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Communicating Science: Insights from Indonesian Higher Education Institutions

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ABSTRACT

This study investigates science communication processes at Universitas Indonesia (UI), Universitas Gadjah Mada (UGM), and Institut Teknologi Bandung (ITB) using a qualitative multiple case study design. Data were collected through in-depth interviews and document analysis, involving 15 key informants. Analysis employed an explanation-building approach in three stages—data collection, case profiling, and conclusion formulation—supported by triangulation through data cross-checking, member checks, and expert consultations to enhance reliability. Findings show that science communication in these universities forms an ecosystem that integrates communicators, messages, media, receivers, and feedback. Institutional actors act as strategic intermediaries, translating scientific knowledge into accessible, actionable forms. Messages align with national and global priorities and are tailored to audience needs. Communication channels combine formal academic outlets with digital media, public events, and community engagement, ensuring broad reach. Receivers—ranging from policymakers and industry to grassroots communities—participate actively, fostering two-way knowledge exchange and collaborative problem-solving. Feedback loops from internal teams and external stakeholders refine both research and its dissemination. Overall, the study highlights a holistic and impact-oriented framework for science communication in Indonesian higher education, bridging academia, industry, policymakers, and the public. This model strengthens national science communication capacity and offers a replicable strategy for linking research with societal needs.

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1. INTRODUCTION

Science communication plays a crucial role in bridging the gap between scientific knowledge and the public, ensuring that research and innovation contribute meaningfully to societal development. In recent years, the importance of effective science communication has become increasingly recognized across the globe, particularly within the context of academic institutions. As hubs of research and innovation, universities play an essential role in disseminating scientific knowledge to both academic and non-academic audiences, which include policymakers, industry professionals, and the general public.

This communication is vital for ensuring that research findings have a tangible impact and are understood and utilized in ways that address societal challenges. In Indonesia, universities such as Universitas Indonesia (UI), Universitas Gadjah Mada (UGM), and Institut Teknologi Bandung (ITB) are central to the nation's academic and research landscape. Supporting studies demonstrate that academic institutions are critical for influencing public understanding and policy decisions through effective science communication [1]. These academic institutions not only generate cutting-edge research but also actively engage in communicating their scientific findings.

However, while these universities have made strides in enhancing their communication efforts, the process of science communication within these institutions remains relatively underexplored. There is limited research focusing on the strategies employed by these universities, the roles of the individuals or groups involved in science communication, and the kinds of messages that are being conveyed. This study aims to fill this gap by investigating how science communication is carried out at Indonesian universities, specifically focusing on UI, UGM, and ITB.

Through a case study approach, the research seeks to identify the key communicators, the types of messages that are being communicated, the media used to convey the messages, the communicants, and the feedbacks. Understanding the dynamics of science communication in these universities provide valuable insights into the effectiveness of current communication strategies and offer recommendations for improving the dissemination of scientific knowledge in Indonesia.

By focusing on these leading Indonesian universities, the study contribute to a deeper understanding of how science is communicated in an emerging scientific community. The findings have broader implications for enhancing the effectiveness of science communication strategies, not only in Indonesia but also in other developing countries with similar academic and communication challenges.

2. LITERATURE REVIEW

Communication is the process of delivering information between individuals using language, symbols, or behaviors and actions directed from one individual to another [2]. Communication is the process of conveying a message from one person to another to inform or change attitudes, opinions, and behaviors, either directly (face-to-face communication) or indirectly (communication through media)[3]. Communication is the process of conveying information, ideas, emotions, expertise, and others [4]. In general, communication is defined as the activity of exchanging opinions or the relationship between humans, whether individually or in groups [5]

Science communication is defined as the use of appropriate skills, media, activities, and dialogues to communicate scientific research to the public, aiming to generate awareness, interest, opinions, and/or understanding of science [6]. Science communication activities conducted in research institutions' communication and PR departments include issuing press releases, writing news articles and features on their websites, posting videos, blogs, presentations, or podcasts, and organizing museum exhibitions.

The 2000 report from the Office of Science and Technology and the Wellcome Trust, Science and the Public: A Review of Science Communication and Public Attitudes Toward Science in the UK, states that science communication involves communication between: groups within the scientific community, including those in academia and industry, the scientific community and the media, the scientific community and the public, the scientific community and government or other authority figures, the scientific community and policy influencers, industry and the public, media (including museums and science centers) and the public, and government and the public.

Science communication must perform four interconnected tasks: identifying the most relevant science for decisions faced by people, determining what people already know, designing communication to bridge the gap between what people know and what they need to know, and evaluating the sufficiency of that communication [7]. The success of science communication is influenced by multi-disciplinary experts. Communication practitioners play a crucial role in building communication channels between researchers, who are the source of scientific content, and the public [8].

Communication practitioners are responsible for translating research findings, connecting scientists with audiences, and creating opportunities for public engagement. Science communication requires the role of PR in promotional activities and persuasive communication to create engaging content [9]. Science communication focuses on the credibility of the information conveyed to the public. Credibility refers to the assessment made by the message receiver regarding their trust in the communicator [10]. Academic scientists and science journalists are considered highly credible in delivering scientific content [11]. Government PR needs to collaborate to enhance the public's understanding of science.

Lasswell [12] proposes a crucial concept for understanding effective communication by asking the fundamental question: "Who Says What in Which Channel To Whom With What Effect?" This paradigm provides a solid foundation for viewing communication as a process involving five key interacting elements. These elements are as follows:

a. Sender or Communicator

The sender, also referred to as the source or communicator, is the entity that initiates the communication process. Other terms used to describe the sender include sender, speaker, encoder, or originator. The sender is an individual, group, organization, or even a country with the need or desire to transmit information to others. The sender is responsible for creating and transmitting the message, both verbally and non-verbally. In a broader context, the sender may be an individual conveying news to the public via media, or a company communicating its products and services to consumers. The sender plays a crucial role in determining the direction and objectives of the communication.

b. Message

The message is the core of the communication process, consisting of the information conveyed by the sender to the receiver. The message may consist of a set of symbols, both verbal and non-verbal, representing ideas, values, emotions, or intentions that the sender wishes to communicate. In verbal communication, the message is conveyed through words, while in non-verbal communication, it may be conveyed through body language, facial expressions, or other visual symbols. Therefore, the message is a powerful element in transmitting meaning from the sender to the receiver. It is important to note that the message must be understood consistently by the receiver for the communication to be effective.

c. Channel

The channel refers to the medium or platform used by the sender to convey the message to the receiver. This includes various forms of communication, from face-to-face interactions to modern technologies such as telephone, email, social media, or television. The communication channel determines how the message is delivered and how the receiver can access the information. Additionally, the channel refers to the format of the message itself, whether delivered through spoken or written language, images, or sound. The choice of the appropriate channel significantly impacts the effectiveness of communication. A suitable channel can facilitate understanding, while an inappropriate one may lead to misunderstanding or ambiguity.

d. Receiver or Communicant

The receiver, or the communicant in communication theory, is the individual or group who receives and interprets the message from the sender. The receiver acts as the decoder, processing the received message for understanding. The receiver may be anyone in a position to hear, see, or receive the message, either directly or indirectly. Other terms used for the receiver include audience, listener, communicant, or interpreter, depending on the context. The receiver's role is crucial, as the success of communication depends on their ability to understand the message. Feedback from the receiver, which can manifest as changes in thought, attitude, or action, serves as a key indicator of whether the communication has been successful.

e. Effect or Feedback

Effect or feedback is the final element in the communication process, indicating the impact of the message on the receiver. This effect may be immediate or long-term and includes changes in understanding, attitude, behavior, or actions of the receiver after receiving the message. Feedback is vital in communication because it provides insight into whether the message has achieved its intended purpose. In interpersonal communication, feedback can be a direct verbal or non-verbal reaction from the receiver, while in mass communication, the effect may be broader and less direct. This effect can also lead to larger social or cultural changes, especially in communication involving a larger audience.

Based on Lasswell's paradigm, communication can be understood as a dynamic process involving five key elements: the sender, the message, the channel, the receiver, and the effect. This process is continuous, with each element depending on the others. By understanding these components more deeply, we can more effectively design, deliver, and manage communication in individual, organizational, and societal contexts. It is important to note that communication is not just about transmitting messages but also about how those messages are received, understood, and impact the receiver.

3. METHODS

This study utilized a qualitative approach to investigate the science communication process in the Indonesian Higher Education institutions. This approach was selected since it facilitated deep exploration of complex phenomena related to science communication process [13].Additionally, a multiple case study was selected to investigate science communication process within the three higher education institutions namely UI, UGM and ITB. The data collection techniques in this study included in-depth interviews and documentation. The study involved 15 key informants consisting of lecturers, heads of division/subdivision, and administration staffs at the Directorate of Research, Science Technopark and relevant directorates at UI, UGM and ITB.

Data analysis in this study utilized an explanation-building approach. This approach enabled the researcher to construct a coherent narrative from field data, establish relevant connections, and explore science communication within the context of research commercialization. The analysis was conducted in three main

stages: data collection, case profile development, and conclusion formulation.The study also employed various triangulation methods, such as cross-checking data from interviews and documents, performing member checks, and frequently consulting with academic supervisors and informants. These measures contributed to improving the study's reliability and confirmability [14].

4. RESULTS AND DISCUSSIONS

4.1 Science Communication Process at UI

The science communication process at the University of Indonesia (UI) involves the exchange of information between researchers, the Directorate of Research and Development, the Science and Technology Park (STP), the public, government, industry, and other relevant stakeholders. This science communication process at UI can be further elaborated through the key elements of communication, which include the communicator, message, media, receiver, and feedback.

4.1.1 Communicator

4.1.2 Lecturers

Researchers or lecturers play a central role as the primary communicators in science communication. Their responsibility is significant, as they are not only tasked with generating scientific knowledge through research but also with disseminating this knowledge to various audiences through a range of scientific communication channels. In this context, researchers function as the producers of research findings, which are then communicated to the public.An example of science communication by researchers/lecturers as communicators is through the publication of research results in reputable international journals. In this case, UI lecturers collaborate with partners from other universities to jointly communicate research findings in international journals, as explained in the following interview data:

> *"I keep communicating with my partner. Coincidentally, the partner is in Delft, the Netherlands. So, I continuously communicate with the partner. UI has a team, and they also have a team. I communicate together to ensure that this research can be published quickly in a Scopus-indexed journal." (Interview with RAM, November 28, 2024)*

This interview data indicates that science communication at the University of Indonesia is not only carried out by individual UI researchers independently but is done collaboratively between researchers and their partners. In this case, science communication becomes a joint effort between the research teams from UI and international partners to disseminate research results through scientific publications, particularly in reputable international journals indexed by Scopus.

Additionally, as communicators in the context of science communication through policy briefs, researchers contribute by recommending policy actions based on their research findings. They are not only generating knowledge for academic purposes but also playing a role in providing practical, evidence-based input for decision-making, at local, national, and international levels. In this process, researchers, as communicators, disseminate their findings to IKN (Indonesian Capital City Authority) partners through policy brief dissemination seminars, as shown in the following documentation:

Figure 1. Policy Brief Dissemination
Source: https://kaltim.idntimes.com/news/kaltim/erik-alfian-1/universitas-indonesia-serahkan-30-rekomendasi-kebijakan-untuk-oikn

4.1.3 Directorate of Research and Development

The Directorate of Research and Development (DRP) at the University of Indonesia (UI) plays an important role in science communication, such as in the process of preparing and distributing research-based policy briefs. As the primary facilitator in the communication between the academic world and the policy-making world, DRP UI ensures that the research findings conducted by UI researchers are accessible and useful to relevant parties, such as the government. In this context, DRP UI serves as a link connecting research findings to policymakers and ensuring that the research can have a real impact on the evidence-based decision-making process. As one informant explained during the interview:

> *"During the G20, we worked with the government and G20 researchers. Now we are working with IKN. Recently, there were 30 policy briefs related to IKN, which will be disseminated in November 2024 at IKN. Each researcher has their tandem. But, of course, their tandem is related to ministries or government agencies related to IKN."(Interview with AD, October 21, 2024)*

This statement illustrates how DRP UI acts as the main link between researchers and relevant government partners, ensuring that research findings are conveyed to the right parties. Additionally, DRP UI also plays a crucial role in disseminating research findings to relevant parties, such as ministries or government agencies. They not only ensure that research results are compiled in an appropriate format, such as policy briefs, but also ensure that the research is presented in a manner that is easily understood and accessible to policymakers. In the interview, it was explained:

> *"Each researcher has their partner, but of course, their partner is related to ministries or government bodies involved in IKN."(Interview with AD, October 21, 2024)*

This demonstrates how DRP UI connects researchers with relevant government agencies to ensure proper dissemination, particularly for policies related to IKN. DRP UI also plays a critical role in aligning research findings with government policies. In this case, DRP UI ensures that each research project conducted by UI researchers can directly contribute to government policy. One crucial aspect of DRP UI's role is ensuring that the involved government partners share a collective responsibility in delving into the research findings and integrating them into the policies being formulated.

4.1.4 Directorate of Science Technopark (STP) UI

In the context of science communication, the Directorate of Science Technopark (STP) at Universitas Indonesia (UI) acts as a key communicator, bridging the gap between research outcomes at UI and the industrial sector. STP UI ensures that academic research is effectively communicated to industry partners, acting as a mediator between researchers and industry, and facilitating mutual understanding of the research's potential applications and economic benefits. As one informant explained:

> *"When the research product has reached the prototype stage at UI, around TRL 6 or 7, we meet with industry partners, conduct business matching, and establish a non-disclosure agreement." (Interview with TIS, October 8, 2024)*

In this role, STP UI helps explain the maturity of research products and how they can evolve for industrial applications.

4.1.5 Partners

International collaborators play a strategic role as science communicators, particularly in the publication of research in reputable journals. For example, a UI faculty member collaborated with a partner from Delft, the Netherlands, to expedite the publication process. The faculty member shared:

> *"I continuously communicate with my partner in Delft. UI has a team, and they have their own. I work together with them to ensure the research findings are published quickly in Scopus journals." (Interview with RAM, November 28, 2024)*

This highlights the importance of intensive communication between the two teams, focusing not only on research but also on strategic decisions regarding article content, writing roles, and journal selection. The National Policy Authority (IKN) serves as a crucial science communicator in policy brief dissemination. Through seminars, IKN ensures research findings reach policymakers and the public. IKN's role is not just to inform but also to contextualize research in broader policy frameworks, ensuring the findings contribute to informed public policies. Moreover, Industry partners also play a significant role in communicating research findings to the public. As explained in an interview:

> *"When our focus is on industry, it then reaches the public. Engineering drives industry, and industry ultimately drives the economy and society." (Interview with SS, December 10, 2024)*

Industry not only translates technical innovations but also educates the public on the benefits of new technologies, thus serving as a vital bridge between scientific research and society. Through effective

communication, industry can foster public trust and accelerate the adoption of innovations that improve quality of life.

4.1.6 Messages

In science communication, the message conveyed by Universitas Indonesia (UI) represents research findings relevant to the university's research focus, as outlined in the Rector's Decree No. 1738 of 2020. These research focuses include five main themes: health and well-being, energy and material resources, innovative and connected societies, earth, climate, and the environment, and security and resilience (https://sci.ui.ac.id/wp-content/uploads/2024/08/SK-1738-tentang-Penetapan-Fokus-Riset-dan-Inovasi-UI-Tahun-2020-sampai-dengan-2024-2.pdf).

Additionally, research outcomes align with the achievement of the Sustainable Development Goals (SDGs), which aim to enhance quality of life and preserve the planet (https://research.ui.ac.id/research/wp-content/uploads/2025/02/Panduan-Hibah-Riset-UI-2025.pdf). Therefore, the messages in science communication include scientific findings that support broader global goals, such as poverty alleviation, health improvement, and environmental protection. These messages function not only as technical information but also as tools to build deeper understanding of the challenges and solutions faced by global society in achieving sustainability.

Meanwhile, the messages communicated in UI policy briefs include policy recommendations based on academic research. Key issues addressed in these policy briefs include strengthening the global health architecture, digital transformation, and sustainable energy transition for the G20 policy brief (https://research.ui.ac.id/RI/wp-content/uploads/2023/02/Materi_Kumpulan-Policy-Brief-Universitas-Indonesia untuk-Presidensi-G20-Indonesia-2022-.pdf). In the context of IKN development, key messages cover aspects such as Energy, Food, and Transportation, Social Humanities, Well-Being & Environmental Conservation, and Technology & Informatics (https://research.ui.ac.id/research/wp-content/uploads/2024/11/Kumpulan-Policy-Brief-Universitas-Indonesia-untuk-Ibu-Kota-Nusantara.pdf).

Messages in science communication via journal publications and UI policy briefs funded by the Community Fund (DAMAS) are generally determined by UI's internal parties. However, messages from partner organizations, such as research funded by Bank Indonesia (BI), focus on topics determined by BI, such as the impact of geopolitics on global trade and investment flows and its implications for Indonesia's economy, optimizing national food security considering logistics and trade flows, and more (https://www.spektro-bi.org/pages/rgbi).

Research topics in collaborations like the Indonesia Research Collaboration Program (RKI) are defined by a consortium of PTNBH universities such as Institut Teknologi Bandung, Universitas Gadjah Mada, Universitas Airlangga, and Bogor Agricultural Institute (https://research.ui.ac.id/research/wp-content/uploads/2025/02/Panduan-RKI-2025.pdf). Added to this, UI tailored their messages based on the stakeholders' needs (e.g. the industry or society needs) through feedback mechanism given by the stakeholders which serve as input for determining the research ideas, transformed into messages in the disemination process.

4.1.7 Media

Based on the interview data and documentation, UI utilizes a wide range of science communication media and activities covering both formal and non-formal publications. Scientific dissemination is carried out through journals, books, and policy briefs containing strategic research outcomes. The institutional website serves as an official information hub. UI also reaches wider audiences by leveraging mass media such as *Koran Kompas* and creative digital platforms, including the *FIB UI Podcast*, the *LPEM FEB UI* YouTube channel, Instagram (@risetinovasi_ui), and TikTok (*LPEM FEB UI*). Public discussion forums initiated by faculties such as FISIP and LPEM FEB UI foster direct interaction with the public. Large-scale events like the *UI Innovation Festival* (UIIF) showcase research and innovation. In addition, community service activities act as a direct channel for applying knowledge in real-world contexts.

4.1.8 Communicants/Receivers

In the science communication process, the receiver of the message can vary, ranging from the general public, industry partners, to government entities, each with distinct needs and methods for accessing and interpreting scientific information.

4.1.8.1 Academic and Non-Academic Communities

At the higher education level, publishing in international journals serves as a key method for conveying research findings to the global scientific community. This community includes not only academics and professionals but also individuals from diverse backgrounds with an interest in or connection to specific scientific issues. As the receiver of the message, the public plays a significant role in science communication, as they are

the ultimate target of scientific knowledge dissemination, aiming to create real-world impacts on social, economic, and environmental issues.

"Publishing in journals is a means of communicating research findings to the broader public." (Interview with AD, October 21, 2024)

This statement emphasizes that publishing in international scientific journals acts as a strategic channel to connect the research with the broader public, reinforcing public understanding of scientific issues and encouraging active participation in building a knowledge-based society. At events like the UI Innovation Festival (UUIF) and university-organized scientific conferences, the recipients of the scientific message are diverse, ranging from practitioners to the general public. Through these events, participants gain direct insights into the functions, benefits, and potential implementations of the innovations presented.

4.1.8.2 Industry Partners

In science communication, industry partners serve as communicants who receive scientific messages delivered by researchers and the Science and Technology Park (STP) team at Universitas Indonesia (UI). As communicants, industries are expected to adopt, develop, and apply research outcomes to create innovations that benefit the industrial sector and the broader economy.

One of the primary channels used to communicate scientific messages to industry partners is forums such as the UI Innovation Festival (UIIF). This annual event serves as a platform where UI researchers, along with the STP team, communicate their latest research outcomes to industry partners. It provides an opportunity for industry participants to directly receive and understand innovations and research products developed within academia, as described in the following interview:

"*Every year, we hold the UI Innovation Festival (UIIF), usually in the city center of Jakarta for ease of transportation and industry partner attendance. We invite industry partners and regulators to the event, which includes product exhibitions, seminars, workshops, and business matching." (Interview with TIS, October 8, 2024)*

UIIF positions the industry as a communicant receiving scientific messages through various interactive formats, such as exhibitions, seminars, workshops, and business matching. Here, the industry not only accesses scientific information but also engages in processes that allow them to explore the commercialization potential of the research and innovations applicable to their sector.

4.1.8.3 Government

In science communication, the government is a key actor as a communicant or receiver of scientific messages, particularly when research outcomes are aimed at influencing or supporting the formulation and evaluation of public policies. Governments—both at the central and regional levels—receive scientific information through various channels, one of which is the policy brief, prepared by research institutions or academics, simplifying research findings for policymaking purposes. The government plays a strategic role in responding to scientific messages, as the policies they adopt can have widespread implications for society. In this context, science communication is not only informative but also argumentative and persuasive, aiming to ensure that the information presented serves as a basis for decision-making, as emphasized by one informant:

"For example, if a policy brief is related to a law, it can become a consideration for amending the law. Many stakeholders, including local governments, central government, and ministries, are involved." (Interview with AD, October 21, 2024)

This interview data shows that the government is a primary audience for science communication aimed at influencing policy or regulations. Research results presented in policy briefs have the potential to be used as a basis for revising or formulating policies, including laws. This illustrates the advocacy function of science communication—not just conveying information, but also driving social change through policy intervention. Another example is the National Capital Authority (IKN), which plays a role as a communicant in science communication related to public policy based on scientific research. The following interview data concretely illustrates the role of government institutions as communicants in science communication:

"*IKN had 30 policy briefs related to IKN that will be disseminated in November 2024. Each researcher has a partner related to ministries or agencies involved in IKN." (Interview with AD, October 21, 2024)*

This quote indicates that in the science communication process through policy briefs, government agencies directly involved in the development of the National Capital Authority (IKN) agenda are the main target. The policy briefs produced by researchers are not standalone; they are strategically designed and communicated in collaboration with relevant government ministries or agencies. This demonstrates the two-way relationship in science communication—not just a one-way message from researchers to the government, but a collaborative dialogue based on policy needs. As communicants, government agencies require scientific information that is

concise, targeted, and applicable. Policy briefs serve as a form of scientific message designed to meet these needs—simplifying complex research into policy recommendations that can be considered and adopted by government bodies.

4.1.8.4 Feedback

Feedback in science communication at the University of Indonesia (UI) occurs in multiple forms. Within the context of *policy briefs*, policymakers, other academics, and researchers provide responses to the recommendations presented, either through policy evaluation or direct discussions with researchers.

> *"We usually present it to our partners, then to the IKN authority, in a ceremonial event. We hand over the book containing the results of 30 studies to the IKN authority." (Interview with AD, October 21, 2024)*

Beyond policy briefs, feedback is also collected from end-users of research-based innovations through the UI Science Technopark (STP) Directorate. This process adopts a two-way communication model in which the university—via STP—actively interacts with industry partners to assess the utilization of research products.

> *"Then they can produce and use it, and once a year we conduct monitoring to see the extent of its use, and we issue an invoice for the agreed royalty payment." (Interview with TIS, October 8, 2024)*

This process is not limited to administrative assessment but also serves as a channel for collecting valuable user feedback that reflects the product's effectiveness and acceptance in real-world contexts. As the public does not directly interact with the university, the industry plays a central role as an intermediary, facilitating communication between end-users and researchers:

> "*Feedback from end-users usually comes through the industry. We also request feedback because every year we conduct monitoring and evaluation. But we always ask the industry to open a link or provide an avenue for the public to give feedback." (Interview with TIS, October 8, 2024)*

In addition to industry-mediated feedback, scientific seminars serve as another important platform for two-way interaction. These events are not only channels for disseminating research findings but also spaces for receiving feedback from participants representing diverse academic and professional backgrounds. Such forums enable direct researcher–audience engagement, allowing researchers to evaluate how well their findings are understood, appreciated, or critiqued by the scientific community:

> *"Outputs from the Directorate of Research and Development are in the form of publications. In DSTP, there are products. We don't have products, so it's more about disseminating research results through publications, journals, seminars, discussions, and so forth. Research results are communicated to the public through journal publications or scientific writings such as policy briefs."*
>
> *(Interview with AD, October 21, 2024)*

This statement illustrates that seminars function not only as channels for delivering research results but also as dialogue spaces encouraging researchers to receive feedback—ranging from methodological clarifications to critiques of findings and suggestions for further development.

4.2 Science Communication Process at UGM

The science communication process at Universitas Gadjah Mada (UGM) involves key elements such as the communicator/sender, message, media, communicants/receiver, feedback. Each element is detailed below:

4.2.1 Communicators/senders

4.2.1.1 Lecturers

Lecturers at UGM are integral to the science communication process, particularly in conveying research findings to relevant stakeholders, including industry partners. As one informant explained:

> *"Typically, we involve the researchers early on because they provide an overview of their research. Due to our limited knowledge about the specific research or innovations they develop, we engage them at the beginning." (Interview with AS, November 23, 2024)*

Researchers play a key role in delivering technical explanations, as the Directorate for Business Development lacks specialized knowledge in certain research areas. Thus, the Directorate relies on researchers to convey technical details to ensure the findings are well understood by industry partners.

4.2.1.2 Research Directorate, Faculties, Schools, Study Centers, Laboratories

The Research Directorate and the Directorate for Business Development at UGM collaborate to support the science communication process. While each Directorate has distinct focuses, they share the goal of ensuring that research produces meaningful impacts in academia, industry, and society. As one informant noted:

"*The Research Directorate collaborates with faculties, schools, and laboratories. Once we meet with partners and the research product is ready, we bring it to our Directorate. Our role is to identify industry needs and align them with what UGM can offer." (Interview with AS, November 23, 2024)*

The Research Directorate facilitates early-stage dissemination of research findings through academic publications, seminars, and forums, while fostering collaboration among researchers across disciplines.

4.2.1.3 Directorate for Business Development

The Directorate for Business Development plays a crucial role in science communication during the commercialization phase of research. The Directorate manages research outcomes where the technology or innovation is ready for industry application. As one informant explained:

"*Our role differs from the Research Directorate. We focus on TRL 6 to 9, where research is ready for market application. We step in when the product is at that stage." (Interview with AS, November 23, 2024)*

The Directorate facilitates business matching, aligning university innovations with industry needs. This process ensures that research outcomes are effectively communicated to industry partners, advancing commercialization. The Directorate uses three approaches namely academic-driven, industry-driven, and community-driven. As described by one informant:

"*Our three basic approaches are academic-driven, industry-driven, and community-driven." (Interview with AS, November 23, 2024)*

The academic-driven approach focuses on research development based on academic needs, ensuring innovation contributes to global scientific advancement. In the industry-driven approach, the Directorate actively engages with industry to identify relevant problems and collaboration opportunities, as noted:

"*We focus on industry-driven approaches, where we identify industry needs and align them with what we can offer at the university." (Interview with AS, November 23, 2024)*

Business matching is a key strategy in this approach, where industry and academia meet to match innovations with market needs. In the community-driven approach, the Directorate connects research with end-user communities, ensuring that innovations are socially relevant. As stated:

"*Community-driven involves connecting with associations like medical associations to introduce new products." (Interview with AS, November 23, 2024)*

The Directorate listens to government policy directions to align research with national needs, ensuring that innovations are applicable to societal challenges.

4.2.1.4 Messages

The message in science communication refers to the ten priority themes outlined in the UGM Research Master Plan (RIP) 2017–2022. These themes cover various strategic fields such as Food and Smart Agricultural Systems; Smart Systems and Materials for Renewable and New Energy; Smart Systems and Materials for Health Service and Medical Equipment Provision; Culture, Democracy, and Good Governance; Socio-Economic Systems and National Resilience; Demography, Gender, and Cultural Transformation; Advanced Systems and Materials for Infrastructure, Transportation, and National Defense; Smart Systems and Materials for Environmental Protection and Disaster Prevention; Nanotechnology, Biotechnology, and Material-Biological Systems Interfaces; and Maritime Affairs (https://penelitian.ugm.ac.id/wp-content/uploads/sites/295/2020/10/RIP-UGM-2017-2022-draf.pdf).

These themes serve as the broad framework for crafting science messages that align with both national and global development needs. Therefore, each research communication is aimed at demonstrating both its scientific relevance and practical benefits, for businesses, government, and the wider community. In addition, UGM customizes its communication messages to meet stakeholder needs—whether from industry or the wider community—by incorporating their feedback into the formulation of research concepts, which are subsequently conveyed as targeted messages during dissemination.

4.2.1.5 Media

Based on the interview data and documentation, UGM utilized different media for science communication including scientific journals, both scholarly and popular books, as well as the *Knowledge Channel Website*. Major academic events include conferences and scientific seminars such as *UASC*, *ICST*, and *ICoSIA*. Signature events like *Research Days (FEB UGM)* bring together academics, industry, and the public. Digital communication is facilitated via the UGM YouTube channel, *#UGMPodcast*, and official social media platforms such as Instagram and Facebook.

Public engagement is strengthened through interactive webinars and public discussion forums. Business gatherings are organized to expand research partnership networks, and community service activities are carried out to directly contribute to society.

4.2.1.6 Communicants/Receivers

4.2.1.6.1 Academic and Non-Academic Communities

Science communication at UGM targets both academic and non-academic communities. Journal publications primarily address the academic community due to their technical nature, but events like research days and conferences are designed to engage a broader audience. For example, the FEB UGM Research Day 2024 attracted students, lecturers, researchers, practitioners, and the general public, illustrating that research dissemination is aimed at diverse stakeholders (https://feb.ugm.ac.id/id/agenda/5172-feb-ugm-research-day-2024).

4.2.1.6.2 Associations

Associations such as ASPAKI (Indonesian Medical Equipment Producers Association) play a key role in science communication through the community-driven approach. ASPAKI is a critical partner in assessing the commercial viability of research products. As one informant explained:

"*When we have a new tool, and no one wants it, we approach ASPAKI to gauge whether the product is of interest." (Interview with AS, November 23, 2024)*

ASPAKI provides strategic feedback on whether a product should be further developed or adjusted to meet industry standards, strengthening the innovation process.

4.2.1.6.3 Industry

In the context of science communication, industry serves as the receiver of research outcomes. As one informant noted:

"*We share our research findings and ask industry what they need. We map out the problems they face to match our research with their needs." (Interview with AS, November 23, 2024)*

This interactive process helps universities understand industry challenges while providing research that meets industry needs, facilitating the practical application of research.

4.2.1.6.4 Feedback

Based on an interview with YMS, feedback in the context of science communication, particularly related to the downstream process of medical research products, can be categorized into two types: internal feedback and external feedback. YMS explained that internal feedback is obtained from internal teams involved in the development and implementation of the product—in this case, a medical device:

"The feedback from our internal team is generally in the form of discussions and monthly and annual activity reports." (Interview with YMS, January 23, 2025)

Internal feedback is crucial as it provides an initial evaluation of the progress and effectiveness of the developed product or innovation. Regular discussions and reports offer opportunities for the internal team to assess the extent to which the product meets the desired standards and to identify potential improvements or modifications needed. In addition, external feedback, which comes from end users such as hospitals or direct users of the medical device, is also highly significant in science communication. YMS stated:

"External feedback includes input from users or hospital staff." (Interview with YMS, January 23, 2025)

This external feedback provides deeper insights into how the product is received and utilized in real-world settings. Responses from external parties are particularly valuable because they interact directly with the product in its practical context of use. Also, Scientific seminars provide a vital forum for mutual dialogue, enabling the presentation of research findings while capturing feedback from a wide range of academic and professional participants.

4.3 Science Communication Process at ITB

The science communication process at ITB can be explained through the elements of communication, which consist of communicators/senders, messages, media, communicants, and feedback. They are explained as follows:

4.3.1 Communicators/senders

4.3.1.1 Researcher/Lecturer

In science communication, lecturers or researchers play a key role in bridging research findings with the scientific audience. One common form of communication is through presentations, seminars, and workshops.

These platforms allow researchers not only to share their data but also to build understanding, promote critical discussions, and strengthen collaboration. As one interviewee mentioned:

> *"We communicate with the local and international scientific community through publications, international journals, reputable national journals, and presentations at seminars and workshops for scientists."*
> *(Interview with EFM, December 24, 2024)*

These activities are essential for sharing knowledge, validating scientific findings, and explaining the broader significance of research. Researchers act as active communicators, presenting their work coherently, targeting specific audiences, and answering questions with data-based arguments.

4.3.1.2 Directorate of Research and Community Service

The Directorate of Research and Community Service at ITB plays a vital role in conveying research outcomes and community service activities to the public in an open and structured manner. One example is the Research, Innovation, and Community Service Exhibition (PRIMA), which is held annually to share research findings and demonstrate accountability. As explained in the interview:

> *"At the end of the year, you can see on YouTube the PRIMA ITB exhibition, where we publicize our research and community service activities." (Interview with NV, December 3, 2024)*

This highlights the Directorate's role not only in administration but also in actively facilitating science communication through platforms like YouTube to reach a broader audience.

4.3.1.3 Directorate of Science Technopark

The Directorate of Science and Technopark (KST) at ITB serves as a science communicator by introducing research results to the public, industries, and stakeholders through events and dissemination forums. This includes activities like research expos, innovation meetings, and product exhibitions, where ITB's research is presented to non-academic audiences. As stated in an interview:

> "*We have a routine activity called the CEO Summit, where we exhibit ITB's research products and invite investors and stakeholders. We try to facilitate meetings between our products and potential users." (Interview with RF, December 18, 2024)*

This shows KST's active role in connecting the academic world with practical applications, positioning research outcomes as real solutions for industry and societal needs.

4.3.1.4 Message

In the context of ITB's science communication, the message refers to the key information conveyed to the public, industry, and stakeholders about the research conducted at ITB. ITB's research focuses on four main areas: Information and Communication Technology (ICT), Transportation and Energy Engineering, Infrastructure and Disaster Management, and Food and Health. Each of these topics addresses key issues in Indonesia and has significant potential for impact. In ICT, the focus is on how technologies like AI, IoT, Big Data, and 5G strengthen innovation in areas like cybersecurity and public services.

In Transportation and Energy Engineering, ITB aims to address national issues like traffic congestion and energy efficiency through smart energy and sustainable transportation systems. For Infrastructure and Disaster Management, ITB emphasizes disaster preparedness and the development of resilient infrastructure, aligning with the Sustainable Development Goals (SDGs). In Food and Health, the focus is on utilizing Indonesia's biodiversity to develop technologies for food and health, including personalized medicine and new pharmaceutical discoveries.

Overall, the message ITB conveys emphasizes its commitment to advancing technology and societal welfare, with research supported by frontier technologies like AI and Big Data, creating solutions for the nation's future. Furthermore, ITB adapts its communication messages to align with the needs of its stakeholders—such as industry and society—by using feedback from these groups as input for shaping research ideas, which are then translated into messages during the dissemination stage.

4.3.1.5 Media

Based on the interview data and documentation, the dissemination media for research findings include journals as well as books. The *Markheb* and the institutional website serves as the main hub for distributing scientific information. Conferences and seminars span both academic and industrial contexts, bridging cross-sector collaboration. Digital communication is strengthened through the use of social media and collaborations with influencers. ITB also actively organizes FGDs, workshops, and regular meetings to deepen thematic discussions. Large-scale events such as PRIMA ITB and the CEO Summit serve as strategic platforms connecting

academics, business leaders, and other stakeholders. Community service initiatives are implemented as part of translating research into practical applications.

4.3.1.6 Receiver

Based on interview data, the audience in science communication can be divided into several groups, depending on the type of event or meeting being held.

> *"There are various forms, such as international seminars, national seminars, FGDs, workshops, regular meetings, for example, at the lab level, faculty level, or ITB level, those are regularly held, communication meetings among scientists to report on their research." (Interview with EFM, December 24, 2024)*

> *"Then we have a routine activity called the CEO Summit. The CEO Summit is like an exhibition of ITB's research product outcomes, where we invite investors and relevant stakeholders. We usually try to create opportunities for our products to meet with potential users. So we have regular activities in this regard." (Interview with EFM, December 24, 2024)*

The audience in science communication can be categorized into several groups based on the type of event. International and national seminars typically attract scientists, researchers, academics, and students with relevant academic backgrounds, gathering to share knowledge and research findings. In Focus Group Discussions (FGD) and workshops, the audience consists of professionals, both researchers and practitioners, who engage in in-depth discussions and practical workshops to exchange ideas and gain deeper insights into specific topics.

Routine meetings at the lab, faculty, or institutional level focus on the internal community of the institution, such as researchers, lecturers, and students, to communicate research progress and experimental results. Meetings among scientists provide a platform for researchers to report findings, share information, and collaborate on future studies. Lastly, in events like the CEO Summit, investors and stakeholders are invited to assess and potentially invest in the research products and innovations, with a focus on the commercialization potential and application of these products in industry, while also serving as potential users of the solutions developed.

4.3.1.7 Feedback

One of the most significant forms of feedback comes from industry partners, who often serve as the direct users of technological innovations resulting from academic research. In this context, industry feedback functions as a practical evaluation of the effectiveness and relevance of scientific findings. The industry provides input concerning deficiencies, technical challenges, or mismatches between the research product and market or operational needs, thereby enabling researchers to make adjustments or pursue further development, as illustrated in the following interview excerpt:

> *"For instance, in my case, my research is on speech processing—one aspect involves converting speech into text. It turns out there is inaccuracy; for example, when there are English words, it sometimes fails, or when there is background noise, it struggles. In such cases, the industry informs us about the weaknesses of the current technology, and from there we conduct additional research to improve those conditions."*
> *(Interview with DPL, 23 December 2024)*

This statement demonstrates that industry feedback not only reflects the performance of the technology but also serves as a critical input for the next research cycle. In science communication, this process is referred to as two-way communication, wherein researchers not only present their results but also listen to responses, make adaptations, and build collaborative partnerships. Consequently, industry feedback constitutes a strategic form of communication, as it promotes research relevance, accelerates technology transfer, and strengthens the academic contribution to solving real-world problems.

Additionally, Scientific seminars function as key venues for reciprocal exchange, serving not only to disseminate research outcomes but also to gather input from participants with varied academic and professional expertise. The process of science communication, involving the elements of the communicator, message, and communicator (audience), is an integrated and dynamic system. Each element plays a critical role in the success of scientific communication, and the interaction among these elements determines the effectiveness of information delivery. The findings of this study illustrate how these elements function and interact in the context of science communication at Indonesian universities, particularly in the downstream application of research outcomes. This study contributes to a better understanding of the dynamics of science communication.

a. Communicator: The Message Developer

Researchers serve as the primary communicators in the science communication process. Adapting messages to suit the characteristics of the audience has been proven to be crucial. In previous research [15], it

was found that techniques such as analogies are highly effective in simplifying complex scientific messages. These findings align with the research conducted at UI, UGM, and ITB, which shows that researchers and lecturers play a significant role in formulating targeted scientific messages. Researchers at these three universities employ various channels, ranging from scientific journal publications to public discussions, to reach a wider audience, both academic and non-academic.

b. Message: Clear and Accurate Delivery

Scientific messages must be tailored to the specific audience and context. This aligns with the existing study which highlighted that contextual tailoring could significantly enhance public engagement and comprehension.[16]

c. Media: Diverse Channel

This study found that the communication channels employed in science communication can significantly influence the effectiveness of message delivery. These three universities employ a wide range of media—from traditional outlets to digital platforms—to ensure broader outreach to both academic and non-academic audiences. One of the media used is social media. The existing literature highlighted that social media, as a communication channel, can expand the reach of information and help mitigate communication noise, such as the spread of misinformation [17] .

d. Communicants: Actively Engaged Audiences

This research shows that audiences are not passive recipients of information; they are actively involved in the communication process. Audiences who actively engage in scientific discussions tend to have a better understanding. Considering the active role of audiences play in public science engagement, [18] argue that communicators should design their messages in ways that empower audiences to become "conscious actors of change" rather than passive consumers of information.

e. Feedback: Evaluation and Message Adjustment

Feedback plays a vital role in ensuring the effectiveness of science communication. Feedback not only evaluates messages delivered but also fosters active collaboration between communicators and audiences. Researchers at these three universities receive feedback through various channels, including policy briefs, seminars, and monitoring and evaluation activities [19].

The findings of this study align with the work of [6] , who state that science communication not only involves message delivery but also an ongoing interaction between the communicator, message, channel, communicator (audience), and feedback. In the context of research downstreaming, the interaction among these elements is essential to ensure that research outcomes are accepted and applied effectively. Overall, effective science communication requires the precise adaptation of messages for different audiences, the use of appropriate communication channels, and the engagement of audiences in providing feedback to improve the messages conveyed. This study also highlights the importance of adaptation and innovation in science communication to support the broader and more applicable downstreaming of research outcomes in society.

5. CONCLUSIONS

The science communication at Universitas Indonesia (UI), Universitas Gadjah Mada (UGM), and Institut Teknologi Bandung (ITB) form an essential interplay of communicator, message, media, receiver, and feedback in a mutually reinforcing cycle. Across the three institutions, communicators serve as strategic intermediaries between research and society. This adaptive role ensures that complex scientific concepts are translated into accessible, relevant, and actionable knowledge. The messages developed in these institutions address pressing national and global challenges, ranging from technological innovation and infrastructure resilience to public health and community welfare.

Collectively, these approaches ensure that messages not only inform but also inspire collaboration and real-world application. Media selection is intentionally diverse and strategic. Formal academic channels such as journals, conferences, and seminars coexist with digital platforms, social media, and flagship events, enabling each institution to reach both academic and non-academic audiences. Receivers across all three universities are recognized as active participants rather than passive recipients. Engagement spans multiple layers—from scientists, policymakers, and industry leaders to grassroots communities—allowing for two-way knowledge exchange and collaborative problem-solving.

This inclusivity ensures that scientific communication remains responsive to both local and global contexts. Feedback serves as a critical mechanism for refining communication and guiding research trajectories. In short, the science communication at UI, UGM, and ITB exemplifies a holistic, adaptive, and impact-oriented ecosystem. It bridges academic knowledge with societal needs, balances traditional and modern communication channels, and integrates feedback as a driver for continuous improvement. Together, these universities not only

strengthen the national capacity for science communication in Indonesia but also offer a replicable framework for fostering collaboration between academia, industry, policymakers, and the wider public.

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