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DISASTER COMMUNICATION STRATEGIES IN FLOOD RESPONSE: A CASE STUDY OF THE PUNJAB DISASTER MANAGEMENT AUTHORITY (PDMA)

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Abstract

Disaster communication has been discovered to be very effective in risk mitigation, preparedness, and management of flood response. This paper examines the disaster communication efforts of the Punjab Disaster Management Authority (PDMA), specifically focusing on how Facebook and X were used during the floods in Punjab. The research employed the quantitative design method, and a sample of 1,600 youths of the age group 18-25 years was used across eight flood-prone districts. The study examines how PDMA communication campaigns affect the population's awareness, community involvement, information-seeking behaviour, behaviour change, and participation in holistic disaster management, including prevention, preparedness, response, and recovery. According to the descriptive statistics, the mean scores for all significant variables are above the overall average, indicating a generally positive attitude toward and positive results from PDMA's disaster communication activities. Factor analysis has high construct validity, as evidenced by high sampling adequacy and high variance explained. The independent-samples tests revealed that there was no significant difference between the genders, which means that there was equal access to the communication campaigns. However, one-way ANOVA indicates significant differences between groups in all the major variables, and indicates that there is campaign efficacy based on exposure, previous flood experience, and engagement. The findings indicate that PDMA's use of social media to facilitate catastrophe communication programs was effective in increasing flood preparedness, awareness, and adaptive behaviour. At the same time, the identified group-level differences indicate that more audience-specific, focused communication approaches would be needed. The study adds to the literature on disaster communication. It offers viable ideas for enhancing social media-based approaches to managing disasters and fostering community resilience to floods in flood-prone regions of Punjab.

INTRODUCTION

The term disaster communication (DC) can be defined as the systematized exchange of information following a hazardous incident in the period before, throughout, and following the incident, where the

intention behind the sharing is to minimize lives and property loss and provide assistance to people impacted by the disaster through its response and recovery. This paper utilizes the Punjab Disaster Management Authority (PDMA) as the case study, investigating how the Facebook and X campaign influence public awareness, participation, capacity-building, and behaviour change during flood disasters, and whether the use of the current social media is reaching the various users in Punjab, and whether this is helpful in creating collective community action.

Definitions of Disaster Communication

A disaster is an event that occurs haphazardly and has negative impacts on a particular society, organization, or country, inflicting damage or loss on people. Disasters can be natural, technological, or man-made. They include hurricanes, industrial accidents, and terrorist attacks. Disaster Communication refers to the acquisition of the information that is needed to manage a disaster. Emergency communication is the dissemination of information with a view to handling an unforeseen, hazardous event requiring an urgent response.

Disaster communication of PDMA

Flood is one of the most frequently occurring and catastrophic natural disasters that result from the over flooding of rivers, dams, or levees. Being the most affected part of the country with a dense system of rivers and located in the flood zone at the foothills of the Himalayas, Punjab is highly affected by the floods, especially during the monsoon period from June to September. In a bid to reduce the effects of floods and inform its citizens, the Punjab Disaster Management Authority (PDMA) carries out flood disaster communication awareness campaigns.

The PDMA is the leading government body that oversees disaster management, covering pre-incident planning and risk assessment, response, rehabilitation, and risk reduction throughout the Indian state of Punjab (PDMA Punjab n. d.). As its mandate, the PDMA has designed and implemented various public education and awareness campaigns, and early warning and evacuation initiatives prior to and during the flood season. These three forms of campaigns employ the following methods of communication, such as TV and radio, Facebook and Twitter, short message service, handbills, and town hall meetings.

In the context of the present essay, the communication campaigns can be divided into pre-flood and disaster-specific campaigns mounted by the PDMA Punjab during the actual flood period; the latter can be further categorized into specific early warning campaigns. It will measure the efficiency of these practices and advise on how their efficiency can be improved.

Pre-Flood Communication Campaign

In fact, prior to the onset of flood season, the PDMA implements many awareness-raising efforts for the communities so that they may undertake necessary precautions (UNDP, 2010). These pre-flood campaigns include increasing awareness, ensuring the citizen has the capabilities to respond adequately to an event of flood, and inter-organization coordination in planning for flood events.

Awareness Campaigns

A typical part of pre-flood risk communication aims at informing the citizens, including the most susceptible populations, of possible flood risks in their area, locations of safe places to go during the floods, and measures that should be taken prior to the flood.

For example, the PDMA distributed pamphlets and placed hoardings and banners in major regional languages across flood-prone villages of Punjab even before the floods in 2020. Each of these materials contained information on the following: expected weather conditions, emergency contacts likely to be used during disasters, and the emergency supply kit (PDMA Punjab, 2020). Awareness vans were also mobilised to spread awareness on the doorstep through announcements from loudspeakers. As per survey results, about 75% of the respondents view these media as very useful for creating awareness (UNICEF, 2021).

Capacity Building Workshops

Apart from this general awareness creation, the PDMA also organizes special training for the citizens of the vulnerable districts on the appropriate response in floods. These workshops also show

different ways of swimming, accident first aid, and evacuation, as well as the cleaning process of houses after floods, so that communities have more capacity to respond and recover themselves during a disaster (PDMA Punjab, 2018).

In regard to capacity building, the PDMA employs local NGOs and community churches to sensitize the people to participate. The tracer survey study undertaken at the end of the 2018 floods found that all the participants statistically had over 80% improvement of their knowledge in terms of flood response (PDMA Punjab, 2019).

Inter-Agency Coordination

Additionally, the PDMA is trusted with the preparations for floods with contingency plans as well as standard operating procedures offered annually. It sits down with all the concerned government departments, such as police, health, irrigation, and civil administration, to develop strategies and deployment of resources during a disaster (National Institute of Disaster Management, 2013).

Such cooperative actions before the beginning of the monsoon season help to coordinate the flood response among the agencies and reduce risks to human lives.

Early Warning Communication

Once flood season begins, and the water level of the rivers increases, the PDMA begins warning communication early enough. These prompt warning messages on potential flood events will help provide enough time for communities to embark on evacuation and protective measures.

The PMD provides analysis of the current weather situations and the probable heavy rainfall and river level forecast to the PDMA control room present at the state and district levels (Government of Punjab, 2020). Using this information and the data received from water resource departments about the anticipated discharge from dams, the PDMA airs flood warnings through television, radio, mobile phone short messaging services, and social networks.

In case of threatened villages, police mobiles announce through a siren to the people to shift to consolidated temporary shelters developed by the government as immediately required (PDMA Punjab, 2016). The early warning messages pass information on the severity of the flooding, areas that are likely to be affected, and the duration that people should move valuables, food, and livestock to higher ground.

Evacuation Warnings

Whenever the rivers are in full flood, and they are near the dangerous stage, the PDMA mobilizes with the DDMCs to provide flood evacuation advice through all available media. Depending on the intensity of the flood, messages urge citizens to shift to multi-story government buildings, temporary structures on elevated plinths, or relief camps as directed by the administration (Ministry of Information & Cultural Affairs, Government of Punjab, 2017).

Through local media, constant reminders disseminate information on water levels, danger areas, and ongoing evacuations. The PDMA also establishes emergency telephone numbers that people can call in and receive instructions and information as to safe areas or welfare centers in their area (PDMA Punjab, 2015). Through early communication, the PDMA also ensures that lakhs of citizens are evacuated early without loss of many lives during each flood season.To this end, the PDMA Punjab continuously uses appropriate communication channels specific to each area to conduct awareness and early warning campaigns to acquaint communities with the flood response Protocol.

Statement of the Problem

The disaster communication campaigns conducted by the Punjab Disaster Management Authority on social media play a vital role in improving disaster preparation, response, and resilience. However, the efficacy of these campaigns relies on variables such as the extent of their reach, the quality of their content, the level of user involvement, and the resulting behavioural modifications.

Significance of the Study

This research is important in that it could lead to improvement in disaster communication measures , especially the utilization of social media, which has now become a crucial instrument of disaster

management in the current era. Through a review of the disaster communication campaigns by the Punjab Disaster Management Authority (PDMA) on social media, the research provided useful information on the effectiveness of the disaster communication campaign in increasing awareness, involving the community, and the behavior of flood-impacted individuals. Such knowledge can be used to assist PDMA in enhancing its communication policies, which enhances the general preparedness and response to flood disasters.

Objectives of the Study

The study is organized to explore the following objectives;

To find out the level of awareness of Facebook and X users regarding the disaster communication campaigns of PDMA.

To examine the impact of disaster communication campaigns on the capacity building of vulnerable communities.

To evaluate the effectiveness of disaster communication action plans, attitude change, and action for disaster response.

To examine the active engagement with social media campaigns related to disaster communication, particularly during flood events.

To analyze the authority's perception of disaster communication campaigns.

Research Questions

On evaluating the impact of disaster communication campaigns by the Provincial Disaster Management Authority (PDMA) on Facebook and X users in Punjab, the study will explore the following research questions to assess the effectiveness and outcomes of these campaigns:

RQ1: What level of exposure to PDMA's disaster communication campaigns do Facebook and X users in Punjab experience?

RQ2: To what extent do PDMA's disaster communication campaigns on Facebook and X influence users' awareness, attitudes, and preparedness behaviours related to floods?

1.14: Hypotheses

H1: The PDMA's disaster communication campaigns on Facebook and X have a statistically significant impact on users' disaster-related awareness and understanding of flood risks in Punjab.

H2: The exposure to PDMA's social media campaigns is linked to better preparedness and resilience in communities that are at risk.

H3: The PDMA's disaster communication campaigns on Facebook and X have a big effect on how people think and act.

LITERATURE REVIEW

The literature review section particularly talks about areas of concern to understand the research problem and its relevance to society.

Disaster Communication Strategies

The dissemination of timely and accurate information to impacted people through disaster communication campaigns is of utmost importance in lessening the effects of both natural and man-made catastrophes. Since 2018, an increasing amount of scholarly work has been dedicated to the examination, improvement, and comprehension of the efficacy of catastrophe communication efforts. The objective of this literature review is to consolidate and evaluate significant discoveries, approaches, and patterns in catastrophe communication efforts.

The field of disaster management has witnessed the development of many communication techniques that now span a wide range of channels. These channels include traditional media, social media platforms, mobile apps, and community participation efforts. The significance of utilizing various platforms to effectively disseminate knowledge to a broad range of individuals, while prioritizing accessibility and inclusion, has been underscored by scholars (Smith et al., 2018).

The importance of social media in disaster communication operations has become more significant. The research conducted by Li and Liu (2019) highlights the expeditious propagation of information via social media platforms such as X and Facebook. However, it also underscores the difficulties involved in effectively handling and controlling the spread of disinformation. Researchers have conducted investigations on the utilization of sentiment analysis and artificial intelligence

techniques for the dissemination of erroneous assumptions (Batrinca& Treleaven, 2020).

In conclusion, the scholarly discourse around disaster communication initiatives demonstrates a fluid and progressive domain. Considerable progress has been achieved by scholars in comprehending the intricacies of communication within crisis scenarios, with a particular emphasis placed on the necessity of employing multi-platform approaches, fostering community involvement, and integrating technology advancements. Given the persistent worldwide hazards posed by catastrophes, it is imperative to conduct continuous studies in this field. Such research plays a crucial role in informing the creation of communication techniques that are successful in enhancing the resilience and well-being of communities confronted with these problems.

Keeping in view the key variables of the topic, related literature has been collected, and the literature provides an overview of how social media has been considered as a key factor in disaster communication strategies. Moreover, references to various studies have been provided that relate to the topic of the study. The major factors surrounding disaster communication strategies have been identified with the help of relevant literature, i.e., knowledge, attitude, beliefs, and behavior. Furthermore, through the literature, the researcher has identified the intervening variable, i.e., indirect channels of communication, which play a key role in enhancing the disaster communication strategies.

Social Media in Flood Communication

Risk and crisis communication models have shifted from the one-way, top-down models used by government agencies to a more two-way, bottom-up model, though enabled by the use of social media by the general public (Hughes & Palen, 2012). In particular, social media enables both disaster managers and community members to generate and access content related to a disaster (Alexander, 2014). Facebook and X are some of the most popular social media platforms that have been commonly parental in the process of seeking, sharing, and distributing flood information (Luo et al., 2022).

The uses of Facinclude, for instance, during the 2015 South Carolina floods, where members of the public and emergency managers posted current flood information, safety information, locations of emergency shelters, closures of roads, areas that should be avoided from flooding, information, and ways on how to donate and volunteer (Coles et al., 2017). It was found that the public was very active in using and sharing flood data during the 2011 flood in Thailand, including water levels, flooded area's location, and flood relief information (Smith et al., 2015).

Other notable applications also include situation awareness and decision making by disaster agencies during flood incidents by employing the results of public communication and concern expressed through social media (Plotnick et al., 2015).

D C Campaigns and the usage of Facebook and X in Pakistan

Disasters like floods, earthquakes, and droughts are among the frequently observed disasters in Pakistan that bring about devastation affecting people, hence the need for disaster management and **disaster** relief. Communications during disasters are also critical in the reduction of impact on societies that are vulnerable to the event. Modern tools such as Facebook and Twitter are some of the media that have been used frequently in the Pakistani context due to mobile phones.

Types of Disaster Communication

Communication in disasters and emergencies is very important due to its significant role in responding to disasters, including protecting lives. This increases communication among the response teams, keeps people informed and updated, and provides them with information they need to make choices on how best to protect themselves (Liu et al., 2022). There are several major categories of disaster communication that are employed in anticipation of, during, and after crisis incidents.

Warning Communication

Warning communication is a type of communication conveyed to the public to inform them of a likely dangerous situation, which may include a storm, an earthquake, or a flood. Three warning modes include alarms that act as a warning via television, radio, and telephone, sirens, and warnings through a warning-giving application on mobile devices. Concisely, the

best warnings mention the threat, give directions, and often include a map with labeled target people (McComas, 2010). Specific suggestions given by Wray and Jupka (2004) indicate that interventions are more likely to be protective if warnings originate from credible sources, contain specific risk information, and have consistent messages across all the communicating channels.

Crisis Communication

Crisis communication involves messages sent during an emergency to convey new conditions, guide people, and provide information to dispel rumors (Seeger, 2006). This is usually done by response organizations and public authorities. According to Ulmer et al. (2021), strategic crisis communication is timely, transparent, and empathetic and has the goal of minimizing uncertainty. Those used depend on the functionality of infrastructures and may range from simple things like a press conference to Facebook, Twitter to amateur radio operations. Message content concerns are to communicate response decisions, control expectations, explain support roles, and enable self-promotion Kotloff et al, 2013).

Community participation is also important in the management of disasters and emergencies. Community communication, way, allows response teams to get a feel of issues on the ground and at the same time, allows the community to have a voice, which is very important according to McComas et al (2016). This fosters self-organizing behavior, which is important for selecting essential roles to fill during or after an emergency (Rodriguez & Trainor, 2018)

Risk Communication

In disasters, there are populations that suffer more when rescue efforts are not communicated, and this never gets to them. Such population categories as people with poor command of the native language, the disabled, lonely people, and other vulnerable populations may experience difficulties in receiving, understanding, and responding to warnings if efforts do not address these issues (Andrulis et al., 2007).

Flood Disaster Communication

Flooding is one of the simplest and most frequent disasters that have a negative impact on global societies annually. Stakeholder communication during flood disasters is important in order to reduce the number of fatalities and loss of property (Sene, 2008). Correct, timely, and comprehensive information enables people and communities to prevent floods, mitigate impacts while a flood is in progress, and rebuild after it is over. The present work will focus on the evaluation of communication processes and practices in the context of flood risk before, during, and after a large-scale flood: case studies and references to flood literature will be provided for this purpose.

Pre-Flood Communication

Pre-flood warning informs the communities living in flood plains of the dangers, gets the households to buy flood insurance, and makes the residents move out in case of a flood (Parker et al, 2009). It is recommended that the education programs before floods include simple, unambiguous information on previous floods and comprehensive, but at the same time non-technical flood forecasts in the future (Moore et al, 2015). Catastrophe-specific data leads to people panel, and most importantly, seeing their particular risk of floods defeats the misconceptions of "but it will not reach me".

Before using any of the four methods of disseminating information, multiple channels were used, including media, Facebook, community meetings, handouts, warning signs, and flood indicators to counter difficulties in communicating core messages (Dufty, 2012). Another element of message content should consider social science, highlight danger to life, show special preparedness steps, and apply personal experiences stimulating the community response (Bradford et al, 2012).

During Flood Communication

Communications during a flood event should convey up-to-date and individualized information regarding the hazard and correct public protective measures. Information should be provided by local and national authorities using any media in order to reach the entire population (Vieweg et al, 2010). Messages should tell recipients to avoid specific areas, give suggestions on where to go, what kind of shelters to use, caution against polluted water and other health hazards, give helpful safety tips, and

provide contacts in emergencies (Leykin et al, 2016). Government agencies followed social media in order to respond to rumors, different information, and appeals for help. Real-time feedback was easily obtained to allow officials to modify their message and response activities (Sutton et al, 2008).

Post-Flood Communication

Because after any flood, the style of communication adopted shifts from notifications of the flood occurrence to focusing more on the recovery process, while still providing some public safety alerts. Other topics should include government help programs, status on utilities and facilities, health precautions, and if the residents were evacuated, how they can safely return (CDC, 2016). Leaders should regulate people's expectations of time and assure them that help will stay for several more months.

According to the different case studies, lack of communication during the rebuilding phase sharply hinders the community rebuild and recovery process since the people feel they have been neglected and underinsured (Consoer & Milman, 2016). Alleviating such short-term pressure, authorities are now faced with another problem of long-term resilience communication to encourage those who are likely to stay in the dangerous zone not to rebuild.

Flood risk communication is a relatively young field, and its development will go on through technological progression, occurrences of societal benefits due to the social sciences, and experience from flood disasters. However, case studies have demonstrated that messaging and source credibility, audience segmentation and framing, and communication strategies can be better implemented by officials in the high-stakes battle against flood destruction. When community individuals are given proper and effective flood communication strategies in the different preparedness, response, and recovery phases, then both lives and property will be protected.

THEORETICAL FRAMEWORK

The Theoretical framework combines the ideas of crisis communication, media effects, and the theory of public engagement to evaluate the extent, clarity, and effectiveness of the campaigns made by PDMA. It directs the search into the influence of social media platforms, which enable two-way communication, influence the general perception of people, and eventually the behavioral outcomes in disaster situations. This theoretical basis has made the research methodologically sound and led to academic insight and improvements in the communication of disaster management in practice. The following theories and models are quite relevant to understanding the statement of the problem;

1. Disaster Risk Reduction Theory
2. Situational Crisis Communication Theory

Disaster Risk Reduction Theory

The DRR theory is based on the transformation of the past interpretation of disasters based on hazardous perceptions to modern ones that focus on vulnerability, resilience, and governance. In the past, the initial disaster scholarship focused on physical hazards, and the disasters were approached as the unexpected forms of nature that are beyond human control (White, 1945). This hazard-based solution focused on the engineering interventions and technological solutions and centered on hazard monitoring, early warning systems, and protective infrastructure. Even though these interventions played a big role in curbing the material effects of the hazards, they failed to address the social and structural factors that caused the disaster risks in the first place (O'Keefe et al., 1976).

Altogether, the DRR theoretical framework is multidimensional, incorporating hazard science, vulnerability theory, resilience thinking, governance, climate adaptation, and social justice views. It recognizes that disasters are not only natural processes but multifaceted socio-ecological processes that are conditioned by human choices, institutional organization, and environmental processes. Proper DRR should be based on thorough knowledge of these theoretical basics to develop interventions that decrease the current vulnerability and increase resilience and sustainable development. DRR theory is going to be evolving as world risks increase, incorporating new understanding, technologies, and 360 degrees in order to help people in society to deal with and adapt to the future that is becoming more uncertain.

Situational Crisis Communication Theory

The full conceptual model of SCCT emerged in the early 2000s as a coherent framework, which allows for evaluating the reputational threat of the crisis, and choosing the most suitable reputational protective response (Coombs, 2007). SCCT proposes assessing three factors: Factor one is "Quick Crisis Imputation" – refers to the amount of stakeholder imputing organizational responsibility at the onset of the crisis from the crisis information. The second factor is how common intensifiers are – For example, crisis history and relationship history as factors that increase attribution of responsibility. The third factor is "Playback: Defenses", aspects that diminish the attributions, including goodness of intentions and other so-called conditions (Coombs, 2007)

In response, the model directs the identification of the match between the level of reputational threat and the crisis response postures anchored on the accommodative-defensive continuum. SCCT identifies three main postures: These strategies include: (1) denial where the organization will deny the existence of crisis or deny responsibility, (2) minimization, where the organization admits to the existence of the crisis but will try to down play its severity or the involvement it had to the tragedy and (3) restoration where the organization fully accepts responsibility for the tragedy and endeavors to compensate for the losses (Coombs, 2007).

METHODOLOGY

The research approach is employed to attain the study's specific purpose. It denotes the methodologies and techniques employed to investigate a research issue. The examination of approaches to resolve a research issue is termed 'Research Methodology' (Kapoor et al., 2022). The research technique encompasses the strategies employed by researchers to understand and analyse events within their study (Sileyew, 2020).

The provincial disaster management authority chose Facebook and X for disaster mitigation strategies because they are widely used social media platforms. Facebook and X have emerged as influential platforms for the distribution of information pertaining to disasters, enabling provincial disaster management authorities to interact with the public in real-time throughout emergency situations. The study used a survey methodology to assess the influence of disaster communication initiatives conducted via social media on the participants.

Universe of the Study

A study universe can be made of people, groups, institutions, or objects (Lavrakas, 2008). In this study, the universe is officially declared a flood disaster in eight districts, Kasur, Okara, Pakpattan, Vehari, Multan, Lodhran, Bahawalnagar, and Bahawalpur, during the 2023 flood disasters.

Population of the Study for Survey

The population of the study comprised all the youth from public sector colleges in eight designated districts of Punjab. The survey includes individuals aged 18 to 25. This research examined both male and female participants from the selected public sector district colleges. This study encompasses educational levels of intermediate, undergraduate, and postgraduate degrees. The locations under scrutiny were determined by districts significantly impacted by disasters.

DATA ANALYSIS RESULTS AND DISCUSSION

The descriptive and inferential statistics have been calculated using statistical software. There are inferential statistics that involve parametric and nonparametric tests. The tests were conducted depending on the features of the data obtained.

Demographic Characteristics of Respondents

Table 1: Demographic Characteristics of Respondents

Demographics	Categories	Frequency	Percent
Age	18-25	1600	100%
Gender	Male	800	50%

	Female	800	50%
Location	Urban	157	9.8%
	Rural	1443	90.2%
Marital Status	Married	177	11.1%
	Unmarried	1423	88.9%
Education Level	Intermediate	1156	72.3%
	B.A/B.SC (14 years)	333	20.8%
	BS/M.A/M.Sc. (16 years)	111	6.9%
District	Okara	200	12.5%
	Bahawalnager	200	12.5%
	Pakpattan	200	12.5%
	Bahawalpur	200	12.5%
	Kasur	200	12.5%
	Lodhran	200	12.5%
	Multan	200	12.5%
	Vehari	200	12.5%

The sample size is 1,600 people (100 percent), aged 18 to 25. There is an equal balance of gender (800 male, 50% and 800 female, 50%). The sample mainly consists of rural people (1,443; 90.2), an insignificant city segment (157; 9.8). The majority of them are not married (1,423; 88.9%), and 11.1% (177) of them are married. Intermediate (1,156; 72.3%), BA/BSc (333; 20.8%), and a smaller percentage of BS/MA/MSc (111; 6.9%), are the most common education levels. The geographic coverage is well balanced as there is even distribution of the number of districts represented (eight) (200 respondents each) within the chosen districts.

The sample is mainly composed of young adults (18-25 years) and the number of male and females is balanced. The respondents are mostly rural, unmarried and most have intermediate level education. The information also has a good representation in different districts, implying that there must have been a well-organized and regionally balanced survey or study.

5.2. 5: Measurement: Analysis of Descriptive Statistics

Table 2: Analysis of Descriptive Statistics

	Total participants Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	Skewness Statistic	Skewness Std. Error	Kurtosis Statistic	Kurtosis Std. Error
Awareness regarding Disaster Communicatio	1600	1	5	3.5999	0.78865	-1.166	0.061	2.304	0.122

n									
Community Engagement	1600	1	5	3.6386	0.82764	-1.151	0.061	2.237	0.122
User Perceptions	1600	1	5	3.6217	0.82475	-0.872	0.061	1.641	0.122
Information seeking Behavior	1600	1	5	3.6114	0.82723	-0.988	0.061	1.697	0.122
User behavioral Change	1600	1	5	3.6415	0.84681	-0.945	0.061	1.517	0.122
Disaster management cycle: Prevention	1600	1	5	3.6117	0.85558	-0.787	0.061	1.17	0.122
Disaster management cycle: Preparedness	1600	1	5	3.6112	0.84888	-0.678	0.061	1.215	0.122
Disaster management cycle: Response	1600	1	5	3.6152	0.89565	-0.648	0.061	0.918	0.122
Disaster management cycle: Recovery	1600	1	5	3.6316	0.87649	-0.65	0.061	0.911	0.122

The descriptive statistics indicate that all constructs were measured on a scale of 1600 respondents, with a large, consistent sample size of 1-5. The overall mean scores for all variables range from 3.60 to 3.64, mainly suggesting positive, above-average perceptions of disaster communication, community engagement, user perceptions, information-seeking behaviour, behavioural change, and all phases of the disaster management cycle. Of the latter, user behavioural change and community engagement are the most frequently recorded, with the highest mean values, indicating a relatively good level of outcomes; however, with a slight difference, the other with a relatively good level of outcomes is awareness of disaster communication. The standard deviation values of 0.79-0.90 are moderate levels of variation in the responses; there is no significant variation among the respondents; they all agree with each other. The skewness of all variables is negative, indicating that the responses are located on the more positive side of the scale, and that more respondents will choose the higher offerings. Also, negative kurtosis values are positive, which implies that the distributions are instead peaked, i.e., the responses are closely concentrated around the mean rather than dispersed everywhere. All in all, the findings indicate stable, high levels of positive attitudes and behaviours regarding disaster communication and disaster management, with a tendency to rate higher across all the measured dimensions.

KMO and Bartlett's Test

These tests advise determining the sample size's sufficiency and are crucial for doing so. Accordingly, Hair et al. (2010) claimed that KMO values should range from 0 to 1, with values close to 1 being considered appropriate. In particular, social sciences are advised to use KMO values of 0.5 and higher. To have sufficient sample adequacy, Bartlett's test of sphericity should also be significant. The ranges of KMO and Bartlett's Tests are from 0 to 1, and the acceptable range is 0.5. However, Tabachnick and Fidell (2007) proposed KMO value of 0.6 is a good value for factor analysis. Knutson et al. (2007) also

suggested a value of 0.6. Exploratory factor analysis was also conducted with the extraction method of principal component analysis and rotation method of varimax. Table: 6 show the KMO value and results of Bartlett's Test of Sphericity.

Table 3: Kaiser-Meyer-Olkin and Bartlett's Test

KMO Measure of Sampling Adequacy.	Approx. Chi-Square	0.898
Bartlett's Test of Sphericity	Df	8752.615
	Sig.	15
		<.001

The table shows findings of two statistical tests that are usually applied in factor analysis, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and the Test of Sphericity. The KMO value stands at 0.898 which is excellent. This statistic quantifies the appropriateness of the sample on factor analysis. The closer the value of a KMO is to 1, the higher the correlation of the variables and the possibility of using factor analysis. Most values below 0.8 are seen to be good and those below 0.9 are excellent.

The Chi-square = 8752.615 of 15 degrees of freedom (df) and the level of significance is less than 0.001.

The null hypothesis that is tested in this test is whether the correlation matrix is an identity matrix (which would imply that the variables are not related and cannot be subjected to factor analysis). The level of significance is less than 0.001 so we can reject the null hypothesis indicating that the correlation matrix is not an identity matrix and that there are significant correlations between the variables. Factor analysis is, thus, suitable. To conclude, KMO value shows that the sample size is sufficient to perform a factor analysis

and the Bartlett test proves that the variables are correlated enough to extract factors.

Total Variance Explained

The table on the Total Variance Explained contains the findings of a Principal Component Analysis (PCA) that has been conducted to decrease the dimensions of the data and define the underlying components. The first element explains a variance of 69.13, showing that it is the most important factor that can be used to explain the variability of the data. The second component adds a further variance of 17.59 to the overall variance explained by the first two components that is 86.72. The third element explains 4.51 percent and then the other elements are the ones which explain the smaller portions of the total variance; the final element is the one that explains just 0.15 percent. All in all, the two initial components combined together explain a significant portion of the variance, implying that they represent the most significant information in the dataset. The analysis aids in simplifying the data without losing major patterns and structures.

Table 4: Total Variance Explained

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	Variance	Cumulative	Total	Variance	Cumulative	Total	Variance	Cumulative
1	10.370	69.130	69.130	10.370	69.130	69.130	10.105	67.363	67.363
2	2.639	17.591	86.721	2.639	17.591	86.72	2.904	19.358	86.721

1

3	.676	4.509	91.230
4	.304	2.027	93.257
5	.242	1.612	94.869
6	.151	1.006	95.875
7	.134	.891	96.766
8	.129	.861	97.627
9	.080	.531	98.157
10	.074	.491	98.648
11	.061	.408	99.056
12	.047	.315	99.371
13	.036	.240	99.612
14	.036	.238	99.849
15	.023	.151	100.000

Extraction Method: Principal Component Analysis.

Screen Plot

The given Screen Plot helps to gain the understanding of the outcomes of the Principal Component Analysis (PCA), which is aimed at decreasing the number of dimensions in the data and keeping as much of the variance as possible. The eigenvalues of each element are displayed in the plot and indicate the amount of variance that is being captured by this component. The fact that the second component has a sharp decrease is a major characteristic, since it means that the first component can explain most of the variance in the data. The first component has an eigenvalue that is much greater, approximately 10, indicating that the first component accounts for a considerable part of information.

When the plot progresses to the second component, the eigenvalue reduces to around 2.64 that is quite large but much less than the initial one. The eigenvalues then begin to decrease steadily, with the rest of the components having values nearer to or less than 1. It is commonly known as the “elbow” in a Scree Plot, in which the point of inflexion (where the steep drop levels off) indicates that most of the information useful to data analysis is concentrated in the earliest few components.

Considering this trend, it would be appropriate to retain the first two components to further analysis since they explain the majority of the variance (more than 86 percent of cumulative variance). It is possible that other components would add noise to the model because the extra components add minimal variance. Practically, it implies that these two elements can serve as an efficient representation of this data, which makes the analysis process much easier without the necessity to lose any valuable information.

On the whole, the analysis has demonstrated that the initial two components will be adequate to summarize the essence of the dataset, whereas the other components will add insignificant value. This is done by reducing the dimensions to enable easier modeling and visualization of the data, particularly where the size of the dataset is high.

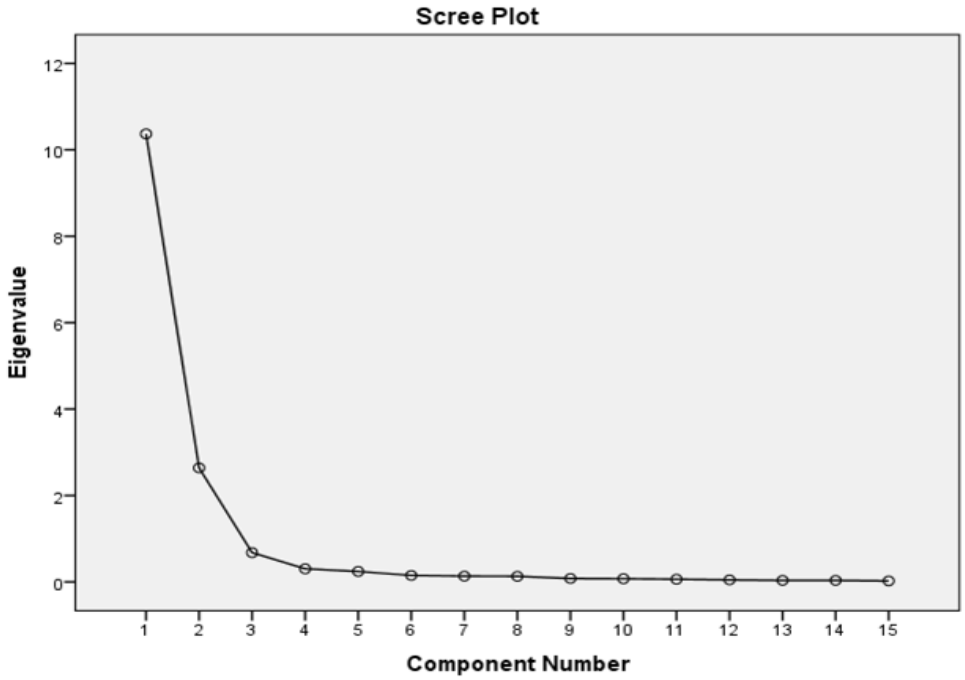

Figure 1: Screen Plot Representing the Data in Number of Factors

Independent Sample T-Test Gender Wise

Table 5: Independent Samples T-Test; Awareness Regarding Disaster Communication

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.000	.999	.025	1598	.980	.00097	.03944	-.07640	.07834
Equal variances not assumed			.025	1597.998	.980	.00097	.03944	-.07640	.07834

The independent-samples t-test findings reveal that the level of awareness as to disaster communication is not statistically significant at the two groups. The assumption of the equality of variances is correct as the value of Levene test is non-significant (F = 0.000, p = .999). With this assumption, the t-test demonstrates a very small difference (MD = 0.00097) in means between the groups which is not statistically significant (t = 0.025, df = 1598, p =.980). The confidence interval (95% -0.076 0.078) contains the zero, which once again proves the statement that the means of the groups are not statistically different. Generally, there seems to be uniformity in terms of awareness on disaster communication.

Table 6: Independent Samples T-Test; Community Engagement

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.002	.964	.057	1598	.954	.00237	.04139	-.07882	.08357
Equal variances not assumed			.057	1598.00	.954	.00237	.04139	-.07882	.08357

Results of an independent-samples t-test on community engagement indicate that the two groups did not differ significantly. It does not satisfy the test of equal variances (F = 0.002, p =.964), which means that the same assumption is satisfied. On this assumption, the t-test indicates a minimal mean difference (MD = 0.00237) that is not significant (t = 0.057, df = 1598, p = .954). The 95 percent confidence interval for the difference between the means (-0.0788 to 0.0836) contains zero, indicating no significant difference. Overall, these findings suggest no statistically significant difference in community engagement levels between the two groups.

Table 7: Independent Samples T-Test; User Perceptions

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.013	.910	.009	1598	.993	.00038	.04125	-.08054	.08129
Equal variances not assumed			.009	1597.987	.993	.00038	.04125	-.08054	.08129

The independent-samples t-test for user perceptions shows no statistically significant difference between the two groups. The test of Levene is not substantial (F 0.013, p = 0.910), which means that the assumption of equal variances was satisfied. Under this assumption, the t-test reveals an almost negligible mean difference (MD = 0.00038) that is not statistically significant (t = 0.009, df = 1598, p = .993). The mean difference (-0.0805 to 0.0813) were fallen within the 95 percent confidence interval around zero, which is not significant. Overall, the findings suggest that user perceptions are consistent across both groups.

Table 8: Independent Samples T-Test; Information Seeking Behavior

	Levene's Test for Equality of Variances		t-test for Equality of Means					
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Equal variances assumed	.000	.997	-.060	1598	.952	-.00250	.04137	-.08365	.07865
Equal variances not assumed			-.060	1597.999	.952	-.00250	.04137	-.08365	.07865

The independent-samples t-test results for information-seeking behaviour indicate no statistically significant difference between the two groups.

The assumption of equal variances is fulfilled as the Levene test is not significant (F 000: p .997). Based on this assumption, the t-test shows a minimal and negligible mean difference (MD = −0.00250) that is not statistically significant (t = −0.060, df = 1598, p = .952). The confidence interval for the mean difference (−0.0837 to 0.0787) includes 0, which also supports the conclusion that the difference between the groups is not meaningful. Overall, information-seeking behaviour appears to be uniform across both groups.

Table 9: Independent Samples T-Test; Prior Experience with Flood Disasters

	Levene's Test for Equality of Variances		t-test for Equality of Means					
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Equal variances assumed	.008	.931	-.026	1598	.980	-.00113	.04383	-.08710	.08485
Equal variances not assumed			-.026	1597.994	.980	-.00113	.04383	-.08710	.08485

The independent-samples t-test of previous exposure to flood disasters shows no statistically significant difference between the two groups. The Levene test is not important (F = 8.08, p = .931), indicating that the assumption of equal variances is met. With this assumption, the t-test shows an insignificant mean difference (MD = -.00113) that does not reach statistical significance (t = -.026, df = 1598, p =.980).

The confidence interval for the mean difference (-0.0871: 0.0849) includes 0, further confirming the lack of a significant difference. On the whole, the findings indicate that the experience before a flood disaster is similar across the groups.

Table 10: Independent Samples T-Test; User Behavioral Change

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Equal variances assumed	.005	.942	-.089	1598	.929	-.00375	.04235	-.08682	.07932
Equal variances not assumed			-.089	1597.986	.929	-.00375	.04235	-.08682	.07932

The independent-samples t-test shows that there is no statistically significant difference in users' behavioural change between the two groups. Levene test is not essential (p = .942), indicating that the assumption of equal variances is met. The t-test value is insignificant (t = -0.089, df = 1598, p =.929), and the difference in means is also not significant (MD = -0.00375). The 95% confidence interval (-0.08682, 0.07932) contains zero, indicating no substantial difference between groups.

Table 11: Independent Samples T-Test; Disaster Management Cycle Prevention

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Equal variances assumed	.013	.909	-.039	1598	.969	-.00167	.04279	-.08560	.08227
Equal variances not assumed			-.039	1597.990	.969	-.00167	.04279	-.08560	.08227

In the prevention phase, Levene test indicates no violation of the equal-variance assumption (p = .909). The t-test does not indicate a statistically significant difference between the groups (t = -0.039, df = 1598, p = .969). The mean difference is negligible (MD = -0.00167), and the 95 percent confidence interval (-0.08560 to 0.08227) does not include 0, indicating similar perceptions of prevention efforts across groups.

Table 12: Independent Samples T-Test; Disaster Management Cycle Preparedness

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Equal variances assumed	.002	.967	.021	1598	.983	.00089	.04246	-.08238	.08417
Equal variances not assumed			.021	1597.998	.983	.00089	.04246	-.08238	.08417

Preparedness results indicate that the variances meet the assumption of homogeneity of variances (Levene = .967). According to an independent-samples t-test, the differences between the two groups are not significant (t = 0.021, df = 1598, p = .983). The difference between the means is slight (MD = 0.00089), and the 95 percent confidence interval (-0.08238 to 0.08417) contains 0, indicating similarity between groups.

Table 13: Independent Samples T-Test; Disaster Management Cycle Response

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Equal variances assumed	.019	.889	-.037	1598	.970	-.00167	.04480	-.08953	.08620
Equal variances not assumed			-.037	1597.978	.970	-.00167	.04480	-.08953	.08620

During the response phase, Levene test is not significant (p = .889), indicating homogeneous variances. The non-significance of the t-test is also non-significant (t = -.037, df = 1598, p =.970), and the mean difference (MD) is very small (= -0.00167). The confidence interval (0.08620 – 0.08953) includes the value zero, indicating that the two groups are not significantly different.

Table 14: Independent Samples T-Test; Disaster Management Cycle Recovery

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-	Mean	Std. Error	95%	Confidence

					tailed)	Difference	Difference	Interval of the Difference Lower	Upper
Equal variances assumed	.013	.909	.008	1598	.994	.00036	.04384	-.08563	.08634
Equal variances not assumed			.008	1597.985	.994	.00036	.04384	-.08563	.08634

To recover, equal variances are ensured, as indicated by Levene test (p = .909). The independent-samples t-test results indicate no statistically significant difference between the two groups (t = 0.008, df = 1598, p = .994). The mean difference is nearly 0 (MD = 0.00036), and the 95 percent confidence interval (-0.08563 to 0.08634) contains 0, indicating that responses related to recovery are essentially the same across groups.

One way ANOVA

The analysis of the results of the ANOVA of many variables connected with the disaster communication campaigns and their influence on various factors of user engagement, perceptions, and behavior is presented in the table. The variables in the table are dependent on the different rows of the table, i.e. awareness on disaster communication, community engagement, and user behavior change among others. The F-statistic and the p-value are the major findings of the table.

Table 15: One way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Awareness regarding disaster communication	Between Groups	94.917	4	23.729	42.072	.000
	Within Groups	899.599	1595	.564		
	Total	994.516	1599			
Community Engagement	Between Groups	82.251	4	20.563	32.375	.000
	Within Groups	1013.040	1595	.635		
	Total	1095.291	1599			
User Perceptions	Between Groups	119.331	4	29.833	49.140	.000
	Within Groups	968.327	1595	.607		
	Total	1087.657	1599			
Information Seeking Behavior	Between Groups	127.278	4	31.819	52.487	.000
	Within Groups	966.938	1595	.606		

	Total	1094.216	1599			
Prior Experience with Flood Disasters	Between Groups	155.829	4	38.957	57.953	.000
	Within Groups	1072.184	1595	.672		
	Total	1228.013	1599			
User Behavioral Change	Between Groups	145.472	4	36.368	57.940	.000
	Within Groups	1001.152	1595	.628		
	Total	1146.624	1599			
Disaster Management Cycle Prevention	Between Groups	132.838	4	33.210	51.047	.000
	Within Groups	1037.655	1595	.651		
	Total	1170.493	1599			
Disaster Management Cycle Preparedness	Between Groups	149.148	4	37.287	59.290	.000
	Within Groups	1003.082	1595	.629		
	Total	1152.229	1599			
Disaster Management Cycle Response	Between Groups	204.605	4	51.151	75.676	.000
	Within Groups	1078.103	1595	.676		
	Total	1282.708	1599			
Disaster Management Cycle Recovery	Between Groups	225.909	4	56.477	89.857	.000
	Within Groups	1002.501	1595	.629		
	Total	1228.410	1599			

The p-value of 0.000 and F-statistic of 42.072 are less than 0.05. This means that it is a huge disparity between the groups in the awareness on disaster communication. This implies that various groups possess different degrees of awareness, which are determined by issues like exposure to the disaster communication campaigns.

The F-test of 32.375 and p-value of 0.000 show that there will be significant differences among the groups where they interact with disaster communication. This implies that there are groups that are more interested in the content that PDMA publishes, which can have an impact on the varying levels of access, interest or responsiveness to the campaigns.

The F-statistic of 49.140 and p-value of 0.000 are indicative that there exist significant differences in the perceptions of the disaster communication

campaigns held by the users. The groups differ on the perceptions of the usefulness, trustworthiness and clarity of the campaigns.

The f-statistic 52.487 and the p-value 0.000 indicate that there is a significant variation in the way the users search information about disaster-related issues. Certain groups might be more vigorous in seeking information on social media or any other platform hence the need to have customized information sharing.

The F-statistic of 57.953 and the p-value of 0.000 indicate that the differences exist in the previous experiences with flood disasters significantly. This means that people having varying degrees of previous exposure to floods might have varied reaction to the disaster communication campaign, some are more prepared and responsive.

The F-test of 57.940 and the p-value of 0.000 indicate that there exist significant differences in user behavioral changes as a result of the disaster communication campaigns. This implies that the campaigns have been able to influence people differently in terms of their actions including evacuation, preparedness or other mitigation.

The F-statistic and p-value of 0.000 and 51.047 respectively show that large differences exist in the activity of the various groups regarding prevention activities. This implies that the communication activities might be having different impacts on groups in regard to their participation in preventive activities, including flood risk education and environmental safety.

The F-statistic of 59.290 (p-value of 0.000) shows that there are significant differences between the approaches to preparedness that different groups have. It may involve such things as the development of emergency kits, evacuation routes, and other preparations regarding floods, which appear more effective to certain groups over others.

F-statistic of 75.676 and the p-value of 0.000 indicate that there is a significant difference in the way the groups react in an incident of disaster. It means that different degrees of influence have been produced by the communication campaigns on the response behaviors of the users, including evacuation or obeying emergency instructions.

Lastly, the F-statistic of 89.857 and the p-value of 0.000 indicate that there are significant differences in the process of different groups participating in the recovery phase of a disaster. This incorporates actions regarding the receipt of aid, the rebuilding and the recovery of flood damage implying that certain groups are more active or more knowledgeable than others.

The general findings suggest that PDMA disaster communication campaigns have varied effects on different groups on awareness, engagement, perception, behavioral change, and involvement in the various stages of the disaster management cycle. The large disparities in the variables indicate that some groups react differently to the communication activities and the communication campaigns might not be effective depending on the previous experiences with floods, access to information or access to social media sites. Thus, such findings indicate that specific communication approaches should be developed to make sure that the campaigns are specific to the needs and behavior of various demographic groups.

CONCLUSION

This paper has investigated how well the Punjab Disaster Management Authority (PDMA) can communicate its disaster management activities to the population via Facebook and X based on a large and demographically representative sample of 1,600 youths of disaster affected regions has provided a comprehensive understanding of the impact of disaster communication on social media regarding awareness, engagement, perception, information-seeking behaviour, behaviour change, and participation in the entire disaster management cycle.

All in all, the descriptive findings show that the audience highly accepts the disaster communication campaigns developed by PDMA, as the average score across all dimensions is above average. The respondents claimed that they received information, were involved in their community, trusted the information, sought information on their own, changed their behaviour, and were also involved in disaster response, preparation, prevention, and recovery. The peaked distributions and negative skewness indicate that a considerable portion of users rate PDMA's communication activities

positively, suggesting that it is generally accepted and that the campaigns are perceived as effective.

High sampling adequacy (KMO = 0.898) and a highly significant Bartlett Test of Sphericity indicate the strength of the data regarding methodology and confirm that the variables are sufficiently interrelated to be analyzed as factors. Principal component analysis suggests that a majority of the variance can be explained by a few underlying factors. This implies that the consequences of disaster communication are driven by interdependent, collaborative factors rather than independent, unrelated ones.

These results are far more meaningful when inferential analyses are used. In terms of awareness, engagement, perceptions, and behavioural change, as well as all stages of the disaster management cycle, gender-based independent-samples t-tests depict no statistically significant differences. Therefore, the PDMA's communication strategies are mostly gender-neutral, making it easier for people of all genders to access information and support in the event of floods. The one-way ANOVA, however, shows that the groups differ significantly on all variables, including awareness, engagement, perceptions, information-seeking behaviour, prior flood experience, behavioural change, and involvement in prevention, preparedness, response, and recovery. These results show that the campaigns are pretty successful, though their impact differs across groups. This is likely due to differences in people's disaster experience, the use of social media, and the ease of communication.

The results affirm the study's hypotheses that PDMA's social media disaster communication campaigns are critical for raising awareness, preparing people, and driving behaviour change during floods. The differences between groups also prove that more specific communication strategies are necessary. If PDMA personalized its messages to meet the needs of people with varying levels of experience, internet access, and information needs, its campaigns may be successful. This would ensure that weak or uninvolved groups do not lag.

Overall, the paper has shown the increasing importance of social media as a primary communication channel during disasters in regions such as Punjab, which are prone to flooding. There is no doubt that PDM's use of Facebook and X has empowered, educated, and reached out to communities. Nevertheless, to take advantage of these platforms, we need to adjust our communication style to the personalities of the people and their responses at different points in the disaster management cycle. Such changes, combined with support in the management of emergency flooding, would contribute to the improvement of the stability of communities throughout Punjab, as well as decrease the risk of a new calamity.

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