



**Stronger together: cultivating a sense of community in
virtual communities during disasters**

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Stronger together: cultivating a sense of community in virtual communities during disasters

Abstract

Purpose – The presence of unverifiable, inaccurate, and irrelevant information during disasters can encourage people to withdraw from virtual communities. One way to combat this problem is to cultivate a sense of community. However, little is known about how a sense of community can be fostered quickly in virtual communities during a disaster. Our study addresses this limitation of prior research work.

Design/methodology/approach – We conducted an in-depth qualitative case study of a Reddit community during Hurricane Harvey. The main sources were archival data, including community threads and associated comments. Data from newspapers, magazine reports, and government websites were also collected to capture contextual information about the disaster.

Findings – Our findings indicate that socialisation and formal control can foster a sense of community. This is made possible through the strategic use of social media, which involves (i) endorsing emergent norms and (ii) enforcing those norms through a disciplining process.

Practical implications – We offer practical suggestions for virtual community moderators and members on strategically using social media features to create, enforce and institutionalise emergent norms. We recommend that system designers develop adaptable social media features that can be reconfigured according to the context.

Originality/value – We show how socialisation and formal control must coexist in virtual communities to foster a sense of community, rather than prioritising one over the other. We also unpack how the strategic use of social media can inform this process. We argue that social media features should be adaptable, rather than pre-set, to meet emergent needs.

Keywords: sense of community, virtual communities, social media, disaster, moderation, qualitative case study

Paper type Research paper

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3 **1. Introduction**
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5 The world is witnessing a significant increase in the frequency and intensity of natural disasters,
6 including hurricanes, wildfires, floods, and earthquakes. Over the last decade, natural disasters
7 have affected approximately 1.6 billion people worldwide, resulting in the loss of 188,583 lives
8 and causing over \$1.7 trillion in damage costs (Ogie *et al.*, 2022). In 2024, Hurricane Helene had
9 a devastating impact, striking Florida’s Gulf Coast before sweeping through other areas,
10 including Georgia, Virginia, and Kentucky, causing an estimated \$160 billion in damages and
11 significantly affecting human lives across the region (The Guardian, 2024). In 2025, the wildfire
12 in Los Angeles destroyed the habitats of both humans and animals, and predictions show that it
13 caused losses of up to \$135 billion (BBC Future, 2025). When disaster strikes, people seek
14 information from various sources to understand the situation and make informed decisions (Li *et*
15 *al.*, 2023; Yoo *et al.*, 2024). Many disaster incidents have been documented where people turn to
16 virtual communities for information (Jurgens & Helsloot, 2018; Mirbabaie *et al.*, 2020; Nan and
17 Lu, 2014; Pinto *et al.*, 2024; Van Wyk and Starbird, 2020). A virtual community is an IT-based
18 virtual space that “connect geographically distant individuals and facilitate their pursuit of
19 mutual interests and goals” (Li *et al.*, 2022; p. 678). People need verified, accurate and reliable
20 (VAR) information to reduce uncertainty about a disaster. However, virtual communities are not
21 a panacea and can also amplify chaos and increase uncertainty (Luna & Pennock, 2018; Oh *et*
22 *al.*, 2013). Information overload and irresponsible digital behaviour (e.g., trolling, posting
23 insensitive comments, rumour mongering, spamming) have been documented in virtual
24 communities during disasters. For example, during Hurricane Ida, a rumour circulated that the
25 Federal Emergency Management Agency (FEMA) was covering the costs of evacuees’ hotel
26 rooms (Breslin, 2021). False information about COVID-19 had been circulated online, such as
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the claim that wearing a mask activates the coronavirus. A good disaster-oriented virtual community is digitally responsible, where moderators and community members intervene to correct falsehoods and promote pro-social behaviour (Oh *et al.*, 2013; Palen & Hughes, 2018; Qu *et al.*, 2009). It has been demonstrated that a sense of community among virtual community members is critical to fostering self-corrective and pro-social behaviour (Heverin and Zach, 2012; Shklovski *et al.*, 2008; Tim *et al.*, 2017) thereby allowing virtual communities to weather disasters and attain community goals (Houston *et al.*, 2017; Norris *et al.*, 2008).

A sense of community is the feeling of belonging, being attached to a community and having shared faith in members' mutual commitment to fulfil their needs (McMillan and Chavis, 1986). Sense of community is a recognised critical dimension of resilient communities that enhances their capacity to respond quickly and recover from a disaster (Norris *et al.*, 2008). As a disaster unfolds, communities' active participation (e.g., sharing local information, correcting falsehoods) is required to generate VAR information (Qu *et al.*, 2009; Tim *et al.*, 2017). If a sense of community is absent, people become isolated and detached from community issues (Blanchard and Markus, 2004; McMillan and Chavis, 1986), potentially delaying recovery efforts.

Developing a sense of community during disasters differs significantly from doing so in normal times (Al-Omoush *et al.*, 2021). Disasters are time-sensitive, high-stakes events that unfold in unpredictable and chaotic ways (Oh *et al.*, 2013). These conditions often give rise to antisocial behaviours, misinformation, information overload, and sudden surges of new participants - all of which can alienate members and erode the sense of community (Lu & Yang, 2011). As such, fostering a sense of community in these times is particularly complex. We emphasise the time-sensitive nature of disasters because building a true sense of community is typically a gradual process (Chandrasekharan *et al.*, 2018; Savage, 2019). Sense of belonging grows through

repeated positive exchanges, and shared norms gradually develop to create an inclusive environment. However, during disasters, time is a scarce resource, making this process exceptionally challenging. This is further exacerbated due to the structural properties of virtual communities. Unlike physical communities, they are more fluid, information-driven, and self-governed, with coordination that is often ad hoc and decentralised (Faraj et al., 2011; Nan & Lu, 2014). These structural differences, combined with the unique challenges of virtual communities during disasters, raise an important question: ***How can a sense of community be cultivated and maintained in virtual communities during disasters?***

To answer this research question, we conducted an in-depth qualitative case study of a virtual community on Reddit (i.e., the r/Houston subreddit) that focused on disaster response during Hurricane Harvey in 2017. Our findings indicate two factors: (1) *socialisation* and (2) *formal control*, to foster a sense of community. Socialisation is a bottom-up approach by which community members form emergent group norms. On the other hand, formal control is a top-down approach by which moderators regulate the community. We find that socialisation and formal control are insufficient on their own and must interact to foster a sense of community effectively. We theorise two processes that enable this interaction—*endorsing* and *disciplining*—which foster the efforts of community members and moderators to cultivate a sense of community. Community members can inform moderators how emergent group norms work, transfer community feedback, and introduce emergent leadership through the endorsing process. While moderators can impose emergent group norms, sanction uncivil behaviour and authorise emergent leaders through the disciplining process. We find that emergent leaders act as a conduit between community members and moderators. Furthermore, we show how the strategic use of social media enables endorsing and disciplining processes. We argue that the social media

features should be *adaptable* rather than fixed, depending on situational needs. This is because disaster times differ significantly from normal times due to shifts in priorities (e.g., from entertainment or casual interaction to survival).

We contribute to (i) sense of community and (ii) virtual community literature on disaster management. While previous studies give importance to either socialisation (e.g., Blanchard et al., 2011; Capece and Costa, 2013; Sproull, 2011) or formal control (e.g., Petrič and Petrovčič, 2014) to foster a sense of community, we theorise how both socialisation and formal control must interact through two processes: endorsing and disciplining. We develop a conceptual framework showing how the strategic use of social media plays a key role in enabling this process. In addition, while existing virtual community literature on disaster management considers social media features as static, material artefacts with preset functions (Nan and Lu, 2014; Qu *et al.*, 2009; Silver and Matthews, 2017), we suggest that it needs to be adaptable depending on the contextual situation.

This research provides recommendations for virtual community members and moderators on effective disaster management. When social media features are used randomly and without careful thought, it fosters misinformation and information overload, thereby eroding the sense of community. Instead, we emphasise the importance of careful planning and execution in strategically utilising social media to achieve community goals. We also offer implications for system designers on developing adaptable social media features that can be reconfigured based on the context.

The rest of this paper is organised as follows. The next section provides a review of the literature on virtual communities during disasters. We then explore the theoretical aspects of sense of community and ways to foster it, followed by an analysis of the strategic use of social media

within virtual communities in disaster contexts. Subsequently, we describe our case study research methodology, detailing our data collection and analysis procedures. After presenting our findings, the paper concludes with the discussion and conclusion sections.

2. Related literature

2.1 Virtual communities during disasters

During a disaster, informational needs increase significantly due to high levels of uncertainty (Jurgens and Helsloot, 2018; Palen and Hughes, 2018). As a result, people often gather on social media to create or appropriate existing virtual communities to reduce uncertainty about the situation, praise each other’s efforts, validate information and provide psychological and social support to victims (Qi et al., 2025; Nan and Lu, 2014; Procopio and Procopio, 2007; Qu et al., 2009; Tim et al., 2017; Vieweg et al., 2008). For example, during Hurricane Katrina in 2005 (Vieweg et al., 2008), the Sichuan earthquake in 2008 (Nan and Lu, 2014), Cyclone Yasi in 2011 (Taylor et al., 2012), and the Thailand flood in 2011 (Leong et al., 2015), virtual communities were created or appropriated to seek and provide disaster related information, disseminate information about missing persons and facilitate relief efforts. Table I offers insight into recent articles on using social media and virtual communities for disaster response.

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Insert Table I here
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Virtual communities are not typically designed for disaster response. Compared with physical communities, virtual communities have weaker social forces to keep members in a community; members can easily join or leave (Faraj et al., 2011; Kim et al., 2020). During a disaster, information of importance tends to be generated by specific sets of virtual community members - people on site (i.e., local individuals) and people who possess expert knowledge (Hasan et al.,

2025). However, many virtual communities face challenges regarding the presence of uncivil behaviours that can impact public perception of the virtual community and encourage people to withdraw (Luna and Pennock, 2018). Consequently, it is crucial for virtual communities to understand the processes by which a sense of community develops during times of disaster in order to prevent the loss of local and other valuable members and their contributions. Existing information systems (IS) studies have primarily explored why people seek information from virtual communities in disaster events and what information they usually create, share and exchange (Leong *et al.*, 2015; Nan & Lu, 2014; Qu *et al.*, 2009; Tim *et al.*, 2017). However, how a sense of community can be cultivated and help encourage virtual community members to generate VAR information in times of disaster is little understood.

2.2 Sense of community

Sense of Community is one of the key psychological dimensions relevant to disaster-affected communities (Norris *et al.*, 2008). A well-developed sense of community fosters stronger social support and increases community participation in disaster response, thus reducing situational uncertainty and increasing the safety of community members (Bergstrand *et al.*, 2015; Kim *et al.*, 2017). Once established, community members exhibit community-like behaviours and social processes such as exchanging support, building trust, and maintaining norms and rules (Blanchard & Markus, 2004; McMillan & Chavis, 1986). Such social processes are mostly self-governed and emerge from within the community (Engert *et al.*, 2025). We argue that the presence of a virtual community does not imply a sense of community, quite the contrary. A virtual community provides an enabling space for a sense of community to materialise (Blanchard *et al.*, 2011). Within this space, a true sense of community can only occur when individuals feel a sense of belonging, identity and emotional connection (McMillan and Chavis,

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3 1986). As such, a sense of community is a psychological property of a community that makes
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5 information verifiable, accurate and reliable (Kim *et al.*, 2020). Constructing a sense of
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7 community requires four elements in physical settings: (1) *membership*, (2) *influence*, (3) *needs*
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9 *fulfilment*, and (4) *shared emotional connection* (McMillan & Chavis, 1986). These four
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11 elements dynamically interrelate to construct a sense of community in physical communities.
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15 **Membership** represents the feelings of belongingness or personal relatedness, akin to
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17 identification with the collective (Garrett *et al.*, 2017; Naranjo-Zolotov *et al.*, 2021).
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19 Membership provides boundaries for community members (i.e., knowledge of who belongs to
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21 the community and who does not) through a common symbol system (e.g., community logo,
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23 name, insider language). As a result, members can identify themselves as part of the community,
24
25 feel emotionally safe, and participate in community issues. Membership also fosters loyalty and
26
27 facilitates the regulation of community behaviour (Hsu and Liao, 2014; Naranjo-Zolotov *et al.*,
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29 2021).
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34 **Influence** refers to a sense of mattering, where one can make a difference in a community, and
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36 the community is meaningful to its members. It means that a member can sway the decisions or
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38 opinions of other members and vice versa (Naranjo-Zolotov *et al.*, 2021). People are drawn to
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40 communities where they feel they have a sense of influence. Influence fosters a community's
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42 cohesiveness and conformity (Abfalter *et al.*, 2012). Moreover, it encourages members to
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44 personally invest resources such as time and effort to solve community issues (Capece and
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46 Costa, 2013). As a result, members' trust is developed within the community (Capece and Costa,
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48 2013).
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53 **Needs fulfilment** represents reinforcement, shared values, and the feeling members have that
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55 their needs will be met through mutual support (Canevez *et al.*, 2022; Garrett *et al.*, 2017).
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People like to engage more with a community that provides more resources or demonstrates an ability to resolve community issues. A strong community integrates members and prioritises its need-fulfilment activities (Chih *et al.*, 2017; McMillan and Chavis, 1986).

Finally, ***shared emotional connection*** represents the feelings of relationship, quality interaction among members, sharing similar experiences, history, time, and spirit of community (Capece and Costa, 2013). Once more people start interacting, they are more likely to form sympathetically intimate relationships (Capece and Costa, 2013) which leads to stronger bonds (Abfalter *et al.*, 2012) thereby infusing the community with a greater sense of purpose.

2.3 How to cultivate a sense of community in virtual communities

There are two literature streams on cultivating a sense of community in virtual communities in non-disaster situations, neither of which provides sufficient understanding to guide decision making. One stream of research gives prominence to socialisation among community members and neglects the need for formal control in institutionalising new norms (Blanchard *et al.*, 2011; Capece & Costa, 2013; Faraj *et al.*, 2011; Sproull, 2011). The second stream highlights the advantages of formal control (Carey & Meyer, 2016; Petrič & Petrovčič, 2014). It argues that formal control can help control uncivil behaviour, hence promoting a sense of community.

However, it does not acknowledge the role of community members in providing input on new norms and enabling this process. Recent research suggests that both socialisation and formal control may co-exist in virtual communities (Dosono & Semaan, 2019; Spagnoletti *et al.*, 2015; Safadi *et al.*, 2025). Nevertheless, how they relate to each other remains an open question. This lack of understanding may result in ineffective interventions and conclusions concerning the efficacy of sense of community during disasters. We now discuss the literature streams of

socialisation and formal control separately, while also delineating their respective limitations to constructing a sense of community when pursued in isolation during disasters.

Socialisation refers to the inculcation and transmission of community values, rules, and norms (Maccoby, 2007; Sukel, 1983). It teaches us how to behave in accepted ways and helps us minimise uncivil behaviours (Blanchard et al., 2011; McMillan and Chavis, 1986). Social interaction among members is the foundation of socialisation (Abfalter *et al.*, 2012; Mamonov *et al.*, 2016).

Socialisation generally consists of two aspects: (1) norm formation and (2) norm enforcement via informal control. While socialising, members create norms and acquire a shared identity (Ahuja & Galvin, 2003; Blanchard et al., 2011). Norms are shared cognitions on the basis of which a group of people manifest routinised behaviour (Bettenhausen & Murnighan, 1985; Ivaturi & Chua, 2019). Norms are informal, unwritten, and arise from repeated interactions among members over time (Chandrasekharan *et al.*, 2018). Norms can help reduce falsehoods in virtual communities (Gimpel *et al.*, 2021) and promote greater levels of trust (Blanchard *et al.*, 2011). However, humans have agency—the ability to obey or reject any rule or norm (Giddens, 1984). One way to enforce norms is through informal control. Informal control refers to unwritten, implicit forms of control based on shared norms, values, and beliefs (Kreutzer *et al.*, 2016). As such, while socialising, community members can enforce informal control (e.g., members correcting each other’s inappropriate behaviour) with minimal reliance on formal authorities, such as moderators (Chua *et al.*, 2007; Long & Perkins, 2007). Applications of informal control include peer pressure, disapproval, questioning deviant behaviour, monitoring, and reporting to moderators (Watson *et al.*, 2019). It has been demonstrated that informal control can foster a sense of community in physical communities (Long & Perkins, 2007). It acts to empower

communities and to give users a sense of having some control over community issues (Caffrey & Gary, 1997). As a result, people feel they can trust their co-residents and feel safe in their communities (Forrest & Kearns, 2001). However, prior findings suggest that informal control can erode an individual's sense of community (Blanchard *et al.*, 2011). The act of regulating others or the observance of being regulated causes a loss of the perception of sense of community because people feel they are not alike - the regulated are not the regulators and vice-versa (Blanchard *et al.*, 2011).

During a disaster, socialisation may be insufficient to construct a sense of community in virtual communities. Socialisation is a bottom-up process (i.e., it emerges from within the community), and norms usually take time to institutionalise through this process (Chandrasekharan *et al.*, 2018; Savage, 2019). However, disasters are time-sensitive and require rapid intervention by the community to minimise risks, such as preventing falsehoods. In addition to socialisation, therefore, there is growing evidence that virtual communities can have formal control that involves top-down management (e.g., by moderators) to quickly impose norms to minimise risks (Petrič and Petrovčič, 2014; Wise *et al.*, 2006).

Formal control means officially sanctioned institutional mechanisms, such as written rules, procedures and policies (Kreutzer *et al.*, 2016). In virtual communities, formal control is created and enforced by moderators (Watson *et al.*, 2019). Research suggests that formal control can help foster a sense of community in virtual communities (Carey and Meyer, 2016; Petrič and Petrovčič, 2014) by making community values explicit, defusing conflict before it escalates, fostering institutional trust (i.e., trust in rules), and helping build supportive relationships between members (Matzat and Rooks, 2014). By reducing the presence of insensitive or aggressive comments and repetitive information, moderators create a safe environment that

encourages participation and improves sense of community (Carey and Meyer, 2016; Sood *et al.*, 2012; Wise *et al.*, 2006). Moderators can guide discussions, ensure the discussion is conducted in a civil manner, and suspend users who act in an uncivil manner (Badreddine and Blount, 2021). Furthermore, moderators can also build and enforce norms in virtual communities (Ivaturi and Chua, 2019). However, moderator-imposed norms can create several issues. First, they can cause member disengagement or attrition (McWilliam, 2000). Research has demonstrated that moderators can be too sensitive and unwilling to accept criticism. Hence, they perform arbitrary moderation which can have negative impacts on the individual's sense of community in virtual communities (Perrault and Zhang, 2019; Wolfgang, 2019). Arbitrary moderation occurs when moderators force community members to conform to expectations (i.e., follow norms and rules imposed by the moderators). As a result, people experience negative emotions (e.g., resentment) and feel treated unfairly. Further, it can fuel conflicts in the community when there is misalignment of expectations between users and moderators (Petrič and Petrovčič, 2014; Wright, 2005). Therefore, when moderators firmly enforce rules and norms, they face the risk of member dissatisfaction (Carey and Meyer, 2016).

Importantly, research on fact-checking procedures in Wikipedia offers complementary insights into socialisation and formal control (Forte *et al.*, 2009). Wikipedia focuses on crowdsourcing and relies on the crowd's wisdom to edit and verify information continuously (Greenstein and Zhu, 2018). As such, it is a decentralised approach, involving community norms such as verifiability and a neutral viewpoint (Greenstein and Zhu, 2016). Notably, administrators (akin to moderators) play a helpful role in maintaining community norms and resolving disputes (Arazy *et al.*, 2011). However, their power is limited in the sense that they cannot dictate content to adhere to their views and must work according to the rules established by Wikipedia (Wikipedia,

n.d). In contrast, moderators in virtual communities (e.g., on Reddit) have more power, such as creating and enforcing new norms on how to verify information (Ivaturi and Chua, 2019).

Virtual communities depend on social media platforms for their existence. Thus, socialisation and formal control largely rely on how virtual community members and moderators use different features available on social media platforms. We argue that the strategic use of social media helps foster a sense of community, while the non-strategic use impedes it. We discuss this next.

2.4 Strategic use of social media in virtual communities during disasters

Social media are “*computer-based tools (such as websites and apps) that enable people to create and share content with other people and/or participate in a community*” (McKenna et al., 2017, p. 88). Social media features are material artefacts available on social media (e.g. comment, block, polls) that allow members to enact certain actions (Iivari, 2017; Orlikowski and Iacono, 2001), such as posting a comment, messaging privately, opening a group, or banning/blocking an account. Therefore, social media features are built-in functions available for use (Majchrzak and Markus, 2012). Drawing on the research work of Morton et al., (2023) and Leidner et al., (2009), we define the strategic use of social media as the ability of virtual community members to use available features on social media in an integrated way to put into motion a plan of action and achieve common goals.

While we still do not know *how* exactly the strategic use of social media fosters sense of community, we find some evidence pointing to its importance from past cases of natural disasters. For instance, in 2008, in the aftermath of an earthquake in Wenchuan, China, an emergent virtual community comprising academic staff and students used an online forum, and its messaging feature, to communicate with each other and organise a crisis response (Nan and Lu, 2014). In another case, in 2009, during the Red River Valley floods in the US and Canada,

people used Twitter to effectively generate, synthesise and share reliable information as part of the disaster recovery process (Starbird *et al.*, 2010). The posting and sharing features of Twitter facilitated the process. As such, the strategic use of social media may be essential for virtual communities to achieve common goals in times of disaster.

In contrast, we also find some evidence that the non-strategic use of social media can impede sense of community in virtual communities during disasters. When people share posts spontaneously and without careful thought, it can lead to information overload which makes it challenging for other disaster victims to find useful information (Misra *et al.*, 2020). Further, random sharing of information creates a jumble of information that is true, false or a combination of both (Oh *et al.*, 2013; Stieglitz *et al.*, 2022). This reduces information reliability for disaster victims and leads to confusion (Rai, 2020). In addition, vindictive individuals can use comment and posting features to engage in cyberbullying behaviours (Slonje *et al.*, 2013). Such antisocial behaviours are further exacerbated when they can hide behind anonymised identities (Barlett, 2015). As a result, the victims or observers of cyberbullying become alienated and reduce their engagement in the virtual community to protect themselves from being targeted in the future. Moderators may also use the banning and deleting features to socially exclude certain individuals from the virtual community. They may exercise this power due to personal conflict with certain individuals or if those individuals do not share their values and beliefs (Prakasam and Huxtable-Thomas, 2021). Such practices may foster the formation of echo chambers, whereby criticisms and counterarguments are not welcome (Kitchens *et al.*, 2020). Therefore, when social media is not strategically put into practice, it hinders sense of community in virtual communities during disasters.

Overall, prior empirical work on sense of community offers limited insight into the strategic use of social media. While previous sense of community studies offer a rich understanding of its (i) theoretical properties (ii) how it emerges and (iii) why it is crucial for people (Blanchard and Markus, 2004; Kim *et al.*, 2017; McMillan and Chavis, 1986; Norris *et al.*, 2008; Paton and Irons, 2016) it falls short of teasing out the role of social media in enabling this process.

Understanding the role of social media is vital to unpack **how** and in what ways social media and its associated features can be used in a systematic way to foster sense of community and achieve common goals. Not taking these into account will impede the practicality of the research insights and offer a limited view of user interactions in virtual communities. Based on the above arguments, we argue the need to integrate the strategic use of social media into the sense of community discourse.

To summarize, Figure 1 illustrates a process model of constructing a sense of community in virtual communities during a disaster. The literature argues that a combination of socialisation and formal control can help construct a sense of community. Once formed, it can help generate VAR information. During a disaster, it is critical to have the presence of emergent norms in the community. However, institutionalising norms via socialisation is time-consuming. Hence, it can be beneficial for the virtual community to engage with formal control (i.e., via moderators).

However, when formal controllers impose norms, several potential issues arise, such as arbitrary moderation, which may make individuals leave the community. Therefore, how both socialisation and formal control relate and work together during a disaster remains unknown.

Besides, there is limited understanding of how the strategic use of social media enables Socialisation and formal control to foster a sense of community in virtual communities. This paper seeks to address these theoretical limitations.

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Insert Figure 1 here

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3. Methodology

We performed an in-depth qualitative case analysis of a virtual community focusing on how it responded to a disaster. We adopted an interpretive approach to gain an in-depth understanding of how a virtual community can foster sense of community to help generate VAR information in times of a disaster (Klein and Myers, 1999).

3.1 Case site

Hurricane Harvey made landfall near Corpus Christi, Texas on August 25, 2017. The category 4 hurricane brought historic rainfall and left millions of residents without power. Later, Harvey moved slowly inland towards Houston, where it remained for four days and caused extreme flooding. According to the National Hurricane Centre, it damaged over 200,000 homes, resulted in 70 deaths, and caused USD 125 billion in damage (Cheong and Babcock, 2021). Residents in the area ran low on food, safe water and gas. The official emergency number, 911, was overloaded (Luna and Pennock, 2018). When victims could not receive effective help from official channels, they turned to virtual communities to call for help (Li *et al.*, 2019). The National Hurricane Center ceased tracking Harvey’s remnants on August 31.

Community-generated archival data in Reddit was our main data source. In addition, we obtained data from newspapers, magazine reports and government web sites. We collected data from these sources to capture contextual information related to the disaster event (Benbasat *et al.*, 1987). Reddit is a social news aggregation and discussion forum of self-governed virtual communities. We chose Reddit for two reasons. First, in other well-studied disaster virtual community

platforms like X (previously Twitter), communities are intermingled with diverse populations and topics. Thus, information concerning the disaster is not easily identifiable. It is, therefore, difficult to observe how a particular disaster affected community could develop sense of community. By contrast, Reddit divides itself into topic-based communities called subreddits that are formed, maintained, and participated in by pseudonymous users. Within subreddits, registered users can create threads upon which others can upvote, downvote, comment and reply to comments (Davis and Graham, 2021). They can also report problematic users or contents to the moderators using the report button. Second, Reddit data is archived and open to the public, making data collection straightforward.

We chose the r/Houston subreddit (i.e., a virtual community on Reddit) as our case site for two reasons. First, this subreddit focuses on local issues, people, and events pertinent to the Houston area thereby allowing us to explore how a specific disaster affected community engaged in surviving Hurricane Harvey. Second, critical to our research context, substantial activity arose in the r/Houston community during this hurricane. Table II summarizes activities of the selected case site.

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3.2 Data collection and analysis

Data collection and analysis were done iteratively. The database of Reddit threads and comments from 2005 until the end of 2019 (more than 3 billion) was available on Google Big Query and PushShift (i.e., a social media data collection and archiving platform), which at the time provided full access to threads and comments. The first author wrote SQL queries using Google BigQuery to retrieve relevant data of the r/Houston subreddit and timeframes. Other IS studies have also

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3 utilised PushShift for archival data access (e.g., Safadi *et al.*, 2024). Although public access to
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5 Pushshift data via BigQuery was discontinued in 2023, Reddit threads and comments remain
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7 publicly accessible through their original URLs and Reddit’s native interface, including its
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9 search functions. One can visit the relevant subreddit and search for the threads and comments
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11 directly.
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15 We first collected all threads in the two weeks during the hurricane (August 25-August 31, 2017)
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17 from the selected case site. The focus of this study is on how a sense of community can be
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19 constructed and maintained in virtual communities during a disaster. Therefore, the focus of our
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21 analysis was the threads (and associated comments) that were created around the time of the
22
23 Hurricane Harvey. In line with established approaches in prior research (e.g., Slemon et al.,
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25 2021; Gliniecka, 2023), we adopted ethical practices appropriate for working with publicly
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27 available online data. All Reddit data used in this study were drawn from public sources and did
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29 not involve direct interaction with users or access to personal information; therefore, formal
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31 ethical approval was not required. We took several steps to safeguard user privacy. For example,
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33 usernames were not reported and written as [username withheld]. We also avoided using directly
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35 traceable quotes and filtered out any content containing personally identifiable information.
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41 In this study, we followed a systematic analytical approach consistent with established qualitative
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43 research practices in information systems (e.g., Myers, 2020). Specifically, we adopted a two-step
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45 process. In Step 1, we used Leximancer to conduct an initial unstructured data analysis (McKenna
46
47 et al., 2017). This step helped surface emergent community needs, problematic situations and key
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49 thematic concepts. Through this automated analysis, we observed patterns of interaction between
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51 members and moderators but at the surface level. While manually going through the thematic
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53 concepts identified by Leximancer, we noticed the evidence of socialisation, formal control, and
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the emergence of a sense of community. In Step 2, we conducted manual thematic coding guided by these emergent concepts (and their definitions) to conduct a deeper interpretive analysis (Walsham, 1995; Flick, 2013). From this step, we also observed how moderators and community members strategically used social media features to enact certain actions. Figure 2 below visually summarises the key steps of our data collection and analysis process.

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Insert Figure 2 here
=====

We analysed the data using the concepts of *socialisation*, *formal control*, *strategic use of social media* and *sense of community* based on definitions from literature.

Socialisation. In our coding, we observed that both members and moderators participated in socialisation activities. A piece of evidence was considered supportive of socialisation if it signaled the formation of new norms/rules/beliefs or identification with others. We also observed what the community user/moderator did to form new norms/rules/beliefs. For example, members formed an emergent group norm of posting personal information, and the moderator acknowledged their request. Further, we looked for evidence of informal control. Informal control was identified if community members relied on new norms/values/beliefs to regulate behaviors. For example, they reported fake news and problematic users to the moderators. In addition, we observed how the community members reacted to informal control. While coding, we also observed emergent leadership. Evidence was coded as emergent leadership when a member assumed responsibility, took the initiative, and liaised with the moderators.

Formal control. Formal control was identified when moderators created new or enforced existing mechanisms (e.g., norms, rules, procedures, and policies) to moderate the community.

For example, moderators banned problematic users or created a megathread. We also observed how the community members reacted towards formal control.

While Reddit does not publicly provide detailed data on user bans or reports, we assessed governance activity using indirect indicators such as removed threads or comments (by moderators), deleted threads or comments (by users who posted them), and comments such as “I reported you to moderators”. For example, in one megathread with 2,235 comments, 22 comments were removed by moderators, 250 comments were deleted by users (who posted them), and 8 users were publicly identified as banned by moderators.

Strategic use of social media. Within socialisation (i.e., informal control) and formal control, we paid special attention to how social media features were being used to structure information and regulate the community (e.g., norm enforcement). We looked for repeated examples of community members doing things with Reddit features for informal control. For example, community members used the “report” feature to signal problematic users or applied the “down-voting” feature to indicate harmful information. For formal control, we looked for repeated examples of moderators doing things with Reddit features, such as using the “ban users” feature to remove problematic users from community discussion or the “sticky” feature to make the megathread easily visible.

Sense of community. The sense of community was evaluated based on the presence or absence of its four elements: (1) *membership*, (2) *influence*, (3) *needs fulfilment*, and (4) *shared emotional connection*. Although these elements are conceptually distinct, they are not orthogonal. Hence, they can overlap and occur at the same time. Although a specific piece of evidence could map to multiple sense of community elements, we focused on identifying

evidence than mapped to one element rather than finding dimensional overlap. We summarise the final codes applied in Table III below.

=====
Insert Table III here
=====

In our study, we also ensured the trustworthiness of qualitative research by following established guidelines focusing on credibility, confirmability, and dependability (Guba and Lincoln, 1994; Miles and Huberman, 1994). To ensure credibility, we were extensively immersed in the collected data for 5+ years, understanding contextual nuances. Given the interpretive nature of this study, intercoder reliability was not formally required and calculated (Braun and Clarke, 2021). Instead, to maintain confirmability, we met regularly to review codes, applied consistent coding practices (Myers, 2020), and made sure the findings reflected the original publicly available content. Further, we actively challenged each other's assumptions and interpretations to avoid individual bias. We documented all methodological changes to address dependability and used a transparent, consistent process throughout the study.

4. Findings

Our findings address how a sense of community can be cultivated and maintained in virtual communities during a disaster. The three vignettes discussed below illustrate (1) what problematic situations arose during the disaster, (2) how the strategic use of social media features enabled (or did not enable) socialisation and formal control, and finally (3) how socialisation and formal control contributed (or did not contribute) to the construction of sense of community thus generating VAR information.

Vignette 1: Managing the spread of falsehoods

Problematic situation: While the target market of r/Houston is individuals living in Houston or who have a connection with Houston, the community allows others (i.e., individuals not from Houston) to participate. During the hurricane, individuals from both Houston and outside of Houston visited the community. Disaster victims (i.e., individuals from Houston) wanted to survive. While many outsiders provided well-intentioned assistance, other outsiders had a non-survival agenda (e.g., propagate rumors, fake news). For example, an outsider propagated a rumor of a shark swimming on the freeway of Houston.

“My wife saw this [photo of a shark swimming] on her Facebook feed. Believe it or not, this is a shark on the freeway in Houston, Texas.”

Before the hurricane, the r/Houston subreddit welcomed all kinds of discussion related to Houston including making claims without supporting evidence. The community moderators did not explicitly specify any rules regarding posting falsehoods. As a result, unsubstantiated claims and sharing unreliable information led to wrong actions. For example, legitimate information was downvoted by community members for not providing evidence such as a link to official source.

“I posted 2 days ago a couple tips to prepare, everyone downvoted my post to hell saying it’s a tropical storm and that I’m an idiot for spreading fear mongering crap.”

Socialisation: Forming emergent group norm: During Hurricane Harvey, the term ‘Houstonian’ became popularized and individuals living in Houston identified themselves as ‘Houstonian.’ The community favored Houstonians and helpful outsiders over problematic outsiders.

1
2
3 “What Houstonians need are other locals who actually know what's going on. Not non-locals
4 (who don't know shit about what's going on) tossing blame at this official and that official.”
5
6

7
8 Another community norm emerged that any informational posts must be backed by evidence
9 (e.g., an image or a video) or by a link to official sources.
10
11

12
13 “I repeat stop asking questions here there is only two acceptable comments in this thread that
14 won't get you downvoted: 1. Picture/description of where water is. 2. Some sort of caring “stay
15 safe friends” comment.”
16
17
18

19
20
21 **Acknowledging emergent group norm by moderators:** Moderators became aware of the
22 community preference (i.e., members gave prominence to Houstonians and other helpful
23 outsiders) and norms of attaching evidence by actively participating in the conversation. For
24 example, they provided a link to an official source and asked the original poster to delete the
25 shark rumor.
26
27

28
29 “Delete. Along with anything else on here: [https://www.washingtonpost.com/news/the-](https://www.washingtonpost.com/news/the-intersect/wp/2017/08/28/no-the-shark-picture-isnt-real-a-running-list-of-harveys-viral-hoaxes/?utm_term=.1346b2f3ab6c)
30
31
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61
62
63 **Informal control via the strategic use of social media features:** Community members spotted
64 users who propagated falsehoods and asked for evidence. The community members used the
65 “report” button feature to flag problematic outsiders to the moderators. Community members
66 spotted users who propagated falsehoods and asked for evidence. By applying the “voting”
67 feature of Reddit, they gave many up-votes on the evidence-based informational posts and those
68 without evidence were down-voted. The following comment was made by a community member
69 on a post being downvoted:
70

1
2
3 *“What is your "reliable source"? Clear Lake City Water Authority issued a statement that*
4
5 *rumors on social media that the water supply is threatened are false.”*
6

7
8 ***Formal control via the strategic use of social media features:*** Moderators banned unwanted
9
10 users who were not from Houston by using the “ban user” feature available for moderators,
11
12 where they can specify the ban duration and provide a reason for the ban, which notifies the user.
13
14 This helped the community to maintain the in-group/out-group distinction between Houstonians
15
16 and problematic outsiders. The below comment is made by a moderator.
17
18

19
20 *“He's already been banned. His second account has also been banned.”*
21
22

23 Moderators also endorsed the new norm of attaching evidence and played an influential role by
24
25 enforcing it. They encouraged members not to spread any falsehoods. For example, a person
26
27 claimed that the city of Houston was shutting down the water supply. However, this was a
28
29 rumor. Using the comment feature on Reddit one moderator said this:
30
31

32 *“I've seen no evidence of that. Please encourage them to not spread information without a*
33
34 *source.”*
35
36

37 ***Sense of community and generating VAR information:*** Community members participated to
38
39 correct falsehoods which demonstrates the personal influence of members within the community.
40
41 For instance, a member was trying to share external news that circulated in a WhatsApp group.
42
43 However, this member was not sure about the authenticity of the information. After realising that
44
45 the news was a false rumour, he deleted the news link (**dimension: influence - conforming to**
46
47 **norms**).
48
49
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1
2
3 *“This was on one of the whatsapp group... I don't believe that's true...but just wanted to*
4 *share...will delete if mods think it is spreading rumor... thoughts? EDIT: Deleted to avoid*
5 *spreading rumors.”*
6
7

8
9
10 People started attaching evidence, such as images, while seeking help or providing information.

11
12 Users found this evidence useful and appreciated those who provided it (**dimension: influence**
13 **& shared emotional connection**):
14

15
16
17 *“Thank you for actually posting evidence [link to an official source] instead of telling people to*
18 *go find it.”*
19
20

21
22
23 As a result, members started relying on the given sources and acknowledged that r/Houston
24 provided useful informative news during Hurricane Harvey (**dimension: needs fulfilment, VAR**
25 **information**). They also expressed how the community-generated content influenced them to
26 subscribe and be a part of this community (**dimension: membership**).
27

28
29
30
31
32 *“This subreddit gave me better news than I would have gotten anywhere else, I would have been*
33 *completely blind, so having this here is wonderful.”*
34
35

36 37 38 **Vignette 2: Simplifying the search for information**

39
40 **Problematic situation:** The needs and interests of the r/Houston community changed
41 significantly during the hurricane. Most individuals needed rescue, basic necessities, and trusted
42 sources of information. Furthermore, they needed specific local information. Initially, the
43 community members created individual threads or commented on the existing threads to seek or
44 provide information. However, the multitude of generated threads made it difficult to find
45 specific useful information as such information was scattered across multiple threads. For
46 example, one person was unable to find emergency numbers that were posted earlier by others.
47
48
49
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1
2
3 “Where to find emergency numbers? I tried but was unable to find them.”
4
5

6 Many users continued posting irrelevant and non-useful information including politics and
7
8 callous comments such as the one below:
9

10
11 “You guys deserve this. Why didn’t you evacuate, you f[expletive] moron. My fiancé and I are
12
13 enjoying hurricane Harvey.”
14

15
16 **Socialisation: Forming emergent group norm:** A member (hereafter called emergent leader)
17
18 noticed the problem and suggested a moderator (by tagging the moderator) create a dedicated
19
20 thread placed on top of the pile of threads (called a megathread) so all information would be
21
22 gathered in a central place. Several other members voiced their support for the suggested
23
24 solution.
25
26

27
28 “Fun times ahead. Hopefully the mod [moderator] team can create a megathread for the
29
30 tropical storm? /u/ [moderator’s name withheld]?”
31
32

33
34 **Acknowledging emergent group norm by moderators:** Moderators listened to the suggestion
35
36 and agreed to create megathreads for each day of the hurricane. Before the hurricane, the
37
38 community allowed users to create individual threads or comment on the existing threads if they
39
40 want to seek or provide information. However, a new norm emerged that people should seek and
41
42 provide information in the megathread instead of creating individual threads.
43
44

45
46 **Informal control via the strategic use of social media features:** Using the comment feature
47
48 available on Reddit, many members pressured others to seek information in the megathread
49
50 instead of creating individual threads.
51

52
53 “Look at megathread. Don’t make posts like this.”
54
55
56
57
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59
60

Members also confronted political and insensitive comments. Applying the voting and reporting features, they downvoted and reported them to moderators. For example, one member suggested political comments be moved to another subreddit.

“Take this s[expletive] to /r/politics. People are using this sub [subreddit] as a means of communication about what is happening on the ground in an important time. You’ll have plenty of time to s[expletive] on Trump after all this is over.”

Moreover, they used the tagging (@) feature and asked moderators to remove political and callous comments.

“@[username withheld] Mods, you should delete all this s[expletive] insensitive comments.”

Formal control via the strategic use of social media features: During the hurricane the moderators were outside of Houston. Creating a megathread required moderator permission. Hence, the moderator granted the emergent leader (who suggested the solution) temporary moderator status. He then started creating the megathread and used the “sticky” feature to improve the visibility of the megathread. When a thread is stickied in a subreddit on Reddit, it stays at the top of the subreddit regardless of when it was posted. It ensures that community members see it first when they visit the subreddit. This visibility makes it useful for important updates, rules, or featured content that the moderators want everyone to notice before diving into the rest of the threads. It helps draw attention to critical information that might otherwise get buried as new threads are added.

“It was always the understanding that I was going to be a guest mod [moderator]...that way, I could sticky the megathreads and delete trolling comments in those megathreads.”

While many members followed the dedicated thread others still created individual threads. The emerging leader (temporary moderator) redirected their questions to the megathread.

“Please post in the megathread. Thanks!”

The moderators (including the emergent leader) explicitly listed community rules and enforced them to ensure members’ emotional safety and protect group intimacy. Besides, they also encouraged users to avoid personal attacks and name-calling.

“Spirited debates are great, but if you have to resort to personal attacks, you’ve already lost.

Name-calling can result in bans from the subreddit.”

Although the megathread was helpful, community members could not first see the latest comments (information) within the megathread. This is because the default sorting for comments was set to “best”. This sorting method prioritizes comments with the most upvotes and engagement, meaning the comments with higher scores (upvotes minus downvotes) appear at the top. Comments that are highly upvoted and have many replies are more likely to be seen first. Moderators changed the comment sorting to “new” so that members could see the latest information first during the disaster.

“Not true. In this thread, sorting is done so that people see newer stuff first. Downvotes, upvotes don’t matter much in this instance.”

Sense of community and generating VAR information: Members started contributing and following the megathreads to fulfil their needs. The community met members’ needs through mutual support. Some members were seeking situational information, whereas others were describing the situation of a place, providing advice or suggestions, as well as sharing official

sources (**dimension: needs fulfilment**). For instance, one person was asking where to volunteer and received replies from community members.

“I would like to know where to volunteer. Let's come together.”

“At George Brown Convention Center. Volunteers should check in at the check in booth by the pappadeaux on the corner closest to the Toyota Center. Get a wrist band and start asking where they need help.”

Another member asked a problematic user to stop trolling and posting unhelpful information during the hurricane (**dimension: influence**).

“Stop trolling. AGAIN. You make it very obvious which one you are. You consistently post these useless comments using hours-old accounts”

Many members directed others to the megathreads and shared their appreciation for the moderators for their efforts (**dimension: influence & shared emotional connection**).

“Much acclaim and appreciation to our moderators for helping to disseminate all of this valuable information. I've directed so many people to this megathread because of your amazing work. Thanks again, guys and girls! Your hard work and dedication does not go unnoticed or appreciated.”

Many members continued expressing concern for their own safety and the well-being of others in the community. By emphasizing togetherness, mutual support, and collective endurance, the below comment reflects a shared emotional connection among subreddit members (**dimension: shared emotional connection**).

1
2
3 *“To everyone out there, stay safe, stay with neighbours and friends in the meantime, lots of*
4 *places getting flooded out as of now. We all need to just go through this and hope for the best*
5 *and prepare for the worst.”*

6
7
8
9
10 Moderators also showed gratitude towards members and especially thanked some members who
11 had a significant contribution (**dimension: membership & shared emotional connection**).

12
13
14
15 *“I’ve been astounded by how everyone on in /r/Houston has worked together through this*
16 *horrible and unprecedented situation. A huge thanks to the community and everyone who has*
17 *been monitoring the megathreads and giving invaluable advice to people in need. I’m really*
18 *proud to live in Houston and see how well everyone came together in a time of crisis.”*

19
20
21
22 All in all, disaster victims showed gratitude for the subreddit’s role in providing valuable
23 information (**VAR information**) during the hurricane as shown in the below quote:

24
25
26 *“I sincerely appreciate all the wealth of information that /r/houston has supplied to the*
27 *community and knowing that I can come to this subreddit for valuable information is gold.”*

28
29
30
31
32
33 **Vignette 3: Changing rules to help people**

34
35
36 **Problematic situation:** During the hurricane, members needed rescue or emergency supplies to
37 be provided at a specific location. However, posting personal information (e.g. address, contact
38 details) was against the community rules and Reddit policy. This meant it was not possible to
39 send or obtain support during the disaster without knowing the physical location of the victims.
40 Initially, moderators strictly followed rules and took down threads or comments with attached
41 personal information. They mentioned the community rules:

42
43
44 *“Posting personal information, harassment, and other breaches are strictly forbidden.”*

While some members questioned such moderation practices and asked for justification, other members reminded people not to post personal information.

“Hey you will get banned in half a second if you ask that [address]. The mods [moderators] are f[expletive] crazy.”

People became dissatisfied and wanted to leave the community.

“I must say mods are dumb. Time to leave this sub [subreddit].”

Socialisation: Forming emergent group norm: A norm emerged among the members that moderators should allow posting personal information. For example, a member suggested victims should share their zipcode to indicate location. They asked moderators to relax rules on self-disclosure.

“People should hashtag their zipcode so people with boats who are volunteering can filter who is in their vicinity.”

Acknowledging emergent group norm by moderators: Moderators acknowledged members’ feedback and agreed to allow the posting of personal information. This was done to facilitate critical communication, such as sharing contact details to find missing people, offering help, or coordinating rescue efforts.

“You can now share your address and contact details if necessary.”

Informal control via the strategic use of social media features: While a few members continued to advocate against making private information public, the majority disapproved (by downvoting) and encouraged the posting of personal details. This was done by applying the voting and commenting features provided by Reddit.

“Drown or stay anonymous take your pick.”

Formal control via the strategic use of social media features: Moderators relaxed rules on posting personal information. They also created a new digital identifier called a “flair” to indicate the location of the information seeker/provider. The location-based flairs allowed community members to quickly find the area or areas they were interested in helping (e.g., volunteering), providing related information and improving response efforts during the disaster. Below is an example of flair that moderators created to indicate the location called “Montrose” which is one of the major neighborhoods in Houston. While in normal times flairs were used for tagging specific interests to organize threads, during the disaster they indicated urgent information like victim locations. This shift helped streamline communication and response efforts effectively.

Posted by u/username/ **Montrose** ← *flair*

Sense of community and generating VAR information: People started providing personal information and received the required support (**dimension: influence & needs fulfilment**). For example, one person posted an address to get rescue assistance.

“My friends are stuck in their home, they need rescue. Here's the exact address it's [house address]”

Community members appreciated those who helped in the rescue effort (**dimension: shared emotional connection**).

“You have such a big heart, thank you for rescuing them.”

They further acknowledged and appreciated the r/Houston community for providing accurate and up to date information (**VAR information**).

1
2
3 “While I had the news on, accurate and up to date information was posted on here with replies
4 before I saw it elsewhere. False information and crap posts were quickly tossed out. This
5
6 subreddit helped connect me to people across the city to help check on areas when there was no
7
8 information available.”
9
10
11

12 13 **5. Discussion**

14
15 Research has proven that a sense of community improves the spread of verifiable, accurate and
16
17 reliable (VAR) information during a disaster (Chang, 2021; Paton and Irons, 2016). Research
18
19 also suggests that virtual communities can enforce norms to cultivate a sense of community,
20
21 thereby improving VAR information (Blanchard *et al.*, 2011; Petrič and Petrovčič, 2014). Prior
22
23 IS discourse highlights the importance of socialisation and formal control as a means of norm
24
25 enforcement in virtual communities (Blanchard *et al.*, 2011; Petrič and Petrovčič, 2014; Watson
26
27 *et al.*, 2019; Wise *et al.*, 2006). However, institutionalising norms via socialisation is time-
28
29 consuming, which is why research suggests imposing norms via formal control. But norms
30
31 imposed by formal control can cause conflicts and erode individuals’ sense of community.
32
33 Therefore, it remains a theoretical puzzle how both socialisation (bottom-up, community-driven
34
35 approach) and formal control (top-down, moderator-driven approach) can act together to
36
37 cultivate and maintain a sense of community in virtual communities during a disaster. In
38
39 addition, how social media and its associated features can be applied to foster a sense of
40
41 community remains an open question. We contribute to IS discourse on virtual community
42
43 governance by suggesting that two processes, endorsing and disciplining, interacting between
44
45 socialisation and formal control, can work together to foster a sense of community. Endorsing
46
47 and disciplining are enacted through the strategic use of social media.
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We have demonstrated how socialisation and formal control contributed to the formation of a sense of community in the r/Houston community. Socialisation can inform formal controllers (i.e., moderators) about how emergent group norms work, transfer community feedback, and introduce emergent leadership through the endorsing process. At the same time, formal controllers can improve socialisation through the disciplining process. They can enforce emergent group norms, sanction uncivil behaviour, and authorise emergent leadership. Table IV summarizes the key points of our findings. Figure 3 illustrates our revised process model of cultivating and maintaining a sense of community in virtual communities during a disaster.

=====

Insert Figure 3 here

=====

=====

Insert Table IV here

=====

5.1 How socialisation and formal control interact: the virtuous cycle of endorsing and disciplining

One reason moderator-imposed norms can create conflict and hinder an individual’s sense of community is the misalignment of expectations among community members and moderators (Carey and Meyer, 2016; Petrič and Petrovčič, 2014). Imposing norms via formal control discourages users from seeking and providing support. For example, in our case, it was not possible to get support without disclosing personal information during Hurricane Harvey. Therefore, while socialising, members formed the emergent group norm of posting personal information. However, posting personal information was against Reddit policy. Therefore, initially, moderators removed posts that contained personal information. This led to members becoming dissatisfied and wanting to leave the community.

1
2
3 The simultaneous existence of socialisation and formal control raises an important question.

4
5 How can one make sure the norms imposed by formal control work? Our findings suggest that
6
7 moderators need to impose emergent group norms instead of moderators' norms. This poses
8
9 another question of how moderators get informed of emergent group norms. Our case illustrates
10
11 that moderators can learn about emergent group norms and changing needs of the community
12
13 through a communicative process. We refer to this process as *endorsing*. During this process, the
14
15 community members highlight their specific disaster-information needs and form emergent
16
17 group norms (e.g., posting personal information, attaching evidence, isolating unwanted users).
18
19 The moderation team learns about these emergent needs and norms by actively participating in
20
21 the conversation. As such, moderators acknowledge emergent group norms by listening to
22
23 the conversation. As such, moderators acknowledge emergent group norms by listening to
24
25 community feedback and formalise them.
26
27

28
29 As part of the endorsement process, it can be helpful for moderators to recognise emergent
30
31 leaders. Our findings suggest that moderators must be sensitive to community sentiment during a
32
33 disaster, and emergent leaders are often more sensitive to comments from people on the ground
34
35 than prior moderators. In our case, the emergent leader identified solutions to address the
36
37 community's unique needs during the disaster. The emergent leader acted as a conduit and
38
39 helped channel emergent group norms to the moderators. Our findings resonate with other
40
41 studies that demonstrate the importance of emergent leadership during disasters (Gardner, 2013;
42
43 Twigg and Mosel, 2017).
44
45

46
47 It is also necessary to regulate uncivil behaviours and isolate problematic users from the
48
49 community during a disaster. The moderators applied emergent group norms and sanctioned
50
51 uncivil behaviours through an enforcement process. We refer to this process as *disciplining*. The
52
53 process of disciplining resonates with the Black Sheep Effect (Marques and Paez, 1994), which
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describes how community members harshly judge those who deviate from community norms and rules (Lewis and Sherman, 2010). During the hurricane, emergent norms and rules were enforced strictly, showing harshness toward outgroup members with bad intentions and ingroup members who failed to conform. Prior work argues that virtual communities should be open and inclusive (Pi *et al.*, 2013; Rheingold, 1993). Further, they should encourage uninterrupted participation because regulating one's behaviour can erode individual-level sense of community (Blanchard *et al.*, 2011; Meyer and Carey, 2014). However, our findings suggest that isolating problematic users and losing *individual-level* sense of community improved *group-level* sense of community during the disaster. For example, the community only preferred Houstonians and helpful outsiders during the hurricane. Thus, non-Houstonians lost their individual-level sense of community and stopped participating, which was desirable. Members reported problematic users, and subsequently, moderators banned them. As a result, the community reinforced its membership and received the desired support. We also noticed that moderators granted the emergent leader temporary moderator status to exert formal control. Subsequently, the emergent leader made community rules explicit and regulated uncivil behaviours. We agree with prior studies that alienation at the individual-level can erode an individual's sense of community (Blanchard *et al.*, 2011; Meyer and Carey, 2014). Moreover, alienated individuals have lower trust in others. However, we argue this is a desirable outcome so long as the individuals alienated are not the ones the virtual community wants to serve during the disaster, which in our case were Houstonians suffering from the natural disaster and helpful outsiders.

We recognise that a sense of community can become harmful when it fosters groupthink, as observed in conspiratorial groups like the Flat Earth community (Diaz Ruiz and Nilsson, 2023). This brings us to question how to develop a sense of community that is not harmful and does not

1
2
3 foster groupthink in the community during disasters. Our conceptual framework suggests that
4
5 moderators should not merely learn from individual community members but, more importantly,
6
7 develop rules to prevent claims from being posted without supporting evidence. In our case,
8
9 initially shaped through community interaction, these evidence-based norms became
10
11 institutionalised as core moderation practices to build consensus grounded in fact. Particularly,
12
13 the endorsing and disciplining processes in our framework did not encourage groupthink.
14
15 Instead, it fostered a trusted environment where people could find VAR information. This further
16
17 highlights that moderators should not allow or support any factless or non-scientific claims, as
18
19 doing so would undermine evidence-based norms.
20
21
22
23

24 **5.2 How the strategic use of social media enables the virtuous cycle and fosters a sense of** 25 **community**

26
27 The strategic use of social media is crucial for virtual community members to apply available
28
29 features on social media in an integrated way to solve problems and achieve common goals
30
31 (Leidner *et al.*, 2009; Morton *et al.*, 2023). Previous sense of community discourse sheds light on
32
33 its conceptual properties and dimensions, while also delineating how it can be formed and in
34
35 what ways it benefits individuals and communities (Blanchard and Markus, 2004; Kim *et al.*,
36
37 2017; McMillan and Chavis, 1986; Norris *et al.*, 2008; Paton and Irons, 2016). However, limited
38
39 insight remains on the role of social media in enabling this process. Our findings offer nuanced
40
41 insight into how social media features are applied to enable endorsing and disciplining.
42
43
44
45

46 On the one hand, the strategic use of social media allowed members to endorse norms in virtual
47
48 communities to foster socialisation. In vignette 1, members used the reporting feature to signpost
49
50 problematic people who spread misleading information. They also applied the voting feature to
51
52 downvote posts that did not have verifiable evidence. In vignette 2, members used the voting
53
54 feature to downvote political discussions and used the tagging feature to signpost them to
55
56
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moderators for further action. In vignette 3, community members applied the voting and commenting features to advocate a change in norms that allowed people to share personal information.

On the other hand, the strategic use of social media enabled disciplining in virtual communities to foster formal control. In practice, moderators adopted and applied a range of features available on social media to enforce community norms and safeguard the community members against uncivil behaviours. For example, in vignette 1, moderators used the “ban user” feature to remove problematic outsiders from spreading falsehoods. In vignette 2, moderators used the “sticky” feature to pin the megathread and make it more prominent. Moderators also changed the comment sorting feature to “new” to present the latest information on that megathread. They also applied the commenting feature to redirect people to post on the megathread. In vignette 3, moderators introduced digital identifiers – known as “flairs” - as a means for people to share personal information (e.g., location).

Therefore, the strategic use of social media is essential for virtual communities to achieve common goals during disasters. Our case evidence suggests that community members and moderators could carefully use social media features to not only develop emergent norms, but to institutionalise them successfully. We argue that when social media features are used randomly and without careful thought, they exacerbate problems and impede the sense of community (Misra *et al.*, 2020; Oh *et al.*, 2013; Stieglitz *et al.*, 2022). For example, in vignette 1, posting randomly without fact-checking fuelled misinformation. In vignette 2, members randomly created many threads, which made it difficult to find useful information, such as shelter locations and emergency numbers. In vignette 3, initially, moderators used the deleting and banning features to remove posts that included personal information, while also removing those

individuals from the community. In this case, moderators could not strategically envision that new norms are required due to the evolving disaster situation, thus eroding sense of community. The above discussion further suggests that social media features cannot be fixed, and their use must be adapted based on the situation at hand. What might be considered appropriate in normal situations could be entirely inappropriate during disasters and impose greater problems. Therefore, the key to minimising problems and fostering a sense of community in virtual communities during disasters is the *adaptability* of social media use and its associated features. For example, in vignette 2, seeking information from a centralised thread was more effective than creating or seeking information from random threads. In vignette 3, flair was adapted (e.g., created or renamed) for localised use to help signal geographical locations. As such, while existing virtual community literature on disaster management has viewed social media features as static, material artefacts—fixed interfaces with preset functions designed for broad, generalised use (Nan and Lu, 2014; Qu *et al.*, 2009; Silver and Matthews, 2017), our findings offer an alternative perspective, proposing that social media features should be *adaptable*, i.e., capable of reconfiguring to emergent contexts such as disasters. This adaptability enables strategic use of social media, helping foster a sense of community in virtual communities during disasters.

5.3 Practical contributions

Our findings have several implications for moderators, community members and system designers. First, excessive moderation during disasters should be avoided, as it can lead to perceptions of censorship, accidentally marginalise quieter voices, and undermine the sense of community. Instead, moderators should actively participate in the community to learn the changing needs and emergent group norms during a disaster. This will help moderators adjust

their moderation practices according to changing needs. For instance, our case evidence showed that moderators learnt from the community that the previous norm of not disclosing personal information is hindering people from coping with the disaster. Such a realisation enabled moderators to relax those norms. Further, since humans have agency (Giddens, 1984), moderators typically have the choice to engage or not in community discussion. However, we argue that active participation is not optional or a choice during disasters but mandatory. Disasters are high-stakes events, and falsehoods or irrelevant information during disasters can have life-or-death consequences. In addition, we recommend moderators to adapt their existing practices and strategically use social media to sanction uncivil behavior and isolate problematic users. Our findings show that the use of “ban” and “delete” features were instrumental in this process. Moderators should also recognize emerging leaders, cooperate with them, and grant them appropriate power. We find that emergent leaders were more grounded in the current disaster reality and offered constructive ways in generating reliable information. Thus, moderators are encouraged to expand their moderation team during disasters to cope with uncertainty.

Second, we recommend community members to strategically use social media to endorse emergent norms. For instance, our case evidence showed that by using the comment, reporting and tagging features, members endorsed the norm of attaching verifiable evidence. Without the contribution of community members in this process, the moderators may not be able to envision new norms. Once new norms are institutionalized, community members are encouraged to contribute towards maintaining those norms so that the overall community benefits from it. In our case, community members constantly monitored the threads and signposted those that did not adhere to emergent norms. For example, those posts that did not have any evidence were

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3 reported and downvoted. Most importantly, we suggest community members to not randomly
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5 use social media features without careful deliberation during disasters. They should familiarize
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7 themselves with the community norms or contribute towards creating new ones. Our empirical
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9 evidence showed that the non-strategic use social media fueled misinformation and information
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11 overload.
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15 Finally, we recommend system designers carefully develop adaptable social media features that
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17 help foster a sense of community. By adaptable social media features, we refer to the capacity of
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19 platform features to be configured to fit specific situational needs. For example, platforms could
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21 provide options using checkboxes or radio buttons that allow moderators to toggle anonymity on
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23 or off, customise digital identifiers to reflect temporary roles, professional status (e.g.,
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25 meteorologist) or location, and adjust visibility settings for sensitive content. For example, our
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27 findings showed how the adaptation of the sorting feature offered flexibility to the community to
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29 consume the latest information that aligns with the changing needs (vignette 2). In addition, we
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31 recommend the introduction of digital identifiers to signpost personal information. These
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33 identifiers are particularly relevant in disaster times to flag one's location to receive help.
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35 Finally, we suggest system designers pay close attention to features that enable virtual
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37 communities to control irrelevant and misinformation from being spread. Our empirical evidence
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39 showed that banning, tagging and reporting features were instrumental in this process.
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46 **6. Conclusion**

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48 This paper has addressed the question of how a virtual community can cultivate and maintain a
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50 sense of community during disasters. Our evidence suggests that although disasters create chaos
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52 and uncertainty, they also provide an opportunity for developing a sense of community within
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54 the virtual community. Our findings demonstrate that socialisation and formal control are
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essential factors in fostering a sense of community and thus, minimising disaster-associated risks, such as antisocial behaviour and the propagation of falsehoods. Practically, this is made possible through the strategic use of social media, which involves (i) endorsing emergent norms and (ii) enforcing those norms through a disciplining process. As such, our study is relevant for virtual community moderators and members, as we demonstrate how our research insights enable a virtual community to establish emergent group norms, sanction uncivil behaviours, and isolate problematic users. As a result, the sense of community can be improved at the group level.

The findings of this study should be considered in light of its limitations. First, the empirical support of our findings is limited to a single virtual community (subreddit). Although our contributions are generalisable at an analytical level to the sense of community theory, like all qualitative studies, we cannot generalise to a population (Lee & Baskerville, 2003; Sarker et al., 2013). We acknowledge that if other social media platforms share similar characteristics and IT features to Reddit, our findings may be useful to those platforms. However, social media platforms such as Telegram and Facebook have some unique features that limit the applicability of our research insights beyond Reddit. Hence, the study's findings may not be plausible in all virtual communities across other social media platforms. In particular, other social media platforms with different features may yield different insights. Second, virtual communities on Reddit are generally moderated communities. Future studies might investigate how the sense of community emerges in other unmoderated virtual communities. Third, this study focuses on only one disaster incident. We acknowledge that each disaster is unique. As such, we encourage researchers to explore variations in our proposed model based on different types of disasters (e.g., man-made vs. natural disasters). Fourth, our study only focuses on the disaster response

period. However, a sense of community may develop over time. Hence, there may be other factors contributing to sense of community that should be explored in future research. Fifth, this study used only digital trace data. Future research can use other data collection methods, such as surveys, interviews, and participant observation, to confirm or negate our findings. Finally, while this study is grounded in qualitative interpretivist inquiry, future research could build on our findings by incorporating complementary analysis techniques such as sentiment analysis, topic modelling, or social network analysis. These approaches could help provide insights and offer a complementary or additional view of community response during disasters.

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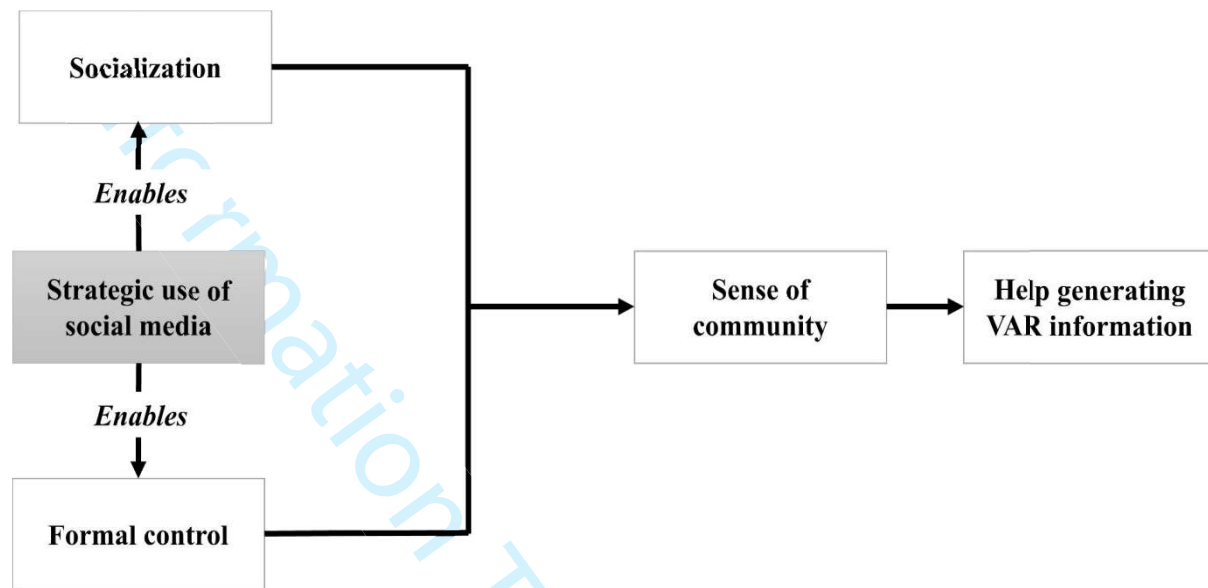
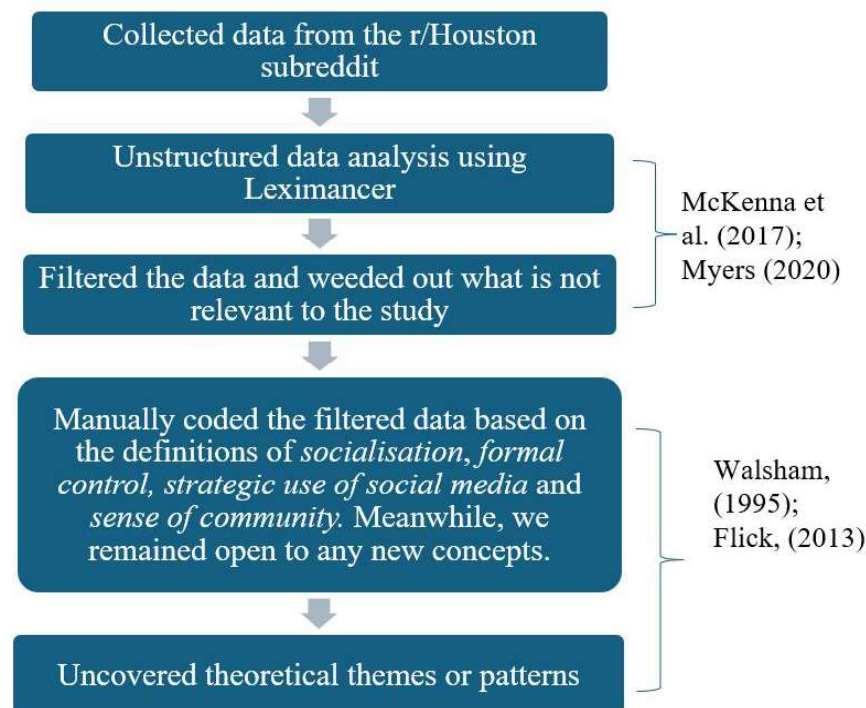
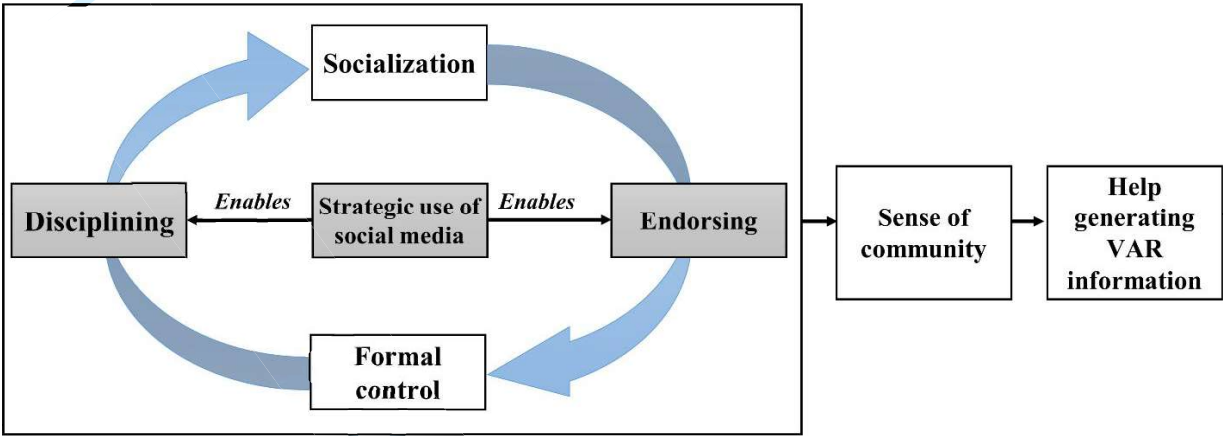
Figure 1*Process model of constructing sense of community in virtual communities during disasters**Credit attribution: authors***Figure 2***Data collection and analysis steps**Credit attribution: authors*

Figure 3
Conceptual framework: Cultivating and maintaining a sense of community



Credit attribution: authors

Table I*Selected studies on social media and virtual communities during disasters*

Study	Social media platform	Disaster	Key insight(s)
Zou <i>et al.</i> , (2023)	Twitter	Hurricane Harvey	Highlights the challenges of social media for disaster response during Hurricane Harvey. Victims post messages that contain information gaps (e.g., lack of location data), and many were from vulnerable communities. Offers practical suggestions on how social media can be adequately used in future disaster management.
Karimiziarani & Moradkhani (2023)	Twitter	Hurricane Ian	Highlights that community sentiments change during disasters, suggests key discussion topics and shows that posting on social media varies depending on the geographical location of the hurricane.
Qi <i>et al.</i> , (2025)	Facebook	COVID-19	Shows that indigenous values in Vietnam, particularly the tương thân tương ái perspective, can inform how communities manage disasters using social media.
Hasan <i>et al.</i> , (2025)	Reddit	Hurricane Harvey	Suggests that virtual communities need to reconfigure themselves during disaster times. In practice, virtual communities need to change their practices, norms and use of IT features to become digitally resilient.
Qin <i>et al.</i> , (2022)	WeChat	COVID-19	Suggests the importance of empathy during natural disasters and that social support promotes it. Also highlights that sense of empathy depends on demographic and geographic differences between individuals.
Momin <i>et al.</i> , (2024)	Twitter	Hurricane Laura	Unpacks how crisis communication unfolds on social media between stakeholders to cope with the disaster and offer support to disaster victims.
Liu <i>et al.</i> , (2023)	haodf.com	COVID-19	Suggests how physicians who use online healthcare communities can become digitally resilient during natural disasters.
Li <i>et al.</i> , (2024)	Sina Weibo	Henan floods	Offers insight into how individuals use social media to post helpful information during disasters and mobilise resources to help the public cope adequately with the crisis.
Lerouge <i>et al.</i> , (2023)	Twitter	COVID-19	Governments sharing public announcements during disasters can shape the public's emotions, such as fear.
Hao <i>et al.</i> , (2024)	Reddit	COVID-19	Highlights that discussion topics and sentiments evolve during disasters in virtual communities.

Source: Authors own work

Table II
Summary of the r/Houston subreddit (virtual community) used

Number of members (as of 25 August 2017)	62000+
Disaster response period: Aug 25- Aug 31,2017	Total number of threads created: 5315
	Total number of comments made: 99078

Source: Authors own work

Table III
Summary of coding rules

Element	Coding rules	Illustrative evidence
Socialization	<i>Forming emergent group norm:</i> observed by the activity of community members to form new disaster-specific norms/rules/beliefs or identification with others.	<i>“What is your "reliable source"? Clear Lake City Water Authority issued a statement that rumors on social media that the water supply is threatened are false.”</i>
	<i>Acknowledging the emergent group norm:</i> observed by moderators’ positive reaction or activity towards the emergent group norms/rules/beliefs.	<i>“I reported their comments for being vulgar and offensive. No evidence. The mods might have also taken it down.”</i>
	<i>Informal control:</i> community members desire to follow emergent group norms/rules/beliefs or action to regulate behaviors based on those norms.	
Formal control	Observed by moderator’s action to regulate/manage the community by enforcing emergent and existing mechanisms (e.g., norms, rules, procedures, and policies).	<i>“Posting personal information, harassment, and other breaches are strictly forbidden.”</i> <i>“He's already been banned. His second account has also been banned. People are coming here for accurate information. We don't need the shitty name calling and posts right now from someone who doesn't know what's going on!”</i>

Strategic use of social media	Repeated examples of community members and moderators doing things with Reddit features.	<i>"Thank you, have an upvote. I'll share this on fb [Facebook]."</i>
Sense of Community		
Membership	Comments or activities indicating boundaries (i.e., in-group/out-group), reflecting members' safety (revealing how one feels about the community), expressing members'/moderators' involvement and sense of belonging.	<i>"Dude it's been an amazing outpour of coverage, pics, people relaying other people info and getting help out. The discussion threads were phenomenal over the past 5 days and this subreddit has been amazing. It's good to get everyone together as a community. Seeing everyone come together in a time of desperation and coming though alright. Makes me damn proud to be a Texan and even prouder to be a Houstonian."</i>
Influence	Comments suggesting, planning or taking actions and conforming to community norms and rules.	<i>"There is a false report going around claiming 50+ inches of rain..this is confirmed fake. Please do not spread it."</i>
Needs fulfilment	Comments related to seeking, providing or integrating situational information, advice, and suggestion. We also noticed what activities members/moderators performed during the hurricane Harvey so the community could satisfy members' needs.	<i>"If you're still looking for bottled water, there is some at Walmart (Yale St). They were restocking an hour ago."</i> <i>"Yes! I was mostly getting my news from the megathread...To everyone who contributed on the thread, you did an amazing job."</i>
Shared emotional connection	Comments expressing gratitude (praising community members/moderators) and sharing similar experiences.	<i>"Category 4 is damn serious. Stay safe, Houstonians!"</i> <i>"Thank you, mods [moderators], for a megathread!!...This subreddit was literally a life or death tool. Really highlights the strengths, powers, and potentials of technology."</i>

Source: Authors own work

Table IV
Summary of findings

Concepts	Case evidence from the r/Houston community	Process enabling sense of community
Socialization	<i>Forming emergent group norm</i> • Members made their needs explicit • Members formed emergent group norms • Emergent leader tagged moderators to inform concerns and suggest solutions	Endorsing
	<i>Acknowledging the emergent group norm</i> • Moderators acknowledged emergent group norms and feedback • Moderators recognized emergent leader	
	<i>Informal control</i> • Members reported falsehoods and unwanted users to the moderators • Members confronted and reported insensitive comments to the moderators • Members spotted falsehoods and asked for evidence	Disciplining
Formal control	• Moderators took down threads or comments for violating emergent group norms and community rules • Moderators banned unwanted users • Moderators removed insensitive comments • Moderators granted authority to emergent leader	
Strategic use of social media	• Members used the commenting and voting feature to form emergent group norms • Members used the tagging and commenting feature to communicate emergent group norms • Members used the reporting feature to signpost problematic people who spread misleading information • Members applied the voting feature to downvote posts that did not have verifiable evidence or harmful and irrelevant information (e.g., politics)	

	• Moderators used the commenting feature to acknowledge emergent group norms • Moderators used the “ban user” feature to remove problematic outsiders from spreading falsehoods • Moderators applied the commenting feature to re-direct people to post on the megathread • Moderators used the “sticky” feature to pin the megathread and make it more visible • Moderators adjusted the comment sorting feature to “new” to showcase latest information • Moderators introduced digital identifiers i.e., “flairs” for members to share personal information	Endorsing and Disciplining
Sense of Community	• Reinforced membership through in-group/out-group distinction • Members followed emergent group norms and community rules • Members actively corrected falsehoods • Improved shared emotional connection and social support	
Outcome	• Helped generating verifiable, accurate, and reliable (VAR) information	

Source: Authors own work