Article

Exploring Hype in Metaverse: Topic Modeling Analysis of Korean Twitter User Data

Seungjong Sun [1], Jang-Hyun Kim [1,2,3], Hae-Sun Jung [2], Minwoo Kim [1], Xiangying Zhao [1,3] and Pim Kamphuis [3,*]

[1] Department of Human Artificial Intelligence Interaction, Sungkyunkwan University, Seoul 03063, Republic of Korea; tmdwhd406@g.skku.edu (S.S.); alohakim@skku.edu (J.-H.K.)
[2] Department of Applied Artificial Intelligence, Sungkyunkwan University, Seoul 03063, Republic of Korea
[3] Department of Interaction Science, Sungkyunkwan University, Seoul 03063, Republic of Korea
[*] Correspondence: p.i.m@skku.edu

Abstract: Growing expectations and interest in the metaverse have increased the need to explore the public hype. This study measured the hype in the South Korean metaverse context and analyzed its temporal pattern. To this end, 129,032 tweets from Korean users who used the "metaverse" keyword were collected, and 86,901 tweets were analyzed. Using BERT-based topic modeling, a content analysis was performed. The extracted topics were classified into three expectation frameworks: specific expectations, generalized expectations, and frames. Our results imply that the pre-emptive inflation of expectations by the Korean government caused the public's excessive expectations of the metaverse. Additionally, by using Twitter as a source for analyzing user-perceived hype, it was confirmed that the public responds to the expectations of other actors about the technology rather than expecting the technology itself. Furthermore, pronounced hype dynamics were observed by analyzing the distribution of topics over time.

Keywords: metaverse; hype cycle; Twitter; topic modeling

1. Introduction

Since 2020, the metaverse has attracted significant attention [1]. The metaverse is a space where individuals interact with the world, objects, people, and even the real world by using an avatar representing themselves in a three-dimensional virtual world [2,3]. It is expected that the metaverse will engage in and facilitate a wide range of economic sectors, including the medical field, education, ecommerce, and entertainment [4]. The worldwide metaverse market was valued at USD 38.85 billion in 2021, and it is expected to exceed USD 772.24 billion by 2030 [5]. However, there are criticisms of the expectations for the metaverse, such as that the metaverse is nothing more than a buzzword—a new product of companies for commercial profit [6]. Such excessive expectations and disappointment of new technologies suggest that the technology has hype [7,8].

Hype is described as intense and excessive advertising or sales promotions intended to foster a positive environment before and after launching a technology or product [9]. Hype is created to increase the success of the introduction, but it can also be harmful; when a product or service is over-hyped, the public can easily be disappointed [10]. However, despite its drawbacks, hype aims to make technology more enticing.

Hype is a concept that has been widely used in business but has recently begun to be used as a theoretical background for studying the diffusion and acceptance of technology in academia [11]. In particular, Gartner's hype cycle model has gained substantial attention from practitioners; however, over recent decades, it has received rapidly increasing attention from the technology and innovation management literature [7,12].

2. Metaverse

The metaverse is an interactive and immersive virtual world, allowing users to engage with the world and interact with objects using their avatars [1,13]. Recent developments in immersive technologies, such as virtual reality (VR), augmented reality (AR), and mixed reality (MR), as well as more advanced network technologies, such as 5G Internet, enable the Metaverse to serve as a space for learning, business, and entertainment [14].

The tech sector is looking at the metaverse as having new economic potential because of the recent boom in interest [1]. Through the metaverse, businesses may engage customers and employees virtually and expand into new markets. Facebook, a social networking giant, has declared its intention to embrace the metaverse as the next phase of social interaction and has even changed its corporate name to Meta to reflect their commitment to the metaverse [15]. Additionally, Nvidia and Microsoft pioneered the market by developing their own metaverses, known as Omniverse and Teams [1].

In addition, there is ongoing academic research on the metaverse. Since the term is in the early stages of gaining attention, studies are being conducted to argue for the metaverse's definition, opportunities, and challenges. Park and Kim [16] examined research on the related metaverse, avatar, and extended reality (XR) concepts. Park and Kim addressed the three essential parts of the metaverse (hardware, software, and content) in detail. Dwivedi et al. [17] investigated metaverse topics in detail by combining a well-informed narrative with a multidimensional approach from specialists with various academic backgrounds to the facets of the metaverse and its transformative effects.

2.1. Hype in the Metaverse

Despite the explosive interest, there have been criticisms of the metaverse. Some critics refer to the metaverse as an ambiguous concept, a kind of existing virtual world newly declared by IT giants [18]. Alternatively, another criticism is that the metaverse is just a buzzword to encourage new consumption [6]. Others, however, think that the metaverse is not just a fad but an evolution already in motion [19]. Technology businesses generate enthusiasm for the metaverse by declaring themselves metaverse companies or building a metaverse to supplement and enhance people's physical and digital realities [20]. These expectations and criticisms of the metaverse suggest that there is hype in the metaverse.

As a proxy for measuring hype, prior studies used the volume of related literature publications and related keyword search queries [11]. The following section describes these two metaverse indicators. First, 784 publications were found by searching the Scopus database using the keyword "metaverse" (see Figure 1). Studies related to the metaverse surged to over 549 publications in 2022, with most publications coming from China, the US, and South Korea, in that order.
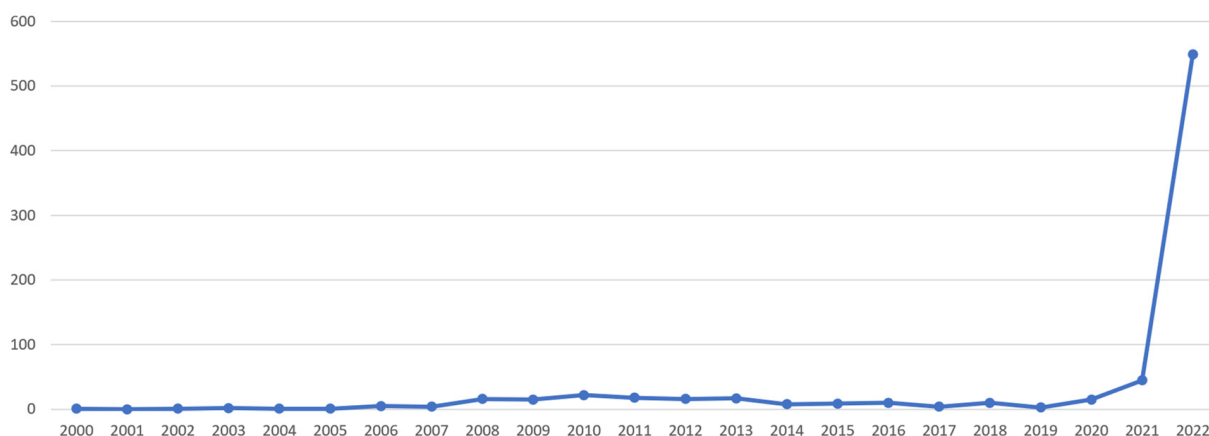

Figure 1. Number of publications related to the metaverse.

Second, search traffic was analyzed using Google Trends. Figure 2 shows a representation of the number of metaverse-related web searches on Google over the last five years. The blue line indicates global search queries with the term 'metaverse', while the orange line accounts for searches including 'metaverse' or "메타버스" (metaverse in Korean) in South Korea. Search traffic peaked in October 2021 in both Korea and the rest of the world. The amount of search traffic in Korea started to increase from February to October 2021, whereas worldwide interest sharply increased in October 2021. This peak in metaverse-related search traffic was maintained until February 2022 and then started a gradual decline. While a global decrease in search traffic can be observed, the decline in search queries in Korea appears to be less steep.
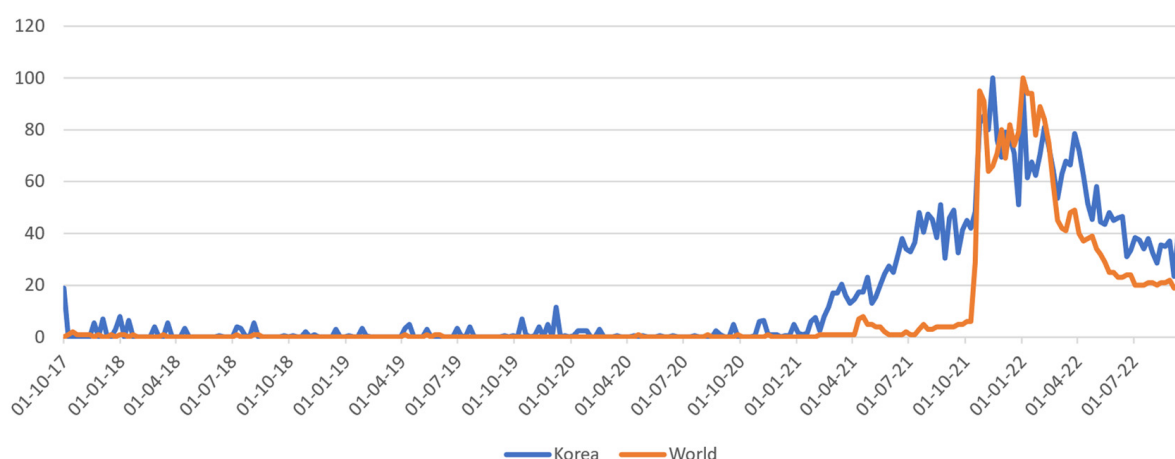

Figure 2. Google search trend comparison between Korea and worldwide.

These trends indicate that the metaverse is receiving relatively high interest in Korea. This is due to the activeness of government policies and corporate activities regarding the metaverse. The Korean government aspires to take the lead in the metaverse market and plans to fund the development of the metaverse with KRW 9.3 trillion by 2022. An estimated KRW 2.6 trillion (approximately USD 2.2 billion) will be spent on blockchain, the metaverse, and other related technologies by 2025 [21]. Moreover, the Ministry of Science and ICT launched the Metaverse Economic, Social, and Cultural Forum on 30 September 2021, in order to predict and respond to the economic and social changes caused by the metaverse [22]. Owing to such active investment and support for the metaverse, interest in the metaverse is growing rapidly in Korea.

Previous studies have examined the implications of the metaverse in Korea. Han and Kim [22] identified topics and major keywords by collecting and analyzing metaverse-related news data through topic modeling. Furthermore, Kim et al. [23] presented implications for the metaverse phenomenon in Korean society by analyzing news data through collection and topic modeling. In addition, Lee [19] identified and analyzed the hype of the metaverse in Korea through a time-dependent count of search traffic, news articles, and research articles and applied topic modeling for analysis of news articles and research articles.

Although these studies use data-driven analysis to reveal interest in and expectations of the metaverse in Korea, they have limitations in that they only describe the results without providing a theoretical explanation [24]. Therefore, this study analyzes the metaverse hype in the Korean context by referring to the hype cycle model and its theoretical discussion.

2.2. Hype Cycle Model

One commonly used approach for mapping the trajectory of a technology in terms of its perceived value or visibility over time is the hype cycle model, which was created by

Gartner Inc. back in 1995 [11]. It is created by combining two unique equations/curves; the first is human-centric and expresses expectations in the form of a hype-level curve, and the second is a traditional technical S-curve depicting technological maturity) [25].

This hype cycle is divided into five stages (see Figure 3):

1. Innovation trigger: The hype cycle for innovation or technology begins with a first event that sparks the interest of the media and industry. Public presentations, research publications, news items or opinions, and the registration of patents are examples of how an event might take place.

2. Peak of inflated expectations: A peak in public conversations, optimistic future predictions, and upbeat expectations that may exceed the reality of the innovation's capabilities.

3. Trough of disillusionment: Expectations gradually decline over time. Extremely optimistic and hyped projections about the innovation's potential will scale back.

4. Slope of enlightenment: The innovation has passed the hype stage and becomes mature. Increased adoption leads to a greater understanding of the technology context, which improves performance. This may persuade more people to adopt the invention.

5. Plateau of productivity: Innovation's acceptance rate continues to rise as its benefits and real-world applications are confirmed. Adoption spreads throughout society and organizations, with the levels of perceived risk now greatly reduced.
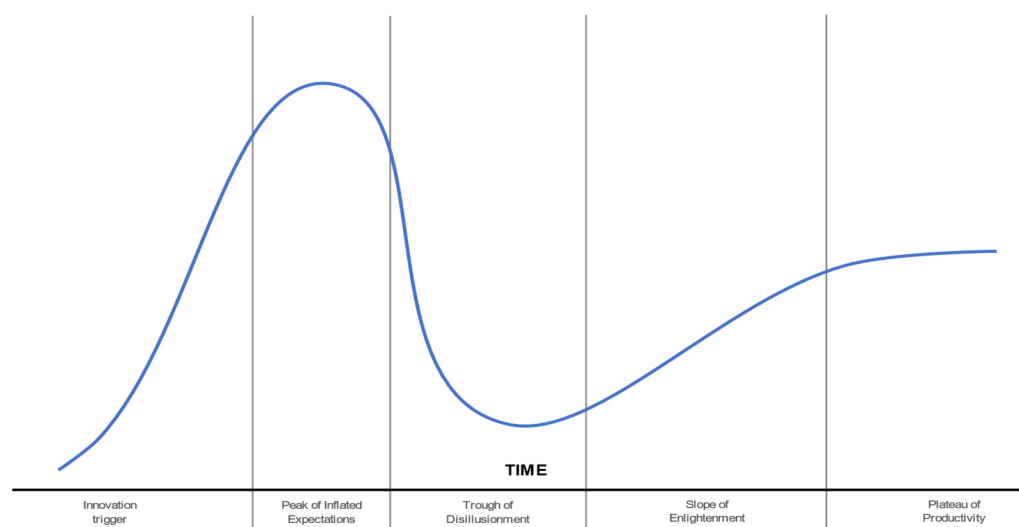

Figure 3. Hype cycle model [25].

Hype Cycle Model in the Literature

Although the hype cycle model has received continuous attention from practitioners, its discussion has been lacking in academia. In the last decade, scholars have attempted to theoretically establish and develop the hype cycle model [11]. There are two major research problems in hype cycle studies: (1) How can hype be detected and measured? (2) Is the trajectory of the hype cycle model reasonable?

The horizontal axis (x) of the hype cycle represents the passage of time, and the vertical axis (y) represents expectations [25]. The variables of expectation include news volume, news sentiment, financial factors, and the level of web and market research data indicators. It is measured using a proxy indicator [25].

Previous research has sought theoretical confirmation of the hype cycle through empirical investigations. Järvenpää and Mäkinen [9] explored the application of the hype cycle to real-world empirical data. Comparing the publication trends of tech newspapers (e.g., Electronic Engineering Times) and mainstream newspapers (e.g., New York Times) on DVD players, they suggest that the peak of hype appeared earlier in the former. In subsequent studies, qualitative analysis was performed with quantitative analysis. Alkemade

and Suurs [7] first examined the expectations associated with three sustainable mobility technologies in the Netherlands using the Lexis/Nexis news database. Concurrently, Alkemade and Suurs specified some crucial characteristics of each article, such as whether the expectation is positive or negative, whether the expectation is general or specific, whether the expectation is short- or long-term, and who is stating the expectation. The strategic responses of those involved in the development of stationary fuel cell innovation were examined using news article content analysis [26]. According to their findings, many articles were upbeat when the hype was building and less optimistic when expectations were falling short.

In addition, some studies have approached new data. Publications by Jun [27,28] support the "search traffic" technique for researching and predicting technological adoption. Jun examined hype cycles in relation to the user, producer (or researcher), and information distributor—the three major actors that make up a socio-technical system [29]. Data were acquired via web search traffic for users, patent applications for producers, and news articles for information distributors.

In line with these studies, there are two considerations in measuring expectations in the hype cycle. First, qualitative analysis, such as content analysis, should be conducted to measure expectations. Second, hype phenomena may be observed differently by different stakeholders.

Conversely, there have been discussions about the shape of the hype cycle suggested by Gartner. As previously stated, the hype cycle is a time-based trajectory separated into five stages. Empirical studies have been conducted to determine whether real-world technologies follow this pattern.

According to Van Lente et al. [8], the hype curve can be determined by three factors: the shape of the peak, the depth of the dip, and the overall length of the hype. The study found variances based on the characteristics of the technology or the environment surrounding it. This shows that the pattern of actual technological expectations does not correspond to the hype cycle. Dedehayir and Steinert [11] attempted to demonstrate the explanatory capacity of the hype cycle through a meta-analysis of empirical studies. Only nine of the twenty-three empirical findings are explained by the authors as having displayed a hype cycle pattern. In eight other studies, a pattern of hype disappointment was observed. However, this pattern did not fully represent a hype cycle pattern because there was no recovery time after the disappointment. Additionally, there were two occurrences of fluctuating dynamics and six cases with many peaks and troughs.

According to these studies, the hype pattern does not always follow the trajectory proposed by Gartner. The hype surrounding technology diffusion varies according to the characteristics of the technology and external events [8]. Despite the uncertainty about these hype cycle patterns, measuring and tracking the hype and hype dynamics of technology has value as a tool for understanding and predicting the adoption of technological innovations [11].

2.3. Research Framework

Based on the review of literature discussed above, it is evident that hype surrounding the metaverse exists, emphasizing the importance of conducting research in the Korean context. Our analysis of previous studies on the hype surrounding new technologies revealed two key theoretical insights. Firstly, measuring hype requires both quantitative and qualitative analyses, and the measurement should be tailored to suit the perspectives of different stakeholders. Secondly, the trajectory of the hype cycle model does not necessarily align with the diffusion pattern of technology in the real world. Instead, it depends on the characteristics of the technology and the surrounding environment.

On the other hand, previous studies on the hype surrounding the metaverse have primarily measured hype through the lens of the three stakeholders proposed by Jun [29]. However, these studies have been limited in their qualitative measurement of user hype and have provided little discussion based on the unique characteristics of the metaverse

and its surrounding environment. To address this gap in the literature, this study aims to perform a qualitative analysis of user hype within the metaverse and provide an interpretation of the results based on the distinct characteristics of the metaverse, as well as the temporal and contextual factors specific to the Korean context.

This study analyzed social media data from Twitter to qualitatively investigate the diffusion of hype by users. Social media is considered a medium for generating and transmitting critical information and drawing attention as a research topic [30,31]. Unlike other social media platforms for friendships or personal exchanges, Twitter is a channel with significant information-type network features, such as quick distribution of information and sharing of opinions on societal topics [32]. In previous studies, Twitter data were used to analyze innovation diffusion patterns [33].

In prior studies, content analysis has been offered as a qualitative approach for identifying hype. A previous study used content analysis to categorize data (e.g., articles, events) as positive/negative, specific/general, based on researcher's assessment [7]. However, this strategy has the limitation that personal bias could arise. Therefore, this study adopts topic modeling as an objective content analysis to address this shortcoming. Topic modeling is a useful methodology for deriving a latent agenda in a large amount of text and is used in social media data analysis research [34].

Therefore, this study investigates users' perceptions of the metaverse in the Korean context using two years of Twitter data. The research questions were as follows:

RQ1: *What hype about the metaverse happens on Twitter by Korean users?*

RQ2: *How has the hype of the metaverse changed over the past two years?*

3. Method
3.1. Data Collection

To answer the research questions, 129,032 Twitter posts spanning a two-year period were collected. The collected tweets were posted between 1 September 2020 and 31 August 2022. This follows prior literature that metaverse-related tweets started appearing in the fourth quarter of 2020 [19]. Only tweets containing the Korean keyword "메타버스" (metaverse in Korean) were collected. The Twitter developer API and Python programming language were used for the data collection.

3.2. Data Pre-Processing

A series of pre-processing steps were performed on the textual data using Python to prepare the tweet dataset for analysis. First, normalization was performed on the text for Korean natural language analysis. Retweets, mentions, URLs, and hashtags were removed and all texts that did not correspond to Korean, such as English letters and numbers, were excluded. After removing duplicate texts in the original dataset of 129,032 tweets, 86,303 tweets remained. Additionally, words with little semantic significance were eliminated from the corpus, such as the Korean equivalents of the stop words "this" and "that."

3.3. Topic Modeling

Topic modeling was used to extract latent topics from the tweet data. The main purpose of this analysis is to examine the discourses that primarily appear and to determine how often these topics appeared over the two years.

Topic modeling is a clustering method to extract latent topics from vast amounts of textual data [35]. Topic modeling is used in scientific research as a method for classification, categorization, and segmentation of textual data [36–38]. In this study, Bidirectional Encoder Representations from Transformers (BERT) is used for topic modeling. Latent Dirichlet Allocation and Probabilistic Latent Semantic Analysis have been widely used for topic modeling; however, these methods require several topics and morpheme analysis to obtain optimal results, and they have the disadvantage of ignoring semantic relationships [39]. Therefore, the BERTopic technique was proposed to generate a coherent topic

expression by utilizing the clustering technique and class-based transformation of term frequency-inverse document frequency (TF-IDF) [39]. BERTopic is a topic modeling technique that uses BERT-based embedding and c-TF-IDF word weights in the text embedding stage and then performs text clustering for each domain to find potentially meaningful topics in the text [39]. BERTopic was confirmed to show high topic coherence and diversity compared to other topic modeling techniques.

The BERTopic package in Python was used. The pre-processed text dataset was embedded with the Korean SBERT embedding model for the analysis. Next, the Python package kiwipiepy was used for tokenizing. In the clustering process, hierarchical density-based spatial clustering of applications with noise (HBDSCAN) with built-in BERTopic is intended to operate on English data that have not been pre-processed. This study used the k-means clustering model for the cluster algorithms to analyze the pre-processed Korean text dataset. Finally, the results of this analysis were translated from Korean into English.

4. Results

As a result of the topic modeling analysis, a total of 13 topics were extracted using the BERTopic clustering algorithm, as shown in Table 1. The extracted topics were classified into three types of expectation as suggested by the work of Ruef and Markard [40] for analyzing hype. Those three types of expectations are specific expectations, generalized expectations, and frames.

4.1. Extracted Topics

(1) Specific Expectations

Specific expectations deal with the expectations for the development of specific functions and systems for innovative technologies and their outcomes. This includes information and expectations regarding metaverse-related policies and projects. The first sub-topic is metaverse, the subject of the fourth industrial revolution. Tweets about the expectations that fourth industrial revolution technologies, such as artificial intelligence, blockchain, and Web 3.0, are being integrated into the metaverse are included (e.g., "Metaverse is at the center of the 4th industrial revolution. Big tech companies are competitively presenting business plans that incorporate metaverse, and various seminars and events are held through metaverse platforms such as Zepeto and Getter Town.").

The second sub-topic is Korea, which leads the metaverse field. Tweets that convey information about the Korean government's active support and investment in the expansion of the metaverse business and each local government's attempts to utilize the metaverse are included (e.g., "Establishing the Korea Metaverse Industry Association, which will be the center of the estimated 31 trillion won in the metaverse market in 2025"; "Seoul city collaborates with North Gyeongsang Province to promote the metaverse project.").

The third sub-topic is global companies leading the metaverse market. News about the metaverse movements of big tech companies, such as Tesla, Apple, and Facebook, as well as discussions on which company will dominate the metaverse business, are included (e.g., "Regarding the space expressed as metaverse, Apple, Meta, and MS seem to have different models, and the market landscape will change depending on which company persuades users well. Google doesn't seem to be interested lol.").

Table 1. Number of tweets for each topic.

Framework of Expectation	Topic Label	Topic Proportion	Topic Keywords	Example Reactions on Twitter
Specific expectations	4th industrial revolution	16.90%	base, utilize, education, global, expand, contract, launch, economy, open,	Metaverse is at the center of the 4th industrial revolution. Big tech companies are competitively presenting business plans that incorporate metaverse, and various seminars and events are held through metaverse platforms such as Zepeto and Getter Town
	Korea as metaverse leader	8.94%	Seoul, Korea, education, culture, Gyeongbuk, first, Republic_of_korea, represent, utilize, Lee_jae_myeong	Establishing the Korea Metaverse Industry Association, which will be the center of the estimated 31 trillion won in the metaverse market in 2025
	Global leading company	2.10%	economy, bitcoin, Tesla, market, currency, Apple, Facebook, change, most, transaction	Regarding the space expressed as metaverse, Apple, Meta, and MS seem to have different models, and the market landscape will change depending on which company persuades users well. Google doesn't seem to be interested lol
	International trends	1.53%	China, dollar, market, scale, Seoul, city, global, economy, Japan, inducement	By 2025, the Chinese metaverse market will have grown ten-fold.
	Relevance to social media	0.50%	Twitter, Facebook, change, Meta, tweet, Zuckerberg, Musk, name, change, company_name	Facebook in crisis change company name to Meta. It is Metaverse all-in. I didn't know that Zuckerberg was so into the Metaverse.
Generalized expectations	Reaction to expectations	45.83%	funny, sound, interesting, like, friend, feel, cute, love, seriously, song	My friend says that if it's fun, it's a game, and if it's not, it's a metaverse. It's hell right, so I think of it and laugh every time.; The metaverse will succeed, I felt it myself yesterday. Human just needs it.
	Expectations and cheers	8.65%	participate, thanks, underpin, interest, exhibition, youtube, various, work, expect, event	The issue I am interested in is that the metaverse is developing again these days;
	Differences from existing content	4.84%	contents, movie, feel, graphic, user, player, most, real, enjoy, friend	This is the reason why MMORPGs like WoW are always mentioned when describing the metaverse. You cannot explain the metaverse by listing only technical elements. The essence of the metaverse lies in culture and experience, while technology helps.

Table 1. *Cont.*

Framework of Expectation	Topic Label	Topic Proportion	Topic Keywords	Example Reactions on Twitter
Frames	Negative reactions	2.46%	bloody, stop, hell, serious, sound, fail, impound, date, wow, total	What the hell is that metaverse; what the metaverse is? how is that different from a game, I don't understand.
	Market scale	1.64%	Facebook, dollar, Apple, market, scale, change, semiconductor, inducement, this_year, global	By 2030, the metaverse will reach a market size of $5 trillion and continue to grow. The largest revenue are from e-commerce at $2.6 trillion, virtual learning at $70 billion, advertising at $206 billion and games at $25 billion.
	Profitability of Metaverse	2.91%	market, bitcoin, profit, economy, related_stock, currency, rise, situation, fell, interest	A metaverse must be able to generate profits in that space. It is not just about calling any game a metaverse. This is it, talking about this and not mentioning Ethereum can be said that you don't know a single thing about the metaverse . . . .
	Academic interest	2.61%	study, friend, funny, professor, animal, feel, interest, enjoy, like, picture	My professor also continuously said that the metaverse is a concept that has existed before, and if you search for papers, there are a lot of existing data, so it will be easy to write a report if I find it well, and there are actually a lot of them.
	Education	1.09%	education, tree, participate, utilize, apply, group, kids, campaign, recruit, course	Metaverse application in education that will change the process of education that has not changed for 100 years

The fourth sub-topic concerns the international status of the metaverse. Information on metaverse-related policies in each country is included (e.g., "By 2025, the Chinese metaverse market will have grown ten-fold."; "Japanese cryptocurrency exchanges form an alliance with the goal of becoming a metaverse leader.").

The fifth sub-topic concerns the metaverse and social media. A tweet about the issue of Facebook changing its name to a meta was found ("Facebook in crisis change company name to Meta. It is Metaverse all-in. I didn't know that Zuckerberg was so into the Metaverse."). Also, some users say that Twitter is related to the metaverse ("I'm really curious about why Elon Musk buys Twitter stock. If he is thinking about the metaverse, shouldn't we also buy it?").

(2) Generalized Expectations

Generalized expectations deal with discussions and developments in the overall technical field and opportunities. Topics discussing the definition and prospects of the metaverse were extracted from the results of this analysis. The first sub-topic is the reaction to expectations in the metaverse. Tweets were found in positive and negative reactions to discourse about the metaverse (e.g., "My friend says that if it's fun, it's a game, and if it's not, it's a metaverse. It's hell right, so I think of it and laugh every time."; "The metaverse will succeed, I felt it myself yesterday. Human just needs it.").

The second sub-topic is expectations and support for the metaverse. Tweets expressing expectations and interest in the metaverse ("The issue I am interested in is that the metaverse is developing again these days.") and positive reactions after experiencing the metaverse service ("The trip to the metaverse gallery was really fun. I didn't notice the time passing, and when I looked at the work, two hours had passed. Thank you for giving me a good time.") were included. In addition, metaverse-related non-fungible token (NFT) holders expressed their profit and project success expectations (e.g., "cheering for the development and success of high-quality 3D metaverse NFTs. More events please.").

The third sub-topic is the difference between the metaverse and existing content (e.g., video games or VR games). It includes discourses on what makes the metaverse different from online games like MMORPGs ("This is the reason why MMORPGs like WoW are always mentioned when describing the metaverse. You cannot explain the metaverse by listing only technical elements. The essence of the metaverse lies in culture and experience, while technology helps."; "I think it's probably distinguished by the presence or absence of purpose. Each game has a goal presented by the developer, but the metaverse is missing a lot of those elements [. . .]"). There were also tweets that refer to SF movies like "Ready Player One" to demonstrate the metaverse ("I watched the Ready Play One movie and I had so much fun thinking, "This is almost the near future." This was released in 2018, but after 21 years and 3 years, a metaverse like Ready Play One is actually going to be built. No, it's already started . . . ").

The fourth sub-topic is negative reactions to the metaverse. This includes tweets from users claiming that the metaverse is nothing new or that they find it boring (e.g., "what the hell is that metaverse"; "damn the metaverse"; "what the metaverse is? how is that different from a game, I don't understand.").

The fifth sub-topic concerns the metaverse market scale. It includes tweets discussing the growth and scale of investment in the metaverse market and expectations for new opportunities in the field (e.g., "The metaverse world is coming. A new growth engine following semiconductors and batteries [. . .]"; "By 2030, the metaverse will reach a market size of $5 trillion and continue to grow. The largest revenue is from e-commerce at $2.6 trillion, virtual learning at $70 billion, advertising at $206 billion and games at $25 billion.").

(3) Frames

The frames are the expectations of new technological fields in terms of social, political, and economic aspects. This theme encompasses expectations on how the metaverse will be utilized in economics, academics, and education. The first frame concerns the economic potential of the metaverse. Tweets on how the metaverse could provide individuals with

economic income and investment opportunities were included (e.g., "A metaverse must be able to generate profits. It is not just about calling any game a metaverse. [. . .]."; "Even common mmorpgs are metaverse if you insist on it, but they have no productivity. They don't give any benefit to my profit or reality lol. But now I can sell items I've made and exchange them for real money [. . .]").

The second sub-topic is academic interest in the metaverse. Twitter users showed their interest in studying the metaverse (e.g., "My professor also continuously said that the metaverse is a concept that has existed before, and if you search for papers, there are a lot of existing data, so it will be easy to write a report if I find it well, and there are actually a lot of them."; "In order not to be eaten up by the new concept platform called the metaverse, I have to study, but I wonder if I can do it.").
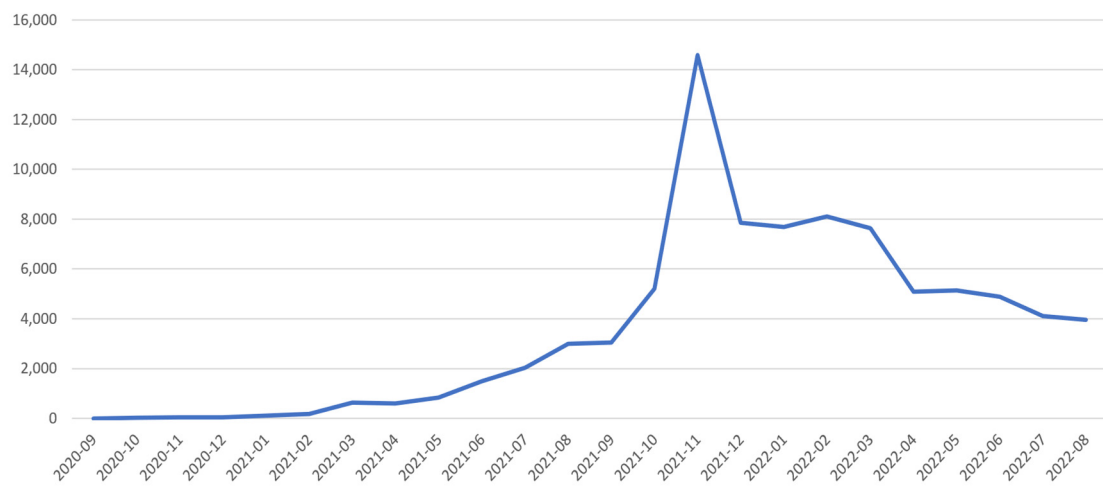
The third sub-topic concerns education using the metaverse. It includes the expectation that the metaverse will become a new environment for non-face-to-face education and cases were described in which local governments, universities, and companies have used the metaverse for education (e.g., "Metaverse application in education that will change the process of education that has not changed for 100 years."; The Gyeongnam Office of Education provided instruction on how to use the metaverse when developing career education resources for students.").
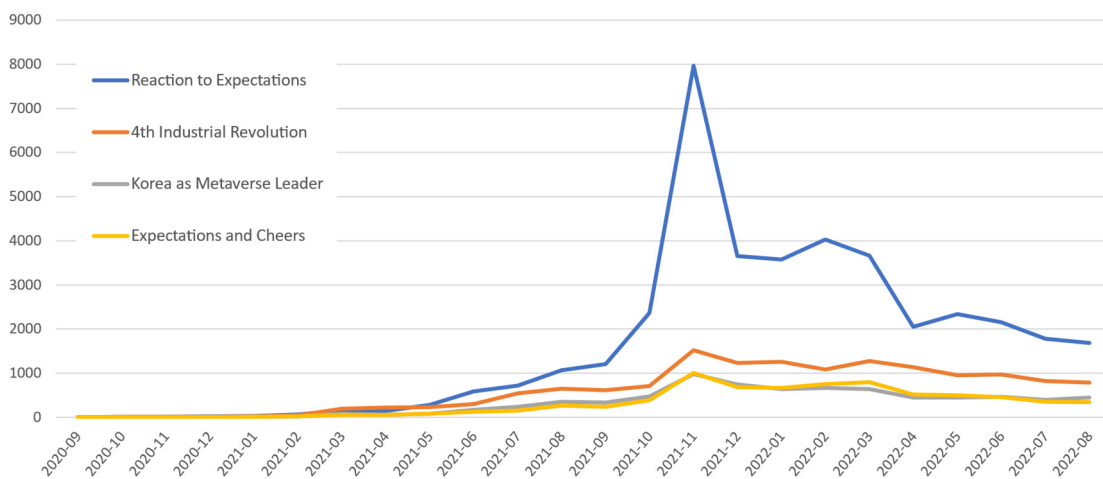
4.2. Topic Proportions and Relations over Time

To answer research question two and thereafter determine whether timely patterns impacted topic proportions, the distribution of the extracted topics over time was analyzed. Figure 4 shows the frequency of the total number of tweets over time, and Figure 4a–c show the frequency of the number of tweets for each topic. Tweets including the keyword "metaverse" began to rise in March 2021 and continued to rise gradually until August 2021. The market scale topic increased significantly in March 2021 in response to the debut of Roblox, known as a representative metaverse game, on 10 March 2021. Before May 2021, topics about the "4th Industrial Revolution" accounted for the largest number of tweets. After May 2021, however, the topic of reaction to expectations to the metaverse recorded the greatest number of tweets.

In October 2021, the total number of tweets increased significantly. During this time, tweets about "reaction to expectations" to the metaverse surged. Until September 2021, on this topic, there were reactions about public interest in the metaverse, such as "In fact, I never imagined that the metaverse would be so popular". There was also a response that the metaverse is a technology that does not yet exist (e.g., "Even, Nvidia is looking at commercializing the metaverse for at least 20 years, the metaverse that entrepreneurs are currently discussing is rubbish."). From October 2021, the number of responses from people who experienced metaverse-related services increased rapidly (e.g., "it's too hard to play the metaverse, I'm not used to moving [. . .]"; "Playing Metaverse is quite challenging. I'm unable to change point of view [. . .]"; "I had to give up accessing Metaverse concert after crashing 3 times, but it was fun lol. I couldn't hear the sound well, but first of all, this was the first hip-hop concert I went to and I can see people dancing in the air [. . .]").
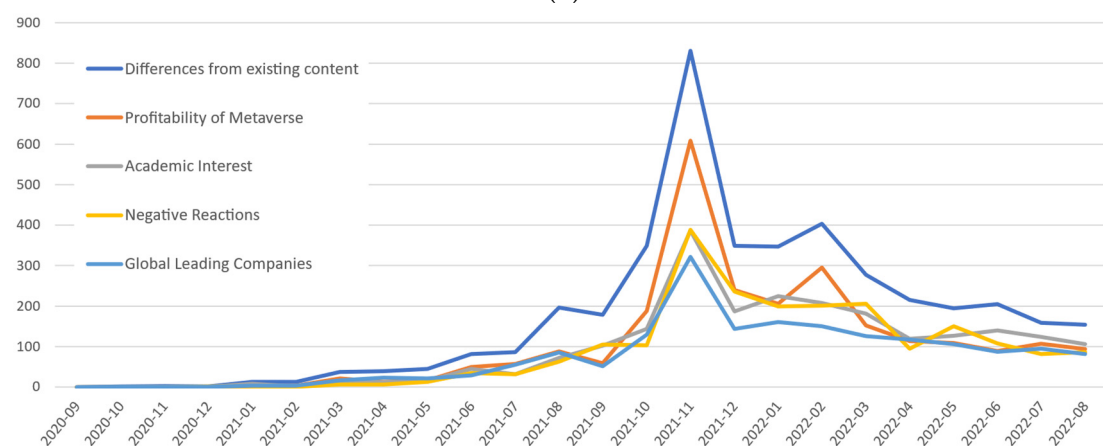
The overall number of tweets would surge and reach a peak in November 2021. During this period, topics such as "difference from existing contents", "profitability", and "relevance to social media" increased significantly, as well as "reaction to expectations". One of the reasons for this surge is that, on 28 October 2021, Facebook declared that it would change its name to Meta. In this regard, in relation to social media, there were tweets such as "Facebook bet everything on Metaverse and changed its name to Meta because it knows that Metaverse will surely become the next-generation SNS in the future [. . .]".

(**a**)

(**b**)

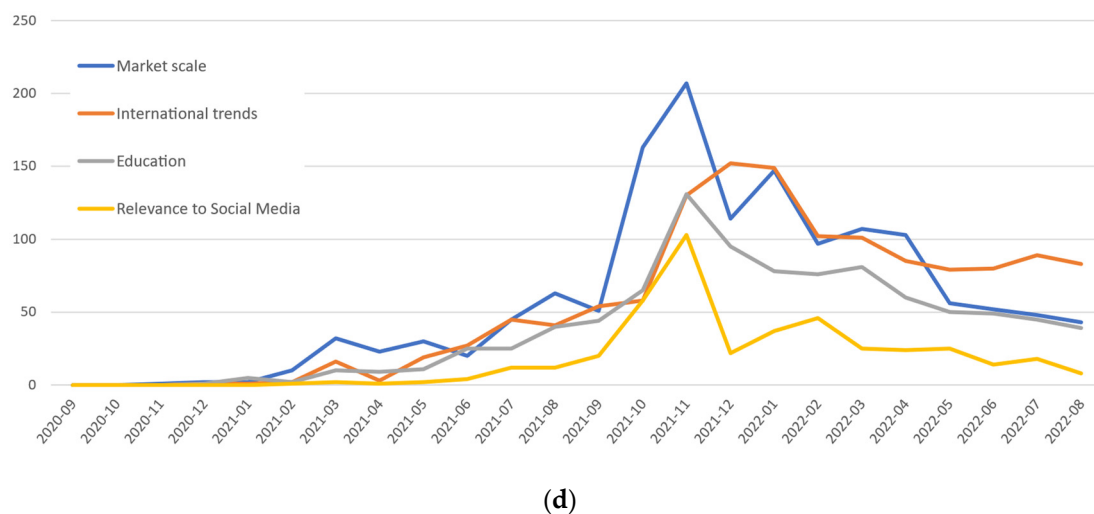

(**c**)

Figure 4. *Cont.*

(**d**)

Figure 4. (**a**): Total number of tweets over time. (**b**): Total number of tweets in *specific expectations* over time. (**c**): Total number of tweets in *generalized expectations* over time. (**d**): Total number of tweets in *frames* over time.

Subsequently, the total number of tweets declined significantly by December 2021. The topic that showed the steepest decline was relevance to social media, which seems to reflect the reduced interest in Facebook's name change. The topic that showed the least decline was "negative reaction", which contained tweets containing short, negative reactions about the metaverse (e.g., "NO METAVERSE", "STOP THE METAVERSE"). It seems that the negative reactions that formed after intensive attention in the metaverse continue. The only "international trends" topic increased rather than decreased until December 2021. This seems to be a response to issues such as China-related metaverse regulation (e.g., "China started regulating P2E metaverse games linked to blockchain").

After that, the total number of tweets decreased moderately and then slightly increased again in February 2022. During this time, many skeptical tweets about the metaverse appeared. In the "profitability" topic, which showed a large increase at this time, there were tweets saying that the metaverse was just a commercial concept for firms (such as "[. . .] I think it might be ok for investment, but I think it's nothing more or less than that. Metaverse is not a big deal, I don't think it was a new idea or an invention at all [. . .]"; "[. . .] I still don't know the fundamental reason why everyone is crazy about the metaverse, I think it's a wingman trying to create a new flow of money [. . .]"). The downward trend continued until August 2022, at the end of data collection.

Furthermore, the distributions of the number of tweets for each expectation framework over time were analyzed (see Figure 5). The temporal patterns of the generalized expectations and frames were similar. However, the flow of specific expectations showed a difference, and more tweets were distributed from March to September 2021. The specific expectation showed a relatively small rise in October and November 2021. In addition, expectations showed a relatively small rise until it reached its peak in November 2021. Nearly 20% of tweets were on generalized expectations and frames themes which were distributed in November 2021, while only 11.8% were on specific expectations.
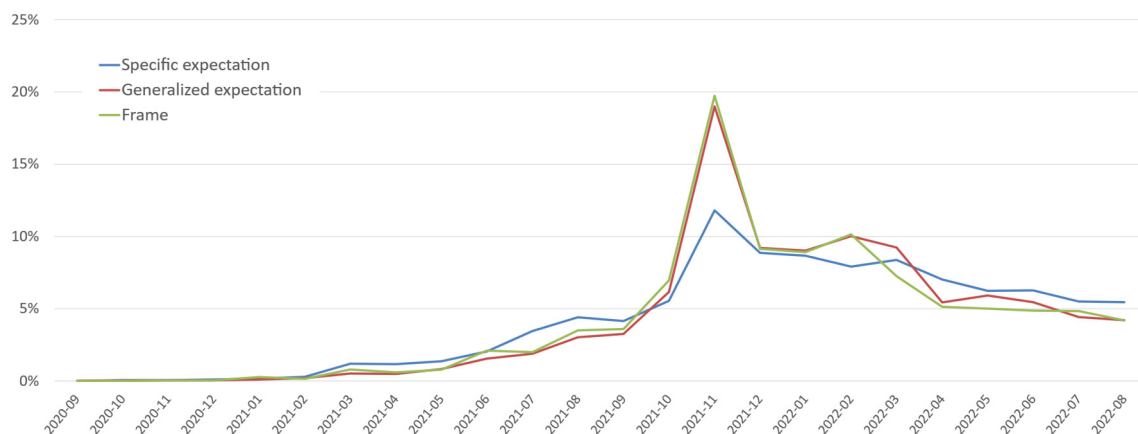
Figure 5. Distributions of tweets by expectation framework.

5. Discussion

This study tracks and analyzes the hype of the metaverse in the Korean context. Twitter data spanning two years, from September 2020 to August 2022, were analyzed to determine what kind of discourse exists about the metaverse and how this discourse has changed over those two years. The hype cycle and expectation framework were used as theoretical lenses to analyze the results.

To answer RQ1, tweets related to the metaverse were collected and analyzed to extract main topics. The extracted topics were classified into three expectation framework themes. The theme with the highest proportion was generalized expectations. The subtopic "reaction to expectations" accounts for 45% of all tweets. This is because instead of acting in accordance with underlying technological advances, public actors in hype (i.e., technology adopters) respond to the expectations of other actors [7]. In other words, Twitter users did not express direct expectations and opinions about the metaverse but reacted to the discourse formed about it.

Specific expectations included approximately 30% of the tweets. This theme primarily covers tweets concerning government and business projects related to the metaverse. This result confirms the findings of previous research that Twitter users tend to seek out and share information. In the early stages of technological development, innovation actors such as governments and businesses deliberately inflate expectations to attract public interest and investment [7]. In particular, the Korean government has actively supported and invested in the metaverse field to become a leading country in this field [21]. This implies that hype was created as Twitter users commented on or reacted to this news.

In the case of frames, a small percentage of tweets were included, at 6.6%. While frames comprise the expectation for the use and debate of technology in social and economic areas, the metaverse is still in its infancy; therefore, these precise utilization plans and expectations appear to be limited. In addition, according to the case study of Van Lente et al. [8], frames mainly include issues such as ethical debates and social regulations about technology. Still, the metaverse is a technology that has not yet materialized, so these social debates seem to be relatively few.

To answer RQ2, this study analyzed the temporal patterns of the extracted topics and themes. Consequently, hype dynamics were observed. In terms of overall tweet count frequency, there was a pronounced peak in November 2021. In terms of the tweet distribution of each theme, specific expectations showed a relatively high distribution of tweets compared to the other two themes from March to September 2021. However, in the two surges in October and November 2021, generalized expectations and frames represent a very strong rise compared with specific expectations. This implies that the pre-emptive and intentional expectations of the metaverse (i.e., specific expectations) by governments and corporations shape and fuel the expectations of innovation adopters (i.e., generalized expectations and frames).

In this context, the decline in the number of tweets since the peak in November 2021 is due to public disappointment and a drop in interest, as expectations inflated by governments and businesses have not been met. This is implied by a relatively high percentage of tweets on the topic "negative reaction" during the decline period.

Based on this analysis, it can be argued that the hype of the metaverse from the user's point of view in Korea entered the disappointment phase after the peak.

5.1. Theoretical Contributions

This study analyzed the hype dynamics of the metaverse by analyzing Twitter content. The theoretical contributions of this study are as follows. First, it analyzed the metaverse hype from the user's perspective. According to previous research, hype measurement requires data from different sources for different stakeholders. Lee [19] analyzed news and research articles using a topic modeling methodology to measure hype for the metaverse. However, in Lee's study, only search traffic from the user's perspective was considered, and user-generated discourse analysis was limited. To fill this gap, this study qualitatively explored users' hype by performing content analysis on tweets.

Second, this study analyzed specific hype in the Korean context. The hype for the metaverse in Korea was predicted to be over-enthusiastic compared to other countries through government-led projects. This was confirmed through an analysis of the tweet data generated in Korea. Therefore, the results of this study suggest that the future analysis of hype should not only be measured differently depending on specific stakeholders but should also be approached differently depending on cultural backgrounds, such as countries/regions.

The literature on recent information systems has seen an increase in data-driven research using techniques from computer science, such as text mining, owing to the availability and simplicity of access to data through open APIs and other tools [24]. Most of the data-driven research, however, only describes what is concealed behind the data; recent research calls for a theoretical discussion through data analysis [24]. This study makes a theoretical contribution to this emerging research stream by understanding the public's expectations based on academic discussions of hype in science, technology, and innovation studies [41].

5.2. Practical Contributions

Our study contributes to the literature by understanding how the hype of individuals surrounding the metaverse was formed and changed in social media. This can help industry and policy managers track the process of technological innovation and the creation of hype. In particular, this study's results revealed that the temporal patterns of tweets for each theme of expectation differed, suggesting that this was similar to the cause of hype. To measure hype for a particular technology, practitioners will have to monitor social media and consider the type of user response.

Meanwhile, the results of this study provide scientific insight on how the public is responding to the metaverse. Most of the discourse is a response to expectations, implying that the current interest in the metaverse is the interest itself.

5.3. Limitations and Future Research

Our research has some limitations. The data used for analysis include tweets from two years, from September 2020 to August 2022. Although hype dynamics were observed in this study, long-term follow-up of the hype pattern is required because the metaverse is still in its infancy [42]. In 2022, Gartner identified key emerging technologies, and the metaverse entered the hype cycle for the first time [43]. According to Gartner's hype cycle, the metaverse is in the innovation trigger stage, and it is predicted that it will take more than ten years to enter the plateau of productivity. Therefore, future studies could investigate whether the hype dynamics explored in this study are valid.

Future studies should also compare the responses given by users of other SNS. Facebook, for example, has no limit on the length of a post, allowing users not only to respond briefly to an issue but also to give detailed opinions and arguments. Therefore, future research using other social media platforms, such as Facebook, will be able to explore individual descriptive responses to the metaverse.

References

1. Kim, J. Advertising in the Metaverse: Research Agenda. *J. Interact. Advert.* **2021**, *21*, 141–144. [CrossRef]
2. Collins, B. The Metaverse: How to Build a Massive Virtual World. Mag. 2021. Available online: https://www.forbes.com/sites/barrycollins/2021/09/25/the-metaverse-how-to-build-a-massive-virtual-world/?sh=1dc9560b6d1c (accessed on 3 January 2023).
3. Austin, S. The New Wave of Web 3.0 Metaverse Innovations. *Entrepreneur* **2021**. Available online: https://www.entrepreneur.com/money-finance/the-new-wave-of-web-30-metaverse-innovations/380250 (accessed on 3 January 2023).
4. Aharon, D.Y.; Demir, E.; Siev, S. Real returns from unreal world? Market reaction to Metaverse disclosures. *Res. Int. Bus. Finance* **2022**, *63*, 101778. [CrossRef]
5. Research, G.V. Metaverse Market Size, Share & Trends Report, 2030. *Grand View Res.* **2022**. Available online: https://www.grandviewresearch.com/industry-analysis/metaverse-market-report (accessed on 3 January 2023).
6. Bogost, I. Facebook Understands the Metaverse All Too Well. *Atlantic* **2021**. Available online: https://www.theatlantic.com/technology/archive/2021/10/facebook-metaverse-name-change/620449/ (accessed on 3 January 2023).
7. Alkemade, F.; Suurs, R.A. Patterns of expectations for emerging sustainable technologies. *Technol. Forecast. Soc. Chang.* **2012**, *79*, 448–456. [CrossRef]
8. van Lente, H.; Spitters, C.; Peine, A. Comparing technological hype cycles: Towards a theory. *Technol. Forecast. Soc. Chang.* **2013**, *80*, 1615–1628. [CrossRef]
9. Jarvenpaa, H.M.; Makinen, S.J. An empirical study of the existence of the Hype Cycle: A case of DVD technology. In Proceedings of the 2008 IEEE International Engineering Management Conference, Estoril, Portugal, 28–30 June 2008; pp. 1–5. [CrossRef]
10. Yeon, S.-J.; Park, S.-H.; Kim, S.-W. A dynamic diffusion model for managing customer's expectation and satisfaction. *Technol. Forecast. Soc. Chang.* **2006**, *73*, 648–665. [CrossRef]
11. Dedehayir, O.; Steinert, M. The hype cycle model: A review and future directions. *Technol. Forecast. Soc. Chang.* **2016**, *108*, 28–41. [CrossRef]
12. Konrad, K. The social dynamics of expectations: The interaction of collective and actor-specific expectations on electronic commerce and interactive television. *Technol. Anal. Strat. Manag.* **2006**, *18*, 429–444. [CrossRef]
13. Sun, S.; Nan, D.; Che, S.; Kim, J.H. Investigating the knowledge structure of research on massively multiplayer online role-playing games: A bibliometric analysis. *Data Inf. Manag.* **2022**. [CrossRef]
14. Mystakidis, S. Metaverse. *Encyclopedia* **2022**, *2*, 486–497. [CrossRef]
15. Kelly, S.M. Facebook Changes Its Company Name to Meta|CNN Business. *CNN* **2021**. Available online: https://www.cnn.com/2021/10/28/tech/facebook-mark-zuckerberg-keynote-announcements/index.html (accessed on 3 January 2023).
16. Park, S.M.; Kim, Y.G. A Metaverse: Taxonomy, Components, Applications, and Open Challenges. *IEEE Access* **2022**, *10*, 4209–4251. [CrossRef]
17. Dwivedi, Y.K.; Hughes, L.; Baabdullah, A.M.; Ribeiro-Navarrete, S.; Giannakis, M.; Al-Debei, M.M.; Dennehy, D.; Metri, B.; Buhalis, D.; Cheung, C.M.; et al. Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *Int. J. Inf. Manag.* **2022**, *66*, 102542. [CrossRef]
18. Affair, A.P. Enter the Metaverse. 15 October 2021. Available online: https://www.wortfm.org/enter-the-metaverse/ (accessed on 3 January 2023).
19. Lee, J.Y. A Study on Metaverse Hype for Sustainable Growth. *Int. J. Adv. Smart Converg.* **2021**, *10*, 72–80. [CrossRef]
20. Wiles, J. What Is a Metaverse? And Should You Be Buying In? *Gartner* **2022**. Available online: https://www.gartner.com/en/articles/what-is-a-metaverse (accessed on 3 January 2023).
21. Ning, H.; Wang, H.; Lin, Y.; Wang, W.; Dhelim, S.; Farha, F.; Ding, J.; Daneshmand, M. A Survey on Metaverse: The State-of-the-art, Technologies, Applications, and Challenges. *arXiv* **2021**. [CrossRef]

22. Han, S.; Kim, T. News Big Data Analysis of 'Metaverse' Using Topic Modeling Analysis. *J. Digit. Contents Soc.* **2021**, *22*, 1091–1099. [CrossRef]
23. Kim, T.; Ahn, B.; Lee, W.; Kang, H. Analysis of metaverse trends using news big data. *J. Digit. Contents Soc.* **2022**, *23*, 203–216. [CrossRef]
24. Kar, A.K.; Dwivedi, Y.K. Theory building with big data-driven research, Y.K. "What" towards the "Why". *Int. J. Inf. Manag.* **2020**, *54*, 102205. [CrossRef]
25. Fenn, J.; Raskino, M. *Mastering the Hype Cycle: How to Choose the Right Innovation at the Right Time*; Harvard Business Press: Boston, MA, USA, 2008; p. 237.
26. Konrad, K.; Markard, J.; Ruef, A.; Truffer, B. Strategic responses to fuel cell hype and disappointment. *Technol. Forecast. Soc. Chang.* **2012**, *79*, 1084–1098. [CrossRef]
27. Jun, S.-P. An empirical study of users' hype cycle based on search traffic: The case study on hybrid cars. *Scientometrics* **2011**, *91*, 81–99. [CrossRef]
28. Jun, S.-P.; Yeom, J.; Son, J.-K. A study of the method using search traffic to analyze new technology adoption. *Technol. Forecast. Soc. Chang.* **2014**, *81*, 82–95. [CrossRef]
29. Jun, S.-P. A comparative study of hype cycles among actors within the socio-technical system: With a focus on the case study of hybrid cars. *Technol. Forecast. Soc. Chang.* **2012**, *79*, 1413–1430. [CrossRef]
30. Abbate, S.; Centobelli, P.; Cerchione, R.; Oropallo, E.; Riccio, E. A first bibliometric literature review on Metaverse. In Proceedings of the 2022 IEEE Technology and Engineering Management Conference (TEMSCON EUROPE), Izmir, Turkey, 25–29 April 2022; pp. 254–260. [CrossRef]
31. Zhang, L.; Luo, M.; Boncella, R.J. Product information diffusion in a social network. *Electron. Commer. Res.* **2018**, *20*, 3–19. [CrossRef]
32. Kim, Y.Y. Social Media Use and the Users' Perception of Social Support. *J. Korea Contents Assoc.* **2015**, *15*, 407–419. [CrossRef]
33. Shin, S.; Kang, J. Structural features and Diffusion Patterns of Gartner Hype Cycle for Artificial Intelligence using Social Network analysis. *J. Intell. Inf. Syst.* **2022**, *28*, 107–129. [CrossRef]
34. Fischer-Preßler, D.; Schwemmer, C.; Fischbach, K. Collective sense-making in times of crisis: Connecting terror management theory with Twitter user reactions to the Berlin terrorist attack. *Comput. Hum. Behav.* **2019**, *100*, 138–151. [CrossRef]
35. Blei, D.M. Probabilistic topic models. *Commun. ACM* **2012**, *55*, 77–84. [CrossRef]
36. Liu, B.; Zhang, L. A Survey of Opinion Mining and Sentiment Analysis. In *Mining Text Data*; Springer: Berlin/Heidelberg, Germany, 2012; pp. 415–463. [CrossRef]
37. Wallach, H.M.; Murray, I.; Salakhutdinov, R.; Mimno, D. Evaluation methods for topic models. *ACM Int. Conf. Proceeding Ser.* **2009**, *382*, 1105–1112. [CrossRef]
38. Mimno, D.; Wallach, H.M.; Talley, E.; Leenders, M.; Mccallum, A. Optimizing semantic coherence in topic models. In Proceedings of the 2011 Conference on Empirical Methods in Natural Language Processing, Scotland, UK, 27–31 July 2011; pp. 262–272.
39. Grootendorst, M. BERTopic: Neural topic modeling with a class-based TF-IDF procedure. *arXiv* **2022**. [CrossRef]
40. Ruef, A.; Markard, J. What happens after a hype? How changing expectations affected innovation activities in the case of stationary fuel cells. *Technol. Anal. Strat. Manag.* **2010**, *22*, 317–338. [CrossRef]
41. Kwon, S.; Park, A. Understanding user responses to the COVID-19 pandemic on Twitter from a terror management theory perspective: Cultural differences among the US, UK and India. *Comput. Hum. Behav.* **2021**, *128*, 107087. [CrossRef]
42. Nan, D.; Sun, S.; Gopi, S.; Lee, K.M.; Kim, J.H. A bibliometric analysis of Metaverse research using VOSviewer. In *2023 17th International Conference on Ubiquitous Information Management and Communication (IMCOM)*; IEEE: Piscataway, NJ, USA, 2023; pp. 1–4. [CrossRef]
43. Perri, L. What's New in the 2022 Gartner Hype Cycle for Emerging Technologies. *Gartner*. Available online: https://www.gartner.com/en/articles/what-s-new-in-the-2022-gartner-hype-cycle-for-emerging-technologies (accessed on 3 January 2023).