from these privileges: “the virtual format allows folks to Zoom in at their convenience or when a particular topic interests them.”

Other researchers have found that increases in civic engagement during the pandemic can be attributed to social isolation and the stronger desire to cultivate a sense of community online (Yazdani et al. 2022).

Impact of the COVID-19 Pandemic on Online Participation

Online meetings were available before the COVID-19 pandemic; however, as one interviewee noted, turnout was not high: "our virtual format option was probably the least popular. It was always poorly attended pre-COVID." One interview described the pre-COVID-19 era as "almost two separate audiences: people who loved to meet in-person and never engaged with us virtually. And then, the tech savvy people who never attended our in-person meetings." However, in the wake of COVID-19, interviewees frequently brought up observed changes in participation. The interviewee cited above felt there was a "coalescence of the two where the people who previously just like in-person meetings are doing more on the virtual environment." This coalescence can be attributed to a larger effort by senior adults and their families to maintain socialization and combat loneliness during the pandemic (Elimelech et al. 2022; Haase et al. 2021). One interviewee found that older participants "were really reluctant at first, but they acknowledged that we couldn't do in-person meetings." Like findings in the literature (Haase et al. 2021), many of these seniors gradually picked up the skills necessary to use technology and engage virtually: "then we started seeing more of those representatives on our virtual meetings once they got used to the system. We made it very convenient to where people could access it on their phones or laptops."

According to the participants in this study, the COVID-19 pandemic made people addicted and hungry for information. Speaking about the previously described event (i.e., the virtual event with 646 participants), the interviewee stated, "there was an information vacuum when we hosted our first virtual meeting. Attendance was triple, quadruple what we had in-person. People were starved for information updates." Their observations can be validated by a recent study that found that those who reported feeling worried about the pandemic were more likely to seek out information, even from sources unrelated to COVID-19 (Abir et al. 2022). In addition to the pandemic, social movements were taking place across the United States. Concern over these events may have also added to the community's anxiety, and thus their desire to participate in virtual events (Hou et al. 2021; Weixia et al. 2015). As one interviewee noted, "we've seen an uptick in open records requests. People are asking for documentation to prove we're doing what we're saying and engaging with the public." It is difficult to delineate why community members are exhibiting these pro-social norms. The examples provided above center around individual willingness to

participate and seek information. However, other factors such as eliminating transportation barriers and time conflicts may also play a significant role.

Importance of Funding on Online Engagement Adoption

Funding sources for the agencies interviewed in this study appeared to determine their willingness to adopt online meeting formats—not only for their stated preferences but in how they mandated community engagement. The importance of funding sources was frequently observed. Agencies operating with grants tended to have more flexibility about when to host meetings. Occasionally, grants may span several years, and deliverables may be completed at any time over that period. However, agencies operating with tax dollars need to be more transparent and often have policies dictating requirements to meet with the public more frequently. For instance, they may be required to meet with the community at specific points in a project timeline. Another factor contributing to an agency's willingness is its role in stormwater management. For example, some participants interviewed in this study represent agencies with missions centered around information dissemination, while others were more concerned with stormwater management and infrastructure projects. These stormwater projects are often bound to broader political and socio-cultural contexts, making them inevitably politically contentious. The engineers behind these infrastructure projects are also marred by the political nature of their work, as they often determine how resources are disbursed. Some researchers argue that the science and engineering used in disbursements of resources and stormwater infrastructure decisions make them a de facto political institution — or a technocratic government making high-impact decisions (Björkman and Harris 2018; Connelly 2012; Finewood et al. 2019; Sabbagh 2017). In contrast to project-centered community engagement, information-based meetings can feel more voluntary and less risky (e.g., no influence on infrastructure decisions) for their community.

Overcoming the Learning Curve for Online Engagement Tools

In the initial interviews, the learning curve for transitioning to a virtual format was frequently mentioned by all agencies and cited by some as particularly burdensome — with specific examples citing time and costs associated with the transition. However, follow-up interviews revealed many factors contributing to a facilitating agency's overall experience, thus resulting in conflicting statements. As the interviewees stated, Houston had been building up its communication and internet infrastructure in the years leading up to COVID-19 due to environmental emergencies. According to Resilient Houston's 2020 report, emergency alert communication systems were identified as a challenge in meeting the city's resiliency goals (Turner et al. 2020). For this reason, transitioning

online in Houston and Harris County was easier during the pandemic because the infrastructure was there. In fact, several of the agencies interviewed in this study were able to transition entirely within a few months: “it took three to four months to reassess what's the best approach to community engagement. We obviously couldn't meet with people in person." As previously noted, other interviewees cited collaborations with other agencies working in the region as essential to their success. For community members, the adaptation was necessary, and the anecdotal demographic information indicates senior presence at virtual meetings. However, agencies working throughout the state (i.e., beyond the study area) did not always benefit from the resilient communication system developed for Harris County, and their experiences may reflect a more difficult transition in under-resourced regions.

There are those who would prefer to return to in-person meetings, such as some of the facilitators interviewed in this study. For instance, one interviewee stated, “I love in-person meeting – interacting face-to-face and capturing non-verbals.” Another interviewee felt similarly, stating, “We understand [and] enjoy the benefits technology brings us, but it does not replace in-person interaction.” However, regardless of facilitator preferences, it is important to continue giving the community options. Hybrid versions were already emerging as agencies eased their social distancing measures. As one interviewee noted, even though “people are grateful we've returned in-person, hybrid options are necessary for individuals with transportation barriers, health concerns, or childcare needs.” The interviewee emphasized the importance of moving toward a hybrid approach for those who cannot attend and provide feedback in-person. There may be other ways to integrate technical aspects in-person as well. One interviewee suggested that such integrations can allow their agency to be more efficient in-person as well: “in the future, hybrid options that integrate in-person events with the technology from online formats (e.g., tablets) will help us capture data accurately and efficiently.”Calil et al. (2021) found that the use of virtual reality at engagement meetings enhanced environmental literacy, improved dialogue and inclusivity, evoked stronger emotional responses, and increased attendance. The incorporation of technology at in-person engagement events is likely to increase in the future and will provide opportunities to investigate their impact further.

Opportunities for Tracking Social Impact through Online Engagement

Finally, there may be a way to track social impact, a theme identified by salience. Online community engagement tools, when coupled with deliberative processes, provide a continuous and open platform for a broader range of community members to express their grievances. More importantly, the capability of online tools for providing regular contact between facilitators and community members presents an opportunity for agencies to be

584 more tuned in on community needs and priorities, thus improving community trust. Within the study area, there are
585 individuals and agencies working to improve and measure social impact while simultaneously democratizing data.
586 One interviewee cited a collaboration with a tech company to track the impact of the agency's grant program on the
587 community. The team looked at 311 calls and other factors and compared this data to community members' self-
588 reported use of grant money to determine if there is a reduction in crime, homelessness, or improvements to health
589 and well-being. Their work can be replicated to evaluate social impacts of continued online engagement and
590 implementation of hybrid engagement models; even more, these methods can also be translated for an evaluation of
591 engineering projects under these socioeconomic metrics.

592 Other researchers have cited "jargon" and the time to process information as challenges to community
593 engagement success (Abelson et al. 2003; Benson et al. 2014; Coote and Lenaghan 1997; Harden et al. 2015; Rinner
594 and Bird 2009; Rowe and Frewer 2008). Improved resource availability and perceptions about project relevance
595 may foster sustained development (Carr et al. 2012). Online tools can assist in these efforts by integrating data that
596 is important and relevant to the community's needs and priorities; the transparency and accessibility offered by
597 online tools through their datafication of community engagement can also improve trust, accountability, and
598 legitimacy of stormwater management infrastructure. As the interviewee emphasized, caring about the people in a
599 community means being "intentional [about] how we gather data, how we represent the data and how we tell the
600 story." However, Fan and Fox (2022) cautions that datafication of civic engagement can raise concerns about
601 privacy and surveillance; this may be particularly true for communities with low levels of trust and cynicism toward
602 facilitating agencies. Therefore, strategies to collect and utilize data from community engagement should be
603 balanced with community perceptions of these processes.

604 **Conclusion**

605 Online tools should be part of a resilient and robust communication strategy. The COVID-19 pandemic
606 forced stormwater management agencies and other business lines to acknowledge the limitations of traditional, in-
607 person communication strategies and adapt to the challenge of keeping the public informed. Early investment in
608 information and communication infrastructure can not only improve emergency warning systems during storm
609 events but allow stormwater agencies to pivot this resource quickly in an unanticipated crisis. Resilient
610 communication streams provide the community with real-time information about ongoing stormwater projects and
611 protect agencies from failing to conduct mandated community engagement, delaying project timelines, and inciting

612 public backlash. Incorporating virtual engagement options ahead of an emergency can also provide agencies with
613 the opportunity to improve computer literacy (i.e., the necessary skills for engaging and accessing digital content)
614 within the communities they serve. Diversifying communication streams should be a part of the design process and
615 contract documents. Contractual obligations to seek open and resilient communication lines, such as hybrid
616 solutions that involve both in-person and virtual engagement events, can spur research and development for better
617 virtual engagement technologies. While planners, designers, and engineers cannot address all social issues in one
618 comprehensive technology, online community engagement tools are a step toward improving access equality,
619 transparency, and accountability. Mandates for the inclusion of these virtual strategies and future research in this
620 area signal a commitment and interest in community input while enabling and empowering community members to
621 understand and participate in solving community problems.
622 While anecdotal information provides some insight about representation at virtual events, demographic
623 information collected at future events could allow for a comprehensive assessment of the digital divide; this
624 information may also provide valuable insights about demographic differences between in-person and virtual events.
625 This study was conducted during COVID-19, and the results may capture manifestations of broader social
626 issues impacting the community. Therefore, the timing and circumstances surrounding transitions to virtual formats
627 may have fueled negative sentiments and control-aversive behavior. As time separates us from the impacts of the
628 COVID-19 pandemic, future studies can benefit from comparing their results with this study and how online tools
629 have evolved in response to the concerns identified here.

630 **Data Availability Statement**

631 Data with identifying information removed that support this study's findings are available from the
632 corresponding author upon reasonable request.

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635 **Supplemental Materials**

636 Table S1: Original quotes with modifications to summarize interview responses succinctly are available
637 online.

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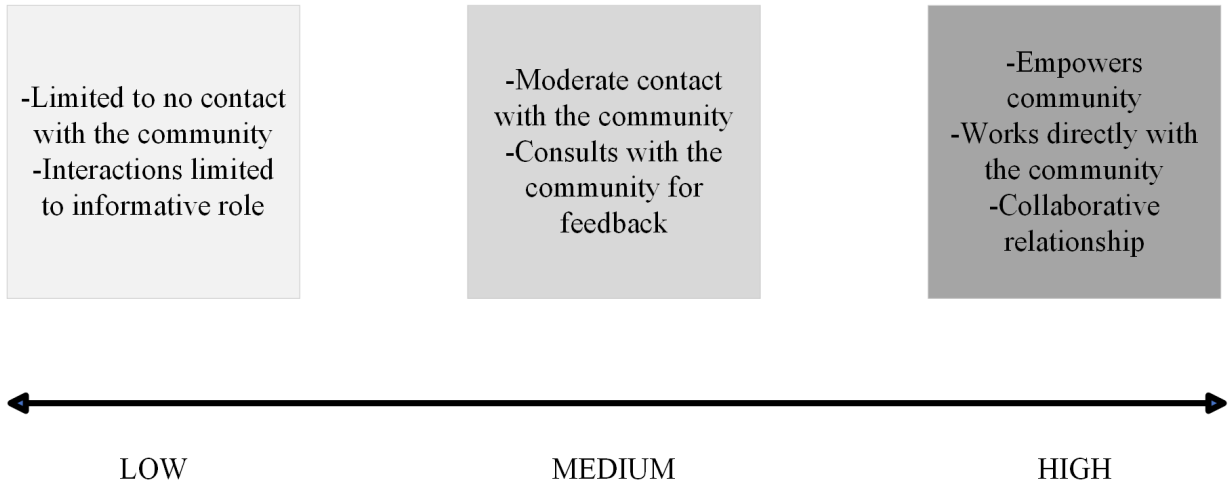

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877 **Figure 1.** Spectrum of involvement in the community engagement process

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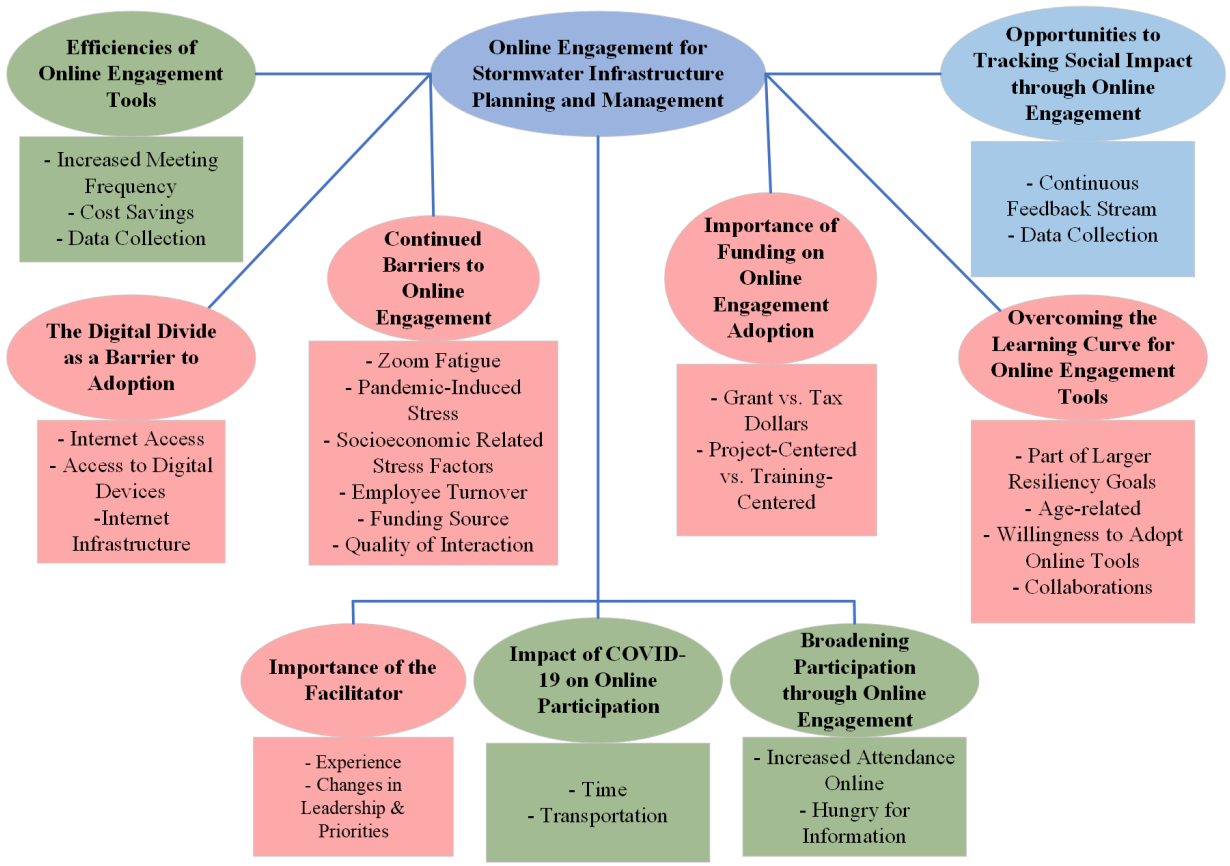

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881 **Figure 2** Micro-level thematic map demonstrating the cross-connections among the main and sub-themes identified

882 in this study. Main and sub-themes are categorized as advantages (green), challenges (red), and opportunities (light

883 blue).

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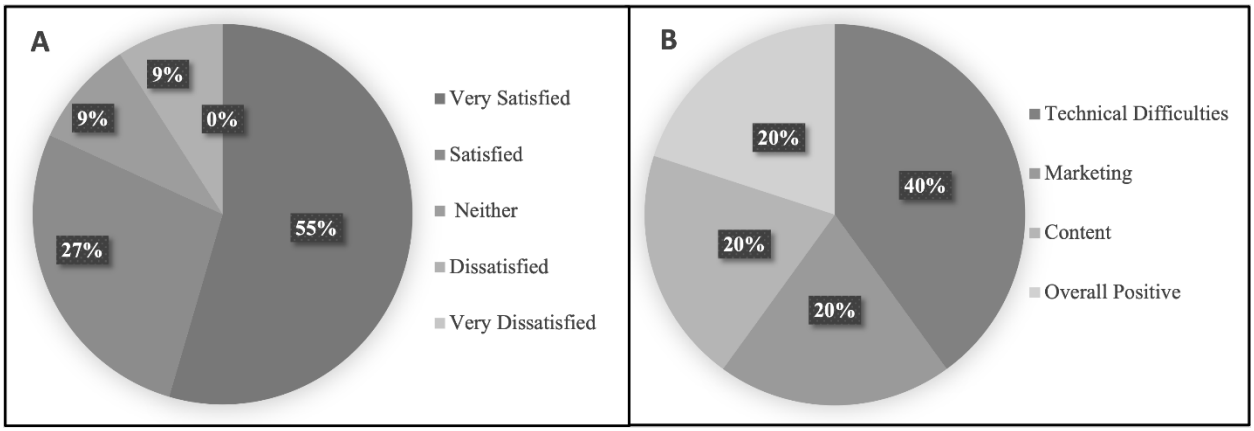

Figure 3 Post-virtual-meeting survey results from a participant's organization. A) Results from a survey question about participant satisfaction with five choices for respondents. 82% of respondents reported feeling either very satisfied or satisfied with the meeting while only 9% reported feeling dissatisfied. There were no respondents that expressed feeling very dissatisfied with the meeting. B) Results from a survey question prompting participants to leave a comment or question. 40% of respondents made comments about technical difficulties they experienced while attempting to join the meeting or while in the meeting (e.g., asking questions). 20% of respondents were concerned with marketing strategy, stating that they were not aware the meeting was taking place in a timely manner, or that meeting information was posted in an obscure location. Marketing and content concerns were more related to organizational mishaps rather than with the virtual format.

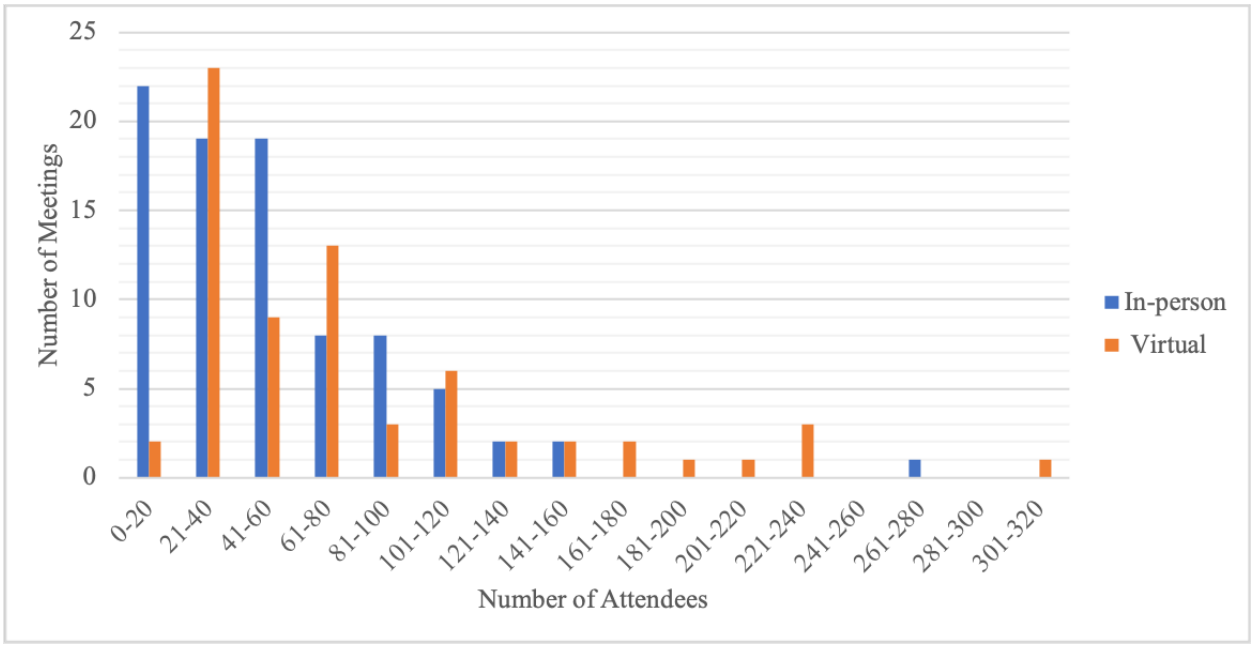

Figure 4 The number of attendees (based on the largest event after the outlier was removed) were divided into bins of equal width. As expected, there are more events with low attendance than events with high attendance for both formats. However, around 96.5% of in-person events had less than or equal to 140 participants compared to around 84% for online events. This information coupled with the information in Table 3 provide evidence that online formats are more likely to attract larger audiences.

Table 1. Participant occupation and organization type. Colors correspond to the level of involvement with light, medium, and dark grey associated with low, medium, and high levels of involvement, respectively. (See Fig. 1)

Participant Occupation	Type of Organization	Involvement in Community Engagement Process
Project Manager	Federal	Low
Environmental Specialist	NGO	Low
Community Outreach	NGO	High
Engineer	County	Medium
Professor	University	Low
Communications Officer	County	High
Program Coordinator	State; University	High
Program Director	State; University	High
Advisor	County	Low
Advisor	County	Low

Table 1. Post-meeting survey response rates for virtual and in-person formats

County	Number of Surveys Received	Number of Participants	Response Rate (%)	Event Format	Average (%)
Guadalupe	9	35	25.71	Virtual	22.60
Comal	1	19	5.26	Virtual	
Ellis	11	35	31.43	Virtual	
Taylor	7	25	28.00	Virtual	
Walker	21	21	100.00	In-Person	86.21
Cameron	21	29	72.41	In-Person	

911 **Table 2. Attendance statistics for in-person and virtual meeting formats. There were 86 in-person**

912 **meetings and 69 online meetings over the study period**

				% Difference Between In-Person and Virtual	
Statistical Variable	In-Person	Virtual	Virtual (outlier removed)	With outlier	Without Outlier
Total	4533	5970	5324	31.70	17.45
Minimum	4	12	12	200.00	200.00
Maximum	268	646	318	141.04	18.66
Mean	52.71	86.52	78.29	64.15	48.54
Mode	50	38	38	24.00	24.00
St. Dev	43.57	92.39	62.62	112.02	43.72
Range	264	634	306	140.15	15.91
Variance	1898.70	8535.08	3921.88	349.52	106.56
1st Quartile	20.5	35	34.75	70.73	69.51
3rd Quartile	68.75	107	102.5	55.64	49.09

913

914 **Table 3 Summary of key findings and limitations of this study**

Key Findings	Summary	Limitation
Organizational Efficiencies	Online events do not require venue rental, security, childcare, staffing, food, or other accommodations. Therefore, they offer cost-savings and reduced planning time, and allow agencies to host meetings more frequently.	It is unclear if additional expertise may be required for managing virtual engagement platforms and addressing technical difficulties experienced by participants.
Digital Divide	There are discrepancies in internet and technology access and digital literacy, known as the digital divide. The divide disproportionately impacts elderly, rural, low-income, homeless, immigrant, and low-level education communities most.	With increases in attendance and lack of demographic information, its difficult to measure the impact of the digital divide in this study.
Quality of Interaction in Online Engagement Meetings	The transition to virtual formats marked a deterioration in interaction quality, according to some participants in this study. Examples provided include virtual engagement participants keeping their cameras off during events and not completing post-meeting surveys.	Camera use in virtual meetings contributes to fatigue and lower levels of engagement. This is likely the result of an increase in cognitive load (e.g., forced eye gazing and identifying non-verbal cues) and sentiments of invasion of personal space. Women were more vulnerable to fatigue during the pandemic due to disproportionate levels of childcare

		and the grooming gap (i.e., the higher expectation on physical appearance). Activists were also more likely to experience anxiety, depression, and burnout from social justice movements. This may have impacted their level of engagement. COVID-19 created new stressors, like death and illness, while exacerbating others (e.g., employment, housing, childcare, food security). Facilitators working closely with the communities in this study were experiencing burn out and turnover from back-to-back emergency events. This may have required additional efforts to reestablish trust within communities and impacted engagement quality.
Increased Attendance at Online Engagements	Facilitators interviewed in this study reported increases in attendance. Even with an outlier event removed, one agency experienced a 48% increase in the average number of attendees at their virtual engagement events compared with their in-person events.	Online engagement meetings allow a broader range of audience members, including individuals who may not be from the target community near a project. Additionally, data provided by participants did not include demographic information. For this reason, it is difficult to know if community members with different socioeconomic characteristics in the target community were represented at the virtual engagement events cited in this study. Additionally, researchers have revealed that anxiety related to COVID-19 induced information seeking behavior. It is unclear if increases in attendance during the pandemic were the result of information seeking behavior or the desire to combat social isolation with virtual civic engagement.
Funding Sources Influenced Agency Adoption of Online Engagement	Mandates on community engagement by funding sources required some agencies to adopt virtual formats quickly, particularly those that impact project timelines. Other agencies were information-based and had fewer time constraints on conducting engagement.	Funding sources and community engagement mandates vary from city to city and from agency to agency. Therefore, there are local and regional contexts for the results in this study.
Datafication of Engagement Through Online and Hybrid Meeting Formats	Virtual and hybrid engagement meetings as well as the use of digital devices at in-person meetings allow facilitating agencies to collect more information quickly, increase trust through improved accountability and transparency, and increase the time community members have to process and understand meeting materials.	Datafication of engagement can lead to perceptions of surveillance and invasion of privacy. Integrating digital devices at in-person events may require additional personnel and time to assist community members in using these devices.

915

916 **Table S4. Original quotes with modifications to summarize interview responses succinctly**

Original Quote	Modified Quote

“We're holding [virtual meetings] more regularly as well. We're probably doing about 20 percent more meetings in a typical calendar year because the logistics of pulling it together where we don't have to reserve venues, […] the security and staff time has helped us become more efficient and hold more meetings throughout the year as well. So, just a lot of efficiencies.”	"We can host meetings more regularly because the logistics of virtual formats. With virtual formats, we don't have to worry about reserving venues, hiring security, or staff time"
“[Our organization is] based in Houston […] travel costs, you know, it can be significant […] if you're taking a team of folks from Houston down to the city of Harlingen down to the lower Rio Grande valley, that adds up. We had to fly folks down there and put folks up in hotels, meals, and per diem, and stuff.”	"We’ve experienced cost-savings with the virtual formats, especially for our geographically dispersed communities. We don't have to worry about travel, lodging, meals, per diem, or staff time."
“In terms of efficiency, we have all the systems in sync. Now we have Salesforce to get the database queries from the website from the meetings. And our phone systems now transcribe voicemails so that it's all captured now.”	"We're able to retrieve virtual meeting data with SalesForce, and our phone systems now transcribe voicemails."
“I think about the days when everything was handwritten comment cards that we had to transcribe.”	N/A
“Do they have cameras and technology that allows that to happen? Do they have the available internet bandwidth to host those things or to participate?”	"Do they cameras, technology, and internet bandwidth to participate?"
“I'm home in my house, in my apartment in the middle of Houston, and I'm having issues staying connected to the internet. There's certainly some discrepancies in access.”	"I'm having issues staying connected in the middle of Houston. There’s certainly some discrepancies in access."
“one of the reasons why the one workshop has been postponed is because they just didn't feel like the stakeholders really had the high-speed internet capabilities to stream something like that.”	"One meeting was postponed because the stakeholders lacked the high-speed internet capabilities necessary for streaming"
“they're very scared when a flood comes, they don't know where to go. They have a lot of misinformation. A lot of them may or may not have internet. So, there are a lot of hurdles that we have to get over to address this issue.”	"People are scared when floods come because there's a lot of misinformation and they may not have internet."
“many, many iPhones and smartphones are out there in those communities.”	"Many community members own smartphones"
“it was social media that saved a lot of lives during hurricane Harvey because people used their Facebook, Instagram, sites to communicate with the city to say, ‘Hey, we're stuck in this house.’ Or you know, ‘my neighbor is sitting on the first floor in six feet of water.’ Like, they were able to use those tools to communicate, to get help where it was needed. So, it was just a national inclination to go back to what worked.”	"Social media saved lives during Hurricane Harvey. People used social media to contact the city when they needed help."
“we understood some of the digital divide that was happening in the city prior to COVID. So, we had, we called them small grant projects, early action projects […] where we were already working in several communities to close that infrastructure gap with creative ways.”	"We understood that the digital divide was happening in the city prior to COVID. So, we awarded grants for communities to close that infrastructure gap in creative ways.

“the fact that we had to build more robust communication systems because of the storms that we were getting in, it seemed like every year it was cranking up […] So, we had to have the infrastructure established to be responsive to the unknown. So, that kinda put us ahead of the rest.”	"We built this robust communications system in response to flood emergencies, but it allowed us to be responsive to the pandemic"
“we would do a lot of face-to-face, but occasionally we would have [virtual meetings], we had the infrastructure to go online quickly and the pivot that took place was very beneficial for us because we had an organization that had the resources and the know how to pivot quickly.”	"Virtual meetings were already integrated with in-person meetings prior to COVID, and this allowed us to pivot quickly"
"That was very instrumental in our success in keeping the communication lines open.”	
“I feel like relationships are so important in the work. And so, if you already have strong relationships, you have the rapport with the communities and you have some type of communication structure established already. You can just ramp it up in times of need versus trying to build from scratch.”	"Relationships are so important. When you have the rapport with the community and you have the communication structure established, you can just ramp it up in time of need"
“Also learning from other agencies that have to do what initially starts as crisis communications and then evolves into long term strategic communications.”	
"I think it was the collaborative effort across the board, local government, you know, nonprofits, and the community leaders themselves prior to the pandemic hitting, we understood the gaps that existed because of Harvey.”	"Addressing digital infrastructure gaps was a collaborative effort prior to the pandemic"
“Some folks aren't comfortable with Zoom, some folks hide on Zoom with their cameras off, or really aren't participating as much.”	"People aren't comfortable with Zoom. They hide with their cameras off and don't participate."
"I think what was really devastating about communication was the deaths that were taking place. Many key community leaders passed away from COVID during that time […] So those communities that had all this information, had the history, passed away and then it left a significant gap.”	"Many key community leaders passed away from COVID, and that was really devastating for communication. All this information and history passed away with these leaders and that left a significant gap."
“We also understood that many of our residents and leaders were Zoom fatigued. Not only did they have to be able to Zoom for their own work, the real day jobs, but then they were communicating via Zoom for family members, checking on people, whether across town or across the nation. And then, we were asking them to join on Zoom for a weekend training or a weeknight meeting.”	"We understood many residents were Zoom-fatigued. They had to use Zoom for work, to communicate with family, to check on people. Then we were asking them to Zoom with us."
“we were really intentional about spacing it out, because we understood some people had been staying on Zoom like 9- 10 hours a day. And, that gets old quick, and you sometimes lose the attention or the investment of a person if it's just solely online.”	"We modified our meeting frequency because people were on Zoom for 9-10 hours day, and that gets old quick"
“Even though they were tired, we didn't really have a lot of absentee and we set up our meets. But like I said, we were very intentional on how we did that. We moved it to monthly.”	"Even though participants were tired, we didn't have a lot of absentees because of how we modified our meeting frequency"

“Were struggling with food insecurity. They were already struggling with affordable housing or paying the bills for utilities that were growing up […] many of them struggled with just keeping employment.”	"Were struggling with food insecurity, affordable housing, paying their bills, or keeping employment."
“Many of [the facilitators] were blessed to be able to work from home because of [their] career choices, educational status. But what about those residents that did not have a college degree or did not work for an organization that prioritized safety? And they had to go in anyway or else they wouldn't get paid or lose their job. So, it was a lot of that happening in real time.”	“Facilitators often come from a different economic and education status than the community. Many residents don't have college degrees and don't work for employers who prioritize their safety.”
“Then you had the issues with turnover in many organizations, cause we were already burnt out from Harvey. So, you have to take into consideration: the timeline, the chronology of what happened. So, we were just off the Hills of recovery for Harvey, and then COVID hit not even a year later from like that pivotal point where we were seeing progress with recovery work for the hurricane. And so, it was just emotional fatigue and physical fatigue for many of the workers working to serve these vulnerable communities because it was one thing after the next.”	“There was a lot of turnover in many organizations during the pandemic. People were burnt out from Harvey. We were just seeing progress with the recovery work, and then COVID hit. There was emotional and physical fatigue for many of the workers serving vulnerable communities.”
“We did have one on the books that, it was in partnership with [partner organization], and their funder did not want them to do it virtually. So, we kept pushing that one back and pushing that one back. But now it's scheduled for May of 2021, and it's going to be virtual.”	"Our partner's funder did not want them to host the meeting virtually. So, we kept pushing it back."
“There was an online space where they're accustomed to us meeting anyway, to have those group debriefings and updates and things like that.”	"People were accustomed to meeting online for group debriefings or updates"
“We've had response rate issues with the virtual format,”	
“But we do look at the participant and the input we get from them and try to make revisions to our programs to allow us to reach more people and provide content and programming that's really relevant to the communities we were working in.”	"We look at attendance and input, and make revisions to our program to reach more people and provide content and programming relevant to the community."
“You have your people who are really for, or opposed to the setup are the main ones giving their opinion.”	"Opinionated people are the main ones giving their opinion"
“A lot of residents felt like no one cared about what they needed, what they wanted, and how they felt.”	
“They're very vocal about it,”	
“They're not shy. They'll tell you, ‘No one cares. No one's coming into our community and investing [for] decades’.”	
“[this leadership] understood the benefits of engagement, not just outreach, but you want to engage the residents, have them understand the language, you're speaking the projects, what the impact's gonna be. So, they're willing to kind of grab the resident's hand and walk with them through the process versus some other organizations there have a, well, as long as we set a meeting on the calendar and a few people showed up, we did our part, that's outreach. Um, but there is a difference between outreach and engagement. You need	"One major point the community highlighted was previously, they felt the leadership treated their community engagement programs as outreach rather than engagement, where it necessitates to hear what the residents' concerns, questions, preferences are. With the recent changes, the community feels these meetings are more like an engagement and their voices are finally being heard.”

both. You need to educate, which is what outreach does, but engagement gives residents the opportunity to participate in the process and be a decision maker with others around the table.”	
“We were experiencing a Renaissance of data-driven work. So, all organizations, be it local government, private business or NGOs or nonprofits, everybody had started to look to how data can, should, and will inform our decisions to make the best choices for the people we're trying to serve. So, we already had started like this culture of participatory planning, going into the communities, having meetings with the residents, hearing their voices, hearing their real experiences. And then coming back to the table to create solutions that they have shared with us will work versus us going in there telling them what we think will work because we don't live there.”	"Everybody started to look at how data can, should, and will inform our decisions to make the best choices for the people we're trying to serve. We already started this culture of participatory planning, going into the communities, having meetings with the residents, hearing their voices, hearing their real experiences. And then coming back to the table to create solutions that they have shared with us will work.”
“You have to remember sometimes they schedule these meetings where people can't attend if they have a job. And so, it happens in the middle of the day or the first thing in the morning while everybody, the rest of us are at work.”	"People work, and sometimes these meetings are in the morning when everyone is at work."
“Really opened up the opportunity for a different set of people to engage and participate because they don't have to worry about travel time, [they] don't have to worry about somebody watching the kids, [they] don't have to worry about the time of day it takes place. If they can, if it's around lunchtime, they'll take their lunch and participate. If it's at like five or six o'clock, that's not a heavy lift because they're already at home, they've already picked up the kids, and they could just jump on. So, I do think technology has opened up the field to have more diverse voices at the decision-making table.”	“Virtual meetings allowed more people to participate because they didn't have to worry about transportation, time conflicts, or childcare. Technology has opened up the field to have more diverse voices at the decision-making table.”
“It's a little easier if they're not able to send folks out to workshops. If they can sometimes Zoom, it makes it a little easier, I think, for us to get the folks in the room—especially if they're maybe not able to participate for the full time or don't have a particular interest maybe in that specific area.”	"The virtual format allows folks to zoom in at their convenience or when a particular topic interests them."
“I'd say virtual was probably the least popular of any of our options. We've done joint virtual meetings with other county agencies and they were always very poorly attended pre-COVID.”	"Our virtual format option was probably the least popular. It was always poorly attended pre-COVID"
“Almost two separate audiences. We had the people who loved to just meet with us in-person, never engaged with our website or social media. And then, we have the tech savvy people who never attended our in-person meetings. And I'm sure there's some cross groups that fit both categories, but there were almost two separate groups that we had to update electronically, and we had to update in-person.”	"Almost two separate audiences: people who loved to meet in-person and never engaged with us virtually. And then, the tech savvy people who never attended our in-person meetings."
“Coalescence of the two where the people who previously just like in-person meetings are doing more on the virtual environment.”	

“Were really reluctant at first. They acknowledged that we couldn't do in-person meetings, but they initially refused to attend the virtual meetings.”	“Were really reluctant at first, but they acknowledged that we couldn't do in-person meetings”
“Then we started seeing more of them, more and more of those representatives on our virtual meetings once they got used to the system. We made it very convenient to where people could access it on their phones, on their laptops.”	“Then we started seeing more of those representatives on our virtual meetings once they got used to the system. We made it very convenient to where people could access it on their phones or laptops.”
“There was kind of like an information vacuum when we did start hosting our first virtual meeting several months later after the pandemic. We saw attendance higher than triple, quadruple what we had in-person. I think people were just so starved for information updates that they were happy to meet us virtually.”	"There was an information vacuum when we hosted our first virtual meeting. Attendance was triple, quadruple what we had in-person. People were starved for information updates."
“I don't know if this is just another outflow from the pandemic, but open records requests. We've seen an uptick in that Texas freedom of information act. People can always ask for written documentation to prove that we're saying what we're doing and engaging with the public. So, we've had several of those —not just from the public, but from media outlets to just kind of prove that we are engaging with community.”	"We've seen an uptick in open records requests. People are asking for documentation to prove we're doing what we're saying and engaging with the public."
"We had to kind of reassess what what's the best way to, to approach. It was actually like a three, four-month gap where, um, we were figuring that piece out. We obviously couldn't meet with, with people in person."	"It took three to four months to reassess what's the best approach to community engagement. We obviously couldn't meet with people in person."
“I love the in-person meetings, you know, just being able to interact face-to-face and capture non-verbals and those types of things.”	"I love in-person meeting – interacting face-to-face and capturing non-verbals"
“We understand [and]enjoy the benefits technology brings us, but it does not replace in person interaction.”	
“People are just so grateful [we have returned to in-person and] […] they’re really happy that things have shifted, […] it's also still a good option to keep online meetings for those residents [who] don't have transportation, may have health issues, or don't have childcare so they can still engage.”	"People are grateful we've returned in-person, hybrid options are necessary for individuals with transportation barriers, health concerns, or childcare needs."
“[toward] a hybrid approach for those that can't physically make a meeting, they can definitely attend via zoom or Teams, or we can record and send it to them and give them a safe space for feedback.”	“[toward] a hybrid approach for those that can't physically make a meeting. They can attend and give feedback"
“But I think in the future, we'll have tablets and laptops available [so that participants] could just type in their input. So then that way it's all captured. It's captured accurately. There's no transcription [needed].”	"In the future, hybrid options that integrate in-person events with the technology from online formats (e.g., tablets) will help us capture data accurately and efficiently."
“Intentional [about] how we gather data, how we represent the data and how we tell the story.”	