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Exploring user perceived beliefs, evaluations, and gratifications in ASM: applying expectancy-value approach for U&G theory on Mastodon instance Liker.social

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This study aims to explore users' perceived beliefs of the decentralized alternative social media (ASM), selecting one of Mastodon instances, Liker. social, as the unique case of exploratory investigation. The study employs the online exploratory survey method and uses purposive sampling to identify 152 valid users actively engaged in the Liker.social. Based on the expectancy-value approach to uses and gratifications theory, the study identifies two factors within users' subjective perceived beliefs: informative decentralized benefits and descriptive centralized benefits. The study also finds that the "Writing messages" is the most important functionality evaluated by users but gets fewer level of gratifications obtained, representing that there is still room for improvement. Additionally, the study presents four types of users based on their combined perceived beliefs: (1) All-benefit Rejectors, (2) All-benefit Obtainers, (3) Former-benefit Conservatives, and (4) Newer-benefit Seekers. Users (2) and (4) stressed more value on overall functionality and obtained more gratifications than users (1) and (3), so users (2) and (4) are the same statistically, having greater evaluations of importance and gratifications obtained for Liker.social than that of users (1) and (3). It signifies that the different users held varying beliefs about the benefits brought by the decentralized ASM. It was concluded that the casual relationship is valid: users' evaluations of importance, informative decentralized benefits combined with descriptive centralized benefits eventually affect the level of users' gratifications obtained on the decentralized ASM. Therefore, further research is needed to pay greater attention to users' feedback and experiences on the decentralized ASM.

KEYWORDS

perceived beliefs, alternative social media, ASM, uses and gratifications, evaluations

Introduction

Over the past couple of decades, people have grown accustomed to engaging with social media within the established economic framework, regulations, and media logic of social media conglomerates during the Web2.0 era. We participate in various everyday social activities on centralized social networking sites. The majority of users around the world seem to have existed within the realm of "walled gardens" (Rozenshtein, 2022). However, the emergence of a decentralized community structure, championed by the World Wide Web Consortium (W3C), aims to disrupt the current centralized paradigm and transition toward the development of decentralized alternative social media (ASM). This shift is exemplified by the community network protocol named ActivityPub, which places emphasis

on open-source standards and decentralization (ActivityPub, 2023). Despite this movement, existing research on Web3.0 largely concentrates on the technical aspects of decentralized communities or platforms (Liu et al., 2021), leaving fewer investigations into users of decentralized alternative social media.

In both Web1.0 and Web2.0, regardless of early blog writing or contemporary social media services, issues of uses and gratifications have been integral avenues of exploration in the realm of new media research (Hsu and Lin, 2008; Dogruer et al., 2011; Ghaisani et al., 2017). In the midst of the burgeoning wave of decentralized Web3.0, a selection of alternative social media services has emerged, characterized by decentralization promoted by the ActivityPub protocol and incentivized through new forms of cryptocurrencies. For the purpose of this study, the Mastodon instance Liker.social has been chosen to observe this distinctive ASM. It seems to have attracted early users due to specific socio-economic factors, such as the unique incentive presented by the cryptocurrency LikeCoin, as well as its decentralized attributes.

As per its homepage, Liker.social is described as "a microblog based on LikeCoin and Mastodon open-source facilities. Unlike other Mastodon blogs, Liker.social supports the conversion of likes into rewards, and the conversion of likes into LikeCoin, which can be traded freely" (Liker.social, 2023). Furthermore, the operational team behind Liker.social operates on a non-profit basis, in line with the ethos of Web3.0, striving to counteract unequal attention distribution. To achieve this, the platform relies on donations from users via the patreon.com platform (Liker.social, 2023).

While the number of early users from Taiwan may not be substantial, their subjective perceived beliefs of decentralized ASM and experiential data related to evaluations and gratifications, as supported by prior research (Lee and Wang, 2023), could provide invaluable insights for the future development of Web3.0 social media. Consequently, the significance of conducting this exploration into ASM becomes paramount at this juncture.

Amidst the broader Web3.0 trends, this study delves into how users' perceived beliefs regarding decentralized ASM, specifically Liker.social, and how their holistic beliefs, combined with their evaluations of core functionalities (such as the cryptocurrency-related aspect of LikeCoin), affect the ultimate gratifications obtained from their usage. The researchers have selected Mastodon, the currently most popular and largest decentralized alternative social media service (Lee and Wang, 2023), with a specific Chinese-speaking instance, Liker.social, as the focus of investigation. Given the dearth of research on decentralized alternative social media, this study has developed its own exploratory measuring scale for perceived beliefs, as discussed later. Against the backdrop of the global shift from centralized to decentralized internet, what lies behind users to engage with decentralized alternative social media? How do users perceive their participation in decentralized ASM? Positioned at the potential cusp of a paradigm shift in the global internet landscape, this study embarks on an exploration rooted in decentralization advocacy and uses and gratifications theory (U&G theory) (Katz et al., 1973). As the researcher, I seek to comprehend users' holistic perceived beliefs of decentralized ASM, while examining their evaluations of importance and the gratifications obtained from their everyday usage experiences.

This study delves into a specific Mastodon instance within the Fediverse, Liker.social, primarily due to its integration with the cryptocurrency, LikeCoin, which serves as a motivation and reward mechanism for users. Moreover, Liker.social predominantly employs Traditional Chinese as its main language, attracting numerous users from Taiwan and Hong Kong to engage in daily interactions within the instance. With the focus on understanding the perceived beliefs, evaluations of importance, and gratifications of users using Traditional Chinese participating in decentralized alternative social media, the chosen instance Liker.social holds significance and necessity due to its originality. In summary, the research questions are as follows:

Q1: What encompasses the holistic images of users' perceived beliefs when using the Mastodon instance Liker.social?

Q2: How do users evaluate the importance of the Mastodon instance Liker.social, and to what extent do they ultimately obtain gratifications? Are there disparities between the two?

Q3: What types of users have engaged with the Mastodon instance Liker.social? Do they hold similar evaluations of importance and obtain equivalent gratifications from Liker.social?

Q4: How do users' perceived beliefs and evaluations of the Mastodon instance Liker.social ultimately affect the gratifications obtained?

Perceived beliefs of centralized social media vs. decentralized ASM

Users used those mainstream centralized social media, because those media usually provide some helpful socio-psychological benefits that users need, like amusement arousing, time killing, social capital building, and valuable information gaining (Ko and Yu, 2019). Some needs, like self-expressing, social belonging or communicating, may derive from users' motivational beliefs, such as attitudes toward creating behaviors (Ham et al., 2014). With the mobile development, mainstream social media have been transferred into people's smartphones with instant messengers (like Line or Facebook messenger, etc.), but users' fundamental needs are similar as usual: maintaining their social activities and relationships for affection, information-sharing, stress-relieving, and self-promoting, and so on (Chou and Liu, 2016). All in all, it should be recognized that mainstream centralized social media these years actually help people a lot to pass time and maintain relationships in ordinary everyday life and even under social distancing conditions during the COVID-19 pandemic (Bowden-Green et al., 2021). Furthermore, because of the characteristics of centralization, mainstream social media are applied broadly on marketing and profitable purposes for almost all businesses in the world, making users become empowered customers and their brands valuable in the certain kinds of brand communities in the social media (Basimakopoulou et al., 2022).

However, social media have changed because of the trends going from Web2.0 toward Web3.0 at the present time. When we say that the alternative social media is decentralized, it is likely to imply that there are a few centralized social media dominating the

world for a long period of time. We must ask directly what benefits those decentralized alternative social media (ASM) in Web3.0 offer to users, so that they may perceive these new comparatively new benefits that those social media in Web2.0 have lacked.

According to W3C's ActivityPub webpage, W3C has embraced the so-called vision of decentralization: "Don't you miss the days when the web really was the world's greatest decentralized network? Before everything got locked down into a handful of walled gardens? So do we" (ActivityPub, 2023). Building upon this context, Mastodon is a free social media software developed by a non-profit organization (NGO) based in Germany, utilizing the W3C's ActivityPub protocol. As per information from its official website (Mastodon, 2023), Mastodon diverges from being a singular social networking platform where all users congregate for online social activities. Instead, it operates as a network of distributed servers worldwide, allowing users to create accounts on various servers and establish connections with individuals on different Mastodon servers. This enables cross-site interactions like cross-server tracking, commenting, liking, and more. Mastodon's unique approach to linking many sites (aka "instances" in Mastodon) and users in the world is referred to as the "Fediverse."

Referring to Wikipedia's description, the term "Fediverse" is a blend of "Federation" and "Universe" (Wikipedia, 2023): "Fediverse is used to describe a combination of freely available software that consists of a set of interconnected servers (self-hosted or third-party hosted) providing various web publishing (such as social media, microblogging, blogging, or websites) or file hosting services. Although each server operates independently and there is diversity in instances and content, servers can intercommunicate. Users on different servers (instances) can create accounts that can communicate across instance boundaries because the software running on the servers supports one or more open standards for communication. Users can use their accounts in the Fediverse to publish text or other media files, as well as to follow other users...."

As this definition aforementioned, the goal of the Fediverse is to offer an alternative way of communicating beyond the domination of centralized social media, because the Fediverse is more open in its implementation compared to mainstream social media running on a single server on certain giant corporations (Wikipedia, 2023). By so doing, the decentralization of its servers makes the Fediverse more secure and reliable. Furthermore, decentralized alternative social media has not only disrupted the existing web technologies, but also brought about grassroots democracy, as it champions the user's freedom and individual data rights (Kwet, 2020; Rozenshtein, 2022). This means that on the decentralized Web3.0 platforms, users can break free from the high costs and expenses associated with placing excessive trust in centralized social media or other centralized platforms. Just as one of the creators of Ethereum, Gavin Wood, advocated that applying blockchain technology could record public information, protect personal privacy, and eliminate the need for trusted third parties with smart contracts.

Nowadays, with combining blockchain with the Internet, this definition of Web3.0 is accepted by the industry of cryptocurrency (Zheng and Lee, 2023). In terms of line of flight, Anderlini and Milani (2022) argued that Fediverse provides us with an always-changing way of building individual and collective digital identities that offers greater degrees of freedom compared to the centralized social media. Therefore, in the operation of the decentralized alternative social media, there should no longer be a need to relinquish control over data or individual privacy rights to others ideally.

As for topology, abstraction, and scale, Zulli et al. (2020) also stated that Mastodon can enable autonomy, promote social enterprise; and more importantly, successfully shift the focus from number of users to quality of engagement in the decentralized ASM. Decentralized social media or platforms refer to the concept that a database no longer relies on a single organization or giant corporate, but is instead distributed across nodes of all peers. Once Web3.0 developers create a platform that makes it easier for non-technical users to interact with one another, it will drive a more decentralized, transparent, and secure online environment. The decentralized nature might offer a decentralized solution for human communication and transactions (Filipcic, 2022). Thus, People may have more sense of ownership, more free financing from cryptocurrency, and creative innovation fostering (Zheng and Lee, 2023).

Cao also believes that decentralization, in terms of systematic, comprehensive, multi-dimensional goals, functionality, and significant consequences, complements and enhances current centralized operations, leading to a paradigm shift. The emergence of blockchain technology has inspired the transformation of centralized financial systems into decentralized finance, while also transitioning the World Wide Web to Web3.0 (Cao, 2022). It can be said that decentralization supplements the concept of centralization in the realm of networking, influencing the trajectory of social media and even other fields within many fields of sciences, technologies, and societies.

In May 2022, Vitalik Buterin, the founder of the Web3.0 decentralized platform "Ethereum," along with economists Glen Weyl and Puja Ohlhaver, jointly published a research paper titled "Decentralized Society: Searching for the Soul of Web3." The paper discusses the potential for a decentralized society in the future Web3, using a mechanism called "Soulbound Tokens" (SBT). The aim of this decentralized society is to address the current issue in Web3.0 decentralized finance, where assets can be easily transferred, leading to excessive financialization. The proposed solution involves creating non-transferable soul identities through SBT tokens, fostering a community with enhanced mutual trust, self-verification, and stronger interconnectedness (Weyl et al., 2022).

Therefore, a decentralized society linked by SBT tokens possesses distinct characteristics of decentralized social media. In this decentralized society, SBT tokens are used to amplify social relationships in both the real and virtual worlds. This empowers individual soul identities and various bottom-up communities, encoding rich social and economic relationships programmatically. A significant advantage of Decentralized society is its ability to span diverse community networks, similar to how individuals can join multiple clubs or organizations in the real world, offering "composability" of social networks. Additionally, it helps prevent the monopolization of resources of centralized social media by certain "whale" users (Weyl et al., 2022). As a result, we can anticipate that Web3.0 social media is continuously evolving toward a more decentralized society, moving away from the

constraints of specific corporate conglomerates or rent-seeking investment, which characterized the challenges of Web2.0.

However, alternative social media, based on the logic of a decentralized network, lack sufficient empirical research to conclusively prove their superiority over centralized platforms. In fact, ASM requires further studies to reveal users' profiles on Fediverse, enabling the implementation of a decentralized landscape from users' perspectives for the future development of social media (La Cava et al., 2022). Therefore, the researcher aims to address this research gap from the perspective of uses and gratifications theory, as it places emphasis on active users: why did users use Mastodon, the largest and most popular ASM now on the Internet? Lee and Wang (2023) found the users' gratifications obtained most for using Mastodon are easy to use conveniently, privacy protecting, and information seeking, etc., in which "Convenience" is the top satisfying factor both in users' gratifications sought (GS) and gratifications obtained (GO). However, Lee and Wang (2023) haven't clearly explained what exactly drives users to bear those needs to seek gratifications on Mastodon yet since those needs could also be sought and obtained through centralized social media too.

Expectancy-value approach for uses and gratifications theory

Uses and gratifications theory (U&G theory) was born before the development of the World Wide Web. Earlier researches of U&G theory focused on more logic steps for investigating: (1) the social and psychological origins of (2) needs, which generate (3) expectations of (4) the mass media or other sources, which lead to (5) differential patterns of media exposure (or engagement in other activities), resulting in (6) need gratifications and (7) other consequences, perhaps mostly unintended ones (Katz et al., 1973). Until the ages of Internet and World Wide Web, whether in the era of Web1.0, Web2.0, or the current Web3.0 era, online writing on mainstream social media has been a significant online activity for various types of users (Miura and Yamashita, 2007; Sauter, 2014). Therefore, the U&G theory is also applied in the related topics in extant studies, exploring more focally on the uses and gratifications of social networking service or social media.

Extant empirical studies on social media thus signified that users exhibit diverse behaviors on platform, such as information sharing, caring for friends, interacting with old acquaintances, making new friends, and self-promotion (Kim et al., 2019; Anweh and Ugondo, 2021). The motivations behind centralized social media services include information seeking, self-expression, immersion and leisure, personal status enhancement, relationship maintenance, and entertainment (Dogruer et al., 2011). Overall, these motivations and gratifications sought/obtained tend to lean toward information seeking, self-identity, interpersonal relationships maintaining, and entertainment. In other words, the motivations and gratifications of mainstream social media platforms often revolve around game sharing, information sharing, leisure entertainment, fostering diverse interpersonal relationships and interaction needs, and culminate in self-promotion effects.

Furthermore, previous studies have identified similar motivations, such as contributing useful information, being better recognized by others, helping others, sharing political opinions, and sharing casual content (Ghaisani et al., 2017), which primarily pertain to information sharing. Additionally, from observing user proactive behaviors on social media, previous motivations for using community media also include seeking social recognition and personal reputation, such as altruistic knowledge sharing and seeking community recognition (Hsu and Lin, 2008). However, whether these motivations will continue and become the beliefs and gratifications for users of decentralized Web3.0 social media with their inherent decentralization features remains to be clarified in this study.

Back to the social and psychological origin of media uses and gratifications, Palmgreen and Rayburn (1982) provided an expectancy-value approach as an answer. They argued that audiences or users could seek gratifications from media that are influenced by people's beliefs, because they think the media possess certain attributes, so that people would subjectively make evaluations of these media attributes. From the standpoints of the expectancy-value approach to U&G theory provided by Palmgreen and Rayburn (1985), audiences or users would bear expectancy and value toward certain media, and then go on seeking their own gratifications on certain media, thus obtaining the final gratifications. Therefore, extant research applied the approach to any other online social media operationally: (1) the expectancy is users' holistic perceived belief of certain media that possess some attributes which are supposed to be needed; (2) the value is users' subjective evaluations of overall importance that media core functions represent. (3) The gratifications are overall satisfactory effects of certain media that users finally obtain (Azizah, 2020; Xiao et al., 2022). Therefore, expectancy-value approach for uses and gratifications theory focused more about users' subjective beliefs, evaluations, and positive or negative feelings when they actively choose certain media to satisfy their media needs.

According to the expectancy-value approach, audiences' or users' perceived beliefs about certain media are derived from two main sources: one is from their direct observation or exposure of certain media and their attributes, called descriptive beliefs; the other is from accepting outside information about some media and their attributes, called informational beliefs, like news reporting or media advertisements. In other words, descriptive beliefs are our direct experiences from the media, while informational beliefs are those sources with which we have little personal experience. Assumably, it indicates the processes of people's beliefs acquisition and change regarding the media (Palmgreen and Rayburn, 1985). In the process, people can actively form perceived beliefs from these two sources before selecting the media, and thus the media they believe will gratify their needs (Krause and Brown, 2021).

Based on literature review above, the most important Web3.0 issue is whether the perceived beliefs of decentralized alternative social media (ASM) become key variables for "emerging" new motives and gratifications obtained. Furthermore, according to the expectancy-value approach by Palmgreen and Rayburn (1985), those perceived beliefs combined with positive evaluations of importance could represent a positive approach to obtaining gratifications on decentralized ASM. It serves as the primary core

exploratory aspect of this study. Additionally, in terms of the traditional perspective on uses and gratifications theory (U&G theory), I proposed that users had perceived some accumulated problems in centralized social media and wanted to find solutions before generating motivations, leading to using some decentralized alternative social media and thus obtaining gratifications.

Method

Participants

This study focuses on the Mastodon instance "Liker.social" (https://Liker.social) as a unique case for research analysis. I chose this peculiar case because the researcher believes, as the Kwet argues, before we like to transform the mainstream social media into democratic commons, a free and open sourced, decentralized ecosystem, supported by thorough and strong privacy policies and laws, is needed (Kwet, 2020). The users within Like.social could be viewed as their active but unique behaviors and/or actions toward fulfilling their democratic purposes on the Internet. The instance receives 11.1K visits per month (Similarweb, 2023). The target participants of the study consist of users who have their own exclusive accounts and personal pages on Liker.social and have the ability to post, edit and delete their own articles. Moreover, every participant has his/her own "Liker ID," which can be bound to his/her Liker.social account, so that every user can obtain "LikeCoin" when posting articles on the instance. Due to the dynamic nature of decentralized Mastodon instances, the number of users can increase or decrease at any time. During the course of this survey (From 6 June to 6 July 2023), the average population number of users was ∼330. However, many of these accounts were not actively operated at that time and were merely dormant. Therefore, the study does not use random or systematic sampling.

The study employs the exploratory online survey method, placing the questionnaire on the researcher's personal Google Sheets for users to fill out. Generally, exploratory online surveys are convenient and yield quick results, making them popular for internet research nowadays. However, due to the difficulty in establishing a sampling frame, the study can only be conducted using a nonprobability sample, encouraging active users to participate in the study. Considering the research questions of this study, I aim to identify users who consistently engage in writing articles on Liker.social during the study period. The method of identification involves observing the "Local Timeline" section on the instance, where updated articles are displayed as soon as Liker.social users post them. Then, I could find any user's personal account and access his/her private message for sending the request link of the survey to them. Consequently, although the list of an ever-changing total population of users cannot be determined, users actively engaged in writing open articles can be located on this instance at any time. In this research context, I decided to employ "purposive sampling."

I selected samples from the "Liker.social Local Timeline" during the study period, and chose users who have been operating the personal accounts for over 1 month and have written over 10 articles on the account. Based on the previous research (Lee and Wang, 2023), users of Mastodon instances can be voluntary to participate in the study. Thus, for the sake of inviting more users to participate in this study, I promised and sent 100 LikeCoin to 100 users by drawing randomly after finishing the survey.

Upon selecting and inviting users, the researcher records their account names to avoid duplicating their responses in the questionnaire for the research. The official implementation period starts from 6 June to 6 July 2023. During these 30 days, a total of 153 questionnaires were collected, with 152 valid responses after excluding one duplicate submission. Of all the respondents, 46.1% were female, and 53.9% were male, with their age ranging from under 17 (0.7%), 18–27 (26.3%), 28–37 (40.2%), 38–47 (23.7%) to above 48 (9.2%). Thus, the majority of users' age is 28–37 years old. Besides, most of the respondents (92.2%) had completed at least a bachelor's degree; and most of them (52%) are general office workers; others are freelancers (17.1%), students (12.5%), business owner (9.2%), homemakers (5.9%), and other jobs (3.3%). All of the participants in this study were Chinese speakers.

Measurements

Since the study focuses on a new form of decentralized ASM with the cryptocurrency "LikeCoin" as a unique way of motivating users to join the instance, I, as a researcher, initially adopted a role as a participant observer. I joined Liker.social on July 7, 2022, gaining 1 year of experience using this Mastodon instance. However, due to the limited research on users' uses and gratifications in Mastodon or other decentralized ASMs, I conducted a pilot study involving interviews with several friends who are also users of Liker.social. The purpose of this pilot study was to gather insights and develop preliminary survey questions. The questions I posed via private messages were as follows: What differences do you perceive between mainstream social media (e.g., Facebook or Instagram) and Liker.social?

Following the pilot study, I not only synthesized insights from the pilot study but also incorporated findings from the literature review mentioned earlier to design the survey questionnaire, which is presented in Table 1. The questionnaire encompasses three main sections: "Evaluations of Importance of ASM," "Gratifications of ASM," and "Perceived Beliefs of ASM Scale." Within this survey questionnaire, 13 statements about "perceived beliefs" were organized and utilized to assess users' agreement levels when comparing Liker.social with mainstream social media. All the questions employed a 7-point Likert scale to enhance the precision of users' responses.

Results

Firstly, I will present a holistic overview of users' perceived beliefs regarding ASM as they engage with Liker.social. Secondly, I will demonstrate and compare users' evaluations of importance with the gratifications obtained, aiming to identify differences between the rational considerations and subjective feelings of Liker.social users. Thirdly, and perhaps most importantly, the researcher will analyze the causal relationship among perceived beliefs, evaluations of importance, and the eventual gratifications obtained.

TABLE 1 Phrases used in the questionnaire of the study.

Evaluations of importance of ASM
Initial phrase: do you think the following items are important…
1. I believe that the overall functionality of "Writing Messages" on Liker.social (including posting images, text, and links) ...
2. I believe that having the "NFT BookStore" on the homepage for quick browsing of featured, latest, and hottest "WritingNFT"...
3. I believe that the feature of linking to "Liker Id" on Liker.social...
4. I believe that Liker.social use of LikeCoin within the platform's policies...
Gratifications of ASM
Initial phrase: do you feel the following items are satisfactory…
1. I feel that the overall functionality of "Writing Messages" on Liker.social (including posting images, text, and links) ...
2. I feel that having the "NFT BookStore" on the homepage for quick browsing of featured, latest, and hottest "WritingNFT"...
3. I feel that the feature of linking to "Liker Id" on Liker.social...
4. I feel that Liker.social use of LikeCoin within the platform's policies...
Perceived beliefs of ASM
Initial phrase: compared to centralized social media like Facebook and Instagram…
1. I believe that Liker.social allows for more tangible rewards
2. I believe that Liker.social allows me to express greater writing creativity
3. I believe that Liker.social genuinely lets me "own" my work
4. I think Liker.social better safeguards users' personal privacy data
5. I believe that Liker.social offers more frequent opportunities for interaction with other users
6. I feel that Liker.social enables me to better showcase my daily life
7. I believe that Liker.social allows me to proactively access more useful information
8. I think Liker.social helps me gain more personal recognition
9. I believe that Liker.social offers more chances for branding and promotion
10. I think Liker.social provides more opportunities for selling and trading goods
11. I believe that the overall possibility of receiving LikeCoin is the biggest motive for using Liker.social
12. I think that there's an overall significant difference in the personal user experience with Liker.social
13. I believe that Liker.social generally represents a more promising form of social media for future development

Holistic images of perceived beliefs of ASM

The researcher investigates users' images of perceived beliefs of ASM by employing the "Perceived beliefs of ASM scale" (see Table 1) to explore their holistic images of perceived beliefs for Liker.social. With the 13 questions in the questionnaire, I delve into users' initiatives into Liker.social uses and seek to understand if users have core beliefs for using ASM. Therefore, using data from these 152 users, the study conducted "factor analysis" and employed the "Principal components analysis" method in SPSS 26.0. Under the condition that eigenvalues are >1, the "varimax" method was used to rotate the factors, and the results obtained after rotation are shown in Table 2.

As Table 2 represents, the result of factor analysis identified two principal factors that contribute to the holistic images of perceived beliefs of Liker.social. Within factor 1 (item 3, 4, 12, 13, 2, 1, 7, 11), its Cronbach' alpha is 0.878, representing its internal reliability is satisfactory for this exploratory study. Besides, within factor 2 (item 8, 9, 10, 6, 5), its Cronbach' alpha is 0.873, showing its internal reliability is also satisfactory for this exploratory study. Owing to the total variance explained of the factor analysis is up to 61.595%, the researcher found that both factor 1 and factor 2 compounded here could suggest the validity of the study.

Then, in this section, I must give each principal factor an appropriate and meaningful name for further analysis and discussion later. Because the result of factor analysis here is in accordance with Palmgreen and Rayburn (1985)'s theory, factor 1 can be given the name "informative decentralized benefits"; factor 2 can be given the name "descriptive centralized benefits." Through the work of naming, the researcher can distinguish factor 1 from factor 2, and represent that the holistic images of Liker.social users' perceived beliefs are derived from two sources. Both factors commonly compose to give users different benefits when using this decentralized alternative social media. That is to say, descriptive centralized benefits formed people's media enduring experiences like long-termly using Facebook (Meta), Twitter (X), etc.; while

TABLE 2 Factor analysis of perceived beliefs of Liker.social users.

Items in the scale	Factor	
Compared to centralized social media platforms…	1	2
3. I believe that Liker.social genuinely lets me "own" my work	0.806	0.203
4. I think Liker.social better safeguards users' personal privacy data	0.795	0.122
12. I think that there's an overall significant difference in the personal user experience with Liker.social	0.778	0.022
13. I believe that Liker.social generally represents a more promising form of social media for future development	0.664	0.351
2. I believe that Liker.social allows me to express greater writing creativity	0.652	0.413
1. I believe that Liker.social. allows for more tangible rewards	0.650	0.347
7. I believe that Liker.social allows me to proactively access more useful information	0.558	0.508
11. I believe that the overall possibility of receiving LikeCoin is the biggest motive for using Liker.social	0.541	0.247
8. I think Liker.social helps me gain more personal recognition	0.158	0.891
9. I believe that Liker.social offers more chances for branding and promotion	0.126	0.872
10. I think Liker.social provides more opportunities for selling and trading goods	0.199	0.775
6. I feel that Liker.social enables me to better showcase my daily life	0.539	0.629
5. I believe that Liker.social offers more frequent opportunities for interaction with other users	0.405	0.593
Eigenvalues	4.314	3.694
Variance explained (%)	33.183%	28.412%
Total variance explained (%)		61.595%
Internal reliability (Cronbach' alpha)	0.878	0.873

informative decentralized benefits formed people's newer media belief system introduced from many outside sources, like news reporting about new Web3.0 trends, concepts of decentralization, or newly developed alternative social media (ASM), like Mastodon, Threads, etc.

Evaluations of importance and gratifications obtained

The researchers then attempted to compare the average differences between Evaluations of importance and gratifications obtained by users regarding Liker.social, using the "paired-sample *T*-test" method. The results of the paired *t*-tests of the users' mean responses and correlation coefficients between each item are shown in Table 3. Correlations between each paired item for this sample range from a low of 0.596 to a high of 0.832, showing that all paired items of evaluations of importance and gratifications obtained are significantly correlated.

Based on the important functionality of Liker.social, this study designed a 4-item scale. Users evaluated their importance and gratifications with these four functions. According to users, the more important functions, ranked by average scores, are as follows: "Writing messages," "Liker ID linking," "LikeCoin policy." For users, the least important function is "NFT bookstore." as shown in Table 3. Nonetheless, all items exceed 4 points (in the 7-point scale), signifying that most users consider all functionality important for Liker.social (total average = 5.3438). Besides, for users' gratifications obtained, the top three items are: "Liker ID linking," "Writing messages," and "LikeCoin policy." For users, the least satisfactory is still the function, "NFT bookstore," as shown in Table 3. However, all items exceed 4 points (in the 7-point scale), signifying that most users consider all functionality satisfactory for Liker.social (total average = 5.35).

From Table 3, it can be observed that there are two differences for the items of functionality mean scores (T1–T2) that are statistically different at the 0.01 level- "Writing messages" (evaluations > gratifications) and "NFT bookstore" (gratifications > evaluations). However, no significant differences were found between the other two paired items- "Liker ID linking" and "LikerCoins policy," signifying little difference between evaluations of importance and gratifications obtained. Nonetheless, both received average scores exceeding the "neutral score" (3.5 points) for evaluations of importance and gratifications.

All in all, the higher up in the ranking, the more the ASM executive needs to pay attention to it, as it indicates that users genuinely believe the functionality is important and satisfactory. But there is always room for improvement to enhance users' gratifications, like "Writing messages." Instead, the analysis revealed "NFT bookstore" can be both the least important and the least satisfactory functionality item of Liker.social, representing that users don't understand its meanings deeply for ASM than others.

TABLE 3 Paired *t*-test of evaluations of importance and gratifications obtained.

Items of functionality	Evaluation of importance mean (T1)	Gratifications obtained mean (T2)	Correlation (T1–T2)*	Significance of *t*-value**
1. Writing messages	5.81	5.57	0.596	2.664**
2. NFT bookstore	4.33	4.65	0.607	−3.069**
3. Liker ID linking	5.68	5.70	0.817	−0.197
4. LikeCoin policy	5.55	5.49	0.741	0.863
Total average	5.34	5.35	0.832	−0.171

*All correlations statistically significant at 0.001 level.
**Statistically significant at 0.01 level.

Users' different combination of perceived beliefs on evaluations and gratifications

In order to classify users' groups in perceived beliefs with the results of factor analysis, the researcher applied the "cluster analysis with k-means algorithm" and used the two variables derived from factor analysis to depict the scatterplot. Firstly, these two variables, "informative decentralized benefits" and "descriptive centralized benefits," could be used to classify all sample of 152 users into the four groups as shown in Figure 1.

Clearly, as Figure 1 shows, there are four groups within the four quadrants. Thus, secondly, I named those four groups according to the positions located in the Figure 1 and the result of the k-means algorithm as known as $k = 4$ here. Four groups within the sample in this study are: All-benefit Rejectors (quadrant 3), All-benefit Obtainers (quadrant 1), Former-benefit Conservatives (quadrant 4), and Newer-benefit Seekers (quadrant 2), as shown in Table 4.

Definitely speaking, first, All-benefit Rejectors are those who believe Like.social could bring neither centralized nor decentralized benefits; second, All-benefit Obtainers are those who believe Like.social could bring both centralized and decentralized benefits; third, Former-benefit Conservatives are those who believe Like.social could bring only older centralized benefits; fourth and finally, Newer-benefit Seekers are those who believe Like.social could only bring newer decentralized benefits.

Thirdly, I conducted the "One-way ANOVA" with SPSS 26.0 to clarify the effects of different-type perceived beliefs on both evaluations of importance and gratifications obtained. Table 5 summarizes the results of One-way ANOVA analysis, in which we examined how the four types of users' perceived beliefs (see Table 4) influenced both their evaluations of importance and gratifications obtained for Liker.social.

Based on types of users, there were significant differences in both evaluations of importance and gratifications obtained, signifying that all of the four types of users' perceived beliefs have significant impacts on their own evaluations of importance and gratifications obtained for Liker.social. Furthermore, a *post-hoc* Scheffe's method as shown in Table 6, indicated that the types of users' influences on both evaluations of importance and gratifications obtained was greatly consistent. That is, Newer-benefit Seekers and All-benefit Obtainers are the same statistically, having greater evaluations of importance and gratifications obtained for Liker.social than that of Former-benefit Conservatives and All-benefit Rejectors.

In other words, Newer-benefit Seekers and All-benefit Obtainers value importance and obtain their gratifications equally. However, for Former-benefit Conservatives and All-benefit Rejectors, both of them together roughly equal in holding importance of Liker.social in less account, thus obtaining less gratifications, because these latter two types of users' differences were not statistically significant.

Causal relationship among perceived beliefs, evaluations, and gratifications

For further exploration, a multiple regression analysis was conducted to examine the extent to which the three independent variables ("informative decentralized benefits," "descriptive centralized benefits," and "evaluations of importance") affect the dependent variable ("gratifications obtained"). The independent variables were extracted both from outcomes of the factor analysis and users' subjective evaluations. Table 7 summarized the results of the multiple regression analysis.

The results of multiple regression analysis reveals that the model using "enter method" is significant ($p < 0.001$) and the adjusted coefficient of determination (R^2) for this regression is 0.783, which means that the model has a good fit. It also signifies that 78.3% of the variation in the dependent variable (gratifications obtained) was explained by the independent variables included in this regression model. The result of the multiple regression analysis shows that all of the three variables are significant on the effects of the dependent variable, which could indicate the variance in users' gratifications obtained from Liker.social is explained by these independent variables mostly.

Furthermore, as Table 7 has shown, "evaluations of importance" has the highest standardized coefficient ($\beta = 0.491$), indicating that the user's level of gratifications obtained through Liker.social is primarily affected by their evaluation of importance. Meanwhile, "informative decentralized benefits" ($\beta = 0.442$) also explained the variance mostly, having the predictive power in this model. Finally, "descriptive centralized benefits" ($\beta = 0.158$) have the lowest standardized coefficient ($\beta = 0.127$), indicating the weakest power to explain the dependent variance. As a side note, all the variance inflation factors (VIF) are between 1 and 5, meaning that the three independent variables are moderately correlated to each other, but it could be acceptable (Shrestha, 2020).

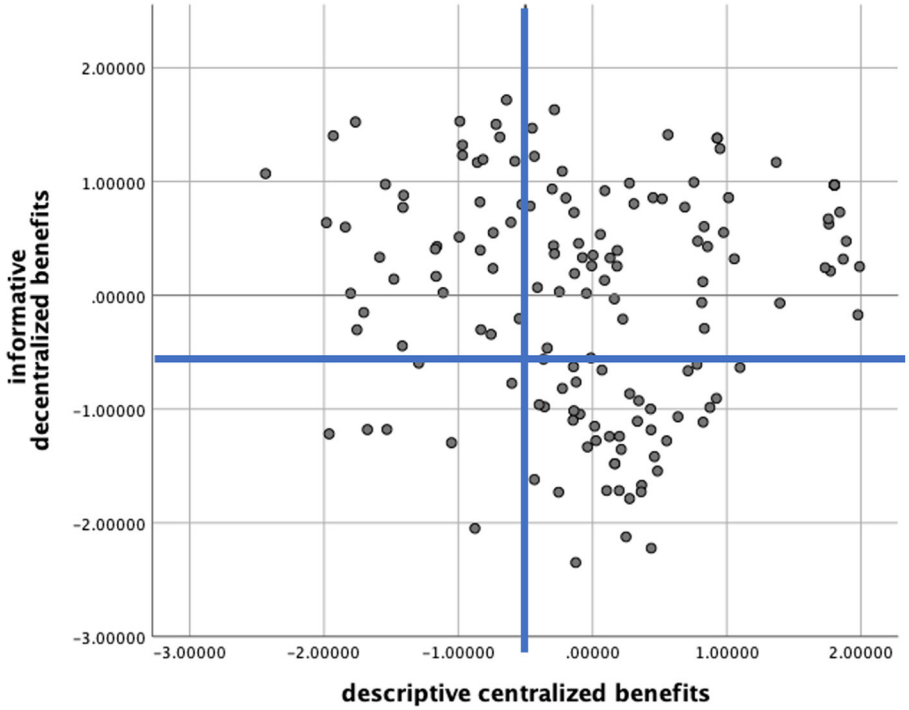

FIGURE 1
Scatterplot of descriptive centralized benefits (*x*-axis) vs. informative decentralized benefits (*y*-axis).

TABLE 4 **Final four cluster centers with *k*-means algorithm.**

Factors	Types of users			
	1. All-benefit Rejectors	2. All-benefit obtainers	3. Former-benefit conservatives	4. Newer-benefit seekers
Descriptive centralized benefits	−1.44111	1.30661	0.16059	−0.48284
Informative decentralized benefits	−0.16141	0.66261	−1.18939	0.77685

TABLE 5 **Results of one-way ANOVA for four types of users.**

Variables		Sum of squares	df	Mean square	*F*	Sig.
Evaluations of importance	Between groups	70.229	3	23.410	35.310	0.000***
	Within groups	98.122	148	0.663		
	Total	168.352	151			
Gratifications obtained	Between groups	72.350	3	24.117	51.306	0.000***
	Within groups	69.569	148	0.470		
	Total	141.919	151			

***Statistically significant at 0.001 level.

Therefore, to enhance users' gratifications obtained through Liker.social, increasing both users' sense of value and informative decentralized benefits toward the decentralized ASM are crucial. The results are thus correspondent with the expectancy-value approach for U&G (Palmgreen and Rayburn, 1985).

Discussion

The results of this study have delved into users' perceived beliefs, their perception of the overall decentralized alternative social media on the Mastodon instance Liker.social, while

TABLE 6 Multiple comparisons between four types of users.

Variables	(I)Type of users (mean)	(J)Type of users	Mean difference (I–J)	SE	Sig.	95% confidence interval	
						Lower bound	Upper bound
Evaluations of importance	All-benefit Rejectors ($M = 4.7262$)	All-benefit obtainers	−1.38810*	0.22475	0.000	−2.0237	−0.7525
		Former-benefit conservatives	0.16890	0.21303	0.890	−0.4335	0.7713
		Newer-benefit seekers	−1.11235*	0.21303	0.000	−1.7148	−0.5099
	All-benefit obtainers ($M = 6.1143$)	All-benefit Rejectors	1.38810*	0.22475	0.000	0.7525	2.0237
		Former-benefit conservatives	1.55699*	0.18098	0.000	1.0452	2.0688
		Newer-benefit seekers	0.27574	0.18098	0.510	−0.2361	0.7876
	Former-benefit conservatives ($M = 4.5573$)	All-benefit Rejectors	−0.16890	0.21303	0.890	−0.7713	0.4335
		All-benefit obtainers	−1.55699*	0.18098	0.000	−2.0688	−1.0452
		Newer-benefit seekers	−1.28125*	0.16621	0.000	−1.7513	−0.8112
	Newer-benefit seekers ($M = 5.8385$)	All-benefit Rejectors	1.11235*	0.21303	0.000	0.5099	1.7148
		All-benefit obtainers	−0.27574	0.18098	0.510	−0.7876	0.2361
		Former-benefit conservatives	1.28125*	0.16621	0.000	0.8112	1.7513
Gratifications obtained	All-benefit Rejectors ($M = 4.8810$)	All-benefit obtainers	−1.28333*	0.18925	0.000	−1.8185	−0.7482
		Former-benefit conservatives	0.37574	0.17938	0.227	−0.1315	0.8830
		Newer-benefit Seekers	−0.93155*	0.17938	0.000	−1.4388	−0.4243
	All-benefit obtainers ($M = 6.1643$)	All-benefit Rejectors	1.28333*	0.18925	0.000	0.7482	1.8185
		Former-benefit conservatives	1.65908*	0.15239	0.000	1.2281	2.0900
		Newer-benefit seekers	0.35179	0.15239	0.154	−0.0792	0.7827
	Former-benefit conservatives ($M = 4.5052$)	All-benefit Rejectors	−0.37574	0.17938	0.227	−0.8830	0.1315
		All-benefit obtainers	−1.65908*	0.15239	0.000	−2.0900	−1.2281
		Newer-benefit seekers	−1.30729*	0.13995	0.000	−1.7031	−0.9115
	Newer-benefit seekers ($M = 5.8125$)	All-benefit Rejectors	0.93155*	0.17938	0.000	0.4243	1.4388
		All-benefit Obtainers	−0.35179	0.15239	0.154	−0.7827	0.0792
		Former-benefit conservatives	1.30729*	0.13995	0.000	0.9115	1.7031

*Statistically significant at 0.05 level.

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TABLE 7 Multiple regression analysis of the causal relationship of perceived beliefs and evaluations of importance on gratifications obtained of Liker.social.

Independent variables	Unstandardized coefficients		Standardized coefficients	*t*-value	Sig. (*p*-value)	Collinearity
	B	SE	Beta (β)			VIF
(Constant)	2.944	0.283		10.415	0.000	
Informative decentralized benefits	0.428	0.053	0.442	8.061	0.000	2.088
Descriptive centralized benefits	0.123	0.040	0.127	3.072	0.003	1.182
Evaluations of importance	0.451	0.052	0.491	8.594	0.000	2.270

F = 182.623 (Sig. = 0.000); $R^2 = 0.787$; Adjusted $R^2 = 0.783$; dependent variable = gratifications obtained.

simultaneously investigating users' evaluations of importance and the levels of gratifications obtained through their use.

First and foremost, this study has portrayed the holistic landscape of users' perceived beliefs on Liker.social through factor analysis. This landscape includes two reliable and significant factors: informative decentralized benefits and descriptive centralized benefits. The novel decentralized benefits encompass sense of ownership, enhanced privacy, unique user experience, promising potential form, heightened writing creativity, tangible rewards, enhanced access to valuable information, and LikeCoin. These align with numerous studies on Web3.0 (Cao, 2022; Filipcic, 2022; Zheng and Lee, 2023). The established centralized benefits encompass personal recognition, branding and promotion, commerce and trade, life showcasing, and interaction with others (Ham et al., 2014; Chou and Liu, 2016; Ko and Yu, 2019). Though these results align with the expectancy-value approach proposed by Palmgreen and Rayburn (1985), which originally differentiates users' media beliefs between informational and descriptive categories, the research is limited in its generalizability to just one Mastodon instance, Liker.social.

Secondly, based on the results of paired *t*-tests, it is evident that writing activity is still deemed the most crucial functionality within decentralized ASM, although the level of gratifications obtained from it is slightly lower than the evaluations of its importance. This reaffirms that, regardless of the era—Web1.0, Web2.0, or the present Web3.0—writing on social media retains its significance (Miura and Yamashita, 2007; Sauter, 2014). Consequently, there remains ample room for enhancing the writing functionality of decentralized ASM, considering users' subjective evaluations of importance and their expectancy for gratifications. Regarding other functionalities of Liker.social, such as linking Liker ID and the overarching LikeCoin policy, users tend to evaluate these functions above the neutral point (3.5 points) and rate them as yielding gratifications of an equal level. These findings are congruent with users' perceived beliefs in informative decentralized benefits, suggesting that users readily embrace newer Web3.0 concepts and experience satisfactory outcomes when using this decentralized ASM. However, there is an exception in the form of the NFT bookstore, which users consider currently ambiguous in its meaningful application, thus awarding it the lowest scores for both evaluations and gratifications obtained. Overall, these findings imply that while decentralized ASM, such as Like.social in this research, can function as alternatives or checks on mainstream social media (Braun, 2023), ASM might place a more focused emphasis on addressing users' actual needs, values, and experiences in their new services, aiming to be not merely an alternative but a user-centered complement to mainstream social media.

Thirdly, the outcome of the multiple regression analysis in this research also aligns with the expectancy-value approach proposed by Palmgreen and Rayburn (1982, 1985), as users' holistic perceived beliefs combined with evaluations of importance positively affect the gratifications obtained within the decentralized ASM Liker.social. In essence, these variables collectively establish a robust causal relationship (adjusted $R^2 = 0.783$). Moreover, the multiple regression analysis sequentially underscores the significance of three key independent variables: evaluations of importance, informative decentralized benefits, and slighter descriptive centralized benefits. This suggests that the perceived beliefs regarding informative decentralized benefits hold even more prominence than those concerning descriptive centralized benefits within this decentralized ASM. This phenomenon can be attributed to the fact that the newer beliefs about Web3.0 benefits, when merged with individuals' subjective evaluations of importance, tend to stimulate the utilization and gratifications of Liker.social for most users, in contrast to the older beliefs related to benefits from centralized social media that users are accustomed to—such as personal recognition, branding and promotion, commerce and trade, life showcasing, and interaction with others—as highlighted in previous studies (Gruzd et al., 2018; Kim et al., 2019; Anweh and Ugondo, 2021).

Fourthly, although the aforementioned causal relationship is clearly significant, the perceived beliefs regarding descriptive centralized benefits cannot be entirely excluded from the analysis due to their subtle impact on users' gratifications obtained, as indicated by multiple regression analysis. This can be attributed to the notion that Web3.0 concepts may not completely replace Web2.0, despite the proposals and projections by many scholars (Guan et al., 2023). Rather, the concepts, technologies, or even "transformation" of Web3.0 can be viewed as a progression from Web2.0, particularly concerning the improvement of centralized social media at the present time. Intriguingly, as users increasingly opt for decentralized ASM, the relationship between Web2.0 centralized social media and Web3.0 decentralized ASM has become more intertwined. Therefore, in this study,

users on Liker.social have been categorized into four types based on their distinct perceived beliefs: All-benefit Rejectors, All-benefit Obtainers, Former-benefit Conservatives, and Newer-benefit Seekers. Additionally, since All-benefit Rejectors and Former-benefit Conservatives appear to exhibit less expectancy and value toward the new decentralized ASM compared to All-benefit Obtainers and Newer-benefit Seekers, this study cannot universally suggest that all users hold the same fondness for the newer benefits of decentralized social media, as illustrated in the aforementioned factor analysis. In other words, I cannot conclusively assert that the perceived benefits of the peculiar Mastodon instance Like.social encompass all the benefits of centralized social media for these users, despite the unanimous beliefs of Web3.0 proponents that Web3.0 social media aims to break free from the centralization characteristic of Web2.0 social media (Cao, 2022; Weyl et al., 2022; Guan et al., 2023).

Conclusion

In conclusion, this study aimed to uncover users' genuine beliefs within the Mastodon instance and demonstrated that the original uses and gratifications theory (U&G theory) still holds relevance in the era of Web3.0 (Katz et al., 1973). Through this study, I can assert that decentralized alternative social media indeed brings new benefits to users through the characteristics of decentralization, as previous research has argued (Kwet, 2020; Zulli et al., 2020; Rozenshtein, 2022; Zheng and Lee, 2023). However, despite the distinct media logics between centralized social media in Web2.0 and decentralized ASM in Web3.0, which represent different technological paradigms and societal visions (centralization vs. decentralization), executives and designers of both platforms cannot avoid addressing new user challenges and gaining insights from users' perceived beliefs (expectancy), evaluations, and, if applicable, gratifications obtained on the platforms. If Web3.0 decentralized ASM is intended to be more democratic than Web2.0 centralized social media, what challenges will emerge next? As Weyl et al. (2022) indicated, even within a decentralized alternative social media, users continually anticipate stronger mutual trust, self-verification, and interconnectedness. As anticipated by Zulli et al. (2020), alternative social media should inherently strive to create a more cohesive community than centralized social media. Therefore, the study acknowledges that users possess diverse perceived beliefs, and more importantly, the majority of individuals within mainstream or alternative social media conscientiously integrate their most valued aspects, ultimately obtaining gratifications. From the perspective of this study, the endeavors of users across every social media platform merit heightened recognition.

To sum up, this study has delved into users' perceived beliefs, evaluations of importance, and gratifications obtained within the decentralized Mastodon instance. It contributes to the understanding of users' perspectives on Web3.0 development, particularly in the context of decentralized alternative social media. The study concludes that, in addition to addressing technical aspects of Web3.0, more research should be directed toward capturing user feedback and experiences with decentralized social media and related platforms. This collaborative approach aims to foster the creation of stronger internet communities that align with the expectancy of all participants. These communities should encompass both informative and descriptive benefits for users, fostering the growth of new, yet more inclusive, decentralized social media platforms.

Although this study attempted to elucidate the reasons behind people's uses of decentralized alternative social media (ASM) by investigating users' perceived beliefs, evaluations of importance, and gratifications obtained through an exploratory survey. However, certain limitations arise from this methodological perspective. Firstly, there are over 9,000 Mastodon instance servers globally (Mastodon, 2023). The selected case, Liker.social, in this study represents merely one type of Mastodon instance. The study might lose its ability to generalize results due to the focus solely on online users from a single case (a Mastodon instance), even though Liker.social stands out for its Chinese-speaking participants and LikeCoin cryptocurrency policy. Additionally, while this study recognized the suitability of users from purposive sampling to address research questions, the absence of viewpoints from Liker.social executives presents a limitation in terms of contrasting their experiences with those of the users. Owing to the lack of a fixed population list, this study employed non-random sampling, leading to certain statistical inferences that can only be approximated based on the sampled users, potentially introducing biases.

Secondly, the primary objective of this study was to explore users' subjective perceived beliefs using the Perceived Beliefs of ASM Scale, developed from relevant literature and pilot studies. While the scale's reliability has been established, its focus was confined to perceived beliefs among users of Liker.social. Hence, should future studies employ this scale to explore other Mastodon instances, it would be prudent to expand the scale's items to adequately capture diverse perceived beliefs across multiple instances. Consequently, further research is imperative to address and bridge this gap.

Thirdly, the initial contributions of this study encompass the portrayal of perceived beliefs held by users of decentralized ASM, elucidation of potential intricate perceptions associated with using specific ASM, and comprehension of subjective evaluations and gratifications obtained. However, given the breadth of topics related to decentralized ASM, it remains impossible to cover all relevant issues within a single study. As a result, the subsequent recommendations are furnished, serving as guiding directions for future research:

(1) Further research can focus on the diverse activities of users within decentralized ASM (Lee and Wang, 2023). For instance, inquiries like "What types of WritingNFT do users produce, purchase, and sell?" or "Do more varied benefits beyond cryptocurrency exist in other Mastodon instances, and what significance do they hold for the U&G theory?" Are worthy of further investigation.
(2) This study evaluated users' assessments of importance and obtained gratifications based on the existing functionality of Liker.social. As the scale is fixed and inflexible, future research could delve into users' anticipated expectancy and potential new needs (Zheng and Lee, 2023), uncovering more about the evolving landscape of decentralized ASM as envisioned by users. Additionally, as mentioned earlier, exploring the

perceived beliefs of various roles within decentralized ASM, such as the executives of Mastodon instances, could be worthwhile. Given the decentralized nature, no single role might control the entire social media landscape (Cao, 2022; Filipcic, 2022; Guan et al., 2023), making it challenging for any one role's perceived beliefs to accurately depict the entirety of decentralized ASM. Therefore, I recommend that future research should encompass a wide range of perspectives from participants, users, and executives, striving for inclusivity. This approach would allow for a comprehensive comparison to facilitate a consensus on the decentralization of social media.

(3) While this study employed online questionnaires to explore users' perceived beliefs, evaluations of importance, and gratifications obtained, the multidimensional nature of Mastodon instances, combined with users from diverse backgrounds and knowledge domains, suggests the potential for mixed methods. In addition to using quantitative survey methods to investigate users' perceived beliefs, future research can incorporate qualitative research methods such as in-depth interviews or focus groups to provide deeper theoretical insights.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

KL: Investigation, Methodology, Writing—original draft.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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