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Setting the Quantum Agenda: How International Media Shapes the Narratives of Quantum Technology

Completed Research Paper

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Abstract

News coverage can influence public perception and adoption of technologies. To investigate how media covers quantum technology, an emerging technology of the 21st century, we analyzed 2,331 news articles from the US, UK, China, and India – nations at the forefront of this industry. Using BERTopic modeling and sentiment analysis, we identified six narratives containing 54 topics. Overall, news focused on quantum computing, while other technological aspects like quantum cryptography were less prevalent. Over time, a notable shift from a societal and scientific discourse to political and economic discussions was observed. This development emphasizes narratives about national strategies, commercialization, and global politics and competition, highlighting the growing rivalry, especially between the US and China. Moreover, regional sentiments varied, with more positive news coverage in Chinese and Indian media compared to the Western counterparts. These insights are vital for stakeholders directing the future of quantum technologies.

Keywords: Quantum Technology, Narratives, BERTopic modeling, Public Discourse

Introduction

Quantum technologies – such as quantum computing, quantum communication, and quantum sensing – are considered a critical technological frontier of the 21st century. Making use of the unique principles of

quantum mechanics, they can perform certain measurements exponentially faster or more precise than classical technologies we have today (Hoofnagle & Garfinkel, 2022). A fault tolerant quantum computer could, for instance, be used for drug discovery and financial modeling, solving calculations that classical computers cannot solve today (Blunt et al., 2022; Egger et al., 2020; Santagati et al., 2024). Quantum communication, on the other hand, could provide a more secure transfer of information (Shalm, 2022). An important aspect given the fact that a functioning quantum computer could potentially break encryption methods we use today making sensitive data and secure communications vulnerable to attacks (Vermaas, 2017). This threat extends to critical infrastructure, including banking systems or governmental networks, making it necessary for nations and organizations to rethink their cybersecurity strategies to mitigate these risks. Beyond the immediate benefits and risks, the development of quantum technology also carries broader implications for global security and geopolitics. Countries are already engaged in a race to achieve early quantum advancements to gain substantial strategic and economic advantages. Nations such as the US, China, India or the EU are at the forefront of quantum technology development due to substantial investments and advancements in this field (Kung & Fancy, 2021). This concentration can lead to an uneven distribution of technological power, with broader implications for global security, economic influence, possibly deepening existing geopolitical tensions (Seskir et al., 2023; Ten Holter et al., 2022).

Despite their capabilities, researchers argue that the complexity and abstract nature of quantum technologies might pose challenges for popularizing these innovations (Grinbaum, 2017; Roberson et al., 2021; Vermaas, 2017). Societal engagement, however, is essential to increase the benefits of quantum technology for society and diminish its risks (Roberson et al., 2021; Ten Holter et al., 2022). Gathering diverse perspectives has the potential to get more robust solutions on how this innovation affects various social contexts, enhancing the understanding of its impacts (Gasser et al., 2024; Roberson et al., 2021; Ten Holter et al., 2022). Therefore, understanding how quantum technology is perceived, framed, and debated across different societies becomes crucial. Public discourse, shaped largely by media, influences both the diffusion and acceptance of new technologies (Rogers et al., 2014).

In the literature, narratives are often referred to as a story or an explanation that puts events into a meaningful pattern to trigger emotions and shape a shared understanding. Narratives can therefore influence opinions, decisions and social dynamics. Further, they spread easily and often evolve over time (Shiller, 2020). Narratives in media are particularly powerful in this regard, as they can communicate complex and abstract scientific concepts to a very broad audience (Dahlstrom, 2014). Understanding these narratives is crucial because they can influence how various stakeholders, e.g. policymakers, industry leaders, and the public perceive the benefits and risks associated with quantum technology. For instance, narratives that emphasize the potential threats of quantum computing might lead to stricter regulations and slower adoption, while narratives highlighting its transformative potential could foster public support and investment. As demonstrated in other fields, such as artificial intelligence and biotechnology, how narratives communicate both the opportunities and challenges can significantly impact public acceptance, policy development, and the diffusion of innovations (Yang & Hobbs, 2020; Bareis & Katzenbach, 2022).

To our knowledge, only a few studies investigated this topic in the context of quantum technologies. Focusing on discussions by practitioners, researchers identified the use of metaphors and frames that describe the counterintuitive nature of the technology or emphasize beneficial use cases without giving adequate attention to risks (Godoy-Descazeaux et al., 2023; Meinsma et al., 2023). Another study found narratives hindering the democratization of quantum computing, pointing out its portrayal as geopolitically important, incomprehensible, or a potential threat (Seskir et al., 2023). These studies, which focus primarily on companies and the quantum community within Western economies, suggest the need for an analysis of geographically and culturally diverse discourses. In addition, existing studies lack a longitudinal perspective, which is crucial for understanding long-term trends in public discourse (Godoy-Descazeaux et al., 2023; Meinsma et al., 2023).

Adding to these insights, we employed a mixed method approach to analyze global media coverage around quantum technologies. We combined automated content analysis via BERTopic¹, a transformer-based

¹ BERT being short for Bidirectional Encoder Representation from Transformers

unsupervised learning² method, with qualitative screening to detect underlying narratives. Focusing on key economic regions – namely the US, China, the UK, and India – we examined the topics, the overall sentiment, and narratives used to get insights into the breadth and tonality of news coverage over two decades. This way, we offer valuable insights for researchers by mapping the evolution of media narratives about quantum technology. This enhances the understanding of crucial aspects of communication within the diffusion of innovation process, adding perspectives across different cultures and stakeholders. Moreover, the results help practitioners in the field of information systems by highlighting trending topics in the discourse about quantum technologies. These insights serve as a foundation for, e.g., policymakers or industry professionals to foster public acceptance and guide technology development in an inclusive and responsible way. The following questions drove our research:

RQ1: What narratives are prevalent in news coverage of major US, UK, Chinese, and Indian newspapers?

RQ2: How do these narratives change over time?

RQ3: What sentiments do news evoke regarding quantum technology?

RQ4: Are there country-specific differences regarding news coverage about quantum technology?

The study is structured as follows. First, we introduce quantum technology and explain the relevance of narratives in this context. Next, the data collection and analytical approach using automated content and sentiment analysis are described. Afterwards, we present the findings, followed by a discussion and concluding remarks.

Research Context and Related Works

Quantum Technology and the Second Quantum Revolution

With the progress made in quantum research in the past few years, experts call the current era the second quantum revolution, building on the first quantum revolution, which established foundational principles of quantum mechanics and challenged the rules of the physical world (Dowling & Milburn, 2003). This new phase uses quantum mechanical principles, such as superposition and entanglement, to create technologies with the potential to revolutionize fields like finance, chemistry, healthcare, and transportation (Aspect, 2008; Vermaas, 2017). The three markets and technologies that are being distinguished are quantum computing, quantum communication, and quantum sensing:

Quantum computing uses quantum bits (qubits) instead of binary bits, in contrast to classical computing. These qubits use superposition to exist in multiple states simultaneously, unlike classical bits that are limited to 0 or 1. This allows quantum computers to process vast amounts of possibilities at once, enabling exponential performance improvements for solving certain problems that classical computers cannot solve today. Additionally, entanglement – where qubits become interlinked and the state of one instantly affects the state of another – enables parallel processing, further enhancing computational power (Rietsche et al., 2022).

Quantum communication focuses on securely transmitting information using principles like quantum key distribution (QKD). Here, entanglement ensures that any attempt to eavesdrop would be immediately detected. Even in a future with powerful quantum computers, quantum communication can provide security that cannot be breached by classical or quantum attacks. While quantum computing threatens existing encryption methods, it also allows for new, more secure forms of encryption (Hoofnagle & Garfinkel, 2022).

Quantum sensing is using entanglement and superposition to measure physical properties (such as time, magnetic fields, and gravity) more accurately than classical sensors (Acín et al., 2018). These technologies are already finding their way out of the lab and into the marketplace, with industry leaders like Google and IBM developing quantum computers and offering public cloud-based quantum services (Google, 2024; IBM, 2024) or quantum sensors used for satellite imaging by the military (Krelina, 2021).

Looking at the quantum technology investment landscape, predictions state a potential market size of \$106B by 2040, with 350 start-ups currently in the ecosystem (McKinsey, 2023). Comparing different nations, China leads global investments in quantum technology with \$15.3B, followed by the EU (\$8.4B), the US (\$3.7B), and India (\$1.0B) (Kung & Fancy, 2021). These numbers highlight the strategic economic

² Unsupervised learning is a type of machine learning where the model learns unknown patterns and structures from data without being given labeled information.

and political importance of the field to major economic powers. However, critical voices state that we are amidst a quantum hype, with unkept promises and slow improvements in commercial applications (Ball, 2021; Linnhoff-Popien, 2019). When comparing the current discourse about quantum technologies to the one about Artificial Intelligence (AI) in its early stages in the 1970s-1990s, a similar trend was visible. Ambitious claims about AI first led to a push for commercialization. When practical applications fell short and expectations were too high, research funding was reduced, leading AI companies to shut down, a period also known as the "AI winter" (Floridi, 2020; Sartori & Theodorou, 2022). This comparison raises the question of whether the field of quantum computing will face a similar development. Quantum technologies, while attracting substantial investments and interest from different organizations, remain a complicated and not fully understood field (Rietsche et al., 2022).

Narratives and Technology Discourse

In the context of quantum technology, narratives might be particularly potent in rendering complex technology more accessible. Narratives form a natural and basic concept of interaction between individuals and their communication and can therefore help to share information understandably and acquire knowledge easily (Fadlallah et al., 2019; Hinyard & Kreuter, 2007). As Grinbaum states: "If quantum technologists are to succeed in building trust in their work, they ought to provoke an aesthetic perception in the public commensurable with the mathematical beauty of quantum theory experienced by the physicist. The power of the narrative method lies in its capacity to do so." (2017, p. 296). For us humans, abstract concepts we cannot experience in the real world are more complex to understand (Dahlstrom, 2014). This also applies to quantum technology, which describes processes on the level of elementary particles and light – phenomena that we cannot experience directly and, therefore, are hard to imagine (Grinbaum, 2017; Vermaas, 2017). Researchers argue that narratives like "Stock Market Bubbles" or "AI Replacing almost all Jobs" have the potential to influence individual economic actions and can therefore drive major economic events, like depressions or recessions (Shiller, 2020), which illustrates the potential impact of narratives in different areas.

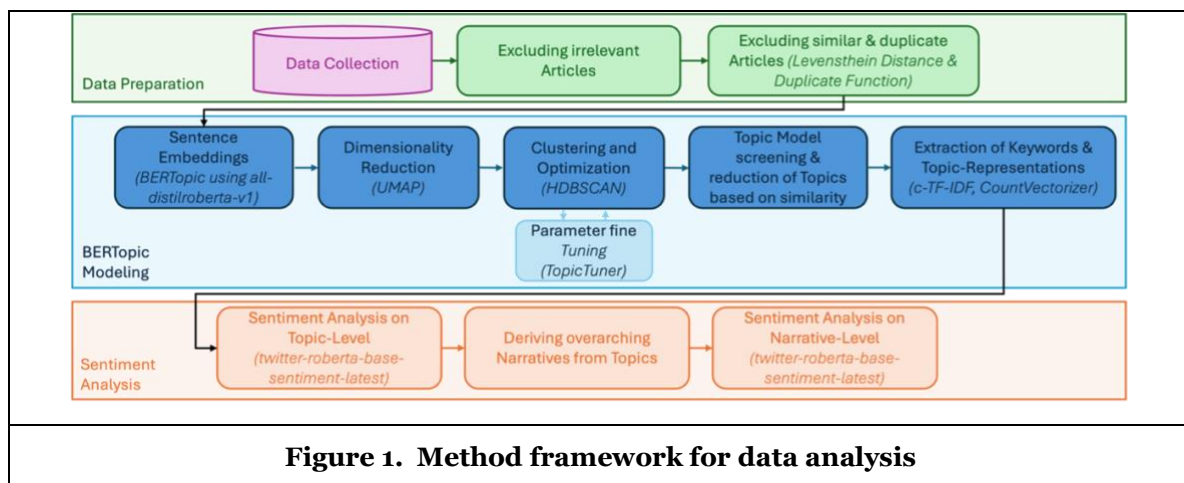
Narratives are also often used in mass media, to inform the public in a relatable way (Dahlstrom, 2014). With their function as gatekeepers, journalists prioritize what, how, and how often they report about specific topics (Mast, 2018). Media theory posits that the more prominent and frequently a topic is covered in the media, the more salient it becomes in the public's mind (McCombs & Shaw, 1972). By selecting and emphasizing certain topics or a specific narrative, the media is setting the agenda for public discourse (McCombs and Shaw, 1972). Research has also shown that agenda setting can significantly shape the political agenda since politicians and policymakers often pay attention to the issues most prominently covered in the media (Cook et al., 1983), with this effect being more pronounced in countries with free press compared to authoritarian regimes like China or North Korea (Wanta & Alkazemi, 2017). By connecting media theory with diffusion of innovation theory, we argue, that news coverage plays a vital role in public discourse on new technologies such as quantum, which is crucial to understanding the technology, as well as the adoption of the technology itself (Rogers et al., 2014). Comparing logical-scientific vs. narrative communication in a choice experiment, one study found that narratives help reduce negative perceptions regarding gene editing of foods, a topic that became highly relevant after recent advancements with CRISPR-Cas9. The researchers point out that despite the efforts of scientists and regulators, public acceptance of agricultural biotechnology remains rather negative, thus holding back the diffusion of the technology (Yang & Hobbs, 2020). Positive and understandable narratives could help with this problem. Another study analyzing national AI policies in China, the US, France, and Germany found that while narratives in AI strategies were similar, they reflected cultural, political, and economic variations. It was noted that governments may not adequately address the risks and potentials of the technology (Bareis & Katzenbach, 2022).

To the best of our knowledge, three studies investigated the public discourse in the context of quantum technologies so far. With a thematic analysis of 140 video presentations from practitioners available publicly, one study investigated metaphors used to describe quantum computing. It revealed ten distinct metaphors that show practitioners' views on the technology's potential and challenges. These metaphors are further summarized into four perspectives – each representing different attitudes toward the feasibility and strategic impact of quantum computing (Godoy-Descazeaux et al., 2023). A content analysis of 501 TEDx talks, found the following frames related to quantum computing: spooky/enigmatic framing, lack of explanation of quantum concepts, narrow framing in terms of public good, and a strong focus on quantum

computing. The findings revealed that about a quarter of talks showed spooky/enigmatic framing, discussions on quantum technology predominantly highlighted benefits over risks, and a significant emphasis on quantum computing compared to other quantum technologies (Meinsma et al., 2023). Another study specifically investigated narratives regarding the concept of democratization of quantum computing. The study identifies three narratives that currently hinder broader democratization: quantum technology as an arena for geopolitics, quantum mechanics as incomprehensible, and quantum computing as a potential threat. The researchers argue that these narratives exclude broader societal participation and engagement, emphasizing the need for a more inclusive approach. The authors also advocate for democratization efforts that extend beyond access, including active involvement, stakeholder engagement, and public discourse (Seskir et al., 2023).

Although these existing studies provide valuable insights into this topic, further exploration is needed to address persistent research gaps. First, it is necessary to broaden insights about the discourse adding perspectives from more diverse stakeholders and economic regions. Moreover, a more comprehensive quantitative and a longitudinal analysis is necessary to understand evolving trends and shifts. In their research, Godoy-Descazeaux et al. (2023) highlight the absence of longitudinal analysis. Additionally, incorporating sentiment analysis could enhance our understanding of the legitimacy and the public acceptance of quantum technology, similar to its use in AI research (Korneeva et al., 2023). Addressing these gaps will help researchers gain more insights into the communication around complex innovations such as quantum technology, expanding knowledge about the role of communication within the diffusion of innovation process. Furthermore, practitioners from the information systems field such as policy makers, governments, or companies can draw conclusions for strategic decisions around technology development, integration, and regulation. Additionally, our insights are crucial given the public's limited familiarity with quantum technology and its complexities that may lead to skepticism and hinder adoption.

Research Method and Data Analysis



To answer our research questions, we used automated content analysis and sentiment analysis as a popular method to analyze large amounts of text and uncover underlying topics and narratives (Lee et al., 2021; Mustak et al., 2021). Figure 1 shows the detailed method framework, which will be explained below in detail. We used BERTopic modeling, an unsupervised modeling technique to derive topics from our data (Grootendorst, 2022a). Unlike traditional methods like latent dirichlet allocation (LDA) or structural topic modeling (STM), that solely rely on the frequencies of words, BERTopic uses a natural language processing model, called BERT, to understand the meanings of words in their specific context. This allows BERTopic to distinguish between different meanings of the same word depending on the context it is used and therefore create more semantically meaningful topics. Furthermore, it requires less extensive preprocessing than previously mentioned traditional methods and handles longer sentences and texts more efficiently (Grootendorst, 2022a; Reimers, 2022; Roberts et al., 2019), crucial for news article analysis. The method has been used to e.g. investigate topics and narratives about COVID-19 on social media (Joloudari et al., 2023; Unlu et al., 2024). To additionally get insights into the tonality and emotions expressed in news articles, we conducted sentiment analysis using an open-source transformer-based approach from the

HuggingFace library (Cardiff-NLP, 2024). With this approach, we also explore the emotional undertones that are essential parts of narratives (Dahlstrom, 2014). Sentiment analysis has already been used to e.g., investigate how public discourse portrays artificial intelligence (Korneeva et al., 2023) or robotic technologies (Savela et al., 2024), providing insights to the aspect of legitimacy and social evaluation of emerging technologies. Both of our approaches are based on deep-learning methods, that achieve a high degree of accuracy and reliability through their contextual understanding of words. Further they have the ability to process high-dimensional data efficiently (Devlin et al., 2018; Grootendorst, 2022a), ideal for analyzing a large amount of text like in this study.

Data Collection and Sample

The four selected countries play a critical role in shaping quantum technologies due to their substantial investments in national development programs (Kung & Fancy, 2021). In addition, their cultural and political diversity allows us to identify patterns, differences, and similarities in how quantum technology is represented and understood in different economic regions. We focused on daily newspapers since they reach a broad audience, impact the public discourse, and are the primary source from which nonexpert audiences obtain most of their science information (Casero-Ripollés, 2020; Dahlstrom, 2014; McCombs & Shaw, 1972). For our analysis, we chose English-language daily newspapers from the four respective countries: the US, UK, China, and India. Here, we draw on articles from eight national newspapers with high reach and impact, two for each country, which were available in the TDM Studio library (TDM-Studio, 2024) from ProQuest. For each country, we chose the following publications:

United States – Wall Street Journal and Washington Post: Looking at the latest average print circulation in 2023, both are among the top three daily newspapers in the US, with the Wall Street Journal in first place (609,654 daily circulations) and the Washington Post in third place (139,232 daily circulation) (Majid, 2023).

United Kingdom – The Daily Telegraph and The Guardian: These newspapers are among the most popular in the UK, ranking fifth and seventh with estimated daily circulations at 188,371 for the Daily Telegraph and 74,183 for The Guardian in 2023 (Maher, 2023).

India – The Times of India and The Economic Times: We included The Economic Times, with a daily circulation of 289,899, and The Times of India, with a daily circulation of 47,7708 (RNI, 2022).

China – China Daily and South China Morning Post: We included China Daily as China's most prominent English-speaking daily. The paper claims to have a circulation of 600,000 overseas and 300,000 in the US (China-Daily, 2024). Further, we added the South China Morning Post, since it is considered the most credible paid newspaper in China and Hong Kong according to surveys (CCPOS, 2022). Despite the limited availability of Chinese dailies in the library, this choice is consistent with previous research efforts (Lee et al., 2021).

To select relevant articles for our study, we applied a topic-based sampling approach using a set of predefined keywords to search the title and full text of the articles in the online library (Bruns & Stieglitz, 2017). Starting with keywords such as “quantum technology”, “quantum computing”, “quantum communication”, and “quantum sensing” we expanded our list by identifying additional two- or three-word combinations related to “quantum” that were identified during our initial screening of articles. This iterative process continued until adding new keywords no longer changed the composition of the search results. Finally, we included all available articles based on keyword search (56 keywords in total) from both print and online sources in our sample.

Data Cleaning and Preprocessing

The initial sample consisted of 2,754 articles and covered a period of 20 years, from January 1, 2000, to August 15, 2023. Using R Studio (RCore-Team, 2023) for data cleaning, we excluded all observations for which the full text was not available. To ensure that all articles were related to our research, we searched for our keywords in the articles and inspected the frequency of keywords per article. We found that some articles mentioned the keywords but were unrelated to the technology (e.g., articles about a company called Quantum Computer Services). We excluded these articles from the sample. Furthermore, we deleted articles that were longer than 10,000 words because they were mostly transcripts of political speeches. After these first steps, we deleted articles with high similarity scores, calculating the Levensthein distance, using 0.3 as a cutoff value using the package stringdist (Van der Loo, 2014). We did this because news articles are often published multiple times, e.g. in both print and online versions of a newspaper, and feature only small

changes, leading to similar content. We also deleted duplicates with the duplicated function of the R base version 4.3.0 (RCore-Team, 2023). After data cleaning, we had a final sample of $n=2,331$ articles. Table 1 shows the distribution of articles and sentences for each country, first for the initial sample after data cleaning and second for the final BERTopic model.

	Initial sample		BERTopic model	
<i>Countries</i>	<i>Articles</i>	<i>Sentences</i>	<i>Articles</i>	<i>Sentences</i>
United States	850	26949	825	10473
China	526	14485	518	5335
Great Britain	364	13415	349	4552
India	591	12163	557	5087
<i>Total</i>	<i>2331</i>	<i>67012</i>	<i>2249</i>	<i>25447³</i>

Table 1. Number of articles and sentences per country ⁴

Data Analysis

Automated Content Analysis: To analyze the textual data and derive common topics, the BERTopic package in Python was used (Grootendorst, 2022a). Due to the large volume of data and the limitations related to runtime and memory constraints (Reimers & Gurevych, 2019), we split each article into individual sentences before to the initial analysis. This resulted in 67,021 sentences from 2,331 news articles (Table 1). For the final model, we used the “all-distilroberta-v1” sentence embedding, due to its efficient handling of longer sentences (Reimers, 2022), which is necessary when analyzing news articles. Further parameters for the analysis were set the following way: The Uniform Manifold Approximation (UMAP) was kept at default settings, following the recommendations for managing high-dimensional data (Grootendorst, 2022b). Next, the Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN) algorithm was applied to form groups of embeddings based on similarity, taking outliers into account. This way, suitable parameters to balance the number of topics and outliers in the model could be defined. To fine-tune the *min_cluster_size* and *min_samples* parameters necessary for the HDBSCAN algorithm, the TopicTuner library in Python was used. This tuning process, involving random and refined grid searches, resulted in *min_cluster_size* of 95 and *min_samples* of 57, to avoid missing or redundant topics in the final model. To derive keywords and topic representations, the *c-TF-IDF* and *CountVectorizer* were used. The process involved using default settings for *c-TF-IDF* while customizing *CountVectorizer* to exclude common and irrelevant terms and stop words, ensuring more precise topic insights. The calculated BERTopic model proposed 79 topics, for which we derived the representative keywords and sentences. After we screened each topic, we identified similar ones that were merged to avoid redundancies. The remaining 54 topics were labeled based on the representative sentences and words (overview in Table 1).

Sentiment Analysis: For sentiment analysis we used a pre-trained, open-source model available on HuggingFace called “twitter-roberta-base-sentiment-latest” (Cardiff-NLP 2024). The model is trained on enormous data and contains a neutral label to account for the fact that not all sentences necessarily contain strong sentiments (Cardiff-NLP, 2024; Loureiro et al., 2022). This method provides an advanced deep learning approach compared to other techniques, such as lexicon-based methods, which rely solely on single-word sentiment scores (Silge & Robinson, 2016). Our approach, on the other hand, considers contextual relationships in the texts. Especially for lengthy text data such as news articles, these single-word sentiment scores would have potentially undermined the accuracy and reliability of research findings.

³ Sentences defined as outliers: 41565

⁴ Table 1: The second column shows the number of articles and sentences per country for the final BERT-model. The methods used to identify outliers (i.e., the parameter settings explained in the section Data Analysis) were set relatively conservatively, resulting in a higher proportion of sentences being classified as outliers. This prioritizes the cohesion of clusters over the inclusion of diverse data points ensuring that the analysis focuses on the most representative topics within the data.

The model has a polarity score from 0 to 1 for each sentiment: negative, neutral, and positive, adding up to 1. We applied it to the 20 most representative sentences for each topic and calculated the average scores across the sentences for each topic or narrative.

Narratives: Through an iterative process, the topics were screened repeatedly using the representative sentences and words to uncover similar patterns and narratives among the topics in a qualitative approach. This way, we identified six overarching narratives that were common in the topics, and that each topic was assigned to. More narratives didn't add significant insights, while a smaller number would have led to loss of information. The narratives were described and labeled considering the top representative sentences and words from the topics related to the narrative. In addition, we considered the sentiment scores to determine whether the narratives were predominantly positive, negative, or neutral. This approach is similar to Shiller's (2020) research on popular economic narratives. An overview of the narratives, their assigned topics, and representative words can be found in Table 2. In the following section, we provide a detailed description of the narratives, point out how they overlap and relate to each other, highlight differences between countries, and examine how their prevalence has changed over time.

Narratives	Topics	Top 3 representative words
<i>National Tech Strategies</i>	T2 Educational Programs T3 India: National Tech Initiatives T6 China: Lead in Tech Developments T13 Military & Warfare T15 National Space Missions T16 UK: National Tech Initiatives & Economic Strategy T29 US National R&D Funding	students, engineering, iit india, technology, modi china, technology, development military, army, defense space, moon, nasa uk, britain, brexit dollar, budget, billion
<i>Global Politics and Tech Competition</i>	T8 Semiconductor Industry T26 Huawei T30 China: Lead in AI Developments T37 Democracies & Global Order T1 US - China Trade Relations & Tensions T7 Ukrainian War & Sanctions on Russia T18 US Election Campaigns T19 Geopolitical Dynamics in the Indopacific: AUKUS, Tech Collaboration & Warfare T20 US Legislative Actions T27 Covid-19 Vaccines T35 EU China Relations T40 US-China Visa Policy Tensions T47 Geopolitical Dynamics Regarding Taiwan	semiconductor, chip, manufacturing huawei, 5g, chinese artificial, intelligence, china democracy, countries, world china, biden, beijing russian, ukraine, sanctions biden, president, voters aukus, australia, nuclear senate, house, legislation vaccine, covid, 19 eu, macron, china students, chinese, visa taiwan, china, island
<i>Commercialization</i>	T4 Quantum Computing T12 Venture Capital & Investments T21 Digital Transformation in Business T24 Commercialization of Quantum Computing T33 Alibaba T41 Microsoft T43 Sequoia China Investment T46 Googles Quantum Supremacy T50 Autonomous Driving T53 Generative AI	quantum, computers, computing dollar, investors, million business, digital, technology quantum, computing, ibm alibaba, ma, alibaba group microsoft, nadella, mundie sequoia, sequoia capital, china google, sycamore, quantum supremacy driving, self-driving, car chatgpt, artificial, chatbot

<i>Security and Regulation</i>	T0 Cybersecurity T9 Social Media & Regulation T17 Post Quantum Cryptography T45 Tik Tok & Data Security	cybersecurity, cyber, security facebook, twitter, social encryption, quantum, cryptography tiktok, bytedance, app
<i>Science and Technical Aspects</i>	T10 Biotech & Genetic Engineering T22 Multiverse Theory T25 Quantum Communication T28 Quantum Mechanic Mysteries T31 Nobel Prize T34 Classical Versus Qubits T36 Moore's Law T38 5g Technology T39 Blockchain & Digital Currency T42 Cloud Computing T44 Quantum Entanglement T48 Superconductors T49 Nanotechnology T51 Schrödinger's Cat T54 Atoms & Lasers	cells, cancer, brain universe, multiverse, universes pan, quantum, satellite mechanics, quantum mechanics, quantum wave prize, nobel prize, physics qubits, bits, quantum moore, moore law, transistors 5g, networks, 6g blockchain, digital, cny cloud, data, services entanglement, particles, entangled temperature, superconductors, superconductivity nanotechnology, materials, nano cat, dead, alive atoms, light, laser
<i>People, Society and Culture</i>	T5 Entertainment & Scifi T11 Artificial Intelligence & Humans T14 Climate Change & Renewable Energy T23 New Technologies & Tomorrow T32 Scientific Knowledge Transfer T52 Women in STEM	book, film, fiction artificial, artificial intelligence, intelligence climate, energy, climate change technology, new, innovation science, research, results women, girls, science
Table 2. Overview of narratives, related topics, and top representative words ⁵		

Results and Findings

RQ1: What narratives are prevalent in news coverage of major US, UK, Chinese, and Indian newspapers? Our analysis revealed the following six narratives that were prevalent in the news coverage. Each narrative is described in a short text with additional excerpts from news articles for a better overall impression of the narrative:

National Tech Strategies discusses strategies to navigate the developments of quantum technologies and related fields from a national, domestic politics perspective. It discusses the need for educational programs in STEM and explains fields of application such as space exploration or military and warfare, e.g. for the Indian armed forces: *“Stressing the role of niche technologies like Artificial Intelligence (artificial intelligence), quantum computing, autonomous and unmanned systems in modern-day warfare, Gen Naravane said the developments along our northern borders with China are a stark reminder that the Indian armed forces need to continually adapt to the exigencies of modern wars to preserve the country's territorial integrity.” (Economic Times 7.03.2021)*. The narrative points out the necessity for countries to keep track of technical advancements, and eventually gain a leading position in technological developments, like in this case China: *“Beijing wants to attract people who can contribute to ‘our country’s drive to become a global power in science and technology development’ The city of Beijing will develop new trillion yuan hi-tech manufacturing clusters and strengthen its capabilities in areas such as artificial intelligence and quantum communication research, according to its new five-year action plan.” (South China*

⁵ The topic number is indicative of the topic prevalence in the sample. Topic 0 had the highest prevalence, topic 54 the lowest.

Morning Post 21.01.2021). Overall, the narrative is about building and strengthening a country's expertise in emerging technologies such as quantum, to ensure national growth, security, and self-sufficiency.

Global Politics and Tech Competition gives a broader perspective on the strategic race for technological supremacy between different nations. It offers insights into the interplay between global political debates in general and the role of technological advancements within these conflicts. The narrative contains topics about the tensions regarding Taiwan and China's territorial claims or the US and China, with the Biden administration's posing investment sanctions on Chinese technology sectors: "[...] *the White House is planning a fresh round of restrictions on chip exports to China, further escalating its offensive against the Chinese mainland's semiconductor, quantum-computing and artificial intelligence sectors.*" (*China Daily* 20.07.2023). In addition, it covers conflicts such as the sanctions on Russia regarding the war in Ukraine, or strategic defense alliances like AUKUS in the Indo-Pacific. Overall, the narrative paints a picture of a world where technological advancement is closely linked to geopolitical strategy, with global power dynamics increasingly revolving around control over emerging technologies. This strategic race is reshaping international relations, where tech supremacy is synonymous with economic power, military capability, and influence on a global scale.

Commercialization focuses on industry leaders who contribute to the developments and applications of quantum technology, such as Google, Alibaba, and Microsoft. It mentions the intense research and development efforts of these players and highlights the substantial investments from private sectors due to the importance and promising capabilities of quantum technologies: "*Although prototypes are often crippled by errors, big tech companies such as Google, IBM, Microsoft and Alibaba, which owns South China Morning Post, have ventured into the development of quantum computing.*" (*South China Morning Post* 02.11.2021). Further, it discusses how companies explore innovations as well as their integration into existing technological systems: "*Air India is also exploring emerging trends such as the application of quantum computing to solve some of the most complex optimization challenges in the industry, it said. It expects to sustain this pace of investment over the next five years as the transformation journey shifts from catching up with world-class airlines to taking a leadership position by deploying the most cutting-edge technologies ranging from traditional digital technologies to modern generative Artificial Intelligence.*" (*Times of India* 25.04.2023). The narrative encourage progress in emerging technologies and commercializing these.

Security and Regulation is a narrative that addresses key issues at the intersection of technology, security, and policy. Cybersecurity is a central concern, with for example legislative efforts like the Cyber Diplomacy Act aiming to improve international cyber policy and secure domestic technological developments: "*The meeting follows an announcement by Senate Majority Leader Charles E. Schumer (D-N.Y.) that an upcoming bill will appropriate previously authorized funds for domestic semiconductor manufacturing alongside tech priorities such as artificial intelligence and quantum computing. [...] The Cyber Diplomacy Act of 2021 would create an international cyberspace policy bureau to oversee the economic and security dimensions of cyber policy within the department.*" (*Washington Post* 24.02.2021). Furthermore, the narrative mentions that the developments around quantum computing have started a race around post-quantum cryptography to protect sensitive data against future threats: "*That is why Dr. Peikert and hundreds of the world's top cryptographers are involved in a competition to develop new encryption standards for the U.S., which would guard against both classical and quantum-computing cyberattacks.*" (*Wall Street Journal* 10.07.2020). As these excerpts clarify, this narrative emphasizes the critical need for robust security measures to protect digital spaces in the realm of quantum technologies.

Science and Technical Aspects explains fundamental physical principles like quantum mechanics and their relation to cutting-edge technology, including genetic engineering, or nanotechnology. The narrative describes how specific technological entities such as a quantum entanglement, qubits, etc. work: "*Synthetic diamonds are in the race to become the bedrock of quantum computing - a theoretical field that promises massive computational power that eschews the digital technology of classical machines. Quantum computing involves the entanglement of particles in the subatomic realm. When one particle becomes entangled with another, it synchronizes with its partner, even when they have no physical connection. Manipulating one can change the state of the other.*" (*Daily Telegraph* 01.03.2017). It further reflects how such technologies impact the industry and society: "*Pretty soon, chips will no longer be able to accommodate enough transistors (the switches that operate the computer) to keep pace with the sheer flood of data being unleashed by humans. The solution may lie in quantum computers, which would be*

far more powerful than conventional ones.” (Times of India 11.08.2009). Overall, this narrative explains scientific principles and potential applications of advanced technologies like quantum computing, as well as their potential to revolutionize industries.

People, Society and Culture is about the interplay of technological advancements and society. More particularly, it covers topics like reshaping job markets, and societal norms to effectively utilize technologies like quantum computing. For example, it mentions developing a workforce that is not only technologically proficient but also ethically aware: “Rather than following the ‘ready, fire, aim’ approach sometimes used in developing new technologies, we hope to provide resources that allow developers and industry to create better, more responsible technologies that positively benefit society, said Mark McKenna, acting director of the Technology Ethics Center at Notre Dame. The accelerating development of artificial intelligence, quantum computing and other technologies is also putting pressure on universities to think about these issues at earlier stages. A variety of academic disciplines could play a role.” (Washington Post 07.01.2020). Besides that, it mentions currently relevant issues in society, such as climate change, where quantum technology is promised to help find solutions, as the following statement exemplifies: “Dr. Gil said quantum computers will be able to speed up research-and-development discoveries because the machines will excel at modeling physics, chemistry and materials science. This could lead to developing more energy-efficient batteries in the auto sector, he said, or better carbon-capture membranes to fight climate change.” (Wall Street Journal 3.03.2021). Overall, it explores the intersection of society, technology, and future developments, putting the focus on responsible decision-making in the context of such innovations.

RQ2: How do these narratives change over time?

Focusing on the prevalence of narratives over time (Figure 2), it becomes clear that after 2016, narratives about *Science and Research* as well as *People, Society and Culture* decreased. In contrast, quantum technology is increasingly being mentioned in the context of *Global Politics & Tech Competition*, *National Tech Strategies*, and *Security and Regulation*. In the last five years, these narratives dominated news coverage, with a prevalence of 13% up to 36%. Narratives around *Commercialization* have also increased since 2014. Crucially, this shows that news coverage regarding quantum technology shifted from a scientific and societal perspective, towards a political and economic discourse, highlighting increasing international competition.

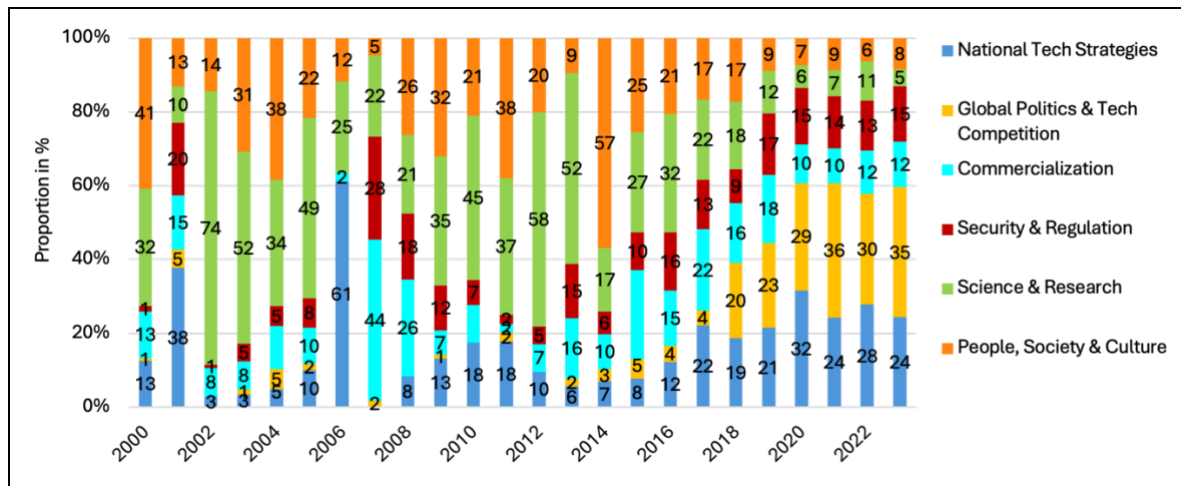


Figure 2. Narratives over time

RQ3: What sentiments do news evoke regarding quantum technology?

Examining Figure 3, showing the distribution of positive and negative sentiment for the overall sample and each topic, it is notable that overall sentiment tends to be neutral with an average score of 0.6 over all articles. Comparing the topics individually, *T6-China: Lead in Tech Developments*, *T31-Nobel Prize*, *T46-Google's Quantum Supremacy* and *T21-Digital Transformation in Business* show the highest values of

positive sentiment. *T7-Ukrainian War & Sanctions on Russia*, *T1-US – China Trade Relations & Tensions*, and *T26-Huawei* score highest in negative sentiment.

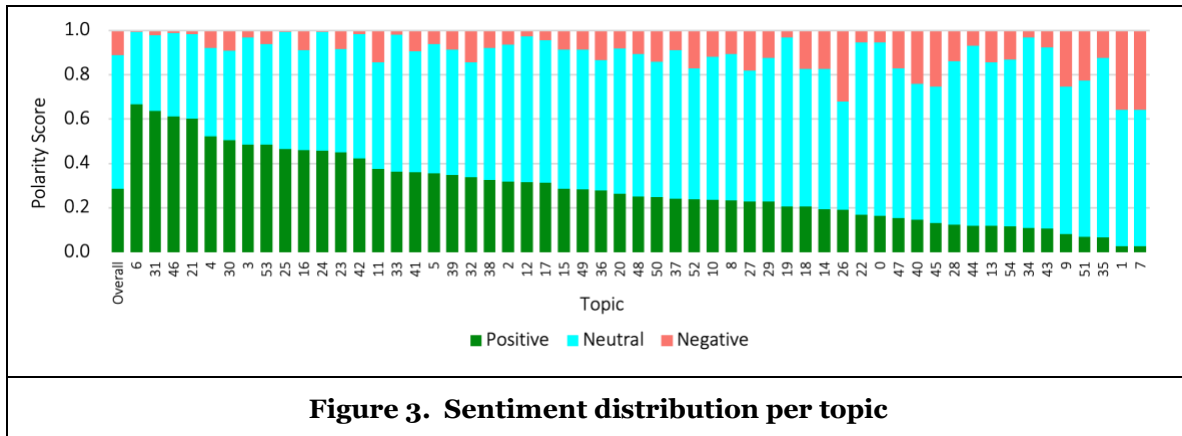


Figure 3. Sentiment distribution per topic

Focusing on each narrative (Figure 4), it is apparent that narratives are dominantly neutral. We also see that positive sentiment is the second most common, while negative sentiment shows the least prevalence for most of the narratives, with *Global Politics & Tech Competition* being a notable exception. Overall, *Commercialization* shows the highest score in positive sentiment (0.41), as well as the lowest in negative sentiment (0.05), compared to the other narratives. *National Tech Strategies* follow with positive sentiment at 0.37 and negative at 0.08. *People, Society and Culture* is third, comparing positive sentiment with a score of 0.33 and negative sentiment at 0.13.

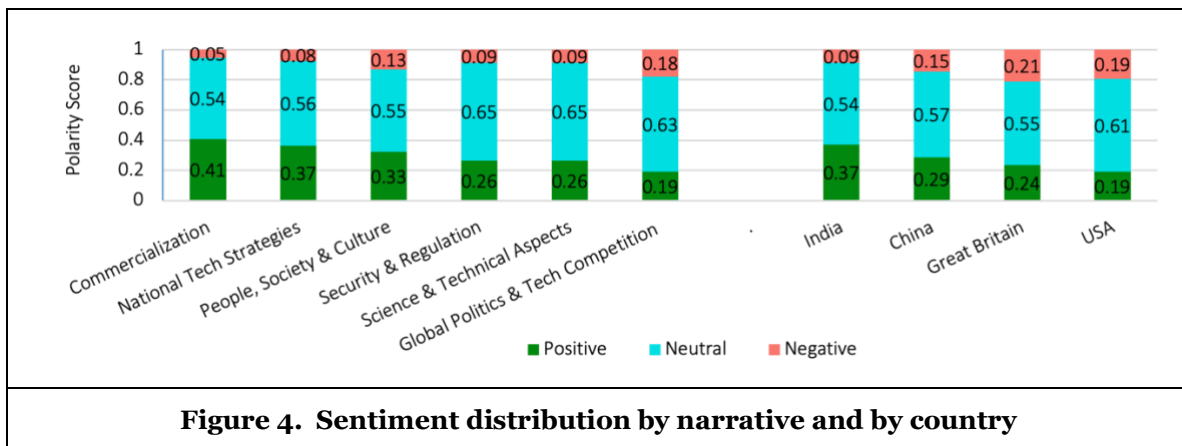


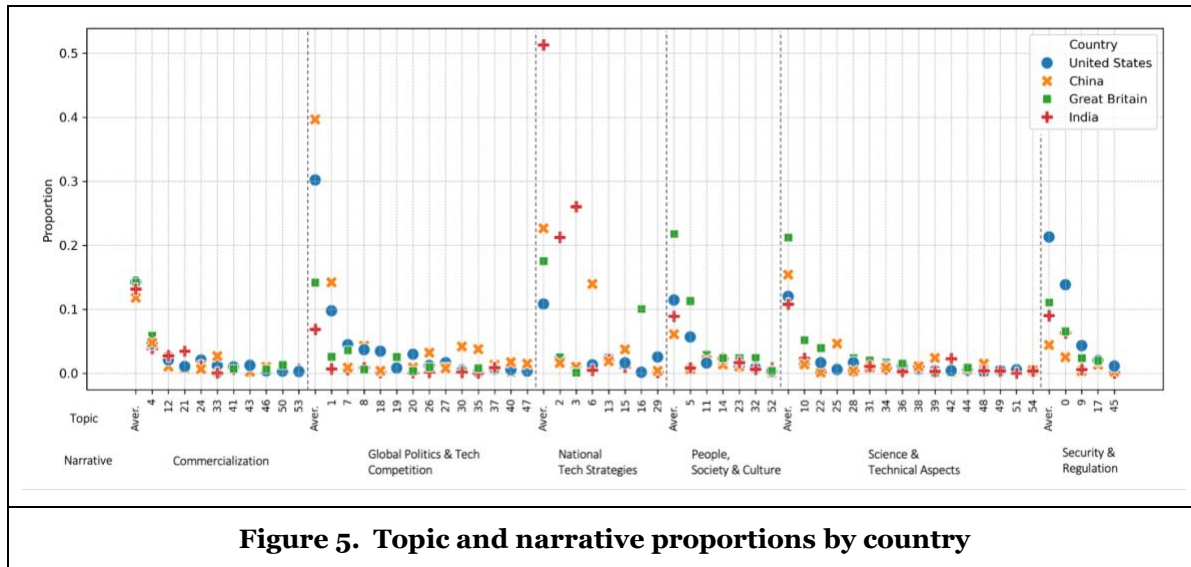
Figure 4. Sentiment distribution by narrative and by country

RQ4: Are there country-specific differences regarding news coverage about quantum technology?

A comparison of sentiment across locations (Figure 4) shows that news coverage in India exhibits the highest score of positive sentiment (0.37), followed by China (0.29), while both have the lowest values in negative sentiment at a score of 0.09 and 0.15. This must be interpreted in the context of respective local media landscapes including restrictions and censorship. Compared to India, the UK and the US articles show more than 10% less positive sentiment and higher values of negative sentiment (around 0.20).

Taking a closer look at the distribution of topic proportions among the countries and the underlying narratives (Figure 5), we draw the following conclusions: Topics from *National Tech Strategies* are dominantly prevalent in the countries they target, like e.g. *T-6 China: Lead in Tech Developments* in Chinese news articles, with very little to no prevalence in articles of other countries. Focusing on the narrative of *Global Politics and Tech Competition* it is notable that Chinese and US media especially tend to mention topics that focus on competition in the tech industry, contributing to the overall picture of a US-China quantum race being established. Further, US and Indian news articles show a higher prevalence of

topics with commercial aspects. Topics regarding *Security and Regulations* are most prevalent in the US, followed by UK media. Topics about *People, Society and Culture* are primarily prevalent in UK news.



Discussion and Implications

Our analysis of 2,331 news articles from the US, UK, India, and China examined evolving media narratives on quantum technology. Using BERTopic and sentiment analysis, we identified six narratives, as well as 54 topics, providing a nuanced overview of how media shapes the agenda for this technology. Over a span of 20 years, the findings showed a shift from narratives about science and society to increasing attention on international political and economic competition. Our insights about the narratives on Global Politics, Tech Competition, and Security and Regulation align with previous findings that identify quantum technology as an arena for geopolitics and a potential threat to current cybersecurity infrastructure (Seskir et al. 2023) Further, we provide new insights into how media discourse shapes the agenda for quantum technology and its implications for stakeholders from this domain.

Our Sentiment analysis revealed predominantly neutral sentiment with a tendency towards positivity, particularly in narratives related to national tech strategies or commercial aspects. While this positivity may accelerate technology adoption, it risks overlooking potential downsides, possibly leading to future disappointment. Research has shown a connection between sentiment and technology legitimacy (Etter et al., 2018; Markard et al., 2016), suggesting that the current positive framing reduces the likelihood of quantum technology being delegitimized by media.

Further, we see a growing focus on Global Politics & Conflicts in recent years, emphasizing the technological race and tensions between nations. This narrative shows the highest values of negative sentiment observed in all narratives, potentially exacerbating international tensions and fueling public resentment, eventually putting international cooperation on quantum technology development at risk. Given that such cooperation is vital for addressing complex challenges such as cybersecurity or ethical governance, stakeholders should foster a more collaborative discourse (Gasser et al., 2024). Emphasizing the shared benefits of quantum technology, rather than focusing too much on the competitive aspects, could help maintain an atmosphere of international openness and cooperation.

Besides the countries analyzed in our sample, Russia and regions around the Indo-Pacific were mentioned in the articles. However, the lack of significant coverage of regions such as Africa or Latin America in our view suggests, that certain parts of the world are being left out from discussions about quantum technologies. This oversight raises concerns about a growing global imbalance and underscores the need for democratization and global access to the technology. Including these economic regions in the discourse is crucial, given the transformative potential of quantum technology and the need to prevent a "quantum divide" that could intensify existing global inequalities (Seskir et al., 2023; Ten Holter et al., 2022). We argue that this finding might occur due to the current early stage of quantum technology and a hype-cycle

period focused on progress and economic opportunities. Stakeholders should however ensure a dialogue that involves stakeholders from these underrepresented regions and develop potential strategies to democratize quantum technology.

Furthermore, the discussion of quantum technologies highlighted significant differences between countries. Media coverage in India and China was more positive, with only minimal critical sentiment. Further, while China focuses more on technical aspects and progress in a positive sense, US and UK media are picking up the narratives about risks new technologies pose to data security. We argue that these differences in sentiments result from distinct degrees of press freedom in media systems influencing the tonality of news coverage. For example, in countries such as China, where there is a high level of media censorship, coverage may be skewed toward more positive news and underrepresent negative sentiment to comply with government policy. Compared to India, the UK and the US articles show less positive sentiment and higher values of negative sentiment, indicating a more critical discourse in these countries when it comes to quantum technology. To ensure that stakeholders have a balanced understanding of quantum technologies, we do advocate for a critical examination that includes both positive and negative perspectives. This approach promotes realistic expectations and also helps avoid the risk of a “quantum winter”.

These results enhance the existing body of research by providing insights about the public portrayal of quantum technology. By analyzing the evolution of narratives and topics over time, our results are indicators for what the broader public perceives as important, potentially impactful, or critical about this innovation. These insights can be further used by researchers to develop frameworks for responsible quantum technology that address ethical, legal, and societal aspects in a grounded manner. Although such frameworks already exist (Gasser et al., 2024), our findings provide real world context for e.g. safeguarding and engaging principles. These could include proactive strategies to address the public’s concerns about cybersecurity threats posed by quantum technologies. Similarly, engaging principles could focus on fostering a quantum discourse that involves underrepresented regions and stakeholders to mitigate the risk of global imbalances. From a governance perspective, our findings suggest the need for inclusive governance strategies that democratize access to quantum technology. As a practical contribution, this study therefore provides policymakers, industry leaders, and IS professionals with detailed insights into current and emerging narratives and topics around quantum technology that could influence public perception and for example inform policy making. Insights into current trending or critical topics are useful for companies developing such technologies and adjusting their strategies accordingly.

Limitations and Future Research

While our study provides valuable insights, it is not without limitations and offers opportunities for future research. Since our focus was exclusively on English-language articles, future research should consider news coverage in native languages. Moreover, to understand the media discourse regarding quantum technologies and investigate possible inequalities, other economic regions, such as the global south should be analyzed. We focused exclusively on news articles as a representation of public discourse. Including other perspectives, e.g. from social media or public stakeholders such as governments, would be beneficial. This approach would allow us to not only confirm but further elaborate on our finding’s implications for both theoretical knowledge and practical application in the field of information systems. Future studies should also investigate how specific narratives influence public perception, e.g. in an experimental setting. Understanding these dynamics is essential for assessing the effectiveness of narratives in shaping attitudes and behavior towards new technologies. Next, quantum technologies are still developing rapidly, with uncertainty regarding future applications. As the technology evolves, its narratives will also change. Future research should track these changes to understand their broader societal and economic impacts. Lastly, our approach utilizes quantitative methods, offering a broad but generalized overview of the QT discourse. To enhance these findings, future studies could adopt qualitative methods to gain more detailed and nuanced insights into particular themes within the QT discourse. The findings in this study serve as a starting point for such investigations.

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