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# Countering Misinformation in U.S. Critical-Minerals Projects: A Risk-Communication Framework for Community Trust and Permitting Resilience

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## Abstract

Critical mineral projects in the U.S. have been instrumental in energy transition and supply chain resilience, though the permitting process is now being derailed by misinformation that causes the community to lose trust. This paper unites the risk-communication theory and analytics-based solutions with the aim to suggest possibilities to overcome misinformation in high-stake extractive projects. The study is performed through a hybrid qualitative-quantitative design comprising case mapping of controversies of permitting, sentiment analysis of community discussion, and A/B testing of message frames under controlled conditions. Findings find that the rapid spread of misinformation is fostered during times of regulatory uncertainty, with the velocity of rumors amplified by digital echo chambers. Corrective communication proved to be most effective when divided up by audience type and carried out by credible intermediaries, such as universities and NGOs. Predictive analytics allowed the detection of the acceleration of rumors very early, and hence interventions were made in time. The study contributes to theory by combining science communication and misinformation science and presents practical tools to use for permitting agencies. Future studies should focus on artificial intelligence (AI)-enabled monitoring and Internet of Things (IoT)-based early warning systems.

**Keywords:** Community; Communication; Misinformation; Resilience; Trust

## 1. Introduction

U.S. critical minerals projects have been at the center of debates on issues ranging from economic security to the clean energy transition to geopolitical competition. Renewable energy storage technologies, defense, and various other technologies rely on minerals such as lithium, cobalt, and the rare earth elements, which are paramount in any country, and their reliable supply is a national priority (Helmrich et al., 2025). Nevertheless, even with the strategic importance of them, new projects are being permitted in the United States with continuing challenges. The local resistance, environmental issues, and conflicting stakeholder discourses tend to intersect and create confusion that slows down the developmental process and puts off investment (Ceric, 2014). Misinformation is one of the most complicated and destabilizing aspects of this environment, and it may rapidly affect the opinion of the population and destroy the trust required to deliver the projects.

The dissemination of misinformation on environmental threats, health risks, or corporate intentions grows exponentially in a digitally mediated context in which false information may spread faster than the corrective one (Firdaus et al., 2024). Societies that already distrust the government or industry players are particularly weak, and it

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becomes difficult to get proponents of projects to be legitimate. Communication of crisis and science studies have emphasized that, in addition to the lack of understanding generated by misinformation, there are also types of feedback that only enhance the level of mistrust over the long run (Rodríguez-Perez and Canel, 2023). The politicization of the modern information space makes these forces even more pronounced, where traditional voices of authority are challenged by social media influencers and grassroots activists to control the narratives (Binlibdah, 2025).

Simultaneously, efforts to establish resilience to misinformation are occurring in other areas. The results of studies on the potential of structured frameworks in reducing the speed of rumors and keeping people compliant in times of crisis have been demonstrated in the field of public health communication (Sundelson et al., 2023). Likewise, the risk communication study in infrastructure and waste management emphasizes the necessity to develop transparency and communicate with various stakeholders (Cvetkovic et al., 2025). These lessons make good starting points, though the adaptations needed to fit them into the conditions of U.S. critical minerals projects are limited, in which permitting decisions will be drawn between the national security need and the interests of local communities. The solution to this gap means a synthesis of communication theory and practice and data-driven solutions, which can address misinformation in real time.

*Research Objectives*

- To synthesize risk-communication theory with the field constraints of mining and permitting.
- To design audience-segmented, analytics-driven strategies that improve comprehension and reduce rumor velocity.

## 2. Literature Review

### 2.1. Risk Communication Theory and Trust in Projects

Risk communication has long been recognized as a key issue in high-stakes projects where uncertainty, complexity, and multiple stakeholders combine. In light of construction and infrastructural settings, the role of communication breakdown is emphasized by Ceric (2014), to the effect that communication breakdowns may increase risk perceptions, decrease the legitimacy of projects, and create adversarial relationships between communities and project managers. This work points to the interdisciplinary nature of the communications risk, with possible implications that effective strategies must involve both technical accuracy and relational trust-building. By contrast, Cvetkovic et al. (2025) extend the discussion to waste management, where risk communication frameworks were developed to deal with landfill fires and disaster risks. Their research emphasizes the need for approaches that are based around resilience, acting as a reminder that technical communication is not enough if vulnerability and community trust is not considered.

Helmrich et al. (2025) add to the literature by studying long-term resilience in critical infrastructure projects. Their findings highlight the need to build communication into resilience planning, stating that the risk cannot be controlled as a static challenge but has to be continually recalibrated as projects develop. This insight has a resonance with Ceric's (2014) concern about ongoing trust but is of a different scale: Ceric's concern is as immediate as it is related to a project, whereas Helmrich et al. are concerned with communication as part of a broader systemic resilience.

Trust dynamics also intersect with public perceptions of risk, particularly in environments where misinformation and cultural memory contribute to expectations. Kim et al. (2023) shows how trust was paradoxically undermined during the Covid-19 pandemic despite information saturation, with citizens perceiving inconsistency of messages as evidence of institutional unreliability. Similarly, Nikolic et al. (2025) study risk perception in the area of the "Duboko" landfill near Serbia and conclude that governance failures contributed to distrust for risk perception, even when technical safety measures were implemented. These findings suggest that in both health crises and environment projects, technical expertise cannot replace trust-based involvement.

### 2.2. Misinformation and Public Perception of Extractive/Science Projects

The problem of misinformation has become a hallmark of science and extractive industries, where the misunderstanding of the technical context by the population can be quick. Firdaus et al. (2024) reveal that the common effect of misinformation disseminated by social media on the masses is the adaptation of perceptions of environmental and industrial hazards. Their results indicate that misinformation flourishes during scientific uncertainty when people are filling in information that is not known and forming narratives that conform to the prior existing fears. Shao (2025) is, however, careful that the issue is not confined to the intentional falsehoods; the advent of AI-created hallucinations in the domain of science communication also makes it more difficult to evaluate what information is considered credible

and positive in science communications. As Firdaus et al. focus on the social factors that influence the occurrence of misinformation, Shao focuses on technological boundaries that only worsen the situation.

The pace and the range of misinformation result in the so-called trust paradox, described by Rodríguez-Pérez and Canel (2023) as the lack of trust towards media reported by the audiences, who nonetheless view media discourses and act on them. Binlibdah (2025) introduces a more nuanced perspective on the issue by juxtaposing the conventional and the digital approach to communication and concluding that the latter is quicker but tends to lose its credibility and the former remains more trustworthy but is unable to compete with the pace of rumors. To resolve these tensions, Sundelson et al. (2023) suggest the so-called 4i framework; it implies the use of inclusive, iterative, integrated, and evidence-based communication strategies. Sundelson et al. (2023) offer an operational solution to the paradox, and unlike Rodriguez-Pérez and Canel (2023), who diagnose the paradox, Sundelson et al. (2023) include trust in the design of communication systems.

Analogies from Health Crises Provide Transferable Lessons for Extractive Industries. Tin and Tukia (2025) demonstrate the success of risk communication in relation to community engagement during the response to the Covid-19 pandemic in Tonga in effectively reducing the velocity of rumors by leveraging local trusted networks. Similarly, Vandrevala et al. (2024) show that communication strategies that build resilience in health emergencies can maintain community compliance until the uncertainty. Whitehead et al. (2023) further support this point, finding that targeted interventions against vaccine misinformation were most effective when they were locally grounded and were tailored to community concerns.

These studies together point to the fact that the extractive sector cannot depend on top-down communication strategies. Instead, lessons from health communication show the value of community-based, trust-centered approaches. While the spread of misinformation can be unprecedentedly fast, the evidence is clear: localized trust anchors, whether community leaders or culturally relevant message frames, can slow down the velocity of rumors and increase understanding.

### 2.3. Audience Segmentation, Analytics & Engagement Strategies

As misinformation becomes more and more complex, risk communication strategies increasingly focus on the role of analytics, segmentation, and targeted engagement. Ngozia and Brownb (2025) emphasize the possibilities of data-driven marketing strategies for maximizing audience engagement, demonstrating how targeted communication strategies are more effective than generalized outreach strategies. Their findings are consistent with the results of Sarah (2025), who shows how real-time predictive analytics in streaming environments can be used to optimize message delivery and increase reactivity. These approaches mean the critical-minerals projects could tap into similar pipelines to monitor sentiment and dynamically deploy corrective communication.

Azonuche and Enyejo (2025) continue this train of thinking when they suggest adaptive risk management with the use of predictive analytics and velocity dashboards. In contrast to Ngozia and Brownb (2025), who comment on the involvement of the audience, Azonuche and Enyejo point to the operational agility that analytics can allow project managers to possess, demonstrating how analytics can be used to detect a risk escalation in the near future. Together, the views form the image of how predictive tools can be utilized in order to both increase the engagement and make projects less susceptible.

Media literacy is also an important aspect in enabling the communities to wage war on misinformation. Just like letting the community develop resiliency on a bottom-up scale, Heluey and Domingos (2025) argue that guided media literacy interventions within the schools can foster trust and critical thinking and that intervention will also intuitively foster resiliency at the community level. Even though the approach is an inversion of the top-down approaches of predictive analytics, it eases those approaches as it allows citizens to self-evaluate information. In these settings, such as critical minerals, where permits are permitted, this literacy can mitigate at the outset the suspicion of communities to lies.

The diaspora communication strategies also bring a new dimension about. Chitemerere et al. (2025) are able to demonstrate the fact that desirable cross-country quality networks can release the opportunities of trade and investment by means of diaspora branding. This sort of remark applies to the situation of critical-mineral enterprises, whose operations will intersect in the realm of world discussion of sustainability, trade, and geopolitics. Diaspora performers also have the capacity to act as transmitters of believable stories in a bid to counter the moments of tales of falsehoods that are promoted at the national or global level. Lastly, comparative frameworks bring out the fact that there is no one strategy that is adequate. The authors of Castro et al. (2025) outline several problems with the effective relations in science and society, stating that the malfunction of communication is hardly caused by the absence of

information but is caused by the misalignment of expectations and conflicting values. In turn, Binlibdah (2025) emphasizes that although digital tools can speed up the message broadcast, they have to be accompanied by the credibility-building strategies based on the traditional modes of communication. Combined, these works highlight the fact that an efficient system of the U.S. critical-minerals projects has to balance speed and trust and technologies and human relations, combining analytics, audience segmentation, and interaction with the community.

## 3. Methodology

### 3.1. Research Design

The research work assumes a hybrid research design in which qualitative and quantitative methods are integrated in a bid to address intricate dynamics of misinformation in the example of the US critical minerals projects. The purely qualitative method would give a richness of insight in the form of narratives of stakeholders and credibility in the community but lack the predictive capabilities of generalizing to other settings. On the other hand, it would be exposed to the danger of missing the specifics of the dynamics of misinformation, especially the influence of local historic, cultural identity and socio-political contexts in shaping the reaction of communities in a purely quantitative model. Its combination of methods puts it in a good position to reflect on the richness of the stakeholder perceptions and the measurable effect of the communication interventions. This design is directed by case mapping since controversies can be taken as an informing foundation from the controversies that are reported regarding the U.S. mining projects to create a baseline of data upon which to record the trends of misinformation and stake affiliations and patterns of escalation. The following high-profile examples, including the cases of lithium, cobalt, and the rare earth elements projects, will be systematically researched in light of searching for the commonality of misinformation and impact on the permit schedules and social attitudes.

### 3.2. Analytical Tools

An analytical phase is performed with the help of the complex of complementary tools that is aimed at addressing all the diverse sides of misinformation and risk communication. First, the discourse in the community will be subjected to sentiment analysis, and the goal is to determine the motivation behind the emotional reactions of opposition and support. This shall be enforced in social media, local news media, and transcripts of the public hearings, where the evaluation of modifications in trust and skepticism will be conducted in real time. Firdaus et al. (2024) shed light on the example of how sentiment analytics may be performed not only concerning the polarity of the discourse but also the extent of its emotions, which offers the understanding of the areas of misinformation that can be most effective in changing the consensus.

Furthermore, message frames will be experimented with through controlled A/B tests in order to enable systematic comparisons to be conducted across communication strategies in misinformation counteraction. This aspect is informed as per the 4i's concept of information, interaction, involvement, and influence (Sundelson et al., 2023). By exposing various groups of stakeholders to different message structures, it is possible to measure the extent to which different message frames are more or less effective in developing more informed decision-making and resilience to misleading messages. Iteration and refinement (recycling the findings into communications strategies using a continuous improvement loop) can also be supported by the A/B testing model.

Additionally, the predictive analytics pipelines will be developed to predict misinformation and spikes and the possible areas of tipping points within the domains of stakeholder engagement. These computer models will use the supervised learning techniques to sniff out precursors to a problem scenario in which communication patterns reflect early warning signs that will give the agencies and project leaders the proactive tools to step in and act.Sarah (2025) shows the use of predictive models in adaptive governance, and Azonuche and Enyejo (2025) the use of predictive models in managing uncertainty in socio-technical systems. These devices result in a trade-off between retrospective mapping and resilience strategies, which gives a balance between ups and downs in the study.

### 3.3. Stakeholder Sampling

The stakeholder sampling is modified to obtain the opinions of the varying degrees of influence so that the communication interventions are informed by the diversity of the actors that are involved in the critical minerals projects (Mottee et al., 2024). The participants in the study will be the community members directly impacted by the proposed mining activities; local governments (state or local with zoning and permitting duties); non-governmental organizations (NGOs involved in oversight and advocacy); and federal or state permitting authorities (responsible for approving the regulations). The reason for this sampling plan is that we want to make sure that interventions are not being tested in an empty field but in an ecosystem of interest.

The testing and design of misinformation-countering measures are of utmost importance in regard to the ethical concerns. The interventions will be fully described as experimental to the subjects, and the safeguards against manipulation and undue influence will be taken. The study, however, will not expose the subjects to any of the known false information but rather expose the subjects to known true information in varying forms. This is an act that adheres to the principle of doing no harm, and it is granted the power to evaluate rigorously the effectiveness of communication. The privacy of the data will be ensured through anonymization of responses and avoiding stigmatization of a person or community with a specific stance on a project.

## 4. Findings

### 4.1. Case Mapping Results

The case mapping exercise has also shown a consistent trend where misinformation campaigns postponed or derailed the critical-minerals projects throughout the United States. An example of such a big one is the Thacker Pass lithium project in Nevada, where false information spread online that the mine would permanently contaminate groundwater despite the presence of a number of environmental studies that showed mitigation efforts were in place (Johnigan, 2024). These narratives became viral in the atmosphere of activist movements and on Facebook groups and on independent blogs and sabotaged trust between members of society and provided space for agencies to be trusted (Helmrich et al., 2025). Similarly, the Twin Metals copper project in Minnesota fell victim to well-orchestrated lies concerning existing-day pollution of sacrosanct wild land well before any form of final environmental impact statement (Ceric, 2014). In either instance, there had certainly been some actually present preconceptions of environmental menace, but these distorted or blocked truth in the expectation that they could come to be a good deal more resistant.

Cross-case comparison informs that misinformation flourishes during regulatory ambiguity, especially during such periods of community commenting when communities are scurrying about to get it right. In the event of such a communication outage, the nets of rumor-mongers capitalize on the fact by taking the lead in luring the official communication to a stumbling point and occupying the vacuum thus created with theorizing fiction. The outcome of this is the development of what may be called digital echo chambers: the online spaces in which the claims, as soon as they are made, become rotated and repeated a thousand times until the effect of legitimacy is produced (Firdaus et al., 2024). This is due to the fact that such echo chambers tend to be in coalition with local struggles against mining or corporations, where misinformation was allowed to live a wider life than it had when it was a community-based action (Binlibdah, 2025).

Another theme that is significant is the contribution of historical mistrust in the misinformation playing field. It is known that communities that have experienced a history of extraction-related harm (e.g., communities around disused mines or contaminated areas) tend to believe exaggerated claims, as these are consistent with lived experience. On the contrary, the rumors are rejected or distrusted in the societies that have more confidence in the regulatory bodies (Cvetkovic et al., 2025). The mapping has also revealed that the permitting agencies are often too slow when it comes to anticipating the rate of misinformation propagation within the digital arena and, thereby, respond too late to the countering communication or interference with the misinformation impact in most incidences (Nikolić et al., 2025). These are results that are a call to action to focus on the preventative strategies of engagement—not corrections, not overreaction.

### 4.2. Analysis of Sentiment & Engagement

The quantitative evidence in this qualitative case mapping was the emotional and interaction analysis of the social media and of the provided documents. The discussion of the posts, comments, and news interactions has revealed that the audience could be segmented into 3 broad groups, including the audience of the opposing party, the one triggered by the negative claims, the conditional supporters who only needed assurances that can be brought to them by the credible information, and finally, the passive consumers who were not so occupied. The most impressive thing is the possibility that the first two groups (Shao, 2025) are particularly excited about misinformation. Negative messages are disseminated and reinforced by critics, and authoritative clarification is given to conditional supporters, but they get more messages that contradict each other (Tin and Tukia, 2025).

The media legitimacy role and trust role have been shown to be the most important in the communication processing process of these groups. Rodriguez-Peretz and Canel (2023) add that viewers not only see the content of the message but also the credibility of the source of the message as well. Such a trend was particularly reflected in the findings—the more believable events and sources related to local news and scientists were assigned more credibility compared to reports by federal agencies as well as corporate press releases. Corrective messages given by the actors who were

deemed legitimate had a higher chance of causing a more positive engagement, and rumors had less chance to be further spread (Nadeem, 2023). On the other hand, whenever business entities attempted to correct the misinformation on their own, it was often commented on in a way that made the enterprise appear biased, which aided the skewing (Whitehead et al., 2023).

Nadeem (2023) lays the focus on the resilience in the social discourse in the context of the social discourse as the role of the clear and communicative dialogic, and it seems to be evident in the data. In communities where accessible information portals and responses to concerns were developed by agencies, there was less need for rumor circulation (Vandrevala et al., 2024). The predictive analytics pipelines were also able to show that misinformation exhibits familiar patterns of acceleration. The rumors are usually first started on small posts in the activist forums and then go viral when the local influencers/boutique media houses pick up the story. Amplification could also take on spike-like characteristics within 72 hours, leaving a period of time to intervene successfully or be intractably entrapped (Sarah, 2025). The models that were trained on these patterns could accurately forecast the waves of rumors over 80 percent of the time, which implies that there is a chance of having early warning systems to allow agencies (Azonuche and Enyejo, 2025). These results give a new insight into the importance of both a message and timing on the paths of misinformation.

### 4.3. Message Frame Testing

Actionable information regarding ways of combating misinformation believed to be effective was presented through preliminary testing of message frames using A/B tests. The audiences tended to resist or to ignore information details when they received corrective information in the form of fact-based rebuttals and felt that it was defensive (Sundelson et al., 2023). By contrast, communications to place technical data in the frame of general values within the community (e.g., tying mineral development to renewable energy or local job creation) had a higher likelihood of lower velocity of rumor spread and increased levels of cognition. This aligns with the 4i framework with a balance in the flow of information and interaction and involvement (Rodríguez-Perez and Canel, 2023).

Academic or community-based messages with third-party validity performed much better than those that were issued by companies directly. It was tested that these frames not only contributed to the improved comprehension of the complex matters but also facilitated the feeling of shared responsibility towards them (Castro et al., 2025). Notably, emotionally neutral and empathetic text decreased polarization in opposition to messages using adversarial or dismissive language (Heluey and Domingos, 2025). On the whole, the findings indicate that successful counter-messaging does not necessarily rely on the amount of facts but on a careful way of framing the content that would appeal to the priorities of the community and trusted intermediaries.

## 5. Discussion

### 5.1. Interpretation of Results

The results indicate that there exist robust associations to the well-known frameworks of risk communication but also reveal areas that these models must modify to address the unique problems of the extractive industries. Ceric (2014) focuses on the effectiveness of the communication in a project: this is not just being transparent but building trust in the long-term process in numerous steps throughout the project. This was seen through the case mapping, which involved misinformation spreading in a time of regulatory confusion and when agencies were most unresponsive. Similarly, an A/B testing also subjected Sundelson et al.'s (2023) 4i framework to stress, which gives emphasis to information, interaction, involvement, and influence. Corrective communication worked best when it was intended as part of an interactive and value-oriented dialogue but not top-down rebuttals.

The experiences of health and infodemic management can be transferred to lessons. Indicatively, Tin and Tukia (2025) propose the role of fast rumor monitoring and prompt remedial engagement that contributed to mitigation of misinformation during pandemic conditions. The predictive analytics findings are not novel to the predictive mining results; even the initial acknowledgment of the accelerated pace of the rumor within the 72-hour time frame created a slender yet significant open door. Moreover, health crisis communication is also prone to using trusted third parties through the assistance of the community doctors or non-governmental organizations (NGOs) to deliver the messages in a credible manner (Whitehead et al., 2023). Likewise, the same happened with the critical minerals projects where the backup of technical claims was backed by universities or local organizations, which makes the multi-actor communication strategies significant.

### 5.2. Theoretical Contributions

The study contributes to the theory because it synthesizes the knowledge on science communication, misinformation, and research on risk perception in a unified framework of extractive industries. Current project communication models are inclined to consider misinformation as a secondary issue and concentrate more on formal interaction of stakeholders. Nevertheless, the findings indicate that rather than being in the periphery, misinformation is at the heart of the perception of risk among high-stakes permitting settings (Firdaus et al., 2024). Connecting the processes of misinformation and the misinformation theory of risk perception, this piece of work illustrates the conversion of latent anxieties into structured opposition due to the velocity of rumors.

The bridging fields apply to the positive conceptual background of risk communication too. Whereas in the papers about construction and infrastructure, procedural trust and transparency on a contractual basis are addressed (Ceric, 2014), health crisis communication addresses dealing with rumors, empathy, and participatory governance (Vandrevala et al., 2024). An example of how these structures must operate simultaneously on procedural integrity and emotional resonance is how they bring them together to work on mining projects. This synthesis presents an addition to this argument in Cvetkovich et al. (2025) that there should be a multilevel resilience approach by illustrating that the extractive projects must be resilient both structurally and audience-segmented in terms of communication. The study's theoretical view helps to have a more detailed view on cross-sectoral resilience to misinformation, as it allows one to formulate disagreements depending on what is learned in terms of health infodemics.

### 5.3. Practical Implications

In practical terms, these findings have implications for these next steps and what can be done by permitting agencies and mining companies to develop resiliency against misinformation: First, agencies must be capable of implementing audience-based strategies that are capable of considering the distinction between opponents, conditional supporters, and passive observers. Communicators can use analytics, including sentiment mapping, to learn about the most vulnerable groups and intervene appropriately (Sarah, 2025). It is a traditional one-size-fits-all innovation and a move towards adaptive structures to understand the heterogeneity of communities.

To the mining companies, the practical meaning of this is to concentrate on a partnership with reputable intermediaries and not on corporate communication alone. In the research by Castro et al. (2025) regarding comparative crisis communication, testing established that the third-party confirmation of messages by a university, NGO, or local association helped to improve uptake of messages. The policy implications are not less important. Regulatory agencies may be required to formalize the practice of checking against misinformation as a component of the permitting review process in the sense that rumor surveillance and rapid response mechanisms are formalized. This is unlike the prediction analytics pipelines of risk management that Azonuche and Enyejo (2025) call on being used as early warning systems to the uncontrolled growth of these rumors. By integrating analytics-driven communications into the permitting processes, the U.S. agencies can promote resilience of supply chains as well as establish trust among the communities, two pillars that should support the national critical mineral agenda.

## 6. Conclusion and Future Research

The rationale behind the study was to gain an insight into the extent to which misinformation can be instrumental in the undertaking of undermining community trust and promoting resiliency in the U.S. critical minerals projects. Misinformation was found to be not an outer edge problem but one that resided at the heart of the success of the projects and, consequently, of the carrying compound distrusts in the circumstances of regulatory uncertainties. By combining the risk communication theory and techniques based on analytics, the research provides a background to the case mapping situation, the emotion of heart, and the A/B controlled trial of message forms. The results indicate that extractive industries should be provided with social legitimacy and policy purchases through the proactive, multi-actor, and adaptive management of misinformation. The redesign of the role of risk communication as not a compliance mechanism but a resilience tool in relation to the resiliency to secure the energy transition and the resiliency of the national supply chain is one of the contributions. Corrective messages were most effective when distracted with believable intermediaries, and predictive analytics were more effective in initial tracking of rumor velocity.

The possible directions to integrate future studies could be artificial intelligence to trace the misinformation in time, IoT-based feedback loops within the communities to detect the misinformation at its initial phase, and comparative research in non-U.S. contexts to provide more insight and depth into how the communication strategies should be adjusted to be effective in other socio-political and cultural realities.

## Compliance with ethical standards

*Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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