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# User Reviews as a Reporting Mechanism for Emergent Issues Within Social VR Communities

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## ABSTRACT

Social virtual reality (VR) will potentially change online communities, transforming how people meet, interact, and socialise online. However, issues surrounding the growing threat of harassment (from verbal to cyber-physical assault) posed within social VR platforms are increasingly being noted within research. Yet, while prior research has successfully captured singular qualitative insights (e.g. identifying individual types of harassment or target user groups) it is essential that systems be developed to monitor emergent threats to community cohesion, including harassment, in a platform independent manner. In this paper, we explore whether user reviews are a valid and useful source of data around harassment incidences in social VR, a crucial first step towards platform agnostic, large scale and longitudinal monitoring of emerging harassment in social VR communities through user reviews posted about social VR applications.. We analysed 1000 user reviews posted on the Meta Quest store page for the social VR platform *Rec Room* and found 114 reviews report experiencing and/or witnessing harassment during use. Our results establish the validity of analysing user reviews as a means of monitoring harassment in social VR communities and we close by discussing their use in large scale, longitudinal monitoring systems.

## CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**.

## KEYWORDS

Virtual Reality, Social Virtual Reality, Virtual Environments, User Reviews, Harassment

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## 1 INTRODUCTION & BACKGROUND

Social Virtual Reality (VR) has the potential to fundamentally transform how people meet, interact, and socialise online [14, 20, 60]. From enabling meaningful, embodied social interactions [19, 28, 37] to new forms of social augmentation that exceed what is possible

in face-to-face contexts [52], to allowing far apart individuals to occupy and explore varied and engaging online worlds together [26, 41]. Yet, while these examples highlight the societal benefits of social VR, issues surrounding harassment and user safety within social VR have already emerged [3, 4, 8] with it being suggested that “VR worlds are no better or worse than anywhere else online” [27]. While expected given the long history of users harassing others in online communities (e.g. as witnessed historically in massively multiplayer online games [17, 18]), social VR presents new challenges as users fully embody and immerse themselves within their social VR identity/character. Such embodiment can be used to increase degrees of psychological realism of events in social VR - beneficial for enhancing social interactions [26, 43], but also potentially amplifying experienced harms such as harassment [21]. Furthermore, the potential types of harassment that can be enabled in social VR both mimic existing platforms (e.g. mobbing, verbal/textual abuse [1]) but also go beyond prior web and even gaming harassment (e.g. avatar rapes [25], abusive augmentations [5, 21, 46], etc).

It is essential then research investigate how harassment occurs and evolves with social VR communities. While VR headsets are increasingly becoming equipped with techniques to protect users from nearby persons in their surrounding reality and during collocated VR use (e.g. [36, 44, 47–50]) it is essential also that systems are developed to protect users within VR from other persons. To this end, much research has been conducted using surveys of social VR users [8, 35], in-situ observations [30, 33, 59, 60], interviews with social VR users [3, 12, 18, 21, 22, 29, 32, 34], or a combination of these methods [31, 33, 38–40]. Such works have reported many instances of harassment within social VR [31, 35], with Backwell et al. reporting experienced harassment can be categorised as either: verbal harassment (e.g. insults or slurs), physical harassment (e.g. unwanted touching), or spatial harassment (e.g. displaying unwanted content on a shared screen) [4]. Freeman et al. have identified that marginalised groups within social VR contexts (e.g. women, LGBTQ, and ethnic minorities) are subject to group-based targeting [22], a result also found by Blackwell et al. who reported identity cues may be used by users as a targeted form of harassment (e.g. users making sexist remarks to a female avatar) [3]. And many works have investigated specific user groups to explore issues surrounding their harassment within social VR, e.g. Maloney et al. highlighting the complexity of adult-child interactions within social VR and the risks posed to children [29, 30] and Schulenberg et al. investigating how women experience and manage harassment risks within social VR [55].

Yet while prior works present a clear case for the need to protect users from the identified risks and harms, at present, there is no standardised reporting mechanisms nor public auditing for such harassment encounters across social VR platforms. As such,

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there is no way of knowing the prevalence of such behaviours on a particular social VR platform as we are limited only to what information platforms choose to release to understand the prevalence, and types, of harm occurring therein. Therefore, while prior work has demonstrated harmful behaviours occur within social VR platforms, as they likely will in any online community with a degree of anonymity [17, 58], there remains a pertinent need for novel, platform-agnostic approaches to understanding and monitoring emergent harassment and harms in social VR.

One possible method of achieving this is to analyse the content of user reviews and comments posted about social VR platforms on storefronts and forums. User reviews and comments are often used online as a form of protest/complaint [23] with the perception that publishing issues will lead towards more pressure to act [11, 56]. Prior works have shown that such reviews and comments can be analysed to gain insights on a variety of topics from identifying usability issues within an application [2], to identifying what people like in an application [24], to understanding the ethical implications of application usage [7], to reviewing the accessibility of a system [13], etc. Such works either manually capture and thematically analyse users' reviews/comments at a smaller scale (e.g. [7]) or use natural language processing methods at a larger scale (e.g. [2]).

Such user postings (reviews/comments) are a promising potential data source due to the large existing quantities of them (e.g. *Rec Room* [54] a popular social VR platform having 27,000+ user reviews on its Meta Quest store page alone and approximately 52,000 members on its dedicated subreddit). Such data is also one of the few independent, publicly available insights into the activities that occur on these platform. Furthermore, such data, by its nature, records user insights at specific moments in time (e.g. *Rec Room*'s store page on the Meta Quest store hosts user reviews posted from today dating to its release on the store). This can enable longitudinal analysis to explore the emergence of trending user behaviours and changing prevalence over time, to provide a means of monitoring problems on these platforms in real-time and historically. This approach can also enable the investigation of any differences in discourse before/after a new feature is introduced to a platform. For example, a social VR platform may examine user discourse for a 3 week period after the introduction of a new player moderation system to investigate how discourse surrounding user harassment has changed from existing patterns/comments over the last 12 months. Finally, this approach provides such analyses in a platform agnostic manner, enabling an ease of comparison between different social VR platforms for researchers and practitioners.

A crucial first step towards conducting such analyses on a large scale is to establish the validity and utility of user reviews as a means of monitoring harassment in social VR communities. While user reviews are often used as a form of complaint by users [23], it is unknown to what depth issues such as harassment within a social VR community are recorded and reported within them. Therefore, we conducted a study to investigate user reviews as a reporting mechanism for emergent issues (e.g. user harassment) within social VR communities. We analysed 1000 user reviews posted on the Meta Quest store page for the social VR platform *Rec Room* and found that 114 reviews referred to user harassment experienced and/or witnessed on the platform. Our results confirm that users record known forms of harassment in social VRs (e.g. [3, 22]) within

their reviews, albeit to varying degrees of detail describing the experienced and/or witnessed harassment. Our findings highlight the potential for large scale analyses to be conducted on user reviews of social VR platforms. We close by discussing the viability of building large-scale monitoring systems of social VR communities through the automated analysis of user reviews and discuss how such systems might be used alongside “on the ground” methods (e.g. surveys, interviews, and observations) to monitor and investigate social VR communities and further protect users of these communities.

## 2 METHODOLOGY

A web scraper was developed to capture the 1000 most recently posted user reviews for the social VR application *Rec Room* [54] on the Meta Quest application store [42]. The decision was made to capture most recently posted reviews, over the alternative option of “most relevant” as determined by the review platform, in order to capture a complete set of reviews posted within a fixed time interval, opposed to a selection of all reviews posted by users sorted by some unknown relevancy algorithm. This approach helped increase the real-world applicability of our results (by capturing a fixed time interval of user reviews), and replication of our work. We opted to collect 1000 reviews as this provided a sizeable set of user reviews but one that was manageable for a researcher to read and thematically analyse. *Rec Room* was selected for our study as it is widely downloaded social VR platform (with more than 75 million downloads [51]) that is often used by researchers investigating player experience in social VRs (e.g. [4, 55]). For each collected user review, the review's heading, body text and user rating (e.g. 1 star out of 5) was extracted. To test the web scraper's functionality, it was first run to collect 50 reviews and a researcher then manually inspected these to ensure that all of the data was collected correctly for each review. The web scraper was then run (and study data of 1000 user reviews collected) at 11am on March 1st, 2023.

A researcher then read through all 1000 of the collected reviews and flagged any whose content negatively referred to *Rec Room*'s community, player base or featured a negative scenario the user had experienced and/or witnessed within *Rec Room* with other players (e.g. observing verbal harassment from one player to another). For example, a user review which was flagged for further analysis was “4/5 - my opinion - Good game, too addictive, too many degenerates saying racist slurs, and everything is overpriced.”, whereas a user review which we did not further investigate was “5/5 - best game - This is the king here.”. This filtering process left 114 user reviews to be analysed, with each review assigned a unique ID (e.g. *UR1* for user review 1, *UR2* for user review 2, and so on).

We then analysed these 114 user reviews to investigate how users referred to *Rec Room*'s community and player base, and their experience(s) interacting with them, as recorded in their user reviews. The user reviews were coded using initial coding [10] where review comments were assigned emergent codes over repeated cycles with the codes grouped using a thematic approach. Multiple coding was allowed meaning statements could be encoded as multiple categories, e.g. “The gameplay is great but the community is toxic. Its so bad I deleted the application.” was coded as THEME: “Good game but bad community” for “The gameplay is great but

*the community is toxic*” and THEME: “Due to other players quit playing” for *“I deleted the application.”*

A single coder performed the coding and reviewed the coding with another researcher to resolve unclear codes and discuss the depth and specificity of codes. Two coding cycles were completed. Finally, upon completing the thematic analysis, the themes were then cross referenced with results from the literature to identify which, if any, were found to occur through alternative methodologies (e.g. surveys, observation, interviews).

### 3 RESULTS

#### 3.1 A Good Game Let Down by a Bad Community and Player Base

Table 1 summarises themes regarding general attitudes towards *Rec Room*'s community which emerged from the user reviews. 46 reviews said while they thought *Rec Room* was a good, well designed game that their experience with it was severely impacted by a bad community and their experience with the online player base, e.g. UR35: *“It’s a really fun game but the thing is toxic players ruin it. I can’t go 10 seconds without hearing something toxic.”* and UR10: *“The game and content is fun, but it brings out the worst of everyone. The toxic community ruins it for me.”* Furthermore, 13 of these reviews explicitly stated that because of this *“toxic community”* that they felt *Rec Room* was inappropriate for use by children, UR85: *“Terrible community don’t let your children play it!”*

However, it is worth noting 7 reviews defended *Rec Room*'s community. 5 reviews were empathetic towards users who had experienced harassment whilst playing but argued the community overall was good and that some bad users were to be expected when playing online games, UR103: *“No matter what game it is, there will always be toxic people”*. Meanwhile, 2 were less empathetic towards users who had experienced harassment and said such users should either ignore it or stop playing the game, UR62: *“I think y’all should just deal with it instead of crying 24/7 or play a different game because clearly y’all don’t understand ANYTHING about the internet”*.

Noteworthy also were 13 reviews from users indicating due to their experienced harassment whilst using *Rec Room* that they had uninstalled the application, UR92: *“I had to delete it because of the other users”*. This provides direct evidence of one potential consequence of inadequately supporting the needs of users within social VR, i.e. they will stop using it if they feel uncomfortable continuing to do so. In their way, such reviews serve as a user’s final broadcasting of their frustration with the application, perceiving any player moderation and management systems to have failed to protect them and forcing them to halt their use of the application completely. Such reviews also highlight a user which other methodologies (e.g. observation within social VR) will miss.

#### 3.2 How Harassment Was Reported to Occur

Table 2 summarises the emergent themes surrounding experienced and/or witnessed forms of user harassment from the user reviews. The most prevalent theme was users stating they had experienced and/or witness some form of user harassment whilst using *Rec Room*. 67 reviews stating it occurred generally while 36 reviews stated that the harassment involved a child (being disrespectful to other users of all ages, bullying other children, etc). Surprisingly,

only verbal harassment was reported as occurring within the user reviews, despite prior work indicating that physical and spatial harassment are also often experienced by users [3].

Regarding how verbal harassment said to occur, 47 reviews reported inappropriate language (e.g. verbal abuse from other users through swearing and racist language generally), UR50: *“I jump on and it was horrible language. What a terrible place.”* and UR77: *“most people are always swearing and cussing saying the N-word”*. Of these, 22 explicitly mentioned the user had witnessed and/or experienced racial harassment within *Rec Room*, UR25: *“It’s full of racist people”* and UR39: *“I’ve heard the N word in literally every server”*. 13 reviews reported sexual harassment, UR4: *“ALL I can hear is teenage kids swearing and making sexual, racist, and all around disgusting comments”* and UR21: *“people moaning and being freaky on the mic”*. 5 reported transphobic language, UR17: *“there is a lot of people who are very toxic to the lbgtq+ community”*, 2 homophobic language, UR79: *“I’ve ran into people who yell racial slurs and homophobic slurs too many times”*, and 1 violent language, UR37: *“A child was pretending to kill a baby through audio”*.

19 reviews said they considered this witnessed and/or experienced harassment to be bullying and there was a pertinent need for it to be addressed given its prevalence within *Rec Room*, UR101: *“I have been bullied so many times and it needs to stop”*. Interestingly, 7 reviews contained users who admitted to harassing/bullying other users and stated they took enjoyment from such behaviors, UR60: *“if you love trolling them (which I love doing) this is the best game for you”*. This is of particular interest as observation methods are unlikely to be able to capture such insights as the *“trolling user”* is likely to respond as such to any attempted enquiries from a researcher questioning them about their behaviour.

#### 3.3 Concerning Adult-Child Interactions Including Potential Grooming

Concerning was 18 reviews which reported experiencing and/or witnessing distressing interactions between adults and children - ranging from inappropriate language, UR84: *“My 7year old son was playing this game Rec room when I heard a grown man telling my son to shut the F... up”*, to adults discussing inappropriate topics with children, UR19: *“I went into an event where a grown man was talking to a ten year old about abortion, mind you this, is not very appropriate at all for a kids game”*. Significant was that 9 of these reviews reported experienced and/or witnessed attempted grooming of children by adults, UR32: *“Had 2 pedophiles trying to groom my son”* and UR67: *“Too many creeps try and talk and chat with young’s girls and these are men that are 30/40 yrs of age”*. These results reaffirm work by Maloney et al. [29–31] who highlighted significant risks posed to children within social VR. While the potential exists for children and adults to harass the other (e.g. the 36 reviews reporting children disrespecting/harassing other users) the risks posed to children (e.g. grooming and sexual exploitation) are significantly greater than those of adults [30, 35], highlighting an essential need to determine mitigation strategies and best practices for ensuring the safe use of social VR by children [29].

Theme	Exemplary Keywords / Phrases	No. of Reviews
<i>Good game but bad community</i>	“The game is good, but the community...” “Fun game but an extremely toxic community”	46
<i>Not a suitable community for children</i>	“Rec Room is NOT kid friendly”	13
<i>Quit due to other users</i>	“delete / deleted / deleting it”	13
<i>Some bad users are expected</i>	“There are some toxic players but you have to expect that”	5
<i>Ignore it or just stop playing</i>	“This isn't a community problem, its yours”	2

Table 1: An overview of the emergent themes reporting general attitudes towards *Rec Room*'s community. Most prominent was reviews stating the user enjoyed the game's design but highlighted other users as disrupting/ruining their use of *Rec Room*.

Theme	Exemplary Keywords / Phrases	No. of Reviews	Also Reported By
<i>Experienced and/or witnessed harassment</i>	“too many people who are just toxic to other players...” “some of the people that use it are sick!”	67	[3, 55]
<i>Inappropriate language</i>	“horrible / toxic / disturbing / hateful language...” “swearing and making sexual, racist comments”	47	[3]
<i>Experienced and/or witnessed harassment (involving a child)</i>	“an obvious abundance of annoying, disrespectful little kids...” “populated with kids who bully / take advantage of younger kids...”	36	[31]
<i>Racist language</i>	“racism / racist / racial language...” “I've heard the N word in literally every server...”	22	[31]
<i>Experienced and/or witnessed bullying</i>	“If you want to be bullied...” “This game is absolutely disgusting for online bullying...”	19	[15]
<i>Concerning adult-child interactions</i>	“My daughter has been harassed by grown men...” “Too many creeps try and talk and chat with young girls...”	18	[29, 30]
<i>Sexual harassment</i>	“people moaning and being freaky on the mic” “inappropriate sexual comments”	13	[35, 55]
<i>Adults grooming children</i>	“full of child sex abusers...” “pedophiles trying to groom my son”	9	[29, 30]
<i>Admittance of bullying</i>	“if you love trolling them (which I love doing)...” “I like voice-trolling in the game”	7	
<i>Transphobic language</i>	“for having a female avatar and a male voice...” “very toxic to the lgbtq+ community”	5	[55]
<i>Homophobic language</i>	“homophobic slurs...” “very toxic to the lgbtq+ community”	2	[31]
<i>Violent language</i>	“Disgusting, violent language”	1	[3, 55]

Table 2: An overview of the emergent themes highlighting the occurrence of harassment within *Rec Room*, how it occurred (most often verbally through inappropriate language), and concerning interactions such as those of children with adults. Note: *Also Reported By* is not a complete list rather is examples of other works who also obtained this insight through alternative methods (e.g. observation).

### 3.4 Using User Reviews to Argue for New Moderation and Player Reporting Systems

Reviews also included suggestions directed at *Rec Room*'s developers which users believed would improve player experience online. 27 reviews stated they felt *Rec Room*'s player reporting system did not adequately protect users as it was not “strict enough” and failed to provide UR20: “an easy way to record and report instances of harassment”. Instead, such users felt it was necessary to turn to user reviews to broadcast and record their experienced and/or witnessed harassment as they did not believe alternative systems (e.g. the player reporting system within *Rec Room*) would sufficiently address

their complaints. Consequentially, users felt *Rec Room*'s player reporting system, along with its moderation system as a whole, should be improved to (a) more effectively ban users who harass others to improve the general experience online, (b) provide a more comprehensive player reporting system which would allow users to easily record instances of abuse to submit as evidence of a need for moderator actions, and (c) have more transparency and information regarding the outcome of any reported player complaints.

### 3.5 Separation of Users by Age Group to Protect Children Using Social VR

5 reviews, in response to their outlined concern regarding adults intermixing and interacting inappropriately with children in social VR, argued for users to be separated by age group, UR93: “*There should be separate servers from people who are younger, my daughter has been harassed by grown men and that is unacceptable*”. Such interactions are enabled by the shared common space approach to *Rec Room*'s design allowing all users to freely intermix together [52]. And while alternative social VR designs exist (e.g. closed invitation only servers/lobbies [52]) to control user access and interactions, such protections can be easily circumvented by users (e.g. faking a date of birth, being courted by malicious adults via invitation, etc) [6, 31].

Child protections are however necessary within social VR [30] and as argued by Maloney et al. may be achieved through age group based separation, as is typical within educational systems, and tailoring social VRs to the particular development needs of each age group [29]. Essential also is creating awareness among parents and guardians highlighting the risks posed to their children using social VR platforms where adult-child interactions are not controlled by age group [29, 30]. For example, *Rec Room*, a social VR platform marketed to all age groups, could provide users (and parents/guardians), upon first installation, a notification warning users/parents/guardians of the potential risks involved with using an application that intermixes all ages as part of the application's shared, common space design [52].

### 3.6 Users' Review Ratings Were Not an Effective Filter For Our Data

Although we captured the user ratings alongside the review text we found the user ratings often did not fully encapsulate the nuance of the review text. For example, a user review rated 4 stars out of 5 might in its text praise the application's design but discuss frustration with its community, UR 11: “*It's a really fun game but the thing is toxic players ruin it. I can't go 10 seconds without hearing something toxic. (4/5 stars)*”. Similarly, a user review rated 5 stars might contain review text from someone indicating they enjoyed bullying and harassing other users online, UR60: “*if you love trolling them (which I love doing) thus is the best game for you*” (5/5 stars). Such variability is further highlighted in the user review ratings: 1/5 stars (42 reviews), 2/5 stars (6 reviews), 3/5 stars (11 reviews), 4/5 stars (24 reviews), 5/5 stars (31 reviews). Despite the review texts being predominantly negative the mean user rating (out of a possible 5.00) was 2.96 (SD = 1.69) with 48.25% of reviews rating *Rec Room* either 4 or 5 stars. As such, we report users' review ratings were not an effective means of filtering our review data. For example, had we filtered our 1000 reviews initially by 1 or 2 star ratings then we would only have 48 reviews to be thematically analysed.

## 4 DISCUSSION & FUTURE WORK

### 4.1 The Viability of Monitoring Social VR Communities Through User Reviews

Our findings show that user reviews are used as a form of user complaint, record of experienced and/or witnessed user harassment(s), and a reporting mechanism for emergent issues within social VR communities. Over 10% of the 1000 user reviews analysed in our study were found to contain discussion of this. If extrapolated out, for example, by the total number of reviews on the Meta Quest store at the time of writing (27,000 user reviews), this suggests a data set of approximately 2,700 reviews is available to researchers through this data source alone (with a further approximately 5,500 reviews being available through *Rec Room*'s Steam store page [57] assuming a similar frequency of reviews containing emergent issues). This highlights the potential quantity of such data available to researchers - over 8000 reviews from these two store pages alone - with additional data being available through other store pages and user comments left on relevant forums.

Our findings also provide insights into the types of harassment documented in user reviews and the depth to which they are described within them. This is, user reviews contain awareness and acknowledgement of experienced harassment (and types of it) at a high level but provide less specificity describing incidents of harassment types in detail (e.g. compared to that by an interview study designed to capture such data in detail). Therefore, while the themes identified within the user reviews match those of similar results found in related works using alternative methods (e.g. surveys, interviews, observation, etc, Table 2), user reviews may not necessarily provide practitioners with the specificity required to investigate particular types of harassment in depth (e.g. to explore how sexual harassment is experienced and might be mitigated against). Instead, our results suggest user reviews may be better suited to use longitudinally to direct research efforts and observe harassment patterns at scale and over time. For example, the monitoring of user reviews may observe growing dissatisfaction and toxicity in user reviews/comments directed at a particular type of harassment, motivating the use of ethnographic methods (e.g. survey/interview/observation methods) to then assess in detail what is happening “on the ground”.

Future work may also look to develop alternative public reporting mechanisms to systematically capture more detailed accounts of emergent issues within social VR platforms to exert more pressure on social VR platforms to change. One approach may be to redesign storefronts to better support more structured reviews, e.g. through incident reporting techniques [53] and separating considerations about the game design (e.g. its gameplay) and its community (e.g. broadcasting experienced harassment) to further help monitor, assess, and act upon emergent threats through large-scale monitoring systems by enabling the easier extraction of what the issues are that are affecting users. Longer term, an approach could look towards improving cross-platform reporting, generally, to reduce the reliance on piggybacking off review platforms or training users to utilise reviews as how you complain about transient issues in a social VR community/platform. Instead, the creation of such a platform independent metaverse/social VR user protection group would provide a centralised place for monitoring user experience and harassment

within social VR communities in a platform agnostic manner. User reports to such a system could also be designed to work with natural language processing methods to optimise processing to extract insights into the emergent threats within the community. Such an approach would take significant efforts to establish, however, would provide an independent, automated, large-scale means of monitoring user harassment in social VR platforms.

## 4.2 Towards Automated Large-Scale Monitoring of User Reviews

To analyse such data at scale, future work should look to automate the process of analysing sentiment in reviews/comments, extracting emergent themes and patterns, and providing large scale, longitudinal analyses of social VR platforms and communities. Such analyses should make use of text based analysis methods such as sentiment analysis [45], keyword extraction [16], and natural language processing techniques [9] given the practicalities of managing the potential scale of collected data sets. And it is essential that such investigations be conducted, as while prior works have successfully captured singular qualitative insights, e.g. to identifying individual types of harassment or target user groups [3, 18], absent are methods of monitoring emergent threats to community cohesion, including harassment, in a platform independent manner. While methods such as surveys and interviews can be designed in a platform-agnostic manner [31], such methods may require participant recruitment and running the study on each independent platform - a potentially high cost endeavour. In contrast, the approach we outline of a large-scale, platform independent, user review/comment analyses reduces the burden of participant recruitment as respondents naturally review/comment as they use the application being studied. Furthermore, such solutions as this are needed given the lack of standardised reporting mechanisms for users who have experienced and/or witness harassment and the reliance on information selectively shared by the platform owners when assessing the prevalence, and types, of harassment faced by users of a particular social VR.

## 4.3 Limitations of Our Study

Surprisingly, we found harassment was only reported to occur verbally in our user reviews, despite Blackwell et al. suggesting it may occur physically or spatially within *Rec Room* [3, 4]. Such a difference in result may, however, be attributed to platform changes since Blackwell et al's research was conducted, e.g. *Rec Room*'s current design enabling verbal harassment through voice chat features but not spatial and/or physical harassment through its current player moderation systems. Future work could therefore use alternative methodologies such as observation to assess if non-verbal forms of harassment continue to occur within *Rec Room* yet were not reflected in our user reviews. Future work could also look to perform a longitudinal analysis of user reviews to assess historically if physical and/or spatial harassment once was included within review text and when, if ever, its frequency within reviews decreased and why.

It should also be acknowledged that in our study we limited our analysis to user reviews of a single social VR platform (*Rec Room*) posted on a single source (*Rec Room*'s store page on the

Meta Quest store). Future work should therefore go beyond this single data source (e.g. examining user reviews hosted on other storefronts, user comments posted on forums, etc) where differences in emergent issues may be identified. User comments may, for example, record harassment in more detail and specificity than we observed in our analysed reviews. Future work should also consider additional social VR platforms to investigate if platform-specific issues emerge which are initially contained to a single platform before becoming widespread across others. Identifying such "cutting edge" signals of new forms of harm, before they are widely adopted, may also help protect users through the backporting of mitigation/moderation solutions to other platforms *before* such harms have become widespread across them.

## 5 CONCLUSION

Social VR platforms have the potential to revolutionise how people meet, interact, and social online by enabling meaningful embodied interactions in varied and engaging online worlds. Yet, while prior research has successfully captured singular qualitative insights of emergent issues and harassment in social VR platforms, it is essential that systems be developed to monitor emergent threats to community cohesion in a platform independent manner. We explore whether user reviews of social VR platforms are a valid and useful source of data around harassment incidences in social VR, a crucial first step towards the platform agnostic, large scale and longitudinal monitoring of emerging harassment in social VR communities. We analysed 1000 user reviews posted on *Rec Room*'s Meta Quest store page and found 114 reviews report experiencing and/or witnessing harassment during use. Our results establish the validity of analysing user reviews as a means of monitoring harassment and we close by discussing their use in large scale, longitudinal monitoring systems for social VR communities.

## REFERENCES

- [1] Leigh Achterbosch, Charlynn Miller, and Peter Vamplew. 2017. A taxonomy of griever type by motivation in massively multiplayer online role-playing games. *Behaviour & Information Technology* 36, 8 (2017), 846–860.
- [2] Elsa Bakiu and Emitza Guzman. 2017. Which Feature is Unusable? Detecting Usability and User Experience Issues from User Reviews. In *2017 IEEE 25th International Requirements Engineering Conference Workshops (REW)*. 182–187. <https://doi.org/10.1109/REW.2017.76>
- [3] Lindsay Blackwell, Nicole Ellison, Natasha Elliott-Deflo, and Raz Schwartz. 2019. Harassment in social virtual reality: Challenges for platform governance. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (2019), 1–25.
- [4] Lindsay Blackwell, Nicole Ellison, Natasha Elliott-Deflo, and Raz Schwartz. 2019. Harassment in social VR: Implications for design. In *2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)*. IEEE, 854–855.
- [5] Jolie Bonner, Florian Mathis, Joseph O'Hagan, and Mark McGill. 2023. When Filters Escape the Smartphone: Exploring Acceptance and Concerns Regarding Augmented Expression of Social Identity for Everyday AR. In *Proceedings of the 29th ACM Symposium on Virtual Reality Software and Technology* (Christchurch, New Zealand) (*VRST '23*). Association for Computing Machinery, New York, NY, USA, Article 14, 14 pages. <https://doi.org/10.1145/3611659.3615707>
- [6] Jolie Bonner, Joseph O'Hagan, Florian Mathis, Jamie Ferguson, and Mohamed Khamis. 2022. Using Personal Data to Support Authentication: User Attitudes and Suitability. In *Proceedings of the 20th International Conference on Mobile and Ubiquitous Multimedia* (Leuven, Belgium) (*MUM '21*). Association for Computing Machinery, New York, NY, USA, 35–42. <https://doi.org/10.1145/3490632.3490644>
- [7] Dionne Bowie-Dabreo, Corina Sas, Heather Iles-Smith, and Sandra Sünram-Lea. 2022. User Perspectives and Ethical Experiences of Apps for Depression: A Qualitative Analysis of User Reviews. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (New Orleans, LA, USA) (*CHI '22*). Association for Computing Machinery, New York, NY, USA, Article 21, 24 pages. <https://doi.org/10.1145/3491102.3517498>

- [8] Marcus Carter and Ben Eglston. 2020. Ethical implications of emerging mixed reality technologies. (2020).
- [9] KR1442 Chowdhary and KR Chowdhary. 2020. Natural language processing. *Fundamentals of artificial intelligence* (2020), 603–649.
- [10] Strauss A. L. Corbin J. M. 1998. *Basics of qualitative research: techniques and procedures for developing grounded theory*. SAGE Publications, Inc.
- [11] Georgiana Craciun and Kelly Moore. 2019. Credibility of negative online product reviews: Reviewer gender, reputation and emotion effects. *Computers in Human Behavior* 97 (2019), 104–115.
- [12] Elmira Deldari, Diana Freed, Julio Poveda, and Yaxing Yao. 2023. An Investigation of Teenager Experiences in Social Virtual Reality from Teenagers', Parents', and Bystanders' Perspectives. In *Nineteenth Symposium on Usable Privacy and Security (SOUPS 2023)*. 1–17.
- [13] Marcelo Medeiros Eler, Leandro Orlandin, and Alberto Dumont Alves Oliveira. 2019. Do Android App Users Care about Accessibility? An Analysis of User Reviews on the Google Play Store. In *Proceedings of the 18th Brazilian Symposium on Human Factors in Computing Systems (Vitória, Espírito Santo, Brazil) (IHC '19)*. Association for Computing Machinery, New York, NY, USA, Article 23, 11 pages. <https://doi.org/10.1145/3357155.3358477>
- [14] David Englmeier, Joseph O'Hagan, Mengyi Zhang, Florian Alt, Andreas Butz, Tobias Höllerer, and Julie Williamson. 2020. TangibleSphere – Interaction Techniques for Physical and Virtual Spherical Displays. In *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society (Tallinn, Estonia) (NordiCHI '20)*. Association for Computing Machinery, New York, NY, USA, Article 75, 11 pages. <https://doi.org/10.1145/3419249.3420101>
- [15] Cristina Fiani, Robin Bretin, Mark McGill, and Mohamed Khamis. 2023. Big Buddy: Exploring Child Reactions and Parental Perceptions towards a Simulated Embodied Moderating System for Social Virtual Reality. In *Proceedings of the 22nd Annual ACM Interaction Design and Children Conference*. 1–13.
- [16] Nazanin Firoozeh, Adeline Nazarenko, Fabrice Alizon, and Béatrice Daille. 2020. Keyword extraction: Issues and methods. *Natural Language Engineering* 26, 3 (2020), 259–291.
- [17] Chek Yang Foo and Elina MI Koivisto. 2004. Defining grief play in MMORPGs: player and developer perceptions. In *Proceedings of the 2004 ACM SIGCHI International Conference on Advances in computer entertainment technology*. 245–250.
- [18] Jesse Fox and Wai Yen Tang. 2017. Women's experiences with general and sexual harassment in online video games: Rumination, organizational responsiveness, withdrawal, and coping strategies. *New media & society* 19, 8 (2017), 1290–1307.
- [19] Guo Freeman and Dane Acena. 2021. Hugging from a distance: Building interpersonal relationships in social virtual reality. In *ACM international conference on interactive media experiences*. 84–95.
- [20] Guo Freeman, Dane Acena, Nathan J McNeese, and Kelsea Schulenberg. 2022. Working together apart through embodiment: Engaging in everyday collaborative activities in social Virtual Reality. *Proceedings of the ACM on Human-Computer Interaction* 6, GROUP (2022), 1–25.
- [21] Guo Freeman and Divine Maloney. 2021. Body, avatar, and me: The presentation and perception of self in social virtual reality. *Proceedings of the ACM on human-computer interaction* 4, CSCW3 (2021), 1–27.
- [22] Guo Freeman, Samaneh Zamanifard, Divine Maloney, and Dane Acena. 2022. Disturbing the peace: Experiencing and mitigating emerging harassment in social virtual reality. *Proceedings of the ACM on Human-Computer Interaction* 6, CSCW1 (2022), 1–30.
- [23] Emitza Guzman, Muhammad El-Haliby, and Bernd Bruegge. 2015. Ensemble Methods for App Review Classification: An Approach for Software Evolution (N). In *2015 30th IEEE/ACM International Conference on Automated Software Engineering (ASE)*. 771–776. <https://doi.org/10.1109/ASE.2015.88>
- [24] Johannes Huebner, Remo Manuel Frey, Christian Ammendola, Elgar Fleisch, and Alexander Ilic. 2018. What People Like in Mobile Finance Apps: An Analysis of User Reviews. In *Proceedings of the 17th International Conference on Mobile and Ubiquitous Multimedia (Cairo, Egypt) (MUM '18)*. Association for Computing Machinery, New York, NY, USA, 293–304. <https://doi.org/10.1145/3282894.3282895>
- [25] Insider. 2022. A researcher's avatar was sexually assaulted on a metaverse platform owned by Meta, making her the latest victim of sexual abuse on Meta's platforms, watchdog says. <https://www.businessinsider.com/researcher-claims-her-avatar-was-raped-on-metas-metaverse-platform-2022-5?r=US&IR=T>. Accessed: 2023-08-28.
- [26] Jie Li, Vinoba Vinayagamoorthy, Julie Williamson, David A. Shamma, and Pablo Cesar. 2021. Social VR: A New Medium for Remote Communication and Collaboration. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems (Yokohama, Japan) (CHI EA '21)*. Association for Computing Machinery, New York, NY, USA, Article 81, 6 pages. <https://doi.org/10.1145/3411763.3441346>
- [27] Keza MacDonald. 2022. VR worlds are no better or worse than anywhere else online. <https://www.theguardian.com/technology/2022/jan/10/vr-worlds-are-no-better-or-worse-than-anywhere-else-online>. Accessed: 2023-08-28.
- [28] Divine Maloney and Guo Freeman. 2020. Falling Asleep Together: What Makes Activities in Social Virtual Reality Meaningful to Users. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play (Virtual Event, Canada) (CHI PLAY '20)*. Association for Computing Machinery, New York, NY, USA, 510–521. <https://doi.org/10.1145/3410404.3414266>
- [29] Divine Maloney, Guo Freeman, and Andrew Robb. 2020. It is complicated: Interacting with children in social virtual reality. In *2020 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*. IEEE, 343–347.
- [30] Divine Maloney, Guo Freeman, and Andrew Robb. 2020. A Virtual Space for All: Exploring Children's Experience in Social Virtual Reality. *CHI PLAY 2020- Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, 472–483.
- [31] Divine Maloney, Guo Freeman, and Andrew Robb. 2021. Social virtual reality: ethical considerations and future directions for an emerging research space. In *2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*. IEEE, 271–277.
- [32] Divine Maloney, Guo Freeman, and Andrew Robb. 2021. Stay connected in an immersive world: Why teenagers engage in social virtual reality. In *Interaction Design and Children*. 69–79.
- [33] Divine Maloney, Guo Freeman, and Donghee Yvette Wohn. 2020. " Talking without a voice" Understanding Non-verbal Communication in Social Virtual Reality. *Proceedings of the ACM on Human-Computer Interaction* 4, CSCW2 (2020), 1–25.
- [34] Divine Maloney, Samaneh Zamanifard, and Guo Freeman. 2020. Anonymity vs. familiarity: Self-disclosure and privacy in social virtual reality. In *Proceedings of the 26th ACM Symposium on Virtual Reality Software and Technology*. 1–9.
- [35] Mangina and Eleni. 2021. White Paper-The IEEE Global Initiative on Ethics of Extended Reality (XR) Report–Social and Multi-User Spaces in VR: Trolling, Harassment, and Online Safety. *The IEEE Global Initiative on Ethics of Extended Reality (XR) Report–Social and Multi-User Spaces in VR: Trolling, Harassment, and Online Safety* (2021), 1–17.
- [36] Shady Mansour, Pascal Knierim, Joseph O'Hagan, Florian Alt, and Florian Mathis. 2023. BANS: Evaluation of Bystander Awareness Notification Systems for Productivity in VR. In *Network and Distributed Systems Security (NDSS) Symposium 2023*. <https://doi.org/10.14722/usec.2023.234566>
- [37] Florian Mathis, Jolie Bonner, Joseph O'Hagan, and Mark McGill. 2023. Breaking Boundaries: Harnessing Mixed Reality to Enhance Social Engagement. (2023).
- [38] Florian Mathis, Joseph O'Hagan, Kami Vaniea, and Mohamed Khamis. 2022. Stay Home! Conducting Remote Usability Evaluations of Novel Real-World Authentication Systems Using Virtual Reality. In *Proceedings of the 2022 International Conference on Advanced Visual Interfaces (Frascati, Rome, Italy) (AVI 2022)*. Association for Computing Machinery, New York, NY, USA, Article 14, 9 pages. <https://doi.org/10.1145/3531073.3531087>
- [39] Florian Mathis, Joseph O'Hagan, Mohamed Khamis, and Kami Vaniea. 2022. Virtual Reality Observations: Using Virtual Reality to Augment Lab-Based Shoulder Surfing Research. In *2022 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)*. 291–300. <https://doi.org/10.1109/VR51125.2022.00048>
- [40] Florian Mathis, Xuesong Zhang, Joseph O'Hagan, Daniel Medeiros, Pejman Saeghe, Mark McGill, Stephen Brewster, and Mohamed Khamis. 2021. Remote xr studies: The golden future of hci research.
- [41] Joshua McVeigh-Schultz and Katherine Isbister. 2021. The case for "weird social" in VR/XR: a vision of social superpowers beyond meatspace. In *Extended abstracts of the 2021 CHI conference on human factors in computing systems*. 1–10.
- [42] Meta. 2019. Rec Room (Meta Quest Application Store Page). <https://www.oculus.com/experiences/quest/2173678582678296>. Accessed: 2023-08-28.
- [43] Joseph O'Hagan, Jan Gugenheimer, Jolie Bonner, Florian Mathis, and Mark McGill. 2023. Augmenting People, Places & Media: The Societal Harms Posed by Everyday Augmented Reality, and the Case for Perceptual Human Rights. In *Proceedings of the 22nd International Conference on Mobile and Ubiquitous Multimedia (Vienna, Austria) (MUM '23)*. Association for Computing Machinery, New York, NY, USA. <https://doi.org/10.1145/3626705.3627782>
- [44] Joseph O'Hagan, Mohamed Khamis, Mark McGill, and Julie R. Williamson. 2022. Exploring Attitudes Towards Increasing User Awareness of Reality From Within Virtual Reality. In *Proceedings of the 2022 ACM International Conference on Interactive Media Experiences (Aveiro, JB, Portugal) (IMX '22)*. Association for Computing Machinery, New York, NY, USA, 151–160. <https://doi.org/10.1145/3505284.3529971>
- [45] Joseph O'Hagan, Mohamed Khamis, and Julie R. Williamson. 2021. Surveying Consumer Understanding & Sentiment Of VR. In *Proceedings of the International Workshop on Immersive Mixed and Virtual Environment Systems (MMVE '21) (Istanbul, Turkey) (MMVE '21)*. Association for Computing Machinery, New York, NY, USA, 14–20. <https://doi.org/10.1145/3458307.3460965>
- [46] Joseph O'Hagan, Pejman Saeghe, Jan Gugenheimer, Daniel Medeiros, Karola Marky, Mohamed Khamis, and Mark McGill. 2023. Privacy-Enhancing Technology and Everyday Augmented Reality: Understanding Bystanders' Varying Needs for Awareness and Consent. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 6, 4, Article 177 (jan 2023), 35 pages. <https://doi.org/10.1145/3569501>
- [47] Joseph O'Hagan and Julie R. Williamson. 2020. Reality Aware VR Headsets. In *Proceedings of the 9th ACM International Symposium on Pervasive Displays (Manchester, United Kingdom) (PerDis '20)*. Association for Computing Machinery, New York, NY, USA, 9–17. <https://doi.org/10.1145/3393712.3395334>



- [48] Joseph O'Hagan, Julie R. Williamson, and Mohamed Khamis. 2020. Bystander Interruption of VR Users. In *Proceedings of the 9TH ACM International Symposium on Pervasive Displays* (Manchester, United Kingdom) (*PerDis '20*). Association for Computing Machinery, New York, NY, USA, 19–27. <https://doi.org/10.1145/3393712.3395339>
- [49] Joseph O'Hagan, Julie R. Williamson, Mohamed Khamis, and Mark McGill. 2022. Exploring Manipulating In-VR Audio To Facilitate Verbal Interactions Between VR Users And Bystanders. In *Proceedings of the 2022 International Conference on Advanced Visual Interfaces* (Frascati, Rome, Italy) (*AVI 2022*). Association for Computing Machinery, New York, NY, USA, Article 35, 9 pages. <https://doi.org/10.1145/3531073.3531079>
- [50] Joseph O'Hagan, Julie R. Williamson, Florian Mathis, Mohamed Khamis, and Mark McGill. 2023. Re-Evaluating VR User Awareness Needs During Bystander Interactions. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (Hamburg, Germany) (*CHI '23*). Association for Computing Machinery, New York, NY, USA, Article 876, 17 pages. <https://doi.org/10.1145/3544548.3581018>
- [51] Gaming on Phone. 2022. Rec Room crosses 75 million downloads after 6 years of consistent growth. <https://gamingonphone.com/news/rec-room-crosses-75-million-downloads-after-6-years-of-consistent-growth/>. Accessed: 2023-08-28.
- [52] Anya Osborne, Sabrina Fielder, Joshua Mcveigh-Schultz, Timothy Lang, Max Kreminski, George Butler, Jialang Victor Li, Diana R. Sanchez, and Katherine Isbister. 2023. Being Social in VR Meetings: A Landscape Analysis of Current Tools. In *Proceedings of the 2023 ACM Designing Interactive Systems Conference* (Pittsburgh, PA, USA) (*DIS '23*). Association for Computing Machinery, New York, NY, USA, 1789–1809. <https://doi.org/10.1145/3563657.3595959>
- [53] Joseph O'Hagan, Julie R Williamson, Mark McGill, and Mohamed Khamis. 2021. Safety, power imbalances, ethics and proxy sex: Surveying in-the-wild interactions between vr users and bystanders. In *2021 IEEE International Symposium on Mixed and Augmented Reality (ISMAR)*. IEEE, 211–220.
- [54] Rec Room Inc. 2016. Rec Room.
- [55] Kelsea Schulenberg, Guo Freeman, Lingyuan Li, and Catherine Barwulor. 2023. "Creepy Towards My Avatar Body, Creepy Towards My Body": How Women Experience and Manage Harassment Risks in Social Virtual Reality. (2023).
- [56] Shahana Sen and Dawn Lerman. 2007. Why are you telling me this? An examination into negative consumer reviews on the web. *Journal of interactive marketing* 21, 4 (2007), 76–94.
- [57] Valve. 2016. Rec Room (Steam Store Page). [https://store.steampowered.com/app/471710/Rec\\_Room/](https://store.steampowered.com/app/471710/Rec_Room/). Accessed: 2023-08-28.
- [58] Emily A Vogels. 2021. The state of online harassment. *Pew Research Center* 13 (2021), 625.
- [59] Julie Williamson, Jie Li, Vinoba Vinayagamoorthy, David A Shamma, and Pablo Cesar. 2021. Proxemics and social interactions in an instrumented virtual reality workshop. In *Proceedings of the 2021 CHI conference on human factors in computing systems*. 1–13.
- [60] Julie R. Williamson, Joseph O'Hagan, John Alexis Guerra-Gomez, John H Williamson, Pablo Cesar, and David A. Shamma. 2022. Digital Proxemics: Designing Social and Collaborative Interaction in Virtual Environments. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (New Orleans, LA, USA) (*CHI '22*). Association for Computing Machinery, New York, NY, USA, Article 423, 12 pages. <https://doi.org/10.1145/3491102.3517594>