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Science communication models in research downstreaming at Indonesian universities

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ABSTRACT

Indonesian universities are mandated to disseminate research and innovations to support national development; however, a gap persists between knowledge production and its broader societal utilization. This study examines how science communication models operate within research downstreaming at Universitas Indonesia (UI), Universitas Gadjah Mada (UGM), and Institut Teknologi Bandung (ITB) using the deficit, contextual, lay expertise, public engagement, and hybrid models. A qualitative multiple-case study was conducted from September 2024 to January 2025 through in-depth interviews with 15 institutional informants and document analysis. Findings indicate that early downstreaming is largely dominated by deficit-oriented communication through journal outputs and institutional websites that prioritize academic validation and performance indicators, while later stages increasingly employ contextual, participation, and lay expertise models through cross-sector forums, policy interfaces, digital platforms, innovation events, and community service. Importantly, hybrid (multimodel) practices are present across both early and advanced stages, indicating that universities flexibly combine models to meet shifting objectives and stakeholder configurations from validation to adoption. The study concludes that downstreaming involves a communicative reconfiguration where adaptive multimodel strategies are essential to secure credibility, relevance, and uptake.

Keywords: science communication, research downstreaming, multimodel, public engagement, Indonesian universities

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INTRODUCTION

Universities play an essential role in positioning education, science, and technology as strategic investments for national development. In Indonesia, this mandate is reinforced through the Tri Dharma Perguruan Tinggi as stipulated in Law No. 20 of 2003 (Republic of Indonesia, 2003). In addition, Law No. 11 of 2019 obliges universities and other Science and Technology (S&T) institutions to disseminate information on inventions and innovations generated through research and application, while respecting intellectual property protection (Republic of Indonesia, 2019). One of the main objectives of the national S&T system is to enhance national self-reliance and competitiveness.

The wide dissemination of innovations and inventions resulting from university research is expected to provide solutions to various national challenges, including health issues, food crises, natural disasters, energy shortages, maritime affairs, and climate change, thereby enhancing productivity across multiple development sectors. Moreover, research outcomes from university scholars can be used as a foundation for formulating strategic policies by ministries or institutions through research-based policymaking. However, Siegel & Wright (2015) revealed that research and innovation in universities have not yet made a significant contribution to improving the

efficiency and quality of human life. Moreover, Putri & Merkusiwati (2014) explain that university research findings are generally accessible only to the academic community, which has led to the perception of universities as "Ivory Towers," making it difficult for the public to benefit from these research outcomes. This phenomenon is not unique to Indonesia. In other developing economies such as Kazakhstan, similar challenges persist, where a significant gap between knowledge production and societal utilization hinders the commercialization of research and development (R&D), with many technologies remaining unclaimed and a lack of synergy between science and industry (Ilmaliyev et al., 2022). Science is still regarded as exclusive and complex, limiting public access and understanding. Moreover, academics often pay insufficient attention to formal and informal interactions during the knowledge creation process (Azagra-Caro et al., 2017).

This ivory tower phenomenon has become increasingly challenging due to the increasing public expectations for universities to provide tangible solutions to societal issues. Hughes & Kitson (2012) further contend that the ivory tower phenomenon also emerges since universities, as producers of scientific knowledge, have not yet contributed optimally to economic development at either the regional or national level. In line with this, Siegel & Wright (2015) state that university research and innovation have yet to provide solutions that significantly improve quality of life and productivity.

To solve such a problem, universities need to actively respond to societal needs and sustainability goals because their research can greatly influence local and global communities. Universities should embrace the advocacy of sustainable development as part of their mission and view themselves, not only as educators, but as critical sustainable development agents who have the power to bring about solutions to societal problems (Fanea-Ivanovici & Baber, 2022). Positioning universities within a larger sustainability context is one of the strategies which will promote innovative cultures that respond to the needs of society. Moreover, universities should ensure that their research findings are communicated clearly and accessibly to diverse audiences. The dissemination of research outcomes plays a critical role in translating academic knowledge into practical applications that can directly benefit communities (Mayo-Gamble et al., 2021).

Universities also contribute to shaping how science connects with everyday life, and this responsibility unfolds in three meaningful ways. First, they have a unique capacity to make science more accessible and engaging for the broader public. As hubs of knowledge, universities can break down complex concepts through public lectures, interactive workshops, and community outreach, helping more people not only understand but also care about science (Entradas et al., 2020). Research shows that when scientific ideas are communicated clearly and with relevance, they spark curiosity and build a more informed society. Second, universities act as key connectors between research and real-world decision-making. In times of urgent challenges, they provide data, expert analysis, and thoughtful recommendations that inform sound, evidence-based policies (Vitting-Seerup & Achiam, 2023). And when the public is part of that dialogue, the impact of science grows even stronger. Lastly, universities have a responsibility to involve communities not just as recipients of knowledge, but as active participants in science. Through citizen science projects and collaborative research, they can build trust, inspire curiosity, and ensure that science is not only about discovery but about serving people and solving real problems together (Ojeda-Romano et al., 2022).

In today's world, science communication has become a key tool for universities to bridge the gap between academic research and public understanding. By engaging audiences beyond the university walls, institutions not only boost their societal relevance but also help build public trust in science, reinforcing their broader mission to contribute meaningfully to society. At its core, science communication involves using various skills, media, and forms of dialogue to share scientific research with the public. The goal isn't just to inform, but also to inspire curiosity, spark discussion, and promote a deeper understanding of science (Burns et al., 2003). The growing momentum behind science communication is fueled by a desire to make science more accessible, engaging, socially beneficial, and accountable to public needs (Gascoigne & Metcalfe, 2017).

Research in this area has grown rapidly, exploring how science is communicated across social media, news platforms, and within institutional settings. Studies by Cheung et al. (2023),

Silfia & Irwansyah (2022), and Peters et al. (2014) show how digital media has reshaped science communication making it easier for people to access scientific information, while also raising new challenges around accuracy and credibility. Meanwhile, scholars like Peters et al. (2014), Schäfer & Fähnrich (2020) and Yuriawan et al. (2022) stress the importance of intentional communication strategies within scientific institutions, particularly for building public trust and managing relationships with diverse stakeholders. There's also increasing focus on equity and inclusion, with Canfield et al. (2020) emphasizing the need to amplify diverse voices and ensure that science communication reflects the realities of all communities, not just a privileged few.

Despite global progress, science communication within Indonesia's higher education sector especially in the context of research downstreaming remains underexplored. Research downstreaming, or the process of translating academic findings into practical applications, plays a critical role in technology transfer and innovation. It ensures that the fruits of research are not confined to journals or labs but are shared with industries, communities, and broader society (Guerrero & Urbano, 2012; Fauzy, 2019). However, most existing studies have focused either on public outreach or institutional communication capacity, without fully addressing how science communication can serve as a bridge between universities, industry, and the community in turning research into real-world solutions.

This gap reveals a pressing need for deeper investigation into how communication practices can support more inclusive and sustainable innovative ecosystems. As a step in that direction, this study examines how science communication is practiced at three Indonesian universities namely Universitas Indonesia (UI), Universitas Gadjah Mada (UGM), and Institut Teknologi Bandung (ITB), all of which consistently rank highest in national and regional university rankings. Using the framework by Tayeebwa et al. (2022), this research looks at four science communication models: the deficit model, which delivers information one-way to fill gaps in public knowledge; the contextual model, which tailors messages to audience needs and local contexts; the lay expertise model, which values community knowledge and lived experience; and the public engagement model, which fosters open dialogue and collaborative problem-solving between scientists and the public.

METHOD

This study employed a qualitative approach to thoroughly investigated the science communication in the research downstreaming at three Indonesian universities: UI, UGM, and ITB. A qualitative method was chosen because it allowed for deep exploration of complex, real-life dynamics by capturing nuance through rich narratives and detailed context (Creswell, 2019; Moleong, 2017). Within this approach, the researcher played a central role, acting as the main instrument of data collection by conducting in-depth interviews, and document analysis (Guetterman et al., 2018; Moleong, 2017).

Rather than testing a specific hypothesis, this research aimed to describe the science communication models in the research downstreaming process (Rakhmat, 2015). A multiple case study design was selected to examine science communication across the three carefully chosen institutions. This design helped capture both the specific context of each university and the broader patterns that may emerge across cases (Creswell, 2019; Yin, 2013). The study is also exploratory, intended to reveal the full complexity of each institution's practices within its natural setting (De Massis & Kotlar, 2014).

Data collection was conducted over a five-month period, from September 2024 to January 2025. The universities were selected using purposive sampling, based on key criteria. All three are classified under the "Mandiri" Cluster by Indonesia's Ministry of Education, Culture, Research, and Technology, granting them a high degree of autonomy in research and community service (Pujiati, 2024). Additionally, these universities consistently rank among the best in Indonesia in the QS World University Rankings: UI at 237th, UGM at 263rd, and ITB at 281st globally (Ihsan, 2023).

Their academic reputation, strong community outreach, and research productivity make them ideal case studies for investigating how science communication supports the transfer of

university research into tangible societal impact. To identify the most relevant informants, a snowball sampling strategy was used starting with key contacts who then referred to others, expanding the participant pool as the study progressed. This process continued until the researcher gathered a rich, well-rounded, and saturated dataset.

The study drew from both primary and secondary sources. Primary data included in-depth interviews and document analysis, involving 15 key informants such as faculty members, administrative staff, and senior representatives from offices like the Directorate of Research, Science Technopark, and Business Development at each university. Secondary sources provided additional context and included books, journal articles, institutional profiles, strategic plans, research roadmap, and online reports (Arikunto, 2017; Purhantara, 2010).

Two main methods guided the data collection: interviews and document analysis. In-depth interviews offered insight into the experiences, perceptions, and institutional cultures that shape science communication in research downstreaming (Moleong, 2017). Document analysis, on the other hand, supported data triangulation, helping validate findings by cross-referencing multiple sources (Moleong, 2017). Throughout the process, the researcher remained the primary instrument of inquiry, supported by a semi-structured interview guide that helped maintain focus and ensure alignment with research goals.

To ensure the credibility and reliability of the results, the study applied multiple triangulation techniques including cross-verifying data from interviews and documents, conducting member checks, and regularly consulting with academic supervisors and informants. These steps helped enhance the dependability and confirmability of the study (Sugiyono, 2016). For analysis, the study used an explanation-building approach. This method allowed the researcher to develop a logical narrative from field data, draw meaningful connections, and uncover science communication in the context of research commercialization (Yin, 2013). The analysis followed three key stages: collecting data, developing case profiles, and forming conclusions.

FINDINGS AND DISCUSSION

Findings

Science communication at UI, UGM, and ITB, particularly in the context of research downstreaming, is a complex and multi-layered process. The practices observed indicate the use of several science communication models namely, the deficit model, contextual model, lay expertise model, public engagement/participation model, as well as hybrid forms (multimodel) that combine two or more approaches. The models are summarized below.

Universitas Indonesia (UI)

In several institutional practices, UI still reflects a deficit model, which assumes that the public lacks scientific knowledge and therefore requires one-way transmission of information from experts. This logic is most visible in research dissemination through peer-reviewed journal publications and institutional websites, which primarily address academic communities and provide limited space for dialogue or public participation. "*Research findings are communicated to the public through research publications in the form of journals....*" (*Interview with AD, 21 October 2024*). This suggests that journals are treated as a central pathway for communicating research outputs. However, journals especially those required under competitive schemes such as PUTI grants that prioritize Q1/Q2 publications are methodologically dense and not easily accessible to general audiences, reinforcing a top-down communication structure.

UI's institutional and faculty websites also largely reflect deficit-style communication. Although the websites are publicly accessible and provide information, they operate mainly as one-way documentation platforms and offer limited mechanisms for dialogue, feedback, or interactive engagement.

> "*There is the website, and we also usually share information with partners… We create the website so that the public can access it, or at least read and see the results of the study." (Interview with AD, 21 October 2024)*

These excerpts show that websites are designed to distribute research outputs for public viewing, but they do not position audiences as active contributors to interpretation, refinement, or co-development of knowledge. UI also adopts a contextual model in several channels where scientific information is translated into forms that are more socially meaningful and accessible, taking into account the audience's background, interests, and interpretive frameworks. UI's use of mass media reflects contextual communication, where research narratives are mediated and reframed to connect with broader public concerns. Moreover, inviting journalists to dissemination events suggests that UI recognizes the importance of storytelling, relevance, and audience-centered framing in public science communication.

> *I saw several news items, in Kompas. There were also other reports… and at that time some journalists were invited to the dissemination event." (Interview with RAM, 28 November 2024)*

This excerpt indicates that UI leverages professional media actors to translate research into narratives that are more legible to non-academic publics. For example, Kompas coverage on UI research relevance to IKN development shows how messages are structured around public-policy salience rather than purely technical explanations. UI's dissemination through seminars and participation in international forums such as IPIRA also reflects contextual communication. These forums acknowledge that audiences are not "empty vessels" but interpret science through professional, disciplinary, and cultural lenses. "*Usually, research results are also disseminated through seminars.*" (*Interview with AD, 21 October 2024*). This statement reinforces the role of academic forums as communicative spaces. Unlike journal-based dissemination, seminars and conferences typically include discussion panels and Q&A sessions, enabling limited interaction and a stronger orientation to audience context, even though participation is still often dominated by academic and professional communities.

Across multiple channels and publication venues, UI's science communication increasingly combines models, reflecting the diverse demands of downstreaming from academic validation to public relevance, stakeholder dialogue, and policy uptake. For instance, books produced by UI scholars often function as knowledge-translation tools. When written in accessible or semi-popular styles, books enable contextual framing and may incorporate community experiences, thereby acknowledging lay perspectives and practical knowledge. In addition, UI's policy briefs illustrate contextual model because they are designed for specific policy audiences (e.g., ministries and national initiatives such as IKN). They also show public-engagement model when dissemination involves partnerships, ceremonial handovers, and broader open access.

> "*In relation to IKN, there were 30 policy briefs that would be disseminated in November 2024 in IKN. Each researcher had a counterpart… within the relevant ministry or government agency." (Interview with AD, 21 October 2024)*

This excerpt shows that policy brief production is embedded in institutional linkages with policymakers, indicating a movement beyond dissemination toward policy dialogue and uptake.It serves as policy communication combined with broader public access, suggesting an expanded stakeholder orientation.

Podcasts developed by units such as FIB UI illustrate a Public Engagement model by translating academic ideas into accessible, narrative-driven formats that circulate widely online and invite audience response. When these episodes foreground community experiences and local issues, they also align with the Lay Expertise model by valuing non-academic knowledge and lived realities. Similarly, YouTube channels such as LPEM FEB UI communicate research through public discussions, seminars, and thematic dialogues. YouTube reflects Contextual adaptation in how content is framed for diverse audiences, while also enabling Public Engagement through platform features (e.g., comments, live chat, interactive sessions), even if participation remains largely asynchronous. Instagram accounts (e.g., @risetpengmasfibui and @risetinovasi_ui) likewise demonstrate Contextual model through visual design and simplified language suited to social media consumption. However, the dominant mode is still top-down informational broadcasting, which retains key characteristics of the Deficit model. In contrast, TikTok use by LPEM FEB UI (@lpemfebui) tends to be more participatory: short-form, story-

based videos invite comments, reinterpretations, and informal dialogue, thereby supporting Public Engagement while implicitly recognizing Lay Expertise, as audiences are treated as capable of interpreting and responding to policy-relevant knowledge.

Public forums organized by units such as FISIP UI provide spaces where non-academic audiences such as communities, journalists, policymakers, and citizens can question and respond to research findings. These activities reflect lay expertise (valuing non-academic knowledge) and public engagement (interactive dialogue). In addition, UI Innovation Festival (UIIF) represents one of UI's public engagement/participation science communication practices. The event includes exhibitions, seminars, workshops, and business matching involving industry partners and regulators, enabling co-creation and negotiation of research use.

> "*We hold an innovation festival at least once a year, called UIIF… We invite industry partners and regulators. The event includes exhibitions of UI's innovation products, seminars, workshops, and business matching." (Interview with TIS, 8 October 2024)*

This excerpt indicates that UIIF is structured not only for dissemination but also for collaboration and engagement with external stakeholders, reflecting both participation and contextual model. Moreover, Community service at UI as reinforced in UI's PPM Roadmap 2020–2024 functions as a key bridge between research and societal needs, and it reflects a multimodel approach. It may begin as deficit-style knowledge transfer, but frequently becomes contextual (tailored to local conditions), recognizes lay expertise (local wisdom and practical knowledge), and, in stronger forms, moves toward public engagement/participation where communities participate in problem identification, solution design, and evaluation. In this sense, community services operates not only as dissemination but also as collaborative meaning-making and shared learning between university and society.

Universitas Gadjah Mada (UGM)

In UGM, academic journal articles remain a normative and highly valued research output and function as a key performance indicator for lecturers and researchers. This practice aligns with the deficit model because it treats scientific knowledge as authoritative and primarily transmitted one-way from experts to readers. Given that journal articles are technical and written in specialized academic language, they are not designed for broad public access, interaction, or participation, implicitly positioning publics as passive recipients who do not need to be involved in the production or circulation of knowledge. As one informant noted, "*Research outputs take the form of books, and also articles." (Interview with SRS, 8 November 2024)*, indicating that journal articles are understood as a standard academic output that reinforces expert-centered communication rather than public dialogue or co-interpretation. A similar deficit orientation is also evident in UGM's *Kanal Pengetahuan* website, which aims to disseminate research-based knowledge through popular scientific articles, documentaries, community engagement stories, and campus news; although the platform attempts to translate complex academic information into more readable narratives, communication largely remains one-way flowing from academics to the public with limited interactive or participatory mechanisms, thereby continuing to frame the public primarily as an audience that needs to be informed to enhance literacy and trust in science.

UGM's scientific conferences such as UGM Annual Scientific Conferences (UASC 2024), including The 10th International Conference on Science and Technology (ICST) and The 5th International Conference on Smart and Innovative Agriculture (ICoSIA) illustrate a contextual model. In these forums, research is not only presented as technical findings but is also discussed in relation to social, economic, and policy needs. In addition, conference sessions that include discussion, Q&A, and cross-sector interaction further strengthen contextual model, particularly when participants include representatives from industry, government, and civil society. For example, UGM lecturers' research on seaweed production mapping presented at the 4th International Conference on Integrated Coastal Management & Marine Biotechnology ICMMBT 2023 enabled exchange across stakeholders.

Through multiple media and dissemination venues, UGM demonstrates a growing tendency toward multimodel science communication, aligning research downstreaming with requirements for academic legitimacy, social relevance, deliberative exchange, and policy

influence. For instance, books provide a flexible narrative space for communicating research in forms that can be more accessible than journal articles. At UGM, books are institutionally recognized as legitimate research outputs and may function as a bridge between academic knowledge and non-academic publics, particularly when they are written in semi-popular language or grounded in field experience and local cases. As one informant noted, "*Research outputs take the form of books, and also articles" (Interview with SRS, 8 November 2024*). This remark confirms that books are treated as a standard output within UGM's research ecosystem. When the content of books engages with community practices and everyday realities, this channel also signals a lay expertise orientation, because it recognizes that public experience and local knowledge can contribute meaningfully to the interpretation and application of scientific insights.

FEB UGM Research Days exemplify a multimodel approach that combines contextual communication and participatory engagement. The event brings together lecturers, researchers, students, practitioners, and wider publics, and presents research through parallel sessions, plenary discussions, and student poster exhibitions, including work framed under themes such as "Sustainability Frontier in Economic and Business". The program positions research in relation to contemporary issues showing how scientific findings are communicated with attention to social and policy contexts. At the same time, the inclusion of discussion-based formats creates opportunities for dialogue and stakeholder interpretation, indicating movement beyond one-way dissemination toward public engagement.

Business gatherings and matching forums operate as a strategic space for linking research products with industry needs and supporting downstreaming. These activities reflect contextual communication because they respond to real-world industrial challenges, and they also align with public engagement and lay expertise because industry partners contribute practical knowledge that shapes research relevance through dialogue. This orientation is clearly expressed in the following statement.

> "*We actively do it every year, there is business gathering or business matching with companies. The goal is to inform what we have and see what the industry is complaining about" (Interview with AS, 23 November 2024)*

The excerpt suggests that the forum is designed not only to showcase academic assets but also to listen to industry concerns, implying a two-way communicative logic in which researchers are not the only authoritative actors and external practical expertise is treated as meaningful input.

UGM's official YouTube channel also reflects a mixed set of communication models. Formal content such as professor inaugural speeches and lectures tends to align with the deficit model because it is primarily informative and one-directional. In contrast, formats such as #UGMPodcast and recorded thematic discussions show stronger contextual model through more accessible language and topic framing that connects research to everyday concerns. In addition, comment-enabled content and webinars that invite questions can move the channel toward public engagement by enabling limited and largely asynchronous participation, expanding access even if publics are not yet positioned as co-producers of knowledge.

UGM's community service programs, including those regulated under frameworks such as Rector Regulation No. 28 of 2024, represent a multimodel arena for science communication in downstreaming. A deficit logic appears in basic outreach activities where academics transfer knowledge to communities assumed to have limited access or understanding. Contextual model becomes evident when programs are designed around the social, cultural, and economic conditions of target communities, often supported by masterplans or multi-helix collaboration. Lay expertise is central in development-oriented community services when communities' local knowledge is recognized and integrated into solution-making. Over time, the framework increasingly reflects public engagement/participation as communities are involved from planning through evaluation with the aim of building independence and empowerment. In this sense, community services at UGM demonstrates how dissemination, dialogue, participation, and community capacity-building can be integrated within a single downstreaming pathway.

Institut Teknologi Bandung (ITB)

In several institutional activities, science communication at ITB reflects a deficit model, which assumes that audiences lack scientific knowledge and therefore require one-way transmission of information from experts. This orientation is most visible in the prioritization of research outputs in high-ranking international journals (particularly Q1), where communication is technical, formal, and primarily directed to academic communities rather than broader publics. "*For research, we already require Q1 journals; the output is required to be a Q1 journal." (Interview with NV, 3 December 2024)*. This excerpt indicates a strong institutional emphasis on global academic recognition through journal publications as a key performance indicator. At the same time, it implies that the dominant communicative logic in this pathway is largely unidirectional and expert-centered, leaving limited space for public interaction, dialogue, or the validation of non-academic knowledge.

ITB also demonstrates a contextual model through platforms that translate research into more accessible forms for non-academic audiences. A prominent example is "Markheb" website which functions not merely as a repository of scientific outputs but as a public-facing interface designed to bridge the gap between academic knowledge and everyday understanding through more user-friendly presentation and simplified language. "*The website is called Markheb. It is specifically for communicating [research] to the public." (Interview with EFM, 24 December 2024)*. The statement confirms that Markheb is intentionally positioned as a channel for reaching broader publics, rather than serving exclusively internal academic audiences. In contextual terms, this suggests a shift from "knowledge transmission" toward "audience adaptation," where message design and language choices are adjusted to the public's background, interests, and interpretive capacities.

Beyond single-model implementation, ITB adopts a multimodel approach, combining different science communication models. This suggests that ITB treats science communication not as a uniform activity, but as an adaptive practice that shifts from dissemination to dialogue, and from visibility-building to collaboration, depending on the intended audience and the downstreaming stage. Books, for example, illustrate how ITB can merge the Contextual Model with the Lay Expertise Model. Books authored by ITB academics may function as contextual "translation" tools, presenting research-informed insights through narrative and accessible formats while also recognizing the value of everyday reasoning and practical experience outside formal academic settings. For instance, *Merancang yang Akan Dibuang* written by ITB lecturer demonstrates how knowledge about design and packaging can be communicated in a way that is readable for wider audiences and grounded in familiar daily practices, thereby bridging expert knowledge and public comprehension while acknowledging that meaningful understanding is also shaped by lived experience.

In conferences and seminars, ITB's science communication becomes more dialogic and relational, reflecting a combination of the Contextual Model and the Public Engagement Model, particularly when these forums are also used to develop collaboration with external actors. In such settings, communication is not limited to presenting findings; it also involves negotiating relevance with diverse stakeholder groups, including industry."*We communicate research outputs through conferences as well as international journals. And then we collaborate with industry." (Interview with DPL, 23 December 2024)*. This excerpt positions conferences and seminars as hybrid spaces: they remain academic dissemination venues, yet they also operate as gateways for partnership-building. The explicit mention of industry collaboration indicates a communicative orientation that anticipates feedback, aligns research narratives with stakeholder needs, and potentially shapes pathways for application and uptake.

ITB's social media strategy reflects contextual model and an early stage of public engagement. Research messages are repackaged into lighter, visual, and easily consumable formats that match contemporary patterns of media use. This aligns with contextual communication because both the content and its delivery are adjusted to audience habits and platform conventions. At the same time, involving influencers suggests an emerging engagement strategy through trusted intermediaries who can make research outputs socially resonant for wider publics.

> "*For the general public, we use various approaches, especially now with social media. Our social media is also supported by influencers, for example, to introduce our research products to the public." (Interview with EFM, 24 December 2024)*

The quotation signals a deliberate effort to reach broader audiences by using platform-specific tactics and amplification networks. However, the public in this pathway is still primarily positioned as an audience rather than as a co-producer of knowledge, indicating that engagement is expanding but not yet fully participatory.

For FGDs, workshops, and routine meetings, science communication often functions as an internal infrastructure for reporting and coordination among scientists. In this intra-academic context, communication may resemble deficit-like logic. It is not because audiences are "uninformed," but because information is frequently delivered in structured reporting formats that prioritize transmission and standardization. Nevertheless, when external actors are meaningfully involved, these same formats can shift toward participatory engagement depending on whether dialogue and shared decision-making are enabled.

> "*There are various formats: international seminars, national seminars, FGDs, workshops, routine meetings, for example at the lab level, faculty level, and ITB level. Those are held regularly for communication among scientists to report their research." (Interview with EFM, 24 December 2024)*

This excerpt clarifies that such forums are institutionalized and routine, reinforcing their role as internal coordination mechanisms. The emphasis on "reporting" suggests a primarily expert-to-expert communication mode, yet it also implies flexibility: when FGDs or workshops include industry or community stakeholders as active contributors, the communicative model can move closer to participation.

ITB's institutional events, such as PRIMA ITB and the CEO Summit, show stronger orientations toward public-facing engagement and applied communication. PRIMA ITB frames dissemination as institutional accountability and transparency to broader publics, while the CEO Summit foregrounds linkage between research products and potential users or investors emphasizing relevance, fit, and downstream adoption. "*PRIMA ITB is a form of our accountability here to publicize research and community service activities at ITB." (Interview with NV, 3 December 2024)*. This statement frames PRIMA ITB as a legitimacy-building mechanism, where communication is not merely informative but also relational, designed to strengthen visibility and trust through openness. *"The CEO Summit is like an exhibition of ITB's research products, where we invite investors and relevant stakeholders… we try to facilitate meetings between our products and potential users." (Interview with RF, 18 December 2024)*. Here, communication is explicitly oriented toward adoption pathways. The event functions as a brokerage arena where stakeholders can directly assess applicability and where interaction may shape subsequent steps toward implementation.

Finally, community service represents a multimodel arena that can integrate knowledge transfer, contextual tailoring, recognition of local knowledge, and participatory collaboration. Partner-village initiatives provide a sustained setting for negotiating scientific knowledge with community needs and realities, increasing opportunities for reciprocal learning and the integration of lay expertise over time.

> *"We also engage with the community through community service… the pharmacy field has a partner village program… launched about 2–4 years ago… in Tanjung Sari Village in Tasikmalaya." (Interview with EFM, 24 December 2024)*

This excerpt evidences structured, longer-term engagement rather than one-off outreach. Such continuity is significant because it creates conditions for deeper participation especially when communities contribute to problem definition, solution design, and evaluation thereby positioning community service program as a site where multimodel science communication can operate most comprehensively.

Overall, the findings indicate that science communication in UI, UGM, and ITB is not applied as a fixed, linear progression from one model to another, but rather as a flexible repertoire used across the entire research downstreaming pathway. Different models including deficit, contextual, lay expertise, and public engagement can co-occur within the same downstreaming

stage, resulting in multimodel practices that are adjusted to specific audiences, institutional objectives, and stakeholder configurations. At the same time, a clear tendency emerges: as downstreaming moves closer to application, adoption, and societal use, communication practices increasingly shift toward more dialogic and participatory forms, reflecting a greater emphasis on engagement, interaction, and co-creation with non-academic stakeholders.

Discussion

This study investigates how science communication models operate across UI, UGM, and ITB within the research downstreaming pathway. Overall, the patterns indicate a movement from predominantly one-way dissemination toward more participatory and relational forms of communication, in line with broader arguments that contemporary science communication is increasingly driven by trust-building imperatives and the need to situate scientific knowledge within societal contexts (Smeets et al., 2025). In the present cases, institutional communication does not shift uniformly; rather, it changes as research moves across downstreaming stages and stakeholder configurations, requiring universities to mobilize different communicative logics for academic validation, stakeholder alignment, and public legitimacy.

At earlier downstreaming stages, communication practices across the three universities are most visible through deficit-oriented channels, especially journal publications and formal academic forums. This pattern aligns with the conceptual premise of the deficit model: communication is designed to address a presumed knowledge gap by "enlightening" audiences through one-way transmission and popularization, under the assumption that limited scientific knowledge contributes to skeptical or resistant public attitudes (Nadkarni et al., 2019; Tsurkan, 2025). In this logic, scientists and institutions occupy the role of primary knowledge holders, while publics are implicitly positioned as passive recipients who are not expected to contribute to interpretation or knowledge production (Nadkarni et al., 2019). Our findings show that these deficit-style practices remain institutionally salient because they are tightly linked to research performance indicators.

Importantly, however, deficit-oriented communication should not be treated as merely outdated; it continues to serve specific functions in the research ecosystem. Formal channels such as academic seminars and scholarly conferences provide structured arenas for peer feedback, refinement, and scientific validation. They remain central to sustaining credibility and improving the robustness of research claims (Chen et al., 2023). From a downstreaming perspective, these "expert-centered" spaces can be understood as infrastructural stages that stabilize scientific ideas before translation into applied, policy, or market-oriented forms.

As research moves further downstream into applied development, testing, and adoption contexts, science communication becomes more interactive and multimodal. This shift reflects the increased need for coordinated engagement among multiple stakeholders including industry partners, government entities, regulators, and academic institutions whose participation can shape the feasibility and direction of technology transfer and commercialization (Oja & Kivijärvi, 2015). In such settings, communication is not limited to reporting results; it also functions as a sensemaking mechanism through which actors align expectations, negotiate relevance, and determine pathways for use.

The adoption of digital platforms, as observed in the practices of UI, UGM, and ITB through YouTube, podcasts, and social media, is central to this interactive turn. However, the mere availability of these platforms does not guarantee effective engagement. Research by Nogaibayeva et al. (2023) on language teachers in Kazakhstan reveals that while educators are generally willing to use ICT and recognize its benefits, its use is often limited to basic functions like presentations and is heavily influenced by external factors such as access to reliable infrastructure and internal factors like personal motivation and pedagogical beliefs. This suggests that for Indonesian universities to fully leverage digital platforms for downstreaming communication, they must address similar "first order" barriers (like technical support and training) and "second order" barriers (like teachers' attitudes and understanding of technology's pedagogical role) (Nogaibayeva et al., 2023)

This transition is consistent with scholarship that calls for moving beyond deficit logics toward dialogue- and participation-oriented models that emphasize mutual understanding, trust, and active public involvement (Potvin & Bélanger, 2024). It also resonates with evidence suggesting that shifting from one-way dissemination to participatory modes can strengthen engagement and knowledge uptake, although such shifts typically demand substantial institutional support and resources to sustain interaction over time (Schøning et al., 2025). In the cases examined, the growth of public engagement channels such as public events, business matching, policy-oriented engagements, and digital platforms signals an expanding communicative repertoire that extends beyond academic legitimacy toward stakeholder usefulness and broader social resonance.

In addition to public engagement, our findings underline the role of lay expertise and feedback mechanisms as downstreaming progresses. Integrating lay expertise can support trust-building and foster a stronger sense of public ownership, which in turn can enable more meaningful and sustained engagement with scientific initiatives (Nadkarni et al., 2019; Zaelzer, 2020). This is particularly relevant in contexts where research outcomes require social acceptance, contextual fit, and iterative adaptation. Rather than treating non-academic actors as "targets" of communication, the incorporation of community experience, user perspectives, and practical knowledge positions them as interpretive partners whose input can improve relevance and prospective impact.

Taken together, UI, UGM, and ITB illustrate a multimodel orientation, where deficit, contextual, lay expertise, and public engagement approaches coexist and are strategically combined. This integration can be interpreted as a pragmatic response to the limitations of any single model: deficit-style dissemination may ensure standardization and credibility; contextual tailoring improves accessibility and audience fit; and engagement-oriented models enable interaction, trust-building, and responsiveness (Tsurkan, 2025). In this view, downstreaming is best understood not as a linear "transfer" of knowledge but as a staged and negotiated process in which communication must adapt to shifting objectives, namely from validation, to translation, to adoption, and ultimately to societal embedding.

Finally, the findings also highlight the increasingly central role of cross-sector collaboration in shaping downstreaming outcomes. University–industry partnerships, in particular, are repeatedly emphasized in the literature as engines for innovation, economic growth, and social transformation because they enable knowledge co-creation, capacity building, and long-term strategic engagement especially in emerging technology domains (Sarpong et al., 2025). This view is echoed in studies from other developing contexts, such as Kazakhstan, where the success of R&D commercialization is found to be directly reliant not only on the innovation itself but critically on the qualifications, motivation, and teamwork of the project team, underscoring that human capital within these collaborative infrastructures is a decisive factor (Ilmaliyev et al., 2022). In the cases studied, industry actors, regulators, and end users often function as co-drivers by contributing to trials, refinement, and application contexts, reinforcing the argument that downstreaming effectiveness depends on the quality of multi-actor communication infrastructures rather than dissemination intensity alone.

Across the three cases, the findings also indicate that science communication during downstreaming should not be read as a rigid linear progression from deficit to more participatory models. While early-stage downstreaming is indeed dominated by deficit-oriented channels (e.g., journal publications and institutional websites) and later stages more visibly incorporate contextual translation, public engagement/participation, and recognition of lay expertise, hybrid (multimodel) practices emerge throughout the entire downstreaming pathway. In practice, universities often combine one-way dissemination for standardization and legitimacy with contextual framing for audience fit, and with engagement-oriented mechanisms when stakeholder negotiation is required. This suggests that the communicative logic of downstreaming is fundamentally adaptive: model selection is shaped by changing objectives (validation, translation, adoption), the configuration of stakeholders (academia–industry–government–communities), and the communication infrastructure available across channels. Accordingly, multimodel

communication operates not merely as an "advanced stage" strategy, but as a flexible repertoire that can be activated at both early and late stages to respond to different downstreaming demands.

CONCLUSION

This study investigates science communication models across research downstreaming stages in UI, UGM, and ITB. The findings suggest that downstreaming is not only a technical transition from research to products, policies, and social use, but also a communicative process in which universities continually adjust audiences, channels, and message logics as implementation pathways develop. Early downstreaming is more visibly dominated by deficit-oriented practices especially journal publications and institutional websites because these channels support scientific validation, standardized reporting, and performance accountability. However, model use is not strictly linear: hybrid (multimodel) communication can emerge at both early and advanced stages as institutions combine dissemination for legitimacy with contextual framing and engagement when translation, negotiation, and uptake require it. As research moves toward application and adoption, contextual, public engagement, and lay expertise approaches become more prominent through cross-sector conferences, policy briefs linked to governmental counterparts, digital platforms, public forums, innovation events, and community service programs. Future research should track these shifts longitudinally after implementation, compare multimodel patterns across institutional types, and examine how stakeholders experience and evaluate downstreaming communication in practice.

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