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Reframing Government Science Communication in the Digital Era: A Multi-Model Study of BRIN (Indonesia)

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Abstract

In governmental agencies, science communication often focuses on one-way knowledge transfer, even on digital platforms designed for interaction and engagement. This study examines the strategies used by Indonesia's National Research and Innovation Agency (BRIN) across four science communication models—deficit, dialogue, participatory, and scientific agency—to identify shortcomings and opportunities for more inclusive public engagement. Using a qualitative case study approach, we analyzed digital content produced by BRIN, conducted 25 semi-structured interviews, held focus group discussions, and observed digital data. The data were thematically coded using NVivo software 12. Our findings show that BRIN mainly adopts the deficit model, using digital platforms primarily for broadcasting rather than genuine engagement. While some dialogue occurs, it often takes the form of "Controlled Dialogue"—a performative use of interactive tools limited by institutional and bureaucratic obstacles. These barriers impede genuine participation. We recommend a strategic hybrid model that aligns communication methods with specific objectives, offering actionable strategies for public research institutions in the Global South to enhance meaningful public engagement.

Keywords: science communication; deficit model; public engagement; controlled Dialogue participatory model; BRIN; Indonesia; digital platforms

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Academic Editor: Andrew Kirby

Received: 14 August 2025
Revised: 9 September 2025
Accepted: 12 September 2025
Published: 19 September 2025

Citation: Yutainten, Kuswarno, E., Wahyudin, U., & Mirawati, I. (2025). Reframing Government Science Communication in the Digital Era: A Multi-Model Study of BRIN (Indonesia). *Publications*, *13*(3), 45. https://doi.org/10.3390/publications13030045

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1. Introduction

Overview

Research agencies in the Global South are increasingly using websites and social media to share scientific knowledge and engage with the public, although their approaches vary significantly. Indonesia's National Research and Innovation Agency (BRIN) has utilized its official website and social media channels to improve outreach. Aligning with previous studies, digital science communication influences how agencies promote science awareness and foster scientific literacy. The agency's official websites and social media accounts serve as authoritative sources of scientific information, reflecting the credibility of the organization in disseminating in-depth science to both academic and non-academic audiences.

Similarly, BRIN has built a multi-platform online presence through its official website and social media accounts. Its communication strategies adapt to the characteristics of different media types and their audiences. In line with the previous study, the agency identifies existing science communication models and then tailors its communication goals (Nisbet & Scheufele, 2009). To reach a broad audience and promote digital participation, BRIN

uses its official website and various social media channels, including YouTube, Instagram, X/Twitter, and TikTok. Despite BRIN's visible presence on digital media, there is limited empirical research on how these platforms are used, audience reactions, and whether the communication model aligns with the four main models in science communication—the deficit, dialogue, participatory, and scientific agency models. Since it remains unclear how users perceive and interact with scientific content on social media, a deeper understanding of agency and user engagement with published scientific posts is necessary to determine practical communication goals between science content creators and their audiences (Coletti et al., 2022).

This study identifies two critical gaps: First, how BRIN integrates four core elements of the science communication model into its digital communication strategies. Second, the structural and cultural barriers that affect the shift from knowledge transfer to public empowerment. Using a multi-model framework in a qualitative case study design, this study provides both theoretical insights and practical recommendations for strengthening hybrid science communication strategies that are responsive and more feasible.

2. Literature Review and Theoretical Framework

2.1. Models of Science Communication in Digital Platforms

The field of digital science communication continues to develop. However, digital strategies still often follow traditional mass communication principles, especially the Bullet Theory, which sees audiences as passive consumers of media content, lacking scientific understanding and needing information from experts (Bucchi & Trench, 2021). This model tends to place the entire responsibility for understanding scientific content on the public rather than on how to communicate scientific knowledge (Nerghes et al., 2022) effectively. It has been used in developing science policies and government communication efforts to improve scientific literacy (Nerghes et al., 2022; Trench, 2008). Consequently, the deficit model is likely to remain prevalent and continue to influence science communication practices in digital settings (Lee & VanDyke, 2015; Meyer, 2016; Simis et al., 2016). While this top-down approach can increase visibility and reach, it does not foster meaningful dialogue or promote critical thinking among audiences (Metcalfe et al., 2022; Wilkinson & Weitkamp, 2013). This highlights the core idea of Bullet Theory: the belief that the information delivered to the public is received, understood, and accepted as intended. Therefore, it is crucial to move toward dialogical and participatory communication models that empower the public to participate actively in the collaborative creation of scientific knowledge (Bauer & Jensen, 2011; Bucchi & Trench, 2021). A shift from a primarily top-down approach to more interactive and inclusive methods is needed.

The dialogue model, based on the theory of two-way communication, emphasizes the importance of interactive exchanges between participants and highlights dialogic engagement to increase public trust while promoting reciprocal learning (Bauer & Jensen, 2011; Trench, 2008). This approach has shown potential for direct discourse on digital platforms (Roche et al., 2020; Shirk et al., 2012). Therefore, this model encourages scientists to engage in active listening, consider the audience's needs, foster relationships based on mutual respect, and develop trust over time (Reincke et al., 2020). However, some critics point out the practical challenges of achieving genuine dialogue. Social media interactions can be symbolic without meaningful knowledge exchange and can raise issues of communication disparities among already engaged audiences (Jaspal & Nerlich, 2020; Weingart & Joubert, 2019).

Despite meaningful dialogues, the need for public participation has become more urgent. The participatory model promotes collaborative creation of scientific knowledge (Metcalfe et al., 2022). The audience is seen as a capable partner that helps develop a

framework for sharing scientific information. Additionally, they can participate in scientific discussions, offering suggestions and critiques about the information presented (Koivumäki et al., 2020; Trench, 2008). In practice, many participatory science communication activities are started by the public who are directly involved. It encourages a sense of ownership in scientific efforts such as citizen science, deliberative forums, and community-based research (Bonney et al., 2014; Eitzel et al., 2023; Irwin, 2015; Metcalfe et al., 2022). However, critical perspectives raise questions about the actual depth of public participation, pointing out superficial involvement and power imbalances when active participants lack formal training or initiatives (Irwin, 2015; Jasanoff, 2003; Wynne, 2006). Therefore, while the participatory model promotes democratic involvement, it also faces structural barriers.

Another recent approach is the scientific agency model. The scientific agency model is more than just a knowledge transmitter; it involves reflective actors navigating complex social, political, and technological environments (Miah, 2017). However, overemphasizing individual visibility might blur the line between scientific communication and self-promotion, possibly undermining the credibility of science and highlighting the need for practical communication skills to promote science (Baram-Tsabari & Lewenstein, 2017; Bauer & Gregory, 2007). The scientific agency model aligns with modern media trends, but it also risks fragmenting professional identities if there are no supportive institutional structures. Recognizing the interactions and limitations among these models is crucial for creating science communication strategies that are not only effective but also inclusive and responsive to public needs in the digital age.

Therefore, a deeper understanding of both content creators and the audience's interpretation of science digital platforms is essential to achieve communication goals and tailor strategies (Coletti et al., 2022; Nisbet & Scheufele, 2009). BRIN uses various digital communication channels as part of its approach to present scientific knowledge to stakeholders. Although BRIN has several digital repositories, engagement with its content needs assessment. It remains unclear how users socially construct the use of scientific content on digital platforms, underscoring the need for a deeper understanding of both the agency's and users' perceptions of the published scientific content.

The model principles will guide the interpretation of science communication on BRIN's current digital platforms. This study will focus on how the science communication model on these platforms was developed and influenced.

2.2. Multi-Model Conceptual Framework for Analyzing Digital Science Communication

This study examines BRIN's digital science communication through four models: the deficit, dialogue, participatory, and scientific agency models (Coletti et al., 2022; Cagnoli, 2024; Hetland, 2014; Wagenknecht et al., 2021; Meyer, 2016; Miah, 2017; Shirk et al., 2012; Stilgoe et al., 2014; Trench, 2008). Although often seen as a step-by-step process, these models coexist and are used strategically across different digital platforms and content types.

Applying the Framework to the Case of BRIN

As shown in Table 1, this framework functions as the analytical lens for examining BRIN. We argue that a successful national research agency adjusts its strategy based on content, context, and audience. The research questions will analyze BRIN's digital initiatives through this framework to assess the following:

1. The degree to which BRIN's strategy depends on the deficit model.
2. The development of dialogue, participation, and agency, along with their various forms.
3. How Indonesia's institutional and cultural context influences this strategic approach.

Table 1. Multi-model conceptual framework to analyze digital science communication.

Dimension	Deficit Model	Dialogue Model	Participatory Model	Scientific Agency Model
Core Principle	One-way information transmission from experts to a passive public.	Two-way symmetric communication.	Collaborative co-creation.	Scientists act as strategic agents to bridge science and society.
Assumption about the Public	An entity with a knowledge deficit.	A diverse set of stakeholders with valuable perspectives and local knowledge.	The public can contribute to the scientific process (civic intelligence and experiential knowledge).	The public engages with science through trusted, relatable individuals.
Role of the Institution (BRIN)	Authoritative Knowledge Provider.	Facilitator and Listener.	Collaborator and Empowerer.	Platform and Amplifier.
Primary Goal	To inform, educate, and correct public misconceptions.	To build trust, foster dialogue, and incorporate public values into science policy.	To democratize science, empower citizens, and produce socially robust knowledge.	To increase the visibility and relevance of science, humanize researchers, and influence policy/culture.
Typical Digital Tactics	Press releases, infographics, static posts, published papers, formal reports.	Q&A sessions, live streams, moderated comments, polls, webinars with Q&As.	Citizen science apps, crowdsourcing projects, co-creation contests, collaborative document editing.	Researcher blogs, personal social media accounts, podcasts.
Suitability for Content Types	Highly suitable for uncontested facts, established knowledge, and announcements (e.g., new species discovery, job vacancies).	Essential for socially contentious or ethically sensitive issues.	Ideal for problem solving where local knowledge is crucial (e.g., indigenous knowledge).	Effective for translating complex science into actionable advice and building a narrative around science.
Measure of Success	Reach and Literacy: Number of views, downloads, shares.	Trust and Engagement: Quality of conversation, sentiment analysis, perception of openness.	Empowerment and Output: Number of participants, quality of public contributions, policy changes influenced.	Influence and Identity: Follower growth, brand recognition.

Source: compiled by researchers (2025).

The analysis will not only identify different models but also explore the constraints between them. This multi-model framework aims to provide a detailed assessment of BRIN's practices and recommend strategic improvements for its digital public engagement. It will guide the study to offer a nuanced diagnosis of BRIN's current practices and propose a strategic, rather than solely normative, pathway for enhancing its digital public engagement.

3. Materials and Methods

3.1. Informants

The key informants consisted of 25 individuals from both internal and external parties (Table 2). The internal informants included top management responsible for decision making in the communication program, public relations, and scientists. External informants comprised media partner representatives, science communication and digital communication experts, as well as BRIN's stakeholders and social media users who actively engage—such as liking, sharing, commenting, viewing, and subscribing—with the agency's websites and social media.

Table 2. List of informants.

No.	Name Initials	Gender	Status
1	Nuri	Female	BRIN Management
2	Rizal	Male	BRIN Management
3	Penna	Female	Science Communicator (Public Relations—multimedia—YouTube)
4	Erna	Female	Science Communicator (Public Relations—social media)
5	Cela	Female	Science Communicator (Public Relations—social media)
6	Wita	Female	Science Communicator (Public Relations—social media)
7	Nomo	Male	Science Communicator (Public Relations—websites)
8	Dina	Female	Science Communicator (Public Relations—BRIN TV)
9	Aya	Female	Scientist (Nature Field)
10	Hamid	Male	Scientist (Nature Field)
11	Sara	Female	Scientist (Social and Humanitarian Field)
12	Yoga	Male	Scientist (Social and Humanitarian Field)
13	Vali	Male	Science Communicator (Public Relations—social media—youth audiences)
14	Andah	Female	Science Communicator (Public Relations—social media—youth audiences)
15	Ubai	Male	Academic and User of BRIN social media and website
16	Andri	Male	Academic and User of BRIN social media and website
17	Lusa	Female	Academic, Local Government Representative, and User of BRIN social media and website
18	Tomi	Male	Local Government Representative, and User of BRIN social media and website
19	Rita	Female	Local Government Representative, and User of BRIN social media and website
20	Andrea	Female	Local Government Representative, and User of BRIN social media and website
21	Kia	Female	Media Partner Representative
22	Tania	Female	Media Partner Representative
23	Putri	Female	Media Partner Representative
24	Manda	Female	Science Communication Professional
25	Wahyu	Male	Digital Media Professional

Source: compiled by researchers (2024–2025).

The researcher used purposive sampling, selecting informants based on specific criteria to explain social phenomena (Koivumäki et al., 2020). The researcher also conducted digital observation of the agency's social media and its official website from May 2024 to April 2025.

The researchers conducted focus group discussions (FGDs) and in-depth interviews to analyze the informants' opinions on communicating science through digital platforms. The collected data was analyzed to explore and identify BRIN's science communication model in the digital age.

3.2. Design and Analysis

A qualitative case study investigated BRIN's science communication model in the digital era. It offers a detailed examination of complex phenomena within real-world settings by exploring informants' perspectives on meanings and associated issues through interviews, observations, and document analysis. The researchers monitored processes, activities, and programs over time through data collection (Tashakkori & Creswell, 2007). This approach incorporates various sources of information, including digital content and informants' viewpoints.

Data collection and analysis followed the multi-model conceptual framework from Section 2.2. This framework allowed us to code for the principles, assumptions, and institutional roles linked to each communication model used on BRIN's digital platforms, including social media (Instagram, TikTok, Facebook, X), YouTube (BRIN and BRIN TV channels), and its website. Content from these platforms was gathered over a specific period to highlight their unique features. Additionally, we conducted interviews with both internal and external stakeholders to gain insight into their perceptions of technology and digital platforms as tools for science communication. When interviews were not possible, researchers used secondary sources like reports, records, and public communications to supplement their understanding.

As shown in Table 3, the analytical process began with systematically coding the collected data through open and axial coding methods. This involved identifying emerging themes related to the model and theory of science communication. NVivo was used for data reduction, indexing, and marking coded segments. The process also involved defining alternative groupings and conducting advanced analysis to reflect the various interpretations of BRIN's digital platform models.

Table 3. Coding framework.

Code Category (Theme)	Coding Criteria	Linked Science Communication Model(s)	Example of Responses
Communicator	a. Agency and science communicators' motives to inform b. Agency and science communicators' motive to share and discuss scientists and the public as equal partners. c. Scientists as public intellectuals; blend expertise and advocacy.	All four models: a. Deficit; b. Dialogue; c. Participatory; d. The Scientific Agent.	a. "I want information about the latest research findings" b. "I want information about the public's opinion" c. "I want you to contribute to science" d. "We ask people to collaborate and share the scientific information"
Information (Messages)	a. Informative, factual, simplified for lay audiences; avoids ambiguity. b. Interactive, responsive; acknowledges uncertainty and public values. c. Co-created; integrates local/traditional knowledge with science. d. Personalized narratives; bridges science and policy/culture.	All four models: a. Deficit; b. Dialogue; c. Participatory; d. The Scientific Agent	a. "The nature research indicates a decrease in air pollution." b. "The information encourages me to live healthy" c. "We create scientific discovery based on indigenous knowledge" d. "I need to help medical teams with a poisonous snake"

Table 3. *Cont.*

Code Category (Theme)	Coding Criteria	Linked Science Communication Model(s)	Example of Responses
Communication Channels and Methods	a. One-way transmission of information: expert to non-expert. b. Live Q&As, webinars, moderated social media discussions. c. Crowdsourcing platforms, community workshops, collaborative actions. d. Blogs, podcasts, YouTube, Twitter/X (individual or institutional branding).	All four models: a. Deficit; b. Dialogue; c. Participatory; d. The Scientific Agent.	a. "The content is an infographic of the latest research" b. "We conduct the IG livestreaming" c. "Audiences join as co-creators" d. "A podcast presenting scientists"
Communicant/Users	a. Lack of knowledge, eager to learn and absorb knowledge, and passive recipients. b. Curious, involved in active dialogue and interactions; active participants; co-creators of dialogue. c. Willing to contribute and join the dissemination process, empowered contributors. d. Engaged followers may include policymakers or activists.	All four models: a. Deficit; b. Dialogue; c. Participatory; d. The Scientific Agent	a. "Users need the information" b. "Audiences engage in discussions" c. "Audiences contribute to create content" d. "Many stakeholders actively engage"
Impacts	a. Improve basic literacy but fail to build trust or address public concerns. b. Build trust, but may exclude marginalized voices. c. Enhance democratic engagement but face power asymmetries in practice. d. Increase visibility but risk politicization or credibility loss.	All four models: a. Deficit; b. Dialogue; c. Participatory; d. The Scientific Agent	a. "Audiences gain knowledge with the injected information" b. "The public understands why decision-based science is needed" c. "The local knowledge can be scientifically proven" "Science communicators play a pivotal role"

Source: compiled by researchers (2025).

Triangulation was employed to assess the validity and reliability of the findings. Multiple data sources, including content analysis, data interviews, and user interactions, are utilized to cross-verify and interpret data, reveal differences, and provide an integrated understanding of how BRIN uses digital platforms to communicate science and how socio-cultural meanings influence the platforms' mechanisms.

In conclusion, this methodology adopted a qualitative case study design incorporating science communication models and embedded theories on these models. The researchers analyzed data from multiple sources to provide a detailed and empirically grounded explanation of how BRIN has demonstrated the use of social media and website platforms to communicate science.

4. Results

4.1. The Analysis of Digital Content on Social Media and Websites

BRIN leverages social media to share accessible scientific content with the Indonesian public, emphasizing high-quality visuals and diverse topics across various channels. The content includes cinematic, animated videos and interactive elements designed to engage audiences by aligning with digital trends, resulting in reasonable engagement levels. The BRIN website functions as an official portal for news, publications, and recruitment, primarily targeting a domestic audience. However, it needs a more compelling narrative and an updated English version to expand its global reach.

To compare the development of science communication practices in any Global South countries, this study examined the Chinese Academy of Sciences (CAS) website and Instagram. CAS uses social media and its website to boost China's image in science and technology by showcasing impressive achievements with striking visuals. It promotes scientists and features a comprehensive website designed for global outreach, including sections for news, research, and a carefully curated English version. Meanwhile, the Council of Scientific and Industrial Research (CSIR) India demonstrates effective science communication through its website and Instagram by emphasizing applied research that directly impacts people's lives, such as affordable healthcare innovations and agricultural solutions. Their colorful Instagram content and informative website help bridge the gap between laboratories and everyday experiences. However, there is still potential for improvement by producing more modern visual content regularly and enhancing two-way engagement strategies (like educational reels and enriching visual and multilingual storytelling on the website) to not only share achievements but also foster community and dialogue with the public.

Three research institutions—CAS, CSIR, and BRIN—excel at science communication. CAS prioritizes nation branding and international influence, while CSIR promotes a narrative of science serving society ('Science for Society'). BRIN focuses on educational, accessible content for Indonesians, but needs to improve visual quality and foster national pride in scientific achievements. BRIN maintains high standards for digital content like photos and videos. The agency consistently reflects its institutional identity across digital platforms. Its copy style is mainly formal and informative, except on Instagram and TikTok, where it adopts a more casual, trend-aligned tone. Although the captions are quite information-rich, they should be made more concise and engaging to motivate audience interaction better.

Regarding engagement, as shown in Table 4, the engagement rates (ER) of BRIN's social media platforms range from 0.2% to 6%. The highest engagement rate is on TikTok (1% to 1.15%), followed by Instagram (1% to 1.4%). This table highlights the engagement features of these two platforms. TikTok, despite having fewer followers, has high potential for engaging young audiences. Its content is short, educational, and likely to go viral. In contrast, Instagram has a larger follower base but predominantly features educational or institutional content that generates lower engagement. Additionally, longer videos and weaker calls to action contribute to Instagram's lower engagement rates.

Table 4. BRIN's social media engagement data (July 2024–April 2025).

Platform	Average Engagement Rate (Followers April 2025)	Engagement Characteristics
Instagram	1.0–1.05%	IG comments: dominated by compliments, short questions, and friend tags. The engaging visuals gather high engagement.
Facebook	0.2–0.4%	Older audience. Very low engagement. Official news posts and job postings are the most viewed.
Twitter/X	0.1–0.3%	As a News Wire. There is almost no conversation. Used primarily to broadcast news links and announcements.
TikTok	1.0–1.15%	High potential, underutilized. High rate due to small follower base. Short, educational video content has the potential to go viral, but posting frequency is still low.
YouTube	0.12–0.1% (per video)	Large subscriber base, educative or institutional content, weak Call to Action, long video length.

Source: compiled by researchers (2025).

The researcher analyzed visitor behavior in BRIN's website engagement analysis (https://www.brin.go.id/ (accessed on: 12 November 2024). According to Google Analytics 4 (GA4), traffic sources included direct traffic, which occurs when visitors enter the URL directly into their browser. This indicates strong brand awareness and suggests that visitors arrive with a specific purpose. The analysis showed that the average session duration for content exploration was 1 min and 45 s. This relatively low figure implies that the website mainly provides informational content, and visitors leave after finding what they need (e.g., downloading a PDF of the announcement). Additionally, the most visited pages are "Recruitment," "News," and "Profile." This suggests that visitors primarily seek administrative and informational content rather than scientific material. Therefore, engaging content that encourages visitors to stay longer is still limited.

However, this platform has a passive Call to Action (CTA) that instructs users to "Read More" or "Download." There are no strong calls to action like "Leave Your Opinion" or "Take the Survey." Additionally, it lacks interactive multimedia elements (such as infographics or quizzes) that could boost engagement. Although BRIN TV streams the agency's activities live, the website does not yet include a conversation tool like live chat, discussion forums, or comment sections for news stories. This aligns with the one-way communication strategy on social media.

4.2. Dominance of the Deficit Model

This study identified five main types of content on BRIN's digital platform: recent research innovations, the agency's news and documentary programs, educational science content, recruitment and public opportunity information (like job vacancies, scholarships, and grants), and organizational branding such as PR activities. These contents include facts, established knowledge, and announcements (Content Type). The researchers observed that BRIN primarily posts updates about its latest research innovations on social media, while its website emphasizes broader institutional branding activities.

The interview reveals that BRIN science communicators are mostly scientists, public relations professionals, and curated experts from various institutions, all aiming to inform and educate the public (Communicator and Primary Goal).

> *"... academics and non-academics may collaborate to produce science content tailored to their roles and capacity as key speakers, specifically if the topic involves various stakeholders' opinions, such as government policies."* (Wahyu, December 2024)

The digital content has various scopes and is widely shared across BRIN's diverse communication channels, with some material specifically tailored for each channel's audience. On social media, Instagram posts often dominate scientific and technical information, lacking invitations to interaction. As presented in Figure 1, the infographic about the new orchid species is a classic illustration of the Deficit Model. It assumes an audience with a knowledge deficit (Assumption of public) and positions BRIN as the authoritative provider (Role of Institution), making it highly suitable for this type of uncontested factual content (Suitability). On the website, "News" and "Program" contain highly technical and formal language, intended for reading, not discussion. Visitors are not given the option to comment or respond. Hence, the communication pattern is "We (the experts) tell you (the public) what you need to know (Core principle).



Figure 1. Instagram feed about new orchid species.

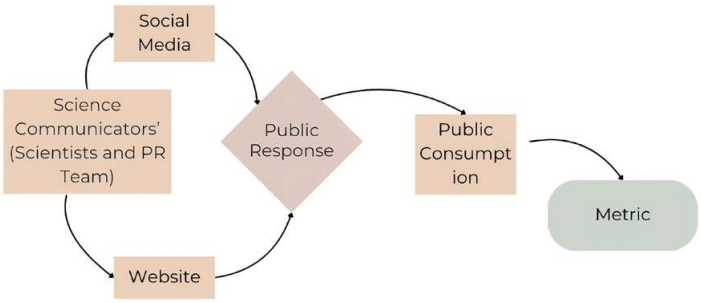
In terms of the general foundation, BRIN's YouTube has a large subscriber base (~233K subscribers) and an extensive video library (4K videos). The data highlights that digital communication channels act as a repository for scientific information in both audiovisual formats and non-academic writings that are open, transparent, and accessible (The Digital Tactic).

By understanding the types of social media interactions that require informative and critical discussions about science policies or related topics, science communicators can respond with engaging and accurate information while maintaining strict objectivity. This information aligns with the statement from Kia, a science journalist, and a BRIN digital user.

> *"I hope content on BRIN's digital platform becomes more personal. They still maintain 'scientific authority" while adding an emotional dimension, including emotions and cultural values, to boost humanistic approaches and increase public engagement."* (Kia, a science journalist and a BRIN digital user, September 2024)

As shown in the Figure 2 below, the BRIN deficit model explains how BRIN science communicators deliver information via their website and social media for public use, with evaluation based on metrics. Despite limited engagement, the findings indicate that the

content effectively conveys knowledge, facts, and institutional branding for the public, assessed through web analytics and engagement metrics data.



DEFICIT MODEL

Element	Website Implementation	Social Media Implementation
Communicators	BRIN Institution (PR Team/Scientists)	BRIN Institution (PR Team/Scientists)t
Message	Fact-heavy reports, infographics	Static posts
Channels	News section, link to BRIN's official platforms	Feed, Story, Short, Reels
Receiver	Passive audiences	Followers
Feedback	Web analytics (page views/downloads	Likes/shares (no substantive dialogue)

Figure 2. BRIN's deficit model in digital platforms based on (Simis et al., 2016). Source: compiled by researchers (2025).

4.3. The Emergence of Dialogue

Although the interactions do not create a sustainable two-way communication model because of their limited scope, features like comments, polls, or "ask a question" offer an opportunity for a two-way exchange between scientists or science communicators and the public (Digital Tactics).

The informant, Andri, a teacher and user, highlighted BRIN's effort to experiment with this model to promote public dialogue, even though it remains limited (Primary Goals).

> *"I noticed the use of a question box in Instagram Stories with the prompt, 'Do you have questions about our research? Write them here!' I also saw that the captions on their posts were open-ended questions, such as 'What innovation do you think Indonesia needs most right now?'"* (Andri, November 2024)

BRIN should improve its responsiveness on social media. Researchers observe that responses fall into three categories: administrative questions, which are answered with templated messages linking to specific resources; technical or scientific inquiries, which are rarely addressed directly to prevent misunderstandings and encourage users to seek information via other channels; and positive comments, which are acknowledged simply with a "Thank you" or emoji without further engagement. The researchers describe this response pattern as "Reactive and Avoidant." In their updates, the team acknowledged the questions and committed to consulting relevant experts, sharing responses via stories or separate threads with questioner attribution. For more urgent inquiries, they proposed continuing the discussion through Direct Message (DM) or email. Researchers called this method "Proactive and Acknowledging," suggesting that the social media team is taking a very cautious approach to communication.

Direct interactions with scientists typically occur during live forums, such as webinars on YouTube or Instagram live sessions. Scientists and public relations staff serve as facilitators and listeners (institutional role). They allow the audience to respond and promote open debates about scientific issues that relate to previous studies (Fahy & Nisbet, 2011). However, the findings showed that some irrelevant feedback often focuses on organizational reputation, government policies, or other unrelated topics. Additionally,

BRIN utilizes live-streaming platforms to address specific issues, share recent information (such as research, funding, and collaborative projects), and gather public feedback (Digital Tactics). In collaboration with various related institutions, BRIN aims to provide clear public explanations based on scientific evidence. BRIN presents dialogue in digital science communication to help institutions address public concerns, answer questions, and build public trust (a measure of success) (Nisbet & Scheufele, 2009; Brossard & Scheufele, 2013).

The informant, Tomi, a user, showed interest in joining webinars and Instagram Live sessions organized by BRIN.

> *"Attending live Q&A sessions helps me understand the importance of science and the role of government. Some hands-on activities were provided by scientists on topics such as preserving local language and managing microplastic waste. Those ideas became my inspiration to apply the knowledge in my local community."* (Informant Tomi, November 2024)

However, Nomo, an informant from BRIN who handles science public communication, discussed the depth of dialogue between scientists and the public (Measure of Success).

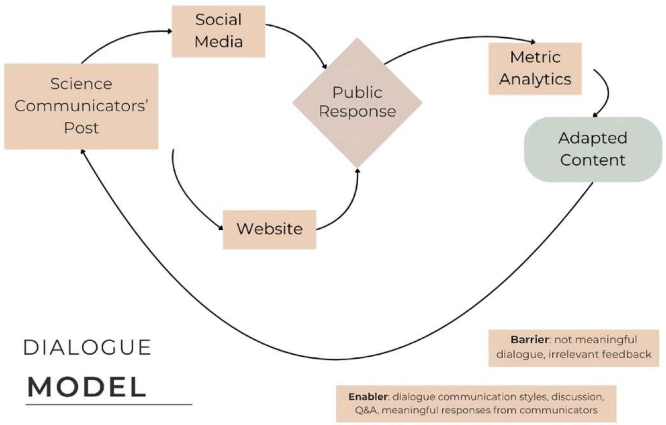
> *"Live Sessions or Instagram Live enables researchers and the public to interact directly. However, the frequency and quality of responses in these sessions still need improvement. BRIN needs to enhance the communication skills of science communicators. They must be able to listen, respond, and engage effectively with public feedback on important science topics."* (Nomo, September 2024)

This statement confirms previous studies that communication skills are necessary in a dialogue model to build trust and foster long-term engagement. Importantly, qualitative engagement should be used as an indicator to assess the quality or depth of conversation (Wynne, 2006). Users' feedback was collected from the number of likes, shares, comments, and emails on social media and the website.

This model is challenging to locate on BRIN's website. The lack of comment sections on news articles, discussion forums, or live chats with researchers suggests that the website serves more as a platform for broadcasting information rather than fostering dialogue.

According to FGD, informants suggest that using the dialogue model on social media and websites risks being superficial, creating an illusion of engagement without genuine responsiveness. In summary, BRIN has begun testing the dialogue model, particularly on social media, but its adoption has not yet become widespread. These initiatives tend to be symbolic and lack integration into a sustainable strategy. The BRIN communication team and local government representatives agree that to address this, agencies should decentralize communication authority for specific issues and redefine success metrics to focus on conversation quality rather than reach.

As shown in the below Figure 3, BRIN's dialogue model describes how BRIN science communicators deliver information through websites and social media for public consumption and evaluate it with metrics. The evaluation results then influence the next institutional posts by adapting content. The measure of success includes the quality of conversation, sentiment analysis, and perceptions of openness.



Element	Website Implementation	Social Media Implementation
Communicators	Scientists, Public Relations Professionals Institutional reps	Scientists as personal brands, PR teams, Top Management
Channels	Public Information Division	Live streams (YouTube/IG)
Message	Structured threads (topic-specific)	Real-time, open discussion,
Public Role	Registered users with moderated input	Anyone with platform access
Feedback Loop	Email updates, comment responses	Likes/shares, threaded replies

Figure 3. BRIN's dialogue model in digital platforms adapted from "dialogic loop" (Kent, 2013). Source: compiled by researchers (2025).

4.4. Participative Actions

Findings from the focus group discussion (FGD) with stakeholders highlight several important points about how digital science communication at BRIN integrates elements of a participatory model in co-creating digital scientific content. The Local Knowledge Acquisition Program (API) reflects the intentions of this participatory approach by viewing communities as partners with valuable experience and knowledge (Assumption). The API program encourages the public to collaborate with experts in developing scientific audiovisual content, working together to write scripts for visualizing knowledge and producing the content (Digital Tactics). Participants in API are regarded as equal partners when working with experts (Assumption). This process empowers the audience to become contributors in the co-creation of local scientific knowledge (Primary Goals). Overall, this initiative fosters collaboration and interactivity, actively involving the community in documenting and sharing their knowledge.

Penna, a science communicator from BRIN, emphasizes the principles of the participatory model in API, going beyond simply providing information.

> "*Several key factors contribute to this model: equal partnerships based on each group's capacity to access resources, recognition of local knowledge, and valuing the non-scientific insights and experiences shared by the public.*" (Informant Penna, September 2024)

Based on digital observations, while API videos might not reach millions of views, they receive overwhelmingly positive like-to-dislike ratios as viewers actively show appreciation. Many comments highlight national and cultural pride, nostalgia for roots, gratitude for the documentation, educational value, and enthusiasm for more content. The channel effectively reframes local knowledge, presenting it as a relevant and sophisticated body of understanding rather than archaic folklore. By integrating local knowledge with scientific research, BRIN enhances its credibility. For example, a traditional healing plant is seen not just as a "belief," but as a potential pharmacological resource.

This approach connects traditional and modern epistemology. YouTube acts as a vast digital archive, preserving knowledge that was once oral and localized, making it accessible worldwide. The channel showcases Indonesia's incredible diversity while integrating it into

a unified national story. It serves as a robust defense against cultural erosion, empowering communities to co-create content.

Nevertheless, BRIN mainly influences the narrative, framing, and community roles (institutional role). Local knowledge must be validated by experts and aligned with scientific recommendations from the institution. This reveals a strategic limitation to full empowerment, highlighting a structural barrier. While dialogue can serve as a foundation for participative actions, structural, cultural, and epistemic factors often restrict this shift, resulting in dialogue that lacks real empowerment. The study shows that 'dialogue' and 'participation' on social media are often superficial, focusing mainly on clarifying facts and co-producing scientific content rather than jointly defining problems or developing solutions. As a result, this discursive limit constrains the transformative potential of genuine participation (Entradas et al., 2020; Weingart & Joubert, 2019).

As illustrated in the below Figure 4, BRIN's participatory model demonstrates how BRIN science communicators share information through an API, co-creating scientific content. The social media team posts updates to encourage community participation and collaboration, allowing the public to influence the scientific material. This process results in the publication of digital local knowledge and the empowerment of communities.



Figure 4. BRIN's participatory model (API), adapted from "Public Participation in Scientific Research" framework (Shirk et al., 2012). Source: compiled by researchers (2025).

4.5. Importance of the Scientific Agency Model (Agency Theory)

This model enables scientists and science communicators to move beyond simply providing information. They are now active participants in dialogue and expected to create collaboration with the public through social media and websites, ss Yoga, a social scientist, argues about the roles of scientists (Core Principles).

> *"Our roles extend beyond merely conveying facts; we serve as facilitators of dialogue and engage with the public and our organizations. We act as knowledge providers and presenters."* (December 2024)

This transformation is driven by access to open science and information technology, which promotes collaboration between scientists and the public to enhance the legitimacy and social relevance of science (Herodotou et al., 2022; Miah, 2017). Ubay, a teacher and user, emphasized how the expanded roles of science communicators on digital platforms contribute to this shift (Primary Goals).

> *"I recognized how BRIN is working to spread information while also boosting users' cognitive engagement and sparking their interest in science. Interestingly, the content enables both researchers and the public to share and distribute information, making them active participants in the scientific community."* (Informant Ubay, November 2024)

Scientists acting as informants suggest that the scientific content on BRIN's digital platform can enhance their personal branding, disseminate their research innovations more broadly, and serve as educational tools for public teaching or presentations (assumption). This strategy frames scientists as autonomous agents who actively promote science within public arenas, combining their roles as experts and public intellectuals.

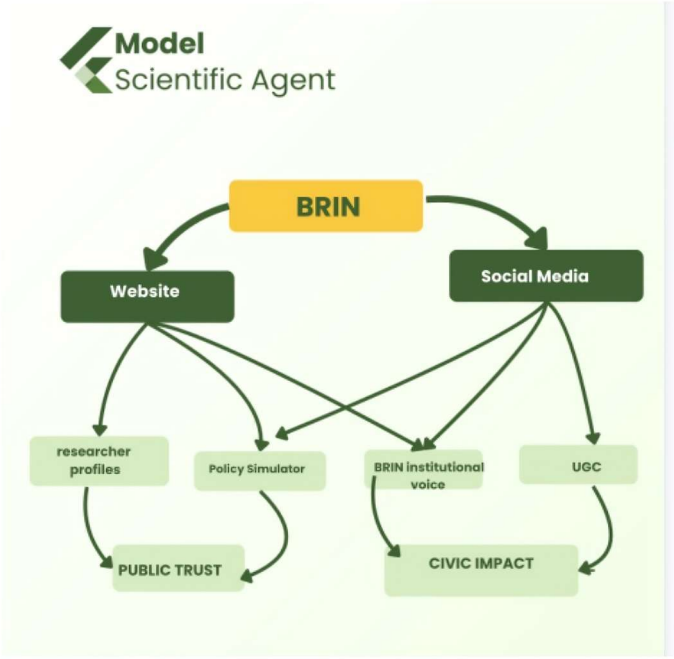
An informant and herpetologist stated that because he is actively involved in a podcast and agency promotional material, he educates the public about reptiles and collaborates with medical staff and firefighters to identify dangerous reptiles (Digital Tactics). In this approach, scientists craft personalized stories that link scientific knowledge with cultural contexts, effectively bridging research and societal concerns. Their communication platforms are carefully chosen and varied, including podcasts, YouTube, Facebook, and Instagram—using both personal and institutional branding to boost engagement with science.

Although BRIN has adopted various elements of the scientific agency model, there is considerable opportunity to improve public engagement in a systematic and sustainable way. Based on discussions with stakeholders and BRIN's communication team, BRIN could prioritize creating a more empowering system that connects researchers with potential collaborators and the public (Digital Tactics). The scientific agency model is not just about expanding participation, but about a knowledge-based redefinition that views the public as an equal partner in knowledge creation. Wahyu, an expert in digital communication, emphasized the strength of this approach.

> *"The model has potential to improve the visibility of Indonesian science and promote cross-sector dialogue; however, it also risks politicization or perceived bias, which could damage credibility if not managed carefully."* (Informant Wahyu, November 2024)

As shown in the below Figure 5, BRIN's scientific agency model describes the relationship between how BRIN science communicators deliver information on the website and social media. BRIN's website and social media accounts exhibit distinct characteristics in their application of this model. On the website, BRIN highlights institutional voices through researcher profiles in official press releases, news updates, and open data portals. The public plays a role as co-commenters on publications shared through private channels, such as email. Hence, the impact metrics are measured by download statistics and citation requests for information.

Social media accounts showcase a wide variety of communicators, such as scientists, influencers, public relations staff, and curated guest experts. These accounts can work with both individual and organizational profiles, enabling the public to participate as co-creators of content. As a result, verification from the institution acts as an authoritative mark of credibility. Impact metrics on social media are primarily gauged by engagement levels, community reactions, and mentions in policy debates by the public or other stakeholders. The success of this model is measured by the growth in the number and identity of science communicators who align with institutional branding, such as the increasing number of scientists acting as science communicators.



	Website Implementation	Social Media Implementation
Communicators (Agents)	BRIN institutional voice researcher profiles	Scientist influencers, BRIN institutional voice,curated guest experts
Message (Content)	- Press release - Reportage and Feature - Open data portals	Personal vlogs and social media account, Institutional podcasts
Public Role	Co-commenters on publications	Co-creators (UGC)
Authority Signals	Official badges, peer-review labels	Verification checkmarks, institutional hashtags (#BRINScience)
Impact Metrics	Download stats, citation requests	Shares, fan communities, policy mentions

Figure 5. BRIN's scientific agency model (API), adapted from "fourth model" (Miah, 2017). Source: compiled by researchers (2025).

5. Discussion

5.1. Controlled Dialogue Phenomenon

Our analysis shows that BRIN's digital engagement strategies exemplify "Controlled Dialogue," where tools like comment sections and live streams are used mainly for performative purposes. This creates an illusion of openness but ultimately maintains a hierarchical communication style rooted in institutional control and risk aversion. The term originates from the tension between a government research agency's conventional emphasis on control and accuracy and the participatory, transparent nature of digital platforms that encourage collaboration.

Initially, this study acknowledges that BRIN's digital science communication is not a single, simple system but a complex ecosystem where multiple models coexist, despite their significant challenges. The results show that the deficit model remains the dominant approach, creating most of the scientific content across platforms. This is confirmed by a high proportion of one-way and informational content, passive calls to action on some posts, and the primary use of analytics to measure reach rather than engagement. The deficit model aligns with BRIN's role as an authoritative source of knowledge. Additionally, this model provides efficient and controlled dissemination to a broad audience.

However, the results show that this dominance is not absolute. Elements of the dialogue model appear in features like comments and live streaming. The reliance on templated responses and the absence of comments on social media indicate that this interaction is heavily curated, serving more as a performative act than a genuine exchange of ideas. It upholds, instead of challenging, institutional control over information and public reactions. Our interviews reveal that bureaucratic rigidity, strict content vetting, and cultural concerns about institutional reputation, combined with a hierarchy that privileges expert knowledge over public input, influence this process. As a result, Controlled Dialogue differs from authentic dialogue and superficial participation (Entradas et al., 2020). It actively shapes and restricts responses to create a specific kind of interaction aimed at reducing the risks associated with open public engagement. These measures keep discussions confined within institutional boundaries.

This concept advances the theory of science communication by introducing a foundational perspective to analyze the transitional phase. It provides a deeper understanding of a hybrid engagement model, which is a common approach among risk-averse organizations globally. For practitioners, acknowledging this phenomenon emphasizes the need to step outside their comfort zones. Moving from Controlled Dialogue to authentic dialogue requires substantial institutional reforms, such as redefining success metrics, decentralizing communication authority, and training scientists in empathetic engagement and active listening, as our informants suggest.

5.2. Reframing Structural and Cultural Barriers Through Digital Science Communication Models

The identified barriers can be seen as symptoms of the tension between the institutional framework of the deficit model and the public's demand for more participatory access. This study highlights structural barriers as institutional inertia. As a research agency operating within a rigid bureaucratic system, BRIN prioritizes its reputation over authentic, unpredictable public engagement. Dialogue naturally involves a willingness to handle unexpected questions, diverse viewpoints, and even public criticism. The findings suggest that scientific discussions rarely intersect with policy issues like environmental regulations and climate change. This necessity often leads to reluctance in open dialogue, with interactions becoming controlled and top-down, appearing participatory but lacking true openness. BRIN's hierarchical structure perceives unpredictable feedback as a threat to its reputation (Weingart & Joubert, 2019); (Autzen, 2018). As a result, public relations often enforces strict content vetting and approval processes that limit the agility essential for genuine interaction on social media or interactive website features.

In many countries of the Global South, digital ecosystems and social media platforms have expanded as interactive spaces for sharing information and facilitating two-way communication. Their ability to enable real-time engagement across geographical and temporal boundaries emphasizes accessibility, effective community outreach, and high interactivity (Dwivedi et al., 2021; Gürer et al., 2023; Huber et al., 2019; Yeo, 2015).

Regarding technological boundaries and platform limitations, the informants emphasize the urgency of understanding algorithm bias and users' psychology when absorbing new information from online materials. The preference for appealing short videos as a means of transmission results in less meaningful engagement but achieves extensive reach to diverse audiences. In contrast, longer videos target a science-oriented public that requires rigorous scientific explanations. Therefore, agencies must understand how to use digital platforms for each communication channel appropriately. These platforms reflect the target audience and the potential reach of the agency's content. For example, to capture public attention within the deficit model, the agency produces short videos, reels, and static social media posts as a one-way transfer of knowledge. Conversely, to foster interactive dialogue, the agency develops open conversations through live-streamed social media. The content leverages social media features to enable two-way exchanges (Roche et al., 2020). Additionally, the agency conducts a co-creation program to offer opportunities for substantive knowledge sharing and hosts a series of podcasts to strengthen institutional branding with the agency's narrative. These strategies aim to grow the audience for science engagement.

Cultural barriers then manifest as epistemic conflicts. Although Indonesian audiences are generally familiar with participatory problem-solving approaches—especially on issues affecting local communities—BRIN's digital content often depicts them as passive receivers of information. For example, topics like disaster preparedness and agricultural development, which have important societal impacts, are usually presented as definitive conclusions instead of open, consultative processes. This approach prevents public input from influencing the results.

Moving toward a participatory or agency model entails an epistemic shift as a recognition that the public possesses valuable knowledge and that science communication becomes a process of co-creation instead of a one-way dissemination. There is concern that public involvement might affect the quality of scientific data, reflecting cultural tensions between "scientific expert knowledge" and "local lay knowledge." Indonesian cultural norms such as "gotong royong" (cooperation) and "musyawarah" (deliberative consensus-building) offer a strong basis for this transition. These values encourage collective decision making, shared responsibility, and the mutual exchange of knowledge.

However, BRIN must actively leverage this cultural strength instead of relying solely on top-down scientific authority. For instance, involving the public as collaborators in creating science content depends on discussions and validation by experts like scientists and academics. This shows the agency's effort to utilize local knowledge by bridging cultural gaps and maintaining data quality. While this program can raise awareness and foster a sense of belonging, it also has limitations. Although community voices are heard, the overall narrative is still directed by a government agency. The agenda—what is documented and how—is determined by BRIN, not by the communities themselves. These risks portray knowledge about communities rather than from or for them. Research suggests that audiences are more likely to accept and act on scientific information when they feel that their perspectives and knowledge are appreciated (Holliman, n.d.; Wynne, 2006).

In comparison, cultural barriers to dialogue and participatory science communication in Global South countries stem from language differences, cultural norms, and power imbalances (Wagenknecht et al., 2021; Nerghes et al., 2022; Roche et al., 2020). Tackling these issues requires inclusive approaches that honor local cultures and foster authentic two-way communication, thereby empowering individuals with scientific knowledge (Wagenknecht et al., 2021; Nerghes et al., 2022; Roche et al., 2020). In Indonesia, where societal norms emphasize inclusion and consensus, science tends to be viewed as an elite domain, and respect for scientific authorities discourages public questioning of institutions or scholars. Consequently, this study argues that overcoming these barriers necessitates a strategic shift within institutions from mere dissemination to empowerment-focused approaches.

5.3. Towards a Strategic Hybrid Model

To overcome barriers, a deliberate and strategic hybrid communication model should be implemented. Different communication approaches are customized for multiple purposes and audiences, rather than defaulting to the deficit model out of habit. BRIN uses digital communication channels and offers four models of science communication, each with unique capabilities. This hybrid framework would strengthen BRIN's communication strategy.

The findings indicate that a hybrid approach, combining the strengths of efficiency, inclusivity, collaboration, and advocacy, could be a practical way forward. This framework suggests (1) using the identified deficits strategically to raise public awareness through effective information delivery and factual knowledge sharing. (2) To foster trust, a move beyond superficial dialogue is necessary; BRIN should invest in communication training for its science communicators, focusing on active listening and empathetic engagement alongside technical skills. (3) Skilled communicators and a democratic communication environment will increase public participation in shaping scientific content. This model aims to empower communities by redefining the relationship between the institution and the public, turning audiences into active collaborators. (4) The hybrid model will strengthen science advocacy, bridging research and societal application. BRIN should adopt a more structured communication strategy among science communicators and incorporate bottom-up public input on science-related issues.

Our hybrid model (Figure 6) provides a strategic framework to move beyond Controlled Dialogue. It encourages the deliberate use of different communication models, with the deficit model being suitable for factual announcements. When trust and social license are needed, institutions should dedicate resources and relinquish some control to foster authentic dialogue and engagement.

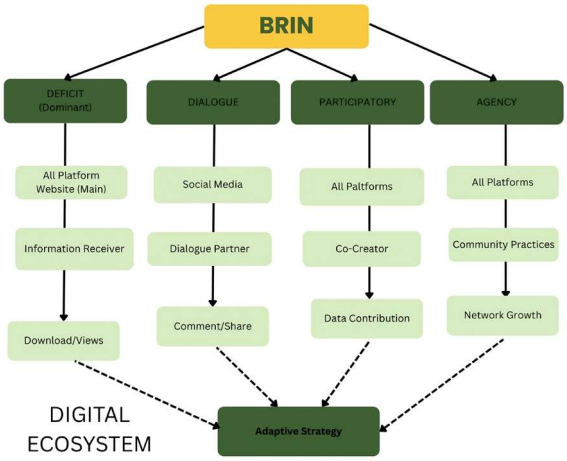


Figure 6. BRIN's hybrid framework adapted by science communication model that continumm with findings (Bucchi & Trench, 2021). Source: compiled by Researchers.

6. Conclusions

This study explores how BRIN engages in digital science communication. Using a multi-model framework, the researchers found that BRIN mainly relies on the deficit model, emphasizing one-way information sharing via digital platforms, as shown by their content focus and passive engagement methods. While BRIN shows some initial efforts toward dialogue and interactive engagement through initiatives like live Q&As and the Local Knowledge Acquisition Program (API), these are often seen as "Controlled Dialogue." This means that although interactive tools are employed, they are still limited by bureaucratic norms and a tendency toward risk aversion.

The findings highlight two main points: First, the term "Controlled Dialogue" is used to describe a hybrid communication state often seen in bureaucratic institutions. Second, successful public engagement for BRIN and similar research agencies depend on a strategic approach that aligns communication methods with their objectives. BRIN can also learn from science communication practices in other countries to improve their strategy engagement. Although this qualitative case study offers valuable insights, its focus on a single institution limits its generalizability. Future research should investigate these dynamics across various contexts and employ longitudinal methods to evaluate how engagement strategies evolve.

In conclusion, transitioning from merely sharing scientific information to actively fostering engagement is a complex process that presents both strategic and cultural challenges. BRIN has the opportunity to evolve from being the sole authority to becoming a collaborative partner in Indonesia's scientific and social progress by leveraging digital communication to inform and connect with the public more effectively.

Author Contributions: Conceptualization, Y., E.K., U.W. and I.M.; methodology, Y., E.K., U.W. and I.M.; software, Y.; validation, Y., E.K., U.W. and I.M.; formal analysis, Y.; investigation, Y.; resources, Y.; data curation, Y.; writing—original draft preparation, Y.; writing—review and editing, Y., E.K., U.W. and I.M.; visualization, Y.; supervision, E.K., U.W. and I.M.; project administration, Y.; funding acquisition, Y. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

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