JOURNAL OF INTERNATIONAL CRISIS AND RISK COMMUNICATION RESEARCH
ISSN: 2576-0017
2024, VOL 7, No S5

Key factors in preventive communication for risk reduction in situations of natural disasters.

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Abstract

The objective of this study is to identify the key factors in preventive communication for risk reduction in emergencies caused by natural disasters. Using the MICMAC technique and a study based on experts, 12 critical factors were assessed and classified, based on their level of influence and dependency within the preventive communication system. A qualitative-descriptive study was carried out, with a mixed methodological approach and a non-experimental cross-sectional design. The results showed that the clarity and precision of messages, trust in institutions, community participation, and transparency of information are considered the most strategic factors for preventive communication when responding to natural disaster situations. The analysis of indirect influences shows critical paths: it is evident that factors such as clarity of messages and transparency of information are indirectly influential on community participation based on other factors. It is concluded that preventive communication strategies must be carried out considering the direct and indirect influences.

Keywords: disaster prevention, communication strategies, prevention culture, community resilience, strategic planning.

Introduction

Natural phenomena represent a significant threat to communities almost everywhere in the world, not only because of the physical and economic impact that may result from such an event, but also because of the complex social dynamics that occur there (Peek et al., 2020). In this sense, preventive communication plays a prominent role in reducing the threat of disaster risk (Heydari et al., 2021), since it could raise awareness among the population, contain and facilitate decisions in the social groups involved, coordinate decisions and carry out actions that are effective against the adverse consequences associated with a threat and a disaster (Lestari et al., 2020).

In this context, preventive communication does not only depend on the content of the messages, the communication systems or the channel used for their dissemination, but

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both aspects and many other factors are determining factors (Hansson et al., 2020), although the acceptance of the messages, their codification, trust in the issuing source or the possibility of making suggestions for their modification, among others, must also be present. In the case of preventive communication in a world with climate change, with increases in extreme phenomena and vulnerable populations, the existence of a robust framework for preventive and evidence-based communication is very necessary (Covello, 2021), and the identification of the factors that determine its success must be a priority objective within the framework of comprehensive disaster risk management (Zuccaro et al., 2020).

Preventive communication has been the subject of study in recent decades. Previous research such as that by Yulianto et al. (2021) and Hansson et al. (2020), have given relevance to both the accessibility of certain messages and the need to adapt them to different audiences, as well as the fact that certain cultural and social dynamics must be clear when designing them (Giardini & Vilone, 2021). However, authors such as Kanellopoulos et al. (2023) and Mitcham et al. (2021), have also highlighted the role of social media as emerging tools for the dissemination of preventive communication in real-time.

On the other hand, structural analysis methodologies (Godet 1986) as well as the MICMAC technique have proven to be suitable tools for characterizing complex relationships between different variables, even in the field of risk management. However, there is a gap in the combination of this technique with studies focused on preventive communication, which hinders the comprehensive knowledge of those conditioning factors.

Although an understanding of preventive communication has been developed, there are difficulties related to being able to discover the strategic factors that, on the other hand, accept various views of experts. For this reason, the main objective addressed by this study is to identify and analyze the key factors in preventive communication for risk reduction in situations of natural disasters using the MICMAC technique. The scope of the study is anchored in the analysis of the key factors from a strategic and applied perspective, based on qualitative data from those experts and documentary evidence.

Applications of the results have been directed at risk managers, public policymakers, and academics interested in preventive communication practices. The impact that this study may have lies in having generated useful knowledge for the design of effective communication strategies appropriate to the needs of vulnerable communities.

Methodology

This is a qualitative-descriptive study that uses a mixed methodological approach since it attempts to describe and analyze phenomena as they occur, without collecting information about them, manipulating variables, or looking for direct causal relationships (Sampieri, 2018). It is developed under a non-experimental cross-

sectional design since it seeks to identify and analyze key factors in preventive communication for risk reduction in situations of natural disasters at a given time (Frölich et al., 2014). To do so, the MICMAC technique (Cross-Impact Matrix Multiplication Applied to a Classification) (Arango & Cuevas, 2014) is used as a structural analysis tool and as a complement to a systematic documentary review to provide a theoretical foundation for the identified factors.

The sample was intentional and consisted of a group of experts selected for their training and experience in risk management, preventive communication, and structural analysis. The inclusion criteria were: having a minimum of 5 years of professional experience in risk management or disaster communication, having previously participated in projects related to the prevention of natural disasters, and finally, being available to participate in the structural analysis using the MICMAC technique. The sample size was adjusted to 12 experts following the principle of theoretical saturation, thus ensuring the heterogeneity of perspectives to enrich the assessment of the key factors (Hernández et al., 2014).

To carry out the study, it was decided to conduct a systematic review of scientific and technical literature on preventive communication in natural disasters, identifying a series of factors included in previous research, international guides, and case studies. The selection of documents for the extraction of results followed the previously defined inclusion criteria (recent articles, relevance of the topic, peer-reviewed). A series of key factors were extracted from this documentary review, which were presented to the experts.

Participatory workshops and virtual sessions were then held to ensure both the understanding of the concepts and the collaborative filling of the cross-impact matrix so that the experts could assess the influence and dependency of the factors using the MICMAC software. The hierarchical and classification analysis has allowed for the identification of those factors that are key, determinant, autonomous, and dependent.

Results

The results obtained from this research are presented below. Firstly, the twelve factors listed in Table 1 were obtained from the documentary review, in which, as can be seen, the first column represents the code or short name of the factor, the second represents the full name, and the third represents the description of the factor.

Table 1. Factors related to preventive communication in situations of natural disasters.

Code	Factor	Description
F1	Clarity and precision of messages	The fact that the messages are clear, accessible and understandable to the entire population, and that they are adapted to the literacy levels of individuals.
F2	Trust in institutions	The credibility of the entities issuing the information is essential to accept preventive recommendations.
F3	Community participation	Involving the community and local groups in the design and implementation of communication strategies increases their effectiveness.
F4	Use of appropriate channels	Mass and social media, as well as the interpersonal communication model, must take into account the characteristics of the message's target audience.
F5	Training and education	Education on risks and disasters must be continuous and is an important ingredient to build a preventive culture in school contexts, for example.
F6	Cultural adaptation	Considering cultural factors, local language, and traditions is an essential element in structuring relevant and effective strategies.
F7	Inter-institutional collaboration	Coordination between government agencies, NGOs and the private sector will ensure that messages are consistent and well supported.
F8	Simulation and preventive practices	Simulations and practical activities help merge memories with the skills needed to respond to emergencies.
F9	Transparency in information	Providing honest and timely information fosters trust and avoids unnecessarily creating panic.
F10	Technology integration	Using technological tools, mobile applications, and early warning systems will improve the dissemination of information on a large scale and quickly.
F11	Continuous assessment and feedback	Conducting a daily evaluation of the effectiveness of communication campaigns is essential to be able to make adjustments in real time and contribute to achieving better results.
F12	Accessibility of information	Ensuring that information reaches vulnerable populations, people with disabilities, older adults or in rural communities is a major challenge.

Source: Authors

Once the factors were identified, the matrix of direct influence/dependency (MDID) was constructed and, in collaboration with the experts, it was completed taking into account the level of influence and dependency that each factor has on the others. For the assessment, a scale of 0 to 3 is used, where 0 is no influence; 1, weak influence; 2, is moderate influence, and 3, is strong influence.

Figure 1 shows the fully completed matrix and it can be observed that the influence relationships (row) of factor F1: with itself has no influence (0), with respect to F2 is strong (3), with factor F3 is strong (3), with F4 is weak (1), with F5 is moderate (2). In this way, the matrix can be interpreted or read.

Figure 1. Matrix of direct influence/dependency

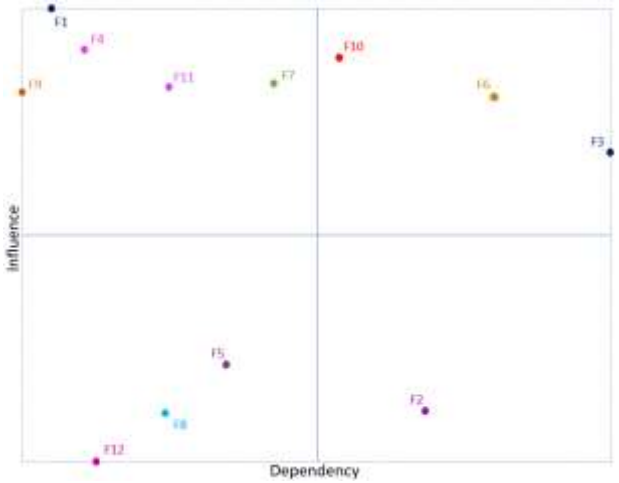
I/D	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
F1	0	3	3	1	2	2	3	3	3	1	2	0
F2	0	0	3	0	1	2	3	0	2	2	1	0
F3	1	2	0	3	2	3	3	2	0	1	3	0
F4	2	3	3	0	0	3	3	2	3	1	0	2
F5	2	0	2	2	0	2	1	2	0	3	0	1
F6	2	2	3	1	1	0	2	1	1	3	2	3
F7	0	3	3	0	3	3	0	2	0	3	3	1
F8	0	1	3	0	2	2	0	0	0	2	2	2
F9	3	3	3	2	0	3	3	0	0	2	1	1
F10	0	3	3	2	2	3	2	1	1	0	2	3
F11	2	3	3	1	2	2	0	3	1	3	0	1
F12	0	2	3	1	3	3	0	0	0	1	0	0

Source: Authors

The results obtained from the MDID lead to the classification of the factors into different categories: key, determinant, autonomous, and results or dependent. The key factors are characterized by having a high influence on the other factors, but at the same time they also depend on them; while the determining factors are characterized by having a high influence on the others and are usually more independent; on the other hand, the autonomous factors are not as influential, but at the same time they are not dependent on the other factors; finally, the dependent or result factors are characterized by being highly dependent on the others. Figure 2 below shows the plane of influence/dependency.

As can be seen, in the first quadrant (top left) are the determinant factors, which are F1, F4, F7, F9, and F11; in the second quadrant (top right) are the key factors, which are F3, F6, and F10; in the third quadrant (bottom right) are the result or dependent factors, in this, only F2 was located, and in the fourth quadrant (bottom left) are the autonomous factors, among which are F5, F8 and F12.

Figure 2. Plane of direct influence/dependency.



Source: Authors

For greater clarity, Table 2 better specifies how the factors were classified.

Table 2. Classification of factors by indirect dependency influences

Type of factor	Factor	Code
Key or strategic	Community participation	F3
	Cultural adaptation	F6
	Technology integration	F10
Determinants	Clarity and precision of messages	F1
	Use of appropriate channels	F4
	Inter-institutional collaboration	F7
	Transparency in information	F9
	Continuous assessment and feedback	F11
Autonomous	Training and education	F5
	Simulation and preventive practices	F8
	Accessibility of information	F12
Dependent or Results	Trust in institutions	F2

Source: Authors

Key factors have a high influence, but are also highly dependent on others, which makes them crucial linking points within the system. In this sense, F3 (Community participation) is influenced by factors such as F1 (Clarity of messages) but also contributes to reinforcing the culture of prevention. On the other hand, F10 (Technology integration) requires input from other elements to function but positively impacts the rapid dissemination of information.

The identified determinant factors (F1, F4, F7, F9, F11) have a high influence on the system, being decisive for its correct functioning and their low dependency indicates that they do not require much external influence to operate, which makes them strategic pillars. For example, F1 (Clarity and precision of messages) is essential to ensure that the population receives useful information, while F9 (Transparency in information) builds trust in preventive communication.

The autonomous factor F2 has little direct influence on others but depends on many elements of the system to function correctly. Thus, F2 (Trust in institutions) makes it necessary to guarantee transparency (F9) and clarity (F1) in order to be consolidated but it does not have a significant direct effect on the system.

Finally, the factors identified as autonomous (F5, F8, F12) function in a more autonomous way, having a low influence and low dependency on the rest of the system. F5 (Training and education), for example, can be carried out independently of other factors but without being able to drag the effect to a large number of factors.

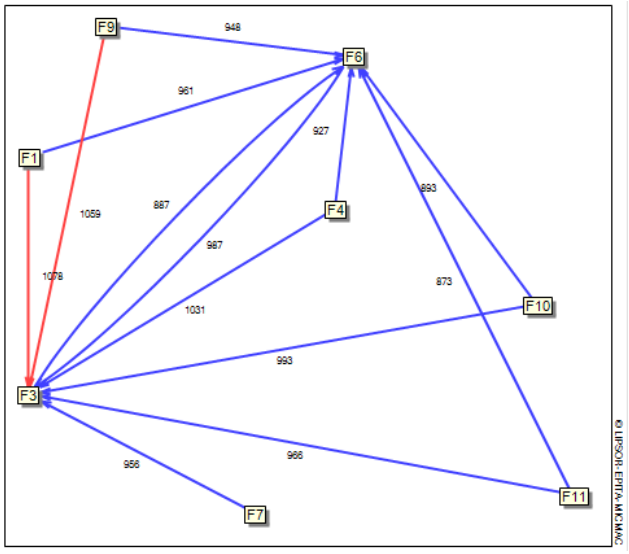
On the other hand, Figure 3 includes the graph of indirect influence/dependency that helps to see the influence relationships that do not exist directly. In this graph, it can be seen that the most indicative influence/dependency relationships (red) are those that go from F1 to F3, since, although F3 does not depend on F1 in the direct influence

matrix, F1 influences F3 through other factors (such as F4 or F6), and its effect is transmitted to Community participation. A clear and precise message (F1) can lead to an improvement in trust (F2) and, through it, to an increase in Community participation (F3). This indication reinforces the importance of guaranteeing clear and understandable messages as a basic element to mobilize the community.

The critical influence/dependency relationship between F9 and F3 is also observed, that is, transparency in information (F9) also indirectly affects community participation (F3). A concrete example is that when the population perceives that the information that reaches them is adequate, trust can increase (F2) and therefore community participation can also increase (F3). This result leads to the conclusion that transparency implies not only the generation of trust but can even be a catalyst for collective actions within the community.

The graph also reveals that indirect influences/dependencies are generally quite strong, such that most factors are interrelated through third parties, reflecting a highly interdependent system. Although some factors may appear isolated in the direct analysis, they actually play a relevant role in the system through their indirect effects. In this sense, the preventive communication system is highly interdependent, which means that the success or failure of one factor can spread to others, even if they are not directly connected. Therefore, strategies must consider both direct and indirect connections to avoid negative cascading effects or take advantage of positive ones.

Figure 3. Graph of indirect influences/dependencies



Source: Authors

Discussions

The results indicate that determinant factors (first quadrant) must be strengthened, that is, the clarity and precision of messages, transparency in information, and inter-institutional collaboration must be prioritized to consolidate the system. These results

are consistent with the literature, for example, Sadiq et al. (2023) stated that the clarity and specificity of the alert message, the use of simple language, and timely and reliable delivery are critical aspects to guarantee an appropriate and rapid response from people. Likewise, Bohorquez-Lopez (2020) points out that for disaster and emergency situations to be managed in a coordinated manner, inter-institutional coordination is a fundamental aspect that must be present.

On the other hand, the key factors (second quadrant) must be taken care of, maintaining balanced management to prevent their high dependency from compromising their functionality, especially community participation and Cultural adaptation. In this regard, in the study developed by Perić and Cvetkovic (2019), there is a broad consensus on the importance of adapting alerts to local linguistic contexts, although in Kuller et al. (2021), it is also highlighted that there is difficulty in developing personalized messages for each social group considering the need to communicate alerts quickly and massively.

As regards the dependent factors (third quadrant), investment should be made in institutional trust, ensuring that influential factors such as transparency in information, as well as clarity and precision of messages, are consistent. According to Panjaitan et al. (2023), government agencies play a central role in disseminating critical health information, shaping public perceptions, and promoting behavior change, which is why investment should be made in this factor. On the other hand, autonomous factors (fourth quadrant) should be optimized, since, although they have a lower overall impact, improving training and the accessibility of information can strengthen the preventive system.

The graph of indirect influences and dependencies highlights the importance of understanding the system as a whole and not only through direct connections. Regarding critical influences, they show that the clarity and precision of messages and transparency in information are strategic determinants to encourage community participation, even through indirect paths. Likewise, strong indirect influences point to the need to design comprehensive strategies that take into account the latent connections between factors.

Conclusions

The research has revealed 12 significant factors that affect communication as a tool for preventing the risk of natural disasters. The most strategic factors are the clarity and precision of messages, trust in institutions, community participation, and transparency of information, which exhibit certain characteristics given their direct and indirect influence on other factors of the system that accompany them. In fact, they become causal vectors that determine the success of prevention strategies.

The analysis using the MICMAC method allowed the factors to be classified into four groups. Determinants: F1, F4, F7, F9, and F11, which are very influential and with which

precautions must be taken to ensure the functioning of the system; key factors: F3, F6, and F10, act as small connecting bridges, these factors depend very strongly on the determinant factors; dependent factors: F2 remains as a key-dependent factor, being affected by the transparency of the messages and the clarity of the messages; autonomous factors: F5, F8, and F12, function independently, although they also contribute to the general strengthening of the system.

The analysis of indirect influences also highlighted that F1 and F9 have strong impacts on F3 through intermediate factors, which points to the need to establish more complex strategies that take into account not only direct influences but also latent connections between the factors; while, on the other hand, the analysis also confirms that the preventive communication system is highly interdependent, with relatively strong influences between most of the factors, which means that the intervention must take into account the system as a whole and not separately, since the impact could be reduced or even contrary to that expected.

The study also highlights that preventive communication requires a multidimensional and context-specific approach. Future work could investigate how these relationships vary in different cultural or geographic contexts, or how these key factors evolve in the face of events with greater intensity or frequency.

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