Online, offline, or word-of-mouth? Complementary media usage patterns and credibility perceptions of nuclear energy information in Southeast Asia

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Abstract

Many Southeast Asian countries are considering the adoption of nuclear energy to meet the rising energy demands and achieve energy efficiency. Considering the emerging regional salience of nuclear energy, this study seeks to understand the public's media consumption patterns regarding nuclear-related information, and credibility perceptions of nuclear-related information sources in countries that are at a nascent stage of nuclear development. Focus groups were conducted with citizens aged between 18 and 69 from five Southeast Asian countries – Indonesia, Malaysia, Singapore, Thailand, and Vietnam. Overall, the findings suggest that the participants utilize communication channels in a complementary manner to receive and seek nuclear-related information. Participants also evaluated the credibility of individuals and organizations that convey nuclear-related information based on their trustworthiness and nuclear expertise. The findings provide practical implications in terms of policy implementation, as well as public communication of nuclear-related information. Directions for future research were also discussed.

Keywords: nuclear energy; Southeast Asia; communication channels; credibility

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1. Introduction

Nuclear energy is a controversial technology that has attracted much public discourse over the years [1]. Proponents of nuclear energy advocate it as a clean and affordable solution to address rising energy demands by providing a stable and secure electricity supply [2]. Conversely, detractors oppose nuclear energy based on the magnitude and irreversibility of the potential destruction posed by nuclear accidents. Other often-cited drawbacks include nuclear-related hazards resulting from the improper disposal of radioactive waste and the substantial costs of nuclear power plant construction [3]. Over the past two decades, a sizable number of studies have been conducted in the United States (U.S.) as well as countries from East Asia, and Europe to understand public perceptions of nuclear energy (e.g., see [4–7]). These studies typically examined public perceptions of nuclear energy in countries with existing nuclear power plants [8–10].

A recent meta-analysis examining public perceptions of nuclear energy showed that while numerous studies have been conducted in European countries and the U.S., there is a lack of studies conducted in Southeast Asia (SEA) [11]. While SEA countries do not currently possess any nuclear power plants, regional interest in nuclear energy has surged in recent years. Various countries have drawn up ambitious plans for nuclear energy development [12–15]. As extant studies are typically premised in countries that are fairly developed in nuclear energy, current research does not comprehensively account for countries that do not possess nuclear energy facilities, or countries that plan to adopt them in future.

SEA also makes for an interesting study context due to its unique socio-cultural background, which differs substantially from countries that have been examined thus far (i.e., the U.S., East Asia, and Europe). The countries in SEA possess rich cultural, language, and

religious diversity [16]. They also possess unique geographical features, with some nations being surrounded by seas, and others being vulnerable to earthquakes [17]. Furthermore, SEA nations have undergone rapid economic progress over the past two decades [16]. These factors could influence regional development of nuclear energy differently, therefore calling for more in-depth examination of the issue in SEA.

Given that there is currently no nuclear power plant in SEA, the SEA public is largely unfamiliar with this novel technology [18]. There also exist wide disparities regarding perceptions of nuclear energy between the public and the experts [18]. For instance, while the general public tend to overestimate the risks of nuclear energy, frequently associating it with nuclear weaponry [19], experts often underestimate the risks of nuclear energy [20–23]. To bridge this gap, policymakers have utilized various communication channels (e.g., word-of-mouth, print, broadcast, online and social media) to share nuclear-related information with the public [24]. Thus, it is imperative to garner a holistic understanding of the public's media consumption patterns to effectively disseminate nuclear-related facts.

Moreover, as SEA countries solidify their plans and progress towards a nuclear future, the public may also actively seek and consult various communication channels (e.g., word-of-mouth, print, broadcast, online and social media) for nuclear-related information. Using a series of focus group discussions, this exploratory study seeks to understand the public's media consumption patterns regarding nuclear energy and their credibility perceptions of the communication channels and sources of nuclear-related information in SEA.

Findings from this study provide both conceptual and practical implications. Conceptually, this study advances research on source credibility and media credibility by applying it to an understudied and unique cultural context. Practically, the findings obtained can inform policymakers and communication practitioners about the appropriate communication channels and information sources through which to disseminate nuclear-

related information to the public.

1.1. Study context: nuclear development in SEA

This study focuses on five SEA nations—Indonesia, Malaysia, Singapore, Thailand, and Vietnam. Since they are among the most economically developed or developing nations in SEA [25], these countries are well-equipped with the financial capabilities to pursue nuclear development plans. The high energy demands in these nations have also prompted considerations of nuclear energy adoption. The adoption of nuclear energy may therefore enhance and sustain the economic competitiveness of these countries, as increased energy use and output may spur industrialization [26].

The above-mentioned countries present a worthwhile study context due to their multitude of commonalities, as well as unique cultural, language, and religious contexts. On one hand, they are tied together by multiple threads of history and shared culture, geographical proximity, economic dependency, and shared resources. However, there exists wide disparities in terms of cultural practices. For instance, the Vietnamese have a unique practice of engaging in conversations while drinking tea in a communal setting [27], which allows them to connect with strangers from all walks of life, sharing stories and the latest news [28]. This practice offers a unique cultural perspective as to how people from different cultures may have distinct ways of receiving and seeking information about nuclear energy.

These SEA countries also differ in terms of their current stages of nuclear development [29], readiness to adopt nuclear energy, and concrete plans to establish nuclear facilities. With the exception of Singapore, the aforementioned SEA countries currently possess nuclear research reactors [30]. Of them, Vietnam possesses the most concrete nuclear development plans to construct nuclear power plants [31]. Although these plans have been scrapped indefinitely [32,31], Vietnam remains the most well-equipped for nuclear energy development, with established nuclear-related institutions responsible for policy formulation,

strategic planning, as well as research and development [33].

Indonesia, Malaysia, and Thailand have also spent the last few decades planning to incorporate nuclear into their national energy mix. These countries have established nuclear-specific governmental institutions to strategize, deliberate, and pass policies regarding the construction of nuclear power plants [34]. These countries also have experience in operating nuclear research reactors [35,36]. Additionally, these countries have implemented initiatives to educate and engage citizens on nuclear energy [3]. This approach reflects the respective governments' intentions to ease their citizens into a potential nuclear future.

In comparison, the Singapore government does not have any immediate plans for nuclear energy development. While Singapore has the capabilities to adopt nuclear energy due to its affluent economy and technological advancements, it will be challenging to site nuclear power plants and prepare socio-politically acceptable contingency measures due to Singapore's limited land mass [37]. Despite this, it is worthwhile to include Singapore in this study due to its close geographical proximity to the countries with plans for nuclear energy development [37]. Considering the symbiotic relationships among the Southeast Asian countries, the regional nuclear energy development plans would have implications on its neighboring countries. Moreover, Singapore is open to developing nuclear-related expertise in light of the regional plans for nuclear energy development [38]. Singapore could also explore other nuclear adoption options such as an offshore floating nuclear power plant [39], or a joint venture with other Southeast Asian countries [40].

Based on the above-mentioned considerations, it is important for Singaporeans to be informed about nuclear energy even if Singapore does not have any immediate plans for nuclear energy development [41]. As such, it would be beneficial to identify the communication channels and information sources that can be utilized to inform the Singaporean public about nuclear energy. The dissemination of facts about nuclear energy

will also increase Singaporeans' awareness of regional nuclear developments, and be more prepared to tackle any nuclear-related issues.

Considering the prospects of nuclear development in SEA, it is important to understand how the public receives, seeks, and perceives nuclear-related information. Given the varying degrees of nuclear readiness in each country, it is also worthwhile to compare the observations obtained across these five SEA countries. It would be interesting to understand whether the distinct political, economic, and cultural background in SEA play a role in the public's media consumption patterns, as well as their credibility perceptions of different media platforms and information sources.

2. Literature review

2.1. Media consumption patterns

People typically strive to reduce uncertainty when faced with obscure science topics such as nuclear energy. Traditionally, mass media platforms (e.g., television, radio, newspapers) serve as key information sources that disseminate information in a top-down manner from media corporations to the public [42,43]. However, the advent of online and social media has drastically altered the media landscape. The novel affordances of new media platforms encourage users to actively participate in content creation, distribution, and information exchange [42,43]. This evolution has expanded the variety of media sources through which the public can receive and seek out information.

Media displacement theorists argue that individuals possess limited time and resources to expend on different types of media [44,45]. The addition of online and social media into the media landscape is perceived to reduce the amount of time that individuals can avail for traditional media. Media consumption is therefore regarded as a zero-sum game in which different types of media platforms compete for audience attention [46].

However, other scholars argue that media consumers utilize various communication

channels in a complementary manner [47]. The use of communication channels to gratify

users' needs are suggested to prevail over the number of channels available, or affordances of

the platforms [48]. As such, competition among communication channels will only occur

when different media platforms perform the same function. The different modalities of

platforms such as traditional media, online and social media, and interpersonal interactions

could function complementarily and supplement individuals' information acquisition

[47,49,50]. Thus, we propose:

> RQ1: What kinds of communication channels do the general public in SEA use to
>
> receive and gather nuclear-related information?

2.2. Credibility

The diverse media environment provides the public with a multiplicity of user-

generated content as well as information from established media outlets. Given the

abundance of information and information sources, the public is tasked with the

responsibility to assess the credibility of these messages [51]. Research on credibility

originally sought to understand source credibility in interpersonal communication [51–53].

Subsequent studies extended credibility research by incorporating media credibility

[51,53,54].

2.2.1. *Source credibility*

Source credibility consists of two key dimensions: expertise and trustworthiness

[51,52]. Expertise refers to individuals' evaluation of a communicator's capability in making

correct assertions, while trustworthiness refers to the degree to which individuals perceive the

communicator to be telling the truth [52]. Source credibility can play an influential role in the

use of scientific information for opinion formation and decision-making [55]. Past research

found that source credibility induced greater message acceptance regarding science-related

issues such as biotechnology and genetically modified foods [56]. The impact of source

credibility on public perception varies depending on the source of the nuclear-related information [57,58]. The effects of source credibility are also especially salient when the public is uncertain and possesses limited knowledge on the topic [59]. Thus, we propose:

RQ2: How does the general public in SEA perceive the credibility of different information sources in the transmission of nuclear-related information?

2.2.2. *Media credibility*

Apart from identifying the popularity and usage patterns of different communication channels, this study also seeks to understand how the public in SEA perceives various communication channels. Media credibility examines the relative credibility of various media channels through which a source sends a message. Media credibility is often operationalized in terms of accuracy, fairness, and completeness of the information [60]. Studies about traditional media platforms compared audiences' credibility perceptions across various communication channels including television and print newspapers [53]. Notably, the emergence and proliferation of online and social media has reignited academic attention to understand the public's credibility perceptions of these new media technologies [53,60]. Traditional media channels are subjected to editorial control from gatekeepers who filter information before disseminating it to the masses [61]. However, this is untenable in online and social media, given the abundance and variety of information available [61], as well as the emergence of user-generated content (e.g., citizen journalism). Scholars have emphasized the crucial role of credibility in influencing public attitudes and acceptance of nuclear energy [62]. Thus, we propose:

RQ3: How does the general public in SEA perceive the credibility of the different communication channels used to disseminate nuclear-related information?

3. Method

3.1. Qualitative approach

This exploratory study adopts a qualitative approach to elicit a spectrum of opinions and insights regarding the key communication features shaping public perceptions of nuclear energy. To provide a comprehensive regional analysis of social attitudes toward nuclear energy, this study teases out public perceptions across five SEA nations — Indonesia, Malaysia, Singapore, Thailand, and Vietnam. The capitals of each of the abovementioned countries — Kuala Lumpur, Bangkok, and Hanoi — were selected, except Singapore, a city-state, and Yogyakarta, the most populous island of Indonesia [63]. These cities were chosen because of their high population density and literacy rates, as these citizens are likely to play a more active role in the decision-making process and vocalize their opinions.

This study collected data using focus groups to provide avenues for interpersonal interaction and discussion, which facilitates in-depth cognitive processing and extensive deliberation of related topic areas [64]. Although focus groups are not designed to derive nationally representative data [65,66], it is an effective method to gauge public opinion due to the spontaneous and free-flowing nature of such discussions [67]. Focus groups also provide high ecological validity by closely mirroring everyday conversations through participant-led discussions [66]. Although it is argued that some dominant participants may influence the discussions, focus group discussions have been found to be a useful method to identify shared and unique opinions among participants [68]. Moreover, the validity of using focus groups in the examination of nuclear energy has been established in prior studies [65,66].

3.2. Sampling and recruitment

3.2.1. Participant recruitment

The local moderators and members of the research team were responsible for recruiting and selecting the focus group participants. A participant recruiter was also hired in

some countries (e.g., Vietnam). Some of the recruiters possessed prior research experience, and all recruiters were briefed before recruitment commenced.

A mixture of sampling methods was utilized in this study. Convenience sampling [69,70] was utilized to recruit participants through various communication platforms, including word-of-mouth (e.g., on the streets, colleges), posters, and public platforms. Quota sampling [69,70] was utilized to ensure that the racial distribution in each focus group closely reflected the country's population demographics. This mitigated the lack of generalizability usually associated with the focus group methodology.

The focus group participants were classified according to age, which was derived from the legal voting age in each country. This criterion was chosen as individuals who hold voting power can impact policy decisions on nuclear energy development [71]. The age classification was also based on the definition of generations from the Pew Research Center[1] [72]. The current spread of ages provides sufficient diversity while simultaneously ensuring that participants would not feel inhibited in opinion expression. Instead of adhering to the legal voting age in Singapore to determine the participants' minimum age, this study utilized the age whereby Singaporeans can make contractual decisions regarding business and property [73]. Singaporeans aged 18 and above are considered as adults who can endorse legally binding agreements. Therefore, the age of contractual capacity is deemed as a mark of adulthood, which allows individuals exercise judgement on national issues, including nuclear energy development.

Across all countries, only citizens and permanent residents were included in the focus groups. Additionally, each focus group included the major ethnic groups in each country to ensure that all prominent social groups were represented. The focus groups conducted in all five countries also consisted of an equivalent gender distribution to minimize gender bias.

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[1] Age classification was chosen as a grouping criteria due to the differences in core values, education and media usage characteristics that exists amongst the different generations which could generate vastly different perceptions towards nuclear energy [74].

Participants were required to complete a minimum of secondary/high school education to participate in the discussions. This requirement ensured that participants possessed sufficient science knowledge about nuclear energy to facilitate a productive conversation and could eloquently voice their opinions. More importantly, this requirement ensured that the participants would not confuse nuclear energy development with nuclear weapons, which would detract from the study's objectives.

3.3. Procedure

Before the start of each focus group session, informed consent was obtained from every participant. In addition, each participant also filled out a survey questionnaire comprising their demographic information and rated their knowledge of nuclear energy. Each focus group discussion lasted for approximately 2 hours, and light refreshments were provided.

3.3.1. *Indonesia*

Three focus group discussions consisting of 34 participants were conducted. Aged from 18 to 69 ($M = 42.24$, $SD = 15.63$), the focus group participants comprised 52.9% male and 47.1% female, and constituted 70.6% Javanese, 2.9% Malay, 2.9% Batak, 5.9% Minangkabau, 2.9% Buginese, 5.9% Balinese, 2.9% Tionghoa and 5.9% from other ethnicities. Education ranged from 1 (junior secondary education) to 6 (doctoral degree) ($Mdn = 3$ or "diploma or professional qualification," $SD = 1.16$). Income ranged from 1 (up to RP 999,999) to 7 (RP 10,000,000 and above) ($Mdn = 2$ or "RP 1,000,000 – RP 1,999,999," $SD = 1.31$). Upon completion, each participant was remunerated IDR295,000.

3.3.2. *Malaysia*

Three focus group discussions consisting of 29 participants were conducted. Aged from 21 to 69 ($M = 41.07$, $SD = 15.30$), the focus group participants comprised 55.2% male and 44.8% female, and constituted 44.8% Chinese, 44.8% Malay, 6.9% Indian, and 3.4%

from other ethnicities. Education ranged from 1 (secondary education) to 6 (doctoral degree) (*Mdn* = 4 or "bachelor's degree or equivalent," *SD* = 1.45). Income ranged from 1 (up to RM 2499) to 7 (RM 15,000 and above) (*Mdn* = 2 or "RM 2500 – RM 4,999," *SD* = 1.95). Upon completion, each participant was remunerated RM120.

3.3.3. Singapore

Four focus group discussions consisting of 39 participants were conducted. Of the 39 participants, 10 participants consisted of undergraduates from a large public university, while the other 29 participants were members of the public. Aged between 18 and 69 (*M* = 34.89, *SD* = 13.43), the focus group participants comprised 51.3% male and 48.7% female, and constituted 76.9% Chinese, 12.8% Malay, 5.1% Indian, 2.6% Eurasian, and 2.6% from other ethnicities. Education ranged from 1 (GSCE "O" Levels) to 6 (doctoral degree) (*Mdn* = 3 or "diploma or professional qualification," *SD* = 1.32). Income ranged from 1 (up to SGD 2499) to 7 (SGD 15,000 and above) (*Mdn* = 3 or "SGD 5000 – SGD 7,499," *SD* = 1.89). Upon completion, the undergraduate participants were remunerated with course credits, while the general public received S$90 each[2].

3.3.4. Thailand

Three focus group discussions consisting of 29 participants were conducted. Aged from 18 to 69 (*M* = 37.24, *SD* = 13.17), the focus group participants comprised 34.5% male and 65.5% female; and constituted 96.4% Thai and 3.6% Chinese. Education ranged from 1 (lower secondary education) to 7 (doctoral degree) (*Mdn* = 5 or "bachelor's degree or equivalent," *SD* = 1.45). Income ranged from 1 (up to THB 9999) to 7 (THB 85,000 and above) (*Mdn* = 3 or "THB 25,000 – THB 39,999," *SD* = 1.75). Upon completion, each participant was remunerated THB450.

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[2] The incentive amount takes into account the potential disruption to participants' work schedule as well as the substantial amount of time and monetary cost they may incur when traveling to and from the FGD location. This amount varies across countries as they are pegged to the different living standard of each respective country.

3.3.5. Vietnam

Three focus group discussions consisting of 25 participants were conducted. Aged from 18 to 69 ($M = 36.92$, $SD = 12.85$), the focus group participants comprised 48% male and 52% female. All 25 participants belonged to the Kinh ethnicity, due to the homogenous ethnic composition in Vietnam. Education ranged from 1 (secondary education) to 6 (doctoral degree) ($Mdn = 4$ or "bachelor's degree or equivalent," $SD = .71$). Income ranged from 1 (up to VND 1,000,000) to 7 (THB 10,000,000 and above) ($Mdn = 6$ or "VND 7,500,000 – VND 9999,999," $SD = 1.73$). Upon completion, each participant was remunerated VND280,000. The descriptive statistics of the focus group participants from all the five countries are summarized in Table A1.

[Insert Table A1 about here.]

3.4. Moderation and guide

The research team prepared an English version of the moderator's guide which included a predetermined list of questions and prompts. The moderator's guide was later translated into the respective local languages. The exact same questions and prompts were used across all countries. The focus group sessions in Indonesia, Singapore, Thailand, and Vietnam were conducted in the most commonly spoken languages: Bahasa Indonesian, English, Thai, and Vietnamese respectively. Meanwhile, the focus groups in Malaysia were conducted in a mixture of Bahasa Melayu and English, which reflects the most commonly spoken languages in daily conversations. This ensured that participants could articulate their opinions fluently and provide elaborative responses freely.

A rigorous selection process was conducted to select the translators and transcribers. Potential candidates had to translate or transcribe a short paragraph to determine their level of proficiency in their native languages and level of accuracy in the required task. Selected candidates were required to undergo a comprehensive briefing session to gain sufficient

background knowledge of the project before commencing on their task. We also recruited a second person to verify the quality of translation and transcription, and returned the transcripts with mistakes to the translators and transcribers for revisions.

The moderators and assistant moderators were briefed by the research team to standardize the focus group procedures and prevent misinterpretation of the moderator's guide. The moderators consisted of university lecturers and doctoral students in the social sciences, who are well-trained in qualitative research. The moderators facilitated the flow of discussion by asking all the questions in the moderator's guide and by ensuring that all the participants get a chance to voice their opinions freely during the focus group sessions. The moderator was also assisted by an assistant moderator in note-taking and recapping key points before concluding the focus group session. The key questions in the moderator's guide were formulated to address the research questions, which sought to understand media consumption patterns, as well as the source and media credibility concepts. These questions specifically examined the key communication channels utilized by the participants, their credibility perceptions of the communication channels, the circumstances under which the participants discussed about nuclear energy, and the mode of discussion.

3.5. Analysis

All the focus group discussions were digitally-recorded and transcribed verbatim. The focus group footages were also supplemented by notes taken by the assistant moderator in each session. Participants' identifying information were excluded from the transcripts and replaced by an alphanumeric code to protect their confidentiality. The transcripts of the focus group sessions were then imported into and analyzed using NVivo software. For each of the five countries, the transcripts were analyzed by two coders to ensure inter-coder reliability. A coding scheme was established and agreed upon by both coders before data analysis. The coders utilized a hybridized approach of coding for the analysis, which consisted of both

deductive and inductive coding. Deductive coding was conducted by predetermining categories based on the moderator's guide and extant literature [75]. Based on this, the major nodes for coding identified included: "communication channels," "perceived credibility of sources," "circumstances for discussion," and "discussion style." The analysis also utilized inductive coding to identify codes and discover themes that may be unique to each country. By considering varying viewpoints of data interpretation, this combination of deductive and inductive coding added strength to the analytical approach through "investigator triangulation" [76, p. 247]. Based on the careful analysis of the focus group transcripts, the major themes were coded, followed by the coding of sub-themes. Finally, the underlying issues or arguments that did not fit into any of the existing overarching themes were coded individually.

Each country was analyzed individually to identify the key themes. Subsequently, the analysis comprised cross-national comparisons across the five nations to establish broader patterns on a regional scale. The key themes were identified by spotting repeated patterns based on the frequency of mentions within and between participants, and their relevance to the research questions [65,75].

4. Results

Four dimensions of nuclear energy communication were identified based on the focus group discussions: communication channels, perceived credibility of sources, circumstances for discussion, and discussion style. Tables A2–A4 summarize the key findings in each country and highlight the similarities and differences across the five countries.

[Insert Tables A2, A3, and A4 about here.]

4.1. Communication channels

Communication channels refer to the medium through which participants receive information about nuclear energy. Participants across all five countries identified four types

of communication channels to acquire and receive information about nuclear energy: online and social media, broadcast media, print media, and word-of-mouth. Across all five countries, the participants engaged in different types of information-seeking behaviors depending on the communication channels used. Generally, participants passively acquired information from broadcast media and word-of-mouth, in comparison to actively acquiring information from print media, and online and social media.

4.1.1. *Online and social media*

Overall, the respondents across all countries utilized online and social media most frequently to acquire and receive nuclear-related information. This preference for using online and social media was especially prominent among the Singaporean and Malaysian participants.

The most commonly cited online and social media platforms consist of social networking sites and search engines. Participants' information-seeking behaviors differed depending on the choice of online and social media platform used. Respondents typically received nuclear-related information on social networking sites (e.g., Facebook, Twitter) by passively scrolling through the posts by their social network on their social media feed. Participants stated that the key strength of using social networking sites lies in its ability to provide bite-sized information (Singapore). Thus, such information could effectively capture the participants' attention by standing out from the clutter of content on the Internet, while simultaneously reducing the cognitive burden of processing large amounts of complex information about nuclear energy.

Conversely, participants who used search engines and websites actively searched for information to reduce their uncertainty about nuclear energy. This information-seeking behavior was facilitated by the ease of Internet search. Most participants agreed that search engines serve as a relatively straightforward and easy method (Malaysia) to gain large

amounts of information (Indonesia) about nuclear energy.

Notably, Singaporean and Malaysian participants were more discerning of nuclear-related information sources in their search process. They reported relying on information from governmental sites or nuclear-related governing bodies (Malaysia) and online news sources (Singapore). These information-seeking behaviors demonstrated greater selectiveness of nuclear-related information source(s) among Singaporean and Malaysian participants. This contrasts with Indonesian participants, who mainly relied on the top search results, and Thai participants who relied on user-generated information from Wikipedia. Meanwhile, Vietnamese participants relied on Facebook postings by laypeople, which may not be credible information sources.

4.1.2. Broadcast media

Despite the increased prominence of online and social media in recent years, the focus group discussions revealed that broadcast media, particularly television, remained among the most accessible source of information for the public. This was especially prominent among older participants who were influenced by information received from television news (Thailand; Vietnam) and documentaries such as CNN, Discovery channel, or National Geographic (Singapore; Thailand) when forming opinions about nuclear energy (i.e., risk perceptions and benefit perceptions). Notably, participants passively received nuclear-related information as a by-product from watching television, rather than actively seeking information to fulfil their own curiosity or interest. Participants disclosed receiving information on nuclear energy from television news broadcasts (Singapore; Thailand; Vietnam).

Besides television, knowledge acquisition through movies was suggested as a visually stimulating and entertaining way to inform the public about nuclear energy (Singapore; Vietnam), especially among younger participants. Despite this, participants' information-

seeking behavior for movies mirrored that of television viewers—passively and as a by-product of the movie's entertainment value (Vietnam).

4.1.3. Print media

In terms of print media, participants identified newspapers, research publications, science-related magazines, and books as their preferred sources of information. Of them, newspapers were identified as the most popular, with participants typically turning to the dominant news organization in their respective countries for information (e.g., The Straits Times, Malaysia Kini, The Bangkok Post, and VNExpress). Additionally, participants who were interested in nuclear energy also reported a preference for reading research publications, science-related magazines, and books.

4.1.4. Word-of-mouth

Word-of-mouth refers to the acquisition of nuclear-related information through face-to-face communication. In contrast to the other communication channels, the type and frequency of word-of-mouth discussions varied the most across the five countries. Notably, word-of-mouth was observed to be a more popular communication channel for Indonesian and Vietnamese participants. Conversely, Singaporean participants rarely acquired nuclear-related information via word-of-mouth. Generally, participants acquired nuclear-related information most frequently via word-of-mouth through formal classroom education, followed by informal conversations with their family and friends, and information provided at science-related institutions.

However, cross-national differences were observed in terms of the educational level whereby participants learnt about nuclear energy, and the depth of educational content. Malaysian, Indonesian, and Vietnamese participants recounted learning about nuclear energy in high school, which provided them a basic understanding of nuclear energy. Contrastingly, Singaporean and Thai participants gained exposure to nuclear energy through academic

modules in tertiary education, which enabled them to gain a comprehensive understanding of nuclear energy.

Alternative forms of word-of-mouth include face-to-face discussions and conversations via mobile messaging applications, such as WhatsApp. Participants expressed that they normally engaged in discussions about nuclear energy with family and friends (Singapore; Malaysia; Thailand). Several Vietnamese participants also engaged in discussions about nuclear energy at "street iced tea shops."[3]

The Malaysian participants also shared that the Malaysian government established a publicly-accessible nuclear energy research center. This research center serves as a venue for the public to learn about nuclear-related topics. Likewise, Indonesian participants pointed out that they had a "Smart Park" that served a similar purpose.

4.2. Credibility perceptions

4.2.1. Credible sources

Across all countries, participants expressed that they viewed sources grounded in research to be credible. In particular, participants identified academic papers and academic scholars to be the most credible sources of nuclear-related information. Participants expressed high levels of trust and confidence in the information presented in academic papers and journals, as it involves a systematic and comprehensive process of investigation (Indonesia; Singapore; Thailand). Academic publications were typically viewed as "well-researched" (Indonesia), as they are based on empirical evidence (Singapore). Moreover, the participants recognized that academic papers are often grounded on established theories and past research that have undergone stringent checks and validation from the scholarly community (Malaysia; Thailand). Similarly, academic scholars with nuclear-related expertise were also viewed as a credible source of information (Malaysia; Thailand; Vietnam).

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[3] It is a common Vietnamese cultural practice for people to gather at street iced tea shops to drink tea and discuss important issues with others [31].

The second most trustworthy source of information commonly mentioned by participants include both local and international energy and nuclear institutions, such as the International Atomic Energy Agency, the Atomic Energy Licensing Board, and the Office for Atoms of Peace. The participants perceived these organizations as trustworthy and transparent information sources that were willing to avail all relevant documents (i.e., nuclear energy policy, nuclear energy standards), which allowed people to refer to and cross-verify the information with alternative sources (Indonesia; Malaysia; Vietnam). These organizations were also viewed to possess adequate nuclear-related expertise, and had the corporate reputation of recruiting qualified nuclear professionals (Malaysia; Thailand).

4.2.2. Non-credible sources

Participants commonly identified social media and online forums as the least credible sources of information. This was largely due to the perceived lack of expertise and anonymity of netizens, which made it difficult for participants to ascertain the nuclear-related expertise of the commenter on these forums (Indonesia; Malaysia; Thailand). Moreover, the trustworthiness of online forums was frequently criticized as being compromised as the information provided were often unsubstantiated (Indonesia; Malaysia). The greatest drawback of social media raised was that netizens often post their personal opinions based on subjective judgments rather than objective facts (Indonesia; Thailand).

4.2.3. Semi-credible sources

Differing credibility perceptions of the news media's reporting on nuclear energy was observed across the focus groups from the five countries. Participants from Malaysia were skeptical of the news media due to the state's censorship of media outlets. Some participants from Singapore viewed the media's coverage of nuclear energy as reinforcing the government agenda. On the other hand, Indonesian, Thai, and Vietnamese participants were concerned about the competitive media landscape, as news outlets were constantly being

pitted against one another to vie for viewers' attention. This detrimentally affected the credibility of news, as news outlets would sensationalize or fabricate media content to raise viewership (Indonesia; Vietnam). Despite this, many participants mentioned that they would trust media reports to a certain degree based on their professionalism but cross-verify the information with alternative sources to determine its accuracy (Indonesia).

4.3. Circumstances for discussion: when, where, and why?

Most participants expressed that nuclear energy is not a common topic for daily conversations among laypeople. They described nuclear as a specialized topic that required expert knowledge of the sciences or energy-related subjects. As such, it was largely viewed as a foreign and uninteresting topic for discussion. Participants stated that they only discussed about nuclear energy with individuals that possess a keen interest or expertise in nuclear-related fields (e.g., experts working in the field of physics, or academics with related research interests; Indonesia). For laypeople, nuclear energy was largely regarded as an intangible and obscure issue in relation to one's daily life (Vietnam). As such, discussions only took place when the news media provides coverage on nuclear disasters (Singapore; Thailand; Vietnam). Moreover, the talk of nuclear energy only emerged under specific circumstances. Across all five countries, discussion typically took place when a sense of uncertainty or threat looms, and/or could potentially implicate their lives. Participants unanimously expressed that the discussion of nuclear usually emerged in response to breaking news regarding nuclear accidents, or when their respective governments or that of neighboring countries announced plans to construct nuclear facilities (Singapore; Thailand; Vietnam). They elaborated that these discussions would be centered on grasping the situation at hand and searching for methods to diminish its effects.

Interestingly, the "not-in-my-backyard" syndrome was observed, as participants accepted the construction of nuclear power plants, on the condition that it must be situated at

a "remote area" (Thailand) away from their homes (Indonesia; Malaysia; Singapore). However, there are also specific circumstances under which participants feel compelled to discuss about nuclear energy even if it would not impact them directly. This usually occurred when participants planned to travel to countries reported to have experienced nuclear accidents, or if they have friends and family living in areas struck by nuclear disasters. These circumstances motivated participants to understand the situation and to assess its potential impact (Malaysia; Singapore).

4.4. Mode of discussion

4.4.1. Face-to-face

Across all countries, participants were more likely to converse about nuclear energy face-to-face with friends and family, as compared to engaging in online discussions with strangers or acquaintances. Discussion about nuclear energy often took place unintentionally, triggered by certain events (i.e., after watching a nuclear-related movie or news on a nuclear accident), or as a natural progression from a related conversation topic.

Participants felt that engaging in face-to-face discussions provided several key advantages. First, nuclear energy was regarded as a relatively somber and controversial topic. As such, participants felt that they could speak their mind freely. In comparison, participants were apprehensive of sharing their opinions online due to the possible backlash from other netizens (Singapore). Other participants added that speaking to another person face-to-face motivated them to think critically about the issue and express themselves tactfully, rather than to engage in uncivil or hostile postings online (Singapore).

Second, face-to-face discussions provided conversational partners with additional nonverbal cues that are typically unavailable on platforms such as online forums. Given the complexity and multi-faceted nature of the topic, participants preferred face-to-face discussions, so that they could decipher and clarify their conversational partner's body

language, facial expression, and paralinguistic cues to attain a wholesome understanding of the other's perspective on nuclear energy (Malaysia). Third, participants expressed that it was easier to articulate and elaborate upon their opinions as well as clarify their doubts face-to-face (Singapore). Moreover, they could receive instant feedback instead of having to wait for an extended period for the other person to respond (Singapore).

4.4.2. Online

Despite the advantages conferred by face-to-face discussions, online discussions were still deemed as valuable for specialized topics such as nuclear energy. Due to the complexities involved, nuclear energy is rarely a casual conversation topic for laypeople. As such, online discussions serve as an alternative platform for expression (Malaysia; Singapore). Several participants also revealed that online discussions exposed them to a diversity of opinions, which allowed them to broaden their understanding and perspective on nuclear energy. For instance, the participation in nuclear-related forums (e.g., Hardwarezone forums and Reddit) allowed participants to interact with many different individuals, some of whom may possess technical knowledge and nuclear-related expertise (Malaysia; Vietnam).

5. Discussion

This study identified the communication channels that people utilize to seek and receive nuclear-related information. This study also examined how the public evaluate the credibility of communication channels and nuclear-related information sources. The findings lend support to earlier research [13] by demonstrating that participants sought information about nuclear energy through communication channels in a complementary manner. Congruent with credibility research, the findings also revealed that the participants evaluate and form opinions about nuclear energy based on the perceived credibility of the communication channels and information sources.

In relation to RQ1, the participants from all five SEA countries utilized multiple

communication channels to receive and seek nuclear-related information. The key communication channels include online and social media, broadcast media, print media, and word-of-mouth. These findings are congruent with Dutta-Bergman's argument that different media platforms function differently and are used complementarily to enhance information acquisition [13]. Interestingly, participants who were interested in nuclear energy reported a preference for reading research publications, science-related magazines, and books. This might be because participants who were interested in nuclear energy tend to be more highly educated (thus are able to read research publications and science books), and vice versa. Aside from receiving and seeking information from media sources, SEA participants were also found to engage in interpersonal discussions via word-of-mouth. This indicates that participants viewed interpersonal communication as an extension of traditional communication channels, which was in line with prior research [14].

Despite the similarities in media consumption patterns across the five countries, the findings demonstrate differences in terms of participants' preferred communication channel used and the frequency of use. For instance, Singaporean and Malaysian participants preferred and relied more on online and social media than the Indonesian, Thai, and Vietnamese participants. This can be attributed to varying economic conditions and penetration rates of technological devices across SEA. Singapore and Malaysia are more affluent, with higher standards of living than Indonesia, Thailand, and Vietnam [77]. Indonesian and Vietnamese participants also engaged in word-of-mouth more frequently than Malaysian, Singaporean, and Thai participants, which could be attributed to their unique cultural contexts.

Participants across the five countries also differ in their acquisition of nuclear-related knowledge from formal education. While Indonesian, Malaysian, and Vietnamese participants recalled learning about nuclear energy in high school, Singaporean and Thai

participants only gained nuclear-related knowledge at the tertiary level. These differences can be ascribed to their country's varying stages of nuclear development. The Vietnamese government may have invested more heavily in public education to increase public support for nuclear energy adoption given their concrete plans to incorporate nuclear into their energy mix. Similarly, the Malaysian and Indonesian governments have implemented various outreach and education programs (e.g., "Smart Park" in Indonesia), as well as established nuclear-related institutions (e.g., Nuclear Agency Malaysia) to raise public awareness and educate their citizens about nuclear energy [77].

Extant literature has stressed the significant role of credibility in influencing participants' evaluation of, and willingness to accept media messages. Relating this to RQ2 and RQ3, this study examined source credibility and media credibility. In line with the source credibility literature, the participants across SEA evaluated the credibility of individuals and organizations relaying nuclear-related information in terms of their trustworthiness and expertise in the field of nuclear energy. The findings were also congruent with media credibility research, as the participants judged the credibility of a communication channel in terms of the accuracy and fairness of the information provided. Interestingly, participants' credibility perceptions of the communication channels were independent of the frequency or extensiveness of using that communication channel. Although online and social media was the most popular communication channel, it was also deemed the least credible. SEA participants also had different concerns regarding credibility perceptions of news media sources, which could be attributed to their different press systems and types of governance. While the Singaporean and Malaysian participants were more skeptical about information provided by official news sources, the Indonesian, Thai, and Vietnamese participants were more concerned about the sensationalization of news information due to competition among numerous media outlets.

Findings from this study provide several practical suggestions for policymakers and communication practitioners. First, based on the insight gained about participants' media consumption patterns, governments may utilize a combination of communication channels including traditional, online and social media, as well as interpersonal communication to disseminate nuclear-related information. However, given that the findings from focus groups may not be nationally-representative, governments should conduct a quantitative study to tease out country-specific media usage patterns to maximize the effectiveness of their public education and outreach efforts.

Second, participants preferred to discuss about nuclear energy in face-to-face conversations, rather than on online platforms. Participants also expressed a tendency to discuss about nuclear energy with individuals who are familiar and interested about nuclear energy. Thus, policymakers can organize events involving nuclear experts who are deemed as credible sources to increase public knowledge and facilitate public discussion on nuclear energy [78,79]. These events can educate the public on nuclear energy, while providing them the opportunity to interact and consult with experts.

Third, policymakers can consider commissioning and screening nuclear-related movies or documentaries. Our focus group findings revealed that movies and documentaries could help to capture audience's attention. In the past two decades, the mainstream media typically provided negative coverage of nuclear energy by focusing on issues such as nuclear accidents and radioactive waste [80]. Documentaries could provide a balanced coverage of nuclear energy by providing information on both the risks and benefits. Documentaries may also raise public interest in nuclear energy indirectly while primarily entertaining viewers. More importantly, documentaries can provide accurate information, clarify misconceptions, and assist the public in making better-informed decisions about nuclear energy. It is also important for newsmakers to ensure that they provide an accurate depiction of nuclear

accidents instead of sensationalizing its risks and detriments in a bid to draw audience's attention.

However, the generalizability of this study's findings to the larger population may be limited due to the qualitative nature of focus group discussions. Nonetheless, this study attempted to mitigate the shortfalls associated with focus group discussions by ensuring that the opinions from all social groups were captured. This study also utilized racial quotas to ensure that the sample population resembled the country's population demographics. Although this study does not seek to provide statistical testing, this in-depth qualitative study provides a good foundation for subsequent studies to build upon. Future research could delve deeper into the cultural and political differences within each country to provide a more nuanced and context-specific interpretations of how their citizens retrieve nuclear-related information. Future studies could also utilize nationally-representative surveys to tease out a larger breadth and depth of information.

Second, this study excluded individuals who did not complete their secondary/ high school education. Despite this, it managed to capture the opinions from participants that more closely reflected the majority, as more than two-thirds of the population across all five countries possessed at least secondary school qualification: 71.2% in Indonesia [81], 68.2% in Malaysia [82], 89.8% in Singapore [83], 80% in Thailand [84], and 77.1% in Vietnam [85]. Future research can consider obtaining the viewpoints of individuals who did not receive formal education and from those who did not complete their secondary education. Future research can also consider comparing the opinions between individuals with low and high education levels.

Third, this study did not engage in back-translation of the participants' responses, which should be considered in future studies. Despite this, this study utilized a rigorous procedure in data collection and analysis by emulating the study procedures in established

research [65,66]. The transcribers and translators recruited were selected after a rigorous procedure to assess their proficiency in English and their native languages. To ensure the accuracy of the translations, the focus group transcripts were also checked by the focus group moderators, who are highly proficient in English and their native languages.

Fourth, this study collected data primarily from the urban regions of the selected Southeast Asian countries. Although these cities were chosen due to the residents' high population density and literacy rates, the findings may not be representative of the views of citizens residing in rural areas. For instance, despite Indonesia's strong public support for nuclear energy [86], studies have observed opposition from rural areas that are in close geographical proximity to potential sites for nuclear power plants [87,88]. Notably, laypeople residing in urban areas may differ from those of the rural regions in terms of their education levels, socioeconomic standing, media consumption patterns, and their evaluation of source credibility. Therefore, future studies can compare the perceptual similarities and differences of residents in urban and rural areas.

Finally, the findings illustrated consistent patterns of active and passive information-seeking behaviors depending on the communication channel used across SEA. Future research can examine if individual or cross-national differences in the level of media literacy, civic participation, or media freedom affect individuals' active or passive behaviors in media consumption. Such an understanding of media consumption patterns will lay the foundation for subsequent research on audience segmentation, which can inform public communication efforts to shape public acceptance of controversial technologies. Future studies may also further explore how active and passive audiences differ in their perceptions towards nuclear energy.

In conclusion, this study examined the public's media consumption patterns and credibility perceptions of nuclear-related information across SEA. This study provides keen

observations about SEA by studying countries in nascent phases of nuclear energy development within close geographical proximity. The findings obtained from this study also reveal the key communication strategies that policymakers and communication practitioners in SEA can utilize to effectively communicate about nuclear energy development.

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Appendix A

Table A1
Focus Groups.

Group No.	Country, City	No. of participants	Age
FGD1	Indonesia, Yogyakarta	12	18-34
FGD2	Indonesia, Yogyakarta	11	35-50
FGD3	Indonesia, Yogyakarta	11	51-69
FGD1	Malaysia, Kuala Lumpur	10	18-34
FGD2	Malaysia, Kuala Lumpur	8	35-50
FGD3	Malaysia, Kuala Lumpur	10	51-69
FGD1	Singapore (Undergraduates from a large public university)	10	18-24
FGD2	Singapore (General public)	9	18-34
FGD3	Singapore (General public)	10	35-50
FGD4	Singapore (General public)	10	51-69
FGD1	Thailand, Bangkok	14	18-34
FGD2	Thailand, Bangkok	7	35-50
FGD3	Thailand, Bangkok	8	51-69
FGD1	Vietnam, Hanoi	10	18-34
FGD2	Vietnam, Hanoi	9	35-50
FGD3	Vietnam, Hanoi	6	51-69

Table A2
Overview of participants' responses to RQ1.

RQ1: What kinds of communication channels do the general public in SEA use to receive and gather nuclear-related information?

Indonesia	Malaysia	Singapore	Thailand	Vietnam	Summary
1. Word-of-mouth 2. Online and social media 3. Broadcast media 4. Print media	1. Online and social media 2. Print media 3. Broadcast media 4. Word-of-mouth	1. Online and social media 2. Print media 3. Broadcast media 4. Word-of-mouth	1. Broadcast media 2. Online and social media 3. Word-of-mouth 4. Print media	1. Word-of-mouth 2. Online and social media 3. Broadcast media 4. Print media	**Similarities**: ▪ Participants across all five countries utilized a combination of communication channels. **Differences**: ▪ Singaporean and Malaysian participants use online and social media most frequently. ▪ Indonesian and Vietnamese participants use word-of-mouth most frequently. ▪ Indonesian, Malaysian, and Vietnamese participants were exposed to nuclear energy in high school. ▪ Singaporean and Thai participants were exposed to nuclear energy at the tertiary level.

Table A3
[a]Overview of participants' responses to RQ2.

RQ2: How does the general public in SEA perceive the credibility of different information sources in the transmission of nuclear-related information?

Indonesia	Malaysia	Singapore	Thailand	Vietnam	Summary
• Academic sources • IGOs • Indonesian government • News media	• Academic sources • News media • NGOs • Nuclear experts	• Academic sources • IGOs • News media • Nuclear experts • Singaporean government	• Academic sources • News media • Nuclear experts • Thai government	• Academic sources • News media	**Similarities**: ▪ Participants across the five countries perceive information presented in academic papers to be credible. ▪ Participants perceive sources from both local and international energy and nuclear institutions to be credible.

[a] The information sources are listed in alphabetical order.

Table A4
Overview of participants' responses to RQ3.

RQ3: How does the general public in SEA perceive the credibility of the different communication channels used to disseminate nuclear-related information?

Indonesia	Malaysia	Singapore	Thailand	Vietnam	Summary
1. Print media 2. Broadcast media 3. Online and social media 4. Word-of-mouth	1. Print media 2. Broadcast media 3. Online and social media 4. Word-of-mouth	1. Print media 2. Broadcast media 3. Online and social media 4. Word-of-mouth	1. Print media 2. Broadcast media 3. Online and social media 4. Word-of mouth	1. Print media 2. Broadcast media 3. Online and social media 4. Word-of-mouth	**Similarities**: ▪ Participants across the five countries perceived print and broadcast media as the most credible communication channels. **Differences**: ▪ Malaysian participants perceived news media as semi-credible due to the state's censorship of media outlets. ▪ Singaporean participants perceived news media as semi-credible as they viewed the media's coverage of nuclear

energy as reinforcing the government agenda.
- Thai and Vietnamese participants perceived the news coverage of nuclear energy to be sensationalized