

Investigating People Who Use Drugs' Safety Goals, Risks, and Practices with Information Technology

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Abstract—Drugs are extensively utilized in contemporary society, posing significant safety risks to people who use drugs (PWUD). The advent of information technologies (IT) is gradually altering PWUD's drug use behaviors and, as a consequence, their safety practices. Yet, the precise impacts and risks these changes introduce to PWUD's safety have scarcely been explored. We conducted 20 semi-structured interviews with PWUD and analyzed content across 29 drug-related subreddits to examine the safety practices of PWUD in the context of IT utilization. Our findings reveal that IT has afforded PWUD broader access to information and community engagement, facilitating emotional support and better management of their drug use. Nonetheless, it has also introduced new risks such as the spread of misinformation, an over-reliance on technology, the promotion of risky behaviors and the risk of financial loss. We further discuss the unmet needs of PWUD, the challenges they face transitioning to online communities, and offer design implications to enhance their safety.

1. Introduction

Recreational use of psychoactive substances (commonly referred to as drugs) is a longstanding problem globally, and its prevalence is growing by the day. The United Nations Office on Drugs and Crime (UNODC) reports that the number of estimated users increased from 240 million in 2011 to 296 million in 2021, an increase of 23% [1]. Laws and policies in many regions impose strict controls on the use of drugs [2], [3], social institutions provide assistance for drug use [4], and public organizations provide people who use drugs (PWUD) with places and instruments for drug tests [5], all of which are aimed at reducing the harm caused by drug use. However, drug use can still lead to harmful and serious consequences, as statistics show that more than 96,700 people die from drug overdoses in the United States in a single year [6].

In the wake of the digital transformation and utilization of information technologies (IT), PWUD have gradually shifted from obtaining information and dealing drugs mainly through offline exchanges to the Internet and mobile devices. These shifts have affected the behaviors of PWUD in a variety of application scenarios. For example, the development of search engines has enabled them to access drug-related information [7], specially designed apps allow for the use of mobile devices to record drug use [8], online social network platforms help them to interact with their

peers and to socialize [9], and the development of online shopping and logistics has provided new ways to purchase drugs [10].

While drug use significantly impacts the safety of PWUD, and IT has a critical role in shaping PWUD's drug-related behaviors, there is a noticeable gap in research concerning the influence and risks of IT on PWUD's safety. Given the inherent risks associated with drug use, overlooking the specific needs of PWUD can lead to persistent safety threats. Therefore, our study explores the safety practice of PWUD when utilizing IT and study the following research questions (RQ), aiming to address the existing knowledge gaps concerning how IT affects the safety of PWUD.

RQ1: How do PWUD perceive the impact of IT on their safety during drug use?

RQ2: What risks do PWUD perceive when utilizing IT during drug use?

To answer our research questions, we employed a mixed-methods approach. Initially, we conducted 20 semi-structured interviews with PWUD in regions where drugs are either partially legalized or where harm reduction services are available. These interviews explored participants' perceptions of safety, their experiences and attitudes towards using IT for drug-related activities, and their views on the impact of IT on their safety. Furthermore, we conducted a content analysis of discussions from the 29 drug-related subreddits. This involved categorizing the content by topics, counting the frequency of each topic, and performing sentiment analysis on the comments. This analysis aimed to capture the community's attitudes towards interactions within the online space, providing insights into how IT influences the safety practices and perceptions of PWUD with broad demographics.

Our study first identified five safety concerns significant to PWUD: two physical safety issues (acute effects and physical health), two mental safety issues (mental health and social image), and privacy. We developed a framework to understand PWUD's utilization of IT across three stages of drug use, categorizing their activities into five actions: searching for information, asking questions, making deals, sharing experiences, and recording drug uses. Based on the framework above, we find that IT not only provides PWUD with a vast array of information and applications for recording drug use, enhancing their capacity to mitigate negative effects and positively influencing their acute effects and physical health, but it also opens up communication channels that offer emotional support and a sense of com-

munity identity. Moreover, the anonymity afforded by online communications protects PWUD's privacy during interactions with community members. However, our findings also highlight several risks perceived by PWUD: misleading information on the internet and PWUD's over-reliance on automatic safety testing can lead to misuse of drugs and pose health risks; unsafe behaviors promoted online may decrease PWUD's awareness of potential risks, thereby increasing the likelihood of engaging in risky behaviors. Additionally, the practice of buying drugs online introduces financial safety issues. These complexities underscore the multifaceted risks PWUD face in safely navigating the digital landscape.

Our paper contributes to human-centered security and privacy in several ways. First, it introduces a framework for understanding the utilization of IT by PWUD across various stages of drug use. This framework is poised to serve as a foundational guideline for future research aimed at evaluating the safety implications of PWUD. Secondly, it addresses the risks perceived by an underrepresented population at risk during the digital transformation, focusing on their specific issues. Finally, we provide insights and implications from the perspectives of user needs, IT development, and safety for PWUD. These contributions are intended to inspire and inform future research in the design of safer IT solutions for populations at risk, aiming to address and mitigate the risks they encounter.

2. Related Work

2.1. Research on PWUD

Prior research investigations on PWUD primarily concentrate on domains such as public health and criminal justice. These studies examine the potential mechanisms precipitating drug addiction, the propagation of infectious diseases associated with drug use, and the impact of policy changes on PWUD.

First, previous works explored the underlying mechanisms driving drug addiction, with implications for treatment approaches [11], [12], [13], [14], and investigated the transmission of infectious diseases associated with drug use [15], [16]. Second, studies have also provided insights into PWUD's behavioral patterns [17], [18], [19]. A key focus has been understanding PWUD's risk perceptions, revealing that despite awareness, younger PWUD and ecstasy users often underestimate the risks [20], [21], [22]. Lastly, the impact of legal and policy changes on PWUD, such as societal attitudes, and stigma, has been a subject of ongoing research [23], [24], [25], [26].

While the disciplines of public health and criminal justice offer valuable insights into the patterns and habits of drug use among PWUD, these perspectives may not fully capture PWUD's experiences in the digital age. PWUD's behaviors, including searching, purchasing, and interacting, are increasingly IT-mediated. Understanding this interaction can enrich our knowledge of PWUD's experiences and inform the development of technology-inclusive interventions and policies.

2.2. IT Able to Be Utilized by PWUD

Previous research has highlighted the important role of IT in shaping the experiences of PWUD mainly in two aspects. On the one hand, it emphasizes how technologies such as search engines, information portals, and social media platforms provide relevant information to PWUD. On the other hand, it discusses the impact of online information on PWUD.

IT plays a key role in providing comprehensive information to PWUD through search engines, web portals, and social media. Accessible websites like PsychonautWiki¹ and Erowid² offer credible information on drug production, dosage, and effects [7]. The utilization of drug-related online forums can foster harm reduction, with these social platforms presenting new avenues for delivering harm reduction services [27], [28], [29]. Moreover, social media platforms have demonstrated the potential to enhance PWUD's access to harm-reduction services [30].

There has been a small amount of research exploring the impact of IT on PWUD. Although online information can potentially reduce drug use risks [31], a lack of credible sources may lead PWUD to experiment with potentially harmful drugs and dosages, causing severe side effects [32]. In addition, despite stringent oversight, search engines continue to index websites disseminating misinformation about illicit drugs. This misinformation can lead PWUD to adopt potentially harmful practices [7], [33]. Moreover, some studies suggest that Internet exposure may increase the propensity for drug abuse among university students to a certain degree [34].

Despite research on drug-related information and its effects, it's unclear how people acquire this information and its impact on their behaviors. In particular, we want to know when, where, and how they acquire certain information and what effect the information has on their drug-related behaviors. Further, privacy and safety concerns of PWUD while obtaining and sharing this information haven't been explored. Therefore, in this study, we expand upon prior research about the effects of drug-related information to hone in on the connections between people's safety and privacy concerns and their behaviors.

2.3. IT Safety Risks for At-Risk People

More and more studies are examining how vulnerable people and other at-risk groups deal with and understand privacy and safety issues brought by IT [35].

IT safety risks for vulnerable groups, including the elderly with mild cognitive impairment (MCI), Intimate Partner Abuse (IPV) survivors, individuals with mental disorders, and the LGBTQ+ community, are a key focus in academia. Older adults with MCI often depend on caregivers for online services, but this can compromise their autonomy

1. https://psychonautwiki.org/wiki/Main_Page

2. <https://www.erowid.org/>

and risk unwanted information disclosure [36]. IPV survivors, in their effort to ensure safety, face the challenge of managing their online presence, including severing connections that might compromise their privacy [37]. Individuals may grapple with the decision to disclose experiences online with mental illness [38] or sexual abuse [39], or aspects of their identity such as gender transition [40], [41], [42] and LGBTQ+ identity [43], [44]. The act of disclosure in these contexts can be daunting and complex to navigate. In weighing the decision to disclose, these individuals may confront potential adverse outcomes such as rejection [45], stigma and judgment [46], and increased stress [41], among other undesirable consequences. This highlights the intricate dynamics involved in managing personal information disclosure in digital spaces.

While current research has light on the safety risks posed by IT for various at-risk groups, it has largely overlooked the PWUD group. The limited studies on PWUD have focused on their safety attitudes [20], [21], without investigating if their safety risks stem from IT use. This gap necessitates further research to understand the interplay between IT use and risk perception among PWUD and whether they face unique safety risks due to IT advancements like other people at-risk groups. Such insights would enrich our understanding of PWUD's behavioral patterns and inform the design of more efficacious interventions.

3. Method

To investigate how IT systems influence safety practices and perceptions among PWUD, we adopted a mixed-methods approach. Initially, we conducted semi-structured interviews with 20 individuals, carefully selected to represent diverse experiences with IT in the context of safety. These interviews aimed to uncover in-depth insights into their views and experiences. Subsequently, to capture a broader spectrum of perspectives, we analyzed discussions within selected drug-related communities on Reddit. This analysis focused on categorizing and statistically examining user interactions, thereby complementing and enriching our interview findings.

3.1. Study1: Interview Study

3.1.1. User Recruitment. To recruit participants for our interviews, we employed a two-pronged approach. Initially, we disseminated recruitment messages across various drug-related online communities, including PsychonautWiki³ and several Telegram groups. Additionally, we also used snowball sampling, where participants recommended other PWUD. To qualify for the study, participants were required to meet two criteria: a history of drug use and the ability to articulate their drug-using experiences in English. Prior to participation, we explained the study's objectives to all participants.

In total, 20 individuals were recruited for the study, and no new themes or findings emerged while coding the final three respondents. The demographic data of the interviewees are presented collectively in adherence to ethical guidelines. Our participant pool ranged in age from 18 to 44 years and included residents of Portugal, the Netherlands, the United States, England, and Switzerland. Their drug use experience varied from several years to multiple decades. The primary substances used by participants were LSD, MDMA, cannabis, and magic mushrooms. This consistency in drug types among our participants helps minimize variations in perceptions that could potentially arise from the use of different drugs.

3.1.2. Interviews. From June 2022 to December 2023, we conducted semi-structured interviews with 20 participants via Telegram or Zoom, depending on the preferences of the interviewees. Each session lasted approximately one hour. Prior to each interview, participants gave oral consent, acknowledging that the interviews would be recorded and their anonymized statements might be used in our report. All interviewees consented to these terms.

The interviews were guided by a structured format to maintain consistency. They were divided into three main parts:

- **Personal Information:** We inquired about the participants' self-identified characteristics and their history with various drugs, focusing on specific drugs and duration of use.
- **Safety Perceptions:** The discussion centered on participants' perceptions of safety in the context of drug use. We explored the safety dimensions they prioritized and how information impacted their safety management strategies. This also included their interactions with others, both in their immediate environment and within online communities.
- **Drug Use Experiences with IT Systems :** Participants were asked to share their experiences with drug use and the related IT systems they accessed. This part aimed to understand how technology intersects with their drug use practices and the perceived risks during the utilization.

3.1.3. Data Analysis. To analyze the interview data, a thematic analysis [47] approach was adopted, focusing on the impact of the safety issues of PWUD. We coded PWUD's perceived safety, the impacts of IT on PWUD's safety issues, and perceived risks when adopting IT systems. The detailed process of developing and iterating the theme is described in Appendix A.

Initially, 20% of the interview data was independently coded by two researchers. Each researcher conducted a preliminary thematic analysis to identify themes related to the research question. This process involved an in-depth reading of the transcripts, followed by the identification and labeling of relevant segments that discussed the influence of IT on the safety of PWUD. After the initial coding

3. https://psychonautwiki.org/wiki/Main_Page

phase, the researchers compared the themes, focusing on similarities and differences in the interpretations. Ultimately the two researchers developed a comprehensive codebook for analyzing how IT affects the safety of PWUD. To ensure the reliability of the developed codebook, a further 10% of the interview data was randomly selected for coding. Both researchers independently applied the codebook to this subset of data. The inter-coder reliability was assessed using Cohen’s Kappa [48], which resulted in a Kappa value of 0.85, which indicates strong reliability of the coding process, suggesting that the codebook provides a consistent framework for analyzing the data. The remaining 70% of the interview data was allocated for final coding. The two researchers collaboratively applied the validated codebook to this substantial portion of the data. Throughout this process, the researchers regularly convened to discuss their findings and resolve any discrepancies in coding, further refining the analysis.

User Behavior	Pre-use	During-use	Post-use
Searching for Drug Related Information	✓	✓	✓
Asking Questions on Drug Use	✓	✓	✓
Making Drug Deals	✓		
Sharing Experience and Discussing About Drug Use		✓	✓
Recording Drug Use	✓		✓

TABLE 1. PWUD’S UTILIZATION OF INFORMATION TECHNOLOGIES. THE FIRST COLUMN OUTLINES THE SPECIFIC BEHAVIOR OF PWUD, WHILE THE SUBSEQUENT COLUMNS DESCRIBE THE STAGES AT WHICH THESE BEHAVIORS CAN TAKE PLACE

3.1.4. Framework of Utilizing IT Systems. From our qualitative study, we observed that the PWUD’s utilization of IT systems varies across different contexts and evolves over time. We categorized the utilization into three distinct phases: pre-use, during-use, and post-use, each characterized by unique engagements with IT systems. This model is represented in Figure 1, which serves as a foundation for our further analysis.

Pre-use Stage. In the pre-use stage, particularly for first-time users, the utilization of IT is primarily centered around gathering knowledge about drugs. This stage involves users using IT to seek details about the drugs they intend to use, including safe dosages, methods of use, and potential effects. In parallel, they use these tools to locate and contact drug suppliers and purchase drugs, leveraging the anonymity and convenience offered by online transactions. Online communities also serve as a resource where users can pose questions about their planned usage. Users also sometimes use apps or websites with recording and reminder functions to record their usage plans in advance and to

observe whether there are any dangerous ways of using drugs.

During-use Stage. During the use of drugs, users turn to IT to verify, understand, and share their immediate physical and psychological states. Users often go through websites or communities where they can find insights or ask questions about the effects they are experiencing. If the effects of the drug are prolonged, users sometimes also share their immediate experiences on social platforms during use, especially if some acute reactions are in effect, such as euphoria, which to some extent may lead to a desire to share. The process of sharing experiences and experiences also carries certain safety risks.

Post-use Stage. After drug use, the main way in which PWUD use IT is manifested in recording, sharing, and seeking information on harm reduction. PWUD may use websites or applications with tracking features to record their drug use experiences, or share drug use experiences and feelings in online communities. In addition, users may search for information about harm reduction after drug use, including addressing side effects, mitigating long-term effects, and even how to avoid the impact of drug use behaviors on one’s social image, such as covering up signs of drug use.

3.2. Study2: Online Discussion Data Analysis

3.2.1. Data Collection. For the second part of our study, we selected Reddit as the data source for gathering online interaction data. With its well-categorized topics and higher engagement in personal discussions, Reddit is more suitable for researching drug-related behaviors in online social networks. This includes discussions among PWUD within their online communities and the rules governing these communities.

Specifically, our initial step involved retrieving the subreddit *r/Drugs*, identified by directly searching for the keyword ‘Drugs’. We compiled a list of relevant subreddits linked by *r/Drugs*, excluding those not pertinent to drug use. These subreddits were then ranked based on their member count, and the top 30 were selected for data collection.

Data collection was conducted using the Reddit API. This included gathering details such as the content and timing of each post, the identity of the posting user, and the content and timing of comments. We also gathered each subreddit’s community rules to analyze from the community management perspective.

Ultimately, this process yielded 27,539 posts and 27 sets of community rules from these subreddits, comprising our Reddit dataset. More detailed descriptions of the collection method can be found in Appendix B.

3.2.2. Data Processing. The data collected from Reddit were processed using various methods. We employed the ChatGLM2-6B [49] to remove sensitive information from the content and summarizing the content of lengthy posts. The ChatGPT-3.5 model [50] was used to categorize topics of the posts. Additionally, sentiment trends in the

comments were analyzed using VADER [51]. We also carried out a qualitative analysis of the community rules.

More detailed descriptions of the methods, like the prompt used for LLMs involved, can be found in Appendix D and E.

Post Topics and Comments. We first randomly sampled 500 posts for a thematic analysis of the types of behaviors in PWUD’s online community and eventually summarized three main categories, i.e., ‘Asking for Help’, ‘Sharing Experience’, and ‘General Discussion’. Each main category was further divided into a total of nine sub-categories. Detailed descriptions of these subcategories, including their definitions and examples, can be found in Appendix C.

Based on the categories summarized above, we designed a special prompt for ChatGPT-3.5 to categorize Reddit post content. In order to make the prompt more complete and the model categorization more accurate, we manually classified a distinct subset of 100 Reddit entries into nine predefined categories. This labeled dataset served as our benchmark. Each entry was individually put into the ChatGPT-3.5 model using an initial categorization prompt. In instances where misclassification occurred, the prompt was meticulously adjusted to improve categorization precision. After every adjustment, we revisited the previous five posts to ensure that the revised prompt didn’t negatively impact their categorization accuracy. We achieved 100% classification accuracy on the benchmark dataset. Finally, as a check, we randomly re-sampled 100 posts, labeled them manually, and classified them using a fixed prompt, obtaining a classification accuracy of 88% for ChatGPT-3.5.

To assess the sentiments of PWUD in online discussions, we applied VADER [51], a sentiment analysis tool, to all comments under each post in our dataset. Furthermore, to ensure privacy and avoid direct identification of post content, we paraphrased all comments when quoting specific content. This approach allowed us to maintain the original meaning of the comments while safeguarding privacy.

Community Rules. In coding the community rules, two researchers employed an open-coding approach [52]. Initially, each researcher independently reviewed 5 sets of community rules, identifying emerging themes of the risks that have been observed in online interactions among PWUD and establishing a preliminary coding framework. This initial analysis led to the creation of a codebook. Subsequently, the researchers individually applied this coding scheme to the rest of community rules. To maintain consistency, all rules underwent double-coding. Following each coding session, the researchers convened to discuss their findings and resolve any discrepancies, thus ensuring accuracy and thoroughness in their analytical process.

3.3. Ethics

Throughout this study, we were deeply aware of its sensitive nature and the vulnerability of our participants. Ethical considerations were at the forefront. Two studies both obtained approval from the Institutional Review Board (IRB) at [institution name hidden for review], and strictly

adhered to their guidelines to ensure ethical conduct. This included obtaining informed consent from interview participants and rigorously maintaining anonymity and privacy by not collecting any personally identifiable information.

Specifically, we ensured that participants could understand general text based on our interactions with them and only recruited adult participants to ensure that they could take responsibility for their own behavior. We conducted the interviews online through telegram and Zoom, where telegram is an end-to-end encrypted communication and Zoom allows participants to participate in the sessions without logging in. Anonymity was maintained by preventing participants from revealing their account information. With the interviewees’ consent, we recorded the sessions and transcribed them locally.

3.4. Limitations

Our study’s findings are shaped by certain limitations related to participant demographics, the laws and policies in the regions where the interviewees were located, and their privacy perceptions concerning drug use.

Firstly, we restricted our interview recruitment to English speakers. This could introduce a sampling bias, particularly as many participants were from countries where English is the primary language, or they had a higher educational background. Secondly, our interviewees were mainly from countries with relatively liberal restrictions on drug use, including Portugal, the Netherlands, the United States, England, and Switzerland. The categorization of drugs as “partially legalized” varies considerably among these countries. For instance, two of our participants came from the United States, in which the legality of drug use can differ dramatically from one state to another. This may have led to biased perceptions of social image and privacy. Additionally, our interviewees were those willing to discuss their drug use and consent to audio recording openly. The online discussion data also came from individuals comfortable with publicly talking about their drug use. This approach may have resulted in a sampling bias regarding the privacy perceptions of PWUD.

Despite these limitations, it is important to recognize that our interviews with 20 participants are typical for qualitative studies aiming for depth over breadth. We achieved data saturation, as no new themes emerged in the final three interviews. Our study’s primary goal was to identify new perceived risks posed by IT in the context of PWUD rather than to provide a comprehensive representation of all PWUD. Future research could engage in a more extensive cross-comparison of our findings to mitigate the effects of these sampling differences.

4. Safety Definition

We found that most participants had mixed views on safety. While the majority identified physical safety as the most obvious issue, some also mentioned mental safety and privacy. For physical safety, we further subdivided it

TABLE 2. SAFETY ISSUES AND THEIR IMPACTS ASSOCIATED WITH DRUG USE

Safety Issue	Description	Example
Acute Effect	Immediate changes in physiology upon drug use	MDMA can lead to euphoria, heightened sensory perception, and increased heart rate.
Physical Health	Subsequent effects of drug use on the body	Long-term use of MDMA may contribute to neurotoxicity and impaired cognitive function.
Mental Health	Emotional and psychological changes due to drug use	MDMA can lead to anxiety, depression, and mood disorder.
Social Image	Perceived social perception and evaluation of PWUD	Be perceived that using MDMA is addictive or that people who use MDMA are dangerous
Privacy	Control by PWUD of their personal information and activities	Can conceal one's MDMA use from coworkers.

into two subcategories, including acute effect and physical health, and for mental health, we also categorized it into mental health and social image. We provide a brief definition of these five safety issues and use MDMA as an example for each safety issue in Table 2.

4.1. Acute Effect

The first safety issue mentioned by PWUD is the acute effect, i.e. whether the immediate reaction of the body after taking drugs is safe and meets their expectation. Most people take drugs because they would like to experience the acute effect. However, not all the acute effects will be positive and meet their expectation or be the same as what they learned from the information source. Especially for some unexpected acute effects, e.g., mixing several drugs. The unknown risks of mixing are higher for the user than for using a fixed number of drugs, and there is a need to ensure that the mixing method is safe and that precautions are taken before use. P4 described an unpleasant experience of use, which had a much negative impact on him. *“I just didn't like the way it made me feel. It was totally speedy and cranky, and it made me almost angry, and so fired up, and it just wasn't a pleasant experience. It was like the exact opposite of the experience that I like, which is a more chilled-out happy by this was an aggressive negative.”* (P4).

4.2. Physical Health

The safety concerns of PWUD also include their own physical health, as the consequences of drug use go far beyond the acute effects to include long-term effects on all aspects of the PWUD. Therefore, the duration that drugs remain active within the body and the metabolic processes required for their elimination are also issues of concern to PWUD. P11 mentioned that he went to look up something about subsequent reactions and solutions after using drugs. *“I think I actually looked it up after I took it like the next day, two or three times like to try and understand how long, like, the hangover from the drugs would be. Also, what's like the best way to make myself like? Should I drink a lot of water?”* (P11).

Additionally, potential side effects and aftermaths of drug use require careful consideration. Chronic use of certain drugs can lead to lasting physiological changes, including damage to vital organs, alteration of brain chemistry, and

a decrease in physical resilience. The risk of developing dependency and facing withdrawal symptoms upon cessation of use is also a significant factor. P7 stated that he would observe the long-term effects of drug use on himself. *“Also, I'm trying to limit the risk to for myself by taking them very rarely, and also observing like what kind of effects do they have on me? And what are also the long-term effects?”* (P7).

4.3. Mental Health

Safety does not only refer to the physical perspective of PWUD, but it also refers to whether people's mental state is under control, whether they feel pressure or other feelings that are not considered common in their perception. PWUD often report feelings of despair, pressure, and a lack of support, potentially triggering mental health disorders. P16 believed that mental safety for him means not getting into out-of-control situations. *“I think is not losing the control, like still having the control over yourself, when you take it or also when you do not take it, like when it gets to addiction. Maybe knowing what you get. Knowing what you consume.”* (P16).

In addition, some participants resorted to drugs as a means to self-medicate or alleviate their mental health conditions. P12 expressed his interest in the role of drug use in treating mental illness. *“Now there's so many documentary series as well about mental health, and I will see stuff that I'm more interested in how, for example, micro-dosing might benefit with depression.”* (P12).

4.4. Social Image

The concerns of PWUD about their social image are related to misunderstanding of people around them and the general public. The misunderstanding may change how people treat them when their drug experiences are disclosed, which always bring negative consequence to the population in many perspectives [53]. Therefore, social image has been considered a safety factor among PWUD. P2 describes frankly the effects of drug use on the social image. *“There's a lot of misconception and stigma and I think for many people you can talk about it and share your perspective but I think there are some people that are not really willing to understand.”* (P2).

Additionally, there are widespread worries about the broader implications of stigmatization, including potential impacts on social welfare and other societal benefits. P12 specifically described this concern, fearing that the status of PWUD will affect the social benefits he is supposed to have. *“I mean, I’m worried that I would be labeled as like a junkie on the health system, and I wouldn’t get as many perks as I do if I am a normal citizen.”* (P12).

Also, the existing of stigmatization even more seriously prevent people to adopting more professional and helpful services. P18 felt that although he thought drug testing was fun, visiting drug testing facilities offline and in public was a shameful thing for him to do. *“I think the testing would be interesting to do. ... I have to say that, to be honest in my own mind, there is also still this stigma around, and going to the testing facility.”* (P18).

4.5. Privacy

In general, perceptions of privacy of PWUD are basically concerned with whether real-life interactions and communications reveal their drug use to people they don’t want to know about. Users may be wary of considering those who have a stake in the user’s own well-being, such as schoolmates, colleagues or superiors. When their drug use is discovered by these people, it may not only affect their reputation and bring about unnecessary arguments. Still, it may also directly affect their income and standard of living. P5 stated that he would not disclose his drug use to some stakeholders such as superiors and schoolmates for privacy reasons. *“Not with the people I live with, not with the general superiors. ... It’s not public knowledge, and this is for privacy reasons.”* (P5).

Since PWUD adopt privacy strategies based on whether groups or individuals will have their interests violated by drug use, different privacy strategies will emerge in specific cases. Some users choose to hide their drug use from elders, such as parents, but if the parents are positive about it (or even use drugs themselves), then the user feels that they have no privacy concerns in front of their own parents.

5. Impacts on Safety (RQ1)

This section focuses on the impact of IT utilization on safety issues concerning PWUD. Guided by the utilization framework depicted in Figure 1, we examine the ways in which various types of IT utilization affect the safety perceptions of PWUD across five distinct safety issues.

5.1. Searching for Drug-Related Information

As highlighted by our interviewees, searching for drug-related information is a crucial use of IT. They believe that the insights gained from such searches not only shape their expectations and behaviors towards drug use but also enhance their understanding of the immediate acute effects. Furthermore, this online information supports the adoption of drug use patterns that are beneficial for long-term physical health.

5.1.1. Enhancing Degree of Knowledge for Drug Reactions. Online searches for drug-related information significantly help PWUD set their expectations regarding the acute effects of drugs. Such knowledge is crucial for preparing for potential reactions, thus minimizing the risk of surprises or adverse outcomes post-consumption. Our interviewees highlighted the importance of understanding both positive and negative reactions before drug use. For example, P7 noted the necessity of being aware of all possible reactions to drugs and discussed how accessing drug-related information influenced his behavior and cognitive processes. This awareness is instrumental in avoiding hazardous situations. *“I always look up the directions like what could be potentially harmful if I mix something, because sometimes I love a poly-experience, and then I can inform myself very accurately, like, what could go wrong, and how to avoid it.”* (P7).

5.1.2. Supporting Health Awareness of Drug Use. Beyond understanding the acute effects, our interviewees also reported that searching for information enhances their awareness of healthier drug use practices. They gain insights into the impact of drugs on their physical health, including how long drugs remain in their system and the metabolic processes needed for their elimination. This knowledge encourages more cautious drug use planning. For example, P5 emphasized the importance of knowing the duration of a drug’s effects and its impact on the body, asserting that such information is invaluable. *“I think, that there’s a huge benefit in it, especially for harm reduction purposes. It’s very, very important to know what’s in your body, how long it’s going to last, and when different interactions will matter, something’s out of your system and generally won’t affect it.”* (P5).

5.2. Asking Questions on Drug Use

Asking questions about drug use represents a significant utilization of IT by PWUD. Our analysis reveals that 56% of online discussions in our dataset consist of PWUD seeking advice on various aspects of drug use. These inquiries cover a wide range of concerns, including the justification of drug use, worries about its social impact, questions regarding their current physical condition, strategies for concealing drug use, and suggestions on overcoming addiction. These discussions span all three stages of drug use (refer to Figure 1), indicating a widespread need among PWUD for personalized advice that addresses their specific circumstances, thereby enhancing both physical safety and privacy.

5.2.1. Receiving Personalized Guidance. Throughout various stages of drug use, PWUD can seek and receive personalized advice from other community members through online platforms, a phenomenon extensively documented in our Reddit dataset. For example, a user shared a particular concern that was troubling him about drug use: *“... When I need to make a decision, my brain gets “stuck” or is in a “frozen” state and I can’t make a decision, or I stubbornly*

think I'm right and disregard the facts." (R12455). The comments provided diverse perspectives, while ultimately other users provided the guidance sought by the user who asked the question: "...*Decision anxiety is a very normal way of showing anxiety; sometimes you have to grit your teeth and get super uncomfortable physically, but just make a decision based on what you know and move on.*" (R12455). This interaction highlights the value of the online community's personalized advice on his safety management, as evidenced by the poster's reaction: "*That's exactly what I was looking for!*" (R12455).

5.2.2. Enhancing Privacy Through Strategic Information Utilization. Beyond physical safety, PWUD seek strategies online to protect their privacy. Online forums, communities, and specialized websites offer extensive advice on managing situations that could potentially expose their drug use. For example, poster of R458 sought advice on an upcoming interview involving a drug test. Community responses provided well-informed estimates about detection times, as seen in one comment stating, "*100 days is absolutely the longest time it takes for anyone to pass a drug test. You are still clear at day 100.*" (R429). The poster later confirmed passing the drug test, affirming the usefulness of the advice received. Such inquiries are common, with our analysis identifying 279 instances of questions related to privacy strategy inquiries. This demonstrates the value PWUD place on online communities for privacy-preserving strategies, highlighting the role of digital platforms in enhancing privacy.

5.3. Sharing Experience and Discussions

In our collected Reddit dataset, posts that share personal drug use experiences constitute 31% of the total, while general discussions account for 28%. Online platforms offer PWUD opportunities to share their daily lives and engage in discussions, providing a space for emotional support. However, this sharing also carries the risk of information misuse, potentially leading to safety issues for other community members.

5.3.1. Getting Emotional and Psychological Support. PWUD who share experiences online are likely to receive supportive responses, which can have a positive impact on their mental health. For example, in post R16905, the poster recounts a drug-related assault experienced over 20 years ago and the recent pain of coming to terms with it. A commenter offered empathy and encouragement, saying: "*I'm really sorry about what happened to you. It happened to me, too. Cheer up, honey. You're very brave to ask such a thing.*" (R16905). This comment provided the encouragement and reassurance the poster needed, as reflected in their response: "*You gave me exactly what I needed to reassure me that I wasn't crazy and that what I was feeling was right.*" (R16905). Such supportive interactions are prevalent in these online discussions. In our Reddit dataset, over 67% of comments (70,172 out of 104,543) on posts sharing

PWUD's experiences were positive, indicating a substantial amount of emotional support and encouragement within these communities.

5.3.2. Enhancing Self-Identity and Community Belonging. Participating in discussions about drug-related topics provides PWUD with an opportunity to cultivate a sense of self-identity and belonging to a community. The prevalent stigmatization of drug use can isolate PWUD, making it difficult to find peers who share similar experiences in their immediate environments. According to our interviewees, sharing their stories online allows them to connect with others facing similar challenges, circumventing the social stigma encountered in everyday life. This form of virtual interaction can significantly bolster a user's self-identity and foster a sense of community belonging. For instance, Participant 9 expressed feeling relieved and validated upon discovering many others with similar experiences, highlighting the positive impact of such engagements. "*A relieving experience like, this actually a lot of people out there that are using the substance.*" (P9).

5.3.3. Causing Potential Safety Issues through Content Misappropriation. While sharing experiences online is often seen as beneficial for the mental health of PWUD, it's important to recognize that disseminating drug-related information could lead to safety risks for community members due to content misappropriation. This is particularly true in cases of fraudulent or deceptive activities conducted by unethical parties.

A significant number of online community guidelines explicitly prohibit the sharing of drug-related images to mitigate such risks. Specifically, 33% (9 out of 27) of examined community rules contain clauses against posting drug-related photos. For example, one rule explicitly states: "*Photos of drugs are prohibited, these kinds of posts belong in /r/drugsarebeautiful. They are often used by those trying to sell drugs through Reddit and do not produce any meaningful discussion. They are only used to brag or in an attempt to get private messages from those trying to purchase drugs through Reddit.*" (Rule1).

This policy underscores the concern that shared drug-related images can be misused by sellers for illicit transactions or deceptive practices. More broadly, the exploitation of any content provided by PWUD, including personal information, for malicious purposes such as targeted scams, harassment, or identity theft, remains a significant issue. Photos or posts revealing identifiable details are particularly vulnerable to such exploitation.

5.4. Recording Drug Use

Numerous applications available today offer PWUD the functionality to track their drug consumption. According to our interviewees, the use of these tracking applications plays a crucial role in managing drug intake. They assist in planning drug use and provide timely reminders to avoid risky behaviors before and after drug consumption, which

not only helps in moderating use but also contributes to the enhancement of PWUD's physical health.

5.4.1. Receiving Warnings of Unsafe Use. At the pre-use stage, PWUD can input their planned drug use into tracking applications, which analyze the entries to pinpoint potential safety hazards, such as overdose risks and the adverse effects of polydrug use. These apps increase PWUD's awareness of the safety profiles of the drugs they plan to use by providing critical information during the planning stage. Feedback from our interviewees about the functionality of these apps was overwhelmingly positive. For example, P4 noted that the app facilitated quicker acquisition of pertinent drug-related knowledge, enhancing his ability to make informed decisions regarding drug use. *"Not much of a plan when it comes to these sorts of things, but with the preset function (from the app), and the fact that I can easily just slide it over to say what dosages, and then what strength it is, and what the percentage of purity is, even though I would obviously just be guessing most of the time of those things."* (P4).

5.4.2. Enhancing Usage Management. Beyond alerting users to risky dosages, tracking applications provide PWUD with the means to log each drug use event meticulously. This capability helps them to achieve a comprehensive understanding of their behavior patterns. By analyzing their logged history, PWUD can discern trends, such as escalations in frequency or dosage, enabling them to make informed adjustments to their usage accordingly. P12 acknowledged the importance of this feature, noting that the tracking applications have assisted in managing his drug use. *"So I want to space out stuff, and for that, I need to keep track of what I'm doing. So I usually do it three times a week. The main motivation is to see When was the last time I used it, or how many times it was then to plan a break that is longer."* (P12).

5.5. Making Drug Deals

Utilizing online platforms for drug transactions has become a prevalent method among PWUD. Online purchases of drugs expand the variety available to users, offer broader access to substances, eliminate the necessity for offline interactions with suppliers, and enhance privacy protection. Nonetheless, engaging in drug transactions on online platforms also poses a risk of deception regarding the purchases made by PWUD.

5.5.1. Enhancing Accessibility of Drugs. Online drug marketplaces have significantly altered the drug procurement landscape, enhancing drug accessibility for PWUD. Online platforms enable PWUD to access familiar drugs and explore new substances that may not be readily available offline. P1 observed that certain drugs, unavailable from local dealers, could be purchased online, noting the broadened spectrum of psychoactive substances accessible via the internet as particularly intriguing. *"You know, maybe a local drug dealer doesn't have but still nonetheless are*

psychoactive and you can order them through the Internet, so I thought that was interesting." (P1). Despite the unexpected consequences posed by exposure to a wider variety of drugs, some interviewees believed that online shopping offers a way to assess the quality of drugs purchased online. Unlike the unpredictability associated with street purchases, online buyers can consult reviews from previous customers, encouraging sellers to maintain high-quality standards to ensure customer satisfaction. P19 emphasized the benefits of online shopping for verifying drug quality: *"Based on my experiences, the quality of what you can buy online is easier to verify because people can leave reviews and that helps make me buy be more certain about what I'm getting. So I think that's a positive index."* (P19).

5.5.2. Enhancing Privacy of Drug Deals. Online platforms offer a level of safety and privacy difficult to achieve through physical transactions. In offline transactions, since PWUD need to get physical goods anyway, direct contact with the supplier is unavoidable, exposing them to real-life risks such as identity exposure. In the online situation, on the other hand, PWUD can interact with suppliers, browse selections, and complete purchases while maintaining anonymity. P12 appreciated the ease and reduced tension of online transactions, along with the convenience of home delivery: *"You don't feel the 'tension' of meeting a dealer, and it comes right to your home!"* (P12).

6. New Risks Perceived by PWUD (RQ2)

In this section, we examine the novel perceived risks on the safety of PWUD arising from the utilization of IT. While various IT applications have positively impacted safe practices among PWUD, we have identified several new perceived risks brought about by the widespread use of IT. These risks are categorized into four main themes: the redundancy of information, overdependence on automated safety testing, increased possibilities of engaging in risky behaviors, and financial loss in online drug purchases.

6.1. Redundancy of Information

With the growth of drug-related online communities, an increasing volume of information has become accessible to PWUD. While this influx of data can be beneficial, it also carries the risk of misinterpretation due to the sheer amount of available information. On one hand, much of this information may contain factual inaccuracies that require users to carefully discern. On the other hand, given the inherent complexities of drug use, a significant portion of this extensive information may not be applicable to the specific circumstances of individual PWUD, potentially leading to safety issues caused by the misuse of information.

Many users lack the expertise needed to discern the accuracy of the vast amount of drug-related information available. The core issue stems from the absence of authoritative institutions or organizations capable of verifying all drug-related information, which is closely linked to the safety

of PWUD. P7 mentioned that across various platforms, including wikis, which are generally more trusted, there can still be incorrect or outdated information. *“I read a lot on forums (reddit, everave, bluelight) and online resources (psywiki, tripsit) and trust some information there according to the level of experience of the user, but take it always with a grain of salt. Even on highly reputed sites like psywiki some information is outdated (e.g. referring to hcl bound drugs, while there are only fumarate or succinate salts of a specific chemical out there).”* (P7).

Drug-related information often involves scenarios in which advice suitable for one individual may not necessarily be appropriate for another. This specificity means that adopting another person’s guidance on dosage behavior can present significant risks if the advice does not match one’s personal health needs, potentially leading to harmful outcomes. Aware of these dangers associated with seeking help online, some interviewees, like P5, choose to prioritize their own judgment, given their greater familiarity with their health conditions. *“... especially that happened then, if I’m going to be doing this, I need to take this seriously. And you know, be aware and educated about what I’m doing.”* (P5).

6.2. Overdependence on IT

Specially designed applications for PWUD, such as tracking applications, offer benefits but may also unintentionally create a false sense of security. A significant concern is users assuming that behaviors not flagged by the app are safe, possibly interpreting the lack of warnings as an implicit confirmation of safety. This can cultivate a false sense of safety towards risks not specifically highlighted by these tools. Such over-reliance might overlook dangerous situations not addressed by the app. P1 exemplified this issue, mentioning that the absence of a safety warning led him to believe that a particular behavior was safe. *“When I don’t see a dangerous interaction with a substance that I want to take, might be encouraged to think that it is safe.”* (P1).

6.3. Increased Possibilities of Risky Behaviors

The utilization of IT also inadvertently encourages riskier drug use behaviors, including increased consumption and unsafe usage practices.

The pervasive nature of IT can lead to PWUD using drugs more frequently. Online platforms provide access to a vast trove of drug-related information, making PWUD aware of new or untried substances. This increased awareness, coupled with the perceived ease of assessing risks digitally, might prompt PWUD to experiment with various drugs they wouldn’t have considered previously. For instance, P15 shared his experience of being inspired to try LSD after watching a video of it online. *“Actually, I’m always a little bit afraid of LSD. ... So now a new video about drugs and LSD online... I’m interested to try it once.”* (P15).

Moreover, the online promotion and sharing of risky behaviors within drug-related communities present additional dangers. Exposure to content that glorifies unsafe practices, such as DIY drug manufacturing, guides on illegal activities and purposely exaggerated dosage recommendations can dangerously lower inhibitions against such behaviors. P19 recounted how reading about others’ cannabis use piqued his curiosity, leading to unfavorable outcomes: *“Sometimes reading other people’s experiences makes me curious about drugs I’ve never tried before. ... I’ve had a couple of bad experiences where when the effects of the drugs were different and I expected this or that, I took a dose that was accidentally bigger than what I then recommended.”* (P19).

6.4. Getting Deceived When Purchasing Online

While online drug markets provide convenience and a wide selection, the potential for financial loss, in addition to safety as we have previously defined it, is a new risk. The often unregulated nature of these platforms, in which there are low barriers to entry for suppliers, coupled with the lack of law enforcement agencies to protect the rights of consumers in the drug trade process, often results in scam activity. For example, P1 recounted stories of individuals who were duped by websites masquerading as legitimate marketplaces: *“I always hear stories from people who accidentally were on some proxies that looked like a market but they actually just steal your money.”* (P1).

Unlike other online purchases that can lead to scams, drug use and purchases are inherently illegal in some areas, and not only is there a lack of corresponding legal and policy support for scams in the purchase and sale of drugs, but PWUD themselves may not choose to defend their rights by turning to the law for help, as their purchases are also pursued, leading to even more unscrupulous scams related to drug purchases.

7. Discussion

Our study unveils the safety practices of users utilizing IT and the new perceived risks IT poses to user safety. In this chapter, we will focus on the needs of PWUD as a basis for exploring how these needs interact with IT and their own safety, alongside the current challenges faced. Furthermore, we will discuss the significant changes IT development brings to the social aspects of PWUD—specifically, the shift from offline to online community, discussing both the necessity and the issues this transformation introduces.

7.1. PWUD’s Needs and Challenges

Despite the increasing number of computer-supported tools developed specifically for PWUD, such as tracking apps, attention to PWUD’s needs remains limited. Consequently, users often feel that current IT solutions do not fully meet their requirements. Through our research, we have identified four types of unmet user needs, along with

TABLE 3. OVERVIEW OF PWUD NEEDS AND CHALLENGES. THE FIRST COLUMN OUTLINES THE SPECIFIC NEEDS OF PWUD, WHILE THE SECOND COLUMN PROVIDES EXPLANATIONS FOR THESE NEEDS. SUBSEQUENT COLUMNS CATEGORIZE THESE NEEDS.

User Needs	Explanation	Can Be Realized	Tech Inadequacy	Threat to User Safety
Personalized Drug Use Counselors	PWUD need personalized advice for specific drug use.	✓		
Supported Drug Testing	PWUD require technologies that enable direct or auxiliary drug testing.		✓	
Stringent Privacy Protection Measures	PWUD need measures that provide stricter privacy protections.		✓	✓
Broad Access to Drug Sources	PWUD seek solutions that provide access to a wide range of drug sources.			✓

an analysis of why these needs have not been satisfied (cf. Table 3). We discovered that some of these needs could potentially be fulfilled by current IT developments, or there are emerging technologies that could meet user demands, yet these solutions are not yet refined. Other needs pose significant challenges due to IT limitations and conflicts between user needs and safety, indicating that addressing these needs will be complex.

7.1.1. Technologically Achievable User Needs. The advancement of IT is progressively meeting some of the expectations that PWUD have from IT. As highlighted in Section 5.2, there is a significant demand among PWUD for personalized advice on drug use and management. This need can be addressed through the development of personalized drug use counseling services. However, while such technological solutions are within reach, implementing them still presents safety challenges that need careful consideration.

The risks associated with drug use are complex and varied and are often closely linked to an individual’s physiological and psychological profile. Generalized programs may not effectively address the unique risk factors of each user. Thus, personalized intervention strategies that consider individual circumstances are crucial for ensuring the safety of PWUD. In Section 5.2, we have shown how seeking advice in online communities can provide personalized insights from experienced PWUD. Yet, crafting a tailored intervention necessitates in-depth knowledge of an individual’s background, health status, usage patterns, and resource availability. This information may not always be effectively conveyed or addressed promptly through online platforms. While some PWUD can obtain specialized advice from healthcare providers, limitations in health resources can constrain access to such assistance.

Artificial intelligence chatbots, trained on specialized datasets, now offer the potential to address specific drug use inquiries ⁴, paving the way for AI-driven personalized drug use counselors. Integration with wearable devices collecting biometric data allows these AI systems to analyze an individual’s physiological state in real-time. This setup facilitates early detection of potential health risks by monitoring vital signs and offering actionable advice,

akin to AI-assisted trip sitters. The concept of a trip sitter denotes monitoring an individual’s physical condition during drug use and providing timely safety alerts or emergency interventions [54].

Despite the potential of these technological advancements, the reliability of AI-driven decision-making presents significant challenges [55], especially in terms of the safety of PWUD. As highlighted in Section 6.2, there’s a risk that PWUD might become overly dependent on AI, leading to irreversible consequences for their safety practices. Therefore, enhancing the reliability and interpretability of AI-assisted decisions [56], [57], as well as providing clear explanations and warnings about the potential for decision errors, are critical concerns that must be addressed in the usable security design of AI technology for PWUD.

7.1.2. Limitations of IT in Meeting User Needs. The inherent limitations of IT can prevent certain user needs from being fulfilled currently. The mismatch between the needs of PWUD and IT support manifests primarily in two areas: the discrepancy between PWUD’s demand for tangible substances and IT’s challenge in interfacing with physical goods; and the clash between PWUD’s desire for privacy and the constraints of existing encryption technologies. These unmet needs stem from specific attributes of PWUD, such as the requirement for authentic substance and the challenges posed by societal stigmatization.

The essence of drug use involves the physical consumption of substances. In Section 5.1, PWUD have expressed their need for detailed information on the composition of the drugs they are using, which is crucial for understanding the acute effects and implications for physical health. However, currently, such services are primarily available only through offline harm reduction organizations [58] and are challenging to replicate with IT technologies. While IT has made significant advances in bridging the digital and physical realms—for example, employing VR technologies to aid in drug abuse treatment [59]—the application of these technologies remains largely confined to mental health interventions. The physical and chemical properties essential for drug use assessment have not seen comparable progress in IT solutions.

The limitations of IT in addressing the needs of PWUD

4. <https://chatbot.drugsand.me/>

include challenges like utilizing mobile devices for drug testing or assistance in such processes. Most readily available mobile devices, such as smartphones and tablets, lack the integrated sensors needed for conducting complex chemical analyses. Additionally, the development and widespread adoption of specialized, drug-specific testing equipment are hindered by legal regulations and limited market demand. These technological constraints leave a gap in meeting the practical needs of PWUD, particularly concerning the direct analysis and verification of substance composition.

On the other hand, from a privacy perspective, the unique privacy needs of PWUD remain challenging to fully satisfy. As we highlighted in Section 4.5 regarding PWUD's privacy awareness, the stigma PWUD face [26] necessitates enhanced privacy protections for this group. Stigmatized communities, including LGBTQ+ individuals [60] and sex workers [61], often experience heightened privacy concerns. For PWUD, legal restrictions on drug use in many areas exacerbate this stigmatization.

When it comes to privacy measures, implementing robust encryption for all data related to PWUD introduces significant computational burdens. Such comprehensive encryption practices become impractical on an individual scale due to the extensive processing power and resources they demand. Moreover, from a policy and regulatory perspective, there often lacks sufficient motivation to protect the privacy of PWUD. This situation results in a significant gap in ensuring the safety and privacy of PWUD.

7.1.3. Conflict Between Needs and Safety. While safety is a practice factor highly valued by PWUD, we have identified that users' needs do not always align with increased safety. This realization compels us not to always seek to fulfill these needs outright but to adopt a more dialectical approach in considering how the design and development of IT can enhance the safety of PWUD. We find that several user needs conflict with user safety in two primary ways: the unsafe nature of the users' own behaviors and the new safety issues that arise from fulfilling these user needs.

As highlighted in Section 5.5, PWUD exhibit a strong demand for broader access to drugs. However, this demand stems not only from considerations of safety but also from the desire of PWUD to experiment with and psychologically stimulate themselves using new substances. Trying new drugs introduces a set of risks, particularly with unknown or newly developed drugs [62]. These novel substances often lack thorough research regarding their mechanisms, side effects, and potential health risks, introducing a higher level of uncertainty and potential danger for PWUD. Apart from instances where PWUD seek specific drugs solely for medical reasons, in most scenarios, increased access to a broader array of drugs is likely to escalate the risks faced by users. Hence, in addressing such needs, it's crucial to extend beyond merely broadening drug access. A more holistic support system for PWUD is necessary, encompassing drug dependence treatment, mental health services, and risk education to mitigate these risks effectively.

The demand for anonymity by PWUD is primarily driven by privacy concerns. However, heightened anonymity also carries a range of potential risks. In settings where anonymity is common, regulation and accountability become challenging. As illustrated in Section 5.3, anonymity allows malicious actors to sell counterfeit or substandard quality drugs, and to manufacture and distribute toxic substances, actions that are often challenging to halt promptly. Within online communities, anonymity can lead to detached aggression [63], inflicting psychological harm on other community members. Therefore, increased anonymity can introduce new safety challenges for PWUD, making it essential to find a balance between anonymity and the complexities of regulation for the wellbeing of PWUD.

7.2. PWUD's Shift from Offline to Online

In the age of ubiquitous IT, a significant transition for PWUD has been the shift from offline communities to online ones. This section will first examine the necessity of online communities for PWUD. Subsequently, we will explore the challenges this transition poses, from the perspectives of online community management and the impact of online communities on offline practices.

The dynamics of PWUD behavior in cyberspace present distinct challenges in comparison to offline settings. By analyzing the new safety challenges posed by IT to PWUD, as presented in Section 6, we first specify the peculiarities of cyberspace interactions. Next, we analyze the challenges posed by these peculiarities from the perspective of social differences in online communication.

7.2.1. Demand for Online Community. Drug use inherently involves offline, physical behavior that cannot be fully replicated through virtual interactions. Nevertheless, the inherent risks associated with drug use, alongside its acute effects and societal stigmatization, have fostered a significant demand for online communities among PWUD.

As discussed in Section 5.2, many PWUD are in search of advice related to drug use, expressing a desire to be well-prepared with guidance from experienced peers serving as an essential resource. On another note, the euphoric acute reactions induced by some drugs can amplify PWUD's inclination towards sharing and communication, a phenomenon that often emerges among users during their drug use experiences [64].

However, as highlighted in Section 5.3, the stigma associated with drug use frequently discourages PWUD from openly discussing their drug use behaviors, thereby complicating their ability to find peers for counseling, sharing, and communication in real life. This leads to the previously mentioned needs not being fulfilled offline. In contrast, the anonymity offered by online communities enables PWUD to express their identities and experiences more freely than in face-to-face interactions [65]. Furthermore, the expansive user base found online, as opposed to the limited availability in the physical world, strengthens the sense of group identity

among PWUD. This sense of belonging has been shown to facilitate collective healing within stigmatized groups [66].

7.2.2. Challenges in Online Community Management.

While there is a strong demand for online communities among PWUD, managing drug-related online communities often presents more challenges than those not involving risky behaviors. This complexity arises mainly from the contradiction between the need for management efforts and the difficulty of achieving these efforts effectively.

As we shown in Section 5.2 and 5.3, the information disseminated within drug-related online communities significantly impacts PWUD. Content that is prevalent in these communities, such as drug sources and risky behaviors shared by members, can directly influence PWUD's decision-making, potentially leading to unsafe behaviors. Therefore, community managers are tasked with better handling the accessibility of information and screening for potentially risky content. Member interactions pose additional challenges due to the acute effects of drug use, such as emotional agitation and hallucinations [67], and long-term mental health effects like depression and anxiety [68]. Coupled with social rejection and stigmatization [69], users in these communities may exhibit unpredictable behaviors and heightened sensitivity [70], presenting significant challenges for community management.

Effective community management requires considerable effort in both the formulation and enforcement of rules within drug-related communities. However, community administrators often manage these platforms on a voluntary basis, making it unreasonable to expect them to respond accurately at all times without compensation. While official automated tools may assist in moderating offensive behavior, their accuracy and efficiency in identifying problematic speech in active communities can be lacking. The automated management bots⁵ provided by platforms like Reddit rely primarily on simple keyword detection rules, which may not be sufficiently accurate for complex content, leading to erroneous deletions or overlooked offensive posts.

The main difficulty in managing drug-related communities lies in the high demand for quality management against the backdrop of limited manpower available for such oversight. Meanwhile, current technological practices have not effectively addressed this issue. Looking forward, the development of natural language processing technology and the use of large language models to assess content against predetermined principles may offer a promising solution [71]. However, this approach could introduce further privacy risks, necessitating future research to explore and resolve these issues.

7.2.3. Conflict Between Online and Offline. One distinctive feature of online communities compared to their offline counterparts is the significantly diverse demographics of users, especially in terms of racial, cultural backgrounds [72]. Online communities for PWUD often attract

members from various countries, regions, races, cultures, and with different levels of education and drug use experience [27]. This convergence can lead to conflicts not typically found in offline communities and may even influence some PWUD's specific offline behaviors.

Each country has vast differences in laws, policies, and public discourse regarding drugs [73]. For instance, while some drugs are gradually being legalized in certain countries [74], others enforce a complete prohibition [75], imposing strict restrictions even on medicinal use. This leads to significant disparities in drug perception among PWUD in different nations. In offline settings, the PWUD community in the same region tends to share similar understandings, but online, due to geographical and cultural differences, they are often exposed to inconsistent information. Exposure to other users' perceptions may cause cognitive shifts in PWUD, challenging their views on the laws and policies of their own societies and potentially leading to conflicts between individual behaviors and local laws and social norms. If PWUD are influenced by different cultural contexts on the Internet, they might adopt behavioral patterns at odds with their local social expectations.

This indicates that while online communities fulfill the social needs of PWUD, they also introduce potential risks to offline activities. Local drug policies might conflict with the information PWUD encounter online, leading to social issues. Therefore, in addressing these social conflicts and associated risks, future research could focus on resolving these conflicts and mitigating risks. From a preventive and educational standpoint, targeted public health campaigns could develop users' critical thinking skills, enabling them to evaluate online information for safety. Legally, exploring ways to establish cross-regional cooperation and information-sharing mechanisms could aid in tracking and controlling the flow of illicit drugs across borders, providing appropriate support and protection for PWUD.

8. Conclusion

Our research shows that while IT provides benefits to PWUD by enhancing access to information, community support, and tools for managing drug use, it also introduces new safety risks such as the spread of misinformation, over-reliance on technology, and increased exposure to risky behaviors. These findings disclosed the same technologies that offer potential harm reduction can also exacerbate existing risks. However, merely catering to user demands—such as increased anonymity or broader access to drugs—can paradoxically undermine user safety by facilitating harmful behaviors or diminishing accountability within online communities. Future research should prioritize developing IT solutions that not only meet user demands but also incorporate robust safeguards to protect PWUD, ensuring that the benefits of these technologies do not come at the expense of user safety.

5. <https://www.reddit.com/wiki/automoderator/>

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Appendix A. Theme Development

In the process of deriving themes, we first identified five primary IT usage behaviors among PWUD, analyzed their safety impacts, abstracted new safety challenges as broader phenomena, and then used these insights to answer our research questions.

We began by examining how PWUD utilize IT. Through a systematic analysis, we identified five primary behaviors that PWUD engage in while using IT: 1) searching for drug-related information, 2) asking questions about drug use, 3) making drug deals, 4) sharing experiences and engaging in discussions, and 5) recording drug use. These behaviors formed the foundational framework for our study.

Following this, we analyzed the impact of these behaviors on participants' safety whenever they mentioned engaging in these activities. Each behavior was further explored to understand its specific safety implications, resulting in sub-themes that addressed various dimensions such as physical safety, mental health, and privacy. For instance, when participants described using IT to search for drug information, we focused on how this behavior influenced their acute reactions and long-term health. Similarly, when discussing the sharing of experiences, we considered how this might affect their social image and the potential risks of privacy breaches.

During this analysis, we discovered that certain new safety challenges could not be easily linked to a single behavior but rather emerged as complex phenomena. Therefore, we abstracted these new challenges and analyzed them as separate themes. These challenges included information redundancy, over-reliance on automated safety testing, increased engagement in risky behaviors, and the potential for financial loss in online drug purchases. We recognized that these challenges were not confined to specific behaviors but were pervasive across multiple aspects of IT usage.

Appendix B. Online Discussion Data Collection Method

In the process of collecting Reddit data, we recognized that active PWUD communities are not limited to subreddits explicitly named "drugs". They often extend to specific drug-related subreddits (e.g., r/psilocybin) or use coding language that is likely to be familiar only to those well-versed in drug culture (e.g., r/trees). As a result, a simple search of "drug"-related subreddits is insufficient to gather comprehensive data. To address this problem, this study uses the well-known drug-related community r/Drugs as its primary entry point. By investigating the "Related Subreddits"

section within r/Drugs and subsequently filtering out less-relevant communities (e.g., subreddits primarily dedicated to music or literature), a total of 74 related drug subreddits were identified. From this pool, the study strategically selected the 30 subreddits with the highest membership as the final sources for data collection, where one subreddit is excluded because it doesn't allow the collection of content in the community.

We used the URS repository ⁶ for the collection of post content in Reddit. Due to the limitations of the Reddit community, it was not feasible to get more than 1,000 topics either through the official API or by scraping the web page. We maximized data collection for each of the 29 subreddits based on two ranking criteria: hot and new. We collected the content and timing of each post, the identity of the posting user, and the content and timing of comments. In addition, we collected community rules in text form from 27 different drug-related subreddits, as two of them had no rules.

Ultimately, this process yielded a total of 27,539 posts and 27 sets of community rules from these subreddits, comprising our Reddit dataset.

Appendix C. Classification of Drug-Related Inquiries and Discussions

After an initial survey of the content of the discussions in the online community, we categorized the content of these discussions into three main categories, i.e., 'Asking for Help', 'Sharing Experience', and 'General Discussion'. Each main category was further divided into a total of nine sub-categories. Table 4 describes these categories and indicates the stages at which these behaviors occur, along with examples. We have selected representative posts that have been assigned to a category, summarized, and rewritten as examples for that category. The last column of the table indicates the percentage of the total number of posts for each category, and since each post may have more than one category, these percentages sum to more than one.

Appendix D. Online Discussion Data Generalization Method

Starting with data collected from Reddit, we constructed specific prompts for the locally deployed ChatGLM2-6B model with the goal of blurring sensitive details such as addresses, phone numbers, and names in order to protect the privacy of posters during subsequent use of the GPT-3.5 service, where inputs to GPT-3.5 will be uploaded to the servers of their owners. To validate this generalization process, we took a random sample of 100 processed data points, scrutinizing each to ensure that the generated summaries were aligned with the original post's sentiment and were void of any sensitive information.

6. <https://github.com/JosephLai241/URS>

TABLE 4. CLASSIFICATION OF DRUG-RELATED INQUIRIES AND DISCUSSIONS

Main Class	Sub-Class	Example	Percentage	Precision	Error Bound
Asking For Help	Concerns about the justification of drug use (Pre-use)	"Is it safe for me to use it in this manner? Should I adjust the dosage?"	34.75%	94.44%	$\pm 2.29\%$
	Worrying about the social impact of drug use on individuals (Pre-use)	"Could this be harmful or distressing to others?"	2.25%	100.00%	$\pm 0.00\%$
	Concerned about their current physical condition (During use)	"(Describe one's terrible physical condition), is this normal? Should I stop?"	34.43%	96.30%	$\pm 1.89\%$
	Concealing one's drug use (Post-use)	"Will there be a noticeable odor after consumption? How long will it linger?"	8.36%	100.00%	$\pm 0.00\%$
	Trying to get rid of drug addiction (Post-use)	"I no longer wish to consume the drug, but struggle due to its addictive nature."	13.95%	100.00%	$\pm 0.00\%$
Sharing Experience	Advising others to do or not to do something based on one's own experience	"I suggest you all try this awesome drug."	2.4%	100.00%	$\pm 0.00\%$
	Sharing experience, getting emotional support or comfort on personal experiences (Post-use)	"I feel great doing this, has anyone else done this?"	29.4%	90.91%	$\pm 2.87\%$
General Discussion	Discussing drug-related policies, current circumstances, Etc. (Anytime)	"I want to express my stance on certain policies."	11.38%	100.00%	$\pm 0.00\%$
	Discussing the minutiae of life-related to drugs (Anytime)	"Can anyone explain the pharmacological action of this drug?"	16.31%	96.67%	$\pm 1.79\%$

The final prompt we used for this generalization task is specified as follows(a fabricated post is used here as a demonstration):

"The following consists of the title and content of a post on a social media platform, for which you are asked to generate a summary, using vague expressions such as "someone" and "somewhere" if a specific date, real name, country or region appears. Please describe the main points expressed in the post in a single paragraph, and reply only this summary.

The text I need you to summarize is:

I messed up. Took my first E pill last night and I don't feel right. I'm in San Diego, Ocean Beach area. The pill was supposed to be 100mg but might've been more cause I'm shaky and can't calm down. Got it from someone at a beach party, don't know if it was pure.

I'm not sure if I'm panicking or if this is serious. I've read too many stories about bad stuff happening with MDMA and now I'm freaking out alone in my apartment on Newport Ave.

Does anyone know if there's a way to handle this without going to the ER? Is this just what rolling feels like? I don't want to get in trouble with the cops or have a medical record of this.

Need advice fast!

Remember, no specific date, real name, country or region."

The output of the model is: "Someone shared their experience of taking their first E pill and feeling uneasy, experiencing shakiness and difficulty calming down. They obtained the pill from a beach party but are uncertain about its purity. Concerned about potential health risks and legal

consequences, they're seeking advice on managing their symptoms without resorting to emergency services."

This prompt enabled the model to produce concise text summaries, blurring identifiable details while retaining the essence of the original content. Based on this prompt, we summarized all posts in the dataset. When posts were so long that they exceeded the maximum length of the model's limitations, such as when there was a long popular science post that prevented the model from summarizing it, we paused the process and summarized it manually.

Appendix E.

Online Discussion Data Classification Method

Based on the categories summarized in Table 4 for the online discussion, we first formed an initial prompt used to explain the classification task and all the categories. In order to make the prompt more complete and the model categorization more accurate, we manually classified a distinct subset of 100 Reddit entries into nine predefined categories. This labeled dataset served as our benchmark. Using an initial categorization prompt, each entry was individually put into the GPT-3.5 model. In instances where misclassification occurred, the prompt was meticulously adjusted to improve categorization precision. We revisited the previous five data after every adjustment to ensure that the revised prompt didn't negatively impact their categorization accuracy. After getting the final prompt, we randomly sampled 100 Reddit posts and manually categorized them to test the classification accuracy of the GPT-3.5 model. 85% of the posts were completely categorized correctly, and the last two columns

in Table 4 provide the classification accuracy and its error bound for each individual category.

The final prompt we used for this classification task is specified as follows (using the summary of the fabricated post in the previous section as input):

Please categorize the text you enter afterward (the description of the post in the forum), the available types are listed below:

A. ****Concerns About the Justification of Drug Use:**** For instance, "Is it safe for me to use it in this manner? Should I adjust the dosage?" "I'm not certain about the drug I'm taking. What drugs are advised for a specific condition?"

B. ****Social Implications of Drug Use:**** Questions such as, "Will this tarnish my reputation?" "Could this be harmful or distressing to others?"

C. ****Worries About Current Physical Condition:**** For example, "I've been experiencing [specific symptoms], is this normal?" "Should I stop taking this?"

D. ****Concealing Drug Consumption:**** For instance, "Will there be a noticeable odor after consumption? How long will it linger?" "How can I ensure I pass a drug test?" "How do I deal with my parents or others who don't approve?"

E. ****Seeking to Break Free from Drug Addiction:**** For example, "I no longer wish to consume the drug for certain reasons, but struggle due to its addictive nature." It is important to make sure that they have made it clear that they want to stop using the drug, then it can be categorized in this category.

F. ****Offering Direct Advice from Personal Experiences:**** For example, "I suggest you all try this drug." This does not include posts asking for advice or simply sharing experiences without the intent to guide others' actions.

G. ****Sharing experiences, seeking emotional support or comfort, gaining acceptance and express their feelings:**** For example, "I'm feeling overwhelmed with the challenges I'm facing." or simply sharing one's experience with a particular drug, and ask are there anyone else have the same experience like them.

H. ****Discussing Drug-Related Policies and Current Events:**** "I want to express my stance on certain policies and seek like-minded support."

I. ****Discussing Everyday Details Related to Drugs:**** "Can anyone explain the pharmacological action of this drug?" "Check out the new equipment I got for consumption," or "This is the medication I'm currently on."

For each input, you can select more than one of these categories. You only need to answer the serial number of the category, no explanations. If the category is not included above or it is not related to drugs, please answer "other".

Remember that posts can only be categorized if their content clearly matches the category description, implied or potentially cannot be categorized.

The text I need you to categorize is:

Someone shared their experience of taking their first E pill and feeling uneasy, experiencing shakiness and difficulty calming down. They obtained the pill from a beach party but are uncertain about its purity. Concerned about potential

health risks and legal consequences, they're seeking advice on managing their symptoms without resorting to emergency services."

The output of the model is: "A, C, G".

This prompt enabled the model to categorize summarized post content into the prescribed 9 categories accurately and to maintain its diversity when it may fall into more than one category. Based on the prompt, we categorized all posts in the dataset. When the content could not be recognized or there was an unexpected situation with the model output, we paused the process and classified it manually.