



## Discursive Patterns of Opinion-Based Knowledge in the Production of Health-Related Social Media Posts in Turkey

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### Abstract

Online media platforms play a central role in presenting opinions, facilitating information exchange, and supporting knowledge production. However, on most social media platforms, verifying the credibility of posts and comments remains highly challenging due to their open nature and lack of a strong governance structure. At the beginning of the COVID-19 pandemic, social media platforms became tainted by uncertain knowledge, partly caused by the limited control these platforms have over user-generated content. This lack of credible information fueled a collective state of panic (Peschke, 2021). Since social media spaces largely involve individuals engaging and sharing their opinions, the credibility of knowledge production on these platforms must be questioned. Despite the proliferation of disinformation, uncertainty, and misinformation on social media platforms (Wardle & Derakhshan, 2017), opinion-based knowledge production has also emerged from these channels, which are challenging to monitor. This article analyzes the communication patterns on health of Turkish posts and comments on Facebook and Twitter during October and November 2021. The data were evaluated against opinion-based content, allowing this study to trace the dynamics of posts and comments by categorizing them as opinion, information, or knowledge production. Data interpretation is grounded in these classifications, with particular attention to the interplay between public engagement and health information. Understanding how the media-based public creates opinion-based knowledge during the uncertainty of the COVID-19 pandemic underscores the potential for collaboration between media-based publics and scientific authorities.

Keywords: Opinion, information, knowledge, opinion-based knowledge, media-based publics

### Introduction

Especially at the beginning of the COVID-19 pandemic, global society was confronted with various forms of uncertain knowledge. The characteristics of SARS-CoV-2 were largely unknown, and the virus's impact and infection rate were particularly concerning. Within three months, scientists launched extensive research efforts to understand the virus's infectiousness, develop treatments, advance vaccination, and analyze the

sociological and economic impacts of measures such as lockdowns and curfews. Governments and political leaders faced the challenge of making decisions under highly uncertain circumstances. This uncertainty drove public demand for information to increase exponentially.

Communication activities among the media-based public were based on information and knowledge of different stakeholders from academia, politics and the economy and were mixed with opinions, emotions and concerns. Discourses and negotiations between experts from science, economy and politics were shaped by uncertain knowledge. Scientists and politicians appeared on TV shows and social media platforms, presenting insights with weak evidence, due to the lack of time, which generated doubts, distrust, and concerns about scientific activities (Peschke, 2021). This environment fostered knowledge production processes rooted in opinion and in some cases, misinformation perceived as true.

Platforms played a vital role in this process.

Unlike disinformation, which is shared to deceive, misinformation refers to false information shared without harmful intent, as defined by Wardle and Derakhshan (2017). Accordingly, the authors of this paper regard misinformation as a typical part of knowledge production within the media-based public. For more than a decade, it has been recognized that sustainable innovation processes need to incorporate insights from the media-based public. Understanding the patterns of knowledge production in this public context is essential. It is assumed that the production and sharing of misinformation provide valuable insights into how different actors construct realities in times of crisis, such as during pandemics or other climate-related events.

In the context of sustainable innovation processes, Carayannis et al. (2012) developed the quintuple helix innovation model which describes the knowledge production and exchange between the five systems of science, politics, economy, the media-based and culture-based public, as well as the natural environment of societies. It considers that all five systems have their specific strategies and ways of knowledge production. While the knowledge production of politics, for instance, is based on ethical criteria and legal norms, the knowledge production of science is mainly based on evidence. However, the knowledge production of the media-based and culture-based public is based on everyday communication processes where evidence plays a vital role but is additionally mixed with opinions, concerns and different kinds of emotions. Media platforms play a central role for the media-based public in the context of knowledge exchange. However, as concerns media platforms, the evaluation of the credibility of information is challenging because of its open nature and the associated lack of a strong governance structure (cf. Ureña et al., 2019). In the case of social media posts circulating among Turkish citizens during a certain scope of time, this tendency becomes more relevant.

This paper analyzes communication patterns in Turkish social media posts from November to December 2021, aiming to gain insights into typical activities within different knowledge systems. Each month, the ten most viewed media posts on Facebook and Twitter related to the themes of Health and Europe were gathered and assessed based on evidence-based and opinion-based content. This study traces the dynamics of social media activity to interpret how knowledge is created and disseminated by citizens in Türkiye. Ultimately, the paper seeks to enhance understanding of content creation within the framework of the five systems of knowledge production.

## Theoretical Framework

First, the relevant models for the relationship between information, knowledge and communication will be described. Social information is understood as a phenomenon which includes different processes in the human realm like data, knowledge, wisdom, meaning, understanding, communication, etc. This definition is based on Hofkirchner's Unified Theory of Information (Hofkirchner, 2014). His theory is based on the three-dimensional semiotic of Morris (1938) where Hofkirchner defines the levels of percept, knowledge and wisdom. According to him, percepts of information are produced on the syntactic level. When the perceived information undergoes interpretation on the semantic level, knowledge will be produced. The pragmatic level confers value to knowledge through evaluation where the outcome of this process is wisdom (Hofkirchner, 2014, 62-63).

In other words, the transformation of information to knowledge occurs on the semantic level through interpretation. Knowledge is the result of the justification of what we believe. Justified belief includes also kinds of what we expect to be true (Audi, 2003, 2). This concept considers the understanding that people always have the urge to achieve true knowledge. Socrates, Plato and Aristotle emphasized that we as people desire to know and achieve knowledge (Blackburn & Blackburn, 2019). They define knowledge basically as justified true belief. However, the concept of knowledge contains different facets. It arises from experiences, emerges from reflections or is the outcome of interferences.

The relation between knowledge and justification is described and analyzed by Audi (2014, 220). However, given that the public's knowledge is mainly generated by information from media platforms, its justified belief as to what is expected to be true is hardly based on experiences, nor is it reflected or interfered on scientifically. The expectation of what is true is often influenced by obvious or charismatically presented opinions on media platforms. Especially the COVID-19 pandemic revealed that the overload of information on media platforms led to a reduced ability to distinguish true and false information (Peschke et al., 2023). Accordingly, opinion-based information plays a central role in social communication and the knowledge production of the media-based public. Separating opinion from knowledge has been an important thought of philosophers, especially Aristotle (Halper, 1984). Opinion is understood as accepted as possible. But between the two poles of knowledge and opinion, there is a realm of uncertainty. Knowledge is not only propositional knowledge where the distinction between true and false is given based on evidence. There is possible knowledge and probable knowledge which considers hypotheses and assumptions as well as discourses where the sharp distinction between true and false is not purposeful (Corcoran & Samawi, 2015). As mentioned above, social media platforms play a central role for the media-based public in the context of knowledge production and exchange. The media-based public consists not only of a section of society but includes people from all types of backgrounds in terms of education and interest areas, involving anyone who can express herself through opinions or previously obtained information. On platforms that are chosen for this paper, Facebook and Twitter, user profiles, content of their posts and comments can be given as an example of user diversity within the media-based public. Even though much of the existing research on textual information processing has been focused on mining and retrieval of factual information (Htay & Lynn, 2013), creating research on opinion-based topics has its value regarding an opinion-based knowledge concept.

During the COVID-19 pandemic, along with panic and uncertainties about people's health and future, the media-based public's expressions tended to merge and the borders separating opinions from information in posts or comments became increasingly hazy and difficult to identify. Dalili and Dastani (2020) observed that, in the context of Twitter, both the content and the number of tweets were largely affected by the pandemic crisis. Indeed, not only the general public but also health professionals, politicians, experts and policymakers were sharing information as well as opinions, emotions, and content based on experiences. In a context in which it became increasingly difficult to distinguish opinion from fact-based information, opinion-based knowledge tended to emerge (Peschke, 2023).

Since the start of knowledge production processes of the media-based public depends on people's opinions, which derive from unique individual as well as shared experiences, the starting point of opinion-based knowledge are opinions of the media-based public. Considering that social influences shape people's practices, judgements and beliefs, which can overall be described as opinions (Asch, 1955), making claims on facts through opinions is a common occurrence and leads to opinion-based knowledge production. Even though there are not enough claims and theories regarding the opinion-based knowledge concept, the article aims to clarify what can be called an opinion-based knowledge case and what makes it different and unique compared to media-based public's posts and comments that are pure opinion, or evidence-based knowledge.

## **Methodology**

The data of this paper were extracted by the research team from Iscte - Instituto Universitário de Lisboa, aiming to investigate practices and tendencies adopted in the use of social media in various countries including Turkey. The selection of data circulating on social media platforms depended on particular dimensions defined as the major preoccupations of European citizens in the Eurobarometer, namely health, the economy and climate in their articulation with Europe. These dimensions were used as the filtering concepts in the Crowdtangle and Brandwatch tools which filtered the posts according to their number of associated interactions such as shares, comments, and likes, indicating connections between the posts and news articles. All posts from each dimension have been coded by the authors.

Data collected for this article covers two months, ranging from October to November of 2021. As of October 2021, international news agencies started to point out that Türkiye was entering a new, fourth wave of the COVID-19 pandemic, almost one year after the Pfizer/BioNTech vaccinations. The authors explored Facebook and Twitter posts for this article. Interactions of the media-based public are apparent in the dataset comprising 20 Facebook posts and 20 Twitter posts, alongside 330 Facebook comments and 5179 Twitter replies. Within this dataset, 13 comments are chosen to be analyzed in terms of producing opinion-based knowledge.

The Quintuple Helix model was applied to 13 selected comments from data on the Health and Europe dimension. As issues regarding health have become more relevant and urgent during COVID-19, news production and sharing on the subject have equally become so. The data, comprising both posts and comments, were evaluated concerning opinion-based knowledge content and evidence-based knowledge. By close reading into the posts and comments, the data is categorized by content analysis under three headings – opinion, information and opinion-based knowledge. Each post or comment belongs to at least one category. There are cases where posts or comments belong to more than one category, and those are

precisely the types of in-between results that are in tune with the aim of this paper, which is that of finding opinion-based knowledge production cases. As a result of the close reading and content analysis conducted on the data, authors have noticed that comments give more efficient results compared to posts. Since these comments are made by the Turkish media-based public who interact and communicate with social media platforms, the data holds importance for understanding the relation between opinion and knowledge when it comes to knowledge production within the Turkish social media sphere. As a result, rather than including posts from the data, all 13 examples given in the paper are comments selected for further analysis.

## Results

Our analysis of health-related social media content in Türkiye during October to November 2021 revealed that the comments sections of posts served as significant venues for opinion-based knowledge production. While the posts themselves were largely information-focused, user interactions demonstrated active interpretation and critical engagement. This section presents three main findings related to content categorization, patterns of user engagement, and thematic insights from highly interactive posts, enriched with additional comments to illustrate these patterns.

### Categorization of Social Media Content

The 40 selected posts (20 from Facebook and 20 from Twitter) were predominantly sourced from verified media or official government accounts. These posts aimed to inform the public about COVID-19 updates, covering statistics, vaccination milestones, and health advisories. Although the posts primarily conveyed factual information, they set the stage for user comments that engaged in interpretive and opinion-based knowledge production.

Within the 330 Facebook comments and 5,179 Twitter replies analyzed, we identified 13 comments as clear examples of opinion-based knowledge production. These comments combined personal reasoning, anecdotal experience, or comparative analysis to build knowledge claims that went beyond straightforward reactions or opinions. For instance, in response to a *Hürriyet.com.tr* post on Portugal's vaccination success, a Facebook user calculated Türkiye's potential infection rate reduction if it matched Portugal's vaccination levels. This comment demonstrated the user's attempt to apply foreign health data to the Turkish context, generating an opinion-based projection rooted in comparative reasoning.

### Patterns of User Engagement in Comments

Opinion-based knowledge production manifested through three primary engagement patterns within the comments:

- **Interpretive Reasoning:** Numerous users engaged by interpreting and contextualizing data presented in posts. In one Facebook example, a commenter questioned Türkiye's high vaccination figures, stating, "In a country of 83 million, if everyone gets vaccinated twice, that would be 166 million doses. So how are we the first?" Here, the user implicitly critiques the metrics used in the

official narrative by challenging the raw vaccination figures, emphasizing the importance of population-adjusted ratios.

- **Challenge to Authority:** Many users expressed skepticism or challenged the credibility of government and institutional sources. Under a Twitter post by the Minister of Health claiming Türkiye's high vaccination rank, one user remarked, "This sounds like propaganda to inflate numbers." Another user questioned whether the 110 million doses included booster shots, indicating mistrust toward official communication. This pattern reveals a public inclination to question the transparency and intentions behind governmental health data.
- **Personal Anecdotes:** Several users introduced personal experiences to validate or contest the information presented in posts. For example, in response to a post by *YOL Televizyonu* reporting a high vaccination count from Türkiye's Health Ministry, one commenter remarked that their grandmother viewed the pandemic as "a tool used by educated elites to control the public." This comment was met with a counter-comment from another user, stating, "Without education, you wouldn't even be able to write this comment." Such exchanges illustrate how personal and cultural narratives inform public interpretations, blending individual experiences with broader social commentary.

### Thematic Insights from High-Interaction Posts

Analyzing the most interacted posts provided further insight into public reactions, especially regarding perceptions of institutional credibility and the portrayal of health information in the media.

- **Facebook:** The post with the highest interaction came from TRT Haber, addressing avian flu symptoms in Europe and Asia. This post received numerous sarcastic and dismissive comments, indicating public fatigue or mistrust toward media portrayal of health threats. One user commented, "What's next? Are we going to vaccinate birds now?" Another remarked, "Fear sells, doesn't it? Avian flu is just the latest scare." Such responses suggest that mainstream media is perceived as prioritizing sensationalism over factual reporting, contributing to a broader public skepticism of health-related news.
- **Twitter:** The most engaged tweet was posted by Minister Koca, who announced that Türkiye had surpassed 110 million administered COVID-19 doses. This post attracted mixed responses, ranging from support to suspicion. One commenter questioned the numbers by asking, "Are we first in Europe or is this just PR?" Another user added, "110 million doses, but what does that mean if most aren't boosters?" This indicates that the public is actively evaluating official data, questioning its implications and seeking greater transparency in governmental health communication.

### Detailed Examples of Opinion-Based Knowledge Production

Additional examples from the comments provide further insight into how users created opinion-based knowledge and engaged with official narratives:

- **Example 1:** Under a Facebook post by *Ensonhaber*, a user commented, "My grandmother said COVID was a hoax from the start. She's seen it all and doesn't trust those educated in high places." In response,

another user countered, "If it weren't for educated people, you wouldn't have hospitals or medicine." This exchange shows how personal beliefs can conflict with public health narratives, framing skepticism of expertise as part of opinion-based knowledge.

- **Example 2:** In response to a tweet stating Türkiye led Europe in anxiety and depression increases, a user replied, "There's no need for statistics to see this. Just look around." Another responded, "It's more than just what we see; it's about actual numbers to understand the severity." This exchange highlights how personal observation can be a powerful tool for users in interpreting health data, although it may conflict with those seeking evidence-based information.
- **Example 3:** A user reacted to a TRT Haber post on a deadly European epidemic with, "Since when did fear-mongering become news? Nothing's 25 times more deadly." This comment directly challenges the media's framing of health crises, expressing skepticism toward the reported mortality rate and implying that media outlets inflate risks to attract viewership. This engagement pattern reflects a critical stance on the media's influence in shaping public perception of health risks.
- **Example 4:** On Twitter, a commenter replied to Dr. Mehmet Ceylan's post on the "fourth wave" of COVID-19 with, "If 80% are vaccinated, why is Singapore still struggling? Numbers alone don't solve this." This comment contextualizes public health data with international examples, suggesting that vaccination data requires further analysis. It reflects users' tendency to draw on global perspectives to critique national claims.
- **Example 5:** In response to a health minister's tweet about a new COVID-19 variant, one user expressed concern, stating, "It can come from Germany, not just South America." This comment not only highlights the variant's potential spread but also suggests that Türkiye's border policy needs reevaluation, integrating opinion with knowledge-based reasoning.

The results underscore how social media comments sections function as active spaces for opinion-based knowledge production, particularly when users encounter official narratives they perceive as uncertain or lacking transparency. Through interpretive reasoning, challenges to authority, and personal anecdotes, users construct a form of public discourse that blends personal experience with public knowledge. These interactions reflect a nuanced relationship between the media-based public and institutional sources, where social media enables critique, reinterpretation, and alternative knowledge construction, especially in times of health crises.

## Discussion

Here is the expanded discussion, integrating the themes from the previous, longer version with additional sections on Europe and Europeanization for a comprehensive analysis.

### Discussion (Revised, Expanded, and with Europeanization References)

The thematic findings from our analysis of Facebook and Twitter comments confirm that opinion-based knowledge production is a prevalent practice among the media-based public, particularly in reaction to

content from experts or official sources. This pattern aligns with the theoretical frameworks discussed in the literature review, especially Hofkirchner's (2014) Unified Theory of Information and Carayannis et al.'s (2012) quintuple helix model. According to Hofkirchner, the transformation of information into knowledge on social media is deeply interpretive, allowing users to blend factual data with subjective insights. This process reflects Carayannis et al.'s view of knowledge exchange within media-based publics, where scientific knowledge intermixes with opinion, emotion, and context-specific beliefs, especially during health crises like COVID-19. Our analysis reveals this process in action, as social media users reinterpret expert data through their own perspectives, engaging in knowledge production that often challenges the traditional hierarchy of information flow.

In examining the 40 posts created by scientists, medical experts, and political agents during the pandemic, we observed that official content on social media functions much like traditional media by presenting expert knowledge to the public. However, the comments sections reveal significant public engagement, where users not only consume but actively reinterpret this information. The heightened demand for accessible, transparent, and reliable information during the COVID-19 crisis underscored this trend. As DeVito (2017) notes, user participation on social media has evolved from passive reception to active interpretation, a shift that was evident in the Turkish context. Here, social media users frequently engaged with posts from Health Minister Fahrettin Koca by adding personal narratives, statistical insights, or critical interpretations, transforming official statements into a dynamic dialogue that reflects the users' perspectives and experiences.

### ### Europeanization in Official Health Communication

A significant finding of this study is the influence of European benchmarks and comparative frameworks in official health communication. Many of the posts analyzed positioned Türkiye's health measures within a European context, referencing vaccination rates, infection statistics, and public health policies to highlight Türkiye's achievements in relation to European standards. This framing reflects a desire by Turkish authorities to situate national health outcomes within a broader Europeanized framework, underscoring a shared commitment to public health values common across European nations.

For instance, official posts frequently cited comparative statistics positioning Türkiye as a leader in vaccination rates, especially against other European countries. This approach of using European standards as a measure of success indicates that public health messaging in Türkiye implicitly or explicitly seeks to align itself with European practices. This emphasis on Europeanization in institutional communication may stem from both a symbolic desire to associate Türkiye with Europe's public health advancements and a practical response to the pandemic, which affected multiple European countries similarly and required comparable solutions.

### ### Disconnect Between Europeanization in Posts and Public Responses

Despite this European framing, the comments sections reveal that public engagement with these posts often bypassed European references. Instead, users tended to prioritize national concerns, questioning the relevance or applicability of European data to Türkiye's unique social and health contexts. For example, comments on posts citing European vaccination rates often shifted the focus to specific local issues, such as



the perceived transparency of Turkish health data or concerns about the pandemic's local socioeconomic impacts. This response suggests that while European benchmarks may serve as valuable reference points for institutions, they resonate less strongly with the media-based public, who are more concerned with the immediate implications of health policy on their lives.

This disconnect may be indicative of a broader skepticism within the Turkish public toward European comparisons in health communication. While institutions may view European standards as a legitimizing factor, many users on social media appear to interpret them as distant or inapplicable to Türkiye's situation. This discrepancy highlights the potential limitations of using Europeanization as a framing strategy for public engagement, particularly when the public's primary interest lies in policies that address national needs and local realities.

### ### Patterns of User Engagement in Comments: A Shifted Knowledge Hierarchy

In addition to the thematic disconnect around Europeanization, our analysis shows that social media interactions vary significantly depending on the source of the content. Posts by health professionals or scientists generally received more formal comments, with users often seeking clarification or contributing factual details. Conversely, posts by media agents attracted a greater degree of sarcasm and skepticism, with users frequently questioning the intent and truthfulness of the information presented. This contrast suggests that the media-based public holds health professionals and scientists in relatively higher regard than media outlets, likely viewing them as more trustworthy sources. Nonetheless, even posts from respected experts like Fahrettin Koca were frequently scrutinized, indicating that skepticism toward institutional communication is pervasive and extends to all types of authoritative sources during the pandemic.

These findings highlight the restructuring of traditional knowledge hierarchies within social media environments, as users increasingly participate in the knowledge creation process. Rather than passively consuming content, they reinterpret, challenge, and contribute new layers of meaning based on personal experiences, contextual understanding, and critical questioning. This aligns with DeVito's (2017) observation that social media engagement has redefined user roles, shifting them from passive recipients to active participants in the discourse. Through direct interaction with scientific and political figures, users contribute uniquely to public knowledge, often through critical or confrontational stances that reflect both distrust of authority and demand for greater transparency.

### ### Europeanization and the Challenges of Cross-Cultural Knowledge Production

While the use of European references in official posts aimed to create a standardized context for health communication, our findings reveal that cross-cultural knowledge production on social media is inherently complex. The lack of resonance of these European benchmarks in the comments sections suggests that, for the Turkish media-based public, knowledge production is anchored in local relevance and personal applicability rather than global comparisons. In other words, while Europeanization offers a useful framework for institutions, the Turkish public seems more engaged with knowledge that speaks to their immediate social, economic, and cultural realities.

This divergence points to a potential limitation of using European references in public health communication in Türkiye, where the public may perceive such references as detached from their everyday experiences. As our analysis shows, comments rarely engaged with European metrics, instead framing health-related discourse around Türkiye-specific issues, such as transparency in government reporting or socioeconomic challenges exacerbated by the pandemic. This gap underscores the importance of balancing Europeanization with local relevance in health communication to ensure resonance with the public and enhance trust.

### ### Implications for Future Knowledge Exchange

Our study highlights that social media, particularly in times of crisis, is a platform for active opinion-based knowledge production, where public engagement with scientific and political information is characterized by reinterpretation, critique, and a blending of local and global perspectives. This complex knowledge exchange supports Hofkirchner's (2014) and Carayannis et al.'s (2012) frameworks, as the Turkish media-based public demonstrated an ability to synthesize information across domains, creating collective understandings that reflect both subjective and empirical insights.

The tension between European framing and national engagement in Turkey's social media discourse during the COVID-19 pandemic suggests that future knowledge exchange efforts, particularly in health communication, may benefit from integrating local relevance with broader benchmarks. Striking this balance is crucial for fostering public trust and ensuring effective engagement, especially in contexts where European standards are used as reference points. Such an approach would not only respect the local context but could also strengthen the public's perception of institutional transparency and responsiveness.

In summary, the media-based public on social media actively redefines the flow of information and knowledge, participating dynamically in the interpretation and critique of institutional communication. By juxtaposing European frameworks with national concerns, Turkish social media users have demonstrated a preference for knowledge production that aligns closely with their lived experiences. This evolution in public engagement suggests that social media platforms will continue to play a critical role in the democratization of knowledge, where global standards must be tempered with local specificity to resonate effectively with diverse audiences.

## Conclusion

This paper analyzed opinion-based knowledge production by the Turkish media-based public through a thematic study of 40 popular Facebook and Twitter posts and the corresponding 330 Facebook comments and 5,179 Twitter replies, focusing on health and Europe between October and November 2021. By examining the patterns of knowledge production on social media during the COVID-19 pandemic, this study identified how Turkish users engaged in opinion-based knowledge production, blending factual information with personal interpretations, contextual insights, and critical responses. As highlighted by the quintuple helix model, both scientific authorities and the media-based public engage in knowledge production, though with differing approaches and priorities. In particular, the science-based system, under pressure to meet public information needs, disseminated uncertain knowledge early in the pandemic, often leading to public reinterpretation and, at times, misinformation.

The findings show that the intense public need for accessible and transparent information prompted users to actively seek answers on social media, leading to the formation of an ecosystem where opinions, verified data, and subjective interpretations circulated widely. Through this active engagement, social media evolved into a significant platform for public participation in health discourse, particularly where official communications intersected with personal relevance. This complex knowledge production dynamic demonstrates that while misinformation risks remain high, dismissing public contributions as insufficiently evidence-based overlooks the nuanced ways that users process and contextualize information. A deeper understanding of these public-generated forms of knowledge can strengthen knowledge exchange within the quintuple helix framework, enabling more effective and inclusive participation across science, media, politics, and the public in times of uncertainty.

This study's analysis was centered on the health and Europe dimensions, reflecting the Horizon 2020 project's objectives. Therefore, further research is needed to evaluate whether these patterns apply to other thematic areas. However, the intersection of models of uncertain knowledge with the quintuple helix model has proven effective for analyzing social media's role in knowledge production, highlighting how diverse systems interact to navigate uncertainties. Future studies can build on these insights to explore communication patterns in other areas, fostering more sustainable and inclusive knowledge-sharing processes across public and scientific domains.

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