Twitter Functions in COVID-19 Pandemic and Other Natural Disasters: A Systematic Review

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Abstract

Background: Twitter is a major tool for communication in emergencies such as natural disasters. This online social network allows the user to produce content, and it is not designed exclusively for news releases, as opposed to other service providers.

Aim: The aim of this study is to investigate Twitter uses in natural disasters and pandemics.

Methods: The included studies reported the role of Twitter in natural disasters. The studies that report in settings other than the natural disasters (such as man-made disasters) and other social media were excluded. Electronic databases for a comprehensive literature search including MEDLINE, Web of Science, CINAHL, PsycINFO, Cochrane Register of Controlled Trials (CENTRAL) and EMBASE were used to identify the records that match the mentioned inclusion criteria published till May 2020. The study characteristics were extracted from the qualified studies including year of publication, findings, and geographical location of the study conduct. A narrative synthesis for this literature review was used.

Results: The search identified 822 articles of which 780 articles were removed, 256 were not available, 311 papers were not relevant, 16 were duplicated articles, and 197 were non-related to the emergencies. 45 articles met the selection criteria and were included in the review. eleven themes were found in the narrative synthesis including early warning, disseminating information and misinformation, advocacy, personal gains, assessment, various roles of organizations, public mood, geographical analysis, charity, using influencers, and trust.

Conclusions: It is recommended that influential individuals be identified in each country and community before disasters occur so that the necessary information can be disseminated in response to disasters. Preventing the spread of misinformation is one of the most important issues in times of disaster, especially pandemics. Disseminating accurate, transparent, and prompt information from relief organizations and governments can help. Also, analyzing Twitter data can be a good source for understanding the mental state of the community, estimating the number of injured people, estimating the points affected by natural disasters, and modeling the prevalence of epidemics. Therefore, various groups such as politicians, the government, non-governmental organizations, aid workers, and the health system can use this information to plan and implement interventions.

Keywords: Twitter, Disaster, Risk Reduction, Preparedness, Response, Recovery

1. Background

All disasters and emergencies are by nature chaotic and dynamic [1, 2]. Natural disasters in seconds change the lives of people and create physical, emotional, and social damages. In such a situation, communication is critical in all phases of disaster management [3]. In the last decades, people just relied on traditional media like TV, radio, and newspapers for the news. Sharing information was not easy and on-time. In the new era, new technologies give us the capability of communicating with others on-time and interactive. With rapidly evolving smartphone technologies, people can access information in milliseconds and just by one click. Online social media like Facebook and Twitter have a vital role in disaster management in the world and are mentioned as the most popular sources in the world for receiving information during disasters [4, 5]. People themselves at a time are the producer and consumers of messages. This statistic shows the number of social media users worldwide from 2010 to 2016 with projections until 2021 [6]. In 2019, it is estimated that there will be around 2.77 billion social media users around the globe, and up from 2.46 billion in 2017 [6]. The increased worldwide usage of smartphones and mobile devices has opened up the possibilities of mobile social networks with increased features such as location-based services like Foursquare or Google Now [7]. Most social networks are also available as mobile social apps, whereas some networks have been optimized for mobile internet browsing, enabling users to comfortably access visual blogging sites via tablet [3].

Among social media networks, Twitter is a great resource for disaster risk management researchers. Twitter was launched in October 2006 and quickly became the largest microblogging service [6]. This study selected Twitter among the social networks because it has the world's largest network of users, it can publish globally at the moment, and allows the user to generate content, and is not designed exclusively for news releases, as opposed to other service

providers and it allows the user to participate actively [8]. It is because of the real-time content, ease in accessing and searching available information. Twitter is a social networking and micro-blogging service, enabling users to read and post tweets or short messages. Twitter messages are limited to 280 characters and users are also able to upload photos or short videos [6]. Tweets are posted to a publicly available profile or can be sent as direct messages to other users. Twitter is one of the most popular social networks worldwide. Part of the appeal is the ability of users to follow any other user with a public profile, enabling users to interact with influencers who regularly post on the social media site.

With the spread of COVID-19 in the world, information about it was spread, too[9, 10]. Other natural disasters usually affect a country or a geographical area. But the global spread of the COVID-19 has made Twitter one of the most frequent tools for publishing and getting information in the world[11]. There has been a lot of debates about the publishing misinformation on Twitter or the impact of Twitter on obtaining health information. By considering pandemics as a natural disaster, identifying Twitter opportunities and threats can help to obtain a strategy for disaster risk communication.

The aim of this study was to show a holistic view of Twitter applications and in the disaster management cycle (preparedness, response, and recovery) and it will help policymakers, public relations, emergency organizations, and other stakeholders to better use Twitter to help people.

2. Methods

2.1. Eligibility

The included studies reported the role of Twitter in natural disasters. Different types of studies including quantitative, and qualitative studies were accepted. Those studies were included that

were published in English language journals or conference proceedings that are accompanied by full-length peer-reviewed papers. Included studies were reported different functions of Twitter in natural disasters' phases including mitigation, preparedness, response, and recovery.

The studies reporting in settings disasters other than the natural disasters (such as man-made disasters) and other social media were excluded from the study.

2.2. Search Strategy

Electronic databases were used for a comprehensive literature search including MEDLINE, Web of Science, CINAHL, PsycINFO, Cochrane Register of Controlled Trials (CENTRAL) and EMBASE to identify records that match the mentioned inclusion criteria published till May 2020. Different keywords for the systematic search were identified during the initial literature search. The search main terms were flood, hurricanes, tornadoes, volcanoes, earthquakes, tsunamis, storms, emergencies, crisis, hazards, risks, fire, bushfire, landslide, haze, sandstorm, drought, snowstorm, heatwave, cold wave, sever weather, avalanche, thunderstorms, outbreaks, Zika, Ebola, Flu, andCOVID-19. Search terms were combined with the appropriate Boolean operators and were searched in titles, abstracts, and keywords.

 2.3. Selection Processes

Two reviewers participated in the selection process. An Endnote desktop was used to store references and subsequently identify and remove duplicates. Two reviewers then separately scanned abstracts and full texts of currently eligible studies against the eligibility requirements of the research, taking into consideration the type of intervention, sample population, and the recorded outcomes.

2.4. Data Extraction

Two reviewers individually performed data retrieval, and agreement was achieved by conversation. The study characteristics were extracted from the qualified studies including year of publication, findings, and geographical location of study conduct.

2.5. Data Synthesis

A narrative synthesis was used for this literature review. Narrative synthesis refers to an approach to reviews that focuses mostly on the use of words and texts to summarize and explain findings [12]. It is usually viewed as the "second best" approach for synthesis in systematic reviews. This approach is a significant method to interpret findings and use in policy and practice, vastly.

Search strategy

In this systematic review, we used a four-step search strategy to identify relevant studies. Only English language studies were searched. The articles were searched using 8 electronic databases ABI/Inform Collection, Science Direct, Emerald Insight, EBSCO Host, Google Scholar, SAGE, Springer, and Elsevier.

When potential articles were identified and duplicate articles were deleted, the titles and abstracts of the remaining articles were researched for reviewing the relevance of the review subject. When an article with the above descriptions was found, the title and summary of the article were reviewed to determine whether the article was relevant to the main purpose of the review. In the case of ambiguity, the full text of the article was also examined to determine whether there are entry criteria. The following table refers to the process of selecting articles. The study was analyzed using the software tool MAXQDA 12 to perform thematic analysis. Then, the two collections of codes extracted were compared, discussed, and summarized in 12 themes.

3. Results

The search identified 822 articles of which 780 articles were removed, those 256 were not available, 311 were papers not relevant, 16 were duplicate articles, and 197 were non-related to emergencies. When potential articles were identified and duplicate articles were deleted, the titles and abstracts of the remaining articles were researched for reviewing the relevance of the review subject. 45 articles met the selection criteria and were included in the review that characteristics are shown in Table 1.

Eleven themes were found in the narrative synthesis including early warning, disseminating information and misinformation, advocacy, personal gains, assessment, various roles of organizations, public mood, geographical analysis, charity, using influencers, and trust.

Table 1: Characteristics of studies about disasters and twitter.

No.	disaster	finding	Country	Ref.
1	Typhoon	people and organizations have used Twitter more often to retweet second-hand information/ social networking users in Philippines are more likely to pay for news released in traditional media than social media.	Philippines	[13]
2	Earthquake, Tsunami	The results suggest that Twitter can be used to track and measure the public's mood after natural disasters.	Japan	[14]
3	Wildfire	the geographic awareness of people is strong about critical events and people are interested in tweeting about fire damage, firefighting, and thanking firefighters/official tweets play a key role in the firefighting network.	USA	[15]
4	Earthquake	Rumors about the earthquake spread more than anything else on Twitter.	Chile	[16]
5	Earthquake	Twitter was used as a tool to report the situation by the affected people. This article suggests that Twitter can be used as a tool for rapid assessment of an accident, as well as for the publication of accurate information by officials.	Japan	[17]
6	Earthquake	Twitter is useful as a tool to show people's mental health, especially in the early days of an disaster.	Japan	[18]
7	Earthquake	During the quake, organizations used Twitter as a tool for risk communication, collect public donations, and provide psychological support.	Haiti	[19]
8	Earthquake	Twitter was used to disaster assessment, response monitoring, and help the affected people.	Haiti	[20]
9	Storm	A lot of first-hand information was published about the current situation. It is useful for disaster assessment.	USA	[3]

10	Tornado	People trusted personal accounts more than government accounts to find out about Tornado. Influential people play a big role in providing the right information. Using the right hashtag will help spread information on Twitter.	USA	[21]
11	Earthquake	Twitter acted as an effective and efficient tool for communication between people and aid organizations, including the police, in the earthquake.	Nepal	[22]
12	Storm	Having a strategy for using Twitter in times of disaster is essential. Twitter is a great tool for publishing content, but it has been suggested that influential people be used to publish it.	USA	[23]
13	Tsunami	Twitter is a powerful tool for quick alerting during tsunamis, especially for Indonesia with a high population distribution. It is necessary to publish the required materials in different languages in the region during disasters.	Indonesia	[24]
14	Volcanic eruption	At the time of the eruption, a lot of misinformation was spread. Therefore, it is necessary for government agencies to have an information strategy in case of disasters so that they can publish the correct information from the first moment.	Iceland	[25]
15	Earthquake, Tsunami	A third of the tweets were released from low credibility sources. Tweets published by anonymous and unidentified accounts have lowered credibility.	Japan	[26]
16	Flood	Tweet analysis helped identify the effects of flooding on people's mental health. This can affect the design of psychosocial support programs.	India	[27]
17	Ebola Outbreak	To spread information about Ebola, influential people on Twitter retweeted the initial information. It is recommended that these people be helped to publish health information with the correct information.	Global	[28]
18	COVID-19 pandemic	Publishing false information about pandemics has reached alarming levels that endanger public health.	Global	[29]
19	COVID-19 pandemic	There was a geographic relationship between the flow of information about the pandemic and the identification of new cases of the COVID-19.	Global	[30]
20	COVID-19 pandemic	Using Twitter text and image analysis, the prevalence in each geographical area can be predicted	Global	[31]
21	COVID-19 pandemic	Use Twitter bots to promote misinformation and political information about the COVID-19	USA	[32]
22	COVID-19 pandemic	At the same time, Twitter played a useful role in promoting positive information and a negative role in disseminating misinformation about the COVID-19.	Global	[33]
23	COVID-19 pandemic	Using tweet analysis, the community's Sentiment can be assessed	USA	[34]
24	COVID-19 pandemic	Using Twitter, the analysis of policies adopted in the United States and its effects on society was analyzed.	USA	[35]
25	COVID-19 pandemic	Analyzing the tweets of the leaders of the G7 on the Coronavirus, Twitter has become a powerful tool for world leaders to disseminate information about public health during the pandemic.	G7 countries	[36]
26	COVID-19 pandemic	Tweet analysis during the virus epidemic in the United States showed that this pandemic has become political. Twitter bots played a major role in disseminating invalid information.	USA	[37]

27	COVID-19 pandemic	The dominant discourse in the society on the coronavirus can be identified and analyzed on Twitter.	Global	[38]
28	COVID-19 pandemic	Wrong information was widely published on Twitter.	Global	[35]
29	COVID-19 pandemic	Analyzing Twitter data on the specifications of people with Coronavirus, it was suggested that in addition to using clinical data on people with the virus, Twitter data should also be used.	Global	[39]
30	COVID-19 pandemic	Using tweet analysis in the United States, various aspects of social distancing (methods of preventing infection) were identified and analyzed.	USA	[40]
31	COVID-19 pandemic	The study found that tweet analysis could be crucial in the geographical distribution and density of the virus outbreak in the UK.	UK	[41]
32	COVID-19 pandemic	The study found that tweet analysis could help identify geographic distribution and the prevalence of the virus in the United States.	USA	[42]
33	COVID-19 pandemic	Tweet analysis showed that a large number of tweets have stigmatized China. Because this pandemic started in China.	USA	[43]
34	Outbreaks	Twitter is useful in predicting disease outbreaks.	Global	[44]
35	Zika outbreak	Tweets showed the social impacts of the epidemic, the role of organizations and policies, information on the transmission of the disease, and the lesson learned.	Global	[45]
36	Flu outbreak	The use of Twitter data is more accurate in modeling the flu epidemic prediction than Google data.	USA	[46]
37	Yellow Fever outbreak	The amount of misinformation about yellow fever was much larger than the correct information, and misinformation was shared and retweeted, which can be dangerous to public health.	Global	[47]
38	Outbreaks	Twitter can act as an early warning system during epidemics. Twitter can also help detect the prevalence of geography at different times and places, and can be analyzed from time to time.	Global	[48]
39	Flu and Ebola Outbreaks	Analyzing tweets about the 2009 and 2014 Ebola epidemics revealed that Twitter could help analyze the state of mental health and general fear during the epidemic.	Global	[49]
40	Ebola outbreak	During the 2014 Ebola outbreak in East Africa, a lot of misinformation was spread on Twitter. Proper information needs to be disseminated through influential people during epidemics.	East Africa	[50]
41	Flu outbreak	Twitter was used as a tool for early warning during the 2009 flu and risk communications in the United States.	USA	[51]
42	Ebola outbreak	Twitter helped spread information about Ebola in Nigeria.	Nigeria	[52]
43	Outbreaks	the potential value of incorporating Twitter into existing unplanned school closures (USCs) monitoring systems.	USA	[53]
44	Influenza Epidemics	Extending the capacity of surveillance systems for detecting emerging influenza.	Korea	[54]
45	Ebola	Using social media to communicate possible disease outbreaks in a timely manner, and that they consider using online search data to tailor their messages to align with the public health interests of their constituents	USA	[55]

Table 2: Themes extracted from papers

Theme	Reviewed articles
Early warning	[22, 24, 41, 44, 46, 48, 51]
Disseminating Information and misinformation	[3, 13-15, 18, 20-23, 25, 26, 29, 32, 33, 35-41, 45, 47, 49-51, 55]
advocacy	[20]
Personal gains	[20]
Assessment	[20, 38-41, 45, 49]
The role of organizations	[3, 13-26, 35, 45]
Public mood	[14, 18, 34, 43, 49]
Geographical analysis	[13, 15, 17, 21, 30, 31, 41, 42, 48, 53, 54]
charity	[18-20]
Using influencers	[13, 16, 21, 23, 24, 28, 50]
Trust	[13, 16-18, 25, 26]

3.1. Early Warning

One of Twitter's uses in emergencies is early warning. It is found that Twitter is useful in predicting disease outbreaks[44]. Paul, Dredze et al. (2014) indicated that Twitter data is more accurate in modeling the flu epidemic prediction than Google data [46].

A study on Indonesia's Padang [24] found that Twitter was used more than other social networks in the local community context. Based on their findings, it was suggested that disasters early warning can alert the people through Twitter. As the geographic distribution patterns of people, the use of Twitter at different hours of the day, week, etc. is available and analyzable. According to the analysis of data extracted from Twitter, authorities will be able to plan early warnings for disasters with high effectiveness. Considering the multilingual nature of the study area (Tagalog,

English, and Indonesian), it was suggested that for rapid alert and covering most of the affected people, there should be tweets in different languages, especially the three languages, to retweet or share it in the local community. Moreover, in another article about the Nepal earthquake [22], it has been shown that the early warning was one of Twitter's applications in the Nepal earthquake.

3.2. Disseminating Information

One of the challenging issues during the COVID-19 pandemic in the world is information and misinformation. Many reviewed articles mentioned this significant issue in outbreaks and other natural disasters [3, 13-15, 18, 20-23, 25, 26, 29, 32, 33, 35-41, 45, 47, 49-52]. Kouzy et al. (2020) claimed that publishing misinformation about the COVID-19 pandemic has reached alarming levels that endanger public health [29]. In contrast, some other articles highlighted the importance of disseminating accurate information to people through Twitter and found this social media as a great tool for enhancing public health [50-52].

Dissemination is another Twitter application for natural disasters. Subba et al. [22] showed in their study that Nepal police used Twitter to disseminate information. Information related to earthquakes in Nepal, including road conditions, flood relief, equipment information, rescue operation, injured and affected people, missing persons, community participation on disasters, and public information. Aside from the use of organizations and officials from Twitter to disseminate information, Twitter is also being disseminated to the public for information. Some studies revealed that Twitter users published their environmental information in natural disaster situations, and others published their first-hand experience on crisis-related issues and some others also share other information.

3.3. Advocacy

Advocacy was one of Twitter's functions so that users became the voice of people in the Haiti earthquake, criticized political institutions, and presented some peoples' requests. Talking about legitimizing some of the organization's actions and criticizing the local TVs that did not include the earthquake news as the first issue was some of these items [20].

3.4. Personal gains

Some Twitter users have posted on Twitter for personal purposes. In a study of the Haitian earthquake and Twitter [20], it became clear that some Twitter users also talked about helping earthquake survivors to find followers. In certain tweets, for some users, the messages were such that the audience has written to be read by a specific person on Twitter, for example, if a celebrity (Justin Bieber) reads his tweets, he will contribute $ 10 to Haiti.

3.5. Assessment

Rapid assessment on the first days of natural disasters and during response is vital for improving operations. Reviewed articles have mentioned this significant topic as a function of twitter in natural disasters [20, 38-41, 45, 49]. For example, Sarker et al. (2020) found that Twitter data on the characteristics of infected people to the COVID-19 were useful the same as clinical data [39]. Kwon et al. (2020) claimed that using tweet analyses in the United States, various aspects of social distancing (methods of preventing infection) were identified and analyzed [40].

Smith in his study showed that users found an opportunity to discuss the effectiveness and scoring of relief efforts and evaluated the activities of relief agencies [20]. In another study, Twitter was shown as a tool to quickly assess the disaster losses on Sandy storm damage in 53 US metropolises [23, 56].

3.6. The Role of Organizations

Many reviewed studies mentioned the importance of the use of government and humanitarian agencies from Twitter in disasters [13, 15, 19, 21-25, 35, 45]. The study of the wildfires [15] showed that official tweets play a key role in sharing information about wildfires. For example, some community elites, such as local authorities and celebrities are dominant in the information-sharing network[15].

It is investigated in a study that focused on the topic of the earthquake, tsunami and nuclear incident in Tokyo [17]. One of the findings was that unreliable retweets (RTs) on Twitter was the biggest problem the users have faced during the disaster, and the solution that can be offered is introducing official hashtags by authorities. Another study of Japan's 2011 earthquake [18] showed that due to the large number of followers of official government accounts on Twitter, the people trust them. Although the study in the metropolitan area of Tokyo showed that people follow official government accounts, another study about storms in the USA [21] showed that locals are more interested in following famous people accounts. They like to receive less information from government accounts.

Another study about the 2010 Haiti earthquake presented various findings on the role of organizations in sharing information on Twitter [19]. The findings of the study indicated that the number of tweets by organizations has doubled after the earthquake, which reflects the communication strategy of these organizations, particularly relief organizations. The research also showed that the content varies according to the organization's differences. For example, UN agencies have given a lot of reference to the main relief organizations, as well as links to many audio and video files related to the disaster. Although the study found that the use of links in tweets is not the most effective method and requires the need for additional steps to be taken by

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the audience, and some other strategies, such as the use of retweeting and mentioning organizations, can provide quick access to the audience. According to the findings of this study, organizations need to use more social networking tools such as Twitter in disasters to provide timely and responsive communication in the crisis with the masses.

Organization's activity on Twitter in disasters is not just one-way, and organizations can also get information from people that are helpful at relief aid. The study [3] on Twitter use in the Sandy storm in the United States showed that ordinary people during a disaster issue publish timely information on the disaster situation that can be used to manage by relief organizations and crisis management. In this study, it became clear that most messages contain information for updating the situation, either in the first category and the content or in the second hand, and are derived from other sources. The volume of first-hand tweets was first and foremost, and this way of downstream information is also needed by crisis management organizations.

A study on the Nepal earthquake [22] found out how many police used Twitter for earthquakes. Information provided in the Nepal earthquake includes dissemination of information (information about roads situation, flood, landslide, emergency kits and equipment, rescue operations, injuries, missing persons, community participation, general information), warnings (landslide/flood warning, abuse warning, public warning), encouraging people (encouragement to cooperate with rescuers, police), and counteracting with rumors. The study showed that the use of Twitter by the Nepal police after the earthquake was effective and efficient and has been used as a bridge between the public and the authorities. Meanwhile, using Twitter has corrected police priorities in reporting with continuous feedback from users.

The study of the Sandy Storm in the United States [23] highlighted the importance of using Twitter by organizations at various stages of the disaster (preparedness, response, and recovery).

It is clear that setting up a network of social media in the preparedness phase is vital for the government. Increasing the quality of the content of tweets for more awareness of the citizens and on-time communicating with people are two important points in relation to the government with people in disaster. The government use social network to deliver messages in emergencies, and one way that the government can handle emergency messages is to identify influencers on Twitter with a high number of followers retweeting official messages to inform people faster.

3.7. Tracking public Mood

Another Twitter application in disasters is to measure the mental state of people. Ahmed et al. (2018) found that Analyzing tweets about the 2009 and 2014 Ebola epidemics revealed that Twitter could help analyze the state of mental health and general fear during the epidemic [49]. a study on the Japan Tohoku earthquake [14], it was shown how people's anxiety returned to normal after the earthquake. The results suggested that Twitter could be used for tracking the public mood of populations affected by natural disasters as well as an early warning system. In another study on the Japanese earthquake [18], it was shown that emotional tweets were much higher in the early days after the earthquake and decreased in the following days. Medford et al. (2020) showed that with analyzing tweets in the USA in the COVID-19 pandemic, the people's sentiments are assessable [34].

3.8. Geographic analysis

Many of the studies that have been conducted to analyze the use of Twitter in disasters have addressed geographic topics [13, 15, 17, 21, 30, 31, 41, 42, 48]. Singh et al. (2020) showed that there was a geographic relationship between the flow of information about the pandemic and the identification of new cases of the COVID-19[30]. Geographic analysis in the Philippines's

Hurricane [13] showed that, as expected, most people who tweeted from the Philippines talked about relief, and those that were outside of the Philippines tweeted from the memory of the affected people. Another study in the United States [15] showed that there was a relationship between the places where the fire occurred and the location of the tweets associated with the fire. Text mining has shown that people have strong geographical awareness during wildfire hazards and people are interested in tweeting about wildfire damage, wildfire response, and thanking firefighters.

Another study on the lesson learned from using Twitter on the tsunami in Japan [17] showed that the place of the tweeting related to the type of content, and people who are tweeted in the Miagi affected area are more concerned about their uninsured and viable conditions. However, people who have been affected indirectly by the earthquake (Tokyo) have reported on being safe, as well as materials for shipping, the dangers of nuclear centers, and so on.

Another article about the storm in the United States [21] suggests using the geographic option when tweeting can help save people. The paper suggests using a proper hashtag to help save people in disasters. For example, someone who needs help tweets containing 911 hashtags and brings out relief workers to rescue them from turning on his mobile location. This highlights Twitter's value in planning, reducing, preparing, and responding to disasters.

Another study suggested the use of published templates on Twitter for quick alert and suggested that the authorities can plan an early warning for disasters with attention to information based on the fact of geographical distribution patterns of people, availability of using Twitter for different hours of the day, week, etc.

3.9. Charity

Gathering public donations and contributions to the affected people were other Twitter applications mentioned in the findings of the studies. It is shows in a study [19] that the rapid use of Twitter caused donations, helps, collection of millions of dollars for the Haitian people, and another study on the Haiti earthquake [20] resulted from Twitter content analysis showed that some people believed that donations through the official channel should be made, and others introduced different informal methods for donating. In another study on Japan's earthquake [18], links which were referred to in tweets included weather, earthquake survivors information, disaster information for foreigners, photo, and video sharing, and donations.

3.10.   The role of influencers

Many of the studies have addressed the role of famous people or influencers on Twitter at the time of disaster [13, 16, 21, 23, 24, 28, 50]. Liang et al. (2019) discussed that for publishing information about Ebola, influential people on Twitter retweeted the initial information [28]. They recommended that these people be helped to publish health information with the correct information. A study of Twitter's role in the Hayan storms [13] showed that various Twitter users post different information according to their traditional position. For example, journalists and news agencies publish second-hand news, celebrities have written more emotional and memorable content, and NGOs have also focused on issues such as the coordination of relief efforts. In the same study [13], the Chi-square analysis revealed an important and influential category of the users. For example, officials and organizations can use Twitter for relief coordination, or celebrities, by using their many followers, are active in advertising for donations. Another study on fire [15] found that official tweets play a key role in the firefighting network, for example, some community elites, such as local authorities and media people, dominate the information republishing network and play an important role. The study [21]

revealed that many sports journalists who were skilled in tweeting and had tweeted before the storm did not publish much after the storm. Similarly, spiritual and religious leaders who have been followed were not active on Twitter after the storm and suggested that educating famous people to produce relevant content for people awareness in disaster can be helpful. The study of the Sandi storm in the United States [23] has shown that identifying Twitter users with the most followers is a quicker way to get people attention to public messages. A study by Indonesian Padang [24] pointed out that Twitter activities of intellectual leaders across different age groups of users can be effective. Intellectual leaders on Twitter are not necessarily political and artistic people, and even teenagers have a lot of followers on Twitter and so they can be an influencer.

3.11.   Trust in the content

One of the points that were highlighted in the studies was the trust of people in the content posted on Twitter in times of disaster, and it seemed to vary in different countries. In a paper on [13] about Hayan storm in Philippine, it has been highlighted that Twitter users in the Philippines are more likely to value traditional media than social networks, and it is maybe because of more trust in news sources due to the volume of rumors on social networks. Findings from a study on Japan's earthquake [18] showed a large number of Japanese government official followers on Twitter show people' trust to the relief organizations' pages on this social network. A further study on the Chilean earthquake [16] showed that rumors were questioned more on Twitter than the confirmed facts, which is a positive finding. Twitter also shows people that many users have questioned some Twitter information. A study of Japan's Tsunami [17] about incorrect and uncontrollable releases from informal sources said that users have recommended to use official hashtags to track information. Some believed that the government should be more active in

providing accurate information, and some users believed that Twitter could add some features to this application to make it more effective in such circumstances.

Findings of the study [26] about Fukushima's nuclear incident also indicate that one-third of the tweets were released from low-credibility sources. Published Tweets from anonymous and unidentified accounts have released lowered credibility information. Given the high number of unofficial accounts by Japanese users, it was expected that more uninformative tweets by users in Japan were published, but the findings did not show that most of the content was tweeted by Japanese users, which may be due to the proximity of incident and sense of responsibility. The study [25] suggested that volcano eruptions in Iceland, due to the prevalence of using Twitter in various eruptions of volcanoes, different organizations would send different information at the moment of the incident on Twitter, to lessen the informal misinformation.

3.12.   Other issues

Other issues that Twitter users have encountered in disasters include memorials for affected people, relief coordination [3, 20, 24], psychosocial support [13], and thanking relief workers [15].

4. Discussion

The finding in this study is similar to other studies done about the role of communication in disasters. Huston et al. [7] analyzed social media functions in disasters in three phases including pre-event, event, and post-event. Social media functions in the pre-event are disaster warning, detect disasters, and crisis communication. During disasters, social media can be used to send and receive requests for help and affected people situations. In post-disaster social media is used for disaster documenting and lessons learned, delivering news, response information, send and

receive donations, raising awareness, mental health support, express emotions, memorialize victims, and sharing stories. reconnecting community members and discussing about disaster happening in post-event [7].

During disasters, many stakeholders like affected people, journalists, authorities, humanitarian organizations use Twitter for various purposes. Many reviewed papers discussed the importance of using Twitter by officials, relief organizations, and other main organizations. Being active and on the time of responsible organizations on Twitter resulted in less fake news. On the other hand, using Twitter resulted in getting feedback from people by organizations and modifying their operations and programs. Various awareness like road situations, flood, landslide, relief and rescue operations, missing people, warning, etc. disseminating from this tool[57]. One of the effective ways to disseminate important information in emergencies is identifying influencers on Twitter. It will result in retweeting official information faster and to more people.

The role of celebrities, famous people active in Twitter is bold in disasters[58]. Famous people are active in promoting philanthropic propaganda, and studies have suggested that various institutions, including humanitarian and governmental institutions, can identify people who are influential on Twitter (religious, sports, artistic, etc.) to transfer information at times of disaster. Some studies have suggested that people get a quick warning of disasters by Twitter since people's geographic distribution patterns to make Twitter' use more accessible at day and week, and so on, and allows authorities to be able to plan quick warning for disasters with high effectiveness with attention to this information. The role of prominent people is one of the things that is highlighted on Twitter in times of disaster. Famous people are active in promoting philanthropic propaganda, and studies have suggested that various institutions, including humanitarian and governmental institutions, can identify people who are influential on Twitter

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(religious, sports, artistic, etc.) to transfer Information at times of disaster. Some studies have suggested that people get a quick warning of disasters by Twitter since people's geographic distribution patterns make Twitter' use more accessible at day and week, and so on, and allows authorities to be able to plan quick warning for disasters with high effectiveness with attention to this information.

The evaluation of relief efforts was one of the studies that is addressed and is vital in disasters[59, 60]. Through Twitter, users found the opportunity to discuss the effectiveness and assessment of relief efforts, as well as the evaluation of the performance of relief agencies, and in another study, Twitter was used as a tool to quickly assess disaster damages.

Disaster analysis is possible from a geographic perspective on Twitter, and it was found in the reviewed studies that using the geolocation option when tweeting could help save people. The paper suggests using proper hashtag help save people in disasters. For example, someone who needs help, tweets containing the 911 hashtag (relief number), and by turning on their mobile location, informs rescuers about his situation and be rescued, and it showed the value of Twitter in planning, reducing, preparing and responding. Among the other uses that Twitter has been mentioned in the review of the studies, the rapid use of Twitter has provided relief assistance and substantial financial contributions.

One of the concerns raised in the review of the studies is the trust in the content posted on Twitter in times of disaster and it looks varies in different countries. In countries where there is a high degree of trust in government agencies and aid workers, it is recommended that these institutions publish issues related to disaster sooner than other sources. Studies also showed that rumors and misrepresentation on Twitter are being questioned by users, and people can actively participate in questioning misconceptions and re-publishing the correct or formal content.

In reviewing the content, the results suggest that Twitter can be used to track and measure the public mood of people after natural disasters, which could be used to design post-disaster psychosocial support programs.

The advocacy was one of the other issues that was taken into consideration in the studies, and studies have shown that some Twitter users have been able to track the situation of the affected people, get relief items, talk about the legitimacy of some organization's actions, and criticize the local television who are not reporting the earthquake news as the first issue.

5. Conclusion

It is recommended that influential individuals be identified in each country and community before disasters occur so that the necessary information can be disseminated in response to disasters. Preventing the spread of misinformation is one of the most important issues in times of disaster, especially pandemics. Disseminating accurate, transparent, and prompt information from relief organizations and governments can help. Also, analyzing Twitter data can be a good source for understanding the mental state of the community, estimating the number of injured people, estimating the points affected by natural disasters, and modeling the prevalence of epidemics. Therefore, various groups such as politicians, the government, non-governmental organizations, aid workers, and the health system can use this information to plan and implement interventions.

Implications for Practice

- Responsible organizations in disasters can use Twitter as an early warning tool
- Using multilingual messages for awareness and early warning in multicultural and multilingual countries will improve crisis communication.

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- Using Twitter as a media for warning (landslide, insecurity, …) and encouraging (participating in recovery,) will be useful during disasters.

- organizations can hear the voice of people on Twitter. Twitter can work as an advocacy tool.

- Organization can use Twitter as an evaluation tool. People give their feedback on Twitter.

- Besides the messages from official accounts, organizations should use famous people and influencers to send their message to people.

- Organizations should tweet on time and clear in disaster for counteracting fake news.

- Using Twitter for tracking public mood can help the government to better plan for psychosocial support in disasters.

- Geolocation extracting from Twitter can help authorities for better response to disasters.

Implications for Policy

- All organizations should plan for using Twitter in preparedness, response, and recovery. It enhanced their communication strategy.

- The organization should plan for identifying influencers in Twitter for better sending messages in preparedness, response, and recovery.

Implications for Research

- Researchers should focus more on Twitter use in neglected disasters like floods and some disaster-prone countries like Iran, Pakistan, South Africa countries, etc.

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- Twitter uses by gender and diversity can show the patterns of Twitter using in disaster and help the responsible organizations in disasters for better planning.

Availability of data and materials

The datasets used during the current study are available from the corresponding author on reasonable request.

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References

1.   Guha-Sapir, D., et al., *Annual disaster statistical review 2016: the numbers and trends*. 2016, Centre for Research on the Epidemiology of Disasters (CRED).

2.   Seddighi, H., *Trust in Humanitarian Aid From the Earthquake in 2017 to COVID-19 in Iran: A Policy Analysis.* Disaster Medicine and Public Health Preparedness, 2020: p. 1-4.

3.   Mukkamala, A. and R. Beck. *Enhancing Disaster Management through Social Media Analytics to Develop Situation Awareness What Can Be Learned from Twitter Messages about Hurricane Sandy?* in *PACIS*. 2016.

4.   Avasthi, R., *55.1 Social Media and Disasters: A Literature Review.* Journal of the American Academy of Child & Adolescent Psychiatry, 2017. **56**(10): p. S81.

5.   Gray, B., M. Weal, and D. Martin, *Social media and disasters: a new conceptual framework.* 2016.

6.   Murthy, D., *Twitter*. 2018: Polity Press.

7.   Houston, J.B., et al., *Social media and disasters: a functional framework for social media use in disaster planning, response, and research.* Disasters, 2015. **39**(1): p. 1-22.

8.   Weller, K., et al., *Twitter and society*. Vol. 89. 2014: P. Lang.

9.   Seddighi, H., *COVID-19 as a Natural Disaster: Focusing on Exposure and Vulnerability for Response.* Disaster Medicine and Public Health Preparedness: p. 1-4.

10.   Salmani, I., H. Seddighi, and M. Nikfard, *Access to healthcare services for Afghan refugees in Iran in COVID-19 pandemic.* Disaster Medicine and Public Health Preparedness: p. 1-6.

11.   Seddighi, H., et al., *Public-Private-People Partnerships (4P) for Improving the Response to COVID-19 in Iran.* Disaster Medicine and Public Health Preparedness: p. 1-6.

12.   Popay, J., et al., *Guidance on the conduct of narrative synthesis in systematic reviews.* A product from the ESRC methods programme Version, 2006. **1**: p. b92.

13.   Takahashi, B., E.C. Tandoc Jr, and C. Carmichael, *Communicating on Twitter during a disaster: An analysis of tweets during Typhoon Haiyan in the Philippines.* Computers in Human Behavior, 2015. **50**: p. 392-398.

14.   Doan, S., B.-K.H. Vo, and N. Collier. *An analysis of Twitter messages in the 2011 Tohoku Earthquake*. in *International Conference on Electronic Healthcare*. 2011. Springer.

15.   Wang, Z., X. Ye, and M.-H. Tsou, *Spatial, temporal, and content analysis of Twitter for wildfire hazards.* Natural Hazards, 2016. **83**(1): p. 523-540.

16.   Mendoza, M., B. Poblete, and C. Castillo. *Twitter Under Crisis: Can we trust what we RT?* in *Proceedings of the first workshop on social media analytics*. 2010. ACM.

17.   Acar, A. and Y. Muraki, *Twitter for crisis communication: lessons learned from Japan's tsunami disaster.* International Journal of Web Based Communities, 2011. **7**(3): p. 392-402.

18.   Cho, S.E., K. Jung, and H.W. Park, *Social media use during Japan's 2011 earthquake: how Twitter transforms the locus of crisis communication.* Media International Australia, 2013. **149**(1): p. 28-40.

19.   Gurman, T.A. and N. Ellenberger, *Reaching the global community during disasters: findings from a content analysis of the organizational use of Twitter after the 2010 Haiti earthquake.* Journal of health communication, 2015. **20**(6): p. 687-696.

20.   Smith, B.G., *Socially distributing public relations: Twitter, Haiti, and interactivity in social media.* Public relations review, 2010. **36**(4): p. 329-335.

21.   Cooper Jr, G.P., et al., *Twitter as a potential disaster risk reduction tool. Part III: evaluating variables that promoted regional Twitter use for at-risk populations during the 2013 Hattiesburg F4 tornado.* PLoS currents, 2015. **7**.

22.   Subba, R. and T. Bui. *Online convergence behavior, social media communications and crisis response: An empirical study of the 2015 nepal earthquake police twitter project*. in *Proceedings of the 50th Hawaii International Conference on System Sciences*. 2017.

23.   Chatfield, A.T. and C.G. Reddick, *All hands on deck to tweet# sandy: Networked governance of citizen coproduction in turbulent times.* Government Information Quarterly, 2017.

24.   Carley, K.M., et al., *Crowd sourcing disaster management: The complex nature of Twitter usage in Padang Indonesia.* Safety science, 2016. **90**: p. 48-61.

25.   Sreenivasan, N.D., C.S. Lee, and D.H.-L. Goh. *Tweet me home: Exploring information use on Twitter in crisis situations*. in *International Conference on Online Communities and Social Computing*. 2011. Springer.

26.   Thomson, R., et al. *Trusting tweets: The Fukushima disaster and information source credibility on Twitter*. in *Proceedings of the 9th International ISCRAM Conference*. 2012. Vancouver: Simon Fraser University.

27.   Karmegam, D. and B. Mappillairaju, *Spatio-temporal distribution of negative emotions on Twitter during floods in Chennai, India, in 2015: a post hoc analysis.* International Journal of Health Geographics, 2020. **19**(1): p. 19.

28.   Liang, H., et al., *How did Ebola information spread on twitter: broadcasting or viral spreading?* BMC Public Health, 2019. **19**(1): p. 438.

29.   Kouzy, R., et al., *Coronavirus Goes Viral: Quantifying the COVID-19 Misinformation Epidemic on Twitter.* Cureus, 2020. **12**(3): p. e7255-e7255.

30.   Singh, L., et al., *A first look at COVID-19 information and misinformation sharing on Twitter.* arXiv, 2020: p. arXiv: 2003.13907.

31.   Jahanbin, K. and V. Rahmanian, *Using twitter and web news mining to predict COVID-19 outbreak.* Asian Pac J Trop Med, 2020.

32.   Ferrara, E., *# COVID-19 on Twitter: Bots, Conspiracies, and Social Media Activism.* arXiv, 2020: p. arXiv: 2004.09531.

33.   Rosenberg, H., S. Syed, and S. Rezaie, *The twitter pandemic: The critical role of twitter in the dissemination of medical information and misinformation during the COVID-19 Pandemic.* CJEM, 2020: p. 1-7.

34.   Medford, R.J., et al., *An "Infodemic": Leveraging High-Volume Twitter Data to Understand Public Sentiment for the COVID-19 Outbreak.* medRxiv, 2020: p. 2020.04.03.20052936.

35.   Sharma, K., et al., *Coronavirus on Social Media: Analyzing Misinformation in Twitter Conversations.* arXiv, 2020: p. arXiv: 2003.12309.

36.   Rufai, S.R. and C. Bunce, *World leaders' usage of Twitter in response to the COVID-19 pandemic: a content analysis.* Journal of Public Health, 2020.

37.   Yang, K.-C., C. Torres-Lugo, and F. Menczer, *Prevalence of Low-Credibility Information on Twitter During the COVID-19 Outbreak.* arXiv, 2020: p. arXiv: 2004.14484.

38.   Wicke, P. and M.M. Bolognesi, *Framing COVID-19: How we conceptualize and discuss the pandemic on Twitter.* arXiv, 2020: p. arXiv: 2004.06986.

39.   Sarker, A., et al., *Self-reported COVID-19 symptoms on Twitter: An analysis and a research resource.* medRxiv, 2020.

40.   Kwon, J., et al., *Defining Facets of Social Distancing during the COVID-19 Pandemic: Twitter Analysis.* medRxiv, 2020: p. 2020.04.26.20080937.

41.   Golder, S., et al., *Extending A Chronological and Geographical Analysis of Personal Reports of COVID-19 on Twitter to England, UK.* medRxiv, 2020: p. 2020.05.05.20083436.

42.   Gharavi, E., N. Nazemi, and F. Dadgostari, *Early Outbreak Detection for Proactive Crisis Management Using Twitter Data: COVID-19 a Case Study in the US.* arXiv, 2020: p. arXiv: 2005.00475.

43. Budhwani, H. and R. Sun, *Referencing the novel coronavirus as the" Chinese virus" or" China virus" on Twitter: COVID-19 stigma.* Journal of medical Internet research, 2020.

44. St Louis, C. and G. Zorlu, *Can Twitter predict disease outbreaks?* Bmj, 2012. **344**: p. e2353.

45. Fu, K.-W., et al., *How people react to Zika virus outbreaks on Twitter? A computational content analysis.* American Journal of Infection Control, 2016. **44**(12): p. 1700-1702.

46. Paul, M.J., M. Dredze, and D. Broniatowski, *Twitter improves influenza forecasting.* PLoS currents, 2014. **6**: p. ecurrents.outbreaks.90b9ed0f59bae4ccaa683a39865d9117.

47. Ortiz-Martínez, Y. and L.F. Jiménez-Arcia, *Yellow fever outbreaks and Twitter: Rumors and misinformation.* American Journal of Infection Control, 2017. **45**(7): p. 816-817.

48. Kanhabua, N. and W. Nejdl, *Understanding the diversity of tweets in the time of outbreaks*, in *Proceedings of the 22nd International Conference on World Wide Web*. 2013, Association for Computing Machinery: Rio de Janeiro, Brazil. p. 1335–1342.

49. Ahmed, W., et al., *Moral Panic through the Lens of Twitter: An Analysis of Infectious Disease Outbreaks*, in *Proceedings of the 9th International Conference on Social Media and Society*. 2018, Association for Computing Machinery: Copenhagen, Denmark. p. 217–221.

50. Oyeyemi, S.O., E. Gabarron, and R. Wynn, *Ebola, Twitter, and misinformation: a dangerous combination?* BMJ : British Medical Journal, 2014. **349**: p. g6178.

51. Kostkova, P., M. Szomszor, and C.S. Louis, *#swineflu: The Use of Twitter as an Early Warning and Risk Communication Tool in the 2009 Swine Flu Pandemic.* ACM Trans. Manage. Inf. Syst., 2014. **5**(2): p. Article 8.

52. Carter, M., *How Twitter may have helped Nigeria contain Ebola.* BMJ (Clinical research ed.), 2014. **349**: p. g6946.

53. Ahweyevu, J.O., et al., *Using Twitter to Track Unplanned School Closures: Georgia Public Schools, 2015-17.* Disaster Medicine and Public Health Preparedness, 2020: p. 1-5.

54. Woo, H., et al., *Identification of Keywords From Twitter and Web Blog Posts to Detect Influenza Epidemics in Korea.* Disaster Medicine and Public Health Preparedness, 2017. **12**(3): p. 352-359.

55. Wong, R. and J.K. Harris, *Geospatial Distribution of Local Health Department Tweets and Online Searches About Ebola During the 2014 Ebola Outbreak.* Disaster Medicine and Public Health Preparedness, 2017. **12**(3): p. 287-290.

56. Kryvasheyeu, Y., et al., *Rapid assessment of disaster damage using social media activity.* Science advances, 2016. **2**(3): p. e1500779.

57. Seddighi, H. and I. Salmani, *Monetary value and cost analysis of a youth voluntary program on road safety in Iran.* 2020.

58. Seddighi, H., *The performance of the Iranian Red Crescent by launching COVID-19 Testing Centers: Report from the field.* Disaster Medicine and Public Health Preparedness, 2020: p. 1-6.

59. Seddighi, H. and A. Morovati Sharifabadi, *Efficiency evaluation of road relief bases of Yazd province red crescent society in new year plan.* Journal of Rescue & Relief, 2013. **5**(3): p. 18-26.

60. Seddighi, H., F.N. Nejad, and M. Basakha, *Health systems efficiency in Eastern Mediterranean Region: a data envelopment analysis.* Cost Effectiveness and Resource Allocation, 2020. **18**(1): p. 1-7.